(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 September 2018 (27.09.2018)

WIPO | PCT

(10) International Publication Number
WO 2018/175505 A1

(51) International Patent Classification:
C12N 5/0783 (2010.01) *C07K 16/00* (2006.01)
C12N 5/0784 (2010.01) *A61K 39/00* (2006.01)
G01N 33/53 (2006.01) *A61P 35/00* (2006.01)

(21) International Application Number:
PCT/US2018/023442

(22) International Filing Date:
20 March 2018 (20.03.2018)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

62/473,899	20 March 2017 (20.03.2017)	US
62/484,258	11 April 2017 (11.04.2017)	US
62/583,233	08 November 2017 (08.11.2017)	US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

WO 2018/175505 A1

(54) Title: TREATMENT METHODS

(57) Abstract: Methods and compositions for identifying tumor antigens of human lymphocytes, and for identifying subjects for cancer therapy, are provided herein.

TREATMENT METHODS

CROSS REFERENCE TO RELATED APPLICATIONS

[001] This application claims the benefit of U.S. Provisional Application No. 62/583,233, filed November 8, 2017, U.S. Provisional Application No. 62/484,258, filed April 11, 2017 and U.S. Provisional Application No. 62/473,899, filed March 20, 2017, the contents of each of which are hereby incorporated by reference herein in their entirety.

BACKGROUND

[002] Cancer is characterized by proliferation of abnormal cells. Many treatments include costly and painful surgeries and chemotherapies. Although there is a growing interest in cancer therapies that target cancerous cells using a patient's own immune system, such therapies have had limited success.

SUMMARY

[003] The present invention features, *inter alia*, methods of identifying tumor antigens and potential tumor antigens of human lymphocytes, methods of selecting tumor antigens and potential tumor antigens, as well as compositions including the tumor antigens and potential tumor antigens, methods of making such compositions, and methods of using the tumor antigens and potential tumor antigens. The invention also features methods of evaluating an immune response in a cancer subject, *e.g.*, for identifying and/or selecting a cancer subject for initiation, continuation, modification, and/or discontinuation of a cancer therapy

[004] Accordingly, in one aspect the disclosure features a method of obtaining or generating a subject response profile. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen; b) contacting the bacterial cells or beads of the library with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; and e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate a subject response profile.

[005] In some embodiments, the subject response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

[006] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[007] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[008] In another aspect, the disclosure features a method of obtaining or generating a target response profile. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen; b)

contacting the bacterial cells or beads of the library with antigen presenting cells (APCs) from a subject who exhibits or previously exhibited a response to cancer, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; and e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate a target response profile.

[009] In some embodiments, the subject exhibits or previously exhibited at least one beneficial response to cancer. In some embodiments, the beneficial response comprises a positive clinical response, e.g., one or more positive clinical endpoints, to a cancer therapy or combination of therapies. In some embodiments, the beneficial response comprises a spontaneous response to a cancer. In some embodiments, the beneficial response comprises clearance of a cancer, e.g., a level of one or more clinical measures associated with clearance of a cancer. In some embodiments, the beneficial response comprises a lack of a relapse, recurrence, and/or metastasis of a cancer, e.g., over a defined period of time (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 weeks, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 years). In some embodiments, the beneficial response comprises a positive cancer prognosis. In some embodiments, the beneficial response comprises a lack of measurable toxic responses or side effects to a cancer therapy or combination of therapies.

[0010] In some embodiments, the subject exhibits or previously exhibited at least one deleterious or non-beneficial response to cancer. In some embodiments, the deleterious response comprises a negative clinical response and/or a failure to respond, to a cancer therapy or combination of therapies. In some embodiments, the deleterious response comprises a lack of clearance of a cancer, e.g., a level of one or more clinical measures associated with lack of clearance of a cancer. In some embodiments, the deleterious response comprises at least one relapse, recurrence, and/or metastasis of a cancer. In some embodiments, the deleterious response comprises a negative cancer prognosis. In some embodiments, the deleterious response

comprises one or more toxic responses or side effects (e.g., one or more measurable toxic responses or side effects) to a cancer therapy or combination of therapies.

[0011] In some embodiments, the library used to obtain the target response profile is the same library used to obtain a subject response profile.

[0012] In some embodiments, the method further comprises the step of repeating steps a) through e) with antigen presenting cells (APCs) and/or lymphocytes from additional subjects, to obtain a population-based or composite target response profile.

[0013] In some embodiments, the target response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

[0014] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[0015] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[0016] In another aspect, the disclosure features a method of identifying a subject as a candidate for cancer therapy. In some embodiments,, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the

subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate a subject response profile; and f) comparing the subject response profile to a target response profile to select the subject as a candidate subject for initiation, continuation, modification, discontinuation or non-initiation of a cancer therapy. In some embodiments, the subject response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

[0017] In some embodiments, the method further comprises generating the target response profile by a method comprising: g) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a target subject, wherein the APCs internalize the bacterial cells or beads; h) contacting the APCs with lymphocytes from the target subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; i) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; andj) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate the target response profile. In some embodiments, the target response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

[0018] In some embodiments, the target response profile is from one or more target subjects who exhibit or previously exhibited at least one beneficial response to cancer. In some embodiments, the beneficial response comprises a positive clinical response to a cancer therapy or combination of therapies. In some embodiments, the beneficial response comprises a

spontaneous response to a cancer. In some embodiments, the beneficial response comprises clearance of a cancer, e.g., a level of one or more clinical measures associated with clearance of a cancer. In some embodiments, the beneficial response comprises a lack of a relapse, recurrence, and/or metastasis of a cancer, e.g., over a defined period of time (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 weeks, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 years). In some embodiments, the beneficial response comprises a positive cancer prognosis. In some embodiments, the beneficial response comprises a lack of one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses or side effects) to a cancer therapy or combination of therapies.

[0019] In some embodiments, the target response profile is from one or more target subjects who exhibit or previously exhibited one or more deleterious and/or non-beneficial response to cancer. In some embodiments, the deleterious and/or non-beneficial response comprises a negative clinical response and/or a failure to respond, to a cancer therapy or combination of therapies. In some embodiments, the deleterious and/or non-beneficial response comprises a lack of clearance of a cancer, e.g., a level of one or more clinical measures associated with lack of clearance of a cancer. In some embodiments, the deleterious and/or non-beneficial response comprises at least one relapse, recurrence, and/or metastasis of a cancer. In some embodiments, the deleterious and/or non-beneficial response comprises a negative cancer prognosis. In some embodiments, the deleterious and/or non-beneficial response comprises one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses and/or side effects) to a cancer therapy or combination of therapies.

[0020] In some embodiments, the method further comprises selecting the candidate subject for initiation of a cancer therapy or combination of cancer therapies. In some embodiments, the method further comprises selecting the candidate subject for continuation of a cancer therapy or combination of cancer therapies. In some embodiments, the method comprises selecting the subject as a candidate subject (i) if the subject response profile is similar to the target response profile from a target subject who exhibits or previously exhibited one or more beneficial responses to the cancer therapy or combination, and/or (ii) if the subject response profile is dissimilar to the target response profile from a target subject who exhibits or previously exhibited one or more deleterious responses to the cancer therapy or combination. In some

embodiments, the method further comprises administering the cancer therapy or combination of cancer therapies to the candidate subject.

[0021] In some embodiments, the method further comprises selecting the candidate subject for modification of a cancer therapy. In some embodiments, the method further comprises selecting the candidate subject for discontinuation or non-initiation of a cancer therapy. In some embodiments, the method further comprises selecting the subject as a candidate subject for modification, discontinuation, and/or non-initiation of a cancer therapy (i) if the subject response profile is similar to the target response profile from a target subject who exhibits or previously exhibited one or more deleterious responses to the cancer therapy, and/or (ii) if the subject response profile is dissimilar to the target response profile from a target subject who exhibits or previously exhibited one or more beneficial responses to the cancer therapy. In some embodiments, the method further comprises modifying the cancer therapy administered to the candidate subject. In some embodiments, the method further comprises discontinuing or not initiating the cancer therapy to the candidate subject.

[0022] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[0023] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[0024] In another aspect, the disclosure features a method of selecting tumor antigens. In some embodiments, the, method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads;c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level)e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate a subject response profile; f) comparing the subject response profile to a target response profile; and g) selecting one or more tumor antigens based on the comparison. In some embodiments, the subject response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

[0025] In some embodiments, the method further comprises generating the target response profile by a method comprising: h) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a target subject, wherein the APCs internalize the bacterial cells or beads; i) contacting the APCs with lymphocytes from the target subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; j) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; andk) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate the target response profile. In some embodiments, the target response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

[0026] In some embodiments, the target response profile is from one or more target subjects who exhibit or previously exhibited one or more beneficial response to cancer. In some embodiments, the beneficial response comprises a positive clinical response to a cancer therapy or combination of therapies. In some embodiments, the beneficial response comprises a spontaneous response to a cancer. In some embodiments, the beneficial response comprises clearance of a cancer, e.g., a level of one or more clinical measures associated with clearance of a cancer. In some embodiments, the beneficial response comprises a relapse, recurrence, and/or metastasis of a cancer e.g., over a defined period of time (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 weeks, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 years). In some embodiments, the beneficial response comprises a positive cancer prognosis. In some embodiments, the beneficial response comprises a lack of one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses and/or side effects) to a cancer therapy or combination of therapies.

[0027] In some embodiments, the target response profile is from one or more target subjects who exhibit or previously exhibited one or more deleterious or non-beneficial response to cancer. In some embodiments, the deleterious and/or non-beneficial response comprises a negative clinical response and/or a failure to respond, to a cancer therapy or combination of therapies. In some embodiments, the deleterious and/or non-beneficial response comprises a lack of clearance of a cancer, e.g., a level of one or more clinical measures associated with lack of clearance of a cancer. In some embodiments, the deleterious and/or non-beneficial response comprises at least one relapse, recurrence, and/or metastasis of a cancer. In some embodiments, the deleterious and/or non-beneficial response comprises a negative cancer prognosis. In some embodiments, the deleterious and/or non-beneficial response comprises one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses and/or side effects) to a cancer therapy or combination of therapies.

[0028] In some embodiments, the method further comprises selecting (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with a beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with deleterious or not beneficial responses to cancer. In some embodiments, the method further comprises administering to the subject an immunogenic composition comprising

one or more of the selected antigens or immunogenic fragments thereof. In some embodiments, the method further comprises administering to the subject a cancer therapy or combination of therapies.

[0029] In some embodiments, the method further comprises selecting (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with deleterious or not beneficial responses to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with beneficial responses to cancer. In some embodiments, the method further comprises administering to the subject an immunogenic composition that does not comprise one or more of the selected antigens or immunogenic fragments thereof. In some embodiments, the method further comprises administering to the subject a cancer therapy or combination of therapies.

[0030] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[0031] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[0032] In another aspect, the disclosure features a method of inducing an immune response in a subject. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein

each bacterial cell or bead of the library comprises a different tumor antigen; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased level or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate a subject response profile; f) comparing the subject response profile to a target response profile; g) selecting one or more tumor antigens based on the comparison; and h) administering to the subject an immunogenic composition comprising one or more of the selected antigens or immunogenic fragment thereof. In some embodiments, the subject response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

[0033] In some embodiments, the method further comprises generating the target response profile by a method comprising: i) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a target subject, wherein the APCs internalize the bacterial cells or beads; j) contacting the APCs with lymphocytes from the target subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; k) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; andl) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate the target response profile. In some embodiments, the target response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

[0034] In some embodiments, the target response profile is from one or more target subjects who exhibit or previously exhibited at least one beneficial response to cancer. In some embodiments, the beneficial response comprises a positive clinical response to a cancer therapy or combination of therapies. In some embodiments, the beneficial response comprises a spontaneous response to a cancer. In some embodiments, the beneficial response comprises clearance of a cancer, e.g., a level of one or more clinical measures associated with clearance of a cancer. In some embodiments, the beneficial response comprises a lack of a relapse, recurrence, and/or metastasis of a cancer, e.g., over a defined period of time (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 weeks, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 years). In some embodiments, the beneficial response comprises a positive cancer prognosis. In some embodiments, the beneficial response comprises a lack of one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses or side effects) to a cancer therapy or combination of therapies.

[0035] In some embodiments, the method further comprises selecting and administering to the subject (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with one or more beneficial responses to cancer, and/or (i) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with one or more deleterious or not beneficial responses to cancer.

[0036] In some embodiments, the method further comprises administering to the subject a cancer therapy or combination of therapies.

[0037] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[0038] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor

antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[0039] In another aspect, the disclosure features a method of inducing an immune response in a subject. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate a subject response profile; f) comparing the subject response profile to a target response profile; g) selecting one or more tumor antigens based on the comparison; and h) administering to the subject an immunogenic composition that does not comprise one or more of the selected antigens or immunogenic fragment thereof. In some embodiments, the subject response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

[0040] In some embodiments, the method further comprises generating the target response profile by a method comprising: i) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a target subject, wherein the APCs internalize the bacterial cells or beads; j) contacting the APCs with lymphocytes from the target subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; k) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor

antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; and l) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate the target response profile. In some embodiments, the target response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

[0041] In some embodiments, the target response profile is from one or more target subjects who exhibit or previously exhibited one or more deleterious and/or non-beneficial response to cancer. In some embodiments, the deleterious and/or non-beneficial response comprises a negative clinical response and/or a failure to respond, to a cancer therapy or combination of therapies. In some embodiments, the deleterious and/or non-beneficial response comprises a lack of clearance of a cancer, e.g., a level of one or more clinical measures associated with lack of clearance of a cancer. In some embodiments, the deleterious and/or non-beneficial response comprises at least one relapse, recurrence, and/or metastasis of a cancer. In some embodiments, the deleterious and/or non-beneficial response comprises a negative cancer prognosis. In some embodiments, the deleterious and/or non-beneficial response comprises one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses and/or side effects) to a cancer therapy or combination of therapies.

[0042] In some embodiments, the method further comprises selecting one or more tumor antigens that increase expression or secretion of immune mediators associated with deleterious or not beneficial responses to cancer, and/or one or more tumor antigens that inhibit and/or suppress expression or secretion of immune mediators associated with beneficial responses to cancer.

[0043] In some embodiments, the method further comprises administering to the subject a cancer therapy or combination of therapies.

[0044] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different

tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[0045] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[0046] In another aspect, the disclosure features a method of selecting tumor antigens. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; d) determining whether one or more lymphocytes are activated by one or more tumor antigens presented by one or more APCs by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain a subject response profile; and f) selecting from among the identified tumor antigens one or more antigens that increase a level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer, and/or selecting one or more tumor antigens that inhibit and/or suppress a level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer.

[0047] In some embodiments, the method further comprises comparing the subject response profile to a target response profile, e.g., a target response profile generated using a method described herein, and selecting one or more tumor antigens based on the comparison.

[0048] In some embodiments, the target response profile is from one or more target subjects who exhibit or previously exhibited at least one beneficial response to cancer. In some embodiments, the beneficial response comprises a positive clinical response to a cancer therapy or combination of therapies. In some embodiments, the beneficial response comprises a spontaneous response to a cancer. In some embodiments, the beneficial response comprises clearance of a cancer, e.g., a level of one or more clinical measures associated with clearance of a cancer. In some embodiments, the beneficial response comprises a lack of a relapse, recurrence, and/or metastasis of a cancer, e.g., over a defined period of time (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 weeks, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 years). In some embodiments, the beneficial response comprises a positive cancer prognosis. In some embodiments, the beneficial response comprises a lack of one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses or side effects) to a cancer therapy or combination of therapies.

[0049] In some embodiments, the method further comprises administering to the subject an immunogenic composition comprising one or more of the selected antigens or immunogenic fragments thereof.

[0050] In some embodiments, the method further comprises administering to the subject a cancer therapy or combination of therapies.

[0051] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[0052] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor

antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[0053] In another aspect, the disclosure features a method of selecting tumor antigens. In some embodiments, the method comprises a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; d) determining whether one or more lymphocytes are activated by one or more tumor antigens presented by one or more APCs by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain a subject response profile; and f) selecting from among the identified tumor antigens (i) one or more antigens that increase a level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress a level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer.

[0054] In some embodiments, the method further comprises comparing the subject response profile to a target response profile, e.g., a target response profile generated using a method described herein, and selecting one or more tumor antigens based on the comparison.

[0055] In some embodiments, the target response profile is from one or more target subjects who exhibit or previously exhibited one or more deleterious and/or non-beneficial response to cancer. In some embodiments, the deleterious and/or non-beneficial response comprises a negative clinical response and/or a failure to respond, to a cancer therapy or combination of

therapies. In some embodiments, the deleterious and/or non-beneficial response comprises a lack of clearance of a cancer, e.g., a level of one or more clinical measures associated with lack of clearance of a cancer. In some embodiments, the deleterious and/or non-beneficial response comprises at least one relapse, recurrence, and/or metastasis of a cancer. In some embodiments, the deleterious and/or non-beneficial response comprises a negative cancer prognosis. In some embodiments, the deleterious and/or non-beneficial response comprises one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses and/or side effects) to a cancer therapy or combination of therapies.

[0056] In some embodiments, the method further comprises administering to the subject an immunogenic composition that does not comprise one or more of the selected antigens or immunogenic fragments thereof.

[0057] In some embodiments, the method further comprises administering to the subject a cancer therapy or combination of therapies.

[0058] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[0059] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[0060] In another aspect, the disclosure features a method of inducing an immune response in a subject. In some embodiments, the method comprises: a) obtaining, providing, or generating

a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain a subject response profile; f) selecting from among the identified tumor antigens (i) one or more antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one deleterious or non-beneficial response to cancer; and g) administering to the subject an immunogenic composition comprising one or more of the selected antigens or immunogenic fragment thereof.

[0061] In some embodiments, the method further comprises comparing the subject response profile to a target response profile, e.g., a target response profile generated using a method described herein, and selecting one or more tumor antigens based on the comparison, prior to administration of the immunogenic composition.

[0062] In some embodiments, the target response profile is from one or more target subjects who exhibit or previously exhibited at least one beneficial response to cancer. In some embodiments, the beneficial response comprises a positive clinical response to a cancer therapy or combination of therapies. In some embodiments, the beneficial response comprises a spontaneous response to a cancer. In some embodiments, the beneficial response comprises clearance of a cancer, e.g., a level of one or more clinical measures associated with clearance of a cancer. In some embodiments, the beneficial response comprises a lack of a relapse, recurrence, and/or metastasis of a cancer, e.g., over a defined period of time (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 weeks, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, or at least 1,

2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 years). In some embodiments, the beneficial response comprises a positive cancer prognosis. In some embodiments, the beneficial response comprises a lack of one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses or side effects) to a cancer therapy or combination of therapies.

[0063] In some embodiments, the method further comprises administering to the subject a cancer therapy or combination of therapies.

[0064] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[0065] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[0066] In another aspect, the disclosure features a method of inducing an immune response in a subject. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more

APCs, e.g., by assessing e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control). of expression and/or secretion of one or more immune mediators; e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, to obtain a subject response profile; f) comparing the subject response profile to a target response profile, e.g., a target response profile generated using a method described herein; g) selecting from among the identified tumor antigens (i) one or more antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer; and h) administering to the subject an immunogenic composition that does not comprise one or more of the selected antigens or immunogenic fragment thereof.

[0067] In some embodiments, the method further comprises comparing the subject response profile to a target response profile e.g., a target response profile generated using a method described herein, and selecting one or more tumor antigens based on the comparison.

[0068] In some embodiments, the target response profile is from one or more target subjects who exhibit or previously exhibited one or more deleterious and/or non-beneficial response to cancer. In some embodiments, the deleterious and/or non-beneficial response comprises a negative clinical response and/or a failure to respond, to a cancer therapy or combination of therapies. In some embodiments, the deleterious and/or non-beneficial response comprises a lack of clearance of a cancer, e.g., a level of one or more clinical measures associated with lack of clearance of a cancer. In some embodiments, the deleterious and/or non-beneficial response comprises at least one relapse, recurrence, and/or metastasis of a cancer. In some embodiments, the deleterious and/or non-beneficial response comprises a negative cancer prognosis. In some embodiments, the deleterious and/or non-beneficial response comprises one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses and/or side effects) to a cancer therapy or combination of therapies.

[0069] In some embodiments, the method further comprises administering to the subject a cancer therapy or combination of therapies.

[0070] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[0071] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[0072] In another aspect, the disclosure features a method of identifying tumor antigens. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell of a subject; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; and e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, wherein stimulation, inhibition and/or suppression indicate that the polypeptide is a tumor antigen.

[0073] In another aspect, the disclosure features a method of selecting tumor antigens. In some embodiments, the method comprises: a) providing a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell expressed in a cancer or tumor cell of a subject; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, wherein stimulation, inhibition and/or suppression indicate that the polypeptide is a tumor antigen; and f) selecting from among the identified tumor antigens (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer.

[0074] In some embodiments, the method further comprises selecting from among the identified polypeptides one of more polypeptides that have a minimal effect on level of expression and/or secretion of one of more immune mediators.

[0075] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[0076] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor

antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[0077] In another aspect, the disclosure features a method of selecting potential tumor antigens. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell expressed in a cancer or tumor cell of a subject; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, and identifying one or more polypeptides that stimulate, inhibit, and/or suppress as a tumor antigen; and f) selecting from among the identified polypeptides one or more polypeptides that have a minimal effect on level of expression and/or secretion of one or more immune mediators.

[0078] In some embodiments, the method further comprises repeating steps b) through e), or steps c) through e), with lymphocytes from the subject that have undergone one or more previous rounds of exposure to APCs.

[0079] In some embodiments, the method further comprises selecting from among the identified tumor antigens (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to

cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial responses to cancer.

[0080] In some embodiments, the method further comprises administering to the subject an immunogenic composition comprising one or more of the selected tumor antigens or selected polypeptides, or immunogenic fragments thereof. In some embodiments, the method further comprises administering to the subject an immunogenic composition comprising a combination of one or more of the selected tumor antigens and selected polypeptides, or immunogenic fragments thereof. In some embodiments, the method further comprises administering to the subject a cancer therapy or combination of therapies.

[0081] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[0082] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[0083] In another aspect, the disclosure features a method of selecting tumor antigens. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell expressed in a cancer or tumor cell of a

subject; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, and identifying one or more polypeptides that stimulate, inhibit, and/or suppress as a tumor antigen; and f) selecting from among the identified tumor antigens (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer.

[0084] In some embodiments, the method further comprises administering to the subject an immunogenic composition that does not comprise one or more of the selected tumor antigens or immunogenic fragments thereof. In some embodiments, the method further comprises administering to the subject a cancer therapy or combination of therapies.

[0085] In some embodiments, the APCs are human APCs isolated from the subject; and/or the bacterial cells further comprise a cytolysin polypeptide; and/or the cytolysin polypeptide is listeriolysin O (LLO); and/or the APCs are provided in an array, and/or the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen; and/or the APCs and lymphocytes are isolated from peripheral blood; and/or the APCs comprise immortalized cells; and/or the lymphocytes are derived from a cancer or tumor.

[0086] In some embodiments, the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full

length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor; and/or the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor; and/or the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

[0087] In another aspect, the disclosure features a method of inducing an immune response in a subject. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell of a subject; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, and identifying a polypeptide that stimulates, inhibits and/or suppresses as a tumor antigen; f) selecting from among the identified tumor antigens (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial responses to cancer; and g) administering to the subject an immunogenic composition comprising one or more of the selected antigens or immunogenic fragment thereof.

[0088] In another aspect, the disclosure features a method of inducing an immune response in a subject. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell of a subject; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs

internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, wherein stimulation, inhibition and/or suppression indicate that the polypeptide is a tumor antigen; f) selecting from among the identified polypeptides one or more polypeptides that have a minimal effect on level of expression and/or secretion of one or more immune mediators; and g) administering to the subject an immunogenic composition comprising one or more of the selected polypeptides or immunogenic fragment thereof.

[0089] In another aspect, the disclosure features a method of inducing an immune response in a subject. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell of a subject; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, wherein stimulation, inhibition and/or suppression indicate that the polypeptide is a tumor antigen; f) selecting from among the identified tumor antigens and polypeptides (i) one or more polypeptides that have a minimal effect on level of expression and/or secretion of one or more immune mediators, (ii) one or more tumor antigens that increase level of expression and/or secretion of one or more immune

mediators associated with at least one beneficial response to cancer; and/or (iii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer; and g) administering to the subject an immunogenic composition comprising one or more of the selected tumor antigens and polypeptides, or immunogenic fragments thereof.

[0090] In some embodiments, the method further comprises administering to the subject a cancer therapy or combination of therapies.

[0091] In another aspect, the disclosure features a method of inducing an immune response in a subject. In some embodiments, the method comprises: a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell of a subject; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs; d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, and identifying a polypeptide that stimulates, inhibits and/or suppresses as a tumor antigen; f) selecting from among the identified tumor antigens (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer; and g) administering to the subject an immunogenic composition that does not comprise one or more of the selected antigens or immunogenic fragment thereof.

[0092] In some embodiments, the method further comprises administering to the subject a cancer therapy or combination of therapies.

[0093] In any of the aspects described herein, the plurality of tumor antigens comprises at least 1, 3, 5, 10, 15, 20, 25, 30, 50, 100, 150, 250, 500, 750, 1000 or more different tumor antigens, or portions thereof; and/or determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens comprises measuring a level of one or more immune mediators; and/or the one or more immune mediators are selected from the group consisting of cytokines, soluble mediators, and cell surface markers expressed by the lymphocytes; and/or the one or more immune mediators are cytokines; and/or the one or more cytokines are selected from the group consisting of TRAIL, IFN-gamma, IL-12p70, IL-2, TNF-alpha, MIP1-alpha, MIP1-beta, CXCL9, CXCL10, MCP1, RANTES, IL-1 beta, IL-4, IL-6, IL-8, IL-9, IL-10, IL-13, IL-15, CXCL11, IL-3, IL-5, IL-17, IL-18, IL-21, IL-22, IL-23A, IL-24, IL-27, IL-31, IL-32, TGF-beta, CSF, GM-CSF, TRANCE (also known as RANK L), MIP3-alpha, and fractalkine; and/or the one or more immune mediators are soluble mediators; and/or the one or more soluble mediators are selected from the group consisting of granzyme A, granzyme B, sFas, sFasL, perforin, and granulysin; and/or the one or more immune mediators are cell surface markers; and/or the one or more cell surface markers are selected from the group consisting of CD107a, CD107b, CD25, CD69, CD45RA, CD45RO, CD137 (4-1BB), CD44, CD62L, CD27, CCR7, CD154 (CD40L), KLRG-1, CD71, HLA-DR, CD122 (IL-2RB), CD28, IL7Ra (CD127), CD38, CD26, CD134 (OX-40), CTLA-4 (CD152), LAG-3, TIM-3 (CD366), CD39, PD1 (CD279), FoxP3, TIGIT, CD160, BTLA, 2B4 (CD244), and KLRG1; and/or the lymphocytes comprise CD4+ T cells; and/or the lymphocytes comprise CD8+ T cells; and/or the lymphocytes comprise NKT cells, gamma-delta T cells, or NK cells; and/or the lymphocytes comprise any combination of CD4+ T cells, CD8+ T cells, NKT cells, gamma-delta T cells, and NK cells; and/or lymphocyte activation is determined by assessing a level of one or more expressed or secreted immune mediators that is at least 20%, 40%, 60%, 80%, 100%, 120%, 140%, 160%, 180%, or 200% higher or lower than a control level; and/or lymphocyte activation is determined by assessing a level of one or more expressed or secreted immune mediators that is at least one, two, or three standard deviations greater or lower than the mean of a control level; and/or lymphocyte activating is determined by assessing a level of one or more expressed or secreted immune mediators that is at least 1, 2, 3, 4 or 5 median absolute deviations (MADs) greater or lower than a median response level to a control; and/or lymphocyte non-responsiveness is determined by assessing a level of one or more expressed or secreted immune mediators that is

within 5%, 10%,15%, or 20% of a control level; and/or lymphocyte non-responsiveness is determined by assessing a level of one or more expressed or secreted immune mediators that is less than one or two standard deviation higher or lower than the mean of a control level; and/or lymphocyte non-responsiveness is determined by assessing a level of one or more expressed or secreted immune mediators that is less than one or two median absolute deviation (MAD) higher or lower than a median response level to a control; and/or the subject response profile comprises one or more different tumor antigens that increase level of expression and/or secretion of one or more immune mediators; and/or the subject response profile comprises one or more different tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators; and/or the subject response profile comprises one or more different tumor antigens that have a minimal effect on level of expression and/or secretion of one or more immune mediators; and/or the subject response profile comprises a combination of one or more different tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators; and/or the target response profile comprises one or more different tumor antigens that increase level of expression and/or secretion of one or more immune mediators; and/or the target response profile comprises one or more different tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators; and/or the target response profile comprises one or more different tumor antigens that have a minimal effect on level of expression and/or secretion of one or more immune mediators; and/or the target response profile comprises a combination of one or more different tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators; and/or the target response profile comprises an average number of different tumor antigens that increase level of expression and/or secretion of one or more immune mediators, from a population of subjects who respond clinically to the cancer therapy, or from subjects who fail to respond clinically to the cancer therapy; and/or the target response profile comprises an average number of different tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators, from a population of subjects who respond clinically to the cancer therapy, or from subjects who fail to respond clinically to the cancer therapy; and/or the target response profile comprises an average number of different tumor antigens that have a minimal effect on level of expression and/or secretion of one or more immune mediators, from a population of

subjects who respond clinically to the cancer therapy, or from subjects who fail to respond clinically to the cancer therapy; and/or the target response profile comprises a combination of different tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, from a population of subjects who respond clinically to the cancer therapy, or from a population of subjects who fail to respond clinically to the cancer therapy; and or the subject response profile is similar to the target response profile if the number of tumor antigens of the subject response profile differs by no more than 1, 2, 3, 4, 5, or 10 from the number of antigens of the target response profile; and/or the subject response profile comprises the number of different tumor antigens for each of a plurality of cytokines expressed and/or secreted by activated and/or non-responsive lymphocytes; and/or the target response profile comprises the number of antigens for each of the corresponding plurality of cytokines; and/or the target response profile comprises an average number of antigens for each of the corresponding plurality of cytokines expressed and/or secreted by activated and/or non-responsive lymphocytes from a population of subjects who respond clinically to the cancer therapy; and/or the target response profile comprises an average number of antigens for each of the corresponding plurality of cytokines expressed and/or secreted by activated and/or non-responsive lymphocytes from a population of subjects who fail to respond clinically to the cancer therapy; and/or the target response profile comprises a combination of antigens for each of the corresponding plurality of cytokines expressed and/or secreted by activated and/or non-responsive lymphocytes from a population of subjects who respond clinically to the cancer therapy, or from a population of subjects who fail to respond clinically to the cancer therapy; and/or the subject response profile is similar to the target response profile if the number of tumor antigens for at least two of the plurality of cytokines of the subject response profile differs by no more than 1, 2, 3, 4, 5, or 10 from the number of antigens for the corresponding plurality of cytokines of the target response profile; and/or a subject exhibits at least one measure or indication of clinical responsiveness to the cancer therapy; and/or a subject exhibits at least one measure or indication of failure of clinical responsiveness to the cancer therapy; and/or the cancer therapy comprises immune checkpoint blockade therapy; and/or the immune checkpoint blockade therapy comprises administration of pembrolizumab, nivolumab, ipilimumab, atezolizumab, avelumab, durvalumab, tremelimumab, or cemiplimab; and/or the immune checkpoint blockade therapy comprises administration of two

or more immune checkpoint inhibitors; and/or the cancer therapy comprises immune suppression blockade therapy; and/or the immune suppression blockade therapy comprises administration of Vista (B7-H5, v-domain Ig suppressor of T cell activation) inhibitors, Lag-3 (lymphocyte-activation gene 3, CD223) inhibitors, IDO (indolemamine-pyrrole-2,3,-dioxygenase-1,2) inhibitors, or KIR receptor family (killer cell immunoglobulin-like receptor) inhibitors, CD47 inhibitors, or Tigit (T cell immunoreceptor with Ig and ITIM domain) inhibitors; and/or the immune suppression blockade therapy comprises administration of two or more immune suppression inhibitors; and/or the cancer therapy comprises immune activation therapy; and/or the immune activation therapy comprises administration of CD40 agonists, GITR (glucocorticoid-induced TNF-R-related protein, CD357) agonists, OX40 (CD134) agonists, 4-1BB (CD137) agonists, ICOS (inducible T cell stimulator, CD278) agonists, IL-2 (interleukin 2) agonists, or interferon agonists; and/or immune activation comprises administration of two or more immune activators; and/or the cancer therapy comprises adjuvant therapy; and/or the adjuvant therapy comprises administration of a TLR agonist (e.g., CpG or Poly I:C), STING agonist, non-specific stimulus of innate immunity, dendritic cells, GM-CSF, IL-12, IL-7, Flt-3, or other cytokines; and/or the cancer therapy comprises oncolytic virus therapy; and/or the oncolytic viral therapy comprises administration of talimogene leherparepvec; and/or the cancer therapy comprises administration of one or more chemotherapeutic agents; and/or the cancer therapy comprises radiation; and/or the cancer therapy comprises surgical excision; and/or the cancer therapy comprises cell-based therapy; and/or the cell-based therapy comprises administration of dendritic cells, chimeric antigen receptor T (CAR-T) cells, T cell receptor-transduced cells, tumor infiltrating lymphocytes (TIL), or natural killer (NK) cells; and/or the cancer therapy comprises localized hyperthermia or hypothermia; and/or the cancer therapy comprises administration of one or more anti-tumor antibodies; and/or the anti-tumor antibodies comprise bi-specific antibodies; and/or the cancer therapy comprises administration of one or more anti-angiogenic agents; and/or the cancer therapy comprises any combination of immune checkpoint blockade, immune suppression blockade, immune activation, adjuvant, oncolytic virus, chemotherapeutic, radiation, surgical, cell-based, hyperthermia, hypothermia, anti-tumor antibody, and anti-angiogenic therapies.

[0094] In another aspect, the disclosure features a method of inducing an immune response in a subject with one or more selected antigens, the method comprising: a) obtaining, providing

or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen; b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a first subject, wherein the APCs internalize the bacterial cells or beads; c) contacting the APCs with lymphocytes from the first subject, under conditions suitable for stimulation or inhibition and/or suppression of lymphocytes by a tumor antigen presented by one or more APCs; d) identifying one or more stimulatory tumor antigens that stimulate lymphocytes and identifying one or more non-stimulatory tumor antigens that do not stimulate lymphocytes, to produce a subject response profile; e) comparing the subject response profile to a target response profile, wherein the target response profile is from a second subject who responds clinically to a cancer therapy, and wherein the target response profile comprises one or more identified stimulatory tumor antigens that stimulate lymphocytes and comprises one or more identified non-stimulatory tumor antigens that do not stimulate lymphocytes; f) selecting one or more antigens, wherein the one or more antigens are identified as non-stimulatory in the subject response profile and the same one or more antigens are identified as stimulatory in the target response profile; and g) administering to the first subject an immunogenic composition comprising one or more of the selected antigens.

[0095] In some embodiments, the method further comprises administering a cancer therapy to the subject. In some embodiments, the subject response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

[0096] In another aspect, the disclosure features an immunogenic composition of the invention, comprising one or more antigens of the target response profile obtained or generated according to any of the methods described herein.

[0097] In another aspect, the disclosure features an immunogenic composition of the invention, comprising one or more antigens selected according to any of the methods described herein.

[0098] In another aspect, the disclosure features an immunogenic composition comprising (i) one or more heparanase polypeptides or immunogenic fragments thereof and (ii) a SMAD4 polypeptide or immunogenic fragment thereof.

[0099] In some embodiments, the one or more heparanase polypeptides or fragments and the SMAD4 polypeptide or fragment are each 8-29 amino acids in length. In some embodiments,

the heparanase polypeptides comprise the amino acid sequence of SEQ ID NO:6 or SEQ ID NO:7. In some embodiments, the SMAD4 polypeptide comprises the amino acid sequence of SEQ ID NO:8. In some embodiments, the one or more immunogenic fragments consist of about 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% of the total number of amino acids of SEQ ID NO:6, SEQ ID NO:7, or SEQ ID NO:8. In some embodiments, the one or more immunogenic fragments consist of SEQ ID NO:6, SEQ ID NO:7, or SEQ ID NO:8 lacking about 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, or more amino acids. In some embodiments, the one or more heparanse polypeptides comprise an amino acid sequence at least 85%, 90%, 95%, 97%, or 99% identical to SEQ ID NO:6 or SEQ ID NO:7. In some embodiments, the SMAD4 polypeptide comprises an amino acid sequence at least 85%, 90%, 95%, 97%, or 99% identical to SEQ ID NO:8.

[00100] In another aspect, the disclosure features an immunogenic composition comprising a heparanase isoform 1 polypeptide or immunogenic fragment, a heparanase isoform 2 polypeptide or immunogenic fragment, and a SMAD4 polypeptide or immunogenic fragment.

[00101] In some embodiments, the heparanase isoform 1 polypeptide or immunogenic fragment, the heparanase isoform 2 polypeptide or immunogenic fragment and the SMAD4 polypeptide or immunogenic fragment are each 8-29 amino acids in length. In some embodiments, the heparanase isoform 1 polypeptide comprises the amino acid sequence of SEQ ID NO:1 and the heparanase isoform 2 polypeptide comprises the amino acid sequence of SEQ ID NO:2. In some embodiments, the SMAD4 polypeptide comprises the amino acid sequence of SEQ ID NO:3. In some embodiments, the one or more immunogenic fragments consist of about 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% of the total number of amino acids of SEQ ID NO:6, SEQ ID NO:7, or SEQ ID NO:8. In some embodiments, one or more immunogenic fragments consist of SEQ ID NO:6, SEQ ID NO:7, or SEQ ID NO:8 lacking about 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, or more amino acids. In some embodiments, the heparanase isoform 1 polypeptide comprises an amino acid sequence at least 85%, 90%, 95%, 97%, or 99% identical to SEQ ID NO:6 and wherein the heparanase isoform 1 polypeptide comprises an amino acid sequence at least 85%, 90%, 95%, 97%, or 99% identical to SEQ ID NO:7. In some embodiments, the SMAD4 polypeptide comprises an amino acid sequence at least 85%, 90%, 95%, 97%, or 99% identical to SEQ ID NO:8. In some embodiments, the compositions further comprises an adjuvant.

[00102] In another aspect of the invention, methods of treating cancer comprises administering to a subject the immunogenic compositions described herein. In some embodiments, the subject has or is at risk of cancer, and/or exhibits one or more signs or symptoms of cancer, and/or exhibits one or more risk factors for cancer. In some embodiments, the cancer is colorectal cancer, melanoma, or lung cancer.

[00103] In another aspect of the invention, methods of inducing an immune response in a subject, comprise administering to a subject the immunogenic compositions described herein. In some embodiment, the immune response comprises activation of one or more lymphocytes. In some embodiments, the one or more lymphocytes comprise CD4+ T cells. In some embodiments, the one or more lymphocytes comprise CD8+ T cells. In some embodiments, the one or more lymphocytes comprise NKT cells, gamma-delta T cells, or NK cells. In some embodiments, the one or more lymphocytes comprise any combination of CD4+ T cells, CD8+ T cells, NKT cells, gamma-delta T cells, and NK cells. In some embodiments, the immune response comprises an increased expression and/or secretion of one or more immune mediators relative to a control. In some embodiments, the lymphocyte signaling molecule is selected from among immune mediators. In some embodiments, the one or more immune mediators are cytokines. In some embodiments, the one or more cytokines are selected from TRAIL, IFN-gamma, IL-12p70, IL-2, TNF-alpha, MIP1-alpha, MIP1-beta, CXCL9, CXCL10, MCP1, RANTES, IL-1 beta, IL-4, IL-6, IL-8, IL-9, IL-10, IL-13, IL-15, CXCL11, IL-3, IL-5, IL-17, IL-18, IL-21, IL-22, IL-23A, IL-24, IL-27, IL-31, IL-32, TGF-beta, CSF, GM-CSF, TRANCE (also known as RANK L), MIP3-alpha, MCP1, and fractalkine. In some embodiments, the one or more immune mediators are soluble mediators. In some embodiments, the one or more soluble mediators are selected from granzyme A, granzyme B, sFas, sFasL, perforin, and granulysin. In some embodiments, the one or more immune mediators are cell surface markers. In some embodiments, the one or more cell surface markers are selected from CD107a, CD107b, CD25, CD69, CD45RA, CD45RO, CD137 (4-1BB), CD44, CD62L, CD27, CCR7, CD154 (CD40L), KLRG-1, CD71, HLA-DR, CD122 (IL-2RB), CD28, IL7Ra (CD127), CD38, CD26, CD134 (OX-40), CTLA-4 (CD152), LAG-3, TIM-3 (CD366), CD39, PD1 (CD279), FoxP3, TIGIT, CD160, BTLA, 2B4 (CD244), and KLRG1. In some embodiments, a level of one or more expressed or secreted immune mediators that is at least 20%, 40%, 60%, 80%, 100%, 120%, 140%, 160%, 180%, or 200% higher than a control level. In some embodiments, a level of one

or more expressed or secreted immune mediators that is at least one, two, or three standard deviations higher than the mean of a control level indicates lymphocyte activation. In some embodiments, a level of one or more expressed or secreted immune mediators that is at least 1, 2, 3, 4 or 5 median absolute deviations (MADs) higher or lower than a median response level to a control indicates lymphocyte activation. In some embodiments, the immune response comprises a humoral response and/or a cellular response. In some embodiments, humoral response comprises an increase in magnitude of response or fold rise from baseline of antigen specific immunoglobulin G (IgG) levels and/or of antigen specific neutralizing antibody levels. In some embodiments, the humoral response comprises a 4-fold or greater rise in IgG titer from baseline. In some embodiments, the humoral response comprises a 2-fold or greater rise in 50% neutralizing antibody titer from baseline. In some embodiments, the cellular response comprises secretion of granzyme B (GrB). In some embodiments, the cellular response comprises an increase in magnitude of response or fold rise from baseline of granzyme B (GrB) levels. In some embodiments, the cellular response comprises an increase in IFN-gamma secretion for T cells. In some embodiments, the subject has or is at risk of cancer, and/or exhibits one or more signs or symptoms of cancer, and/or exhibits one or more risk factors for cancer. In some embodiments, the cancer is colorectal cancer, melanoma, or lung cancer.

[00104] In another aspect, the disclosure features a method for manufacturing an immunogenic composition, the method comprising combining one or more antigens identified by any method described herein and a carrier.

[00105] In some embodiments, the antigen is produced using recombinant DNA technology in a suitable host cell. In some embodiments, the method comprises formulating the immunogenic composition as a pharmaceutical composition.

[00106] In another aspect, the disclosure features a method for manufacturing an immunogenic composition for administration to a subject in need thereof, the method comprising: a. providing, preparing, or obtaining a plurality of antigenic compositions comprising a plurality of antigens, each composition comprising a different antigen; b. providing, preparing, or obtaining a target response profile, wherein the target response profile comprises a representation of the level of expression and/or secretion of one or more immune mediators associated (e.g., determined, measured, observed) with the plurality of antigens; c. providing, preparing, or obtaining a subject response profile, wherein the subject response profile

comprises a representation of the level of expression and/or secretion of one or more immune mediators associated (e.g., determined, measured, observed) with the plurality of antigens; d. comparing the target response profile to the subject response profile; e. selecting one or more antigens based on the comparison; and f. formulating at least a portion of one or more antigenic compositions comprising the one or more selected antigens as a pharmaceutical composition.

[00107] In some embodiments, the selecting step comprises selecting one or more antigens that increase expression or secretion of immune mediators associated with a beneficial response to cancer, and/or one or more antigens that inhibit and/or suppress expression or secretion of immune mediators associated with deleterious or not beneficial responses to cancer. In some embodiments, the plurality of antigenic compositions are in solution, lyophilized, or on a synthetic matrix.

[00108] In another aspect, the disclosure features a method of manufacturing an immunogenic composition for administration to a subject in need thereof, the method comprising: preparing one or more antigens, or fragments thereof, identified by any of the method described herein; combining one or more antigens, or fragments thereof, wherein the one or more antigens or fragments thereof are selected according to the subject's response profile; and formulating the immunogenic composition as a pharmaceutical composition.

[00109] In another aspect, the disclosure features a method of manufacturing an immunogenic composition for administration to a subject in need thereof, the method comprising: preparing one or more antigens, or fragments thereof, identified by any method described herein; combining one or more antigens, or fragments thereof, wherein the one or more antigens or fragments thereof are selected according to whether or not the one or more antigens have been shown to stimulate, inhibit and/or suppress and/or have minimal effect on level of expression and/or secretion of one or more immune mediators by the subject's lymphocytes; and formulating the immunogenic composition as a pharmaceutical composition.

[00110] In another aspect, the disclosure features a method of manufacturing an immunogenic composition for administration to a subject in need thereof, the method comprising: preparing one or more antigens, or fragments thereof, identified by any method described herein;

[00111] combining one or more antigens, or fragments thereof, wherein the one or more antigens or fragments thereof are selected according to the subject's response profile; and formulating the immunogenic composition as a pharmaceutical composition.

BRIEF DESCRIPTION OF THE DRAWINGS

[00112] The present teachings described herein will be more fully understood from the following description of various illustrative embodiments, when read together with the accompanying drawings. It should be understood that the drawings described below are for illustration purposes only and are not intended to limit the scope of the present teachings in any way.

[00113] **Figure 1** is a graph showing IFNγ secreted in supernatants by T cells from a representative melanoma patient who received immune checkpoint blockade therapy. The T cells were co-cultured with autologous antigen presenting cells pulsed with *E. coli* expressing various tumor-associated antigens.

[00114] **Figure 2** is a graph showing the number of T cell antigens that stimulated cytokine secretion in supernatants by $CD4^+$ T cells from melanoma patients who were non-responders or responders to immune checkpoint blockade therapy. The T cells were co-cultured with autologous antigen presenting cells pulsed with *E. coli* expressing various tumor associated antigens.

[00115] **Figure 3** is a graph showing the number of T cell antigens that stimulated cytokine secretion in supernatants by $CD8^+$ T cells from melanoma patients who were non-responders or responders to immune checkpoint blockade therapy. The T cells were co-cultured with autologous antigen presenting cells pulsed with *E. coli* expressing various tumor-associated antigens.

[00116] **Figure 4** is a scatter plot showing good alignment between replicate measurements for cytokines secreted by T cells from a representative NSCLC patient after stimulation by autologous antigen presenting cells pulsed with *E. coli* expressing putative neoantigens.

[00117] **Figure 5** is a graph showing results for IFNγ and TNFα secretion from $CD8^+$ T cells from a representative NSCLC patient, collected pre- and post-checkpoint blockade therapy, after co-culture with autologous antigen presenting cells pulsed with *E. coli* expressing putative neoantigens.

[00118] **Figure 6** is a graph showing results for IFNγ and TNFα secretion from $CD4^+$ T cells from a representative NSCLC patient, collected pre- and post-checkpoint blockade therapy, after co-culture with autologous antigen presenting cells pulsed with *E. coli* expressing putative neoantigens.

[00119] **Figure 7** is a Venn diagram showing limited overlap between $CD8^+$-specific T cell neoantigens from a representative NSCLC patient, identified using methods of the disclosure and epitope prediction algorithms.

[00120] **Figure 8** is a schematic showing epitope predictions had a high false positive rate, missed relevant antigens and failed to identify suppressive and/or inhibitory neoantigens.

[00121] **Figure 9** is a graph showing IFNγ and TNF-α secreted in supernatants by T cells from a representative patient with colorectal cancer. The T cells were co-cultured with autologous antigen presenting cells pulsed with *E. coli* expressing various tumor-associated antigens. NG = neon green.

[00122] **Figure 10** is a graph showing the percentage of colorectal cancer patients who responded to each TAA, as measured by IFNγ secretion that exceeded three standard deviations of the mean negative control response.

[00123] **Figure 11** is a graph showing results for IFNγ and TNF-α secretion from $CD8^+$ T cells from a patient with colorectal carcinoma after co-culture with antigen presenting cells pulsed with *E. coli* expressing 31 mutations unique to the patient.

[00124] **Figures 12A and 12B** are Venn diagrams representing the limited overlap between $CD8^+$-specific T cell neoantigens identified by ATLAS and epitope prediction algorithms. Figure 12A represents epitopes predicted that had binding affinity projected to be below 500nM for the mutant peptide (neoantigen) but not for its wild-type counterpart, and an IEDB percentile rank of ≤ 1 for the mutant peptide but not for wild-type. Figure 12B represents epitopes predicted to have binding affinity below 500nM or an IEDB percentile rank of ≤ 1, irrespective of the wild-type counterpart predictions.

[00125] **Figures 13A and 13B** are Venn diagrams representing the limited overlap between $CD8^+$-specific T cell inhibitory and/or suppressive neoantigens identified by ATLAS and epitope prediction algorithms. Figure 13A represents epitopes predicted that had binding affinity

projected to be below 500nM for the mutant peptide (neoantigen) but not for its wild-type counterpart, and an IEDB percentile rank of ≤1 for the mutant peptide but not for wild-type. Figure 13B represents epitopes predicted to have binding affinity below 500nM or an IEDB percentile rank of ≤1, irrespective of the wild-type counterpart predictions.

[00126] **Figure 14** is a graph showing response profiles to 25 CRC-associated TAAs across CRC patients with all stages of disease using TNF-α and IFN-γ secretion as an indicator for a recall response to a putative antigen.

[00127] **Figures 15A and 15B** are graphs showing the high frequency of T cell stimulatory responses to three novel ATLAS-identified TAAs in comparison to three TAAs that are or were in clinical development as a therapeutic vaccine.

[00128] **Figure 16** is a graph showing stimulatory response rates to 4 selected TAAs for both $CD4^+$ and $CD8^+$ T cell subsets from CRC patients with early or late stage disease and TNF-α and IFN-γ cytokine release.

[00129] **Figure 17** is a graph showing normalized cytokine concentrations released in response to 4 selected TAAs in healthy individuals and donors with various disease states (polyps or CRC) for $CD4^+$ and $CD8^+$ T cell subsets and for TNF-α and IFN-γ release.

[00130] **Figure 18** is a graph showing an exemplary empirical determination of T cell responses to profiled TAAs. Exemplary data is shown for a single lung cancer patient. T cell responses are reported as natural log concentrations extrapolated from the MSD standard curve and normalized to the patient's response to a negative control protein.

[00131] **Figure 19** is a graph showing shows frequent $CD4^+$ T cell responses to two novel TAAs compared to previously described TAAs (NY-ESO-1, MUC1, and MAGEA3). Each point represents a patient's response to that TAA, normalized to the patient's response to a negative control protein. Stimulatory responses are colored black.

[00132] **Figure 20** is a graph showing $CD4^+$ and $CD8^+$ T cell responses to a broad range of TAAs from lung cancer patients.

[00133] **Figure 21** is a graph showing inhibitory and/or suppressive T cell responses detected in most profiled TAAs across lung cancer patients.

[00134] **Figure 22** is a graph showing a neoantigen screen with ATLAS identifying patient-specific $CD4^+$ and $CD8^+$ T cell responses. Each dot represents a technical replicate. Horizontal dotted lines indicate the cutoffs used to define stimulatory neoantigens and inhibitory and/or suppressive neoantigens at +3 and -3 Median Absolute Deviations (MADs), respectively.

[00135] **Figures 23A, 23B, 23C, and 23D** show that algorithm prediction of MHC Class I binding does not accurately predict $CD8^+$ T cell responses or types of response. Figures 23A and 23C show the total numbers and overlap of neoantigens predicted by algorithm and observed in ATLAS. Figures 23B and 23D show the break-down of predictions by strong binding (< 150nM), weak binding (< 500nM), or non-binding (>= 500nM). There is no enrichment of either stimulatory or inhibitory and/or suppressive responses in $CD8^+$ T cells across binding prediction groups.

[00136] **Figures 24A and 24B** are graphs showing that $CD8^+$ T cell responses identified by ATLAS to candidate neoantigens are not enriched for any mutation type.

[00137] **Figures 25A and 25B** are graphs showing DNA mutant allele frequency is not associated with $CD8^+$ T cell response frequency.

[00138] **Figures 26A and 26B** are graphs showing detection of a mutation in RNA does not predict whether the candidate neoantigen elicits a recall response in $CD8^+$ T cells.

[00139] **Figures 27A and 27B** are graphs showing that CD8+ T cell responses identified by ATLAS to candidate neoantigens do not correlate with gene expression.

[00140] **Figure 28** is a graph illustrating the different cytokine response profiles elicited by 6 representative neoantigens in a screen of $CD8^+$ T cells from a single patient.

[00141] **Figure 29** is a graph showing $CD8^+$ T cell data for healthy donors and cancer patients. When analyzed by IFNγ secretion, there was a large inhibitory response in the healthy donor cohort, that greatly exceeded the inhibitory responses in the cancer patient cohort. Conversely, there was a greater median inhibitory response in the cancer cohort when TNFα secretion was considered.

DEFINITIONS

[00142] *Activate*: As used herein, a peptide presented by an antigen presenting cell (APC) "activates" a lymphocyte if lymphocyte activity is detectably modulated after exposure to the peptide presented by the APC under conditions that permit antigen-specific recognition to occur. Any indicator of lymphocyte activity can be evaluated to determine whether a lymphocyte is activated, *e.g.*, T cell proliferation, phosphorylation or dephosphorylation of a receptor, calcium flux, cytoskeletal rearrangement, increased or decreased expression and/or secretion of immune mediators such as cytokines or soluble mediators, increased or decreased expression of one or more cell surface markers.

[00143] *Administration*: As used herein, the term "administration" typically refers to the administration of a composition to a subject or system. Those of ordinary skill in the art will be aware of a variety of routes that may, in appropriate circumstances, be utilized for administration to a subject, for example a human. For example, in some embodiments, administration may be systemic or local. In some embodiments, administration may be enteral or parenteral. In some embodiments, administration may be by injection (*e.g.*, intramuscular, intravenous, or subcutaneous injection). In some embodiments, injection may involve bolus injection, drip, perfusion, or infusion. In some embodiments administration may be topical. Those skilled in the art will be aware of appropriate administration routes for use with particular therapies described herein, for example from among those listed on www.fda.gov, which include auricular (otic), buccal, conjunctival, cutaneous, dental, endocervical, endosinusial, endotracheal, enteral, epidural, extra-amniotic, extracorporeal, interstitial, intra-abdominal, intra-amniotic, intra-arterial, intra-articular, intrabiliary, intrabronchial, intrabursal, intracardiac, intracartilaginous, intracaudal, intracavernous, intracavitary, intracerebral, intracisternal, intracorneal, intracoronal, intracorporus cavernosum, intradermal, intranodal, intradiscal, intraductal, intraduodenal, intradural, intraepidermal, intraesophageal, intragastic, intragingival, intralesional, intraluminal, intralymphatic, intramedullary, intrameningeal, intramuscular, intraocular, intraovarian, intrapericardial, intraperitoneal, intrapleural, intraprostatic, intrapulmonary, intrasinal, intraspinal, intrasynovial, intratendinous, intratesticular, intrathecal, intrathoracic, intratubular, intratumor, intratympanic, intrauterine, intravascular, intravenous, intravenous bolus, intravenous drip, intraventricular, intravitreal, laryngeal, nasal, nasogastric, ophthalmic, oral, oropharyngeal, parenteral, percutaneous, periarticular, peridural, perineural, periodontal, rectal, respiratory (*e.g.*,

inhalation), retrobulbar, soft tissue, subarachnoid, subconjunctival, subcutaneous, sublingual, submucosal, topical, transdermal, transmucosal, transplacental, transtracheal, ureteral, urethral, or vaginal. In some embodiments, administration may involve electro-osmosis, hemodialysis, infiltration, iontophoresis, irrigation, and/or occlusive dressing. In some embodiments, administration may involve dosing that is intermittent (*e.g.*, a plurality of doses separated in time) and/or periodic (*e.g.*, individual doses separated by a common period of time) dosing. In some embodiments, administration may involve continuous dosing.

[00144] *Antigen*: The term "antigen", as used herein, refers to a molecule (*e.g.*, a polypeptide) that elicits a specific immune response. Antigen-specific immunological responses, also known as adaptive immune responses, are mediated by lymphocytes (*e.g.*, T cells, B cells, NK cells) that express antigen receptors (*e.g.*, T cell receptors, B cell receptors). In certain embodiments, an antigen is a T cell antigen, and elicits a cellular immune response. In certain embodiments, an antigen is a B cell antigen, and elicits a humoral (*i.e.*, antibody) response. In certain embodiments, an antigen is both a T cell antigen and a B cell antigen. As used herein, the term "antigen" encompasses both a full-length polypeptide as well as a portion or immunogenic fragment of the polypeptide, and a peptide epitope within the polypeptides (*e.g.*, a peptide epitope bound by a Major Histocompatibility Complex (MHC) molecule (*e.g.*, MHC class I, or MHC class II)).

[00145] *Antigen presenting cell*: An "antigen presenting cell" or "APC" refers to a cell that presents peptides on MHC class I and/or MHC class II molecules for recognition by T cells. APC include both professional APC (*e.g.*, dendritic cells, macrophages, B cells), which have the ability to stimulate naïve lymphocytes, and non-professional APC (*e.g.*, fibroblasts, epithelial cells, endothelial cells, glial cells). In certain embodiments, APC are able to internalize (*e.g.*, endocytose) members of a library (*e.g.*, cells of a library of bacterial cells) that express heterologous polypeptides as candidate antigens.

[00146] *Autolysin polypeptide*: An "autolysin polypeptide" is a polypeptide that facilitates or mediates autolysis of a cell (*e.g.*, a bacterial cell) that has been internalized by a eukaryotic cell. In some embodiments, an autolysin polypeptide is a bacterial autolysin polypeptide. Autolysin polypeptides include, and are not limited to, polypeptides whose sequences are disclosed in GenBank® under Acc. Nos. NP_388823.1, NP_266427.1, and P0AGC3.1.

[00147] *Cancer*: As used herein, the term "cancer" refers to a disease, disorder, or condition in which cells exhibit relatively abnormal, uncontrolled, and/or autonomous growth, so that they display an abnormally elevated proliferation rate and/or aberrant growth phenotype characterized by a significant loss of control of cell proliferation. In some embodiments, a cancer may be characterized by one or more tumors. Those skilled in the art are aware of a variety of types of cancer including, for example, adrenocortical carcinoma, astrocytoma, basal cell carcinoma, carcinoid, cardiac, cholangiocarcinoma, chordoma, chronic myeloproliferative neoplasms, craniopharyngioma, ductal carcinoma in situ, ependymoma, intraocular melanoma, gastrointestinal carcinoid tumor, gastrointestinal stromal tumor (GIST), gestational trophoblastic disease, glioma, histiocytosis, leukemia (*e.g.,* acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myelogenous leukemia (CML), hairy cell leukemia, myelogenous leukemia, myeloid leukemia), lymphoma (*e.g.,* Burkitt lymphoma [non-Hodgkin lymphoma], cutaneous T cell lymphoma, Hodgkin lymphoma, mycosis fungoides, Sezary syndrome, AIDS-related lymphoma, follicular lymphoma, diffuse large B-cell lymphoma), melanoma, merkel cell carcinoma, mesothelioma, myeloma (*e.g.,* multiple myeloma), myelodysplastic syndrome, papillomatosis, paraganglioma, pheochromacytoma, pleuropulmonary blastoma, retinoblastoma, sarcoma (*e.g.,* Ewing sarcoma, Kaposi sarcoma, osteosarcoma, rhabdomyosarcoma, uterine sarcoma, vascular sarcoma), Wilms' tumor, and/or cancer of the adrenal cortex, anus, appendix, bile duct, bladder, bone, brain, breast, bronchus, central nervous system, cervix, colon, endometrium, esophagus, eye, fallopian tube, gall bladder, gastrointestinal tract, germ cell, head and neck, heart, intestine, kidney (*e.g.,* Wilms' tumor), larynx, liver, lung (*e.g.,* non-small cell lung cancer, small cell lung cancer), mouth, nasal cavity, oral cavity, ovary, pancreas, rectum, skin, stomach, testes, throat, thyroid, penis, pharynx, peritoneum, pituitary, prostate, rectum, salivary gland, ureter, urethra, uterus, vagina, or vulva.

[00148] *Cytolysin polypeptide*: A "cytolysin polypeptide" is a polypeptide that has the ability to form pores in a membrane of a eukaryotic cell. A cytolysin polypeptide, when expressed in host cell (*e.g.*, a bacterial cell) that has been internalized by a eukaryotic cell, facilitates release of host cell components (*e.g.*, host cell macromolecules, such as host cell polypeptides) into the cytosol of the internalizing cell. In some embodiments, a cytolysin polypeptide is bacterial cytolysin polypeptide. In some embodiments, a cytolysin polypeptide is a cytoplasmic cytolysin polypeptide. Cytolysin polypeptides include, and are not limited to, polypeptides whose

sequences are disclosed in U.S. Pat. No. 6,004,815, and in GenBank® under Acc. Nos. NP_463733.1, NP_979614, NP_834769, YP_084586, YP_895748, YP_694620, YP_012823, NP_346351, YP_597752, BAB41212.2, NP_561079.1, YP_001198769, and NP_359331.1.

[00149] *Cytoplasmic cytolysin polypeptide*: A "cytoplasmic cytolysin polypeptide" is a cytolysin polypeptide that has the ability to form pores in a membrane of a eukaryotic cell, and that is expressed as a cytoplasmic polypeptide in a bacterial cell. A cytoplasmic cytolysin polypeptide is not significantly secreted by a bacterial cell. Cytoplasmic cytolysin polypeptides can be provided by a variety of means. In some embodiments, a cytoplasmic cytolysin polypeptide is provided as a nucleic acid encoding the cytoplasmic ccytolysin polypeptide. In some embodiments, a cytoplasmic cytolysin polypeptide is provided attached to a bead. In some embodiments, a cytoplasmic cytolysin polypeptide has a sequence that is altered relative to the sequence of a secreted cytolysin polypeptide (*e.g.*, altered by deletion or alteration of a signal sequence to render it nonfunctional). In some embodiments, a cytoplasmic cytolysin polypeptide is cytoplasmic because it is expressed in a secretion-incompetent cell. In some embodiments, a cytoplasmic cytolysin polypeptide is cytoplasmic because it is expressed in a cell that does not recognize and mediate secretion of a signal sequence linked to the cytolysin polypeptide. In some embodiments, a cytoplasmic cytolysin polypeptide is a bacterial cytolysin polypeptide.

[00150] *Heterologous*: The term "heterologous", as used herein to refer to genes or polypeptides, refers to a gene or polypeptide that does not naturally occur in the organism in which it is present and/or being expressed, and/or that has been introduced into the organism by the hand of man. In some embodiments, a heterologous polypeptide is a tumor antigen described herein.

[00151] *Immune mediator*: As used herein, the term "immune mediator" refers to any molecule that affects the cells and processes involved in immune responses. Immune mediators include cytokines, chemokines, soluble proteins, and cell surface markers.

[00152] *Improve, increase, inhibit, stimulate, suppress, or reduce*: As used herein, the terms "improve", "increase", "inhibit", "stimulate", "suppress", "reduce", or grammatical equivalents thereof, indicate values that are relative to a baseline or other reference measurement. In some embodiments, an appropriate reference measurement may be or comprise a measurement in a particular system (e.g., in a single individual) under otherwise comparable conditions absent

presence of (e.g., prior to and/or after) a particular agent or treatment, or in presence of an appropriate comparable reference agent. The effect of a particular agent or treatment may be direct or indirect. In some embodiments, an appropriate reference measurement may be or may comprise a measurement in a comparable system known or expected to respond in a particular way, in presence of the relevant agent or treatment. In some embodiments, a peptide presented by an antigen presenting cell (APC) "stimulates" or is "stimulatory" to a lymphocyte if the lymphocyte is activated to a phenotype associated with beneficial responses, after exposure to the peptide presented by the APC under conditions that permit antigen-specific recognition to occur, as observed by, *e.g.*, T cell proliferation, phosphorylation or dephosphorylation of a receptor, calcium flux, cytoskeletal rearrangement, increased or decreased expression and/or secretion of immune mediators such as cytokines or soluble mediators, increased or decreased expression of one or more cell surface markers, relative to a control. In some embodiments, a peptide presented by an antigen presenting cell "suppresses", "inhibits" or is "inhibitory" to a lymphocyte if the lymphocyte is activated to a phenotype associated with deleterious or non-beneficial responses, after exposure to the peptide presented by the APC under conditions that permit antigen-specific recognition to occur, as observed by, *e.g.*, phosphorylation or dephosphorylation of a receptor, calcium flux, cytoskeletal rearrangement, increased or decreased expression and/or secretion of immune mediators such as cytokines or soluble mediators, increased or decreased expression of one or more cell surface markers, relative to a control.

[00153] *Invasin polypeptide*: An "invasin polypeptide" is a polypeptide that facilitates or mediates uptake of a cell (*e.g.*, a bacterial cell) by a eukaryotic cell. Expression of an invasin polypeptide in a noninvasive bacterial cell confers on the cell the ability to enter a eukaryotic cell. In some embodiments, an invasin polypeptide is a bacterial invasin polypeptide. In some embodiments, an invasin polypeptide is a *Yersinia* invasin polypeptide (*e.g.*, a *Yersinia* invasin polypeptide comprising a sequence disclosed in GenBank® under Acc. No. YP_070195.1).

[00154] *Listeriolysin O (LLO)*: The terms "listeriolysin O" or "LLO" refer to a listeriolysin O polypeptide of *Listeria monocytogenes* and truncated forms thereof that retain pore-forming ability (*e.g.*, cytoplasmic forms of LLO, including truncated forms lacking a signal sequence). In some embodiments, an LLO is a cytoplasmic LLO. Exemplary LLO sequences are shown in Table 1, below.

[00155] *Polypeptide*: The term "polypeptide", as used herein, generally has its art-recognized meaning of a polymer of at least three amino acids. Those of ordinary skill in the art will appreciate, however, that the term "polypeptide" is intended to be sufficiently general as to encompass not only polypeptides having the complete sequence recited herein (or in a reference or database specifically mentioned herein), but also to encompass polypeptides that represent functional fragments (*i.e.*, fragments retaining at least one activity) and immunogenic fragments of such complete polypeptides. Moreover, those of ordinary skill in the art understand that protein sequences generally tolerate some substitution without destroying activity. Thus, any polypeptide that retains activity and shares at least about 30-40% overall sequence identity, often greater than about 50%, 60%, 70%, or 80%, and further usually including at least one region of much higher identity, often greater than 90% or even 95%, 96%, 97%, 98%, or 99% in one or more highly conserved regions, usually encompassing at least 3-4 and often up to 20 or more amino acids, with another polypeptide of the same class, is encompassed within the relevant term "polypeptide" as used herein. Other regions of similarity and/or identity can be determined by those of ordinary skill in the art by analysis of the sequences of various polypeptides.

[00156] *Primary cells*: As used herein, "primary cells" refers to cells from an organism that have not been immortalized *in vitro*. In some embodiments, primary cells are cells taken directly from a subject (*e.g.*, a human). In some embodiments, primary cells are progeny of cells taken from a subject (*e.g.*, cells that have been passaged *in vitro*). Primary cells include cells that have been stimulated to proliferate in culture.

[00157] *Response:* As used herein, in the context of a subject (a patient or experimental organism), "response", "responsive", or "responsiveness" refers to an alteration in a subject's condition that occurs as a result of, or correlates with, treatment. In certain embodiments, a response is a beneficial response. In certain embodiments, a beneficial response can include stabilization of a subject's condition (e.g., prevention or delay of deterioration expected or typically observed to occur absent the treatment), amelioration (e.g., reduction in frequency and/or intensity) of one or more symptoms of the condition, and/or improvement in the prospects for cure of the condition, etc. In certain embodiments, for a subject who has cancer, a beneficial response can include: the subject has a positive clinical response to cancer therapy or a combination of therapies; the subject has a spontaneous response to a cancer; the subject is in partial or complete remission from cancer; the subject has cleared a cancer; the subject has not

had a relapse, recurrence or metastasis of a cancer; the subject has a positive cancer prognosis; the subject has not experienced toxic responses or side effects to a cancer therapy or combination of therapies. In certain embodiments, for a subject who had cancer, the beneficial responses occurred in the past, or are ongoing.

[00158] In certain embodiments, a response is a deleterious or non-beneficial response. In certain embodiments, a deleterious or non-beneficial response can include deterioration of a subject's condition, lack of amelioration (e.g., no reduction in frequency and/or intensity) of one or more symptoms of the condition, and/or degradation in the prospects for cure of the condition, etc. In certain embodiments, for a subject who has cancer, a deleterious or non-beneficial response can include: the subject has a negative clinical response to cancer therapy or a combination of therapies; the subject is not in remission from cancer; the subject has not cleared a cancer; the subject has had a relapse, recurrence or metastasis of a cancer; the subject has a negative cancer prognosis; the subject has experienced toxic responses or side effects to a cancer therapy or combination of therapies. In certain embodiments, for a subject who had cancer, the deleterious or non-beneficial responses occurred in the past, or are ongoing.

[00159] As used herein, in the context of a cell, organ, tissue, or cell component, *e.g.*, a lymphocyte, "response", "responsive", or "responsiveness" refers to an alteration in cellular activity that occurs as a result of, or correlates with, administration of or exposure to an agent, *e.g.* a tumor antigen. In certain embodiments, a beneficial response can include increased expression and/or secretion of immune mediators associated with positive clinical responses or outcomes in a subject. In certain embodiments, a beneficial response can include decreased expression and/or secretion of immune mediators associated with negative clinical response or outcomes in a subject. In certain embodiments, a deleterious or non-beneficial response can include increased expression and/or secretion of immune mediators associated with negative clinical responses or outcomes in a subject. In certain embodiments, a deleterious or non-beneficial response can include decreased expression and/or secretion of immune mediators associated with positive clinical responses or outcomes in a subject. In certain embodiments, a response is a clinical response. In certain embodiments, a response is a cellular response. In certain embodiments, a response is a direct response. In certain embodiments, a response is an indirect response. In certain embodiments, "non-response", "non-responsive", or "non-responsiveness" mean minimal response or no detectable response. In certain embodiments, a

"minimal response" includes no detectable response. In certain embodiments, presence, extent, and/or nature of response can be measured and/or characterized according to particular criteria. In certain embodiments, such criteria can include clinical criteria and/or objective criteria. In certain embodiments, techniques for assessing response can include, but are not limited to, clinical examination, positron emission tomography, chest X-ray, CT scan, MRI, ultrasound, endoscopy, laparoscopy, presence or level of a particular marker in a sample, cytology, and/or histology. Where a response of interest is a response of a tumor to a therapy, ones skilled in the art will be aware of a variety of established techniques for assessing such response, including, for example, for determining tumor burden, tumor size, tumor stage, etc. Methods and guidelines for assessing response to treatment are discussed in Therasse et al., J. Natl. Cancer Inst., 2000, 92(3):205-216; and Seymour et al., Lancet Oncol., 2017, 18:e143-52. The exact response criteria can be selected in any appropriate manner, provided that when comparing groups of tumors, patients or experimental organism, and/or cells, organs, tissues, or cell components, the groups to be compared are assessed based on the same or comparable criteria for determining response rate. One of ordinary skill in the art will be able to select appropriate criteria.

[00160] *Tumor*: As used herein, the term "tumor" refers to an abnormal growth of cells or tissue. In some embodiments, a tumor may comprise cells that are precancerous (e.g., benign), malignant, pre-metastatic, metastatic, and/or non-metastatic. In some embodiments, a tumor is associated with, or is a manifestation of, a cancer. In some embodiments, a tumor may be a disperse tumor or a liquid tumor. In some embodiments, a tumor may be a solid tumor.

DETAILED DESCRIPTION

[00161] Recent advances in immune checkpoint inhibitor therapies such as ipilimumab, nivolumab, and pembrolizumab for cancer immunotherapy have resulted in dramatic efficacy in subjects suffering from NSCLC, among other indications. Nivolumab and pembroluzimab have been approved by the Food and Drug Administration (FDA) and European Medicines Agency (EMA) for use in patients with advanced NSCLC who have previously been treated with chemotherapy. They have solidified the importance of T cell responses in control of tumors. Neoantigens, potential cancer rejection antigens that are entirely absent from the normal human genome, are postulated to be relevant to tumor control; however, attempts to define them and

their role in tumor clearance has been hindered by the paucity of available tools to define them in a biologically relevant and unbiased way (Schumacher and Schreiber, 2015 *Science* 348:69-74, Gilchuk *et al.*, 2015 *Curr Opin Immunol* 34:43-51)

[00162] Taking non-small cell lung carcinoma (NSCLC) as an example, whole exome sequencing of NSCLC tumors from patients treated with pembrolizumab showed that higher non-synonymous mutation burden in tumors was associated with improved objective response, durable clinical benefit, and progression-free survival (Rizvi *et al.*, (2015) Science 348(6230): 124-8). In this study, the median non-synonymous mutational burden of the discovery cohort was 209 and of the validation cohort was 200. However, simply because a mutation was identified by sequencing, does not mean that the epitope it creates can be recognized by a T cell or serves as a protective antigen for T cell responses (Gilchuk *et al.*, 2015 *Curr Opin Immunol* 34:43-51*)*, making the use of the word neoantigen somewhat of a misnomer. With 200 or more potential targets of T cells in NSCLC, it is not feasible to test every predicted epitope to determine which of the mutations serve as neoantigens, and which neoantigens are associated with clinical evidence of tumor control. Recently, a study by McGranahan et al., showed that clonal neoantigen burden and overall survival in primary lung adenocarcinomas are related. However, even enriching for clonal neoantigens results in potential antigen targets ranging from 50 to approximately 400 (McGranahan *et al.*, 2016 *Science* 351:1463-69). Similar findings have been described for melanoma patients who have responded to ipilimumab therapy (Snyder *et al.*, 2015 NEJM; Van Allen *et al.*, 2015 *Science*) and in patients with mismatch-repair deficient colorectal cancer who were treated with pembrolizumab (Le *et al.*, 2015 NEJM).

[00163] The present disclosure provides methods and systems for the rapid identification of tumor antigens (*e.g.*, tumor specific antigens (TSAs, or neoantigens), tumor associated antigens (TAAs), or cancer/testis antigens (CTAs)) that elicit T cell responses and particularly that elicit human T cell responses, as well as polypeptides that are potential tumor antigens. For purposes of this disclosure, "tumor antigens" includes both tumor antigens and potential tumor antigens. As described herein, methods of the present disclosure identified stimulatory tumor antigens that were not identified by known algorithms. Further, methods of the present disclosure identified suppressive and/or inhibitory tumor antigens that are not identifiable by known algorithms. Methods of the present disclosure also identified polypeptides that are potential tumor antigens, *i.e.*, polypeptides that activate T cells of non-cancerous subjects, but not T cells of subjects

suffering from cancer. The present disclosure also provides methods of selecting tumor antigens and potential tumor antigens, methods of using the selected tumor antigens and potential tumor antigens, immunogenic compositions comprising the selected tumor antigens and potential tumor antigens, and methods of manufacturing immunogenic compositions. The present disclosure also provides methods of evaluating an immune response in a cancer subject, *e.g.*, for identifying or selecting subjects for initiation, continuation, modification, and/or discontinuation of cancer therapy.

Library generation

[00164] A library is a collection of members (*e.g.*, cells or non-cellular particles, such as virus particles, liposomes, or beads (*e.g.*, beads coated with polypeptides, such as *in vitro* translated polypeptides, *e.g.*, affinity beads, *e.g.*, antibody coated beads, or NTA-Ni beads bound to polypeptides of interest). According to the present disclosure, members of a library include (*e.g.*, internally express or carry) polypeptides of interest described herein. In some embodiments, members of a library are cells that internally express polypeptides of interest described herein. In some embodiments, members of a library which are particles carry, and/or are bound to, polypeptides of interest. Use of a library in an assay system allows simultaneous evaluation *in vitro* of cellular responses to multiple candidate antigens. According to the present disclosure, a library is designed to be internalized by human antigen presenting cells so that peptides from library members, including peptides from internally expressed polypeptides of interest, are presented on MHC molecules of the antigen presenting cells for recognition by T cells.

[00165] Libraries can be used in assays that detect peptides presented by human MHC class I and MHC class II molecules. Polypeptides expressed by the internalized library members are digested in intracellular endocytic compartments (*e.g.*, phagosomes, endosomes, lysosomes) of the human cells and presented on MHC class II molecules, which are recognized by human $CD4^+$ T cells. In some embodiments, library members include a cytolysin polypeptide, in addition to a polypeptide of interest. In some embodiments, library members include an invasin polypeptide, in addition to the polypeptide of interest. In some embodiments, library members include an autolysin polypeptide, in addition to the polypeptide of interest. In some embodiments, library members are provided with cells that express a cytolysin polypeptide (*i.e.*, the cytolysin and polypeptide of interest are not expressed in the same cell, and an antigen

presenting cell is exposed to members that include the cytolysin and members that include the polypeptide of interest, such that the antigen presenting cell internalizes both, and such that the cytolysin facilitates delivery of polypeptides of interest to the MHC class I pathway of the antigen presenting cell). A cytolysin polypeptide can be constitutively expressed in a cell, or it can be under the control of an inducible expression system (*e.g.*, an inducible promoter). In some embodiments, a cytolysin is expressed under the control of an inducible promoter to minimize cytotoxicity to the cell that expresses the cytolysin.

[00166] Once internalized by a human cell, a cytolysin polypeptide perforates intracellular compartments in the human cell, allowing polypeptides expressed by the library members to gain access to the cytosol of the human cell. Polypeptides released into the cytosol are presented on MHC class I molecules, which are recognized by $CD8^+$ T cells.

[00167] A library can include any type of cell or particle that can be internalized by and deliver a polypeptide of interest (and a cytolysin polypeptide, in applications where a cytolysin polypeptide is desirable) to, antigen presenting cells for use in methods described herein. Although the term "cell" is used throughout the present specification to refer to a library member, it is understood that, in some embodiments, the library member is a non-cellular particle, such as a virus particle, liposome, or bead. In some embodiments, members of the library include polynucleotides that encode the polypeptide of interest (and cytolysin polypeptide), and can be induced to express the polypeptide of interest (and cytolysin polypeptide) prior to, and/or during internalization by antigen presenting cells.

[00168] In some embodiments, the cytolysin polypeptide is heterologous to the library cell in which it is expressed, and facilitates delivery of polypeptides expressed by the library cell into the cytosol of a human cell that has internalized the library cell. Cytolysin polypeptides include bacterial cytolysin polypeptides, such as listeriolysin O (LLO), streptolysin O (SLO), and perfringolysin O (PFO). Additional cytolysin polypeptides are described in U.S. Pat. 6,004,815. In certain embodiments, library members express LLO. In some embodiments, a cytolysin polypeptide is not significantly secreted by the library cell (*e.g.*, less than 20%, 10%, 5%, or 1% of the cytolysin polypeptide produced by the cell is secreted). For example, the cytolysin polypeptide is a cytoplasmic cytolysin polypeptide, such as a cytoplasmic LLO polypeptide (*e.g.*, a form of LLO which lacks the N-terminal signal sequence, as described in Higgins *et al.*, *Mol.*

Microbiol. 31(6):1631-1641,1999). Exemplary cytolysin polypeptide sequences are shown in Table 1. The listeriolysin O (Δ3-25) sequence shown in the second row of Table 1 has a deletion of residues 3-25, relative to the LLO sequence in shown in the first row of Table 1, and is a cytoplasmic LLO polypeptide. In some embodiments, a cytolysin is expressed constitutively in a library host cell. In other embodiments, a cytolysin is expressed under the control of an inducible promoter. Cytolysin polypeptides can be expressed from the same vector, or from a different vector, as the polypeptide of interest in a library cell.

Table 1. Exemplary Cytolysin Polypeptides

Polypeptide Name (species)	Polypeptide Accession No. GI No.	Polypeptide Sequence
listeriolysin O (*Listeria monocytogenes*)	NP_463733.1 GI:16802248	MKKIMLVFITLILVSLPIAQQTEAKDASAFNKENSISSMAPPASP PASPKTPIEKKHADEIDKYIQGLDYNKNNVLVYHGDAVTNVPPRK GYKDGNEYIVVEKKKKSINQNNADIQVVNAISSLTYPGALVKANS ELVENQPDVLPVKRDSLTLSIDLPGMTNQDNKIVVKNATKSNVNN AVNTLVERWNEKYAQAYPNVSAKIDYDDEMAYSESQLIAKFGTAF KAVNNSLNVNFGAISEGKMQEEVISFKQIYYNVNVNEPTRPSRFF GKAVTKEQLQALGVNAENPPAYISSVAYGRQVYLKLSTNSHSTKV KAAFDAAVSGKSVSGDVELTNIIKNSSFKAVIYGGSAKDEVQIID GNLGDLRDILKKGATFNRETPGVPIAYTTNFLKDNELAVIKNNSE YIETTSKAYTDGKINIDHSGGYVAQFNISWDEVNYDPEGNEIVQH KNWSENNKSKLAHFTSSIYLPGNARNINVYAKECTGLAWEWWRTV IDDRNLPLVKNRNISIWGTTLYPKYSNKVDNPIE (SEQ ID NO:1)
listeriolysin O (Δ3-25)		MKDASAFNKENSISSMAPPASPPASPKTPIEKKHADEIDKYIQGL DYNKNNVLVYHGDAVTNVPPRKGYKDGNEYIVVEKKKKSINQNNA DIQVVNAISSLTYPGALVKANSELVENQPDVLPVKRDSLTLSIDL PGMTNQDNKIVVKNATKSNVNNAVNTLVERWNEKYAQAYPNVSAK IDYDDEMAYSESQLIAKFGTAFKAVNNSLNVNFGAISEGKMQEEV ISFKQIYYNVNVNEPTRPSRFFGKAVTKEQLQALGVNAENPPAYI SSVAYGRQVYLKLSTNSHSTKVKAAFDAAVSGKSVSGDVELTNII KNSSFKAVIYGGSAKDEVQIIDGNLGDLRDILKKGATFNRETPGV PIAYTTNFLKDNELAVIKNNSEYIETTSKAYTDGKINIDHSGGYV AQFNISWDEVNYDPEGNEIVQHKNWSENNKSKLAHFTSSIYLPGN ARNINVYAKECTGLAWEWWRTVIDDRNLPLVKNRNISIWGTTLYP KYSNKVDNPIE(SEQ ID NO:2)
streptolysin O (*Streptococcus pyogenes*)	BAB41212.2 GI:71061060	MSNKKTFKKYSRVAGLLTAALIIGNLVTANAESNKQNTASTETTT TSEQPKPESSELTIEKAGQKMDDMLNSNDMIKLAPKEMPLESAEK EEKKSEDKKKSEEDHTEEINDKIYSLNYNELEVLAKNGETIENFV PKEGVKKADKFIVIERKKKNINTTPVDISIIDSVTDRTYPAALQL ANKGFTENKPDAVVTKRNPQKIHIDLPGMGDKATVEVNDPTYANV STAIDNLVNQWHDNYSGGNTLPARTQYTESMVYSKSQIEAALNVN SKILDGTLGIDFKSISKGEKKVMIAAYKQIFYTVSANLPNNPADV FDKSVTFKDLQRKGVSNEAPPLFVSNVAYGRTVFVKLETSSKSND VEAAFSAALKGTDVKTNGKYSDILENSSFTAVVLGGDAAEHNKVV TKDFDVIRNVIKDNATFSRKNPAYPISYTSVFLKNNKIAGVNNRT EYVETTSTEYTSGKINLSHQGAYVAQYEILWDEINYDDKGKEVIT KRRWDNNWYSKTSPFSTVIPLGANSRNIRIMARECTGLAWEWWRK

		VIDERDVKLSKEINVNISGSTLSPYGSITYK (SEQ ID NO:3)
perfringolysin O (*Clostridium perfringens*)	NP_561079.1 GI:18309145	MIRFKKTKLIASIAMALCLFSQPVISFSKDITDKNQSIDSGISSL SYNRNEVLASNGDKIESFVPKEGKKTGNKFIVVERQKRSLTTSPV DISIIDSVNDRTYPGALQLADKAFVENRPTILMVKRKPININIDL PGLKGENSIKVDDPTYGKVSGAIDELVSKWNEKYSSTHTLPARTQ YSESMVYSKSQISSALNVNAKVLENSLGVDFNAVANNEKKVMILA YKQIFYTVSADLPKNPSDLFDDSVTFNDLKQKGVSNEAPPLMVSN VAYGRTIYVKLETTSSSKDVQAAFKALIKNTDIKNSQQYKDIYEN SSFTAVVLGGDAQEHNKVVTKDFDEIRKVIKDNATFSTKNPAYPI SYTSVFLKDNSVAAVHNKTDYIETTSTEYSKGKINLDHSGAYVAQ FEVAWDEVSYDKEGNEVLTHKTWDGNYQDKTAHYSTVIPLEANAR NIRIKARECTGLAWEWWRDVISEYDVPLTNNINVSIWGTTLYPGS SITYN (SEQ ID NO:4)
Pneumolysin (*Streptococcus pneumoniae*)	NP_359331.1 GI:933687	MANKAVNDFILAMNYDKKKLLTHQGESIENRFIKEGNQLPDEFVV IERKKRSLSTNTSDISVTATNDSRLYPGALLVVDETLLENNPTLL AVDRAPMTYSIDLPGLASSDSFLQVEDPSNSSVRGAVNDLLAKWH QDYGQVNNVPARMQYEKITAHSMEQLKVKFGSDFEKTGNSLDIDF NSVHSGEKQIQIVNFKQIYYTVSVDAVKNPGDVFQDTVTVEDLKQ RGISAERPLVYISSVAYGRQVYLKLETTSKSDEVEAAFEALIKGV KVAPQTEWKQILDNTEVKAVILGGDPSSGARVVTGKVDMVEDLIQ EGSRFTADHPGLPISYTTSFLRDNVVATFQNSTDYVETKVTAYRN GDLLLDHSGAYVAQYYITWDELSYDHQGKEVLTPKAWDRNGQDLT AHFTTSIPLKGNVRNLSVKIRECTGLAWEWWRTVYEKTDLPLVRK RTISIWGTTLYPQVEDKVEND (SEQ ID NO:5)

[00169] In some embodiments, a library member (*e.g.*, a library member which is a bacterial cell) includes an invasin that facilitates uptake by the antigen presenting cell. In some embodiments, a library member includes an autolysin that facilitates autolysis of the library member within the antigen presenting cell. In some embodiments, a library member includes both an invasin and an autolysin. In some embodiments, a library member which is an *E. coli* cell includes an invasin and/or an autolysin. In various embodiments, library cells that express an invasin and/or autolysin are used in methods that also employ non-professional antigen presenting cells or antigen presenting cells that are from cell lines. Isberg *et al.* (*Cell*, 1987, 50:769-778), Sizemore *et al.* (*Science*, 1995, 270:299-302) and Courvalin *et al.* (*C.R. Acad. Sci. Paris*, 1995, 318:1207-12) describe expression of an invasin to effect endocytosis of bacteria by target cells. Autolysins are described by Cao *et al.*, *Infect. Immun.* 1998, 66(6): 2984-2986; Margot *et al.*, *J. Bacteriol.* 1998, 180(3):749-752; Buist *et al.*, *Appl. Environ. Microbiol.*, 1997, 63(7):2722-2728; Yamanaka *et al.*, *FEMS Microbiol. Lett.*, 1997, 150(2): 269-275; Romero *et al.*, *FEMS Microbiol. Lett.*, 1993, 108(1):87-92; Betzner and Keck, *Mol. Gen. Genet.*, 1989, 219(3): 489-491; Lubitz *et al.*, *J. Bacteriol.*, 1984, 159(1):385-387; and Tomasz *et al.*, *J.*

Bacteriol., 1988, 170(12): 5931-5934. In some embodiments, an autolysin has a feature that permits delayed lysis, *e.g.*, the autolysin is temperature-sensitive or time-sensitive (see, *e.g.*, Chang *et al.*, 1995, *J. Bact.* 177, 3283-3294; Raab *et al.*, 1985, *J. Mol. Biol.* 19, 95-105; Gerds *et al.*, 1995, *Mol. Microbiol.* 17, 205-210). Useful cytolysins also include addiction (poison/antidote) autolysins, (see, *e.g.*, Magnuson R, *et al.*, 1996, *J. Biol. Chem.* 271(31), 18705-18710; Smith A S, *et al.*, 1997, *Mol. Microbiol.* 26(5), 961-970).

[00170] In some embodiments, members of the library include bacterial cells. In certain embodiments, the library includes non-pathogenic, non-virulent bacterial cells. Examples of bacteria for use as library members include *E. coli*, mycobacteria, *Listeria monocytogenes*, *Shigella flexneri*, *Bacillus subtilis*, or *Salmonella*.

[00171] In some embodiments, members of the library include eukaryotic cells (*e.g.*, yeast cells). In some embodiments, members of the library include viruses (*e.g.*, bacteriophages). In some embodiments, members of the library include liposomes. Methods for preparing liposomes that include a cytolysin and other agents are described in Kyung-Dall et al., U.S. Pat. No. 5,643,599. In some embodiments, members of the library include beads. Methods for preparing libraries comprised of beads are described, *e.g.*, in Lam et al., *Nature* 354: 82-84, 1991, U.S. Pat. Nos. 5,510,240 and 7,262,269, and references cited therein.

[00172] In certain embodiments, a library is constructed by cloning polynucleotides encoding polypeptides of interest, or portions thereof, into vectors that express the polypeptides of interest in cells of the library. The polynucleotides can be synthetically synthesized. The polynucleotides can be cloned by designing primers that amplify the polynucleotides. Primers can be designed using available software, such as Primer3Plus (available the following URL: bioinformatics.nl/cgi-bin/primer3plus/primer3plus.cgi; see Rozen and Skaletsky, In: Krawetz S, Misener S (eds) *Bioinformatics Methods and Protocols: Methods in Molecular Biology.* Humana Press, Totowa, NJ, pp. 365-386, 2000). Other methods for designing primers are known to those of skill in the art. In some embodiments, primers are constructed so as to produce polypeptides that are truncated, and/or lack hydrophobic regions (*e.g.*, signal sequences or transmembrane regions) to promote efficient expression. The location of predicted signal sequences and predicted signal sequence cleavage sites in a given open reading frame (ORF) sequence can be determined using available software, see, *e.g.*, Dyrløv *et al., J. Mol. Biol.*, 340:783-795, 2004,

and the following URL: cbs.dtu.dk/services/SignalP/). For example, if a signal sequence is predicted to occur at the N-terminal 20 amino acids of a given polypeptide sequence, a primer is designed to anneal to a coding sequence downstream of the nucleotides encoding the N-terminal 20 amino acids, such that the amplified sequence encodes a product lacking this signal sequence.

[00173] Primers can also be designed to include sequences that facilitate subsequent cloning steps. ORFs can be amplified directly from genomic DNA (*e.g.*, genomic DNA of a tumor cell), or from polynucleotides produced by reverse transcription (RT-PCR) of mRNAs expressed by the tumor cell. RT-PCR of mRNA is useful, *e.g.*, when the genomic sequence of interest contains intronic regions. PCR-amplified ORFs are cloned into an appropriate vector, and size, sequence, and expression of ORFs can be verified prior to use in immunological assays.

[00174] In some embodiments, a polynucleotide encoding a polypeptide of interest is linked to a sequence encoding a tag (*e.g.*, an N-terminal or C-terminal epitope tag) or a reporter protein (*e.g.*, a fluorescent protein). Epitope tags and reporter proteins facilitate purification of expressed polypeptides, and can allow one to verify that a given polypeptide is properly expressed in a library host cell, *e.g.*, prior to using the cell in a screen. Useful epitope tags include, for example, a polyhistidine (His) tag, a V5 epitope tag from the P and V protein of paramyxovirus, a hemagglutinin (HA) tag, a myc tag, and others. In some embodiments, a polynucleotide encoding a polypeptide of interest is fused to a sequence encoding a tag which is a known antigenic epitope (*e.g.*, an MHC class I- and/or MHC class II-restricted T cell epitope of a model antigen such as an ovalbumin), and which can be used to verify that a polypeptide of interest is expressed and that the polypeptide-tag fusion protein is processed and presented in antigen presentation assays. In some embodiments a tag includes a T cell epitope of a murine T cell (*e.g.*, a murine T cell line). In some embodiments, a polynucleotide encoding a polypeptide of interest is linked to a tag that facilitates purification and a tag that is a known antigenic epitope. Useful reporter proteins include naturally occurring fluorescent proteins and their derivatives, for example, Green Fluorescent Protein (*Aequorea Victoria*) and Neon Green (*Branchiostoma lanceolatum*). Panels of synthetically derived fluorescent and chromogenic proteins are also available from commercial sources.

[00175] Polynucleotides encoding a polypeptide of interest are cloned into an expression vector for introduction into library host cells. Various vector systems are available to facilitate

cloning and manipulation of polynucleotides, such as the Gateway® Cloning system (Invitrogen). As is known to those of skill in the art, expression vectors include elements that drive production of polypeptides of interest encoded by a polynucleotide in library host cells (*e.g.*, promoter and other regulatory elements). In some embodiments, polypeptide expression is controlled by an inducible element (*e.g.*, an inducible promoter, *e.g.*, an IPTG- or arabinose- inducible promoter, or an IPTG-inducible phage T7 RNA polymerase system, a lactose (*lac*) promoter, a tryptophan (*trp*) promoter, a *tac* promoter, a *trc* promoter, a phage lambda promoter, an alkaline phosphatase (*phoA*) promoter, to give just a few examples; see Cantrell, *Meth. in Mol. Biol.*, 235:257-276, Humana Press, Casali and Preston, Eds.). In some embodiments, polypeptides are expressed as cytoplasmic polypeptides. In some embodiments, the vector used for polypeptide expression is a vector that has a high copy number in a library host cell. In some embodiments, the vector used for expression has a copy number that is more than 25, 50, 75, 100, 150, 200, or 250 copies per cell. In some embodiments, the vector used for expression has a ColE1 origin of replication. Useful vectors for polypeptide expression in bacteria include pET vectors (Novagen), Gateway® pDEST vectors (Invitrogen), pGEX vectors (Amersham Biosciences), pPRO vectors (BD Biosciences), pBAD vectors (Invitrogen), pLEX vectors (Invitrogen), pMAL™ vectors (New England BioLabs), pGEMEX vectors (Promega), and pQE vectors (Qiagen). Vector systems for producing phage libraries are known and include Novagen T7Select® vectors, and New England Biolabs Ph.D.™ Peptide Display Cloning System.

[00176] In some embodiments, library host cells express (either constitutively, or when induced, depending on the selected expression system) a polypeptide of interest to at least 10%, 20%, 30%, 40%, 50%, 60%, or 70% of the total cellular protein. In some embodiments, the level a polypeptide available in or on a library member (*e.g.*, cell, virus particle, liposome, bead) is such that antigen presenting cells exposed to a sufficient quantity of the library members are presented on MHC molecules polypeptide epitopes at a density that is comparable to the density presented by antigen presenting cells pulsed with purified peptides.

[00177] Methods for efficient, large-scale production of libraries are available. For example, site-specific recombinases or rare-cutting restriction enzymes can be used to transfer polynucleotides between expression vectors in the proper orientation and reading frame (Walhout *et al.*, *Meth. Enzymol.* 328:575–592, 2000; Marsischky *et al.*, *Genome Res.* 14:2020–202, 2004; Blommel *et al.*, *Protein Expr. Purif.* 47:562–570, 2006).

[00178] For production of liposome libraries, expressed polypeptides (*e.g.*, purified or partially purified polypeptides) can be entrapped in liposomal membranes, *e.g.*, as described in Wassef *et al.*, U.S. Pat. No. 4,863,874; Wheatley *et al.*, U.S. Pat. No. 4,921,757; Huang *et al.*, U.S. Pat. No. 4,925,661; or Martin *et al.*, U.S. Pat. No. 5,225,212.

[00179] A library can be designed to include full length polypeptides and/or portions of polypeptides. Expression of full length polypeptides maximizes epitopes available for presentation by a human antigen presenting cell, thereby increasing the likelihood of identifying an antigen. However, in some embodiments, it is useful to express portions of polypeptides, or polypeptides that are otherwise altered, to achieve efficient expression. For example, in some embodiments, polynucleotides encoding polypeptides that are large (*e.g.*, greater than 1,000 amino acids), that have extended hydrophobic regions, signal peptides, transmembrane domains, or domains that cause cellular toxicity, are modified (*e.g.*, by C-terminal truncation, N-terminal truncation, or internal deletion) to reduce cytotoxicity and permit efficient expression a library cell, which in turn facilitates presentation of the encoded polypeptides on human cells. Other types of modifications, such as point mutations or codon optimization, may also be used to enhance expression.

[00180] The number of polypeptides included in a library can be varied. For example, in some embodiments, a library can be designed to express polypeptides from at least 5%, 10%, 15%, 20%, 25%, 35%, 40%, 45%, 50%, 55%, 60%, 70%, 75%, 80%, 85%, 90%, 95%, 97%, 98%, 99%, or more, of ORFs in a target cell (e.g., tumor cell). In some embodiments, a library expresses at least 10, 15, 20, 25, 30, 40, 50, 75, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000, 2500, 5000, 10,000, or more different polypeptides of interest, each of which may represent a polypeptide encoded by a single full length polynucleotide or portion thereof.

[00181] In some embodiments, assays may focus on identifying antigens that are secreted polypeptides, cell surface-expressed polypeptides, or virulence determinants, *e.g.*, to identify antigens that are likely to be targets of both humoral and cell mediated immune responses.

[00182] In addition to polypeptides of interest, libraries can include tags or reporter proteins that allow one to easily purify, analyze, or evaluate MHC presentation, of the polypeptide of interest. In some embodiments, polypeptides expressed by a library include C-terminal tags that

include both an MHC class I and an MHC class II-restricted T cell epitope from a model antigen, such as chicken ovalbumin (OVA). Library protein expression and MHC presentation is validated using these epitopes. In some embodiments, the epitopes are $OVA_{247-265}$ and $OVA_{258-265}$ respectfully, corresponding to positions in the amino acid sequence found in GenBank® under Acc. No. NP_990483. Expression and presentation of linked ORFs can be verified with antigen presentation assays using T cell hybridomas (*e.g.*, B3Z T hybridoma cells, which are H2-K^b restricted, and KZO T hybridoma cells, which are H2-A^k restricted) that specifically recognize these epitopes.

[00183] Sets of library members (*e.g.*, bacterial cells) can be provided on an array (*e.g.*, on a solid support, such as a 96-well plate) and separated such that members in each location express a different polypeptide of interest, or a different set of polypeptides of interest.

[00184] Methods of using library members for identifying T cell antigens are described in detail below. In addition to these methods, library members also have utility in assays to identify B cell antigens. For example, lysate prepared from library members that include polypeptides of interest can be used to screen a sample comprising antibodies (*e.g.*, a serum sample) from a subject (*e.g.*, a subject who has been exposed to an infectious agent of interest, a subject who has cancer, and/or a control subject), to determine whether antibodies present in the subject react with the polypeptide of interest. Suitable methods for evaluating antibody reactivity are known and include, e.g., ELISA assays.

Polypeptides of Interest

[00185] In some embodiments, methods and compositions described herein can be used to identify and/or detect immune responses to a polypeptide of interest. In some embodiments, a polypeptide of interest is encoded by an ORF from a target tumor cell, and members of a library include (*e.g.*, internally express or carry) ORFs from a target tumor cell. In some such embodiments, a library can be used in methods described herein to assess immune responses to one or more polypeptides of interest encoded by one or more ORFs. In some embodiments, methods of the disclosure identify one or more polypeptides of interest as stimulatory antigens (*e.g.*, that stimulate an immune response, *e.g.*, a T cell response, *e.g.*, expression and/or secretion of one or more immune mediators). In some embodiments, methods of the disclosure identify

one or more polypeptides of interest as antigens or potential antigens that have minimal or no effect on an immune response (*e.g.*, expression and/or secretion of one or more immune mediators). In some embodiments, methods of the disclosure identify one or more polypeptides of interest as inhibitory and/or suppressive antigens (*e.g.*, that inhibit, suppress, down-regulate, impair, and/or prevent an immune response, *e.g.*, a T cell response, *e.g.*, expression and/or secretion of one or more immune mediators). In some embodiments, methods of the disclosure identify one or more polypeptides of interest as tumor antigens or potential tumor antigens, *e.g.*, tumor specific antigens (TSAs, or neoantigens), tumor associated antigens (TAAs), or cancer/testis antigens (CTAs).

[00186] In some embodiments, a polypeptide of interest is a putative tumor antigen, and methods and compositions described herein can be used to identify and/or detect immune responses to one or more putative tumor antigens. For example, members of a library include (*e.g.*, internally express or carry) putative tumor antigens (*e.g.*, a polypeptide previously identified (*e.g.*, by a third party) as a tumor antigen, *e.g.*, identified as a tumor antigen using a method other than a method of the present disclosure). In some embodiments, a putative tumor antigen is a tumor antigen described herein. In some such embodiments, such libraries can be used to assess whether and/or the extent to which such putative tumor antigen mediates an immune response. In some embodiments, methods of the disclosure identify one or more putative tumor antigens as stimulatory antigens. In some embodiments, methods of the disclosure identify one or more putative tumor antigens as antigens that have minimal or no effect on an immune response. In some embodiments, methods of the disclosure identify one or more putative tumor antigens as inhibitory and/or suppressive antigens.

[00187] In some embodiments, a polypeptide of interest is a pre-selected tumor antigen, and methods and compositions described herein can be used to identify and/or detect immune responses to one or more pre-selected tumor antigens. For example, in some embodiments, members of a library include (*e.g.*, internally express or carry) one or more polypeptides identified as tumor antigens using a method of the present disclosure and/or using a method other than a method of the present disclosure. In some such embodiments, such libraries can be used to assess whether and/or the extent to which such tumor antigens mediate an immune response by an immune cell from one or more subjects (*e.g.*, a subject who has cancer and/or a control subject) to obtain one or more response profiles described herein. In some embodiments,

methods of the disclosure identify one or more pre-selected tumor antigens as stimulatory antigens for one or more subjects. In some embodiments, methods of the disclosure identify one or more pre-selected tumor antigens as antigens that have minimal or no effect on an immune response for one or more subjects. In some embodiments, methods of the disclosure identify one or more pre-selected tumor antigens as inhibitory and/or suppressive antigens for one or more subjects.

[00188] In some embodiments, a polypeptide of interest is a known tumor antigen, and methods and compositions described herein can be used to identify and/or detect immune responses to one or more known tumor antigens. For example, in some embodiments, members of a library include (*e.g.*, internally express or carry) one or more polypeptides identified as a tumor antigen using a method of the present disclosure and/or using a method other than a method of the present disclosure. In some such embodiments, such libraries can be used to assess whether and/or the extent to which such tumor antigens mediate an immune response by an immune cell from one or more subjects (*e.g.*, a subject who has cancer and/or a control subject) to obtain one or more response profiles described herein. In some embodiments, methods of the disclosure identify one or more known tumor antigens as stimulatory antigens for one or more subjects. In some embodiments, methods of the disclosure identify one or more known tumor antigens as antigens that have minimal or no effect on an immune response for one or more subjects. In some embodiments, methods of the disclosure identify one or more known tumor antigens as inhibitory and/or suppressive antigens for one or more subjects.

[00189] In some embodiments, a polypeptide of interest is a potential tumor antigen, and methods and compositions described herein can be used to identify and/or detect immune responses to one or more potential tumor antigens. For example, in some embodiments, members of a library include (*e.g.*, internally express or carry) one or more polypeptides identified as being of interest, *e.g.*, encoding mutations associated with a tumor, using a method of the present disclosure and/or using a method other than a method of the present disclosure. In some such embodiments, such libraries can be used to assess whether and/or the extent to which such polypeptides mediate an immune response by an immune cell from one or more subjects (*e.g.*, a subject who has cancer and/or a control subject) to obtain one or more response profiles described herein. In some embodiments, methods of the disclosure identify one or more polypeptides as stimulatory antigens for one or more subjects. In some embodiments, methods

of the disclosure identify one or more polypeptides as antigens that have minimal or no effect on an immune response for one or more subjects. In some embodiments, methods of the disclosure identify one or more polypeptides as inhibitory and/or suppressive antigens for one or more subjects.

Tumor Antigens

[00190] Polypeptides of interest used in methods and systems described herein include tumor antigens amd potential tumor antigens, *e.g.*, tumor specific antigens (TSAs, or neoantigens), tumor associated antigens (TAAs), and/or cancer/testis antigens (CTAs). Exemplary tumor antigens include, e.g., MART-1/MelanA (MART-I or MLANA), gp100 (Pmel 17 or SILV), tyrosinase, TRP-1, TRP-2, MAGE-1, MAGE-3 (also known as HIP8), BAGE, GAGE-1, GAGE-2, p15, Calcitonin, Calretinin, Carcinoembryonic antigen (CEA), Chromogranin, Cytokeratin, Desmin, Epithelial membrane protein (EMA), Factor VIII, Glial fibrillary acidic protein (GFAP), Gross cystic disease fluid protein (GCDFP-15), HMB-45, Human chorionic gonadotropin (hCG), inhibin, lymphocyte marker, MART-1 (Melan-A), Myo D1, muscle-specific actin (MSA), neurofilament, neuron-specific enolase (NSE), placental alkaline phosphatase (PLAP), prostate-specific antigen, PTPRC (CD45), S100 protein, smooth muscle actin (SMA), synaptophysin, thyroglobulin, thyroid transcription factor-1, Tumor M2-PK, vimentin, p53, Ras, HER-2/neu, BCR-ABL, E2A-PRL, H4-RET, IGH-IGK, MYL-RAR, Epstein Barr virus antigens (e.g., EBNA1), human papillomavirus (HPV) antigen E6 or E7 (HPV_E6 or HPV_E7), TSP-180, MAGE-4, MAGE-5, MAGE-6, RAGE, NY-ESO-1 (also known as CTAG1B), erbB, p185erbB2, p180erbB-3, c-met, nm-23H1, PSA, TAG-72, CA 19-9, CA 72-4, CAM 17.1, NuMa, K-ras, beta-Catenin, CDK4, Mum-1, p 15, p 16, 43-9F, 5T4, 791Tgp72, alpha-fetoprotein (AFP), beta-HCG, BCA225, BTAA, CA 125, CA 15-3\CA 27.29\BCAA, CA 195, CA 242, CA-50, CAM43, CD68\P1, CO-029, FGF-5, G250, Ga733\EpCAM, HTgp-175, M344, MA-50, MG7-Ag, MOV18, NB/70K, NY-CO-1, RCAS1, SDCCAG16, TA-90\Mac-2 binding protein\cyclophilin C-associated protein, TAAL6, TAG72, TLP, MUC16, IL13Rα2, FRα, VEGFR2, Lewis Y, FAP, EphA2, CEACAM5, EGFR, CA6, CA9, GPNMB, EGP1, FOLR1, endothelial receptor, STEAP1, SLC44A4, Nectin-4, AGS-16, guanalyl cyclase C, MUC-1, CFC1B, integrin alpha 3 chain (of a3b1, a laminin receptor chain), TPS, CD19, CD20, CD22, CD30, CD31, CD72,

CD180, CD171 (L1CAM), CD123, CD133, CD138, CD37, CD70, CD79a, CD79b, CD56, CD74, CD166, CD71, CD34, CD99, CD117, CD80, CD28, CD13, CD15, CD25, CD10, CLL-1/CLEC12A, ROR1, Glypican 3 (GPC3), Mesothelin, CD33/IL3Ra, c-Met, PSCA, PSMA, Glycolipid F77, EGFRvIII, BCMA, GD-2, PSAP, prostein (also known as P501S), PSMA, Survivin (also known as BIRC5), and MAGE-A3, MAGEA2, MAGEA4, MAGEA6, MAGEA9, MAGEA10, MAGEA12, BIRC5, CDH3, CEACAM3, CGB_isoform2, ELK4, ERBB2, HPSE1, HPSE2, KRAS_isoform1, KRAS_isoform2, MUC1, SMAD4, TERT,2. TERT.3, TGFBR2, EGAG9_isoform1, TP53, CGB_isoform1, IMPDH2, LCK, angiopoietin-1 (Ang1) (also known as ANGPT1), XIAP (also known as BIRC4), galectin-3 (also known as LGALS3), VEGF-A (also known as VEGF), ATP6S1 (also known as ATP6AP1), MAGE-A1, cIAP-1 (also known as BIRC2), macrophage migration inhibitory factor (MIF), galectin-9 (also known as LGALS9), progranulin PGRN (also known as granulin), OGFR, MLIAP (also known as BIRC7), TBX4 (also known as ICPPS, SPS or T-Box4), secretory leukocyte protein inhibitor (Slpi) (also known as antileukoproteinase), Ang2 (also known as ANGPT2), galectin-1 (also known as LGALS1), TRP-2 (also known as DCT), hTERT (telomerase reverse transcriptase) tyrosinase-related protein 1 (TRP-1, TYRP1), NOR-90/UBF-2 (also known as UBTF), LGMN, SPA17, PRTN3, TRRAP_1, TRRAP_2, TRRAP_3, TRRAP_4, MAGEC2, PRAME, SOX10, RAC1, HRAS, GAGE4, AR, CYP1B1, MMP8, TYR, PDGFRB, KLK3, PAX3, PAX5, ST3GAL5, PLAC1, RhoC, MYCN, REG3A, CSAG2, CTAG2-1a, CTAG2-1b, PAGE4, BRAF, GRM3, ERBB4, KIT, MAPK1, MFI2, SART3, ST8SIA1, WDR46, AKAP-4, RGS5, FOSL1, PRM2, ACRBP, CTCFL, CSPG4, CCNB1, MSLN, WT1, SSX2, KDR, ANKRD30A, MAGED1, MAP3K9, XAGE1B, PREX2, CD276, TEK, AIM1, ALK, FOLH1, GRIN2A MAP3K5 and one or more isoforms of any preceding tumor antigens. Exemplary tumor antigens are provided in the accompanying list of sequences.

[00191] Tumor specific antigens (TSAs, or neoantigens) are tumor antigens that are not encoded in normal host genome (see, e.g., Yarchoan et al., Nat. Rev. Cancer. 2017 Feb 24. doi: 10.1038/nrc.2016.154; Gubin et al., J. Clin. Invest. 125:3413-3421 (2015)). In some embodiments, TSAs arise from somatic mutations and/or other genetic alterations. In some embodiments, TSAs arise from missense or in-frame mutations. In some embodiments, TSAs arise from frame-shift mutations or loss-of-stop-codon mutations. In some embodiments, TSAs arise from insertion or deletion mutations. In some embodiments, TSAs arise from duplication

or repeat expansion mutations. In some embodiments, TSAs arise from splice variants or improper splicing. In some embodiments, TSAs arise from gene fusions. In some embodiments, TSAs arise from translocations. In some embodiments, TSAs include oncogenic viral proteins. For example, as with Merkel cell carcinoma (MCC) associated with the Merkel cell polyomavirus (MCPyV) and cancers of the cervix, oropharynx and other sites associated with the human papillomavirus (HPV), TSAs include proteins encoded by viral open reading frames. For purposes of this disclosure, the terms "mutation" and "mutations" encompass all mutations and genetic alterations that may give rise to an antigen encoded in the genome of a cancer or tumor cell of a subject, but not in a normal or non-cancerous cell of the same subject. In some embodiments, TSAs are specific (personal) to a subject. In some embodiments, TSAs are shared by more than one subject, *e.g.*, less than 1%, 1-3%, 1-5%, 1-10% , or more of subjects suffering from a cancer. In some embodiments, TSAs shared by more than one subject may be known or pre-selected.

[00192] In some embodiments, a TSA is encoded by an open reading frame from a virus. For example, a library can be designed to express polypeptides from one of the following viruses: an immunodeficiency virus (*e.g.*, a human immunodeficiency virus (HIV), *e.g.*, HIV-1, HIV-2), a hepatitis virus (*e.g.*, hepatitis B virus (HBV), hepatitis C virus (HCV), hepatitis A virus, non-A and non-B hepatitis virus), a herpes virus (*e.g.*, herpes simplex virus type I (HSV-1), HSV-2, Varicella-zoster virus, Epstein Barr virus, human cytomegalovirus, human herpesvirus 6 (HHV-6), HHV-7, HHV-8), a poxvirus (*e.g.*, variola, vaccinia, monkeypox, Molluscum contagiosum virus), an influenza virus, a human papilloma virus, adenovirus, rhinovirus, coronavirus, respiratory syncytial virus, rabies virus, coxsackie virus, human T cell leukemia virus (types I, II and III), parainfluenza virus, paramyxovirus, poliovirus, rotavirus, rhinovirus, rubella virus, measles virus, mumps virus, adenovirus, yellow fever virus, Norwalk virus, West Nile virus, a Dengue virus, Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV), bunyavirus, Ebola virus, Marburg virus, Eastern equine encephalitis virus, Venezuelan equine encephalitis virus, Japanese encephalitis virus, St. Louis encephalitis virus, Junin virus, Lassa virus, and Lymphocytic choriomeningitis virus. Libraries for other viruses can also be produced and used according to methods described herein.

[00193] Tumor specific antigens are known in the art, any of which can be used in methods described herein. In some embodiments, gene sequences encoding polypeptides that are

potential or putative neoantigens are determined by sequencing the genome and/or exome of tumor tissue and healthy tissue from a subject having cancer using next generation sequencing technologies. In some embodiments, genes that are selected based on their frequency of mutation and ability to encode a potential or putative neoantigen are sequenced using next-generation sequencing technology. Next-generation sequencing applies to genome sequencing, genome resequencing, transcriptome profiling (RNA-Seq), DNA-protein interactions (ChIP-sequencing), and epigenome characterization (de Magalhaes et al. (2010) Ageing Research Reviews 9 (3): 315-323; Hall N (2007) J. Exp. Biol. 209 (Pt 9): 1518-1525; Church (2006) Sci. Am. 294 (1): 46-54; ten Bosch et al. (2008) Journal of Molecular Diagnostics 10 (6): 484-492; Tucker T et al. (2009) The American Journal of Human Genetics 85 (2): 142-154). Next-generation sequencing can be used to rapidly reveal the presence of discrete mutations such as coding mutations in individual tumors, *e.g.*, single amino acid changes (*e.g.*, missense mutations, in-frame mutations) or novel stretches of amino acids generated by frame-shift insertions, deletions, gene fusions, read-through mutations in stop codons, duplication or repeat expansion mutations, and translation of splice variants or improperly spliced introns, and translocations (*e.g.*, "neoORFs").

[00194] Another method for identifying potential or putative neoantigens is direct protein sequencing. Protein sequencing of enzymatic digests using multidimensional MS techniques (MSn) including tandem mass spectrometry (MS/MS)) can also be used to identify neoantigens. Such proteomic approaches can be used for rapid, highly automated analysis (see, e.g., Gevaert et al., Electrophoresis 21:1145-1154 (2000)). High-throughput methods for de novo sequencing of unknown proteins can also be used to analyze the proteome of a subject's tumor to identify expressed potential or putative neoantigens. For example, meta shotgun protein sequencing may be used to identify expressed potential or putative neoantigens (see e.g., Guthals et al. (2012) Molecular and Cellular Proteomics 11(10):1084-96).

[00195] Potential or putative neoantigens may also be identified using MHC multimers to identify neoantigen-specific T cell responses. For example, high-throughput analysis of neoantigen-specific T cell responses in patient samples may be performed using MHC tetramer-based screening techniques (see e.g., Hombrink et al. (2011) PLoS One; 6(8): e22523; Hadrup et al. (2009) Nature Methods, 6(7):520-26; van Rooij et al. (2013) Journal of Clinical Oncology, 31:1-4; and Heemskerk et al. (2013) EMBO Journal, 32(2):194-203).

[00196] In some embodiments, one or more known or pre-selected tumor specific antigens, or one or more potential or putative tumor specific antigens identified using one of these methods, can be included in a library described herein.

[00197] Tumor associated antigens (TAAs) include proteins encoded in a normal genome (see, e.g., Ward et al., Adv. Immunol. 130:25-74 (2016)). In some embodiments, TAAs are either normal differentiation antigens or aberrantly expressed normal proteins. Overexpressed normal proteins that possess growth/survival-promoting functions, such as Wilms tumor 1 (WT1) (Ohminami et al., Blood 95:286-293 (2000)) or Her2/neu (Kawashima et al., Cancer Res. 59:431-435 (1999)), are TAAs that directly participate in the oncogenic process. Post-translational modifications, such as phosphorylation, of proteins may also lead to formation of TAAs (Doyle, J. Biol. Chem. 281:32676-32683 (2006); Cobbold, Sci. Transl. Med. 5:203ra125 (2013)). TAAs are generally shared by more than one subject, *e.g.*, less than 1%, 1-3%, 1-5%, 1-10%, 1-20%, or more of subjects suffering from a cancer. In some embodiments, TAAs are known or pre-selected tumor antigens. In some embodiments, with respect to an individual subject, TAAs are potential or putative tumor antigens.Cancer/testis antigens (CTAs) are expressed by various tumor types and by reproductive tissues (for example, testes, fetal ovaries and trophoblasts) but have limited or no detectable expression in other normal tissues in the adult and are generally not presented on normal reproductive cells, because these tissues do not express MHC class I molecules (see, e.g., Coulie et al., Nat. Rev. Cancer 14:135-146 (2014); Simpson et al., Nat. Rev. Cancer 5:615-625 (2005); Scanlan et al., Immunol. Rev. 188:22-32 (2002)). *Library Screens*

Human Cells for Antigen Presentation

[00198] The present invention provides, *inter alia*, compositions and methods for identifying tumor antigens recognized by human immune cells. Human antigen presenting cells express ligands for antigen receptors and other immune activation molecules on human lymphocytes. Given differences in MHC peptide binding specificities and antigen processing enzymes between species, antigens processed and presented by human cells are more likely to be physiologically relevant human antigens *in vivo* than antigens identified in non-human systems. Accordingly, methods of identifying these antigens employ human cells to present candidate tumor antigen polypeptides. Any human cell that internalizes library members and presents polypeptides

expressed by the library members on MHC molecules can be used as an antigen presenting cell according to the present disclosure. In some embodiments, human cells used for antigen presentation are primary human cells. The cells can include peripheral blood mononuclear cells (PBMC) of a human. In some embodiments, peripheral blood cells are separated into subsets (*e.g.*, subsets comprising dendritic cells, macrophages, monocytes, B cells, or combinations thereof) prior to use in an antigen presentation assay. In some embodiments, a subset of cells that expresses MHC class II is selected from peripheral blood. In one example, a cell population including dendritic cells is isolated from peripheral blood. In some embodiments, a subset of dendritic cells is isolated (*e.g.*, plasmacytoid, myeloid, or a subset thereof). Human dendritic cell markers include CD1c, CD1a, CD303, CD304, CD141, and CD209. Cells can be selected based on expression of one or more of these markers (*e.g.*, cells that express CD303, CD1c, and CD141).

[00199] Dendritic cells can be isolated by positive selection from peripheral blood using commercially available kits (*e.g.*, from Miltenyi Biotec Inc.). In some embodiments, the dendritic cells are expanded *ex vivo* prior to use in an assay. Dendritic cells can also be produced by culturing peripheral blood cells under conditions that promote differentiation of monocyte precursors into dendritic cells *in vitro*. These conditions typically include culturing the cells in the presence of cytokines such as GM-CSF and IL-4 (see, *e.g.*, Inaba *et al.*, Isolation of dendritic cells, *Curr. Protoc. Immunol.* May; Chapter 3: Unit 3.7, 2001). Procedures for *in vitro* expansion of hematopoietic stem and progenitor cells (*e.g.*, taken from bone marrow or peripheral blood), and differentiation of these cells into dendritic cells *in vitro*, is described in U.S. Pat. No. 5,199,942, and U.S. Pat. Pub. 20030077263. Briefly, $CD34^+$ hematopoietic stem and progenitor cells are isolated from peripheral blood or bone marrow and expanded *in vitro* in culture conditions that include one or more of Flt3-L, IL-1, IL-3, and c-kit ligand.

[00200] In some embodiments, immortalized cells that express human MHC molecules (*e.g.*, human cells, or non-human cells that are engineered to express human MHC molecules) are used for antigen presentation. For example, assays can employ COS cells transfected with human MHC molecules or HeLa cells.

[00201] In some embodiments, both the antigen presenting cells and immune cells used in the method are derived from the same subject (*e.g.*, autologous T cells and APC are used). In these

embodiments, it can be advantageous to sequentially isolate subsets of cells from peripheral blood of the subject, to maximize the yield of cells available for assays. For example, one can first isolate $CD4^+$ and $CD8^+$ T cell subsets from the peripheral blood. Next, dendritic cells (DC) are isolated from the T cell-depleted cell population. The remaining T- and DC-depleted cells are used to supplement the DC in assays, or are used alone as antigen presenting cells. In some embodiments, DC are used with T- and DC-depleted cells in an assay, at a ratio of 1:2, 1:3, 1:4, or 1:5. In some embodiments, the antigen presenting cells and immune cells used in the method are derived from different subjects (*e.g.*, heterologous T cells and APC are used).

[00202] Antigen presenting cells can be isolated from sources other than peripheral blood. For example, antigen presenting cells can be taken from a mucosal tissue (*e.g.*, nose, mouth, bronchial tissue, tracheal tissue, the gastrointestinal tract, the genital tract (*e.g.*, vaginal tissue), or associated lymphoid tissue), peritoneal cavity, lymph nodes, spleen, bone marrow, thymus, lung, liver, kidney, neuronal tissue, endocrine tissue, or other tissue, for use in screening assays. In some embodiments, cells are taken from a tissue that is the site of an active immune response (*e.g.*, an ulcer, sore, or abscess). Cells may be isolated from tissue removed surgically, via lavage, or other means.

[00203] Antigen presenting cells useful in methods described herein are not limited to "professional" antigen presenting cells. In some embodiments, non-professional antigen presenting cells can be utilized effectively in the practice of methods of the present disclosure. Non-professional antigen presenting cells include fibroblasts, epithelial cells, endothelial cells, neuronal/glial cells, lymphoid or myeloid cells that are not professional antigen presenting cells (*e.g.*, T cells, neutrophils), muscle cells, liver cells, and other types of cells.

[00204] Antigen presenting cells are cultured with library members that express a polypeptide of interest (and, if desired, a cytolysin polypeptide) under conditions in which the antigen presenting cells internalize, process and present polypeptides expressed by the library members on MHC molecules. In some embodiments, library members are killed or inactivated prior to culture with the antigen presenting cells. Cells or viruses can be inactivated by any appropriate agent (*e.g.*, fixation with organic solvents, irradiation, freezing). In some embodiments, the library members are cells that express ORFs linked to a tag (*e.g.*, a tag which comprises one or

more known T cell epitopes) or reporter protein, expression of which has been verified prior to the culturing.

[00205] In some embodiments, antigen presenting cells are incubated with library members at 37°C for between 30 minutes and 5 hours (*e.g.*, for 45 min. to 1.5 hours). After the incubation, the antigen presenting cells can be washed to remove library members that have not been internalized. In certain embodiments, the antigen presenting cells are non-adherent, and washing requires centrifugation of the cells. The washed antigen presenting cells can be incubated at 37°C for an additional period of time (*e.g.*, 30 min. to 2 hours) prior to exposure to lymphocytes, to allow antigen processing. In some embodiments, it is desirable to fix and kill the antigen presenting cells prior to exposure to lymphocytes (*e.g.*, by treating the cells with 1% paraformaldehyde).

[00206] The antigen presenting cell and library member numbers can be varied, so long as the library members provide quantities of polypeptides of interest sufficient for presentation on MHC molecules. In some embodiments, antigen presenting cells are provided in an array, and are contacted with sets of library cells, each set expressing a different polypeptide of interest. In certain embodiments, each location in the array includes $1 \times 10^3 - 1 \times 10^6$ antigen presenting cells, and the cells are contacted with $1 \times 10^3 - 1 \times 10^8$ library cells which are bacterial cells.

[00207] In any of the embodiments described herein, antigen presenting cells can be freshly isolated, maintained in culture, and/or thawed from frozen storage prior to incubation with library cells, or after incubation with library cells.

Human Lymphocytes

[00208] In methods of the present disclosure, human lymphocytes are tested for antigen-specific reactivity to antigen presenting cells, *e.g.*, antigen presenting cells that have been incubated with libraries expressing polypeptides of interest as described above. The methods of the present disclosure permit rapid identification of human antigens using pools of lymphocytes isolated from an individual, or progeny of the cells. The detection of antigen-specific responses does not rely on laborious procedures to isolate individual T cell clones. In some embodiments, the human lymphocytes are primary lymphocytes. In some embodiments, human lymphocytes

are NKT cells, gamma-delta T cells, or NK cells. Just as antigen presenting cells may be separated into subsets prior to use in antigen presentation assays, a population of lymphocytes having a specific marker or other feature can be used. In some embodiments, a population of T lymphocytes is isolated. In some embodiments, a population of $CD4^+$ T cells is isolated. In some embodiments, a population of $CD8^+$ T cells is isolated. $CD8^+$ T cells recognize peptide antigens presented in the context of MHC class I molecules. Thus, in some embodiments, the $CD8^+$ T cells are used with antigen presenting cells that have been exposed to library host cells that co-express a cytolysin polypeptide, in addition to a polypeptide of interest. T cell subsets that express other cell surface markers may also be isolated, *e.g.*, to provide cells having a particular phenotype. These include CLA (for skin-homing T cells), CD25, CD30, CD69, CD154 (for activated T cells), CD45RO (for memory T cells), CD294 (for Th2 cells), γ/δ TCR-expressing cells, CD3 and CD56 (for NK T cells). Other subsets can also be selected.

[00209] Lymphocytes can be isolated, and separated, by any means known in the art (*e.g.*, using antibody-based methods such as those that employ magnetic bead separation, panning, or flow cytometry). Reagents to identify and isolate human lymphocytes and subsets thereof are well known and commercially available.

[00210] Lymphocytes for use in methods described herein can be isolated from peripheral blood mononuclear cells, or from other tissues in a human. In some embodiments, lymphocytes are taken from tumors, lymph nodes, a mucosal tissue (*e.g.*, nose, mouth, bronchial tissue, tracheal tissue, the gastrointestinal tract, the genital tract (*e.g.*, vaginal tissue), or associated lymphoid tissue), peritoneal cavity, spleen, thymus, lung, liver, kidney, neuronal tissue, endocrine tissue, peritoneal cavity, bone marrow, or other tissues**.** In some embodiments, cells are taken from a tissue that is the site of an active immune response (*e.g.*, an ulcer, sore, or abscess). Cells may be isolated from tissue removed surgically, via lavage, or other means.

[00211] Lymphocytes taken from an individual can be maintained in culture or frozen until use in antigen presentation assays. In some embodiments, freshly isolated lymphocytes can be stimulated *in vitro* by antigen presenting cells exposed to library cells as described above. In some embodiments, these lymphocytes exhibit detectable stimulation without the need for prior non-antigen specific expansion. However, primary lymphocytes also elicit detectable antigen-specific responses when first stimulated non-specifically *in vitro*. Thus, in some embodiments,

lymphocytes are stimulated to proliferate *in vitro* in a non-antigen specific manner, prior to use in an antigen presentation assay. Lymphocytes can also be stimulated in an antigen-specific manner prior to use in an antigen presentation assay. In some embodiments, cells are stimulated to proliferate by a library (*e.g.*, prior to use in an antigen presentation assay that employs the library). Expanding cells *in vitro* provides greater numbers of cells for use in assays. Primary T cells can be stimulated to expand, *e.g.*, by exposure to a polyclonal T cell mitogen, such as phytohemagglutinin or concanavalin, by treatment with antibodies that stimulate proliferation, or by treatment with particles coated with the antibodies. In some embodiments, T cells are expanded by treatment with anti-CD2, anti-CD3, and anti-CD28 antibodies. In some embodiments, T cells are expanded by treatment with interleukin-2. In some embodiments, lymphocytes are thawed from frozen storage and expanded (*e.g.*, stimulated to proliferate, *e.g.*, in a non-antigen specific manner or in an antigen-specific manner) prior to contacting with antigen presenting cells. In some embodiments, lymphocytes are thawed from frozen storage and are not expanded prior to contacting with antigen presenting cells. In some embodiments, lymphocytes are freshly isolated and expanded (*e.g.*, stimulated to proliferate, *e.g.*, in a non-antigen specific manner or in an antigen-specific manner) prior to contacting with antigen presenting cells.

Antigen Presentation Assays

[00212] In antigen presentation assays, T cells are cultured with antigen presenting cells prepared according to the methods described above, under conditions that permit T cell recognition of peptides presented by MHC molecules on the antigen presenting cells. In some embodiments, T cells are incubated with antigen presenting cells at 37°C for between 12-48 hours (*e.g.*, for 24 hours). In some embodiments, T cells are incubated with antigen presenting cells at 37°C for 3, 4, 5, 6, 7, or 8 days. Numbers of antigen presenting cells and T cells can be varied. In some embodiments, the ratio of T cells to antigen presenting cells in a given assay is 1:10, 1:5, 1:2, 1:1, 2:1, 5:1, 10:1, 20:1, 25:1, 30:1, 32:1, 35:1 or 40:1. In some embodiments, antigen presenting cells are provided in an array (*e.g.*, in a 96-well plate), wherein cells in each location of the array have been contacted with sets of library cells, each set including a different polypeptide of interest. In certain embodiments, each location in the array includes $1 \times 10^3 - 1 \times 10^6$ antigen presenting cells, and the cells are contacted with $1 \times 10^3 - 1 \times 10^6$ T cells.

[00213] After T cells have been incubated with antigen presenting cells, cultures are assayed for activation. Lymphocyte activation can be detected by any means known in the art, *e.g.*, T cell proliferation, phosphorylation or dephosphorylation of a receptor, calcium flux, cytoskeletal rearrangement, increased or decreased expression and/or secretion of immune mediators such as cytokines or soluble mediators, increased or decreased expression of one or more cell surface markers. In some embodiments, culture supernatants are harvested and assayed for increased and/or decreased expression and/or secretion of one or more polypeptides associated with activation, *e.g.*, a cytokine, soluble mediator, cell surface marker, or other immune mediator. In some embodiments, the one or more cytokines are selected from TRAIL, IFN-gamma, IL-12p70, IL-2, TNF-alpha, MIP1-alpha, MIP1-beta, CXCL9, CXCL10, MCP1, RANTES, IL-1 beta, IL-4, IL-6, IL-8, IL-9, IL-10, IL-13, IL-15, CXCL11, IL-3, IL-5, IL-17, IL-18, IL-21, IL-22, IL-23A, IL-24, IL-27, IL-31, IL-32, TGF-beta, CSF, GM-CSF, TRANCE (also known as RANK L), MIP3-alpha, and fractalkine. In some embodiments, the one or more soluble mediators are selected from granzyme A, granzyme B, sFas, sFasL, perforin, and granulysin. In some embodiments, the one or more cell surface markers are selected from CD107a, CD107b, CD25, CD69, CD45RA, CD45RO, CD137 (4-1BB), CD44, CD62L, CD27, CCR7, CD154 (CD40L), KLRG-1, CD71, HLA-DR, CD122 (IL-2RB), CD28, IL7Ra (CD127), CD38, CD26, CD134 (OX-40), CTLA-4 (CD152), LAG-3, TIM-3 (CD366), CD39, PD1 (CD279), FoxP3, TIGIT, CD160, BTLA, 2B4 (CD244), and KLRG1. Cytokine secretion in culture supernatants can be detected, *e.g.*, by ELISA, bead array, *e.g.*, with a Luminex® analyzer. Cytokine production can also be assayed by RT-PCR of mRNA isolated from the T cells, or by ELISPOT analysis of cytokines released by the T cells. In some embodiments, proliferation of T cells in the cultures is determined (*e.g.*, by detecting ^{3}H thymidine incorporation). In some embodiments, target cell lysis is determined (*e.g.*, by detecting T cell dependent lysis of antigen presenting cells labeled with $Na_2\ ^{51}CrO_4$). Target cell lysis assays are typically performed with $CD8^+$ T cells. Protocols for these detection methods are known. See, *e.g.*, *Current Protocols In Immunology*, John E. Coligan *et al.* (eds), Wiley and Sons, New York, N.Y., 2007. One of skill in the art understands that appropriate controls are used in these detection methods, *e.g.*, to adjust for non-antigen specific background activation, to confirm the presenting capacity of antigen presenting cells, and to confirm the viability of lymphocytes.

[00214] In some embodiments, antigen presenting cells and lymphocytes used in the method are from the same individual. In some embodiments, antigen presenting cells and lymphocytes used in the method are from different individuals.

[00215] In some embodiments, antigen presentation assays are repeated using lymphocytes from the same individual that have undergone one or more previous rounds of exposure to antigen presenting cells, *e.g.*, to enhance detection of responses, or to enhance weak initial responses. In some embodiments, antigen presentation assays are repeated using antigen presenting cells from the same individual that have undergone one or more previous rounds of exposure to a library, *e.g.*, to enhance detection of responses, or to enhance weak initial responses. In some embodiments, antigen presentation assays are repeated using lymphocytes from the same individual that have undergone one or more previous rounds of exposure to antigen presenting cells, and antigen presenting cells from the same individual that have undergone one or more previous rounds of exposure to a library, *e.g.*, to enhance detection of responses, or to enhance weak initial responses. In some embodiments, antigen presentation assays are repeated using antigen presenting cells and lymphocytes from different individuals, *e.g.*, to identify antigens recognized by multiple individuals, or compare reactivities that differ between individuals.

Methods of Identifying Tumor Antigens

[00216] One advantage of methods described herein is their ability to identify clinically relevant human antigens. Humans that have cancer may have lymphocytes that specifically recognize tumor antigens, which are the product of an adaptive immune response arising from prior exposure. In some embodiments, these cells are present at a higher frequency than cells from an individual who does not have cancer, and/or the cells are readily reactivated when re-exposed to the proper antigenic stimulus (*e.g.*, the cells are "memory" cells). Thus, humans that have or have had cancer are particularly useful donors of cells for identifying antigens *in vitro*. The individual may be one who has recovered from cancer. In some embodiments, the individual has been recently diagnosed with cancer (*e.g.*, the individual was diagnosed less than one year, three months, two months, one month, or two weeks, prior to isolation of lymphocytes and/or antigen presenting cells from the individual). In some embodiments, the individual was

first diagnosed with cancer more than three months, six months, or one year prior to isolation of lymphocytes and/or antigen presenting cells.

[00217] In some embodiments, lymphocytes are screened against antigen presenting cells that have been contacted with a library of cells whose members express or carry polypeptides of interest, and the lymphocytes are from an individual who has not been diagnosed with cancer. In some embodiments, such lymphocytes are used to determine background (*i.e.*, non-antigen-specific) reactivities. In some embodiments, such lymphocytes are used to identify antigens, reactivity to which exists in non-cancer individuals.

[00218] Cells from multiple donors (e.g., multiple subjects who have cancer) can be collected and assayed in methods described herein. In some embodiments, cells from multiple donors are assayed in order to determine if a given tumor antigen is reactive in a broad portion of the population, or to identify multiple tumor antigens that can be later combined to produce an immunogenic composition that will be effective in a broad portion of the population.

[00219] Antigen presentation assays are useful in the context of both infectious and non-infectious diseases. The methods described herein are applicable to any context in which a rapid evaluation of human cellular immunity is beneficial. In some embodiments, antigenic reactivity to polypeptides that are differentially expressed by neoplastic cells (*e.g.*, tumor cells) is evaluated. Sets of nucleic acids differentially expressed by neoplastic cells have been identified using established techniques such as subtractive hybridization. Methods described herein can be used to identify antigens that were functional in a subject in which an anti-tumor immune response occurred. In other embodiments, methods are used to evaluate whether a subject has lymphocytes that react to a tumor antigen or set of tumor antigens.

[00220] In some embodiments, antigen presentation assays are used to examine reactivity to autoantigens in cells of an individual, *e.g.*, an individual predisposed to, or suffering from, an autoimmune condition. Such methods can be used to provide diagnostic or prognostic indicators of the individual's disease state, or to identify autoantigens. For these assays, in some embodiments, libraries that include an array of human polypeptides are prepared. In some embodiments, libraries that include polypeptides from infectious agents which are suspected of eliciting cross-reactive responses to autoantigens are prepared. For examples of antigens from infectious agents thought to elicit cross-reactive autoimmune responses, see Barzilai *et al.*, *Curr*

Opin Rheumatol., 19(6):636-43, 2007; Ayada *et al.*, *Ann N Y Acad Sci.*, 1108:594-602, 2007; Drouin *et al.*, *Mol Immunol.*, 45(1):180-9, 2008; and Bach, *J Autoimmun.*, 25 Suppl:74-80, 2005.

[00221] As discussed, the present disclosure includes methods in which polypeptides of interest are included in a library (e.g., expressed in library cells or carried in or on particles or beads). After members of the library are internalized by antigen presenting cells, the polypeptides of interest are proteolytically processed within the antigen presenting cells, and peptide fragments of the polypeptides are presented on MHC molecules expressed in the antigen presenting cells. The identity of the polypeptide that stimulates a human lymphocyte in an assay described herein can be determined from examination of the set of library cells that were provided to the antigen presenting cells that produced the stimulation. In some embodiments, it is useful to map the epitope within the polypeptide that is bound by MHC molecules to produce the observed stimulation. This epitope, or the longer polypeptide from which it is derived (both of which are referred to as an "antigen" herein) can form the basis for an immunogenic composition, or for an antigenic stimulus in future antigen presentation assays.

[00222] Methods for identifying peptides bound by MHC molecules are known. In some embodiments, epitopes are identified by generating deletion mutants of the polypeptide of interest and testing these for the ability to stimulate lymphocytes. Deletions that lose the ability to stimulate lymphocytes, when processed and presented by antigen presenting cells, have lost the peptide epitope. In some embodiments, epitopes are identified by synthesizing peptides corresponding to portions of the polypeptide of interest and testing the peptides for the ability to stimulate lymphocytes (*e.g.*, in antigen presentation assays in which antigen presenting cells are pulsed with the peptides). Other methods for identifying MHC bound peptides involve lysis of the antigen presenting cells that include the antigenic peptide, affinity purification of the MHC molecules from cell lysates, and subsequent elution and analysis of peptides from the MHC (Falk, K. *et al. Nature* 351:290, 1991, and U.S. Pat. No. 5,989,565).

[00223] In other embodiments, it is useful to identify the clonal T cell receptors that have been expanded in response to the antigen. Clonal T cell receptors are identified by DNA sequencing of the T cell receptor repertoire (Howie et al, 2015 *Sci Trans Med* 7:301). By identifying TCR specificity and function, TCRs can be transfected into other cell types and used in functional studies or for novel immunotherapies.

In other embodiments, it is useful to identify and isolate T cells responsive to a tumor antigen in a subject. The isolated T cells can be expanded *ex vivo* and administered to a subject for cancer therapy or prophylaxis.

Methods of Identifying Immune Responses of a Subject

[00224] The disclosure provides methods of identifying one or more immune responses of a subject (*e.g.*, a test subject, or a target subject). In some embodiments, one or more immune responses of a subject (*e.g.*, a test subject or a target subject) are determined by a) providing a library described herein that includes a panel of tumor antigens (*e.g.*, known tumor antigens, tumor antigens described herein, or tumor antigens, potential tumor antigens, and/or other polypeptides of interest identified using a method described herein); b) contacting the library with antigen presenting cells from the subject; c) contacting the antigen presenting cells with lymphocytes from the subject; and d) determining whether one or more lymphocytes are stimulated by, inhibited and/or suppressed by, activated by, or non-responsive to one or more tumor antigens presented by one or more antigen presenting cells. In some embodiments, the library includes about 1, 3, 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, or more tumor antigens.

[00225] In some embodiments, a test subject is (i) a cancer subject who has not received a cancer therapy; (ii) a cancer subject who has not responded and/or is not responding and/or has responded negatively, clinically to a cancer therapy; or (iii) a subject who has not been diagnosed with a cancer.

[00226] In some embodiments, a target subject is (i) a cancer subject who responds or has responded positively clinically ("responsive subject") to a cancer therapy; (ii) a cancer subject who has not responded and/or is not responding and/or has responded negatively, clinically ("non-responsive subject") to a cancer therapy; (iii) a cancer subject who responds or has responded spontaneously to a cancer ("spontaneous target subject"); or (vi) a subject who has not been diagnosed with a cancer ("normal subject").

[00227] In some embodiments, lymphocyte stimulation, non-stimulation, inhibition and/or suppression, activation, and/or non-responsiveness is determined by assessing levels of one or

more expressed or secreted cytokines or other immune mediators described herein. In some embodiments, levels of one or more expressed or secreted cytokines that is at least 20%, 40%, 60%, 80%, 100%, 120%, 140%, 160%, 180%, 200% or more, higher than a control level indicates lymphocyte stimulation. In some embodiments, a level of one or more expressed or secreted cytokines that is at least 1, 2, 3, 4 or 5 standard deviations greater than the mean of a control level indicates lymphocyte stimulation. In some embodiments, a level of one or more expressed or secreted cytokines that is at least 1, 2, 3, 4 or 5 median absolute deviations (MADs) greater than a median response level to a control indicates lymphocyte stimulation. In some embodiments, a control is a negative control, for example, a clone expressing Neon Green (NG). In some embodiments, a level of one or more expressed or secreted cytokines that is at least 20%, 40%, 60%, 80%, 100%, 120%, 140%, 160%, 180%, 200% or more, lower than a control level indicates lymphocyte inhibition and/or suppression. In some embodiments, a level of one or more expressed or secreted cytokines that is at least 1, 2, 3, 4 or 5 standard deviations lower than the mean of a control level indicates lymphocyte inhibition and/or suppression. In some embodiments, a level of one or more expressed or secreted cytokines that is at least 1, 2, 3, 4 or 5 median absolute deviations (MADs) lower than a median response level to a control indicates lymphocyte inhibition and/or suppression. In some embodiments, a control is a negative control, for example, a clone expressing Neon Green (NG). In some embodiments, levels of one or more expressed or secreted cytokines that is at least 20%, 40%, 60%, 80%, 100%, 120%, 140%, 160%, 180%, 200% or more, higher or lower than a control level indicates lymphocyte activation. In some embodiments, a level of one or more expressed or secreted cytokines that is at least 1, 2, 3, 4 or 5 standard deviations greater or lower than the mean of a control level indicates lymphocyte activation. In some embodiments, a level of one or more expressed or secreted cytokines that is at least 1, 2, 3, 4 or 5 median absolute deviations (MADs) greater or lower than a median response level to a control indicates lymphocyte activation. In some embodiments, a control is a negative control, for example, a clone expressing Neon Green (NG). In some embodiments, a level of one or more expressed or secreted cytokines that is within about 20%, 15%, 10%, 5%, or less, of a control level indicates lymphocyte non-responsiveness or non-stimulation. In some embodiments, a level of one or more expressed or secreted cytokines that is less than 1 or 2 standard deviations higher or lower than the mean of a control level indicates lymphocyte non-responsiveness or non-stimulation. In some embodiments, a level of one or

more expressed or secreted cytokines that is less than 1 or 2 median absolute deviations (MADs) higher or lower than a median response level to a control indicates lymphocyte non-responsiveness or non-stimulation. In some embodiments, a subject response profile can include a quantification, identification, and/or representation of a panel of different cytokines (*e.g.*, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20, or more cytokines) and of the total number of tumor antigens (e.g., of all or a portion of different tumor antigens from the library) that stimulate, do not stimulate, inhibit and/or suppress, activate, or have no or minimal effect on production, expression or secretion of each member of the panel of cytokines.

Method of Obtaining a Subject Response Profile

[00228] The disclosure provides methods for obtaining a subject response profile from a test subject (a "subject response profile").

[00229] In some embodiments, the subject response profile of a test subject is obtained by a) providing a library described herein that includes a panel of tumor antigens (*e.g.*, known tumor antigens, tumor antigens described herein, or tumor antigens, potential tumor antigens, and/or other polypeptides of interest identified using a method described herein); b) contacting the library with antigen presenting cells from the test subject; c) contacting the antigen presenting cells with lymphocytes from the test subject; and d) determining whether one or more lymphocytes are stimulated by, inhibited and/or suppressed by, activated by, or non-responsive to one or more tumor antigens presented by one or more antigen presenting cells, to obtain the subject response profile. In some embodiments, the library includes about 1, 3, 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 150, 200, 250, 500, 1000, or more tumor antigens.

[00230] The subject response profile can include a quantification, identification, and/or representation of all or a portion of the panel of tumor antigens, identified by the methods of the disclosure, that stimulate lymphocytes, that do not stimulate lymphocytes, that inhibit and/or suppress lymphocytes, that activate lymphocytes, or to which lymphocytes are non-responsive. In some embodiments, the subject response profile further includes a quantification, identification, and/or representation of the level of expression or secretion of one or more immune mediators, *e.g.*, one or more cytokines.

[00231] In some embodiments, the subject response profile includes a quantification, identification, and/or representation of all or a portion of the panel of tumor antigens, identified by the methods of the disclosure, that stimulate expression or secretion of one or more immune mediators, that inhibit and/or suppress expression or secretion of one or more immune mediators, and/or which do not, or minimally, affect expression or secretion of immune mediators. In some embodiments, the subject response profile further includes a quantification, identification, and/or representation of the level of expression or secretion of one or more immune mediators, *e.g.*, one or more cytokines.

Methods of Obtaining a Target Response Profile

[00232] In some embodiments, a subject response profile is compared to a corresponding response profile from a target subject, *e.g.* a cancer subject who responds and/or has responded clinically to acancer therapy; a cancer subject who does not and/or has not responded clinically to a cancer therapy; a subject who has, or has had, spontaneous response to a cancer; or a subject who has not been diagnosed with a cancer (a "target response profile"of a target subject).

[00233] The disclosure provides methods for obtaining a target response profile from a target subject. The target response profile of a target subject is obtained by a) providing a library described herein that includes all or a portion of the same panel of tumor antigens (*e.g.*, known tumor antigens, tumor antigens described herein, or tumor antigens, potential tumor antigens, and/or other polypeptides of interest identified using a method described herein) used to generate the subject response profile; b) contacting the library with antigen presenting cells from the target subject; c) contacting the antigen presenting cells with lymphocytes from the targetsubject; and d) determining whether one or more lymphocytes are stimulated by, inhibited and/or suppressed by, activated by, or non-responsive to, one or more tumor antigens presented by one or more antigen presenting cells, to obtain the target response profile.

[00234] The target response profile includes a quantification, identification, and/or representation of the immune response of cells from the target subject to the same panel of tumor antigens included in the subject response profile.

[00235] In some embodiments, the target response profile includes a quantification, identification, and/or representation of all or a portion of the panel of tumor antigens that stimulate lymphocytes, that do not stimulate lymphocytes, that inhibit and/or suppress lymphocytes, that activate lymphocytes, and/or to which lymphocytes are non-responsive. In some embodiments, the subject response profile further includes a quantification, identification, and/or representation of the level of expression or secretion of one or more immune mediators, *e.g.*, one or more cytokines.

[00236] In some embodiments, the target response profile includes a quantification, identification, and/or representation of all or a portion of the panel of tumor antigens identified by the methods of the disclosure, that stimulate expression and/or secretion of one or more immune mediators, that inhibit and/or suppress expression or secretion of one or more immune mediators, and/or which do not, or minimally, affect expression and/or secretion of immune mediators. In some embodiments, the subject response profile further includes a quantification, identification, and/or representation of the level of expression or secretion of one or more immune mediators, *e.g.*, one or more cytokines.

Comparison of a Subject Response Rrofile to a Target Response Profile

Lymphocytes

[00237] In some embodiments, a subject response profile is similar to the target response profile if the identified tumor antigens that stimulate lymphocytes in the subject response profile differ by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the identified tumor antigens that stimulate lymphocytes in the target response profile; if the identified tumor antigens that do not stimulate lymphocytes in the subject response profile differ by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the identified tumor antigens that do not stimulate lymphocytes in the target response profile; if the identified tumor antigens that inhibit and/or suppress lymphocytes in the subject response profile differ by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the identified tumor antigens that inhibit and/or suppress lymphocytes in the target response profile; if the identified tumor antigens that activate lymphocytes in the subject response profile differ by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the identified tumor antigens that activate lymphocytes in the target response profile; and/or if the identified tumor antigens that do not

stimulate lymphocytes or to which lymphocytes are non-responsive in the subject response profile differ by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the identified tumor antigens to which lymphocytes are not, or are minimally, responsive in the target response profile.

[00238] In some embodiments, a subject response profile is dissimilar from the target response profile if the identified tumor antigens that stimulate lymphocytes in the subject response profile differ by more than 5, 6, 7, 8, 9, 10, 20, or more, from the identified tumor antigens that stimulate lymphocytes in the target response profile; if the identified tumor antigens that do not stimulate lymphocytes in the subject response profile differ by more than 5, 6, 7, 8, 9, 10, 20, or more, from the identified tumor antigens that do not stimulate lymphocytes in the target response profile; if the identified tumor antigens that inhibit and/or suppress lymphocytes in the subject response profile differ by more than 5, 6, 7, 8, 9, 10, 20, or more, from the identified tumor antigens that inhibit and/or suppress lymphocytes in the target response profile; if the identified tumor antigens that activate lymphocytes in the subject response profile differ by more than 5, 6, 7, 8, 9, 10, 20, or more, from the identified tumor antigens that activate lymphocytes in the target response profile; and/or if the identified tumor antigens that do not stimulate lymphocytes or to which lymphocytes are non-responsive in the subject response profile differ by more than 5, 6, 7, 8, 9, 10, 20, or more, from the identified tumor antigens to which lymphocytes are not, or are minimally, responsive in the target response profile.

[00239] In some embodiments, a subject response profile is similar to the target response profile if the identified tumor antigens that stimulate lymphocytes in the subject response profile differ by no more than 1%, 2%, 3%, 4%, 5%, 10%, 15%,20%, or 25% from the identified tumor antigens that stimulate lymphocytes in the target response profile; if the identified tumor antigens that do not stimulate lymphocytes in the subject response profile differ by no more than 1%, 2%, 3%, 4%, 5%, 10%, 15%, 20%, or 25% from the identified tumor antigens that do not stimulate lymphocytes in the target response profile; if the identified tumor antigens that inhibit and/or suppress lymphocytes in the subject response profile differ by no more than 1%, 2%, 3%, 4%, 5%, 10%, 15%, 20%, or 25% from the identified tumor antigens that inhibit and/or suppress lymphocytes in the target response profile; if the identified tumor antigens that activate lymphocytes in the subject response profile differ by no more than 1%, 2%, 3%, 4%, 5%, 10%, 15%, 20%, or 25% from the identified tumor antigens that activate lymphocytes in the target response profile; and/or if the identified tumor antigens that do not stimulate lymphocytes or to

which lymphocytes are non-responsive in the subject response profile differ by no more than 1%, 2%, 3%, 4%, 5%, 10%, 15%, 20%, or 25% from the identified tumor antigens to which lymphocytes are not, or are minimally, responsive in the target response profile.

[00240] In some embodiments, a subject response profile is dissimilar from the target response profile if the identified tumor antigens that stimulate lymphocytes in the subject response profile differ by more than 5%, 6%, 7%, 8%, 9%, 10%, 20%, or more, from the identified tumor antigens that stimulate lymphocytes in the target response profile if the identified tumor antigens that do not stimulate lymphocytes in the subject response profile differ by more than 5%, 6%, 7%, 8%, 9%, 10%, 20% ,or more, from the identified tumor antigens that do not stimulate lymphocytes in the target response profile; and/or if the identified tumor antigens that inhibit and/or suppress lymphocytes in the subject response profile differ by more than 5%, 6%, 7%, 8%, 9%, 10%, 20%, or more, from the identified tumor antigens that inhibit and/or suppress lymphocytes in the target response profile; if the identified tumor antigens that activate lymphocytes in the subject response profile differ by more than 5%, 6%, 7%, 8%, 9%, 10%, 20%, or more, from the identified tumor antigens that activate lymphocytes in the target response profile; and/or if the identified tumor antigens that do not stimulate lymphocytes or to which lymphocytes are non-responsive in the subject response profile differ by more than 5%, 6%, 7%, 8%, 9%, 10%, 20%, or more, from the identified tumor antigens to which lymphocytes are not, or are minimally, responsive in the target response profile.

Cytokines

[00241] In some embodiments, the target response profile can include a quantification, identification, and/or representation of one or more cytokines and the total number of tumor antigens (*e.g.*, of the same tumor antigens included in the subject response profile) that stimulate, do not stimulate, inhibit and/or suppress, or have no or minimal effect on cytokine production, expression and/or secretion. In some embodiments, the target response profile can include a quantification, identification, and/or representation of a panel of different cytokines (*e.g.*, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20, or more (*e.g.*, all) of the cytokines included in the subject response profile) and the total number of tumor antigens (e.g., of the same tumor antigens included in the subject response profile) that stimulate, do not stimulate, inhibit and/or suppress,

or have no or minimal effect on production, expression and/or secretion of the panel of cytokines.

[00242] In some embodiments, a subject response profile is similar to the target response profile if the total number of antigens that stimulate expression and/or secretion of one or more cytokines included in the subject response profile differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the total number of antigens that stimulate the same one or more cytokines included in the target response profile; if the total number of antigens that do not stimulate expression and/or secretion of one or more cytokines included in the subject response profile differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the total number of antigens that do not stimulate the same one or more cytokines included in the target response profile; if the total number of antigens that inhibit and/or suppress one or more cytokines included in the subject response profile differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the total number of antigens that inhibit and/or suppress expression and/or secretion of the same one or more cytokines included in the target response profile; and/or if the total number of antigens that have no or minimal effect on expression and/or secretion of one or more cytokines included in the subject response profile differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the total number of antigens that that have no or minimal effect on the same one or more cytokines included in the target response profile.

[00243] In some embodiments, a subject response profile is dissimilar from the target response profile if the total number of antigens that stimulate expression and/or secretion of one or more cytokines included in the subject response profile differs by more than 5, 6, 7, 8, 9, 10, 20, or more, from the total number of antigens that stimulate the same one or more cytokines included in the target response profile; if the total number of antigens that do not stimulate expression and/or secretion of one or more cytokines included in the subject response profile differs by more than 5, 6, 7, 8, 9, 10, 20, or more, from the total number of antigens that do not stimulate the same one or more cytokines included in the target response profile ; if the total number of antigens that inhibit and/or suppress expression and/or secretion of one or more cytokines included in the subject response profile differs by more than 5, 6, 7, 8, 9, 10, 20, or more, from the total number of antigens that inhibit and/or suppress the same one or more cytokines included in the target response profile; and/or if the total number of antigens that have no or minimal effect on expression and/or secretion of one or more cytokines included in the

subject response profile differs by more than 5, 6, 7, 8, 9, 10, 20, or more, from the total number of antigens that that have no or minimal effect on the same one or more cytokines included in the target response profile.

[00244] The foregoing methods apply to subject response profiles and target response profiles obtained with libraries encoding polypeptides that are potential tumor antigens, as well as tumor antigens.

Methods of Identifying/Selecting Subjects for Cancer Therapy

[00245] The disclosure provides methods of identifying a test subject, *e.g.*, a cancer subject, for initiation, continuation, modification, and/or discontinuation or in some cases non-initiation of a cancer therapy (e.g., a cancer therapy described herein). Generally, such methods include comparing one or more immune responses of a cancer subject who has not received a cancer therapy (or who has not responded and/or is not responding and/or has responded negatively, clinically to a cancer therapy) to one or more immune responses of a target subject, who may be: (i) a cancer subject who responds or has responded positively clinically ("responsive subject") to the cancer therapy; (ii) a cancer subject who has not responded and/or is not responding and/or has responded negatively, clinically ("non-responsive subject") to the cancer therapy; (iii) a cancer subject who responds or has responded spontaneously to a cancer ("spontaneous subject"); and/or (vi) a subject who has not been diagnosed with a cancer ("normal subject").

[00246] One or more immune responses of the test subject that are the same or similar to one or more immune responses of a responsive subject and/or dissimilar to one or more immune responses of a non-responsive subject indicates that the test subject should initiate and/or continue and/or modify (*e.g.*, increase and/or combine with one or more other modalities) the cancer therapy. One or more immune responses of the test subject that are dissimilar to one or more immune responses of a responsive subject and/or similar to (or same as) one or more immune responses of a non-responsive subject indicates that the cancer subject should not initiate and/or should discontinue and/or should modify (*e.g.*, reduce and/or combine with one or more other modalities) the cancer therapy, and/or should initiate an alternative cancer therapy, or in some cases, no cancer therapy.

[00247] In some embodiments, a subject response profile that is similar to a target response profile (of a responsive subject) indicates the test subject should initiate and/or continue and/or modify (*e.g.*, increase and/or combine with one or more other modalities) the cancer therapy. In some embodiments, methods described herein include selecting a test subject for initiation and/or continuation and/or modification (*e.g.*, increase and/or combine with one or more other modalities) of the cancer therapy if the subject response profile is similar to a target response profile (of a responsive subject). In some embodiments, methods described herein include initiating and/or continuing and/or modifying (*e.g.*, increasing and/or combining with one or more other modalities) administration of the cancer therapy to a test subject if the subject response profile is similar to a target response profile (of a responsive subject). In some embodiments, methods described herein include administering the cancer therapy to a test subject if the subject response profile is similar to a target response profile (of a responsivet subject). In some embodiments, methods described herein include modifying (*e.g.*, increasing and/or combining with one or more other modalities) administration of the cancer therapy to a test subject if the subject response profile is similar to a target response profile (of a responsive subject).

[00248] In some embodiments, a subject response profile that is dissimilar to a target response profile (of a responsive subject) indicates the test subject should not initiate and/or should modify (*e.g.*, reduce and/or combine with one or more other modalities) and/or should discontinue the cancer therapy, and/or should initiate an alternative cancer therapy. In some embodiments, methods described herein include not selecting a test subject for initiation and/or selecting a test subject for modification (*e.g.*, reduction and/or combination with one or more other modalities) and/or discontinuation of the cancer therapy and/or initiation of an alternative cancer therapy, if the subject response profile is dissimilar to a target response profile (of a responsive subject). In some embodiments, methods described herein include not initiating and/or modifying (*e.g.*, reducing and/or combining with one or more other modalities) and/or discontinuing administration of the cancer therapy to a test subject and/or initiation of an alternative cancer therapy, if the subject response profile is dissimilar to a target response profile (of a responsive subject). In some embodiments, methods described herein include not administering the cancer therapy to a test subject if the subject response profile is dissimilar to a target response profile (of a responsive subject). In some embodiments, methods described

herein include modifying (*e.g.*, reducing and/or combining with one or more other modalities) administration of the cancer therapy to a test subject if the subject response profile is dissimilar to a target response profile (of a responsive subject). In some embodiments, methods described herein include administering an alternative cancer therapy to a test subject if the subject response profile is dissimilar to a target response profile (of a responsive subject).

[00249] In some embodiments, a subject response profile is compared to a corresponding response profile from a cancer subject who has not responded and/or is not responding and/or responds negatively, clinically to the cancer therapy (a "target response profile" of a non-responsive subject). In some embodiments, the target response profile (of a non-responsive subject) is obtained by providing a library described herein that includes all or a portion of the same panel of tumor antigens (*e.g.*, known tumor antigens, tumor antigens described herein or identified using a method described herein) used to generate the subject response profile; contacting the library with antigen presenting cells from the non-responsive subject; contacting the antigen presenting cells with lymphocytes from the non-responsive subject; and determining whether one or more lymphocytes are stimulated, inhibited and/or suppressed by, or non-responsive to, one or more tumor antigens presented by one or more antigen presenting cells. The target response profile (of a non-responsive subject) includes a quantification, identification, and/or representation of the immune response of cells from the non-responsive cancer subject to the same panel of tumor antigens included in the subject response profile.

[00250] Methods for comparing a subject response profile to a target response profile, and parameters for determining similarity and dissimilarily of a subject response profile to a target response profile are provided in the disclosure.

[00251] In some embodiments, the target response profile (of a non-responsive subject) includes a quantification, identification, and/or representation of all or a portion of the panel of tumor antigens that stimulate lymphocytes, that do not stimulate lymphocytes, and/or that inhibit and/or suppress lymphocytes. In some embodiments, a subject response profile is similar to the target response profile (of a nonresponsive subject) if the identified tumor antigens that stimulate lymphocytes in the subject response profile differ by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the identified tumor antigens that stimulate lymphocytes in the target response profile (of a nonresponsive subject); if the identified tumor antigens that do not stimulate lymphocytes in the

subject response profile differ by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the identified tumor antigens that do not stimulate lymphocytes in the target response profile (of a nonresponsive subject); and/or if the identified tumor antigens that inhibit and/or suppress lymphocytes in the subject response profile differ by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the identified tumor antigens that inhibit and/or suppress lymphocytes in the target response profile (of a nonresponsive subject). In some embodiments, a subject response profile is dissimilar from the target response profile if the identified tumor antigens that stimulate lymphocytes in the subject response profile differ by more than 5, 6, 7, 8, 9, 10, 20, or more, from the identified tumor antigens that stimulate lymphocytes in the target response profile (of a nonresponsive subject); if the identified tumor antigens that do not stimulate lymphocytes in the subject response profile differ by more than 5, 6, 7, 8, 9, 10, 20, or more, from the identified tumor antigens that do not stimulate lymphocytes in the target response profile (of a nonresponsive subject); and/or if the identified tumor antigens that inhibit and/or suppress lymphocytes in the subject response profile differ by more than 5, 6, 7, 8, 9, 10, 20, or more, from the identified tumor antigens that inhibit and/or suppress lymphocytes in the target response profile (of a nonresponsive subject). In some embodiments, a subject response profile is similar to the target response profile (of a nonresponsive subject) if the identified tumor antigens that stimulate lymphocytes in the subject response profile differ by no more than 1%, 2%, 3%, 4%, 5%, 10%, 15%, 20%, or 25% from the identified tumor antigens that stimulate lymphocytes in the target response profile (of a nonresponsive subject); if the identified tumor antigens that do not stimulate lymphocytes in the subject response profile differ by no more than 1%, 2%, 3%, 4%, 5%, 10%, 15%, 20%, or 25% from the identified tumor antigens that do not stimulate lymphocytesin the target response profile (of a nonresponsive subject); and/or if the identified tumor antigens that inhibit and/or suppress lymphocytes in the subject response profile differ by no more than 1%, 2%, 3%, 4%, 5%, 10%, 15%, 20%, or 25% from the identified tumor antigens that inhibit and/or suppress lymphocytes in the target response profile (of a non-responsive subject). In some embodiments, a subject response profile is dissimilar from the target response profile (of a non-responsive subject) if the identified tumor antigens that stimulate lymphocytes in the subject response profile differ by more than 5%, 6%, 7%, 8%, 9%, 10%, 20%, or more, from the identified tumor antigens that stimulate lymphocytes in the target response profile (of a non-responsive subject); if the identified tumor antigens that do not stimulate lymphocytes in the

subject response profile differ by more than 5%, 6%, 7%, 8%, 9%, 10%, 20%, or more, from the identified tumor antigens that do not stimulate lymphocytes in the target response profile (of a nonresponsive subject); and/or if the identified tumor antigens that inhibit and/or suppress lymphocytes in the subject response profile differ by more than 5%, 6%, 7%, 8%, 9%, 10%, 20%, or more, from the identified tumor antigens that inhibit and/or suppress lymphocytes in the target response profile (of a non-responsive subject).

[00252] In some embodiments, the target response profile (of a non-responsive subject) can include a quantification, identification, and/or representation of one or more cytokines and the total number of tumor antigens (e.g., of the same tumor antigens included in the subject response profile) that stimulate, do not stimulate, and/or inhibit and/or suppress cytokine production, expression and/or secretion. In some embodiments, the target response profile (of a nonresponsive subject) can include a quantification, identification, and/or representation of a panel of different cytokines (e.g., 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20, or more (e.g., all), of the cytokines included in the subject response profile) and the total number of tumor antigens (e.g., of the same tumor antigens included in the subject response profile) that stimulate, do not stimulate, and/or inhibit and/or suppress production, expression and/or secretion of the panel of cytokines. In some embodiments, a subject response profile is similar to the target response profile (of a nonresponsive subject) if the total number of antigens that stimulate one or more cytokines included in the subject response profile differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the total number of antigens that stimulate the same one or more cytokines included in the target response profile (of a non-responsive subject); if the total number of antigens that do not stimulate one or more cytokines included in the subject response profile differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 from the total number of antigens that do not stimulate the same one or more cytokines included in the target response profile (of a nonresponsive subject); and/or if the total number of antigens that inhibit and/or suppress one or more cytokines included in the subject response profile differs by no more than 1, 2, 3, 4, 5,10, 15, 20, or 25 from the total number of antigens that inhibit and/or suppress the same one or more cytokines included in the target response profile (of a non-responsive subject). In some embodiments, a subject response profile is dissimilar from the target response profile (of a non-responsive subject) if the total number of antigens that stimulate one or more cytokines included in the subject response profile differs by more than 5, 6, 7, 8, 9, 10, or more, from the total number of antigens that stimulate

the same one or more cytokines included in the target response profile (of a non-responsive subject); if the total number of antigens that not stimulate one or more cytokines included in the subject response profile differs by more than 5, 6, 7, 8, 9, 10, or more, from the total number of antigens that do not stimulate the same one or more cytokines included in the target response profile (of a non-responsive subject); and/or if the total number of antigens that inhibit and/or suppress one or more cytokines included in the subject response profile differs by more than 5, 6, 7, 8, 9, 10, 20, or more, from the total number of antigens that inhibit and/or suppress the same one or more cytokines included in the target response profile (of a non-responsive subject).

[00253] In some embodiments, a subject response profile that is dissimilar to a target response profile (of a non-responsive subject) indicates the test subject should initiate and/or continue and/or modify (e.g., increase and/or combine with one or more other modalities) the cancer therapy. In some embodiments, methods described herein include selecting a test subject for initiation and/or continuation and/or modification of (e.g., increasing and/or combining with one or more other modalities) the cancer therapy if the subject response profile is dissimilar to a target response profile (of a non-responsive subject). In some embodiments, methods described herein include initiating and/or continuing and/or modifying (e.g., increasing and/or combining with one or more other modalities) administration of the cancer therapy to a test subject if the subject response profile is dissimilar to a target response profile (of a non-responsive subject). In some embodiments, methods described herein include administering the cancer therapy to a test subject if the subject response profile is dissimilar to a target response profile (of a non-responsive subject). In some embodiments, methods described herein include modifying (e.g., increasing and/or combining with one or more other modalities) administration of the cancer therapy to a test subject if the subject response profile is dissimilar to a target response profile (of a non-responsive subject).

[00254] In some embodiments, a subject response profile that is similar to a target response profile (of a non-responsive subject) indicates the test subject should not initiate, and/or should modify (e.g., reduce and/or combine with one or more other modalities), and/or should discontinue the cancer therapy, and/or should initiate an alternative cancer therapy. In some embodiments, methods described herein include not selecting a test subject for initiation and/or selecting a test subject for modification (e.g., reduction and/or combination with one or more other modalities) and/or discontinuation of the cancer therapy and/or initiation of an alternative

cancer therapy, if the subject response profile is similar to a target response profile (of a non-responsive subject). In some embodiments, methods described herein include not initiating and/or modifying (e.g., reducing and/or combining with one or more other modalities) and/or discontinuing administration of the cancer therapy to a test subject and/or initiating an alternative cancer therapy, if the subject response profile is similar to a target response profile (of a non-responsive subject). In some embodiments, methods described herein include not administering the cancer therapy to a test subject if the subject response profile is similar to a target response profile (of a non-responsive subject). In some embodiments, methods described herein include modifying (e.g., reducing and/or combining with one or more other modalities) administration of the cancer therapy to a test subject if the subject response profile is similar to a target response profile (of a non-responsive subject). In some embodiments, methods described herein include administering an alternative cancer therapy to a test subject if the subject response profile is similar to a target response profile (of a non-responsive subject).

[00255] In some embodiments, a subject response profile described herein is compared to one or more (e.g., 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or more) target response profiles of one or more responsive subjects and/or of one or more (e.g., 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or more) non-responsive subjects. In some embodiments, a target response profile described herein *(e.g.*, of a responsive subject or non-responsive subject) includes an average of one or more immune responses (described herein) from a population of responsive or non-responsive subjects, respectively. In some embodiments, one or more (*e.g.*, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or more) subject response profiles of the test subject are obtained (*e.g.*, before, during, and/or after initiation, modification, and/or discontinuation of administration of the cancer therapy).

Methods of Selecting Tumor Antigens and Methods of Inducing an Immune Response in a Subject

[00256] In general, immune responses can be usefully defined in terms of their integrated, functional end-effects. Dhabar et al. (2014) have proposed that immune responses can be categorized as being immunoprotective, immunopathological, and immunoregulatory/inhibitory. While these categories provide useful constructs with which to organize ideas, an overall *in vivo* immune response is likely to consist of several types of responses with varying amounts of dominance from each category. Immunoprotective or beneficial responses are defined as

responses that promote efficient wound healing, eliminate infections and cancer, and mediate vaccine-induced immunological memory. These responses are associated with cytokines and mediators such as IFN-gamma, IL-12, IL-2, Granzyme B, CD107, etc. Immunopathological or deleterious responses are defined as those that are directed against self (autoimmune disease like multiple sclerosis, arthritis, lupus) or innocuous antigens (asthma, allergies) and responses involving chronic, non-resolving inflammation. These responses can also be associated with molecules that are implicated in immunoprotective responses, but also include immune mediators such as TNF-alpha, IL-10, IL-13, IL-17, IL-4, IgE, histamine, etc. Immunoregulatory responses are defined as those that involve immune cells and factors that regulate (mostly down-regulate) the function of other immune cells. Recent studies suggest that there is an arm of the immune system that functions to inhibit immune responses. For example, regulatory $CD4^{+}CD25+FoxP3^{+}$ T cells, IL-10, and TGF-beta, among others have been shown to have immunoregulatory/inhibitory functions. The physiological function of these factors is to keep pro-inflammatory, allergic, and autoimmune responses in check, but they may also suppress anti-tumor immunity and be indicative of negative prognosis for cancer. In the context of tumors, the expression of co-stimulatory molecules often decreases, and the expression of co-inhibitory ligands increases. MHC molecules are often down-regulated on tumor cells, favoring their escape. The tumor micro-environment, including stromal cells, tumor associated immune cells, and other cell types, produce many inhibitory factors, such as, IL-10, TGF-β, and IDO. Inhibitory immune cells, including T regs, Tr1 cells, immature DCs (iDCs), pDCs, and MDSC can be found in the tumor microenvironment. (Y Li UT GSBS Thesis 2016). Examples of mediators and their immune effects are shown in Table 2.

Table 2: Immune Mediators

Cytokine	Function	Secreted by	Beneficial Outcomes			Deleterious Outcomes		
			Cancer	ID	AI	Cancer	ID	AI
TRAIL	Induces apoptosis of tumor cells, induces immune suppressor cells	Most cells	X	X	?	X	?	?

Cytokine	Function	Secreted by	Beneficial Outcomes			Deleterious Outcomes		
			Cancer	ID	AI	Cancer	ID	AI
IFN-gamma	Critical for innate and adaptive immunity to pathogens, inhibits viral replication, increases MHC Class I expression	T cells, NK cells, NKT cells	X	X	?	X	?	X
IL-12	Th1 differentiation; stimulates T cell growth, induces IFN-gamma/TNF-alpha secretion from T cells, enhances CTLs	DCs, macro-phages, neutron-phils	X	X	?	X	?	X
IL-2	T cell proliferation, differentiation into effector and memory T cells and regulatory T cells	T cells, APCs	X	X	X	?	?	?
TNF-alpha	Induces fevers, apoptosis, inflammation, inhibits viral replication	Macro-phages, APCs	X	X	?	X	?	X
MIP-1 alpha	Chemotactic/pro-inflammatory effects, activates granulocytes, induces secretion of IL-1/IL6/ TNF-alpha	Macro-phages, DCs, T cells	X	X	?	?	?	X
MIP-1 beta	Chemotactic/pro-inflammatory effects, activates granulocytes, induces secretion of IL-1/IL6/ TNF-alpha	Macro-phages, DCs, T cells	X	X	?	?	?	X
CXCL9	T cell chemoattractant, induced by IFN-gamma	APCs	X	X	?	X	?	X
CXCL10	Chemoattractant for T cells, macrophages, NK and DCs, promotes T cell adhesion to endothelial cells	APCs	X	X	?	?	?	X
MCP-1	Recruits monocytes, memory T cells and DCS	most cells	X	X	?	X	?	X

Cytokine	Function	Secreted by	Beneficial Outcomes			Deleterious Outcomes		
			Cancer	ID	AI	Cancer	ID	AI
RANTES	Recruits T cells, eosinophils, basophils, induces proliferation/activation of NK cells, T cell activation marker	T cells	X	X	?	?	?	X
CXCL11	Chemoattractant for activated T cells	APCs	X	X	?	?	?	X
IL-3	Stimulates proliferation of myeloid cells, induces growth of T cells	T cells, APCs	X	X	?	?	?	?
IL-17 I	Produced by Th17 cells, induces production of IL6, GCSF, GMCSF, IL1b, TGF-beta, TNF-alpha, chemokines	T cells	X	X	?	X	?	X
IL-18	Pro-inflammatory, induces cell-mediated immunity, production of IFN-gamma	Macro-phages	X	X	?	X	?	X
IL-21	Induces proliferation, upregulated in Th2/Th17 TFh	CD4 T cells	X	X	X	X	?	?
IL-22	Cell-mediated immunity, pro-inflammatory	NK cells, T cells	X	X	?	X	?	X
IL-23	Pro-inflammatory	APCs	X	X	?	X	?	X
IL-24	Controls survival and proliferation	Monocytesm acro-phages, Th2 cells	X	X	?	?	?	X
IL-27	Induces differentiation of T cells, upregulates IL-10, can be pro-or anti-inflammatory; promotes Th1/Tr1, inhibits Th2/Th17/ regulatory T cells	APCs, T cells	X	X	X	X	?	X

Cytokine	Function	Secreted by	Beneficial Outcomes			Deleterious Outcomes		
			Cancer	ID	AI	Cancer	ID	AI
IL-32	Pro-inflammatory, increases secretion of inflammatory cytokines and chemokines	T cells, NK cells	X	X	?	X	?	X
CSF	Induces myeloid cells to proliferate and differentiate	APCs	X	X	X	?	?	?
GM-CSF	Promotes macrophage and Eosinophil proliferation and maturation, growth factor	T cells, macro-phages	X	X	?	?	?	X
TRANCE	Helps DC maturation/survival, T cell activation marker, anti-apoptotic, stimulates osteoclast activity	T cells	?	X	?	X	?	?
MIP-3 alpha	Chemotactic for T cells, DCs		X	X	?	?	?	X
fractalkine	Chemotactic for T cells and monocytes	Endothelial cells	X	X	?	?	?	X
IL-4	Stimulates B cells, Th2 proliferation, plasma cell differentiation, IgE, upregulates MHC Class II expression, decreases IFN-gamma production	Th2 cells, basophils	?	X	?	X	X	X
IL-10	Downregulates Th1 cytokines/MHC Class II expression/Co-stimulatory molecule expression	Monocytes Th2 cells, regulatory T cells	X	?	X	X	X	X
IL-5	Stimulates B cells, Ig secretion, eosinophil activation	Th2 cells, mast cells	?	X	?	X	X	X
IL-13	Similar to IL4, induces IgE production, Th2 cytokine	Th2 cells, NK cells, mast cells, eosinophils, basophils	?	X	?	X	X	X

Cytokine	Function	Secreted by	Beneficial Outcomes			Deleterious Outcomes		
			Cancer	ID	AI	Cancer	ID	AI
TGF-beta	Inhibits T cell proliferation, activity, function; blocks effects of pro-inflammatory cytokines	regulatory T cells	?	?	X	X	X	?
IL-1 beta	Induces fevers, pro-inflammatory	Macro-phages	X	X	?	X	?	X
IL-6	Pro-inflammatory, drives osteoclast formation, drives Th17	T cells, macro-phages	?	X	?	X	X	X
IL-8	Recruits neutrophils to site of infection	Macro-phages, epithelial cells	?	X	?	X	?	X
IL-31	Cell-mediated immunity, pro-inflammatory	Th2 cells, macro-phages, DCs	X	X	?	X	?	X
IL-15	T cell proliferation and survival	T cells, NK cells	X	X	X	?	?	?
IL-9	Th2 proliferation, cytokine secretion	T cells, neutrophils, mast cells	?	?	X	X	X	?

ID = Infectious disease

IA = Autoimmune disease

[00257] In some embodiments, a tumor antigen stimulates one or more lymphocyte responses that are beneficial to the subject. In some embodiments, a tumor antigen inhibits and/or suppresses one or more lymphocyte responses that are deleterious or non-beneficial to the subject. Examples of immune responses that may lead to beneficial anti-tumor responses include but are not limited to 1) cytotoxic $CD8^+$ T cells which can effectively kill cancer cells and release the mediators perforin and/or granzymes to drive tumor cell death; and 2) $CD4^+$ Th1 T cells which play an important role in host defense and can secrete IL-2, IFN-gamma and TNF-alpha. These are induced by IL-12, IL-2, and IFN gamma among other cytokines.

[00258] In some embodiments, a tumor antigen stimulates one or more lymphocyte responses that are deleterious or non-beneficial to the subject. In some embodiments, a tumor antigen inhibits and/or suppresses one or more lymphocyte responses that are beneficial to the subject. Examples of immune responses that may lead to deleterious or non-beneficial anti-

tumor responses include but are not limited to 1) T regulatory cells which are a population of T cells that can suppress an immune response and secrete immunosuppressive cytokines such as TGF-beta and IL-10 and express the molecules CD25 and FoxP3; and 2) Th2 cells which target responses against allergens but are not productive against cancer. These are induced by increased IL-4 and IL-10 and can secrete IL-4, IL-5, IL-6, IL-9 and IL-13.

[00259] The disclosure provides methods and systems for identifying and selecting tumor antigens. In some embodiments, methods and systems described herein can identify and select one or more tumor antigens to which one or more immune responses are stimulated in a cancer subject who has not received a cancer therapy (or who has not responded and/or is not responding, clinically to a cancer therapy). In some embodiments, methods and systems described herein can identify and select one or more tumor antigens to which one or more immune responses are not stimulated in a cancer subject who has not received a cancer therapy (or who has not responded and/or is not responding, clinically to a cancer therapy). In some embodiments, methods and systems described herein can identify and select one or more tumor antigens to which one or more immune responses are inhibited and/or suppressed in a cancer subject who has not received a cancer therapy (or who has not responded and/or is not responding, clinically to a cancer therapy). In some embodiments, methods and systems described herein can identify and select one or more tumor antigens which elicit no or minimal immune responses in a cancer subject who has not received a cancer therapy (or who has not responded and/or is not responding, clinically to a cancer therapy).

[00260] In some embodiments, a composition comprising the one or more selected tumor antigens is administered to a cancer subject before, during, and/or after administration of a cancer therapy.

[00261] The disclosure provides methods for selecting tumor antigens identified by the methods herein based on comparison of a subject response profile to a target response profile. The disclosure also provides methods for selecting (or de-selecting) tumor antigens identified by the methods herein, based on association with desirable or beneficial responses. The disclosure also provides methods for selecting (or de-selecting) tumor antigens identified by the methods herein, based on association with undesirable, deleterious or non-beneficial responses. In some embodiments, the methods for selecting tumor antigens are combined. The methods may be combined in any order, *e.g.* selection may be carried out by comparison of a subject response

profile to a target response profile, followed by selection based on association with a desirable (or undesirable) response; or, selection may be carried out based on association with a desirable (or undesirable) response, followed by comparison of the subject response profile to a target response profile.

[00262] Methods for identifying tumor antigens and potential tumor antigens are provided herein. Methods for generating or obtaining a subject response profile are provided herein. Methods for generating or obtaining a target response profile, *e.g.* a population-based or composite target response profile, are provided herein. Methods for comparison of a subject response profile to a target response profile are provided herein. Methods for determining whether a subject response profile is similar to a target response profile are provided herein.

[00263] In some embodiments, a subject response profile and target response profile are generated or obtained using the same plurality of polypeptides of interest. In some embodiments, a subject response profile and target response profile are generated or obtained using the same plurality of tumor antigens.

[00264] The target response profile includes a quantification, identification, and/or representation of one or more tumor antigens that stimulate lymphocytes, that do not stimulate lymphocytes, that inhibit and/or suppress lymphocytes, that activate lymphocytes, and/or to which lymphocytes are non-responsive.

[00265] In some embodiments, one or more tumor antigens are identified as inhibiting and/or suppressing lymphocytes in the test subject (*e.g.*, identified from the subject response profile), and the same one or more tumor antigens are identified as stimulating lymphocytes in the target subject (*e.g.*, identified from the target response profile). In some embodiments, one or more tumor antigens are identified as stimulating lymphocytes in the test subject (*e.g.*, identified from the subject response profile) and the same one or more tumor antigens are identified as inhibiting and/or suppressing lymphocytes in the target subject (*e.g.*, identified from the target response profile). In some embodiments, one or more tumor antigens or potential tumor antigens are identified as eliciting minimal or no response from lymphocytes in the test subject (*e.g.*, identified from the subject response profile), and the same one or more tumor antigens are identified as stimulating, or inhibiting and/or suppressing lymphocytes in the target subject (*e.g.*, identified from the target response profile). In some embodiments, one or more tumor antigens are identified as stimulating, or inhibiting and/or suppressing, lymphocytes in the test subject

(*e.g.*, identified from the subject response profile), and the same one or more tumor antigens are identified as eliciting minimal or no response from lymphocytes in the target subject (*e.g.*, identified from the target response profile).

[00266] Tumor antigens may be identified and/or selected on the basis of similarity or dissimilarity of a subject response profile to a target response profile. Tumor antigens may be identified and/or selected (or de-selected) based on association with desirable or beneficial responses. Tumor antigens may be identified and/or selected (or de-selected) based on association with undesirable, deleterious or non-beneficial responses. Tumor antigens may be identified and/or selected (or de-selected) based on a combination of the preceding methods, applied in any order.

All Positive Responders

[00267] In some embodiments, a subject response profile is compared to a corresponding response profile from a cancer subject who responds and/or has responded clinically to a cancer therapy (a "target response profile" of a responsive subject described herein). In some embodiments, a subject response profile is compared to a target response profile from a target subject who has not been diagnosed with cancer. In some embodiments, a subject response profile is compared to a target response profile from a target subject who has (or had) a beneficial response to cancer. In some embodiments, the subject has (or had) a positive clinical response to a cancer therapy or combination of therapies. In some embodiments, the subject had a spontaneous response to a cancer. In some embodiments, the subject is in partial or complete remission from cancer. In some embodiments, the subject has cleared a cancer. In some embodiments, the subject has not had a relapse, recurrence or metastasis of a cancer. In some embodiments, the subject has a positive cancer prognosis. In some embodiments, the subject has not experienced toxic responses or side effects to a cancer therapy or combination of therapies.

[00268] In some embodiments, one or more tumor antigens of the subject response profile which elicit responses that are different from, or dissimilar to, responses elicited by the same tumor antigens of the target response profile are selected. In some embodiments, one or more tumor antigens are selected (or de-selected) based on association with desirable or beneficial immune responses. In some embodiments, one or more tumor antigens are selected (or de-selected) based on association with undesirable, deleterious, or non-beneficial immune responses.

[00269] Responses whereby tumor antigens or immunogenic fragments thereof (i) stimulate lymphocyte responses that are beneficial to the subject, (ii) stimulate expression of cytokines that are beneficial to the subject, (iii) inhibit and/or suppress lymphocyte responses that are deleterious or non-beneficial to the subject, or (iv) inhibit and/or suppress expression of cytokines that are deleterious or non-beneficial to the subject, are termed "beneficial responses".

[00270] In some embodiments, a selected tumor antigen stimulates one or more lymphocyte responses that are beneficial to the subject. In some embodiments, a selected tumor antigen inhibits and/or suppresses one or more lymphocyte responses that are deleterious or non-beneficial to the subject.

[00271] In some embodiments, a selected tumor antigen increases expression and/or secretion of cytokines that are beneficial to the subject. In some embodiments, a selected tumor antigen inhibits and/or suppresses expression of cytokines that are deleterious or non-beneficial to the subject.

[00272] In some embodiments, administration of one or more selected tumor antigens to the subject elicits an immune response of the subject. In some embodiments, administration of one or more selected tumor antigens to the subject elicits a beneficial immune response of the subject. In some embodiments, administration of one or more selected tumor antigens to the subject elicits a beneficial response of the subject. In some embodiments, administration of one or more selected tumor antigens to the subject improves clinical response of the subject to a cancer therapy.

All Negative Responders

[00273] In some embodiments, a subject response profile is compared to a corresponding response profile from a cancer subject who does not respond and/or has not responded clinically to a cancer therapy (a "target response profile" of a non-responsive subject described herein). In some embodiments, a subject response profile is compared to a target response profile from a target subject who has (or had) a deleterious or non-beneficial response to cancer. In some embodiments, the subject has (or had) a negative clinical response to a cancer therapy or combination of therapies. In some embodiments, the subject has not cleared a cancer. In some embodiments, the subject has had a relapse, recurrence or metastasis of a cancer. In some embodiments, the subject has a negative cancer prognosis. In some embodiments, the subject has experienced toxic responses or side effects to a cancer therapy or combination of therapies.

[00274] Responses whereby tumor antigens or immunogenic fragments thereof (i) stimulate lymphocyte responses that are deleterious or not beneficial to the subject, (ii) stimulate expression of cytokines that are deleterious or not beneficial to the subject, (iii) inhibit and/or suppress lymphocyte responses that are beneficial to the subject, or (iv) inhibit and/or suppress expression of cytokines that are beneficial to the subject, are termed "deleterious or non-beneficial responses".

[00275] In some embodiments, one or more tumor antigens of the subject response profile which elicit responses that are the same as, or similar to, responses elicited by the same tumor antigens of the target response profile are selected. In some embodiments, one or more tumor antigens are selected (or de-selected) based on association with desirable or beneficial immune responses. In some embodiments, one or more tumor antigens are selected (or de-selected) based on association with undesirable, deleterious, or non-beneficial immune responses.

[00276] In some embodiments, a selected tumor antigen stimulates one or more lymphocyte responses that are deleterious or non-beneficial to the subject. In some embodiments, a selected tumor antigen inhibits and/or suppresses one or more lymphocyte responses that are beneficial to the subject.

[00277] In some embodiments, a selected tumor antigen increases expression and/or secretion of cytokines that are deleterious or non-beneficial to the subject. In some embodiments, a selected tumor antigen inhibits and/or suppresses expression of cytokines that are beneficial to the subject.

[00278] In some embodiments, the one or more tumor antigens are de-selected by the methods herein.

[00279] In some embodiments, the one or more selected tumor antigens are excluded from administration to a subject.

Methods of Selecting Potential Tumor Antigens

[00280] In well-established tumors, activation of endogenous anti-tumor T cell responses is often insufficient to result in complete tumor regression. Moreover, T cells that have been educated in the context of the tumor microenvironment sometimes are sub-optimally activated, have low avidity, and ultimately fail to recognize the tumor cells that express antigen. In addition, tumors are complex and comprise numerous cell types with varying degrees of

expression of mutated genes, making it difficult to generate polyclonal T cell responses that are adequate to control tumor growth. As a result, researchers in the field have proposed that it is important in cancer subjects to identify the mutations that are "potential tumor antigens" in addition to those that are confirmed in the cancer subject to be recognized by their T cells.

[00281] There are currently no reliable methods of identifying potential tumor antigens in a comprehensive way. Computational methods have been developed in an attempt to predict what is an antigen, however there are many limitations to these approaches. First, modeling epitope prediction and presentation needs to take into account the greater than 12,000 HLA alleles encoding MHC molecules, with each subject expressing as many as 14 of them, all with different epitope affinities. Second, the vast majority of predicted epitopes fail to be found presented by tumors when they are evaluated using mass spectrometry. Third, the predictive algorithms do not take into account T cell recognition of the antigen, and the majority of predicted epitopes are incapable of eliciting T cell responses even when they are present. Finally, the second arm of cellular immunity, the CD4+ T cell subset, is often overlooked; the majority of *in silico* tools focus on MHC class I binders. The tools for predicting MHC class II epitopes are under-developed and more variable.

[00282] The present disclosure provides methods to a) identify polypeptides that are potential tumor antigens in antigen presentation assays of the disclosure, and b) select polypeptides on the basis of their antigenic potential. The methods are performed without making predictions about what could be a target of T cell responses or presented by MHC, and without the need for deconvolution. The methods can be expanded to explore antigenic potential in healthy subjects who share the same MHC alleles as a subject, to identify those potential tumor antigens that would be most suitable to include in an immunogenic composition or vaccine formulation. The methods ensure that the potential tumor antigen is processed and presented in the context of subject MHC molecules, and that T cells can respond to the potential tumor antigen if they are exposed to the potential tumor antigen under the right conditions (*e.g.*, in the context of a vaccine with a strong danger signal from an adjuvant or delivery system).

[00283] The preceding methods for selection of tumor antigens may be applied to selection of potential tumor antigens, that is, polypeptides encoding one or more mutations present or expressed in a cancer or tumor cell of a subject.

Immunogenic Compositions and Uses thereof

[00284] The present disclosure provides compositions that include a tumor antigen or tumor antigens identified or selected by methods described herein, nucleic acids encoding the tumor antigens, and methods of using the compositions. In some embodiments, a composition includes tumor antigens that are peptides 8-40 amino acids, 8-60 amino acids, 8-100. 8-150,or 8-200 amino acids in length (*e.g.*, MHC binding peptides, *e.g.*, peptides 23-29, 24-28, 25-27, 8-30, 8-29, 8-28, 8-27, 8-26, 8-25, 8-24, 8-23, 8-22, 8-21, 8-20, 8-15, 8-12 amino acids in length). In some embodiments, a composition includes one or more tumor antigens that are about 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99% or 100% of the length of the full-length polypeptides. In some embodiments, a composition includes one or more tumor antigens that are truncated by about 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, or more amino acids, relative to the full-length polypeptides. The compositions can include tumor antigens that are, or that comprise, MHC class I-binding peptides, MHC class II-binding peptides, or both MHC class I and MHC class II-binding peptides. Compositions can include a single tumor antigen, or multiple tumor antigens. In some embodiments, a composition includes a set of two, three, four, five, six, seven, eight, nine, ten, or more tumor antigens. In some embodiments, a composition includes ten, fifteen, twenty, twenty-five, thirty, or more tumor antigens. In some embodiments, the tumor antigens or peptides are provided as one or more fusion proteins. In some embodiments, a composition comprises nucleic acids encoding the tumor antigens or peptides. In some embodiments, the nucleic acids encoding the tumor antigens or peptides are provided as one or more fusion constructs.

[00285] The present disclosure provides immunogenic compositions comprising any combination of two or three TAAs: HPSE1 (SEQ ID NO: 6), HPSE2 (SEQ ID NO: 7), and/or SMAD4 (SEQ ID NO: 8).

[00286] HPSE encodes Heparinase, an endoglycosidase that cleaves heparan sulfate proteoglycans (HSPGs) into heparan sulfate side chains and core proteoglycans. HPSE participates in extracellular matrix (ECM) degradation and remodeling. There is a single functional heparinase: HPSE isoform 1 (HPSE1), a 543 amino acid protein. The splice variant HPSE isoform 2 (HPSE2) has no enzymatic activity, but may regulate HPSE1 activity. The active protein form of HPSE1 is a heterodimer of 8 and 50kDa subunits which are non-

covalently linked. The TIM barrel fold domain contains the active site, and the C-terminal domain of the protein is involved in nonenzymatic signaling and secretory functions. Potential T-cell epitopes within HPSE have been described (Tang. *In vitro* and *ex vivo* evaluation of a multi-epitope heparinase vaccine for various malignancies. Cancer Sci 105 (2014) 9–17). The protein sequences of HPSE1 and HPSE2 may be found by searching in the publicly available database, UniProt (on the World Wide Web, at http://www.uniprot.org/uniprot/Q9Y251) and http://www.uniprot.org/uniprot/Q8WWQ2 respectively). The DNA sequence of HPSE1 and HPSE2 may be found by searching in the publicly available database, Entrez (on the World Wide Web https://www.ncbi.nlm.nih.gov/gene/10855 and https://www.ncbi.nlm.nih.gov/gene/60495 respectively).

[00287] SMAD4 encodes Mothers against decapentaplegic homolog 4, a signal transduction protein and tumor suppressor gene, which is a central mediator of downstream transcriptional output in TGFb signaling pathways. SMAD4 is a 552 amino acid, 60.4 KDa protein. SMAD4 exists as a monomer in the absence of TGF-beta activation, and a heterodimer on TGF-beta activation. SMAD4 is composed of two molecules of a C-terminally phosphorylated R-SMAD molecule, SMAD2 or SMAD3, and one molecule of SMAD4 to form the transcriptional active SMAD2/SMAD3-SMAD4 complex. SMAD4 regulates transcription of a number of target genes through binding to DNA, recognizing an 8-bp palindromic sequence (GTCTAGAC) called the Smad-binding element (SBE). The protein acts as a tumor suppressor and inhibits epithelial cell proliferation. The protein and DNA sequences of SMAD4 may be found by searching in the publicly available databases, UniProt and Entrez (on the World Wide Web, at http://www.uniprot.org/uniprot/Q13485 and https://www.ncbi.nlm.nih.gov/gene/4089 respectively).

[00288] The disclosure also provides nucleic acids encoding the tumor antigens. The nucleic acids can be used to produce expression vectors, *e.g.*, for recombinant production of the tumor antigens, or for nucleic acid-based administration *in vivo* (*e.g.*, DNA vaccination).

[00289] In some embodiments, tumor antigens are used in diagnostic assays. For these assays, compositions including the tumor antigens can be provided in kits, *e.g.*, for detecting antibody reactivity, or cellular reactivity, in a sample from an individual.

[00290] In some embodiments, tumor antigen compositions are used to induce an immune response in a subject. In some embodiments, the subject is a human. In some embodiments, the subject is a non-human animal. The tumor antigen compositions can be used to raise antibodies (*e.g.*, in a non-human animal, such as a mouse, rat, hamster, or goat), *e.g.*, for use in diagnostic assays, and for therapeutic applications. For an example of a therapeutic use, a tumor antigen discovered by a method described herein may be a potent T cell and/or B cell antigen. Preparations of antibodies may be produced by immunizing a subject with the tumor antigen and isolating antiserum from the subject. Methods for eliciting high titers of high affinity, antigen-specific antibodies, and for isolating the tumor antigen-specific antibodies from antisera, are known in the art. In some embodiments, the tumor antigen compositions are used to raise monoclonal antibodies, *e.g.*, human monoclonal antibodies.

[00291] In some embodiments, a tumor antigen composition is used to induce an immune response in a human subject to provide a therapeutic response. In some embodiments, a tumor antigen composition is used to induce an immune response in a human subject that redirects an undesirable immune response. In some embodiments, a tumor antigen composition elicits an immune response that causes the subject to have a positive clinical response described herein, *e.g.*, as compared to a subject who has not been administered the tumor antigen composition. In some embodiments, a tumor antigen composition elicits an immune response that causes the subject to have an improved clinical response, *e.g.*, as compared to a subject who has not been administered the tumor antigen composition. In some embodiments, a tumor antigen composition is used to induce an immune response in a human subject for palliative effect. The response can be complete or partial therapy.

[00292] In some embodiments, a tumor antigen composition is used to induce an immune response in a human subject to provide a prophylactic response. The response can be complete or partial protection.

[00293] In some embodiments, immunogenicity of a tumor antigen is evaluated *in vivo*. In some embodiments, humoral responses to a tumor antigen are evaluated (*e.g.*, by detecting antibody titers to the administered tumor antigen). In some embodiments, cellular immune responses to a tumor antigen are evaluated, *e.g.*, by detecting the frequency of antigen-specific cells in a sample from the subject (*e.g.*, by staining T cells from the subject with MHC/peptide

tetramers containing the antigenic peptide, to detect antigen-specific T cells, or by detecting antigen-specific cells using an antigen presentation assay such as an assay described herein). In some embodiments, the ability of a tumor antigen or antigens to elicit protective or therapeutic immunity is evaluated in an animal model. In some embodiments, the ability of a tumor antigen or antigens to stimulate or to suppress and/or inhibit immunity is evaluated in an animal model.

[00294] In some embodiments, the composition includes a pharmaceutically acceptable carrier or excipient. An immunogenic composition may also include an adjuvant for enhancing the immunogenicity of the formulation, (*e.g.*, oil in water, incomplete Freund's adjuvant, aluminum phosphate, aluminum hydroxide, saponin adjuvants, toll-like receptor agonists, or muramyl dipeptides). Other adjuvants are known in the art.

[00295] In some embodiments, an immunogenic composition includes a tumor antigen linked to a carrier protein. Examples of carrier proteins include, *e.g.*, toxins and toxoids (chemical or genetic), which may or may not be mutant, such as anthrax toxin, PA and DNI (PharmAthene, Inc.), diphtheria toxoid (Massachusetts State Biological Labs; Serum Institute of India, Ltd.) or CRM 197, tetanus toxin, tetanus toxoid (Massachusetts State Biological Labs; Serum Institute of India, Ltd.), tetanus toxin fragment Z, exotoxin A or mutants of exotoxin A of *Pseudomonas aeruginosa*, bacterial flagellin, pneumolysin, an outer membrane protein of *Neisseria meningitidis* (strain available from the ATCC (American Type Culture Collection, Manassas, Va.)), *Pseudomonas aeruginosa* Hcp1 protein, *E. coli* heat labile enterotoxin, shiga-like toxin, human LTB protein, a protein extract from whole bacterial cells, and any other protein that can be cross-linked by a linker. Other useful carrier proteins include high density lipoprotein (HDL), bovine serum albumin (BSA), P40, and chicken riboflavin. Many carrier proteins are commercially available (*e.g.*, from Sigma Aldrich.).

[00296] In some embodiments, an immunogenic composition including a tumor antigen identified by a method described herein is used in conjunction with an available vaccine. For example, an antigen identified as described herein can be used as a supplemental component of a vaccine formulation, or as a boosting antigen in a vaccination protocol.

[00297] In some embodiments, an immunogenic composition is in a volume of about 0.5 mL for subcutaneous injection, 0.1 mL for intradermal injection, or 0.002-0.02 mL for percutaneous

administration. A 0.5 ml dose of the composition may contain approximately 2-500 ug of the tumor antigen.

[00298] In some embodiments an immunogenic composition is administered parenterally (for instance, by subcutaneous, intramuscular, intravenous, or intradermal injection). In some embodiments, delivery by a means that physically penetrates the dermal layer is used (*e.g.*, a needle, airgun, or abrasion).

[00299] In some embodiments, an immunogenic composition is administered to a subject, *e.g.*, by intramuscular injection, intradermal injection, or transcutaneous immunization with appropriate immune adjuvants. Compositions can be administered, one or more times, often including a second administration designed to boost an immune response in a subject. The frequency and quantity of dosage of the composition can vary depending on the specific activity of the composition and clinical response of the subject, and can be determined by routine experimentation.

[00300] The formulations of immunogenic compositions can be provided in unit-dose or multi-dose containers, for example, sealed ampoules and vials and may be stored in a freeze-dried (lyophilized) condition requiring only the addition of the sterile liquid carrier immediately prior to use.

Production of Tumor Antigens

[00301] A tumor antigen suitable for use in any method or composition of the disclosure may be produced by any available means, such as recombinantly or synthetically (see, e.g., Jaradat Amino Acids 50:39-68 (2018); Behrendt et al., J. Pept. Sci. 22:4-27 (2016)). For example, a tumor antigen may be recombinantly produced by utilizing a host cell system engineered to express a tumor antigen-encoding nucleic acid. Alternatively or additionally, a tumor antigen may be produced by activating endogenous genes. Alternatively or additionally, a tumor antigen may be partially or fully prepared by chemical synthesis.

[00302] Where proteins are recombinantly produced, any expression system can be used. To give but a few examples, known expression systems include, for example, *E.coli*, egg, baculovirus, plant, yeast, or mammalian cells.

[00303] In some embodiments, recombinant tumor antigen suitable for the present invention are produced in mammalian cells. Non-limiting examples of mammalian cells that may be used in accordance with the present invention include BALB/c mouse myeloma line (NSO/l, ECACC No: 85110503); human retinoblasts (PER.C6, CruCell, Leiden, The Netherlands); monkey kidney CV1 line transformed by SV40 (COS-7, ATCC CRL 1651); human embryonic kidney line (HEK293 or 293 cells subcloned for growth in suspension culture, Graham et al., J. Gen Virol., 36:59,1977); human fibrosarcoma cell line (e.g., HT1080); baby hamster kidney cells (BHK21, ATCC CCL 10); Chinese hamster ovary cells +/-DHFR (CHO, Urlaub and Chasin, Proc. Natl. Acad. Sci. USA, 77:4216, 1980); mouse sertoli cells (TM4, Mather, Biol. Reprod., 23:243-251, 1980); monkey kidney cells (CV1 ATCC CCL 70); African green monkey kidney cells (VERO-76, ATCC CRL-1 587); human cervical carcinoma cells (HeLa, ATCC CCL 2); canine kidney cells (MDCK, ATCC CCL 34); buffalo rat liver cells (BRL 3A, ATCC CRL 1442); human lung cells (W138, ATCC CCL 75); human liver cells (Hep G2, HB 8065); mouse mammary tumor (MMT 060562, ATCC CCL51); TRI cells (Mather et al., Annals N.Y. Acad. Sci., 383:44-68, 1982); MRC 5 cells; FS4 cells; and a human hepatoma line (Hep G2).

[00304] In some embodiments, the present invention provides recombinant tumor antigen produced from human cells. In some embodiments, the present invention provides recombinant tumor antigen produced from CHO cells or HT1080 cells.

[00305] Typically, cells that are engineered to express a recombinant tumor antigen may comprise a transgene that encodes a recombinant tumor antigen described herein. It should be appreciated that the nucleic acids encoding recombinant tumor antigen may contain regulatory sequences, gene control sequences, promoters, non-coding sequences and/or other appropriate sequences for expressing the recombinant tumor antigen. Typically, the coding region is operably linked with one or more of these nucleic acid components.

[00306] The coding region of a transgene may include one or more silent mutations to optimize codon usage for a particular cell type. For example, the codons of a tumor antigen transgene may be optimized for expression in a vertebrate cell. In some embodiments, the codons of a tumor antigen transgene may be optimized for expression in a mammalian cell. In some embodiments, the codons of a tumor antigen transgene may be optimized for expression in a human cell.

Methods of Manufacturing Immunogenic Compositions

[00307] In some embodiments, the disclosure provides methods of manufacturing an immunogenic composition for administration to a subject in need thereof, the method comprising: a) providing, preparing, or obtaining a plurality of antigenic compositions comprising a plurality of antigens, each composition comprising a different antigen; b) providing, preparing, or obtaining a target response profile, wherein the target response profile comprises a representation of the level of expression and/or secretion of one or more immune mediators associated (e.g., determined, measured, observed) with the plurality of antigens; c) providing, preparing, or obtaining a subject response profile, wherein the subject response profile comprises a representation of the level of expression and/or secretion of one or more immune mediators associated (e.g., determined, measured, observed) with the plurality of antigens; d) comparing the target response profile to the subject response profile; e) selecting one or more antigens based on the comparison; and f) formulating at least a portion of one or more antigenic compositions comprising the one or more selected antigens as a pharmaceutical composition.

[00308] In some instances, about 1, 2, 5, 10, 20, 40 , 60 , 80, 100, 150, 200 or more, antigenic compositions are provided, prepared, or obtained. For example, a plurality of antigens can be produced using a method described herein, e.g., recombinantly or synthetically. The antigens can be provided in a suitable composition, such as a solution or lyophilized composition. In some instances, the antigens are synthetically produced. In some instances, a synthetically produced antigen remains attached to a solid support. In some instances, formulating an antigen includes aliquoting a portion of the antigenic composition, reconstituting at least a portion of a lyophilized antigenic composition, and/or releasing a synthetically produced antigen from a solid support.

[00309] Antigenic compositions may be prepared or obtained and stored in a variety of forms, such as in a suspension, in solution, or lyophilized. Antigenic compositions may be stored at a temperature ranging from less than -80 ºC to about room temperature, for example at about -80 ºC, about -20 ºC, about -15 ºC, about -10 ºC, about 4 ºC or at about room temperature. In some embodiments, antigenic compositions may include a carrier, excipient, stabilizer, preservative and/or adjuvant.

[00310] A plurality of antigens can be derived from a target response profile wherein the target response profile comprises a representation of the level of expression and/or secretion of one or more immune mediators associated with (e.g., determined, measured, observed) with the plurality of antigens.

[00311] A plurality of antigens can be derived from a subject response profile wherein the subject response profile comprises a representation of the level of expression and/or secretion of one or more immune mediators associated with (e.g., determined, measured, observed) with the plurality of antigens.

[00312] In some embodiments, a target response profile and subject response profile are compared and one or more antigens are selected based on the comparision. In some embodiments, one or more antigens are selected that increase expression or secretion of immune mediators associated with a beneficial response to cancer, and/or one or more antigens that inhibit and/or suppress expression or secretion of immune mediators associated with deleterious or not beneficial responses to cancer. The selected antigens, or a portion of the selected antigens may be formulated as a pharmaceutical composition.

Cancer and Cancer Therapy

[00313] The present disclosure provides methods and systems related to subjects having or diagnosed with cancer, such as a tumor. In some embodiments, a tumor is or comprises a hematologic malignancy, including but not limited to, acute lymphoblastic leukemia, acute myeloid leukemia, chronic lymphocytic leukemia, chronic myelogenous leukemia, hairy cell leukemia, AIDS-related lymphoma, Hodgkin lymphoma, non-Hodgkin lymphoma, Langerhans cell histiocytosis, multiple myeloma, or myeloproliferative neoplasms.

[00314] In some embodiments, a tumor is or comprises a solid tumor, including but not limited to breast carcinoma, a squamous cell carcinoma, a colon cancer, a head and neck cancer, ovarian cancer, a lung cancer, mesothelioma, a genitourinary cancer, a rectal cancer, a gastric cancer, or an esophageal cancer.

[00315] In some particular embodiments, a tumor is or comprises an advanced tumor, and/or a refractory tumor. In some embodiments, a tumor is characterized as advanced when certain pathologies are observed in a tumor (e.g., in a tissue sample, such as a biopsy sample, obtained from a tumor) and/or when cancer patients with such tumors are typically considered not to be candidates for conventional chemotherapy. In some embodiments, pathologies characterizing tumors as advanced can include tumor size, altered expression of genetic markers, invasion of adjacent organs and/ or lymph nodes by tumor cells. In some embodiments, a tumor is characterized as refractory when patients having such a tumor are resistant to one or more known therapeutic modalities (e.g., one or more conventional chemotherapy regimens) and/or when a particular patient has demonstrated resistance (e.g., lack of responsiveness) to one or more such known therapeutic modalities.

[00316] In some embodiments, the present disclosure provides methods and systems related to cancer therapy. The present disclosure is not limited to any specific cancer therapy, and any known or developed cancer therapy is encompassed by the present disclosure. Known cancer therapies include, e.g., administration of chemotherapeutic agents, radiation therapy, surgical excision, chemotherapy following surgical excision of tumor, adjuvant therapy, localized hypothermia or hyperthermia, anti-tumor antibodies, and anti-angiogenic agents. In some embodiments, cancer and/or adjuvant therapy includes a TLR agonist (e.g., CpG, Poly I:C, etc., see, e.g., Wittig et al., Crit. Rev. Oncol. Hematol. 94:31-44 (2015); Huen et al., Curr. Opin. Oncol. 26:237-44 (2014); Kaczanowska et al., J. Leukoc. Biol. 93:847-863 (2013)), a STING agonist (see, *e.g.*, US20160362441; US20140329889; Fu et al., Sci. Transl. Med. 7:283ra52 (2015); and WO2014189805), a non-specific stimulus of innate immunity, and/or dendritic cells, or administration of GM-CSF, Interleukin-12, Interleukin-7, Flt-3, or other cytokines. In some embodiments, the cancer therapy is or comprises oncolytic virus therapy, *e.g.*, talimogene leherparepvec. (see, *e.g.*, Fukuhara et al., Cancer Sci. 107:1373-1379 (2016)). In some embodiments, the cancer therapy is or comprises bi-specific antibody therapy (e.g., Choi *et al.*, 2011 *Expert Opin Biol Ther*; Huehls *et al.*, 2015, *Immunol and Cell Biol*). In some embodiments, the cancer therapy is or comprises cellular therapy such as chimeric antigen receptor T (CAR-T) cells, TCR-transduced T cells, dendritic cells, tumor infiltrating lymphocytes (TIL), or natural killer (NK) cells (*e.g.*, as reviewed in Sharpe and Mount, 2015, *Dis Model Mech* 8:337-50).

[00317] Anti-tumor antibody therapies (i.e., therapeutic regimens that involve administration of one or more anti-tumor antibody agents) are rapidly becoming the standard of care for treatment of many tumors. Antibody agents have been designed or selected to bind to tumor antigens, particularly those expressed on tumor cell surfaces. Various review articles have been published that describe useful anti-tumor antibody agents (see, for example, Adler et al., Hematol. Oncol. Clin. North Am. 26:447-81 (2012); Li et al., Drug Discov. Ther. 7:178-84 (2013); Scott et al., Cancer Immun. 12:14 (2012); and Sliwkowski et al., Science 341:1192-1198 (2013)). The below Table 8 presents a non-comprehensive list of certain human antigens targeted by known, available antibody agents, and notes c

[00318] Certain cancer indications for which the antibody agents have been proposed to be useful:

Table 8:

Human Antigen	**Antibody (commercial or scientific name)**	**Cancer indication**
CD2	Siplizumab	Non-Hodgkin's Lymphoma
CD3	UCHT1	Peripheral or Cutaneous T-cell Lymphoma
CD4	HuMax-CD4	
CD19	SAR3419, MEDI-551	Diffuse Large B-cell Lymphoma
CD19 and CD3 or CD22	Bispecific antibodies such as Blinatumomab, DT2219ARL	Non-Hodgkin's Lymphoma
CD20	Rituximab, Veltuzumab, Tositumomab, Ofatumumab, Ibritumomab, Obinutuzumab,	B cell malignancies (Non-Hodgkin's lymphoma, Chronic lymphocytic leukemia)
CD22 (SIGLEC2)	Inotuzumab, tetraxetan,CAT-8015, DCDT2980S, Bectumomab	Chemotherapy-resistant hairy cell leukemia, Hodgkin's lymphoma
CD30	Brentuximab vedotin	
CD33	Gemtuzumab ozogamicin (Mylotarg)	Acute myeloid leukemia
CD37	16	Chronic lymphocytic leukemia
CD38	mumab	Multiple myeloma, hematological tumors
CD40	mumab	Non-Hodgkin's lymphoma

Human Antigen	Antibody (commercial or scientific name)	Cancer indication
CD52	Alemtuzumab (Campath)	Chronic lymphocytic leukemia
CD56 (NCAM1)	Lorvotuzumab	Small Cell Lung Cancer
CD66e (CEA)	Labetuzumab	Breast, colon and lung tumors
CD70	SGN-75	Non-Hodgkin's lymphoma
CD74	Milatuzumab	Non-Hodgkin's lymphoma
CD138 (SYND1)	BT062	Multiple Myeloma
CD152 (CTLA-4)	Ipilimumab	Metastatic melanoma
CD221 (IGF1R)	AVE1642, IMC-A12, MK-0646, R150, CP 751871	Glioma, lung, breast, head and neck, prostate and thyroid cancer
CD254 (RANKL)	Denosumab	Breast and prostate carcinoma
CD261 (TRAILR1)	Mapatumumab	Colon, lung and pancreas tumors and haematological malignancies
CD262 (TRAILR2)	HGS-ETR2, CS-1008	
CD326 (Epcam)	Edrecolomab, 17-1A, IGN101, Catumaxomab, Adecatumumab	Colon and rectal cancer, malignant ascites, epithelial tumors (breast, colon, lung)
CD309 (VEGFR2)	IM-2C6, CDP791	Epithelium-derived solid tumors
CD319 (SLAMF7)	HuLuc63	Multiple myeloma
CD340 (HER2)	Trastuzumab, Pertuzumab, Ado-trastuzumab emtansine	Breast cancer
CAIX (CA9)	cG250	Renal cell carcinoma
EGFR (c-erbB)	Cetuximab, Panitumumab, nimotuzumab and 806	Solid tumors including glioma, lung, breast, colon, and head and neck tumors
EPHA3 (HEK)	KB004, IIIA4	Lung, kidney and colon tumors, melanoma, glioma and haematological malignancies
Episialin	Epitumomab	Epithelial ovarian tumors
FAP	Sibrotuzumab and F19	Colon, breast, lung, pancreas, and head and neck tumors
HLA-DR beta	Apolizumab	Chronic lymphocytic leukemia, non-Hodkin's lymphoma
FOLR-1	Farletuzumab	Ovarian tumors
5T4	Anatumomab	Non-small cell lung cancer
GD3/GD2	3F8, ch14.18, KW-2871	Neuroectodermal and epithelial tumors

Human Antigen	Antibody (commercial or scientific name)	Cancer indication
gpA33	huA33	Colorectal carcinoma
GPNMB	Glembatumumab	Breast cancer
HER3 (ERBB3)	MM-121	Breast, colon, lung, ovarian, and prostate tumors
Integrin αVβ3	Etaracizumab	Tumor vasculature
Integrin α5β1	Volociximab	Tumor vasculature
Lewis-Y antigen	hu3S193, IgN311	Breast, colon, lung and prostate tumors
MET (HGFR)	AMG 102, METMAB, SCH900105	Breast, ovary and lung tumors
Mucin-1/CanAg	Pemtumomab, oregovomab, Cantuzumab	Breast, colon, lung and ovarian tumors
PSMA	ADC, J591	Prostate Cancer
Phosphatidylserine	Bavituximab	Solid tumors
TAG-72	Minretumomab	Breast, colon and lung tumors
Tenascin	81C6	Glioma, breast and prostate tumours
VEGF	Bevacizumab	Tumor vasculature
PD-L1	Avelumab	Non-small cell lung cancer, MCC
CD274	Durvalumab	Non-small cell lung cancer
IDO enzyme	IDO inhibitors	Multiple

[00319] In some embodiments, a cancer therapy is or comprises immune checkpoint blockade therapy (see, e.g., Martin-Liberal et al., Cancer Treat. Rev. 54:74-86 (2017); Menon et al., Cancers (Basel) 8:106 (2016)), or immune suppression blockade therapy. Certain cancer cells thrive by taking advantage of immune checkpoint pathways as a major mechanism of immune resistance, particularly with respect to T cells that are specific for tumor antigens. For example, certain cancer cells may overexpress one or more immune checkpoint proteins responsible for inhibiting a cytotoxic T cell response. Thus, immune checkpoint blockade therapy may be administered to overcome the inhibitory signals and permit and/or augment an immune attack against cancer cells. Immune checkpoint blockade therapy may facilitate immune cell responses against cancer cells by decreasing, inhibiting, or abrogating signaling by negative immune

response regulators (e.g., CTLA-4). In some embodiments, a cancer therapy or may stimulate or enhance signaling of positive regulators of immune response (e.g., CD28).

[00320] Examples of immune checkpoint blockade and immune suppression blockade therapy include agents targeting one or more of A2AR, B7-H4, BTLA, CTLA-4, CD28, CD40, CD137, GITR, IDO, KIR, LAG-3, PD-1, PD-L1, OX40, TIM-3, and VISTA. Specific examples of immune checkpoint blockade agents include the following monoclonal antibodies: ipilimumab (targets CTLA-4); tremelimumab (targets CTLA-4); atezolizumab (targets PD-L1); pembrolizumab (targets PD-1); nivolumab (targets PD-1); avelumab; durvalumab; and cemiplimab.

[00321] Specific examples of immune suppression blockade agents include: Vista (B7-H5, v-domain Ig suppressor of T cell activation) inhibitors; Lag-3 (lymphocyte-activation gene 3, CD223) inhibitors; IDO (indolemamine-pyrrole-2,3,-dioxygenase-1,2) inhibitors; KIR receptor family (killer cell immunoglobulin-like receptor) inhibitors; CD47 inhibitors; and Tigit (T cell immunoreceptor with Ig and ITIM domain) inhibitors.

[00322] In some embodiments, a cancer therapy is or comprises immune activation therapy. Specific examples of immune activators include: CD40 agonists; GITR (glucocorticoid-induced TNF-R-related protein, CD357) agonists; OX40 (CD134) agonists; 4-1BB (CD137) agonists; ICOS (inducible T cell stimulator); CD278 agonists; IL-2 (interleukin 2) agonists; and interferon agonists.

[00323] In some embodiments, cancer therapy is or comprises a combination of one or more immune checkpoint blockade agents, immune suppression blockade agents, and/or immune activators, or a combination of one or more immune checkpoint blockade agents, immune suppression blockade agents, and/or immune activators, and other cancer therapies.

[00324] As discussed herein, in some embodiments, the present disclosure provides methods and systems related to subjects who do not respond and/or have not responded; or respond and/or have responded (e.g., clinically responsive, e.g., clinically positively responsive or clinically negatively responsive) to a cancer therapy. In some embodiments, subjects respond and/or have responded positively clinically to a cancer therapy. In some embodiments, subjects respond and/or have responded negatively clinically to a cancer therapy. In some embodiments, subjects do not respond and/or have not responded (e.g., clinically non-responsive) to a cancer therapy.

[00325] Whether a subject responds positively, responds negatively, and/or fails to respond to a cancer therapy can be measured and/or characterized according to particular criteria. In certain embodiments, such criteria can include clinical criteria and/or objective criteria. In certain embodiments, techniques for assessing response can include, but are not limited to, clinical examination, positron emission tomography, chest X-ray, CT scan, MRI, ultrasound, endoscopy, laparoscopy, presence or level of a particular marker in a sample, cytology, and/or histology. A positive response, a negative response, and/or no response, of a tumor to a therapy can be assessed by ones skilled in the art using a variety of established techniques for assessing such response, including, for example, for determining one or more of tumor burden, tumor size, tumor stage, etc. Methods and guidelines for assessing response to treatment are discussed in Therasse et al., J. Natl. Cancer Inst., 2000, 92(3):205-216; and Seymour et al., Lancet Oncol., 2017, 18:e143-52.

[00326] In some embodiments, a responsive subject exhibits a decrease in tumor burden, tumor size, and/or tumor stage upon administration of a cancer therapy. In some embodiments, a non-responsive subject does not exhibit a decrease in tumor burden, tumor size, or tumor stage upon administration of a cancer therapy. In some embodiments, a non-responsive subject exhibits an increase in tumor burden, tumor size, or tumor stage upon administration of a cancer therapy.

[00327] In some embodiments, a cancer subject is identified and/or selected for administration of a cancer therapy as described herein. In some embodiments, the cancer therapy is administered to the subject. In some embodiments, upon administration of the cancer therapy, the subject exhibits a positive clinical response to the cancer therapy, e.g., exhibits an improvement based on one or more clinical and/or objective criteria (e.g., exhibits a decrease in tumor burden, tumor size, and/or tumor stage). In some embodiments, the clinical response is more positive than a clinical response to the cancer therapy administered to a cancer subject who is identified (using a method described herein) as a cancer subject who should not initiate, and/or should modify (e.g., reduce and/or combine with one or more other modalities), and/or should discontinue the cancer therapy, and/or should initiate an alternative cancer therapy.

[00328] Methods described herein can include preparing and/or providing a report, such as in electronic, web-based, or paper form. The report can include one or more outputs from a method

described herein, e.g., a subject response profile described herein. In some embodiments, a report is generated, such as in paper or electronic form, which identifies the presence or absence of one or more tumor antigens (e.g., one or more stimulatory and/or inhibitory and/or suppressive tumor antigens, or tumor antigens to which lymphocytes are not responsive, described herein) for a cancer patient, and optionally, a recommended course of cancer therapy. In some embodiments, the report includes an identifier for the cancer patient. In one embodiment, the report is in web-based form.

[00329] In some embodiments, additionally or alternatively, a report includes information on prognosis, resistance, or potential or suggested therapeutic options. The report can include information on the likely effectiveness of a therapeutic option, the acceptability of a therapeutic option, or the advisability of applying the therapeutic option to a cancer patient, e.g., identified in the report. For example, the report can include information, or a recommendation, on the administration of a cancer therapy, e.g., the administration of a pre-selected dosage or in a pre-selected treatment regimen, e.g., in combination with one or more alternative cancer therapies, to the patient. The report can be delivered, e.g., to an entity described herein, within 7, 14, 21, 30, or 45 days from performing a method described herein. In some embodiments, the report is a personalized cancer treatment report.

[00330] In some embodiments, a report is generated to memorialize each time a cancer subject is tested using a method described herein. The cancer subject can be reevaluated at intervals, such as every month, every two months, every six months or every year, or more or less frequently, to monitor the subject for responsiveness to a cancer therapy and/or for an improvement in one or more cancer symptoms, e.g., described herein. In some embodiments, the report can record at least the treatment history of the cancer subject.

[00331] In one embodiment, the method further includes providing a report to another party. The other party can be, for example, the cancer subject, a caregiver, a physician, an oncologist, a hospital, clinic, third-party payor, insurance company or a government office.

[00332] All publications, patent applications, patents, and other references mentioned herein are incorporated by reference in their entirety. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting. Unless otherwise defined, all technical and

scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, suitable methods and materials are described herein.

[00333] The disclosure is further illustrated by the following examples. The examples are provided for illustrative purposes only. They are not to be construed as limiting the scope or content of the disclosure in any way.

EXAMPLES

Example 1. Immune responses to the ATLAS melanoma tumor associated antigen (TAA) library – single patient responses

Generation of the ATLAS melanoma TAA library

[00334] 23 full-length genes (labelled as Un001-023, encoding known TAAs as shown below in Table 3) were obtained from the DNA Resource Core at Harvard Medical School, recloned into the ATLAS expression vector (Genocea Biosciences), and sequence-verified. Each TAA was recombinantly expressed in *E. coli*. Protein expression was verified using a surrogate T cell assay (the B3Z hybridoma) which recognizes the C57BL/6 mouse T cell epitope SIINFEKL, which is inserted at the C-terminus of each open reading frame, upstream of the stop codon. Proteins that induced B3Z responses that exceeded 5% of the positive control (the minimal SIINFEKL epitope pulsed onto antigen presenting cells) were considered expressed.

Table 3. ATLAS melanoma TAA library

Code	Antigen Name	Alias	Long Name	**OMIM**	**GeneID**
Un001	MAGEA3	HIP8; HYPD; CT1.3; MAGE3; MAGEA6, MAGE-A3 (G-	MAGE family member A3	300174	4102

		2544)			
Un002	NY-ESO-1	CTAG; ESO1; CT6.1; CTAG1; LAGE-2; LAGE2B; NY-ESO-1	cancer/testis antigen 1B	300156	1485
Un003	ANGPT1	AGP1, AGPT, ANG1	Angiopoietin-1	601667	284
Un004	XIAP	API3; ILP1; MIHA; XLP2; BIRC4; IAP-3; hIAP3; hIAP-3	X-linked inhibitor of apoptosis	300079	331
Un005	LGALS3	L31; GAL3; MAC2; CBP35; GALBP; GALIG; LGALS2	Galectin-3	153619	3958
Un006	VEGF-A	VPF; VEGF; MVCD1	vascular endothelial growth factor A	192240	7422
Un007	ATP6AP1	16A; CF2; Ac45; XAP3; XAP-3; ATP6S1; VATPS1; ATP6IP1	ATPase H+ transporting accessory protein 1	300197	537
Un008	MAGEA1	CT1.1; MAGE1	MAGE family member A1	300016	4100
Un009	BIRC2	API1; MIHB; HIAP2; RNF48; cIAP1; Hiap-2; c-IAP1	baculoviral IAP repeat containing 2	601712	329

Un010	MIF	GIF; GLIF; MMIF, MIF	Macrophage migration inhibitory factor	153620	4282
Un011	LGALS9	HUAT; LGALS9A	Galectin-9	601879	3965
Un012	PMEL	P1; SI; SIL; ME20; P100; SILV; ME20M; gp100; ME20-M; PMEL17; D12S53E	premelanosome protein	155550	6490
Un013	GRN	GEP; GP88; PEPI; PGRN; CLN11; PCDGF	Progranulin	138945	2896
Un014	OGFR		opioid growth factor receptor	606459	11054
Un015	BIRC5	API4; EPR-1; survivin, BIRC5	Surviving	603352	332
Un016	BIRC7	KIAP; LIVIN; MLIAP; RNF50; ML-IAP	baculoviral IAP repeat containing 7		79444
Un017	TBX4	SPS	T-box 4	601719	9496
Un018	SLPI	ALP; MPI; ALK1; BLPI; HUSI; WAP4; WFDC4; HUSI-I	Secretory leukocyte protein inhibitor	107285	6590
Un019	ANGPT2	AGPT2, ANG2	Angiopoietin-2	601922	285
Un020	LGALS1	GBP; GAL1	Galectin-1	150570	3956
Un021	DCT	TRP-2; TYRP2,	dopachrome tautomerase	191275	1638

Un100		, TYRP-2			
Un022	MLANA	MART1; MART-1	Melan-A	605513	2315
Un023	TERT	TP2; TRT; CMM9; EST2; TCS1; hTRT; DKCA2; DKCB4; hEST2; PFBMFT1	telomerase reverse transcriptase	187270	7015
Un024	LGMN	AEP; LGMN1; PRSC1	legumain	602620	5641
Un025	SPA17	CT22; SP17; SP17-1	sperm surface protein Sp17	608621	53340
Un026	HPV_E7		HPV E7 oncoprotein		1489079
Un027	TP53	P53; BCC7; LFS1; TRP53	cellular tumor antigen p53	191170	7157
Un028	CEACAM3	CEA; CGM1; W264; W282; CD66D	carcinoembryonic antigen-related cell adhesion molecule 3	609142	1084
Un029	PRTN3	MBN; MBT; NP4; P29; PR3; ACPA; AGP7; NP-4; PR-3; CANCA; C-ANCA	myeloblastin precursor	177020	5657
Un030 Un031 Un046 Un092	TRRAP	PAF350/400, PAF400, STAF40, TR-AP, Tra1	transformation/transcription domain associated protein	603015	8295

Un032	MAGEA12	CT1.12; MAGE12	melanoma-associated antigen 12	300177	4111
Un033	MAGEA2	CT1.2; MAGE2; MAGEA2A	melanoma-associated antigen 2	300173	4101
Un034	MAGEA9	CT1.9; MAGE9	melanoma-associated antigen 9	300342	4108
Un035	MAGEC2	CT10; HCA587; MAGEE1	melanoma-associated antigen C2	300468	51438
Un036	PRAME	MAPE; OIP4; CT130; OIP-4	melanoma antigen preferentially expressed in tumors	606021	23532
Un037	SOX10	DOM; WS4; PCWH; WS2E; WS4C	transcription factor SOX-10	602229	6663
Un038	MUC1	EMA; MCD; PEM; PUM; KL-6; MAM6; MCKD; PEMT; CD227; H23AG; MCKD1; MUC-1; ADMCKD; ADMCKD1; CA 15-3; MUC-1/X; MUC1/ZD; MUC-1/SEC	mucin-1	158340	4582
Un039	RAC1	MIG5; Rac-1; TC-25; p21-	ras-related C3 botulinum toxin substrate 1 isoform	602048	5879

		Rac1	Rac1b		
Un040	HRAS	CTLO; HAMSV; HRAS1; RASH1; p21ras; C-H-RAS; H-RASIDX; C-BAS/HAS; C-HA-RAS1	GTPase HRas	190020	3265
Un041	GAGE4	CT4.4	G antigen 12I	300597	2576
Un042	BAGE	BAGE1; CT2.1	B melanoma antigen 1 precursor	605167	574
Un043	AR	KD; AIS; AR8; TFM; DHTR; SBMA; HYSP1; NR3C4; SMAX1; HUMARA	androgen receptor	313700	367
Un044	CYP1B1	CP1B; GLC3A; CYPIB1; P4501B1	cytochrome P450 1B1	601771	1545
Un045	CA9	MN; CAIX	carbonic anhydrase 9 precursor	603179	768
Un047	MMP8	HNC; CLG1; MMP-8; PMNL-CL	neutrophil collagenase	120355	4317
Un048	GAGE1	CT4.1; GAGE-1	G antigen 1	300594	2543
Un049	TYR	ATN; CMM8; OCA1;	tyrosinase precursor	606933	7299

		OCA1A; OCAIA; SHEP3			
Un050	HPV_E6		HPV E6 oncoprotein		1489078
Un051	Bcr-abl		BCR/ABL fusion protein e14a5, (peptide atlas A6MFJ9)		107963955
Un052	PDGFRB	IMF1; IBGC4; JTK12; PDGFR; CD140B; PDGFR1; PDGFR-1	platelet-derived growth factor receptor beta	173410	5159
Un053	KLK3	KLKB1, KLK3, PSA	Plasma kallikrein	176820	354
Un054	PAX5	ALL3; BSAP	paired box protein Pax-5	167414	5079
Un055	ST3GAL5	SATI; SIAT9; ST3GalV; SIATGM3S	lactosylceramide alpha-2,3-sialyltransferase	604402	8869
Un056	PLAC1	CT92; OOSP2L	placenta-specific protein 1 precursor	300296	10761
Un057	PSCA	PRO232	prostate stem cell antigen preproprotein	602470	8000
Un058	RhoC	H9; ARH9; ARHC; RHOH9	rho-related GTP-binding protein RhoC precursor	165380	389
Un059	MYCN	NMYC; ODED; MODED; N-myc; bHLHe37	N-myc proto-oncogene protein	164840	4613
Un060	EpCAM	ESA; KSA; M4S1; MK-1; DIAR5; EGP-2;	epithelial cell adhesion molecule	185535	4072

		EGP40; KS1/4; MIC18; TROP1; EGP314; HNPCC8; TACSTD1			
Un061	REG3A	HIP; PAP; PAP1; REG3; INGAP; PAP-H; PBCGF; HIP/PAP; REG-III	regenerating islet-derived protein 3-alpha precursor	167805	5068
Un062	EphA2	ECK; CTPA; ARCC2; CTPP1; CTRCT6	ephrin type-A receptor 2	176946	1969
Un063	CSAG2	TRAG3; CSAG3B; CT24.2; TRAG-3	chondrosarcoma-associated gene 2/3 protein		102723547
Un064	CTAG2-1a	CT2; ESO2; CAMEL; CT6.2; CT6.2a; CT6.2b; LAGE-1; LAGE2B	cancer/testis antigen 2 isoform LAGE-1a		30848
Un065	PAGE4	JM27; JM-27; CT16.7; GAGE-9; GAGEC1; PAGE-1; PAGE-4	P antigen family member 4	300287	9506

Un066	BRAF	NS7; BRAF1; RAFB1; B-RAF1	serine/threonine-protein kinase B-raf	164757	673
Un067	FAP	FAPA; SIMP; DPPIV	prolyl endopeptidase FAP	600403	2191
Un068	GRM3	GLUR3; mGlu3; GPRC1C; MGLUR3	metabotropic glutamate receptor 3	601115	2913
Un069	ERBB4	HER4; ALS19; p180erbB4	receptor tyrosine-protein kinase erbB-4	600543	2066
Un070	KIT	PBT; SCFR; C-Kit; CD117	mast/stem cell growth factor receptor Kit	164920	3815
Un071	LCK	LSK; YT16; IMD22; p56lck; pp58lck	tyrosine-protein kinase Lck	153390	3932
Un072	MAGEA10	CT1.10; MAGE10	melanoma-associated antigen 10	300343	4109
Un073	MAGEA4	CT1.4; MAGE4; MAGE4A; MAGE4B; MAGE-41; MAGE-X2	melanoma-associated antigen 4	300175	4103
Un074	MAGEA6	CT1.6; MAGE6; MAGE3B; MAGE-3b	melanoma-associated antigen 6	300176	4105
Un075	MAPK1	ERK; p38; p40; p41; ERK2; ERT1; ERK-2;	mitogen-activated protein kinase 1	176948	5594

		MAPK2; PRKM1; PRKM2; P42MAPK; p41mapk; p42-MAPK			
Un076	MFI2	MTf; MTF1; CD228; MAP97	melanotransferrin	155750	4241
Un077	SART3	P100; p110; DSAP1; TIP110; p110(nrb); RP11-13G14	squamous cell carcinoma antigen recognized by T-cells 3	611684	9733
Un078	ST8SIA1	GD3S; SIAT8; SIAT8A; SIAT8-A; ST8SiaI	alpha-N-acetylneuraminide alpha-2,8-sialyltransferase	601123	6489
Un079	WDR46	UTP7; BING4; FP221; C6orf11	WD repeat-containing protein 46	611440	9277
Un080	AKAP-4	AKAP 82, AKAP-4, AKAP82, CT99, FSC1, HI, PRKA4, hAKAP82, p8, AKAP4	A-kinase anchoring protein 4	300185	8852
Un081	RGS5	MST092; MST106; MST129; MSTP032; MSTP092;	regulator of G-protein signaling 5	603276	8490

		MSTP106; MSTP129			
Un082	CTAG2-1b	CT2; ESO2; CAMEL; CT6.2; CT6.2a; CT6.2b; LAGE-1; LAGE2B	cancer/testis antigen 2 isoform LAGE-1b		
Un083	FOSL1	FRA; FRA1; fra-1	fos-related antigen 1	136515	8061
Un084	PRM2	MAD-CT-1; CT94.2	protamine-2	182890	5620
Un085	ACRBP	CT23; SP32; OY-TES-1	acrosin-binding protein precursor	608352	84519
Un086	AFP	AFPD, FETA, HPAFP	alpha-fetoprotein	104150	174
Un087	CTCFL	CT27; BORIS; CTCF-T; HMGB1L1; dJ579F20.2	transcriptional repressor CTCFL	607022	140690
Un088	CSPG4	NG2; MCSP; MCSPG; MSK16; HMW-MAA; MEL-CSPG	chondroitin sulfate proteoglycan 4 precursor	601172	1464
Un089	PAX3	WS1; WS3; CDHS; HUP2	paired box protein Pax-3	606597	5077
Un090	CCNB1	CCNB	G2/mitotic-specific cyclin-B1	123836	891
Un091	MSLN	Mesotheline; MPF; SMRP	mesothelin	601051	10232
Un093	EGFR	ERBB; HER1;	epidermal growth factor	131550	1956

		mENA; ERBB1; PIG61; NISBD2	receptor		
Un094	WT1	GUD; AWT1; WAGR; WT33; NPHS4; WIT-2; EWS-WT1	Wilms tumor protein	607102	7490
Un095	SSX2	SSX; HD21; CT5.2; CT5.2A; HOM-MEL-40	protein SSX2	300192	6757
Un096	KDR	FLK1; CD309; VEGFR; VEGFR2	vascular endothelial growth factor receptor 2 precursor	191306	3791
Un097	ANKRD30A	NY-BR-1	ankyrin repeat domain-containing protein 30A	610856	91074
Un098	MAGED1	NRAGE; DLXIN-1	melanoma-associated antigen D1	300224	9500
Un099	CEACAM5	CEA; CD66e	carcinoembryonic antigen-related cell adhesion molecule 5	114890	1048
Un101	MAP3K9	MLK1; MEKK9; PRKE1	mitogen-activated protein kinase kinase kinase 9	600136	4293
Un102	XAGE1B	CTP9; XAGE1; CT12.1; GAGED2; XAGE-1; XAGE1A; CT12.1A; CT12.1B	X antigen family member 1	300742	653220

Un103	PREX2	DEP.2; DEPDC2; P-REX2; PPP1R129; 6230420N16Rik	phosphatidylinositol 3,4,5-trisphosphate-dependent Rac exchanger 2 protein	612139	80243
Un104	ERBB2	NEU; NGL; HER2; TKR1; CD340; HER-2; MLN 19; HER-2/neu	receptor tyrosine-protein kinase erbB-2	164870	2064
Un105	CD276	B7H3; B7-H3; B7RP-2; 4Ig-B7-H3	CD276 antigen	605715	80381
Un106	TEK	TIE2; VMCM; TIE-2; VMCM1; CD202B	angiopoietin-1 receptor	600221	7010
Un107	AIM1	ST4; CRYBG1	absent in melanoma 1 protein	601797	202
Un108	ALK	CD246; NBLST3	ALK tyrosine kinase receptor	613014	238
Un109	PSMA	FOLH1	Glutamate carboxypeptidase 2	600934	2346
Un110	GRIN2A	LKS; EPND; FESD; NR2A; GluN2A; NMDAR2A	glutamate receptor ionotropic, NMDA 2A	138253	2903
Un111	MAP3K5	ASK1; MEKK5; MAPKKK5	mitogen-activated protein kinase kinase kinase 5	602448	4217
Un112	HPSE1		heparanase isoform 1	604724	10855
Un113	HPSE2		heparanase isoform 2	604724	10855

Un114	SAGE	CT14	sarcoma antigen 1	300359	55511

OMIM = Online Mendelian Inheritance in Man database
GeneID = NCBI database

ATLAS library screening

[00335] A peripheral blood sample was collected from a consented melanoma patient who had previously undergone therapy with a checkpoint inhibitor (pembrolizumab) and responded to therapy. Peripheral blood mononuclear cells (PBMC) were enriched by density gradient centrifugation. $CD4^+$ and $CD8^+$ T cells were sorted using antibody-conjugated magnetic beads and non-specifically expanded with anti-CD3 and anti-CD28 stimulation. Monocytes were differentiated into dendritic cells (MDDC).

[00336] Library clones were screened in replicates using 5,000 MDDC and 80,000 T cells, at an *E. coli*:MDDC ratio of 100:1. After 24 hours incubation, assay supernatants were harvested and stored at -80°C. Supernatant cytokines were analyzed using a Meso Scale Discovery V-PLEX Proinflammatory Panel 1 (human) Kit.

Data analysis

[00337] Clones that induced mean IFNγ responses that were statistically different from background (Wilcoxon Rank Sum, $p<0.05$) and exceeded 3 standard deviations (SD) of the mean of the negative control GFP clones (N=10) were considered antigens.

[00338] Figure 1 shows representative results for a single melanoma patient. Clones that induced mean IFNγ responses that were statistically different from background (Wilcoxon Rank Sum, $p<0.05$) and exceeded 3 standard deviations (SD) of the mean of the negative control GFP clones (N=10) were considered antigens (indicated by horizontal dotted line). CEF = positive control peptide pool. GFP = green fluorescent protein. Each symbol represents an individual measurement, horizontal line = mean. Un022 & Un023 were not included in the $CD8^+$ library.

Example 2. Cohort-specific T cell responses to TAAs associated with protective immunity in melanoma patients after checkpoint blockade therapy

[00339] Dozens of subjects were recruited into the study and cohorted based upon their clinical outcome after checkpoint inhibitor therapy. Subjects who had stable disease or tumor regression were considered protected; those who had worsening disease (tumor growth) were considered not protected. Clinical determinations were made by tumor imaging scans.

[00340] Briefly, blood samples were collected from 32 consented melanoma patients who had previously undergone checkpoint inhibitor therapy (one subject had two separate collections). Peripheral blood mononuclear cells (PBMC) were enriched by density gradient centrifugation. $CD4^+$ and $CD8^+$ T cells were sorted and non-specifically expanded using anti-CD3 and anti-CD28-coated microbeads, and $CD14^+$ monocytes were differentiated into dendritic cells (MDDC). Library clones comprising known TAAs (labelled as Un001-023, as shown above in Table 3) were screened in duplicate using 5,000 MDDC and 80,000 T cells, at an *E. coli*:MDDC ratio of 100:1; ten replicates of *E. coli* expressing GFP were included as negative controls. Assay supernatants were harvested at 24 hours and stored at -80°C. Supernatant cytokines were analyzed using Meso Scale Discovery V-PLEX Proinflammatory Panel 1 (human) Kit.

Data analysis

[00341] Clones that induced mean cytokine responses that were statistically different from background (Wilcoxon Rank Sum, $p<0.05$) and exceeded 3 standard deviations (SD) of the mean responses to the negative control GFP clones (N=10) were considered antigens. The mean number of antigens to which each cohort responded with each cytokine were compared to determine if differences existed between protected (Responder) and non-protected (Non-responder) cohort.

[00342] Figure 2 shows cohort data for the $CD4^+$ T cell subset. Subjects were cohorted into "Responder" (gray bars) or "Non-Responder" (black bars) groups based on clinical evaluation of disease. Using a cutoff of 3SD above the mean of the negative control response per patient for each cytokine evaluated, the number of TAAs to which each subject responded with their $CD4^+$ T cell subset is represented. In contrast to the Responder cohort, the Non-Responder group had minimal discernable $CD4^+$ T cell responses, by the majority of cytokines evaluated, to any of the

TAAs included in the library. Data are shown as the mean number (± SE) of TAAs to which each cohort responded with each cytokine measured.

[00343] Figure 3 shows cohort data for the $CD8^+$ T cell subset. Subjects were cohorted into "Responder" (gray bars) or "Non-Responder" (black bars) groups based on clinical evaluation of disease. Using a cutoff of 3SD above the mean of the negative control response per patient for each cytokine evaluated, the number of TAAs to which each subject responded with their $CD8^+$ T cell subset is represented. $CD8^+$ T cells secreting IFNγ were undetectable in Non-Responders, but Responders had responses to a mean of ~ two TAAs. Data are shown as the mean number (± SE) of TAAs to which each cohort responded with each cytokine measured.

Example 3. Immune responses to neoantigens identified using ATLAS in a non-small cell lung cancer (NSCLC) patient

Generation of the ATLAS neoantigen library

[00344] ATLAS (Genocea Biosciences) was applied to screen the entire complement of mutations identified in the tumor of a consented NSCLC patient who was successfully treated with pembrolizumab (αPD-1 antibody (Ab), every other week starting on day 0). An ATLAS library was built that expressed 201 of 202 mutations unique to this patient. Each clone contained 113 amino acids with the mutation positioned near the center of the construct and sequence-verified. Each clone was recombinantly expressed in *E. coli*. Protein expression was verified using a surrogate T cell assay (the B3Z hybridoma) which recognizes the C57BL/6 mouse T cell epitope SIINFEKL, which is inserted at the C-terminus of each open reading frame, upstream of the stop codon. Proteins that induced B3Z responses that exceeded 5% of the positive control (the minimal SIINFEKL epitope pulsed onto antigen presenting cells) were considered expressed.

ATLAS library screening

[00345] Peripheral blood samples were collected from the NSCLC patient before and after checkpoint blockade therapy. Peripheral blood mononuclear cells (PBMC) were enriched by density gradient centrifugation. $CD4^+$ and $CD8^+$ T cells were sorted using antibody-conjugated

magnetic beads and non-specifically expanded with anti-CD3 and anti-CD28 stimulation. Monocytes were differentiated into dendritic cells (MDDC).

[00346] $CD4^+$ and $CD8^+$ T cells from Day 0 and Day 42 (after 3rd injection) of treatment were screened, respectively, against 195 and 201 of the 201 library clones, as well as against 20 negative control clones expressing Neon Green (NG). Library clones were screened in duplicate using 2,000 MDDC and 80,000 T cells, at an *E. coli*:MDDC ratio of 250:1. After 24h incubation, assay supernatants were harvested and stored at -80°C. Supernatant cytokines were analyzed using a Meso Scale Discovery V-PLEX Proinflammatory Panel 1 (human) Kit.

Data analysis

[00347] Clones that induced mean cytokine responses that were statistically different from background (Wilcoxon Rank Sum, $p<0.05$) and exceeded 3 standard deviations (SD) of the mean responses to the negative control Neon Green clones (N=20) were considered antigens (indicated by horizontal dotted line).

[00348] Figure 4 shows good alignment between duplicate measurements of the cytokines IFNγ and TNFα for $CD8^+$ T cell response, with over 74% of replicates falling within 1.5-fold of one another.

[00349] Figure 5 shows results for IFNγ and TNFα for $CD8^+$ T cells pre- and post-treatment (left and right panels respectively). In this NSCLC patient, 5% of mutations screened (9 of 201) were identified as neoantigens recognized by his/her peripheral blood $CD8^+$ T cells taken pre- and post-treatment. Only 1% of the identified neoantigens were found both pre- and post-treatment. Points above the top dotted line indicate neoantigens that stimulate $CD8^+$ T cell responses. Points below the lower dotted line indicate neoantigens that suppress and/or inhibit $CD8^+$ T cell responses.

[00350] Figure 6 shows results for IFNγ and TNFα for $CD4^+$ T cells pre- and post-treatment (left and right panels respectively). In this NSCLC patient, 10% of mutations screened (20 of 195) were identified as neoantigens recognized by his/her peripheral blood $CD4^+$ T cells taken pre-treatment, increasing to 17% of mutations screened (33 of 195) post-treatment. Five percent of the identified neoantigens were found both pre- and post-treatment. Points above the top

dotted line indicate neoantigens that stimulate $CD4^+$ T cell responses. Points below the lower dotted line indicate neoantigens that suppress and/or inhibit $CD4^+$ T cell responses. These results show increased breadth of $CD4^+$ T cell responses to neoantigens following checkpoint inhibitor therapy, particularly with respect to IFNγ.

Table 4 summarizes results shown in Figures 5 and 6.

T cell responses	Pre-treatment	Post-treatment	Both
$CD8^+$	5%	5%	1%
$CD4^+$	10%	17%	5%

[00351] Figure 7 shows the limited overlap between $CD8^+$-specific T cell neoantigens identified by ATLAS and epitope prediction algorithms. MHC class I epitopes were predicted for all screened neoantigens from the NSCLC patient using three commonly used algorithms: NetMHC, NetCTLpan and IEDB, and using patient-specific haplotypes HLA-A*02:01/*32:01, HLA-B*40:01:02/*45:01:01, HLAC*06:02/*03:041 (see Rizvi et al., (2015) Science. 348(6230): 124-8). Eight of the antigens identified by ATLAS were not predicted by any of NetMHC, NetCTLpan, or IEDB. (Note that MHC class II epitopes cannot be effectively predicted using currently available algorithms.)

[00352] Figure 8 further shows that epitope predictions have a high false positive rate, miss relevant stimulatory neoantigens, and are not able to identify suppressive and/or inhibitory neoantigens. Of the 137 neoantigens predicted by at least one algorithm, only 15 (or 11%) were confirmed by ATLAS to effect a $CD8^+$ T cell response in the NSCLC patient. Six of these 15 neoantigens were found to be suppressive and/or inhibitory. Altogether, ATLAS identified 9 + 8 stimulatory neoantigens, and 6 + 3 suppressive and/or inhibitory neoantigens. Thus, 47% of stimulatory antigens found by ATLAS were missed by algorithms, and 33% of suppressive and/or inhibitory neoantigens found by ATLAS failed to be identified by algorithms.

Example 4. Immune responses to the ATLAS colorectal cancer (CRC) tumor associated antigen (TAA) library – single patient response

Generation of the ATLAS colorectal cancer TAA library

[00353] Twenty-six TAA genes (representing 23 unique genes; labelled as "taa1-26" and shown below in Table 5) were cloned into the ATLAS expression vector (Genocea Biosciences), and sequence-verified. Each TAA was recombinantly expressed in *E. coli*. Protein expression was verified using a surrogate T cell assay (the B3Z hybridoma) which recognizes the C57BL/6 mouse T cell epitope SIINFEKL, which is inserted at the C-terminus of each open reading frame, upstream of the stop codon. Proteins that induced B3Z responses that exceeded 5% of the positive control (the minimal SIINFEKL epitope pulsed onto antigen presenting cells) were considered expressed.

ATLAS library screening

[00354] A frozen peripheral blood mononuclear cell (PBMC) vial was purchased from Bioreclamation IVT. The PBMC were derived from a 50 year-old Caucasian male who had stage IV colorectal cancer. $CD8^+$ T cells were sorted using antibody-conjugated magnetic beads and non-specifically expanded with anti-CD3 and anti-CD28 stimulation. Monocytes were differentiated into dendritic cells (MDDC).

[00355] Library clones were screened in replicates using 5,000 MDDC and 80,000 T cells, at an *E. coli*:MDDC ratio of 100:1. After 24h incubation, assay supernatants were harvested and stored at -80°C. Negative controls included 13 replicates of *E. coli* expressing neon green (NG). Supernatant cytokines were analyzed using a Meso Scale Discovery V-PLEX Proinflammatory Panel 1 (human) Kit.

Data analysis

[00356] Measurements that were below the lower limit of detection for the standard curve of each cytokine were masked. Clones that induced mean IFNγ or TNFα responses that exceeded 3 standard deviations (SD) of the mean of the negative control neon green (NG) clones (N=13) were considered antigens.

[00357] Figure 9 shows representative results for a single CRC patient. Clones that induced mean IFNγ and/or TNFα responses that exceeded 3 standard deviations (SD) of the mean of the

negative control NG clones (N=10) were considered antigens (indicated by horizontal dotted line, black symbols). NG = neon green. Each symbol represents an individual measurement, small horizontal line = mean of duplicate measurements. TAA coding conventions are shown in Table 5 below.

Example 5. T cell responses to CRC TAAs in a cohort of CRC patients

[00358] PBMC from 21 CRC patients were screened against a library of 26 known TAAs (shown in Table 5). $CD4^+$ and $CD8^+$ T cells were sorted and non-specifically expanded using anti-CD3 and anti-CD28-coated microbeads, and $CD14^+$ monocytes were differentiated into dendritic cells (MDDC). Library clones were screened in duplicate using 5,000 MDDC and 80,000 T cells, at an *E. coli*:MDDC ratio of 100:1; 13 replicates of *E. coli* expressing neon green (NG) were included as negative controls. Assay supernatants were harvested at 24 hours and stored at -80°C. Supernatant cytokines were analyzed using Meso Scale Discovery V-PLEX Proinflammatory Panel 1 (human) Kit.

Data analysis

[00359] Clones that induced mean cytokine responses that exceeded 3 standard deviations (SD) of the mean responses to the negative control NG clones (N=10) were considered antigens.

[00360] Figure 10 shows data for both the $CD4^+$ (grey bars) and $CD8^+$ (black bars) T cell subsets. The percentage of subjects who responded to each TAA, as measured by IFNγ secretion that exceeded three standard deviations of the mean negative control (NG) response, is represented. Overall, nine of 26 antigens induced a $CD8^+$ T cell response from at least one of the CRC patients. Three TAAs (HPSE1, HPSE2, SMAD4) were antigens for $CD8^+$ T cells from nearly all subjects screened; two TAAs (HPSE1, HPSE2) were also antigens for each subject's $CD4^+$ T cell subset. Results are summarized in Table 5 below.

Table 5:

Table 5. Summary of T cell response rates to TAAs in the ATLAS colorectal cancer library

Code	TAA	CD4	CD8
taa1	BIRC5	0	0

taa2	CDH3	0	0
taa3	CEACAM3	0	0
taa4	CEACAM5	0	0
taa5	CGB_5	0	0
taa6	COA1	0	0
taa7	EBAG9	0	0
taa8	EGFR	0	0
taa9	ELK4	0	0
taa10	ERBB2	0	0
taa11	EpCAM	0	8%
taa12	HPSE1	100%	92%
taa13	HPSE2	100%	77%
taa14	KRAS_isoform1	0	31%
taa15	KRAS_isoform2	0	0
taa16	MAGEA3	0	0
taa17	MUC1	0	0
taa18	SMAD4	0	100%
taa19	TERT.2	0	31%
taa20	TERT.3	0	31%
taa21	TGFBR2	0	8%
taa22	EBAG9_isoform1	0	0
taa23	TP53	0	15%
taa24	CGB_3	0	0
taa25	IMPDH2	0	0
taa26	LCK	0	0

Example 6. Immune responses to neoantigens identified using ATLAS in a colorectal cancer (CRC) patient

Generation of the ATLAS neoantigen library

[00361] ATLAS was applied to screen the entire complement of mutations identified in the tumor of a consented colorectal cancer patient. An ATLAS library was built that expressed

31 mutations unique to this patient. Each clone contained 113 amino acids with the mutation positioned near the center of the construct and sequence-verified. Each clone was recombinantly expressed in *E. coli* and protein expression was verified using Western Blot.

ATLAS library screening

[00362] Frozen peripheral blood mononuclear cells (PBMC) were purchased from Conversant Bio. After thaw, $CD8^+$ T cells were sorted using antibody-conjugated magnetic beads and non-specifically expanded with anti-CD3 and anti-CD28 stimulation. CD14+ monocytes were also sorted using antibody-conjugated magnetic beads and differentiated *in vitro* into dendritic cells (MDDC).

[00363] $CD8^+$ T cells were screened against the 31 library clones, as well as against 2 negative control clones expressing Neon Green (NG). Library clones were screened using 1,500 MDDC and 80,000 T cells, at an *E. coli*:MDDC ratio of 333:1. After 24h incubation, assay supernatants were harvested and stored at -80°C. Supernatant cytokines were analyzed using a Meso Scale Discovery custom plate.

Data analysis

[00364] Clones that induced median cytokine responses that exceeded 3 median absolute deviations (MAD) of the median responses to the negative control Neon Green clones (N=2) (indicated by horizontal dotted line in Figure 11) were considered antigens. Clones that reduced median cytokine responses to 3 MAD below the median negative control responses were considered inhibitory and/or suppressive antigens.

[00365] Figure 11 shows results for IFNγ and TNFα from the patient's $CD8^+$ T cells. The X indicates the median response to the negative controls. Points above the top dotted line indicate neoantigens that stimulate $CD8^+$ T cell responses (black circles). Points below the lower dotted line indicate neoantigens that inhibit and/or suppress $CD8^+$ T cell responses (black squares). In this patient, 16% of mutations screened (5 of 31) were identified as neoantigens recognized by his/her peripheral blood $CD8^+$ T cells. Additionally, 13% (4 of 31) of mutations screened were identified as inhibitory and/or suppressive neoantigens. There was no overlap of the neoantigens that induced IFNγcompared with TNFα, but two of the inhibitory neoantigens suppressed both IFNγ and TNFα.

[00366] Figures 12A and 12B show Venn diagrams representing the limited overlap between $CD8^+$-specific T cell neoantigens identified by ATLAS and epitope prediction algorithms. MHC class I epitopes were predicted for all screened neoantigens using three commonly used algorithms: NetMHC, NetCTLpan and IEDB, and using patient-specific haplotypes HLA-A*30:02/*32:01, B*18:01/*14:01, C*05:01/*08:02. Figure 12A represents epitopes predicted that had binding affinity projected to be below 500nM for the mutant peptide (neoantigen) but not for its wild-type counterpart, and an IEDB percentile rank of $\leq$1 for the mutant peptide but not for wild-type. Figure 12B represents epitopes predicted to have binding affinity below 500nM or an IEDB percentile rank of $\leq$1, irrespective of the wild-type counterpart predictions. In the former case, none of the neoantigens that were identified by ATLAS were predicted by algorithms, and there were six epitopes predicted that were not identified empirically (100% false positive and 100% false negative rate). For the latter, there was one neoantigen that was identified using ATLAS that was also predicted by all three algorithms used. The remaining four neoantigens were not predicted by any algorithm. There were 26 epitopes predicted that could not be confirmed by ATLAS (therefore the algorithms had a 96% false positive rate and an 80% false negative rate).

[00367] Figures 13A and 13B show Venn diagrams representing the limited overlap between $CD8^+$-specific T cell inhibitory and/or suppressive neoantigens identified by ATLAS and epitope prediction algorithms. Epitope predictions do not discriminate between stimulatory or inhibitory and/or suppressive antigens, therefore the same MHC predictions used for Figure 12A and 12B were applied for the inhibitory and/or suppressive, rather than stimulatory neoantigens. Figure 13A represents epitopes predicted that had binding affinity projected to be below 500nM for the mutant peptide (neoantigen) but not for its wild-type counterpart, and an IEDB percentile rank of $\leq$1 for the mutant peptide but not for wild-type. Figure 13B represents epitopes predicted to have binding affinity below 500nM or an IEDB percentile rank of $\leq$1, irrespective of the wild-type counterpart predictions. In the former case, none of the inhibitory and/or suppressive neoantigens that were identified by ATLAS were predicted by algorithms, and there were six epitopes predicted that were not identified empirically (100% false positive and 100% false negative rate). For the latter, there was one neoantigen that was identified using ATLAS that was also predicted by one of the three algorithms (netMHCpan_MT). The

remaining three neoantigens identified empirically with ATLAS were not predicted by any algorithm. Once again, there were 26 epitopes predicted that could not be confirmed by ATLAS.

Example 7. T cell response profiling in colorectal carcinoma patients reveals an enrichment in responses to specific tumor-associated antigens

Generation of an ATLAS Tumor Assciated Antigen library

[00368] ATLAS™ was applied to profile T cell recall responses to a set of Tumor Associated Antigens (TAAs) in 34 subjects with various stages of CRC and pre-malignant lesions in an HLA-independent manner. Twenty-six TAA genes (representing 23 unique genes, shown in Table 5) were cloned into the ATLAS expression vector and sequence verified. Each TAA was recombinantly expressed in *E. coli,* with expression verified using Western Blot analysis.

Table 6. ATLAS colorectal cancer TAA library

Antigen Name	Alias	long name	**OMIM**	**GeneID**
CDH3	CDHP, HJMD, PCAD	cadherin 3	114021	1001
CEACAM3	CEA; CGM1; W264; W282; CD66D	carcinoembryonic antigen-related cell adhesion molecule 3	609142	1084
CEACAM5	CEA; CD66e	carcinoembryonic antigen-related cell adhesion molecule 5	114890	1048
CGB_3	CGB, CGB5, CGB7, CGB8, hCGB	chorionic gonadotropin beta subunit 3	118860	1082
CGB_5	CGB, HCG, hCGB	chorionic gonadotropin beta subunit 5	608825	93659
COA1	C7orf44, MITRAC15	cytochrome c oxidase assembly factor 1 homolog	614769	55744
EBAG9	EB9, PDAF	estrogen receptor binding site associated, antigen, 9	605772	9166

EGFR	ERBB; HER1; mENA; ERBB1; PIG61; NISBD2	epidermal growth factor receptor	131550	1956
ELK4	SAP1	ETS transcription factor	600246	2005
EpCAM	ESA; KSA; M4S1; MK-1; DIAR5; EGP-2; EGP40; KS1/4; MIC18; TROP1; EGP314; HNPCC8; TACSTD1	epithelial cell adhesion molecule precursor	185535	4072
ERBB2	NEU; NGL; HER2; TKR1; CD340; HER-2; MLN 19; HER-2/neu	receptor tyrosine-protein kinase erbB-2	164870	2064
HPSE1		heparanase isoform 1	604724	10855
HPSE2		heparanase isoform 2		
IMPDH2	IMPD2, IMPDH-II	inosine monophosphate dehydrogenase 2	146691	3615
KRAS	C-K-RAS, CFC2, K-RAS2A, K-RAS2B, K-RAS4A, K-RAS4B, K-Ras, K	KRAS proto-oncogene, GTPase	190070	3845
LCK	LSK; YT16; IMD22; p56lck; pp58lck	tyrosine-protein kinase Lck	153390	3932
MAGEA3	HIP8; HYPD; CT1.3; MAGE3; MAGEA6, MAGE-A3 (G-2544)	MAGE family member A3	300174	4102
MUC1	EMA; MCD; PEM; PUM; KL-6; MAM6; MCKD; PEMT; CD227; H23AG; MCKD1; MUC-1; ADMCKD; ADMCKD1; CA 15-3; MUC-1/X; MUC1/ZD;	mucin-1 isoform 14 precursor	158340	4582

	MUC-1/SEC			
SMAD4	DPC4, JIP, MADH4, MYHRS	SMAD family member 4	600993	4089
BIRC5	API4; EPR-1; survivin, BIRC5	survivin	603352	332
TERT	TP2; TRT; CMM9; EST2; TCS1; hTRT; DKCA2; DKCB4; hEST2; PFBMFT1	telomerase reverse transcriptase	187270	7015
TGFBR2	AAT3, FAA3, LDS1B, LDS2, LDS2B, MFS2, RIIC, TAAD2, TGFR-2,	transforming growth factor beta receptor 2	190182	7048
TP53	P53; BCC7; LFS1; TRP53	cellular tumor antigen p53	191170	7157

OMIM = Online Mendelian Inheritance in Man database

GeneID = NCBI database

ATLAS library screening

[00369] Frozen peripheral blood mononuclear cells (PBMC) were purchased from Conversant Bio (Alabama) or obtained from a collaborator at Mayo Clinic. After thaw, $CD8^+$ T cells were sorted using antibody-conjugated magnetic beads and non-specifically expanded with anti-CD3 and anti-CD28 stimulation. CD14+ monocytes were also sorted using antibody-conjugated magnetic beads and differentiated *in vitro* into dendritic cells (MDDCs).

[00370] Frozen peripheral blood mononuclear cells (PBMC) were purchased from Conversant Bio (Alabama) or obtained from a collaborator at Mayo Clinic. After thaw, $CD8^+$ T cells were sorted using antibody-conjugated magnetic beads and non-specifically expanded with

anti-CD3 and anti-CD28 stimulation. CD14+ monocytes were also sorted using antibody-conjugated magnetic beads and differentiated *in vitro* into dendritic cells (MDDCs).

[00371] $CD4^+$ and $CD8^+$ T cells were screened against the 26 library clones, as well as against 10 negative control clones expressing Neon Green (NG). Library clones were screened using 1,000-5,000 MDDCs and 80,000 T cells, at an *E. coli*:MDDC ratio of 333:1. After 24h incubation, assay supernatants were harvested and stored at -80°C. Supernatant cytokines levels were analyzed using a Meso Scale Discovery custom plate.

Data analysis

[00372] Clones that induced median cytokine responses that exceeded 2 median absolute deviations (MAD) of the median responses to the negative control Neon Green (NG) clones (N=10) (indicated by a vertical dotted line in Figure 14 and a horizonatal dotted line in Figure 17) were considered antigens. Clones that reduced median cytokine responses to 2 MAD below the median negative control responses were considered inhibitory and/or suppressive antigens. In CRC patients, the breadth of recall responses to the 26 testedTAAs varied, but there was a strong enrichment of $CD4^+$ and $CD8^+$ T cell responses to a subset of 3 TAAs, which was absent in healthy individuals.

[00373] Figure 14 shows response profiles to 25 CRC-associated TAAs across CRC patients. $CD4^+$ and $CD8^+$ T cells from CRC patients across all stages of disease were profiled for responses to 25 TAAs, using TNF-α and IFN-γ secretion as an indicator for a recall response to a putative antigen. Distributions of normalized cytokine concentrations released in response to each antigen are shown, each row represents one antigen. Dashed vertical lines indicate 2 MADs from median cytokine release in response to the NG negative control antigen. Positive values, indicated by a shift toward the right side of the plot, indicate stimulatory T cell recall responses. Negative values, indicated by a shift toward the left side of the plot, indicate inhibitory and/or suppressive T cell recall responses.

[00374] Figures 15A and 15B shows the high frequency of T cell responses to three TAAs not previously identified by algorithm. Response rates in individuals with CRC to three ATLAS-identified TAAs in comparison to three TAAs that are or were in clinical development as a therapeutic vaccine. Figure 15A shows response rate of $CD4^+$ and $CD8^+$ T cells for HPSE1

and HPSE2, in comparison to MUC1, MAGEA3, and TP53. Figure 15B shows response rate of $CD8^+$ T cells for HPSE1, HPSE2 and SMAD4, in comparison to MUC1, MAGEA3, and TP53. Stimulatory (top panels) and inhibitory and/or suppressive (bottom panels) T cell recall responses are shown.

[00375] Figure 16 shows T cell responses to selected TAAs in CRC patients with early or late stage disease (NR, no responders). Stimulatory response rates to four selected TAAs are shown for both $CD4^+$ and $CD8^+$ T cell subsets and TNF-α and IFN-γ cytokine release (Panel A=HPSE1; Panel B=HPSE2; Panel C=TP53; Panel D=MAGEA3). Patients were grouped by stage of disease with early stage representing stages I and II, i.e., locoregional disease, and late stage representing stages III and IV, i.e., with metastasis to lymph nodes or distant sites. There was no significant difference between response rates in early and late disease for either stimulatory responses (shown) or inhibitory and/or suppressive responses (not shown). Stage of cancer did not impact the T cell response signature.

[00376] Figure 17 shows T cell responses to selected TAAs in healthy individuals and donors with various disease states. Normalized cytokine concentrations released in response to the four selected TAAs in the three cohorts are shown for $CD4^+$ and $CD8^+$ T cell subsets and for TNF-α and IFN-γ release (Panel A=HPSE1; Panel B=HPSE2; Panel C=TP53; Panel D=MAGEA3). Each data point represents one individual. IFN-γ release in different cohorts was compared using a Wilcoxon rank sum test. Asterisks indicate statistical significance in comparison to cytokine release in healthy donors unless otherwise indicated. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Significant differences based on TNF-α levels were detected across the same groups (not shown). Importantly, T cell responses to a subset of TAAs (HPSE1, HPSE2, SMAD4) in individuals with pre-malignant adenomatous polyps were similar to those in CRC patients and clearly distinguishable from the rare responses in healthy individuals. This pattern was not observed for responses to TAAs currently or previously investigated as therapeutic vaccines (MUC1, TP53, MAGEA3).

Example 8. Profiling of T cell responses to Tumor-Associated Antigens in lung cancer patients treated with checkpoint inhibitors

Generation of an ATLAS Tumor Associated Antigen library

[00377] ATLAS was applied to characterize and profile T cell responses to Tumor Associated Antigens (TAAs) in a diverse sample of lung cancer patients undergoing ICI therapy. Seventy-six TAA genes (representing 74 unique genes, shown in Table 7) were cloned into the ATLAS expression vector and sequence verified. Each TAA was recombinantly expressed in *E. coli,* with expression verified using Western Blot analysis.

Table 7. ATLAS lung cancer TAA library

Gene Name	Alias	Long Name	OMIM	GeneID
ACTN4	ACTININ-4, FSGS, FSGS1	actinin alpha 4	604638	81
ACVR1	ACTRIA, ACVRLK2, ALK2, FOP, SKR1, TSRI, ACVR1, ACTIVIN	activin A receptor type 1	102576	90
ADH1C	ADH3	alcohol dehydrogenase 1C (class I), gamma polypeptide	103730	126
ADORA2A	A2aR, ADORA2, RDC8, A2AR	adenosine A2a receptor	102776	135
AKAP-4	AKAP 82, AKAP-4, AKAP82, CT99, FSC1, HI, PRKA4, hAKAP82, p8, AKAP4	A-kinase anchoring protein 4	300185	8852
ARHGEF16	GEF16, NBR	Rho guanine nucleotide exchange factor 16		27237
BAGE	BAGE1; CT2.1	B melanoma antigen 1 precursor	605167	574
BLNK	AGM4, BASH-S, LY57,	B-cell linker	604515	29760

	SLP-65, SLP65, bca, BLNK			
BNC1	BNC, BSN1, HsT19447	basonuclin 1	601930	646
BPIFA1	LUNX, NASG, PLUNC, SPLUNC1, SPURT, bA49G10.5	BPI fold containing family A member 1	607412	51297
CACNB3	CAB3, CACNLB3	calcium voltage-gated channel auxiliary subunit beta 3	601958	784
CASP3	CPP32, CPP32B, SCA-1, CASPASE-3	caspase 3	600636	836
CAV1	BSCL3, CGL3, LCCNS, MSTP085, PPH3, VIP21	caveolin 1	601047	857
CDH1	Arc-1, BCDS1, CD324, CDHE, ECAD, LCAM, UVO	cadherin 1	192090	999
COX8C	COX8-3	cytochrome c oxidase subunit 8C	616855	341947
CPT1A	CPT1, CPT1-L, L-CPT1	carnitine palmitoyltransferase 1A	600528	1374
CTAG1A	CT6.1, ESO1, LAGE-2, LAGE2A, NY-ESO-1	cancer/testis antigen 1A	300657	246100
CTCFL	CT27; BORIS; CTCF-T; HMGB1L1; dJ579F20.2	transcriptional repressor CTCFL	607022	140690
CXCL13	ANGIE, ANGIE2, BCA-1, BCA1, BLC, BLR1L, SCYB13	C-X-C motif chemokine ligand 13	605149	10563
DGKH	DGKeta	diacylglycerol kinase eta	604071	160851
EEF2	EEF-2, EF-2, EF2, SCA26	eukaryotic translation elongation factor 2	130610	1938

EGFR	ERBB; HER1; mENA; ERBB1; PIG61; NISBD2	epidermal growth factor receptor	131550	1956
EIF5A	EIF-5A1, eIF5AI, EIF5A	eukaryotic translation initiation factor 5A	600187	1984
FN1	CIG, ED-B, FINC, FN, FNZ, GFND, GFND2, LETS, MSF, Fibronectin	fibronectin 1	135600	2335
GAGE1	CT4.1; GAGE-1	G antigen 1	300594	2543
GAGE4	CT4.4	G antigen 12I	300597	2576
HLA-DRB1		major histocompatibility complex, class II, DR beta 1	142857	3123
HLA-DRB5		major histocompatibility complex, class II, DR beta 5	604776	3127
HPSE1		heparanase isoform 1	604724	10855
HPSE2		heparanase isoform 2		
HSD17B3	EDH17B3, SDR12C2	hydroxysteroid 17-beta dehydrogenase 3	605573	3293
IDE	INSULYSIN	insulin degrading enzyme	146680	3416
IDO1	IDO, IDO-1, INDO	indoleamine 2,3-dioxygenase 1	147435	3620
IGFBP5	IBP5	insulin like growth factor binding protein 5	146734	3488
IGFBP7	AGM, FSTL2, IBP-7, IGFBP-7, IGFBP-7v, IGFBPRP1, MAC25, PSF,	insulin like growth factor binding protein 7	602867	3490
KCNK1	DPK, HOHO, K2P1,	potassium two pore	601745	3775

	K2p1.1, KCNO1, TWIK-1, TWIK1	domain channel subfamily K member 1		
LAMP3	CD208, DC LAMP, DC-LAMP, DCLAMP, LAMP, LAMP-3, TSC403	lysosomal associated membrane protein 3	605883	27074
MAGEA1	CT1.1; MAGE1	MAGE family member A1	300016	4100
MAGEA3	HIP8; HYPD; CT1.3; MAGE3; MAGEA6, MAGE-A3 (G-2544)	MAGE family member A3	300174	4102
MAGEB2	CT3.2, DAM6, MAGE-XP-2	MAGE family member B2	300098	4113
MAPK13	MAPK 13, MAPK-13, PRKM13, SAPK4, p38delta	mitogen-activated protein kinase 13	602899	5603
MARCO	SCARA2, SR-A6	macrophage receptor with collagenous structure	604870	8685
ME1	HUMNDME, MES	malic enzyme 1	154250	4199
MIIP	IIP45, IGFBP-2	migration and invasion inhibitory protein	608772	60672
MMP12	HME, ME, MME, MMP-12	matrix metallopeptidase 12	601046	4321
MMP7	MMP-7, MPSL1, PUMP-1	matrix metallopeptidase 7	178990	4316
MPZL1	MPZL1b, PZR, PZR1b, PZRa, PZRb	myelin protein zero like 1	604376	9019
MSR1	CD204, SCARA1, SR-A, SR-AI, SR-AII, SR-AIII, SRA, phSR1, ph	macrophage scavenger receptor 1	153622	4481

MUC1	EMA; MCD; PEM; PUM; KL-6; MAM6; MCKD; PEMT; CD227; H23AG; MCKD1; MUC-1; ADMCKD; ADMCKD1; CA 15-3; MUC-1/X; MUC1/ZD; MUC-1/SEC	mucin-1 isoform 14 precursor	158340	4582
MYNN	OSZF, SBBIZ1, ZBTB31, ZNF902	myoneurin	606042	55892
NAGK	GNK, HSA242910	N-acetylglucosamine kinase	606828	55577
NAPSA	KAP, Kdap, NAP1, NAPA, SNAPA	napsin A aspartic peptidase	605631	9476
NFYC	CBF-C, CBFC, H1TF2A, HAP5, HSM, NF-YC	nuclear transcription factor Y subunit gamma	605344	4802
NKRF	ITBA4, NRF	NFKB repressing factor	300440	55922
PLAU	ATF, BDPLT5, QPD, UPA, URK, u-PA	plasminogen activator, urokinase	191840	5328
ROR1	NTRKR1, dJ537F10.1	receptor tyrosine kinase like orphan receptor 1	602336	4919
RUNX1	AML1, AML1-EVI-1, AMLCR1, CBF2alpha, CBFA2, EVI-1, PEBP2aB,	runt related transcription factor 1	151385	861
SFTPA1	COLEC4, PSAP, PSP-A, PSPA, SFTP1B, SP-A, SP-A1, SPA, SPA1,	surfactant protein A1	178630	653509
SFTPA2	COLEC5, PSAP, PSP-A, PSPA, SFTP1B, SP-2A,	surfactant protein A2	178642	729238

	SP-A, SPA2, SPAII			
SFTPB	PSP-B, SFTB3, SFTP3, SMDP1, SP-B	surfactant protein B	178640	6439
SFTPC	BRICD6, PSP-C, SFTP2, SMDP2, SP-C	surfactant protein C	178620	6440
SFTPD	COLEC7, PSP-D, SFTP4, SP-D	surfactant protein D	178635	6441
SLC2A5	GLUT-5, GLUT5, SGT1	solute carrier family 2 member 5	138230	6518
SPAG9	CT89, HLC-6, HLC4, HLC6, JIP-4, JIP4, JLP, PHET, PIG6	sperm associated antigen 9	605430	9043
SSX2	SSX; HD21; CT5.2; CT5.2A; HOM-MEL-40	protein SSX2	300192	6757
SUGT1	SGT1	SGT1 homolog, MIS12 kinetochore complex assembly cochaperone	604098	10910
SULT1C2	ST1C1, ST1C2, SULT1C1, humSULTC2	sulfotransferase family 1C member 2	602385	6819
TGFBR2	AAT3, FAA3, LDS1B, LDS2, LDS2B, MFS2, RIIC, TAAD2, TGFR-2,	transforming growth factor beta receptor 2	190182	7048
TMEM52B		transmembrane protein 52B		120939
TP53	P53; BCC7; LFS1; TRP53	cellular tumor antigen p53 isoform a	191170	7157
VEGF-A	VPF; VEGF; MVCD1	vascular endothelial growth factor A	192240	7422
XPO7	EXP7, RANBP16	exportin 7	606140	23039
YES1	HsT441, P61-YES, Yes,	YES proto-oncogene 1,	164880	7525

	c-yes	Src family tyrosine kinase		
CCDC80	DRO1, SSG1, URB, okuribin	coiled-coil domain containing 80	608298	151887

OMIM = Online Mendelian Inheritance in Man database
GeneID = NCBI database

ATLAS library screening

[00378] Blood samples were collected from 13 consenting patients undergoing ICI therapy. Frozen peripheral blood mononuclear cells (PBMC) were purchased from Bioreclamation (New York). After thaw, $CD4^+$ and $CD8^+$ T cells were sorted using antibody-conjugated magnetic beads and non-specifically expanded with anti-CD3 and anti-CD28 stimulation. $CD14^+$ monocytes were also sorted using antibody-conjugated magnetic beads and differentiated *in vitro* into dendritic cells (MDDCs).

[00379] $CD4^+$ and $CD8^+$ T cells were screened against the 76 library clones, as well as against 10 negative control clones expressing Neon Green (NG). Library clones were screened using 1,000-5,000 MDDCs and 80,000 T cells, at an *E. coli*:MDDC ratio of 333:1. After 24h incubation, assay supernatants were harvested and stored at -80°C. Supernatant cytokines levels were analyzed using a Meso Scale Discovery custom plate.

Data analysis

[00380] Clones that induced median cytokine responses that exceeded 2 median absolute deviations (MADs) of the median responses to the negative control Neon Green clones (N=10) (indicated by a horizontal dotted line in Figure 18 and Figure 19) were considered antigens. Clones that reduced median cytokine responses to two MADs below the median negative control responses were considered inhibitory and/or suppressive antigens.

[00381] Figure 18 shows an exemplary empirical determination of T cell responses to profiled TAAs. Exemplary data is shown for a single lung cancer patient. T cell responses were reported as natural log concentrations back-calculated from the MSD standard curve and normalized to the patient's response to a negative control protein. A stimulatory response was

defined as a TAA with a median concentration greater than two MADs above the median of the negative control replicates. This threshold is shown as the upper dashed horizontal line, and stimulatory responses are shown as filled circles. An inhibitory and/or suppressive response was defined as a TAA with a median concentration greater than two MADs of the negative control replicates below the median of the negative control replicates. This threshold is shown as the lower dashed horizontal line, and inhibitory and/or suppressive responses are shown as filled triangles.

[00382] Figure 19 shows frequent $CD4^+$ T cell responses to novel TAAs compared to previously described TAAs. Across patients, IFN-γ $CD4^+$ T cell responses to two novel TAAs (Novel TAA1 = HPSE1; Novel TAA2 = HPSE2) appeared to be stronger than responses to NY-ESO-1, MUC1, and MAGEA3, three TAAs that have been utilized in cancer vaccines in clinical trials for treatment of lung cancer patients. Each point represents a patient's response to that TAA, normalized to the patient's response to an irrelevant negative control protein. Stimulatory responses, those that fall above the 2xMAD cutoff indicated by the upper horizontal dotted line, are colored black. Both the median normalized concentration and the proportion of stimulatory responses to these two TAAs were higher than those of the three other TAAs. CD8+ responses to these five TAAs were more similar across patients (not shown).

[00383] Figure 20 shows that lung cancer patients develop $CD4^+$ and $CD8^+$ T cell responses to a broad range of TAAs. Across lung cancer patients, stimulatory $CD4^+$ and/or $CD8^+$ T cell responses were observed in at least one individual to a clear majority of the 76 profiled TAAs. The percent of patients that developed a stimulatory T cell response to each TAA is shown separately for $CD4^+$ (grey bars) and $CD8^+$ (black bars) T cells. IFN-γ responses are displayed in the top two panels, and TNF-α responses are displayed in the bottom two panels. Antigens to which patients developed both a $CD4^+$ and a $CD8^+$ T cell response (left panels) were differentiated from antigens to which patients developed either a $CD4^+$ or a $CD8^+$ T cell response (right panels).

[00384] Figure 21 shows that inhibitory and/or suppressive T cell responses were detected in most profiled TAAs. Inhibitory and/or suppressive T cell responses to TAAs were observed frequently across the profiled lung cancer patients. For each profiled TAA, the percent of patients that developed an inhibitory and/or suppressive T cell response, defined as a response that is two MADs lower than the response to the negative control protein, are shown for $CD4^+$

(white bars) and $CD8^+$ (grey bars) T cells. IFN-γ responses are displayed in the top two panels, and TNF-α responses are displayed in the bottom two panels. Antigens to which patients developed both a $CD4^+$ and a $CD8^+$ T cell response (left panels) were differentiated from antigens to which patients developed either a $CD4^+$ or a $CD8^+$ T cell response (right panels).

Example 9. Neoantigen identification using ATLAS^T across multiple tumor types

Generation of the ATLAS neoantigen library

[00385] ATLAS was applied to characterize and profile pre-existing T cell responses to tumor specific mutations in a diverse set of cancer patients. Tumor biopsy and normal tissue samples were collected from 19 consenting patients. Whole exome and RNA sequencing of the tumor sample and whole exome sequencing of the matched normal sample identified mutations which are unique to the tumor and not present in the germline of the patient. Each somatic protein altering mutation was expressed as individual clones in the ATLAS expression vector and sequence verified. Each clone was recombinantly expressed in *E. coli,* with expression verified using Western Blot analysis.

ATLAS library screening

[00386] Blood samples were collected from 19 consenting patients and PBMCs isolated using standard procedures. Frozen peripheral blood mononuclear cells (PBMCs) were purchased from Conversant (Alabama) or obtained from collaborators. After thaw, $CD4^+$ and $CD8^+$ T cells were sorted using antibody-conjugated magnetic beads and non-specifically expanded with anti-CD3 and anti-CD28 stimulation. $CD14^+$ monocytes were also sorted using antibody-conjugated magnetic beads and differentiated *in vitro* into myeloid derived dendritic cells (MDDCs).

[00387] $CD4^+$ and $CD8^+$ T cells were screened against the individuals' specific library clones, as well as against multiple negative control clones expressing Neon Green (NG). Library clones were screened using 1,000-5,000 MDDCs and 80,000 T cells, at an *E. coli*:MDDC ratio of 333:1. After 24h incubation, assay supernatants were harvested and stored at -80°C. Supernatant cytokines levels were analyzed using a Meso Scale Discovery custom plate.

Data analysis

[00388] Clones that induced median cytokine responses that exceeded 2 median absolute deviations (MADs) of the median responses to the negative control Neon Green clones (indicated by horizontal dotted line in Figure 22) were considered stimulatory neoantigens. Clones that reduced median cytokine responses to 2 MADs below the median negative control responses were considered inhibitory and/or suppressive neoantigens.

[00389] Figure 22 shows an exemplary neoantigen screen with ATLAS identifying patient-specific $CD4^+$ and $CD8^+$ T cell responses. For one pancreatic cancer subject, displayed are the CD4+ and CD8+ T cell responses observed in response to each candidate neoantigen. Each dot represents a technical replicate. Horizontal dotted lines indicate the cutoffs used to define stimulatory neoantigens and inhibitory and/or suppressive neoantigens at +3 and -3 Median Absolute Deviations (MADs), respectively.

[00390] Figures 23A, 23B, 23C, and 23D show that an algorithm predicting MHC Class I binding did not accurately predict $CD8^+$ T cell responses or type of response. The diagrams compare MHC class I algorithm-based binding predictions (NetMHCpan predictions with binding affinity cutoff of <500nM) and T cell responses observed in ATLAS across 11 initial subjects and across all 19 subjects. Figures 23A and 23C show the total numbers and overlap of neoantigens predicted by algorithm and observed in ATLAS for the 11 initial subjects and for all 19 subjects, respectively. Figures 23B and 23D show the break-down of predictions by strong binding (< 150nM), weak binding (< 500nM), or non-binding (>= 500nM) for the 11 initial subjects and for all 19 subjects, respectively. There was no enrichment of either stimulatory or inhibitory and/or suppressive responses in $CD8^+$ T cells across binding prediction groups.

[00391] Figures 24A and 24B show that $CD8^+$ T cell responses identified by ATLAS to candidate stimulatory neoantigens were not enriched for any mutation type. In Figure 24A, mutation types for the 11 initial subjects were defined as missense, in-frame, or frameshift. In Figure24B, mutation types for all 19 subjects were defined as short variant (a combination of missense and in-frame mutations resulting in 1-2 amino acid changes relative to wild-type gene sequence) and neoORF (a combination of frameshift and loss-of-stop-codon mutations resulting in 3 or more amino acid changes relative to wild-type gene sequence). In this example, candidate inhibitory and/or suppressive neoantigens were somewhat more frequently associated with missense or short variant mutations.

[00392] Figures 25A and 25B show that lower DNA mutant allele frequency has a moderate association with $CD8^+$ T cell response frequency (P-value = 0.037). Mutant DNA allele frequency was derived from whole exome sequencing and compared to response type observed. Figure 25A shows results for the 11 initial subjects. Figure 25B shows results for all 19 subjects.

[00393] Figures 26A and 26B show that detection of a mutation in RNA did not predict whether the candidate stimulatory or inhibitory/suppressive antigen has a recall response in $CD8^+$ T cells. RNA-seq was performed on the tumor material. Somatic mutations were identified via whole exome sequencing, and the RNA-seq data was interrogated for the presence or absence of mutations identified in DNA. Figure 26A shows results for 8 of the 11 initial subjects. Figure 26B shows results for all 19 subjects.

[00394] Figures 27A and 27B show that CD8+ T cell responses identified by ATLAS to candidate neoantigens did not correlate with gene expression. RNA-seq was performed on the tumor material; quantitative gene expression values were calculated for each gene harboring a candidate neoantigen and compared to normalized cytokine measurements. Figure 27A shows results for 10 of the 11 initial subjects. Figure 27B shows results for all 19 subjects.

Example 10. Different cytokine responses to different neoantigens identified using ATLAS in a pancreatic cancer patient

Generation of the ATLAS neoantigen library

[00395] ATLAS was applied to screen the entire complement of mutations identified in the tumor of a consented pancreatic cancer patient. An ATLAS library was built that expressed 22 mutations unique to this patient. Each clone contained 113 amino acids with the mutation positioned near the center of the construct and sequence-verified. Each clone was recombinantly expressed in *E. coli* and protein expression was verified using Western Blot.

ATLAS library screening

[00396] Frozen peripheral blood mononuclear cells (PBMC) were purchased from Conversant Bio. After thaw, $CD8^+$ T cells were sorted using antibody-conjugated magnetic beads and non-specifically expanded with anti-CD3 and anti-CD28 stimulation. CD14+

monocytes were also sorted using antibody-conjugated magnetic beads and differentiated *in vitro* into dendritic cells (MDDC).

[00397] $CD8^+$ T cells were screened against the 22 library clones, as well as against a negative control clones expressing Neon Green (NG). Library clones were screened using 5,000 MDDC and 80,000 T cells, at an *E. coli*:MDDC ratio of 333:1. After 19.5 h incubation, assay supernatants were harvested and stored at -80°C. Supernatant cytokines CM-CSF, IFNγ, IL-10, MIF, TNFα, and TRAIL were analyzed using a Meso Scale Discovery custom plate.

Data analysis

[00398] Figure 28 shows the different CM-CSF, IFNγ, IL-10, MIF, TNFα, and TRAIL response profiles elicited by six representative neoantigens in a screen of $CD8^+$ T cells from the patient. Each panel corresponds to one neoantigen (denoted G-3618, G-3624, G-3620, G-3627, G-3617, and G-3632). The horizontal line in each panel indicates the median response to the negative controls. Bars above the horizontal line indicate stimulation of cytokine secretion. Bars below the horizontal line indicate inhibition and/or suppression of cytokine secretion. The panels illustrate the different cytokine responses elicited by each neoantigen.

Example 11. T cell responses to VEGF in a cohort of cancer patients and healthy donors

[00399] PBMC from eight cancer patients (seven lung cancer, one colorectal cancer) and 13 healthy donors were screened in duplicate against VEGF, a known TAA. $CD8^+$ T cells were sorted and non-specifically expanded using anti-CD3 and anti-CD28-coated microbeads, and $CD14^+$ monocytes were differentiated into dendritic cells (MDDC). Library clones were screened in duplicate using 5,000 MDDC and 80,000 T cells, at an *E. coli*:MDDC ratio of 100:1; replicates of *E. coli* expressing neon green (NG) were included as negative controls. Assay supernatants were harvested at 24hr and stored at -80°C. Supernatant cytokines were analyzed using Meso Scale Discovery V-PLEX Proinflammatory Panel 1 (human) Kit.

Data analysis

[00400] Clones that induced mean cytokine responses that exceeded 2 median average deviations (MAD) of the median responses to the negative control NG clones (N=10) were considered antigens. Figure 29 shows $CD8^+$ T cell data for healthy donors (black bars) and

cancer patients (white bars). The median log cytokine response normalized to neon green are indicated for each subject cohort. When analyzed by IFNγ secretion, there was a large inhibitory response in the healthy donor cohort, that greatly exceeded the inhibitory responses in the cancer patient cohort. Conversely, there was a greater median inhibitory response in the cancer cohort when TNFα secretion was considered.

Example 12. *In vitro* immunization using combination of 3 TAAs

Protocol for *in vitro* immunization

[00401] PBMCs from healthy donors are enriched using standard protocols. Washed PBMCs are resuspended in supplemented RPMI-1640 medium. 100µL cells ($2x10^6$cell/mL) are added into each well of a 96-well flat-bottom assay plate. Overlapping peptides corresponding to TAAs HPSE1, HPSE2, SMAD4, MUC1, MAGEA3, and TP53 were added to cultures at a final concentration of 50 µg/mL. Cultures are incubated for 5 days, the peptide-containing medium removed, then cultures provided with human IL-2 (10 U/mL) for 11 days, with IL-2-containing medium being replenished every 3 days. The incubation time of 5 days with peptide plus 11 days with IL-2 constitutes one cycle. Primary cultures are subsequently restimulated with the same peptides (50 ng/mL) on day 16 to begin the next cycle. Irradiated (4000 rad) autologous peripheral blood mononuclear cells ($5 \times I0^5$) are added in a volume of 50 µL in complete medium as APCs. An ELISPOT is performed on an aliquot of cells at the end of each cycle to observe *de novo* responses to the peptides.

LISTING OF SEQUENCES

Heparanase isoform 1, preproprotein, NP_001092010.1, NP_006656.2 (SEQ ID NO: 6)

```
   1 mllrskpalp pplmllllgp lgplspgalp rpaqaqdvvd ldfftqeplh lvspsflsvt
  61 idanlatdpr flillgspkl rtlarglspa ylrfggtktd flifdpkkes tfeersywqs
 121 qvnqdickyg sippdveekl rlewpyqeql llrehyqkkf knstysrssv dvlytfancs
 181 gldlifglna llrtadlqwn ssnaqlldy csskgynisw elgnepnsfl kkadifings
 241 qlgedfiqlh kllrkstfkn aklygpdvgq prrktakmlk sflkaggevi dsvtwhhyyl
 301 ngrtatkedf lnpdvldifi ssvqkvfqvv estrpgkkvw lgetssaygg gapllsdtfa
 361 agfmwldklg lsarmgievv mrqvffgagn yhlvdenfdp lpdywlsllf kklvgtkvlm
 421 asvqgskrrk lrvylhctnt dnprykegdl tlyainlhnv tkylrlpypf snkqvdkyll
 481 rplgphglls ksvqlngltl kmvddqtlpp lmekplrpgs slglpafsys ffvirnakva
 541 aci
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Heparanase isoform 2, preproprotein, NP_001159970.1 (SEQ ID NO: 7)

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   1 mllrskpalp pplmllllgp lgplspgalp rpaqaqdvvd ldfftqeplh lvspsflsvt
  61 idanlatdpr flillgspkl rtlarglspa ylrfggtktd flifdpkkes tfeersywqs
 121 qvnqdickyg sippdveekl rlewpyqeql llrehyqkkf knstysrssv dvlytfancs
 181 gldlifglna llrtadlqwn ssnaqlldy csskgynisw elgnepnsfl kkadifings
 241 qlgedfiqlh kllrkstfkn aklygpdvgq prrktakmlk sflkaggevi dsvtwhhyyl
 301 ngrtatkedf lnpdvldifi ssvqkvfqdy wlslfkklv gtkvlmasvq gskrrklrvy
 361 lhctntdnpr ykegdltlya inlhnvtkyl rlpypfsnkq vdkyllrplg phgllsksvq
 421 lngltlkmvd dqtlpplmek plrpgsslgl pafsysffvi rnakvaaci
```

SMAD family member 4 , mothers against decapentaplegic homolog 4, NP_005350.1 (SEQ ID NO: 8)

```
   1 mdnmsitntp tsndaclsiv hslmchrqgg esetfakrai eslvkklkek kdeldslita
  61 ittngahpsk cvtiqrtldg rlqvagrkgf phviyarlwr wpdlhknelk hvkycqyafd
 121 lkcdsvcvnp yhyervvspg idlsgltlqs napssmmvkd eyvhdfegqp slsteghsiq
 181 tiqhppsnra stetystpal lapsesnats tanfpnipva stsqpasilg gshsegllqi
 241 asgpqpgqqq ngftgqpaty hhnstttwtg srtapytpnl phhqnghlqh hppmpphpgh
 301 ywpvhnelaf qppisnhpap eywcsiayfe mdvqvgetfk vpsscpivtv dgyvdpsggd
 361 rfclgqlsnv hrteaierar lhigkgvqle ckgegdvwvr clsdhavfvq syyldreagr
 421 apgdavhkiy psayikvfdl rqchrqmqqq aataqaaaaa qaaavagnip gpgsvggiap
 481 aislsaaagi gvddlrrlci lrmsfvkgwg pdyprqsike tpcwieihlh ralqlldevl
 541 htmpiadpqp ld
```

Cadherin 3, isoform 1 preproprotein, NP_001784.2

```
   1 mglprgplas llllqvcwlq caasepcrav freaevtlea ggaeqepgqa lgkvfmgcpg
  61 qepalfstdn ddftvrnget vqerrslker nplkifpskr ilrrhkrdwv vapisvpeng
 121 kgpfpqrlnq lksnkdrdtk ifysitgpga dsppegvfav eketgwllln kpldreeiak
 181 yelfghavse ngasvedpmn isiivtdqnd hkpkftqdtf rgsvlegvlp gtsvmqvtat
 241 deddaiytyn gvvaysihsq epkdphdlmf tihrstgtis vissgldrek vpeytltiqa
 301 tdmdgdgstt tavavveild andnapmfdp qkyeahvpen avghevqrlt vtdldapnsp
 361 awratylimg gddgdhftit thpesnqgil ttrkgldfea knqhtlyvev tneapfvlkl
 421 ptstativvh vedvneapvf vppskvvevq egiptgepvc vytaedpdke nqkisyrilr
 481 dpagwlamdp dsgqvtavgt ldredeqfvr nniyevmvla mdngsppttg tgtllltlid
 541 vndhgpvpep rqiticnqsp vrqvlnitdk dlsphtspfq aqltddsdiy wtaevneegd
 601 tvvlslkkfl kqdtydvhls lsdhgnkeql tviratvcdc hghvetcpgp wkggfilpvl
 661 gavlallfll lvllllvrkk rkikeplllp eddtrdnvfy ygeegggeed qdyditqlhr
 721 glearpevvl rndvaptiip tpmyrprpan pdeignfiie nlkaantdpt appydtllvf
 781 dyegsgsdaa slssltssas dqdqdydyln ewgsrfkkla dmygggedd
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Cadherin 3, isoform 2 precursor, NP_001304124.1

```
   1 mglprgplas llllqvcwlq caasepcrav freaevtlea ggaeqepgqa lgkvfmgcpg
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       61 qepalfstdn ddftvrnget vqerrslker nplkifpskr ilrrhkrdwv vapisvpeng
      121 kgpfpqrlnq lksnkdrdtk ifysitgpga dsppegvfav eketgwllln kpldreeiak
      181 yelfghavse ngasvedpmn isiivtdqnd hkpkftqdtf rgsvlegvlp gtsvmqvtat
      241 deddaiytyn gvvaysihsq epkdphdlmf tihrstgtis vissgldrek vpeytltiqa
      301 tdmdgdgstt tavavveild andnapmfdp qkyeahvpen avghevqrlt vtdldapnsp
      361 awratylimg gddgdhftit thpesnqgil ttrkgldfea knqhtlyvev tneapfvlkl
      421 ptstativvh vedvneapvf vppskvvevq egiptgepvc vytaedpdke nqkisyrilr
      481 dpagwlamdp dsgqvtavgt ldredeqfvr nniyevmvla mdngsppttg tgtllltlid
      541 vndhgpvpep rqiticnqsp vrqvlnitdk dlsphtspfq aqltddsdiy wtaevneegd
      601 tvvlslkkfl kqdtydvhls lsdhgnkeql tviratvcdc hghvetcpgp wkggfilpvl
      661 gavlallfll lvllllvrkk rkikeplllp eddtrdnvfy ygeegggeed qdyditqlhr
      721 glearpevvl rndvaptiip tpmyrprpan pdeignfiie grgergsqrg ngglqlargr
      781 trrs

Cadherin 3, isoform 3, NP_001304125.1
        1 mgcpgqepal fstdnddftv rngetvqerr slkernplki fpskrilrrh krdwvvapis
       61 vpengkgpfp qrlnqlksnk drdtkifysi tgpgadsppe gvfaveketg wlllnkpldr
      121 eeiakyelfg havsengasv edpmnisiiv tdqndhkpkf tqdtfrgsvl egvlpgtsvm
      181 qvtatdedda iytyngvvay sihsqepkdp hdlmftihrs tgtisvissg ldrekvpeyt
      241 ltiqatdmdg dgstttavav veildandna pmfdpqkyea hvpenavghe vqrltvtdld
      301 apnspawrat ylimggdgd hftitthpes nqgilttrkg ldfeaknqht lyvevtneap
      361 fvlklptsta tivvhvedvn eapvfvppsk vvevqegipt gepvcvytae dpdkenqkis
      421 yrilrdpagw lamdpdsgqv tavgtldred eqfvrnniye vmvlamdngs ppttgtgtll
      481 ltlidvndhg pvpeprqiti cnqspvrqvl nitdkdlsph tspfqaqltd dsdiywtaev
      541 neegdtvvls lkkflkqdty dvhlslsdhg nkeqltvira tvcdchghve tcpgpwkggf
      601 ilpvlgavla llflllvlll lvrkkrkike plllpeddtr dnvfyygeeg ggeedqdydi
      661 tqlhrglear pevvlrndva ptiiptpmyr prpanpdeig nfiienlkaa ntdptappyd
      721 tllvfdyegs gsdaaslssl tssasdqdqd ydylnewgsr fkkladmygg gedd

Chorionic gonadotropin beta subunit 3, precursor, NP_000728.1
        1 memfqgllll lllsmggtwa skeplrprcr pinatlavek egcpvcitvn tticagycpt
       61 mtrvlqgvlp alpqvvcnyr dvrfesirlp gcprgvnpvv syavalscqc alcrrsttdc
      121 ggpkdhpltc ddprfqdsss skapppslps psrlpgpsdt pilpq

Chorionic gonadotropin beta subunit 5, precursor, NP_149032.1
        1 memfqgllll lllsmggtwa skeplrprcr pinatlavek egcpvcitvn tticagycpt
       61 mtrvlqgvlp alpqvvcnyr dvrfesirlp gcprgvnpvv syavalscqc alcrrsttdc
      121 ggpkdhpltc ddprfqdsss skapppslps psrlpgpsdt pilpq

Cytochrome c oxidase assembly factor 1 homolog, isoform a, NP_001308126.1,
NP_001308127.1, NP_001308128.1, NP_001308129.1, NP_001337853.1,
NP_001337854.1, NP_001337855.1, NP_001337856.1, NP_060694.2
        1 mmwqkyagsr rsmplgaril fhgvfyaggf aivyyliqkf hsralyykla veqlqshpea
       61 qealgpplni hylklidren fvdivdaklk ipvsgskseg llyvhssrgg pfqrwhldev
      121 flelkdgqqi pvfklsgeng devkke

Cytochrome c oxidase assembly factor 1 homolog, isoform b, NP_001308130.1
        1 mplgarilfh gvfyaggfai vyyliqkfhs ralyyklave qlqshpeaqe algpplnihy
       61 lklidrenfv divdaklkip vsgsksegll yvhssrggpf qrwhldevfl elkdgqqipv
      121 fklsgengde vkke

Cytochrome c oxidase assembly factor 1 homolog, isoform c, NP_001308131.1,
NP_001308132.1, NP_001308133.1, NP_001308134.1
        1 mmwqkyagsr rsmplgaril fhgvfyaggf aivyyliqsk ypasrlrpdl llacscssir
       61 gnt

Cytochrome c oxidase assembly factor 1 homolog, isoform d, NP_001337857.1
```

```
        1 mqeaggqclw eqgsfstvcs mpgalplcit sfkfhsraly yklaveqlqs hpeaqealgp
       61 plnihylkli drenfvdivd aklkipvsgs ksegllyvhs srggpfqrwh ldevflelkd
      121 gqqipvfkls gengdevkke
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Estrogen receptor binding site associated, antigen, 9, NP_001265867.1, NP_004206.1, NP_936056.1, NP_001308129.1,

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        1 maitqfrlfk fctclatvfs flkrlicrsg rgrklsgdqi tlpttvdyss vpkqtdveew
       61 tswdedapts vkieggngnv atqqnsleql epdyfkdmtp tirktqkivi kkreplnfgi
      121 pdgstgfssr laatqdlpfi hqsselgdld twqentnawe eeedaawqae evlrqqklad
      181 rekraaeqqr kkmekeaqrl mkkeqnkigv kls
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ETS transcription factor, isoform a, NP_001964.2

```
        1 mdsaitlwqf llqllqkpqn khmicwtsnd gqfkllqaee varlwgirkn kpnmnydkls
       61 ralryyyvkn iikkvngqkf vykfvsypei lnmdpmtvgr iegdceslnf sevssssskdv
      121 enggkdkppq pgaktssrnd yihsglyssf tlnslnssnv klfklikten paeklaekks
      181 pqeptpsvik fvttpskkpp vepvaatisi gpsispssee tiqaletlvs pklpsleapt
      241 sasnvmtafa ttppissipp lqepprtpsp plsshpdidt didsvasqpm elpenlslep
      301 kdqdsvllek dkvnnssrsk kpkglelapt lvitssdpsp lgilspslpt asltpaffsq
      361 tpiiltpspl lssihfwstl spvaplspar lqgantlfqf psvlnshgpf tlsgldgpst
      421 pgpfspdlqk t
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ETS transcription factor, isoform b, NP_068567.1

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        1 mdsaitlwqf llqllqkpqn khmicwtsnd gqfkllqaee varlwgirkn kpnmnydkls
       61 ralryyyvkn iikkvngqkf vykfvsypei lnmdpmtvgr iegdceslnf sevssssskdv
      121 enggkdkppq pgaktssrnd yihsglyssf tlnslnssnv klfklikten paeklaekks
      181 pqeptpsvik fvttpskkpp vepvaatisi gpsispssee tiqaletlvs pklpsleapt
      241 sasnvmtafa ttppissipp lqepprtpsp plsshpdidt didsvasqpm elpenlslep
      301 kdqdsvllek dkvnnssrsk kpkglelapt lvitssdpsp lgilspslpt asltpaffsq
      361 vacslfmvsp llsficpfkq iqnlytqvcf lllrfvlerl cvtvm
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Receptor tyrosine-protein kinase erbB-2, isoform a precursor, NP_004439.2

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        1 melaalcrwg lllallppga astqvctgtd mklrlpaspe thldmlrhly qgcqvvqgnl
       61 eltylptnas lsflqdiqev qgyvliahnq vrqvplqrlr ivrgtqlfed nyalavldng
      121 dplnnttpvt gaspgglrel qlrslteilk ggvliqrnpq lcyqdtilwk difhknnqla
      181 ltlidtnrsr achpcspmck gsrcwgesse dcqsltrtvc aggcarckgp lptdccheqc
      241 aagctgpkhs dclaclhfnh sgicelhcpa lvtyntdtfe smpnpegryt fgascvtacp
      301 ynylstdvgs ctlvcplhnq evtaedgtqr cekcskpcar vcyglgmehl revravtsan
      361 iqefagckki fgslaflpes fdgdpasnta plqpeqlqvf etleeitgyl yisawpdslp
      421 dlsvfqnlqv irgrilhnga ysltlqglgi swlglrslre lgsglalihh nthlcfvhtv
      481 pwdqlfrnph qallhtanrp edecvgegla chqlcarghc wgpgptqcvn csqflrgqec
      541 veecrvlqgl preyvnarhc lpchpecqpq ngsvtcfgpe adqcvacahy kdppfcvarc
      601 psgvkpdlsy mpiwkfpdee gacqpcpinc thscvdlddk gcpaeqrasp ltsiisavvg
      661 illvvvlgvv fgilikrrqq kirkytmrrl lqetelvepl tpsgampnqa qmrilketel
      721 rkvkvlgsga fgtvykgiwi pdgenvkipv aikvlrents pkankeilde ayvmagvgsp
      781 yvsrllgicl tstvqlvtql mpygclldhv renrgrlgsq dllnwcmqia kgmsyledvr
      841 lvhrdlaarn vlvkspnhvk itdfglarll dideteyhad ggkvpikwma lesilrrrft
      901 hqsdvwsygv tvwelmtfga kpydgipare ipdllekger lpqppictid vymimvkcwm
      961 idsecrprfr elvsefsrma rdpqrfvviq nedlgpaspl dstfyrslle dddmgdlvda
     1021 eeylvpqqgf fcpdpapgag gmvhhrhrss strsgggdlt lglepseeea prsplapseg
     1081 agsdvfdgdl gmgaakglqs lpthdpsplq rysedptvpl psetdgyvap ltcspqpeyv
     1141 nqpdvrpqpp spregplpaa rpagatlerp ktlspgkngv vkdvfafgga venpeyltpq
     1201 ggaapqphpp pafspafdnl yywdqdpper gappstfkgt ptaenpeylg ldvpv
```

Receptor tyrosine-protein kinase erbB-2, isoform b, NP_001005862.1

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        1 mklrlpaspe thldmlrhly qgcqvvqgnl eltylptnas lsflqdiqev qgyvliahnq
       61 vrqvplqrlr ivrgtqlfed nyalavldng dplnnttpvt gaspgglrel qlrslteilk
      121 ggvliqrnpq lcyqdtilwk difhknnqla ltlidtnrsr achpcspmck gsrcwgesse
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```
 181 dcqsltrtvc aggcarckgp lptdccheqc aagctgpkhs dclaclhfnh sgicelhcpa
 241 lvtyntdtfe smpnpegryt fgascvtacp ynylstdvgs ctlvcplhnq evtaedgtqr
 301 cekcskpcar vcyglgmehl revravtsan iqefagckki fgslaflpes fdgdpasnta
 361 plqpeqlqvf etleeitgyl yisawpdslp dlsvfqnlqv irgrilhnga ysltlqglgi
 421 swlglrslre lgsglalihh nthlcfvhtv pwdqlfrnph qallhtanrp edecvgegla
 481 chqlcarghc wgpgptqcvn csqflrgqec veecrvlqgl preyvnarhc lpchpecqpq
 541 ngsvtcfgpe adqcvacahy kdppfcvarc psgvkpdlsy mpiwkfpdee gacqpcpinc
 601 thscvdlddk gcpaeqrasp ltsiisavvg illvvvlgvv fgilikrrqq kirkytmrrl
 661 lqetelvepl tpsgampnqa qmrilketel rkvkvlgsga fgtvykgiwi pdgenvkipv
 721 aikvlrents pkankeilde ayvmagvgsp yvsrllgicl tstvqlvtql mpygclldhv
 781 renrgrlgsq dllnwcmqia kgmsyledvr lvhrdlaarn vlvkspnhvk itdfglarll
 841 dideteyhad ggkvpikwma lesilrrrft hqsdvwsygv tvwelmtfga kpydgipare
 901 ipdllekger lpqppictid vymimvkcwm idsecrprfr elvsefsrma rdpqrfvviq
 961 nedlgpaspl dstfyrslle dddmgdlvda eeylvpqqgf fcpdpapgag gmvhhrhrss
1021 strsgggdlt lglepseeea prsplapseg agsdvfdgdl gmgaakglqs lpthdpsplq
1081 rysedptvpl psetdgyvap ltcspqpeyv nqpdvrpqpp spregplpaa rpagatlerp
1141 ktlspgkngv vkdvfafgga venpeyltpq ggaapqphpp pafspafdnl yywdqdpper
1201 gappstfkgt ptaenpeylg ldvpv
```

Receptor tyrosine-protein kinase erbB-2, isoform c, NP_001276865.1

```
   1 mprgswkpqv ctgtdmklrl paspethldm lrhlyqgcqv vqgnleltyl ptnaslsflq
  61 diqevqgyvl iahnqvrqvp lqrlrivrgt qlfednyala vldngdplnn ttpvtgaspg
 121 glrelqlrsl teilkggvli qrnpqlcyqd tilwkdifhk nnqlaltlid tnrsrachpc
 181 spmckgsrcw gessedcqsl trtvcaggca rckgplptdc cheqcaagct gpkhsdclac
 241 lhfnhsgice lhcpalvtyn tdtfesmpnp egrytfgasc vtacpynyls tdvgsctlvc
 301 plhnqevtae dgtqrcekcs kpcarvcygl gmehlrevra vtsaniqefa gckkifgsla
 361 flpesfdgdp asntaplqpe qlqvfetlee itgylyisaw pdslpdlsvf qnlqvirgri
 421 lhngaysltl qglgiswlgl rslrelgsgl alihhnthlc fvhtvpwdql frnphqallh
 481 tanrpedecv geglachqlc arghcwgpgp tqcvncsqfl rgqecveecr vlqglpreyv
 541 narhclpchp ecqpqngsvt cfgpeadqcv acahykdppf cvarcpsgvk pdlsympiwk
 601 fpdeegacqp cpincthscv dlddkgcpae qraspltsii savvgillvv vlgvvfgili
 661 krrqqkirky tmrrllqete lvepltpsga mpnqaqmril ketelrkvkv lgsgafgtvy
 721 kgiwipdgen vkipvaikvl rentspkank eildeayvma gvgspyvsrl lgicltstvq
 781 lvtqlmpygc lldhvrenrg rlgsqdllnw cmqiakgmsy ledvrlvhrd laarnvlvks
 841 pnhvkitdfg larlldidet eyhadggkvp ikwmalesil rrrfthqsdv wsygvtvwel
 901 mtfgakpydg ipareipdll ekgerlpqpp ictidvymim vkcwmidsec rprfrelvse
 961 fsrmardpqr fvviqnedlg paspldstfy rslledddmg dlvdaeeylv pqqgffcpdp
1021 apgaggmvhh rhrssstrsg ggdltlglep seeeaprspl apsegagsdv fdgdlgmgaa
1081 kglqslpthd psplqrysed ptvplpsetd gyvapltcsp qpeyvnqpdv rpqppspreg
1141 plpaarpaga tlerpktlsp gkngvvkdvf afggavenpe yltpqggaap qphpppafsp
1201 afdnlyywdq dppergapps tfkgtptaen peylgldvpv
```

Receptor tyrosine-protein kinase erbB-2, isoform d precursor, NP_001276866.1

```
   1 melaalcrwg lllallppga astqvctgtd mklrlpaspe thldmlrhly qgcqvvqgnl
  61 eltylptnas lsflqdiqev qgyvliahnq vrqvplqrlr ivrgtqlfed nyalavldng
 121 dplnnttpvt gaspgglrel qlrslteilk ggvliqrnpq lcyqdtilwk difhknnqla
 181 ltlidtnrsr achpcspmck gsrcwgesse dcqsltrtvc aggcarckgp lptdccheqc
 241 aagctgpkhs dclaclhfnh sgicelhcpa lvtyntdtfe smpnpegryt fgascvtacp
 301 ynylstdvgs ctlvcplhnq evtaedgtqr cekcskpcar vcyglgmehl revravtsan
 361 iqefagckki fgslaflpes fdgdpasnta plqpeqlqvf etleeitgyl yisawpdslp
 421 dlsvfqnlqv irgrilhnga ysltlqglgi swlglrslre lgsglalihh nthlcfvhtv
 481 pwdqlfrnph qallhtanrp edecvgegla chqlcarghc wgpgptqcvn csqflrgqec
 541 veecrvlqgl preyvnarhc lpchpecqpq ngsvtcfgpe adqcvacahy kdppfcvarc
 601 psgvkpdlsy mpiwkfpdee gacqpcpinc thscvdlddk gcpaeqrasp ltsiisavvg
 661 illvvvlgvv fgilikrrqq kirkytmrrl lqetelvepl tpsgampnqa qmrilketel
 721 rkvkvlgsga fgtvykgiwi pdgenvkipv aikvlrents pkankeilde ayvmagvgsp
 781 yvsrllgicl tstvqlvtql mpygclldhv renrgrlgsq dllnwcmqia kgmsyledvr
```

```
      841 lvhrdlaarn vlvkspnhvk itdfglarll dideteyhad ggkvpikwma lesilrrrft
      901 hqsdvwsygv tvwelmtfga kpydgipare ipdllekger lpqppictid vymimvkcwm
      961 idsecrprfr elvsefsrma rdpqrfvviq nedlgpaspl dstfyrslle dddmgdlvda
     1021 eeylvpqqgf fcpdpapgag gmvhhrhrss strnm

Receptor tyrosine-protein kinase erbB-2, isoform e, NP_001276867.1
        1 mklrlpaspe thldmlrhly qgcqvvqgnl eltylptnas lsflqdiqev qgyvliahnq
       61 vrqvplqrlr ivrgtqlfed nyalavldng dplnnttpvt gaspgglrel qlrslteilk
      121 ggvliqrnpq lcyqdtilwk difhknnqla ltlidtnrsr achpcspmck gsrcwgesse
      181 dcqsltrtvc aggcarckgp lptdccheqc aagctgpkhs dclaclhfnh sgicelhcpa
      241 lvtyntdtfe smpnpegryt fgascvtacp ynylstdvgs ctlvcplhnq evtaedgtqr
      301 cekcskpcar vcyglgmehl revravtsan iqefagckki fgslaflpes fdgdpasnta
      361 plqpeqlqvf etleeitgyl yisawpdslp dlsvfqnlqv irgrilhnga ysltlqglgi
      421 swlglrslre lgsglalihh nthlcfvhtv pwdqlfrnph qallhtanrp edecvgegla
      481 chqlcarghc wgpgptqcvn csqflrgqec veecrvlqgl preyvnarhc lpchpecqpq
      541 ngsvtcfgpe adqcvacahy kdppfcvarc psgvkpdlsy mpiwkfpdee gacqpcpinc
      601 ths

Inosine monophosphate dehydrogenase 2 , NP_000875.2
        1 madylisggt syvpddglta qqlfncgdgl tyndflilpg yidftadqvd ltsaltkkit
       61 lktplvsspm dtvteagmai amaltggigf ihhnctpefq anevrkvkky eqgfitdpvv
      121 lspkdrvrdv feakarhgfc gipitdtgrm gsrlvgiiss rdidflkeee hdcfleeimt
      181 kredlvvapa gitlkeanei lqrskkgklp ivneddelva iiartdlkkn rdyplaskda
      241 kkqllcgaai gtheddkyrl dllaqagvdv vvldssqgns ifqinmikyi kdkypnlqvi
      301 ggnvvtaaqa knlidagvda lrvgmgsgsi citqevlacg rpqatavykv seyarrfgvp
      361 viadggiqnv ghiakalalg astvmmgsll aatteapgey ffsdgirlkk yrgmgsldam
      421 dkhlssqnry fseadkikva qgvsgavqdk gsihkfvpyl iagiqhscqd igaksltqvr
      481 ammysgelkf ekrtssaqve ggvhslhsye krlf

KRAS proto-oncogene, GTPase, isoform a, NP_203524.1
        1 mteyklvvvg aggvgksalt iqliqnhfvd eydptiedsy rkqvvidget clldildtag
       61 qeeysamrdq ymrtgegflc vfainntksf edihhyreqi krvkdsedvp mvlvgnkcdl
      121 psrtvdtkqa qdlarsygip fietsaktrq rvedafytlv reirqyrlkk iskeektpgc
      181 vkikkciim

KRAS proto-oncogene, GTPase, isoform b, NP_004976.2
        1 mteyklvvvg aggvgksalt iqliqnhfvd eydptiedsy rkqvvidget clldildtag
       61 qeeysamrdq ymrtgegflc vfainntksf edihhyreqi krvkdsedvp mvlvgnkcdl
      121 psrtvdtkqa qdlarsygip fietsaktrq gvddafytlv reirkhkekm skdgkkkkkk
      181 sktkcvim

Transforming growth factor beta receptor 2, isoform A precursor,
NP_001020018.1
        1 mgrgllrglw plhivlwtri astipphvqk sdvemeaqkd eiicpscnrt ahplrhinnd
       61 mivtdnngav kfpqlckfcd vrfstcdnqk scmsncsits icekpqevcv avwrkndeni
      121 tletvchdpk lpyhdfiled aaspkcimke kkkpgetffm cscssdecnd niifseeynt
      181 snpdlllvif qvtgisllpp lgvaisviii fycyrvnrqq klsstwetgk trklmefseh
      241 caiileddrs disstcanni nhntellpie ldtlvgkgrf aevykaklkq ntseqfetva
      301 vkifpyeeya swktekdifs dinlkhenil qfltaeerkt elgkqywlit afhakgnlqe
      361 yltrhviswe dlrklgssla rgiahlhsdh tpcgrpkmpi vhrdlkssni lvkndltccl
      421 cdfglslrld ptlsvddlan sgqvgtarym apevlesrmn lenvesfkqt dvysmalvlw
      481 emtsrcnavg evkdyeppfg skvrehpcve smkdnvlrdr grpeipsfwl nhqgiqmvce
      541 tltecwdhdp earltaqcva erfselehld rlsgrscsee kipedgslnt tk

Transforming growth factor beta receptor 2, isoform B precursor, NP_003233.4
        1 mgrgllrglw plhivlwtri astipphvqk svnndmivtd nngavkfpql ckfcdvrfst
       61 cdnqkscmsn csitsicekp qevcvavwrk ndenitletv chdpklpyhd filedaaspk
```

```
121 cimkekkkpg etffmcscss decndniifs eeyntsnpdl llvifqvtgi sllpplgvai
181 sviiifycyr vnrqqklsst wetgktrklm efsehcaiil eddrsdisst canninhnte
241 llpieldtlv gkgrfaevyk aklkqntseq fetvavkifp yeeyaswkte kdifsdinlk
301 henilqflta eerktelgkq ywlitafhak gnlqeyltrh viswedlrkl gsslargiah
361 lhsdhtpcgr pkmpivhrdl kssnilvknd ltcclcdfgl slrldptlsv ddlansgqvg
421 tarymapevl esrmnlenve sfkqtdvysm alvlwemtsr cnavgevkdy eppfgskvre
481 hpcvesmkdn vlrdrgrpei psfwlnhqgi qmvcetltec wdhdpearlt aqcvaerfse
541 lehldrlsgr scseekiped gslnttk
```

Actinin alpha 4, isoform 1, NP_004915.2

```
  1 mvdyhaanqs yqygpssagn gaggggsmgd ymaqeddwdr dllldpawek qqrktftawc
 61 nshlrkagtq ienidedfrd glklmlllev isgerlpkpe rgkmrvhkin nvnkaldfia
121 skgvklvsig aeeivdgnak mtlgmiwtii lrfaiqdisv eetsakegll lwcqrktapy
181 knvnvqnfhi swkdglafna lihrhrpeli eydklrkddp vtnlnnafev aekyldipkm
241 ldaedivnta rpdekaimty vssfyhafsg aqkaetaanr ickvlavnqe nehlmedyek
301 lasdllewir rtipwledrv pqktiqemqq kledfrdyrr vhkppkvqek cqleinfntl
361 qtklrlsnrp afmpsegkmv sdinngwqhl eqaekgyeew llneirrler ldhlaekfrq
421 kasiheawtd gkeamlkhrd yetatlsdik alirkheafe sdlaahqdrv eqiaaiaqel
481 neldyydshn vntrcqkicd qwdalgslth srrealekte kqleaidqlh leyakraapf
541 nnwmesamed lqdmfivhti eeieglisah dqfkstlpda drereailai hkeaqriaes
601 nhiklsgsnp yttvtpqiin skwekvqqlv pkrdhallee qskqqsnehl rrqfasqanv
661 vgpwiqtkme eigrisiemn gtledqlshl kqyersivdy kpnldlleqq hqliqealif
721 dnkhtnytme hirvgweqll ttiartinev enqiltrdak gisqeqmqef rasfnhfdkd
781 hggalgpeef kaclislgyd vendrqgeae fnrimslvdp nhsglvtfqa fidfmsrett
841 dtdtadqvia sfkvlagdkn fitaeelrre lppdqaeyci armapyqgpd avpgaldyks
901 fstalygesd l
```

Actinin alpha 4, isoform 2, NP_001308962.1

```
  1 mvdyhaanqs yqygpssagn gaggggsmgd ymaqeddwdr dllldpawek qqrktftawc
 61 nshlrkagtq ienidedfrd glklmlllev isgerlpkpe rgkmrvhkin nvnkaldfia
121 skgvklvsig aeeivdgnak mtlgmiwtii lrfaiqdisv eetsakegll lwcqrktapy
181 knvnvqnfhi swkdglafna lihrhrpeli eydklrkddp vtnlnnafev aekyldipkm
241 ldaedivgtl rpdekaimty vscfyhafsg aqkaetaanr ickvlavnqe nehlmedyek
301 lasdllewir rtipwledrv pqktiqemqq kledfrdyrr vhkppkvqek cqleinfntl
361 qtklrlsnrp afmpsegkmv sdinngwqhl eqaekgyeew llneirrler ldhlaekfrq
421 kasiheawtd gkeamlkhrd yetatlsdik alirkheafe sdlaahqdrv eqiaaiaqel
481 neldyydshn vntrcqkicd qwdalgslth srrealekte kqleaidqlh leyakraapf
541 nnwmesamed lqdmfivhti eeieglisah dqfkstlpda drereailai hkeaqriaes
601 nhiklsgsnp yttvtpqiin skwekvqqlv pkrdhallee qskqqsnehl rrqfasqanv
661 vgpwiqtkme eigrisiemn gtledqlshl kqyersivdy kpnldlleqq hqliqealif
721 dnkhtnytme hirvgweqll ttiartinev enqiltrdak gisqeqmqef rasfnhfdkk
781 qtgsmdsddf rallistgys lgeaefnrim slvdpnhsgl vtfqafidfm srettdtdta
841 dqviasfkvl agdknfitae elrrelppdq aeyciarmap yqgpdavpga ldyksfstal
901 ygesdl
```

Activin A receptor type 1, NP_001096.1, NP_001104537.1, NP_001334592.1, NP_001334593.1, NP_001334594.1, NP_001334595.1, NP_001334596.1

```
  1 mvdgvmilpv limialpsps medekpkvnp klymcvcegl scgnedhceg qqcfsslsin
 61 dgfhvyqkgc fqvyeqgkmt cktppspgqa veccqgdwcn rnitaqlptk gksfpgtqnf
121 hlevgliils vvfavcllac llgvalrkfk rrnqerlnpr dveygtiegl ittnvgdstl
181 adlldhscts gsgsglpflv qrtvarqitl lecvgkgryg evwrgswqge nvavkifssr
241 dekswfrete lyntvmlrhe nilgfiasdm tsrhsstqlw lithyhemgs lydylqlttl
301 dtvsclrivl siasglahlh ieifgtqgkp aiahrdlksk nilvkkngqc ciadlglavm
361 hsqstnqldv gnnprvgtkr ymapevldet iqvdcfdsyk rvdiwafglv lwevarrmvs
421 ngivedykpp fydvvpndps fedmrkvvcv dqqrpnipnr wfsdptltsl aklmkecwyq
481 npsarltalr ikktltkidn sldklktdc
```

Alcohol dehydrogenase 1C (class I), gamma polypeptide, NP_000660.1

```
   1 mstagkvikc kaavlwelkk pfsieeveva ppkahevrik mvaagicrsd ehvvsgnlvt
  61 plpvilghea agivesvgeg vttvkpgdkv iplftpqcgk cricknpesn yclkndlgnp
 121 rgtlqdgtrr ftcsgkpihh fvgvstfsqy tvvdenavak idaasplekv cligcgfstg
 181 ygsavkvakv tpgstcavfg lggvglsvvm gckaagaari iavdinkdkf akakelgate
 241 cinpqdykkp iqevlkemtd ggvdfsfevi grldtmmasl lccheacgts vivgvppdsq
 301 nlsinpmlll tgrtwkgaif ggfkskesvp klvadfmakk fsldalitni lpfekinegf
 361 dllrsgksir tvltf
```

Adenosine A2a receptor, NP_000666.2, NP_001265426.1, NP_001265427.1, NP_001265428.1, NP_001265429.1

```
   1 mpimgssvyi tvelaiavla ilgnvlvcwa vwlnsnlqnv tnyfvvslaa adiavgvlai
  61 pfaitistgf caachgclfi acfvlvltqs sifsllaiai dryiairipl rynglvtgtr
 121 akgiiaicwv lsfaigltpm lgwnncgqpk egknhsqgcg egqvaclfed vvpmnymvyf
 181 nffacvlvpl llmlgvylri flaarrqlkq mesqplpger arstlqkevh aakslaiivg
 241 lfalcwlplh iincftffcp dcshaplwlm ylaivlshtn svvnpfiyay rirefrqtfr
 301 kiirshvlrq qepfkaagts arvlaahgsd geqvslrlng hppgvwangs aphperrpng
 361 yalglvsggs aqesqgntgl pdvellshel kgvcpeppgl ddplaqdgag vs
```

Rho guanine nucleotide exchange factor 16, NP_055263.2

```
   1 maqrhsdssl eekllghrfh selrldaggn pasglpmvrg sprvrddaaf qpqvpappqp
  61 rppgheepwp ivlstespaa lklgtqqlip kslavaskak tparhqsfga avlsreaarr
 121 dpkllpapsf slddmdvdkd pggmlrrnlr nqsyraamkg lgkpgggqgda iqlspklqal
 181 aeepsqphtr spaknkktlg rkrghkgsfk ddpqlyqeiq erglntsqes dddildesss
 241 pegtqkvdat ivvksyrpaq vtwsqlpevv elgildqlst eerkrqeamf eiltsefsyq
 301 hslsilveef lqskelratv tqmehhhlfs nildvlgasq rffedleqrh kaqvlvedis
 361 dileehaekh fhpyiaycsn evyqqrtlqk lissnaafre alreierrpa cgglpmlsfl
 421 ilpmqrvtrl pllmdtlclk tqghseryka asralkaisk lvrqcnegah rmermeqmyt
 481 lhtqldfskv kslplisasr wllkrgelfl veetglfrki asrptcylfl fndvlvvtkk
 541 kseesymvqd yaqmnhiqve kiepselplp gggnrsssvp hpfqvtllrn segrqeqlll
 601 ssdsasdrar wivalthser qwqglsskgd lpqveitkaf fakqadevtl qqadvvlvlq
 661 qedgwlyger lrdgetgwfp edfarfitsr vavegnvrrm erlrvetdv
```

B-cell linker, isoform 1, NP_037446.1

```
   1 mdklnkitvp asqklrqlqk mvhdiknneg gimnkikklk vkappsvprr dyasespade
  61 eeqwsddfds dyenpdehsd semyvmpaee naddsyeppp veqetrpvhp alpfargeyi
 121 dnrssqrhsp pfsktlpskp swpsekarlt stlpaltalq kpqvppkpkg lledeadyvv
 181 pvedndenyi hptessppp ekapmvnrst kpnsstpasp pgtasgrnsg awetkspppa
 241 apsplpragk kpttplkttp vasqqnassv ceekpipaer hrgsshrqea vqspvfppaq
 301 kqihqkpipl prfteggnpt vdgplpsfss nstiseqeag vlckpwyaga cdrksaeeal
 361 hrsnkdgsfl irkssghdsk qpytlvvffn krvynipvrf ieatkqyalg rkkngeeyfg
 421 svaeiirnhq hsplvlidsq nntkdstrlk yavkvs
```

B-cell linker, isoform 2, NP_001107566.1

```
   1 mdklnkitvp asqklrqlqk mvhdiknneg gimnkikklk vkappsvprr dyasespade
  61 eeqwsddfds dyenpdehsd semyvmpaee naddsyeppp veqetrpvhp alpfargeyi
 121 dnrssqrhsp pfsktlpskp swpsekarlt stlpaltalq kpqvppkpkg lledeadyvv
 181 pvedndenyi hptessppp ekgrnsgawe tkspppaaps plpragkkpt tplkttpvas
 241 qqnassvcee kpipaerhrg sshrqeavqs pvfppaqkqi hqkpiplprf teggnptvdg
 301 plpsfssnst iseqeagvlc kpwyagacdr ksaeealhrs nkdgsflirk ssghdskqpy
 361 tlvvffnkrv ynipvrfiea tkqyalgrkk ngeeyfgsva eiirnhqhsp lvlidsqnnt
 421 kdstrlkyav kvs
```

B-cell linker, isoform 3, NP_001245369.1

```
   1 mdklnkitvp asqklrqlqk mvhdiknneg gimnkikklk vkappsvprr dyasespade
  61 eeqwsddfds dyenpdehsd semyvmpaee naddsyeppp veqetrpvhp alpfargeyi
 121 dnrssqrhsp pfsktlpskp swpsekarlt stlpaltalq kpqvppkpkg lledeadyvv
```

```
      181 pvedndenyi hptessppp ekapmvnrst kpnsstpasp pgtasgrnsg awetkspppa
      241 apsplpragk kpttplkttp vasqqnassv ceekpipaer hrgsshrqea vqspvfppaq
      301 kqihqkpipl prfteggnpt vdgplpsfss nstiseqeag vlckpwyaga cdrksaeeal
      361 hrsnkyfgsv aeiirnhqhs plvlidsqnn tkdstrlkya vkvs

B-cell linker, isoform 4, NP_001245370.1
        1 mdklnkitvp asqklrqlqk mvhdiknneg gimnkikklk vkappsvprr dyasespade
       61 eeqwsddfds dyenpdehsd semyvmpaee naddsyeppp veqetrpvhp alpfargeyi
      121 dnrssqrhsp pfsktlpskp swpsekarlt stlpaltalq kpqvppkpkg lledeadyvv
      181 pvedndenyi hptessppp ekgrnsgawe tkspppaaps plpragkkpt tplkttpvas
      241 qqnassvcee kpipaerhrg sshrqeavqs pvfppaqkqi hqkpiplprf teggnptvdg
      301 plpsfssnst iseqeagvlc kpwyagacdr ksaeealhrs nkyfgsvaei irnhqhsplv
      361 lidsqnntkd strlkyavkv s

B-cell linker, isoform 5, NP_001245371.1
        1 mdklnkitvp asqklrqlqk mvhdiknneg gimnkikklk vkappsvprr dyasespade
       61 eeqwsddfds dyenpdehsd semyvmpaee naddsyeppp veqetrpvhp alpfargtas
      121 grnsgawetk spppaapspl pragkkpttp lkttpvasqq nassvceekp ipaerhrgss
      181 hrqeavqspv fppaqkqihq kpiplprfte ggnptvdgpl psfssnstis eqeagvlckp
      241 wyagacdrks aeealhrsnk yfgsvaeiir nhqhsplvli dsqnntkdst rlkyavkvs

Basonuclin 1, isoform a, NP_001708.3
        1 mrrrppsrgg rgaararetr rqprhrsgrr maeaisctln cscqsfkpgk inhrqcdqck
       61 hgwvahalsk lrippmypts qveivqsnvv fdisslmlyg tqaipvrlki lldrlfsvlk
      121 qdevlqilha ldwtlqdyir gyvlqdasgk vldhwsimts eeevatlqqf lrfgetksiv
      181 elmaiqekee qsiiippsta nvdirafies cshrssslpt pvdkgnpssi hpfenlisnm
      241 tfmlpfqffn plppaligsl peqymleqgh dqsqdpkqev hgpfpdssfl tssstpfqve
      301 kdqclncpda itkkedsthl sdsssynivt kfertqlspe akvkpernsl gtkkgrvfct
      361 acektfydkg tlkihynavh lkikhkctie gcnmvfsslr srnrhsanpn prlhmpmnrn
      421 nrdkdlrnsl nlassenykc pgftvtspdc rpppsypgsg edskgqpafp nigqngvlfp
      481 nlktvqpvlp fyrspatpae vantpgilps lpllsssipe qlisnempfd alpkkksrks
      541 smpikiekea veianekrhn lssdedmplq vvsedeqeac spqshrvsee qhvqsgglgk
      601 pfpegerpch resviessga isqtpeqath nsereteqtp alimvpreve dgghehyftp
      661 gmepqvpfsd ymelqqrlla gglfsalsnr gmafpcleds kelehvgqha larqieenrf
      721 qcdickktfk nacsvkihhk nmhvkemhtc tvegcnatfp srrsrdrhss nlnlhqkals
      781 qealessedh fraayllkdv akeayqdvaf tqqasqtsvi fkgtsrmgsl vypitqvhsa
      841 slesynsgpl segtildlst tssmksesss hsswdsdgvs eegtvlmeds dgncegsslv
      901 pgedeypicv lmekadqsla slpsglpitc hlcqktysnk gtfrahyktv hlrqlhkckv
      961 pgcntmfssv rsrnrhsqnp nlhkslassp shlq

Basonuclin 1, isoform b, NP_001288135.1
        1 mrcrnmffsf kaslcgcgaa tapsltaisc tlncscqsfk pgkinhrqcd qckhgwvaha
       61 lsklrippmy ptsqveivqs nvvfdisslm lygtqaipvr lkilldrlfs vlkqdevlqi
      121 lhaldwtlqd yirgyvlqda sgkvldhwsi mtseeevatl qqflrfgetk sivelmaiqe
      181 keeqsiiipp stanvdiraf iescshrsss lptpvdkgnp ssihpfenli snmtfmlpfq
      241 ffnplppali gslpeqymle qghdqsqdpk qevhgpfpds sfltssstpf qvekdqclnc
      301 pdaitkkeds thlsdsssyn ivtkfertql speakvkper nslgtkkgrv fctacektfy
      361 dkgtlkihyn avhlkikhkc tiegcnmvfs slrsrnrhsa npnprlhmpm nrnnrdkdlr
      421 nslnlassen ykcpgftvts pdcrpppsyp gsgedskgqp afpnigqngv lfpnlktvqp
      481 vlpfyrspat paevantpgi lpslpllsss ipeqlisnem pfdalpkkks rkssmpikie
      541 keaveianek rhnlssdedm plqvvsedeq eacspqshrv seeqhvqsgg lgkpfpeger
      601 pchresvies sgaisqtpeq athnserete qtpalimvpr evedgghehy ftpgmepqvp
      661 fsdymelqqr llagglfsal snrgmafpcl edskelehvg qhalarqiee nrfqcdickk
      721 tfknacsvki hhknmhvkem htctvegcna tfpsrrsrdr hssnlnlhqk alsqealess
      781 edhfraayll kdvakeayqd vaftqqasqt svifkgtsrm gslvypitqv hsaslesyns
      841 gplsegtild lsttssmkse ssshsswdsd gvseegtvlm edsdgncegs slvpgedeyp
      901 icvlmekadq slaslpsglp itchlcqkty snkgtfrahy ktvhlrqlhk ckvpgcntmf
```

961 ssvrsrnrhs qnpnlhksla sspshlq

BPI fold containing family A member 1, precursor, NP_001230122.1, NP_057667.1, NP_570913.1

1 mfqtgglivf ygllaqtmaq fgglpvpldq tlplnvnpal plsptglags ltnalsngll
61 sggllgilen lplldilkpg ggtsggllgg llgkvtsvip glnniidikv tdpqllelgl
121 vqspdghrly vtiplgiklq vntplvgasl lrlavkldit aeilavrdkq erihlvlgdc
181 thspgslqis lldglgplpi qglldsltgi lnkvlpelvq gnvcplvnev lrgldltlvh
241 divnmlihgl qfvikv

Calcium voltage-gated channel auxiliary subunit beta 3, isoform 1, NP_000716.2

1 myddsyvpgf edseagsads ytsrpsldsd vsleedresa rrevesqaqq qlerakhkpv
61 afavrtnvsy cgvldeecpv qgsgvnfeak dflhikekys ndwwigrlvk eggdiafips
121 pqrlesirlk qeqkarrsgn psslsdignr rspppslakq kqkqaehvpp ydvvpsmrpv
181 vlvgpslkgy evtdmmqkal fdflkhrfdg risitrvtad lslakrsvln npgkrtiier
241 ssarssiaev qseierifel akslqlvvld adtinhpaql aktslapiiv fvkvsspkvl
301 qrlirsrgks qmkhltvqmm aydklvqcpp esfdvilden qledacehla eylevywrat
361 hhpapgpgll gppsaipglq nqqllgerge ehsplerdsl mpsdeasess rqawtgssqr
421 ssrhleedya dayqdlyqph rqhtsglpsa nghdpqdrll aqdsehnhsd rnwqrnrpwp
481 kdsy

Calcium voltage-gated channel auxiliary subunit beta 3, isoform 2, NP_001193844.1

1 myddsyvpgf edseagsads ytsrpsldsd vsleedresa rrevesqaqq qlerakkysn
61 dwwigrlvke ggdiafipsp qrlesirlkq eqkarrsgnp sslsdignrr spppslakqk
121 qkqaehvppy dvvpsmrpvv lvgpslkgye vtdmmqkalf dflkhrfdgr isitrvtadl
181 slakrsvlnn pgkrtiiers sarssiaevq seierifela kslqlvvlda dtinhpaqla
241 ktslapiivf vkvsspkvlq rlirsrgksq mkhltvqmma ydklvqcppe sfdvildenq
301 ledacehlae ylevywrath hpapgpgllg ppsaipglqn qqllgergee hsplerdslm
361 psdeasessr qawtgssqrs srhleedyad ayqdlyqphr qhtsglpsan ghdpqdrlla
421 qdsehnhsdr nwqrnrpwpk dsy

Calcium voltage-gated channel auxiliary subunit beta 3, isoform 3, NP_001193845.1

1 msfsdssatf llnegsadsy tsrpsldsdv sleedresar revesqaqqq lerakhkpva
61 favrtnvsyc gvldeecpvq gsgvnfeakd flhikekysn dwwigrlvke ggdiafipsp
121 qrlesirlkq eqkarrsgnp sslsdignrr spppslakqk qkqaehvppy dvvpsmrpvv
181 lvgpslkgye vtdmmqkalf dflkhrfdgr isitrvtadl slakrsvlnn pgkrtiiers
241 sarssiaevq seierifela kslqlvvlda dtinhpaqla ktslapiivf vkvsspkvlq
301 rlirsrgksq mkhltvqmma ydklvqcppe sfdvildenq ledacehlae ylevywrath
361 hpapgpgllg ppsaipglqn qqllgergee hsplerdslm psdeasessr qawtgssqrs
421 srhleedyad ayqdlyqphr qhtsglpsan ghdpqdrlla qdsehnhsdr nwqrnrpwpk
481 dsy

Calcium voltage-gated channel auxiliary subunit beta 3, isoform 4, NP_001193846.1

1 megsadsyts rpsldsdvsl eedresarre vesqaqqqle rakhkpvafa vrtnvsycgv
61 ldeecpvqgs gvnfeakdfl hikekysndw wigrlvkegg diafipspqr lesirlkqeq
121 karrsgnpss lsdignrrsp ppslakqkqk qaehvppydv vpsmrpvvlv gpslkgyevt
181 dmmqkalfdf lkhrfdgris itrvtadlsl akrsvlnnpg krtiierssa rssiaevqse
241 ierifelaks lqlvvldadt inhpaqlakt slapiivfvk vsspkvlqrl irsrgksqmk
301 hltvqmmayd klvqcppesf dvildenqle dacehlaeyl evywrathhp apgpgllgpp
361 saipglqnqq llgergeehs plerdslmps deasessrqa wtgssqrssr hleedyaday
421 qdlyqphrqh tsglpsangh dpqdrllaqd sehnhsdrnw qrnrpwpkds y

Caspase 3, preproprotein, NP_001341706.1, NP_001341707.1, NP_004346.3, NP_116786.1

```
        1 mentensvds ksiknlepki ihgsesmdsg isldnsykmd ypemglciii nnknfhkstg
       61 mtsrsgtdvd aanlretfrn lkyevrnknd ltreeivelm rdvskedhsk rssfvcvlls
      121 hgeegiifgt ngpvdlkkit nffrgdrcrs ltgkpklfii qacrgteldc gietdsgvdd
      181 dmachkipve adflyaysta pgyyswrnsk dgswfiqslc amlkqyadkl efmhiltrvn
      241 rkvatefesf sfdatfhakk qipcivsmlt kelyfyh
```

Caspase 3, isoform b, NP_001341708.1, NP001341709.1

```
        1 mdsgisldns ykmdypemgl ciiinnknfh kstgmtsrsg tdvdaanlre tfrnlkyevr
       61 nkndltreei velmrdvske dhskrssfvc vllshgeegi ifgtngpvdl kkitnffrgd
      121 rcrsltgkpk lfiiqacrgt eldcgietds gvdddmachk ipveadflya ystapgyysw
      181 rnskdgswfi qslcamlkqy adklefmhil trvnrkvate fesfsfdatf hakkqipciv
      241 smltkelyfy h
```

Caspase 3, isoform c, NP_001341710.1, NP001341711.1

```
        1 mentensvds ksiknlepki ihgsesmdsg isldnsykmd ypemglciii nnknfhkstg
       61 mtsrsgtdvd aanlretfrn lkyevrnknd ltreeivelm rdvskedhsk rssfvcvlls
      121 hgeegiifgt ngpvdlkkit nffrgdrcrs ltgkpklfii qviilgeiqr mapgsssrfv
      181 pc
```

Caspase 3, isoform d, NP_001341712.1

```
        1 msdalikvsm entensvdsk siknlepkii hgsesmdsgi sldnsykmdy pemglciiin
       61 nknfhkstgm tsrsgtdvda anlretfrnl kyevrnkndl treeivelmr dvskedhskr
      121 ssfvcvllsh geegiifgtn gpvdlkkitn ffrgdrcrsl tgkpklfiiq viilgeiqrm
      181 apgsssrfvp c
```

Caspase 3, isoform e, NP_001341713.1

```
        1 mdsgisldns ykmdypemgl ciiinnknfh kstgmtsrsg tdvdaanlre tfrnlkyevr
       61 nkndltreei velmrdvske dhskrssfvc vllshgeegi ifgtngpvdl kkitnffrgd
      121 rcrsltgkpk lfiiqviilg eiqrmapgss srfvpc
```

Caveolin 1, isoform alpha, NP_001744.2

```
        1 msggkyvdse ghlytvpire qgniykpnnk amadelsekq vydahtkeid lvnrdpkhln
       61 ddvvkidfed viaepegths fdgiwkasft tftvtkywfy rllsalfgip maliwgiyfa
      121 ilsflhiwav vpciksflie iqcisrvysi yvhtvcdplf eavgkifsnv rinlqkei
```

Caveolin 1, isoform beta, NP_001166366.1, NP_001166367.1, NP_001166368.1

```
        1 madelsekqv ydahtkeidl vnrdpkhlnd dvvkidfedv iaepegthsf dgiwkasftt
       61 ftvtkywfyr llsalfgipm aliwgiyfai lsflhiwavv pciksfliei qcisrvysiy
      121 vhtvcdplfe avgkifsnvr inlqkei
```

Cadherin 1, isoform 1 preproprotein, NP_004351.1

```
        1 mgpwsrslsa llllqvssw lcqepepchp gfdaesytft vprrhlergr vlgrvnfedc
       61 tgrqrtayfs ldtrfkvgtd gvitvkrplr fhnpqihflv yawdstyrkf stkvtlntvg
      121 hhhrppphqa svsgiqaell tfpnsspglr rqkrdwvipp iscpenekgp fpknlvqiks
      181 nkdkegkvfy sitgqgadtp pvgvfiiere tgwlkvtepl dreriatytl fshavssngn
      241 avedpmeili tvtdqndnkp eftqevfkgs vmegalpgts vmevtatdad ddvntynaai
      301 aytilsqdpe lpdknmftin rntgvisvvt tgldresfpt ytlvvqaadl qgeglsttat
      361 avitvtdtnd nppifnptty kgqvpenean vvittlkvtd adapntpawe avytilnddg
      421 gqfvvttnpv nndgilktak gldfeakqqy ilhvavtnvv pfevslttst atvtvdvldv
      481 neapifvppe krvevsedfg vgqeitsyta qepdtfmeqk ityriwrdta nwleinpdtg
      541 aistraeldr edfehvknst ytaliiatdn gspvatgtgt lllilsdvnd napipeprti
      601 ffcernpkpq viniidadlp pntspftael thgasanwti qyndptqesi ilkpkmalev
      661 gdykinlklm dnqnkdqvtt levsvcdceg aagvcrkaqp veaglqipai lgilggilal
      721 lilillllll lrrravvkep llppeddtrd nvyyydeegg geedqdfdls qlhrgldarp
      781 evtrndvapt lmsvprylpr panpdeignf idenlkaadt dptappydsl lvfdyegsgs
```

```
      841 eaaslsslns sesdkdqdyd ylnewgnrfk kladmyggge dd

Cadherin 1, isoform 2 precursor, NP_001304113.1
        1 mgpwsrslsa llllqvssw lcqepepchp gfdaesytft vprrhlergr vlgrvnfedc
       61 tgrqrtayfs ldtrfkvgtd gvitvkrplr fhnpqihflv yawdstyrkf stkvtlntvg
      121 hhhrppphqa svsgiqaell tfpnsspglr rqkrdwvipp iscpenekgp fpknlvqiks
      181 nkdkegkvfy sitgqgadtp pvgvfiiere tgwlkvtepl dreriatytl fshavssngn
      241 avedpmeili tvtdqndnkp eftqevfkgs vmegalpgts vmevtatdad ddvntynaai
      301 aytilsqdpe lpdknmftin rntgvisvvt tgldresfpt ytlvvqaadl qgeglsttat
      361 avitvtdtnd nppifnpttg ldfeakqqyi lhvavtnvvp fevslttsta tvtvdvldvn
      421 eapifvppek rvevsedfgv gqeitsytaq epdtfmeqki tyriwrdtan wleinpdtga
      481 istraeldre dfehvknsty taliiatdng spvatgtgtl llilsdvndn apipeprtif
      541 fcernpkpqv iniidadlpp ntspftaelt hgasanwtiq yndptqesii lkpkmalevg
      601 dykinlklmd nqnkdqvttl evsvcdcega agvcrkaqpv eaglqipail gilggilall
      661 ilillllfl rrravvkepl lppeddtrdn vyyydeeggg eedqdfdlsq lhrgldarpe
      721 vtrndvaptl msvprylprp anpdeignfi denlkaadtd ptappydsll vfdyegsgse
      781 aaslsslnss esdkdqdydy lnewgnrfkk ladmyggged d

Cadherin 1, isoform 3, NP_001304114.1
        1 meqkityriw rdtanwlein pdtgaistra eldredfehv knstytalii atdngspvat
       61 gtgtllllils dvndnapipe prtiffcern pkpqviniid adlppntspf taelthgasa
      121 nwtiqyndpt qesiilkpkm alevgdykin lklmdnqnkd qvttlevsvc dcegaagvcr
      181 kaqpveaglq ipailgilgg ilallililll lllflrrrav vkepllpped dtrdnvyyyd
      241 eegggeedqd fdlsqlhrgl darpevtrnd vaptlmsvpr ylprpanpde ignfidenlk
      301 aadtdptapp ydsllvfdye gsgseaasls slnssesdkd qdydylnewg nrfkkladmy
      361 gggedd

Cadherin 1, isoform 4, NP_001304115.1
        1 malevgdyki nlklmdnqnk dqvttlevsv cdcegaagvc rkaqpveagl qipailgilg
       61 gilallilil llllflrrra vvkepllppe ddtrdnvyyy deegggeedq dfdlsqlhrg
      121 ldarpevtrn dvaptlmsvp rylprpanpd eignfidenl kaadtdptap pydsllvfdy
      181 egsgseaasl sslnssesdk dqdydylnew gnrfkkladm ygggedd

Cytochrome c oxidase subunit 8C, NP_892016.1
        1 mpllrgrcpa rrhyrrlall glqpaprfah sgpprqrpls aaemavglvv ffttfltpaa
       61 yvlgnlkqfr rn

Carnitine palmitoyltransferase 1A, isoform 1, NP_001867.2
        1 maeahqavaf qftvtpdgid lrlshealrq iylsglhswk kkfirfkngi itgvypasps
       61 swlivvvgvm ttmyakidps lgiiakinrt letancmssq tknvvsgvlf gtglwvaliv
      121 tmryslkvll syhgwmfteh gkmsratkiw mgmvkifsgr kpmlysfqts lprlpvpavk
      181 dtvnrylqsv rplmkeedfk rmtalaqdfa vglgprlqwy lklkswwatn yvsdwweeyi
      241 ylrgrgplmv nsnyyamdll yilpthiqaa ragnaihail lyrrkldree ikpirllgst
      301 iplcsaqwer mfntsripge etdtiqhmrd skhivvyhrg ryfkvwlyhd grllkpreme
      361 qqmqrildnt sepqpgearl aaltagdrvp warcrqayfg rgknkqslda vekaaffvtl
      421 deteegyrse dpdtsmdsya ksllhgrcyd rwfdksftfv vfkngkmgln aehswadapi
      481 vahlweyvms idslqlgyae dghckgdinp nipyptrlqw dipgecqevi etslntanll
      541 andvdfhsfp fvafgkgiik kcrtspdafv qlalqlahyk dmgkfcltye asmtrlfreg
      601 rtetvrsctt escdfvramv dpaqtveqrl klfklasekh qhmyrlamtg sgidrhlfcl
      661 yvvskylave spflkevlse pwrlstsqtp qqqvelfdle nnpeyvssgg gfgpvaddgy
      721 gvsyilvgen linfhisskf scpetdshrf grhlkeamtd iitlfglssn skk

Carnitine palmitoyltransferase 1A, isoform 2, NP_001027017.1
        1 maeahqavaf qftvtpdgid lrlshealrq iylsglhswk kkfirfkngi itgvypasps
       61 swlivvvgvm ttmyakidps lgiiakinrt letancmssq tknvvsgvlf gtglwvaliv
      121 tmryslkvll syhgwmfteh gkmsratkiw mgmvkifsgr kpmlysfqts lprlpvpavk
      181 dtvnrylqsv rplmkeedfk rmtalaqdfa vglgprlqwy lklkswwatn yvsdwweeyi
```

```
241 ylrgrgplmv nsnyyamdll yilpthiqaa ragnaihail lyrrkldree ikpirllgst
301 iplcsaqwer mfntsripge etdtiqhmrd skhivvyhrg ryfkvwlyhd grllkpreme
361 qqmqrildnt sepqpgearl aaltagdrvp warcrqayfg rgknkqslda vekaaffvtl
421 deteegyrse dpdtsmdsya ksllhgrcyd rwfdksftfv vfkngkmgln aehswadapi
481 vahlweyvms idslqlgyae dghckgdinp nipyptrlqw dipgecqevi etslntanll
541 andvdfhsfp fvafgkgiik kcrtspdafv qlalqlahyk dmgkfcltye asmtrlfreg
601 rtetvrsctt escdfvramv dpaqtveqrl klfklasekh qhmyrlamtg sgidrhlfcl
661 yvvskylave spflkevlse pwrlstsqtp qqqvelfdle nnpeyvssgg gfgpvaddgy
721 gvsyilvgen linfhisskf scpetgiisq gpssdt
```

Cancer/testis antigen 1A, NP_640343.1

```
  1 mqaegrgtgg stgdadgpgg pgipdgpggn aggpgeagat ggrgprgaga arasgpggga
 61 prgphggaas glngccrcga rgpesrllef ylampfatpm eaelarrsla qdapplpvpg
121 vllkeftvsg niltirltaa dhrqlqlsis sclqqlsllm witqcflpvf laqppsgqrr
```

C-X-C motif chemokine ligand 13, NP_006410.1

```
  1 mkfistslll mllvsslspv qgvlevyyts lrcrcvqess vfiprrfidr iqilprgngc
 61 prkeiivwkk nksivcvdpq aewiqrmmev lrkrssstlp vpvfkrkip
```

Diacylglycerol kinase eta, isoform 1, NP_001191433.1, NP_690874.2

```
  1 magaggqhhp pgaaggaaag agaavtsaaa sagpgedssd seaeqegpqk lirkvstsgq
 61 irtktsikeg qllkqtssfq rwkkryfklr grtlyyakds kslifdevdl sdasvaeast
121 knannsftii tpfrrlmlca enrkemedwi sslksvqtre pyevaqfnve hfsgmhnwya
181 csharptfcn vcreslsgvt shglscevck fkahkrcavr atnnckwttl asigkdiied
241 edgvamphqw legnlpvsak cavcdktcgs vlrlqdwkcl wcktmvhtac kdlyhpicpl
301 gqckvsiipp ialnstdsdg fcratfsfcv spllvfvnsk sgdnqgvkfl rrfkqllnpa
361 qvfdlmnggp hlglrlfqkf dnfrilvcgg dgsvgwvlse idklnlnkqc qlgvlplgtg
421 ndlarvlgwg gsydddtqlp qilekleras tkmldrwsim tyelklppka sllpgppeas
481 eefymtiyed svathltkil nsdehavvis saktlcetvk dfvakvekty dktlenavva
541 davaskcsvl nekleqllqa lhtdsqaapv lpglsplive edavesssee slgeskeqlg
601 ddvtkpssqk avkpreimlr anslkkavrq vieeagkvmd dptvhpcepa nqssdydste
661 tdeskeeakd dgakesitvk taprspdara syghsqtdsv pgpavaaske nlpvlntrii
721 cpglraglaa siagssiink mllanidpfg atpfidpdld svdgysekcv mnnyfgigld
781 akislefnnk reehpekcrs rtknlmwygv lgtrellqrs yknleqrvql ecdgqyiplp
841 slqgiavlni psyaggtnfw ggtkeddifa apsfddkile vvaifdsmqm avsrviklqh
901 hriaqcrtvk itifgdegvp vqvdgeawvq ppgiikivhk nraqmltrdr afestlkswe
961 dkqkcdsgkp vlrthlyihh aidlateevs qmqlcsqaae elitricdaa tihclleqel
1021 ahavnacsha lnkanprcpe sltrdtatei ainvkalyne tesllvgrvp lqlespheer
1081 vsnalhsvev elqklteipw lyyilhpned eeppmdctkr nnrstvfriv pkfkkekvqk
1141 qktssqpgsg dtesgscean spgn
```

Diacylglycerol kinase eta, isoform 2, NP_821077.1

```
  1 magaggqhhp pgaaggaaag agaavtsaaa sagpgedssd seaeqegpqk lirkvstsgq
 61 irtktsikeg qllkqtssfq rwkkryfklr grtlyyakds kslifdevdl sdasvaeast
121 knannsftii tpfrrlmlca enrkemedwi sslksvqtre pyevaqfnve hfsgmhnwya
181 csharptfcn vcreslsgvt shglscevck fkahkrcavr atnnckwttl asigkdiied
241 edgvamphqw legnlpvsak cavcdktcgs vlrlqdwkcl wcktmvhtac kdlyhpicpl
301 gqckvsiipp ialnstdsdg fcratfsfcv spllvfvnsk sgdnqgvkfl rrfkqllnpa
361 qvfdlmnggp hlglrlfqkf dnfrilvcgg dgsvgwvlse idklnlnkqc qlgvlplgtg
421 ndlarvlgwg gsydddtqlp qilekleras tkmldrwsim tyelklppka sllpgppeas
481 eefymtiyed svathltkil nsdehavvis saktlcetvk dfvakvekty dktlenavva
541 davaskcsvl nekleqllqa lhtdsqaapv lpglsplive edavesssee slgeskeqlg
601 ddvtkpssqk avkpreimlr anslkkavrq vieeagkvmd dptvhpcepa nqssdydste
661 tdeskeeakd dgakesitvk taprspdara syghsqtdsv pgpavaaske nlpvlntrii
721 cpglraglaa siagssiink mllanidpfg atpfidpdld svdgysekcv mnnyfgigld
781 akislefnnk reehpekcrs rtknlmwygv lgtrellqrs yknleqrvql ecdgqyiplp
841 slqgiavlni psyaggtnfw ggtkeddifa apsfddkile vvaifdsmqm avsrviklqh
```

```
 901 hriaqcrtvk itifgdegvp vqvdgeawvq ppgiikivhk nraqmltrdr afestlkswe
 961 dkqkcdsgkp vlrthlyihh aidlateevs qmqlcsqaae elitricdaa tihclleqel
1021 ahavnacsha lnkanprcpe sltrdtatei ainvkalyne tesllvgrvp lqlespheer
1081 vsnalhsvev elqklteipw lyyilhpned eeppmdctkr nnrstvfriv pkfkkekvqk
1141 qktssqpvqk wgteevaawl dllnlgeykd ifirhdirga ellhlerrdl kdlgipkvgh
1201 vkrilqgike lgrstpqsev
```

Diacylglycerol kinase eta, isoform 3, NP_001191434.1

```
   1 mlcaenrkem edwisslksv qtrepyevaq fnvehfsgmh nwyacsharp tfcnvcresl
  61 sgvtshglsc evckfkahkr cavratnnck wttlasigkd iiededgvam phqwlegnlp
 121 vsakcavcdk tcgsvlrlqd wkclwcktmv htackdlyhp icplgqckvs iippialnst
 181 dsdgfcratf sfcvspllvf vnsksgdnqg vkflrrfkql lnpaqvfdlm nggphlglrl
 241 fqkfdnfril vcggdgsvgw vlseidklnl nkqcqlgvlp lgtgndlarv lgwggsyddd
 301 tqlpqilekl erastkmldr wsimtyelkl ppkasllpgp peaseefymt iyedsvathl
 361 tkilnsdeha vvissaktlc etvkdfvakv ektydktlen avvadavask csvlnekleq
 421 llqalhtdsq aapvlpglsp liveedaves sseeslgesk eqlgddvtkp ssqkavkpre
 481 imlranslkk avrqvieeag kvmddptvhp cepanqssdy dstetdeske eakddgakes
 541 itvktaprsp darasyghsq tdsvpgpava askenlpvln triicpglra glaasiagss
 601 iinkmllani dpfgatpfid pdldsvdgys ekcvmnnyfg igldakisle fnnkreehpe
 661 kcrsrtknlm wygvlgtrel lqrsyknleq rvqlecdgqy iplpslqgia vlnipsyagg
 721 tnfwggtked difaapsfdd kilevvaifd smqmavsrvi klqhhriaqc rtvkitifgd
 781 egvpvqvdge awvqppgiik ivhknraqml trdrafestl kswedkqkcd sgkpvlrthl
 841 yihhaidlat eevsqmqlcs qaaeelitri cdaatihcll eqelahavna cshalnkanp
 901 rcpesltrdt ateiainvka lynetesllv grvplqlesp heervsnalh svevelqklt
 961 eipwlyyilh pnedeeppmd ctkrnnrstv frivpkfkke kvqkqktssq pvqkwgteev
1021 aawldllnlg eykdifirhd irgaellhle rrdlkntvge krdtkengkh mdlgipkvgh
1081 vkrilqgike lgrstpqsev
```

Diacylglycerol kinase eta, isoform 4, NP_001191435.1

```
   1 mlcaenrkem edwisslksv qtrepyevaq fnvehfsgmh nwyacsharp tfcnvcresl
  61 sgvtshglsc evckfkahkr cavratnnck wttlasigkd iiededgvam phqwlegnlp
 121 vsakcavcdk tcgsvlrlqd wkclwcktmv htackdlyhp icplgqckvs iippialnst
 181 dsdgfcratf sfcvspllvf vnsksgdnqg vkflrrfkql lnpaqvfdlm nggphlglrl
 241 fqkfdnfril vcggdgsvgw vlseidklnl nkqcqlgvlp lgtgndlarv lgwggsyddd
 301 tqlpqilekl erastkmldr wsimtyelkl ppkasllpgp peaseefymt iyedsvathl
 361 tkilnsdeha vvissaktlc etvkdfvakv ektydktlen avvadavask csvlnekleq
 421 llqalhtdsq aapvlpglsp liveedaves sseeslgesk eqlgddvtkp ssqkavkpre
 481 imlranslkk avrqvieeag kvmddptvhp cepanqssdy dstetdeske eakddgakes
 541 itvktaprsp darasyghsq tdsvpgpava askenlpvln triicpglra glaasiagss
 601 iinkmllani dpfgatpfid pdldsvdgys ekcvmnnyfg igldakisle fnnkreehpe
 661 kcrsrtknlm wygvlgtrel lqrsyknleq rvqlecdgqy iplpslqgia vlnipsyagg
 721 tnfwggtked difaapsfdd kilevvaifd smqmavsrvi klqhhriaqc rtvkitifgd
 781 egvpvqvdge awvqppgiik ivhknraqml trdrafestl kswedkqkcd sgkpvlrthl
 841 yihhaidlat eevsqmqlcs qaaeelitri cdaatihcll eqelahavna cshalnkanp
 901 rcpesltrdt ateiainvka lynetesllv grvplqlesp heervsnalh svevelqklt
 961 eipwlyyilh pnedeeppmd ctkrnnrstv frivpkfkke kvqkqktssq pvqkwgteev
1021 aawldllnlg eykdifirhd irgaellhle rrdlkdlgip kvghvkrilq gikelgrstp
1081 qsev
```

Diacylglycerol kinase eta, isoform 5, NP_001284358.1

```
   1 mwnisqgctt gtpaptpdpp svtcaervfl esppmacpak vhtackdlyh picplgqckv
  61 siippialns tdsdgfcrat fsfcvspllv fvnsksgdnq gvkflrrfkq llnpaqvfdl
 121 mnggphlglr lfqkfdnfri lvcggdgsvg wvlseidkln lnkqcqlgvl plgtgndlar
 181 vlgwggsydd dtqlpqilek lerastkmld rwsimtyelk lppkasllpg ppeaseefym
 241 tiyedsvath ltkilnsdeh avvissaktl cetvkdfvak vektydktle navvadavas
 301 kcsvlnekle qllqalhtds qaapvlpgls pliveedave ssseeslges keqlgddvtk
 361 pssqkavkpr eimlranslk kavrqvieea gkvmddptvh pcepanqssd ydstetdesk
```

```
421 eeakddgake sitvktaprs pdarasyghs qtdsvpgpav aaskenlpvl ntriicpglr
481 aglaasiags siinkmllan idpfgatpfi dpdldsvdgy sekcvmnnyf gigldakisl
541 efnnkreehp ekcrsrtknl mwygvlgtre llqrsyknle qrvqlecdgq yiplpslqgi
601 avlnipsyag gtnfwggtke ddifaapsfd dkilevvaif dsmqmavsrv iklqhhriaq
661 crtvkitifg degvpvqvdg eawvqppgii kivhknraqm ltrdrafest lkswedkqkc
721 dsgkpvlrth lyihhaidla teevsqmqlc sqaaeelitr icdaatihcl leqelahavn
781 acshalnkan prcpesltrd tateiainvk alynetesll vgrvplqles pheervsnal
841 hsvevelqkl teipwlyyil hpnedeeppm dctkrnnrst vfrivpkfkk ekvqkqktss
901 qpgsgdtesg sceanspgn
```

Eukaryotic translation elongation factor 2, NP_001952.1

```
  1 mvnftvdqir aimdkkanir nmsviahvdh gkstltdslv ckagiiasar agetrftdtr
 61 kdeqerciti kstaislfye lsendlnfik qskdgagfli nlidspghvd fssevtaalr
121 vtdgalvvvd cvsgvcvqte tvlrqaiaer ikpvlmmnkm drallelqle peelyqtfqr
181 ivenvnviis tygegesgpm gnimidpvlg tvgfgsglhg waftlkqfae myvakfaakg
241 egqlgpaera kkvedmmkkl wgdryfdpan gkfsksatsp egkklprtfc qlildpifkv
301 fdaimnfkke etakliekld ikldsedkdk egkpllkavm rrwlpagdal lqmitihlps
361 pvtaqkyrce llyegppdde aamgikscdp kgplmmyisk mvptsdkgrf yafgrvfsgl
421 vstglkvrim gpnytpgkke dlylkpiqrt ilmmgryvep iedvpcgniv glvgvdqflv
481 ktgtittfeh ahnmrvmkfs vspvvrvave aknpadlpkl veglkrlaks dpmvqciiee
541 sgehiiagag elhleiclkd leedhacipi kksdpvvsyr etvseesnvl clskspnkhn
601 rlymkarpfp dglaedidkg evsarqelkq rarylaekye wdvaearkiw cfgpdgtgpn
661 iltditkgvq ylneikdsvv agfqwatkeg alceenmrgv rfdvhdvtlh adaihrgggq
721 iiptarrcly asvltaqprl mepiylveiq cpeqvvggiy gvlnrkrghv feesqvagtp
781 mfvvkaylpv nesfgftadl rsntggqafp qcvfdhwqil pgdpfdnssr psqvvaetrk
841 rkglkegipa ldnfldkl
```

Eukaryotic translation initiation factor 5A, isoform A, NP_001137232.1

```
  1 mcgtggtdsk trrpphrasf lkrleskplk maddldfetg dagasatfpm qcsalrkngf
 61 vvlkgrpcki vemstsktgk hghakvhlvg idiftgkkye dicpsthnmd vpnikrndfq
121 ligiqdgyls llqdsgevre dlrlpegdlg keieqkydcg eeilitvlsa mteeaavaik
181 amak
```

Eukaryotic translation initiation factor 5A, isoform B, NP_001137233.1, NP_001137234.1, NP_001961.1

```
  1 maddldfetg dagasatfpm qcsalrkngf vvlkgrpcki vemstsktgk hghakvhlvg
 61 idiftgkkye dicpsthnmd vpnikrndfq ligiqdgyls llqdsgevre dlrlpegdlg
121 keieqkydcg eeilitvlsa mteeaavaik amak
```

Fibronectin 1, isoform 1 precursor, NP_997647.1

```
  1 mlrgpgpgll llavqclgta vpstgasksk rqaqqmvqpq spvavsqskp gcydngkhyq
 61 inqqwertyl gnalvctcyg gsrgfncesk peaeetcfdk ytgntyrvgd tyerpkdsmi
121 wdctcigagr grisctianr cheggqsyki gdtwrrphet ggymlecvcl gngkgewtck
181 piaekcfdha agtsyvvget wekpyqgwmm vdctclgegs gritctsrnr cndqdtrtsy
241 rigdtwskkd nrgnllqcic tgngrgewkc erhtsvqtts sgsgpftdvr aavyqpqphp
301 qpppyghcvt dsgvvysvgm qwlktqgnkq mlctclgngv scqetavtqt yggnsngepc
361 vlpftyngrt fyscttegrq dghlwcstts nyeqdqkysf ctdhtvlvqt rggnsngalc
421 hfpflynnhn ytdctsegrr dnmkwcgttq nydadqkfgf cpmaaheeic ttnegvmyri
481 gdqwdkqhdm ghmmrctcvg ngrgewtcia ysqlrdqciv dditynvndt fhkrheeghm
541 lnctcfgqgr grwkcdpvdq cqdsetgtfy qigdswekyv hgvryqcycy grgigewhcq
601 plqtypsssg pvevfitetp sqpnshpiqw napqpshisk yilrwrpkns vgrwkeatip
661 ghlnsytikg lkpgvvyegq lisiqqyghq evtrfdfttt ststpvtsnt vtgettpfsp
721 lvatsesvte itassfvvsw vsasdtvsgf rveyelseeg depqyldlps tatsvnipdl
781 lpgrkyivnv yqisedgeqs lilstsqtta pdappdptvd qvddtsivvr wsrpqapitg
841 yrivyspsve gsstelnlpe tansvtlsdl qpgvqyniti yaveenqest pvviqqettg
901 tprsdtvpsp rdlqfvevtd vkvtimwtpp esavtgyrvd vipvnlpgeh gqrlpisrnt
961 faevtglspg vtyyfkvfav shgreskplt aqqttkldap tnlqfvnetd stvlvrwtpp
```

```
1021 raqitgyrlt vgltrrgqpr qynvgpsvsk yplrnlqpas eytvslvaik gnqespkatg
1081 vfttlqpgss ippyntevte ttivitwtpa prigfklgvr psqggeapre vtsdsgsivv
1141 sgltpgveyv ytiqvlrdgq erdapivnkv vtplspptnl hleanpdtgv ltvswerstt
1201 pditgyritt tptngqqgns leevvhadqs sctfdnlspg leynvsvytv kddkesvpis
1261 dtiipevpql tdlsfvditd ssiglrwtpl nsstiigyri tvvaagegip ifedfvdssv
1321 gyytvtglep gidydisvit linggesapt tltqqtavpp ptdlrftnig pdtmrvtwap
1381 ppsidltnfl vryspvknee dvaelsisps dnavvltnll pgteyvvsvs svyeqhestp
1441 lrgrqktgld sptgidfsdi tansftvhwi apratitgyr irhhpehfsg rpredrvphs
1501 rnsitltnlt pgteyvvsiv alngreespl ligqqstvsd vprdlevvaa tptslliswd
1561 apavtvryyr itygetggns pvqeftvpgs kstatisglk pgvdytitvy avtgrgdspa
1621 sskpisinyr teidkpsqmq vtdvqdnsis vkwlpssspv tgyrvtttpk ngpgptktkt
1681 agpdqtemti eglqptveyv vsvyaqnpsg esqplvqtav tnidrpkgla ftdvdvdsik
1741 iawespqgqv sryrvtyssp edgihelfpa pdgeedtael qglrpgseyt vsvvalhddm
1801 esqpligtqs taipaptdlk ftqvtptsls aqwtppnvql tgyrvrvtpk ektgpmkein
1861 lapdsssvvv sglmvatkye vsvyalkdtl tsrpaqgvvt tlenvspprr arvtdatett
1921 itiswrtkte titgfqvdav pangqtpiqr tikpdvrsyt itglqpgtdy kiylytlndn
1981 arsspvvida staidapsnl rflattpnsl lvswqpprar itgyiikyek pgspprevvp
2041 rprpgvteat itglepgtey tiyvialknn qkspligrk ktdelpqlvt lphpnlhgpe
2101 ildvpstvqk tpfvthpgyd tgngiqlpgt sgqqpsvgqq mifeehgfrr ttpptatpi
2161 rhrprpyppn vgeeiqighi predvdyhly phgpglnpna stgqealsqt tiswapfqdt
2221 seyiischpv gtdeeplqfr vpgtstsatl tgltrgatyn iivealkdqq rhkvreevvt
2281 vgnsvnegln qptddscfdp ytvshyavgd ewermsesgf kllcqclgfg sghfrcdssr
2341 wchdngvnyk igekwdrqge ngqmmsctcl gngkgefkcd pheatcyddg ktyhvgeqwq
2401 keylgaicsc tcfggqrgwr cdncrrpgge pspegttgqs ynqysqryhq rtntnvncpi
2461 ecfmpldvqa dredsre
```

Fibronectin 1, isoform 3 precursor, NP_002017.1

```
   1 mlrgpgpgll llavqclgta vpstgasksk rqaqqmvqpq spvavsqskp gcydngkhyq
  61 inqqwertyl gnalvctcyg gsrgfncesk peaeetcfdk ytgntyrvgd tyerpkdsmi
 121 wdctcigagr grisctianr cheggqsyki gdtwrrphet ggymlecvcl gngkgewtck
 181 piaekcfdha agtsyvvget wekpyqgwmm vdctclgegs gritctsrnr cndqdtrtsy
 241 rigdtwskkd nrgnllqcic tgngrgewkc erhtsvqtts sgsgpftdvr aavyqpqphp
 301 qpppyghcvt dsgvvysvgm qwlktqgnkq mlctclgngv scqetavtqt yggnsngepc
 361 vlpftyngrt fysctteqrq dghlwcstts nyeqdqkysf ctdhtvlvqt rggnsngalc
 421 hfpflynnhn ytdctsegrr dnmkwcgttq nydadqkfgf cpmaaheeic ttnegvmyri
 481 gdqwdkqhdm ghmmrctcvg ngrgewtcia ysqlrdqciv dditynvndt fhkrheeghm
 541 lnctcfgqgr grwkcdpvdq cqdsetgtfy qigdswekyv hgvryqcycy grgigewhcq
 601 plqtypsssg pvevfitetp sqpnshpiqw napqpshisk yilrwrpkns vgrwkeatip
 661 ghlnsytikg lkpgvvyegq lisiqqyghq evtrfdfttt ststpvtsnt vtgettpfsp
 721 lvatsesvte itassfvvsw vsasdtvsgf rveyelseeg depqyldlps tatsvnipdl
 781 lpgrkyivnv yqisedgeqs lilstsqtta pdappdptvd qvddtsivvr wsrpqapitg
 841 yrivyspsve gsstelnlpe tansvtlsdl qpgvqyniti yaveenqest pvviqqettg
 901 tprsdtvpsp rdlqfvevtd vkvtimwtpp esavtgyrvd vipvnlpgeh gqrlpisrnt
 961 faevtglspg vtyyfkvfav shgreskplt aqqttkldap tnlqfvnetd stvlvrwtpp
1021 raqitgyrlt vgltrrgqpr qynvgpsvsk yplrnlqpas eytvslvaik gnqespkatg
1081 vfttlqpgss ippyntevte ttivitwtpa prigfklgvr psqggeapre vtsdsgsivv
1141 sgltpgveyv ytiqvlrdgq erdapivnkv vtplspptnl hleanpdtgv ltvswerstt
1201 pditgyritt tptngqqgns leevvhadqs sctfdnlspg leynvsvytv kddkesvpis
1261 dtiipavppp tdlrftnigp dtmrvtwapp psidltnflv ryspvkneed vaelsispsd
1321 navvltnllp gteyvvsvss vyeqhestpl rgrqktglds ptgidfsdit ansftvhwia
1381 pratitgyri rhhpehfsgr predrvphsr nsitltnltp gteyvvsiva lngreespll
1441 igqqstvsdv prdlevvaat ptslliswda pavtvryyri tygetggnsp vqeftvpgsk
1501 statisglkp gvdytitvya vtgrgdspas skpisinyrt eidkpsqmqv tdvqdnsisv
1561 kwlpssspvt gyrvtttpkn gpgptktkta gpdqtemtie glqptveyvv svyaqnpsge
1621 sqplvqtavt nidrpkglaf tdvdvdsiki awespqgqvs ryrvtysspe dgihelfpap
1681 dgeedtaelq glrpgseytv svvalhddme sqpligtqst aipaptdlkf tqvtptslsa
1741 qwtppnvqlt gyrvrvtpke ktgpmkeinl apdsssvvvs glmvatkyev svyalkdtlt
```

```
1801 srpaqgvvtt lenvspprra rvtdatetti tiswrtktet itgfqvdavp angqtpiqrt
1861 ikpdvrsyti tglqpgtdyk iylytlndna rsspvvidas taidapsnlr flattpnsll
1921 vswqpprari tgyiikyekp gspprevvpr prpgvteati tglepgteyt iyvialknnq
1981 kseplgrkk tdelpqlvtl phpnlhgpei ldvpstvqkt pfvthpgydt gngiqlpgts
2041 gqqpsvgqqm ifeehgfrrt tppttatpir hrprpyppnv gqealsqtti swapfqdtse
2101 yiischpvgt deeplqfrvp gtstsatltg ltrgatynii vealkdqqrh kvreevvtvg
2161 nsvneglnqp tddscfdpyt vshyavgdew ermsesgfkl lcqclgfgsg hfrcdssrwc
2221 hdngvnykig ekwdrqgeng qmmsctclgn gkgefkcdph eatcyddgkt yhvgeqwqke
2281 ylgaicsctc fggqrgwrcd ncrrpggeps pegttgqsyn qysqryhqrt ntnvncpiec
2341 fmpldvqadr edsre
```

Fibronectin 1, isoform 4 precursor, NP_997643.1

```
1 mlrgpgpgll llavqclgta vpstgasksk rqaqqmvqpq spvavsqskp gcydngkhyq
  61 inqqwertyl gnalvctcyg gsrgfncesk peaeetcfdk ytgntyrvgd tyerpkdsmi
 121 wdctcigagr grisctianr cheggqsyki gdtwrrphet ggymlecvcl gngkgewtck
 181 piaekcfdha agtsyvvget wekpyqgwmm vdctclgegs gritctsrnr cndqdtrtsy
 241 rigdtwskkd nrgnllqcic tgngrgewkc erhtsvqtts sgsgpftdvr aavyqpqphp
 301 qpppyghcvt dsgvvysvgm qwlktqgnkq mlctclgngv scqetavtqt yggnsngepc
 361 vlpftyngrt fyscttegrq dghlwcstts nyeqdqkysf ctdhtvlvqt rggnsngalc
 421 hfpflynnhn ytdctsegrr dnmkwcgttq nydadqkfgf cpmaaheeic ttnegvmyri
 481 gdqwdkqhdm ghmmrctcvg ngrgewtcia ysqlrdqciv dditynvndt fhkrheeghm
 541 lnctcfgqgr grwkcdpvdq cqdsetgtfy qigdswekyv hgvryqcycy grgigewhcq
 601 plqtypsssg pvevfitetp sqpnshpiqw napqpshisk yilrwrpkns vgrwkeatip
 661 ghlnsytikg lkpgvvyegq lisiqqyghq evtrfdfttt ststpvtsnt vtgettpfsp
 721 lvatsesvte itassfvvsw vsasdtvsgf rveyelseeg depqyldlps tatsvnipdl
 781 lpgrkyivnv yqisedgeqs lilstsqtta pdappdptvd qvddtsivvr wsrpqapitg
 841 yrivyspsve gsstelnlpe tansvtlsdl qpgvqyniti yaveenqest pvviqqettg
 901 tprsdtvpsp rdlqfvevtd vkvtimwtpp esavtgyrvd vipvnlpgeh gqrlpisrnt
 961 faevtglspg vtyyfkvfav shgreskplt aqqttkldap tnlqfvnetd stvlvrwtpp
1021 raqitgyrlt vgltrrgqpr qynvgpsvsk yplrnlqpas eytvslvaik gnqespkatg
1081 vfttlqpgss ippyntevte ttivitwtpa prigfklgvr psqggeapre vtsdsgsivv
1141 sgltpgveyv ytiqvlrdgq erdapivnkv vtplspptnl hleanpdtgv ltvswerstt
1201 pditgyritt tptngqqgns leevvhadqs sctfdnlspg leynvsvytv kddkesvpis
1261 dtiipavppp tdlrftnigp dtmrvtwapp psidltnflv ryspvkneed vaelsispsd
1321 navvltnllp gteyvvsvss vyeqhestpl rgrqktglds ptgidfsdit ansftvhwia
1381 pratitgyri rhhpehfsgr predrvphsr nsitltnltp gteyvvsiva lngreespll
1441 igqqstvsdv prdlevvaat ptslliswda pavtvryyri tygetggnsp vqeftvpgsk
1501 statisglkp gvdytitvya vtgrgdspas skpisinyrt eidkpsqmqv tdvqdnsisv
1561 kwlpssspvt gyrvtttpkn gpgptktkta gpdqtemtie glqptveyvv svyaqnpsge
1621 sqplvqtavt nidrpkglaf tdvdvdsiki awespqgqvs ryrvtysspe dgihelfpap
1681 dgeedtaelq glrpgseytv svvalhddme sqpligtqst aipaptdlkf tqvtptslsa
1741 qwtppnvqlt gyrvrvtpke ktgpmkeinl apdsssvvvs glmvatkyev svyalkdtlt
1801 srpaqgvvtt lenvspprra rvtdatetti tiswrtktet itgfqvdavp angqtpiqrt
1861 ikpdvrsyti tglqpgtdyk iylytlndna rsspvvidas taidapsnlr flattpnsll
1921 vswqpprari tgyiikyekp gspprevvpr prpgvteati tglepgteyt iyvialknnq
1981 kseplgrkk tvqktpfvth pgydtgngiq lpgtsgqqps vgqqmifeeh gfrrttpptt
2041 atpirhrprp yppnvgqeal sqttiswapf qdtseyiisc hpvgtdeepl qfrvpgtsts
2101 atltgltrga tyniivealk dqqrhkvree vvtvgnsvne glnqptddsc fdpytvshya
2161 vgdewermse sgfkllcqcl gfgsghfrcd ssrwchdngv nykigekwdr qgengqmmsc
2221 tclgngkgef kcdpheatcy ddgktyhvge qwqkeylgai csctcfgggr gwrcdncrrp
2281 ggepspegtt gqsynqysqr yhqrtntnvn cpiecfmpld vqadredsre
```

Fibronectin 1, isoform 5 precursor, NP_997641.1

```
   1 mlrgpgpgll llavqclgta vpstgasksk rqaqqmvqpq spvavsqskp gcydngkhyq
  61 inqqwertyl gnalvctcyg gsrgfncesk peaeetcfdk ytgntyrvgd tyerpkdsmi
 121 wdctcigagr grisctianr cheggqsyki gdtwrrphet ggymlecvcl gngkgewtck
 181 piaekcfdha agtsyvvget wekpyqgwmm vdctclgegs gritctsrnr cndqdtrtsy
```

```
 241 rigdtwskkd nrgnllqcic tgngrgewkc erhtsvqtts sgsgpftdvr aavyqpqphp
 301 qpppyghcvt dsgvvysvgm qwlktqgnkq mlctclgngv scqetavtqt yggnsngepc
 361 vlpftyngrt fyscttegrq dghlwcstts nyeqdqkysf ctdhtvlvqt rggnsngalc
 421 hfpflynnhn ytdctsegrr dnmkwcgttq nydadqkfgf cpmaaheeic ttnegvmyri
 481 gdqwdkqhdm ghmmrctcvg ngrgewtcia ysqlrdqciv dditynvndt fhkrheeghm
 541 lnctcfgqgr grwkcdpvdq cqdsetgtfy qigdswekyv hgvryqcycy grgigewhcq
 601 plqtypsssg pvevfitetp sqpnshpiqw napqpshisk yilrwrpkns vgrwkeatip
 661 ghlnsytikg lkpgvvyegq lisiqqyghq evtrfdfttt ststpvtsnt vtgettpfsp
 721 lvatsesvte itassfvvsw vsasdtvsgf rveyelseeg depqyldlps tatsvnipdl
 781 lpgrkyivnv yqisedgeqs lilstsqtta pdappdptvd qvddtsivvr wsrpqapitg
 841 yrivyspsve gsstelnlpe tansvtlsdl qpgvqyniti yaveenqest pvviqqettg
 901 tprsdtvpsp rdlqfvevtd vkvtimwtpp esavtgyrvd vipvnlpgeh gqrlpisrnt
 961 faevtglspg vtyyfkvfav shgreskplt aqqttkldap tnlqfvnetd stvlvrwtpp
1021 raqitgyrlt vgltrrgqpr qynvgpsvsk yplrnlqpas eytvslvaik gnqespkatg
1081 vfttlqpgss ippyntevte ttivitwtpa prigfklgvr psqggeapre vtsdsgsivv
1141 sgltpgveyv ytiqvlrdgq erdapivnkv vtplspptnl hleanpdtgv ltvswerstt
1201 pditgyritt tptngqqgns leevvhadqs sctfdnlspg leynvsvytv kddkesvpis
1261 dtiipavppp tdlrftnigp dtmrvtwapp psidltnflv ryspvkneed vaelsispsd
1321 navvltnllp gteyvvsvss vyeqhestpl rgrqktglds ptgidfsdit ansftvhwia
1381 pratitgyri rhhpehfsgr predrvphsr nsitltnltp gteyvvsiva lngreespll
1441 igqqstvsdv prdlevvaat ptslliswda pavtvryyri tygetggnsp vqeftvpgsk
1501 statisglkp gvdytitvya vtgrgdspas skpisinyrt eidkpsqmqv tdvqdnsisv
1561 kwlpssspvt gyrvtttpkn gpgptktkta gpdqtemtie glqptveyvv svyaqnpsge
1621 sqplvqtavt tipaptdlkf tqvtptslsa qwtppnvqlt gyrvrvtpke ktgpmkeinl
1681 apdsssvvvs glmvatkyev svyalkdtlt srpaqgvvtt lenvspprra rvtdatetti
1741 tiswrtktet itgfqvdavp angqtpiqrt ikpdvrsyti tglqpgtdyk iylytlndna
1801 rsspvvidas taidapsnlr flattpnsll vswqpprari tgyiikyekp gspprevvpr
1861 prpgvteati tglepgteyt iyvialknnq kspeligrkk tdelpqlvtl phpnlhgpei
1921 ldvpstvqkt pfvthpgydt gngiqlpgts gqqpsvgqqm ifeehgfrrt tppttatpir
1981 hrprpyppnv geeiqighip redvdyhlyp hgpglnpnas tgqealsqtt iswapfqdts
2041 eyiischpvg tdeeplqfrv pgtstsatlt gltrgatyni ivealkdqqr hkvreevvtv
2101 gnsvneglnq ptddscfdpy tvshyavgde wermsesgfk llcqclgfgs ghfrcdssrw
2161 chdngvnyki gekwdrqgen gqmmsctclg ngkgefkcdp heatcyddgk tyhvgeqwqk
2221 eylgaicsct cfggqrgwrc dncrrpggep spegttgqsy nqysqryhqr tntnvncpie
2281 cfmpldvqad redsre
```

Fibronectin 1, isoform 6 precursor, NP_997639.1

```
1 mlrgpgpgll llavqclgta vpstgasksk rqaqqmvqpq spvavsqskp gcydngkhyq
  61 inqqwertyl gnalvctcyg gsrgfncesk peaeetcfdk ytgntyrvgd tyerpkdsmi
 121 wdctcigagr grisctianr cheggqsyki gdtwrrphet ggymlecvcl gngkgewtck
 181 piaekcfdha agtsyvvget wekpyqgwmm vdctclgegs gritctsrnr cndqdtrtsy
 241 rigdtwskkd nrgnllqcic tgngrgewkc erhtsvqtts sgsgpftdvr aavyqpqphp
 301 qpppyghcvt dsgvvysvgm qwlktqgnkq mlctclgngv scqetavtqt yggnsngepc
 361 vlpftyngrt fyscttegrq dghlwcstts nyeqdqkysf ctdhtvlvqt rggnsngalc
 421 hfpflynnhn ytdctsegrr dnmkwcgttq nydadqkfgf cpmaaheeic ttnegvmyri
 481 gdqwdkqhdm ghmmrctcvg ngrgewtcia ysqlrdqciv dditynvndt fhkrheeghm
 541 lnctcfgqgr grwkcdpvdq cqdsetgtfy qigdswekyv hgvryqcycy grgigewhcq
 601 plqtypsssg pvevfitetp sqpnshpiqw napqpshisk yilrwrpkns vgrwkeatip
 661 ghlnsytikg lkpgvvyegq lisiqqyghq evtrfdfttt ststpvtsnt vtgettpfsp
 721 lvatsesvte itassfvvsw vsasdtvsgf rveyelseeg depqyldlps tatsvnipdl
 781 lpgrkyivnv yqisedgeqs lilstsqtta pdappdptvd qvddtsivvr wsrpqapitg
 841 yrivyspsve gsstelnlpe tansvtlsdl qpgvqyniti yaveenqest pvviqqettg
 901 tprsdtvpsp rdlqfvevtd vkvtimwtpp esavtgyrvd vipvnlpgeh gqrlpisrnt
 961 faevtglspg vtyyfkvfav shgreskplt aqqttkldap tnlqfvnetd stvlvrwtpp
1021 raqitgyrlt vgltrrgqpr qynvgpsvsk yplrnlqpas eytvslvaik gnqespkatg
1081 vfttlqpgss ippyntevte ttivitwtpa prigfklgvr psqggeapre vtsdsgsivv
1141 sgltpgveyv ytiqvlrdgq erdapivnkv vtplspptnl hleanpdtgv ltvswerstt
```

```
1201 pditgyritt tptngqqgns leevvhadqs sctfdnlspg leynvsvytv kddkesvpis
1261 dtiipavppp tdlrftnigp dtmrvtwapp psidltnflv ryspvkneed vaelsispsd
1321 navvltnllp gteyvvsvss vyeqhestpl rgrqktglds ptgidfsdit ansftvhwia
1381 pratitgyri rhhpehfsgr predrvphsr nsitltnltp gteyvvsiva lngreespll
1441 igqqstvsdv prdlevvaat ptslliswda pavtvryyri tygetggnsp vqeftvpgsk
1501 statisglkp gvdytitvya vtgrgdspas skpisinyrt eidkpsqmqv tdvqdnsisv
1561 kwlpssspvt gyrvtttpkn gpgptktkta gpdqtemtie glqptveyvv svyaqnpsge
1621 sqplvqtavt tipaptdlkf tqvtptslsa qwtppnvqlt gyrvrvtpke ktgpmkeinl
1681 apdsssvvvs glmvatkyev svyalkdtlt srpaqgvvtt lenvspprra rvtdatetti
1741 tiswrtktet itgfqvdavp angqtpiqrt ikpdvrsyti tglqpgtdyk iylytlndna
1801 rsspvvidas taidapsnlr flattpnsll vswqpprari tgyiikyekp gspprevvpr
1861 prpgvteati tglepgteyt iyvialknnq kspepligrkk tgqealsqtt iswapfqdts
1921 eyiischpvg tdeeplqfrv pgtstsatlt gltrgatyni ivealkdqqr hkvreevvtv
1981 gnsvneglnq ptddscfdpy tvshyavgde wermsesgfk llcqclgfgs ghfrcdssrw
2041 chdngvnyki gekwdrqgen gqmmsctclg ngkgefkcdp heatcyddgk tyhvgeqwqk
2101 eylgaicsct cfgggrgwrc dncrrpggep spegttgqsy nqysqryhqr tntnvncpie
2161 cfmpldvqad redsre
```

Fibronectin 1, isoform 7 precursor, NP_473375.2

```
   1 mlrgpgpgll llavqclgta vpstgasksk rqaqqmvqpq spvavsqskp gcydngkhyq
  61 inqqwertyl gnalvctcyg gsrgfncesk peaeetcfdk ytgntyrvgd tyerpkdsmi
 121 wdctcigagr grisctianr cheggqsyki gdtwrrphet ggymlecvcl gngkgewtck
 181 piaekcfdha agtsyvvget wekpyqgwmm vdctclgegs gritctsrnr cndqdtrtsy
 241 rigdtwskkd nrgnllqcic tgngrgewkc erhtsvqtts sgsgpftdvr aavyqpqphp
 301 qpppyghcvt dsgvvysvgm qwlktqgnkq mlctclgngv scqetavtqt yggnsngepc
 361 vlpftyngrt fyscttegrq dghlwcstts nyeqdqkysf ctdhtvlvqt rggnsngalc
 421 hfpflynnhn ytdctsegrr dnmkwcgttq nydadqkfgf cpmaaheeic ttnegvmyri
 481 gdqwdkqhdm ghmmrctcvg ngrgewtcia ysqlrdqciv dditynvndt fhkrheeghm
 541 lnctcfgqgr grwkcdpvdq cqdsetgtfy qigdswekyv hgvryqcycy grgigewhcq
 601 plqtypsssg pvevfitetp sqpnshpiqw napqpshisk yilrwrpvsi pprnlgy
```

Fibronectin 1, isoform 8 precursor, NP_001293058.1

```
   1 mlrgpgpgll llavqclgta vpstgasksk rqaqqmvqpq spvavsqskp gcydngkhyq
  61 inqqwertyl gnalvctcyg gsrgfncesk peaeetcfdk ytgntyrvgd tyerpkdsmi
 121 wdctcigagr grisctianr cheggqsyki gdtwrrphet ggymlecvcl gngkgewtck
 181 piaekcfdha agtsyvvget wekpyqgwmm vdctclgegs gritctsrnr cndqdtrtsy
 241 rigdtwskkd nrgnllqcic tgngrgewkc erhtsvqtts sgsgpftdvr aavyqpqphp
 301 qpppyghcvt dsgvvysvgm qwlktqgnkq mlctclgngv scqetavtqt yggnsngepc
 361 vlpftyngrt fyscttegrq dghlwcstts nyeqdqkysf ctdhtvlvqt rggnsngalc
 421 hfpflynnhn ytdctsegrr dnmkwcgttq nydadqkfgf cpmaaheeic ttnegvmyri
 481 gdqwdkqhdm ghmmrctcvg ngrgewtcia ysqlrdqciv dditynvndt fhkrheeghm
 541 lnctcfgqgr grwkcdpvdq cqdsetgtfy qigdswekyv hgvryqcycy grgigewhcq
 601 plqtypsssg pvevfitetp sqpnshpiqw napqpshisk yilrwrpkns vgrwkeatip
 661 ghlnsytikg lkpgvvyegq lisiqqyghq evtrfdfttt ststpvtsnt vtgettpfsp
 721 lvatsesvte itassfvvsw vsasdtvsgf rveyelseeg depqyldlps tatsvnipdl
 781 lpgrkyivnv yqisedgeqs lilstsqtta pdappdptvd qvddtsivvr wsrpqapitg
 841 yrivyspsve gsstelnlpe tansvtlsdl qpgvqyniti yaveenqest pvviqqettg
 901 tprsdtvpsp rdlqfvevtd vkvtimwtpp esavtgyrvd vipvnlpgeh gqrlpisrnt
 961 faevtglspg vtyyfkvfav shgreskplt aqqttkldap tnlqfvnetd stvlvrwtpp
1021 raqitgyrlt vgltrrgqpr qynvgpsvsk yplrnlqpas eytvslvaik gnqespkatg
1081 vfttlqpgss ippyntevte ttivitwtpa prigfklgvr psqggeapre vtsdsgsivv
1141 sgltpgveyv ytiqvlrdgq erdapivnkv vtplspptnl hleanpdtgv ltvswerstt
1201 pditgyritt tptngqqgns leevvhadqs sctfdnlspg leynvsvytv kddkesvpis
1261 dtiipevpql tdlsfvditd ssiglrwtpl nsstiigyri tvvaagegip ifedfvdssv
1321 gyytvtglep gidydisvit linggesapt tltqqtavpp ptdlrftnig pdtmrvtwap
1381 ppsidltnfl vryspvknee dvaelsisps dnavvltnll pgteyvvsvs svyeqhestp
1441 lrgrqktgld sptgidfsdi tansftvhwi apratitgyr irhhpehfsg rpredrvphs
```

```
1501 rnsitltnlt pgteyvvsiv alngreespl ligqqstvsd vprdlevvaa tptslliswd
1561 apavtvryyr itygetggns pvqeftvpgs kstatisglk pgvdytitvy avtgrgdspa
1621 sskpisinyr teidkpsqmq vtdvqdnsis vkwlpssspv tgyrvtttpk ngpgptktkt
1681 agpdqtemti eglqptveyv vsvyaqnpsg esqplvqtav tnidrpkgla ftdvdvdsik
1741 iawespqgqv sryrvtyssp edgihelfpa pdgeedtael qglrpgseyt vsvvalhddm
1801 esqpligtqs taipaptdlk ftqvtptsls aqwtppnvql tgyrvrvtpk ektgpmkein
1861 lapdsssvvv sglmvatkye vsvyalkdtl tsrpaqgvvt tlenvspprr arvtdatett
1921 itiswrtkte titgfqvdav pangqtpiqr tikpdvrsyt itglqpgtdy kiylytlndn
1981 arsspvvida staidapsnl rflattpnsl lvswqpprar itgyiikyek pgspprevvp
2041 rprpgvteat itglepgtey tiyvialknn qkspepligrk ktdelpqlvt lphpnlhgpe
2101 ildvpstvqk tpfvthpgyd tgngiqlpgt sgqqpsvgqq mifeehgfrr ttppttatpi
2161 rhrprpyppn vgqealsqtt iswapfqdts eyiischpvg tdeeplqfrv pgtstsatlt
2221 gltrgatyni ivealkdqqr hkvreevvtv gnsvneglnq ptddscfdpy tvshyavgde
2281 wermsesgfk llcqclgfgs ghfrcdssrw chdngvnyki gekwdrqgen gqmmsctclg
2341 ngkgefkcdp heatcyddgk tyhvgeqwqk eylgaicsct cfggqrgwrc dncrrpggep
2401 spegttgqsy nqysqryhqr tntnvncpie cfmpldvqad redsre
```

Fibronectin 1, isoform 9 precursor, NP_001293059.1

```
   1 mlrgpgpgll llavqclgta vpstgasksk rqaqqmvqpq spvavsqskp gcydngkhyq
  61 inqqwertyl gnalvctcyg gsrgfncesk peaeetcfdk ytgntyrvgd tyerpkdsmi
 121 wdctcigagr grisctianr cheggqsyki gdtwrrphet ggymlecvcl gngkgewtck
 181 piaekcfdha agtsyvvget wekpyqgwmm vdctclgegs gritctsrnr cndqdtrtsy
 241 rigdtwskkd nrgnllqcic tgngrgewkc erhtsvqtts sgsgpftdvr aavyqpqphp
 301 qpppyghcvt dsgvvysvgm qwlktqgnkq mlctclgngv scqetavtqt yggnsngepc
 361 vlpftyngrt fyscttegrq dghlwcstts nyeqdqkysf ctdhtvlvqt rggnsngalc
 421 hfpflynnhn ytdctsegrr dnmkwcgttq nydadqkfgf cpmaaheeic ttnegvmyri
 481 gdqwdkqhdm ghmmrctcvg ngrgewtcia ysqlrdqciv dditynvndt fhkrheeghm
 541 lnctcfgqgr grwkcdpvdq cqdsetgtfy qigdswekyv hgvryqcycy grgigewhcq
 601 plqtypsssg pvevfitetp sqpnshpiqw napqpshisk yilrwrpkns vgrwkeatip
 661 ghlnsytikg lkpgvvyegq lisiqqyghq evtrfdfttt ststpvtsnt vtgettpfsp
 721 lvatsesvte itassfvvsw vsasdtvsgf rveyelseeg depqyldlps tatsvnipdl
 781 lpgrkyivnv yqisedgeqs lilstsqtta pdappdptvd qvddtsivvr wsrpqapitg
 841 yrivyspsve gsstelnlpe tansvtlsdl qpgvqyniti yaveenqest pvviqqettg
 901 tprsdtvpsp rdlqfvevtd vkvtimwtpp esavtgyrvd vipvnlpgeh gqrlpisrnt
 961 faevtglspg vtyyfkvfav shgreskplt aqqttkldap tnlqfvnetd stvlvrwtpp
1021 raqitgyrlt vgltrrgqpr qynvgpsvsk yplrnlqpas eytvslvaik gnqespkatg
1081 vfttlqpgss ippyntevte ttivitwtpa prigfklgvr psqggeapre vtsdsgsivv
1141 sgltpgveyv ytiqvlrdgq erdapivnkv vtplspptnl hleanpdtgv ltvswerstt
1201 pditgyritt tptngqqgns leevvhadqs sctfdnlspg leynvsvytv kddkesvpis
1261 dtiipevpql tdlsfvditd ssiglrwtpl nsstiigyri tvvaagegip ifedfvdssv
1321 gyytvtglep gidydisvit linggesapt tltqqtavpp ptdlrftnig pdtmrvtwap
1381 ppsidltnfl vryspvknee dvaelsisps dnavvltnll pgteyvvsvs svyeqhestp
1441 lrgrqktgld sptgidfsdi tansftvhwi apratitgyr irhhpehfsg rpredrvphs
1501 rnsitltnlt pgteyvvsiv alngreespl ligqqstvsd vprdlevvaa tptslliswd
1561 apavtvryyr itygetggns pvqeftvpgs kstatisglk pgvdytitvy avtgrgdspa
1621 sskpisinyr teidkpsqmq vtdvqdnsis vkwlpssspv tgyrvtttpk ngpgptktkt
1681 agpdqtemti eglqptveyv vsvyaqnpsg esqplvqtav ttipaptdlk ftqvtptsls
1741 aqwtppnvql tgyrvrvtpk ektgpmkein lapdsssvvv sglmvatkye vsvyalkdtl
1801 tsrpaqgvvt tlenvspprr arvtdatett itiswrtkte titgfqvdav pangqtpiqr
1861 tikpdvrsyt itglqpgtdy kiylytlndn arsspvvida staidapsnl rflattpnsl
1921 lvswqpprar itgyiikyek pgspprevvp rprpgvteat itglepgtey tiyvialknn
1981 qkspepligrk ktgqealsqt tiswapfqdt seyiischpv gtdeeplqfr vpgtstsatl
2041 tgltrgatyn iivealkdqq rhkvreevvt vgnsvnegln qptddscfdp ytvshyavgd
2101 ewermsesgf kllcqclgfg sghfrcdssr wchdngvnyk igekwdrqge ngqmmsctcl
2161 gngkgefkcd pheatcyddg ktyhvgeqwq keylgaicsc tcfggqrgwr cdncrrpgge
2221 pspegttgqs ynqysqryhq rtntnvncpi ecfmpldvqa dredsre
```

Fibronectin 1, isoform 10 precursor, NP_001293060.1

```
       1 mlrgpgpgll llavqclgta vpstgasksk rqaqqmvqpq spvavsqskp gcydngkhyq
      61 inqqwertyl gnalvctcyg gsrgfncesk peaeetcfdk ytgntyrvgd tyerpkdsmi
     121 wdctcigagr grisctianr cheggqsyki gdtwrrphet ggymlecvcl gngkgewtck
     181 piaekcfdha agtsyvvget wekpyqgwmm vdctclgegs gritctsrnr cndqdtrtsy
     241 rigdtwskkd nrgnllqcic tgngrgewkc erhtsvqtts sgsgpftdvr aavyqpqphp
     301 qpppyghcvt dsgvvysvgm qwlktqgnkq mlctclgngv scqetavtqt yggnsngepc
     361 vlpftyngrt fyscttegrq dghlwcstts nyeqdqkysf ctdhtvlvqt rggnsngalc
     421 hfpflynnhn ytdctsegrr dnmkwcgttq nydadqkfgf cpmaaheeic ttnegvmyri
     481 gdqwdkqhdm ghmmrctcvg ngrgewtcia ysqlrdqciv dditynvndt fhkrheeghm
     541 lnctcfgqgr grwkcdpvdq cqdsetgtfy qigdswekyv hgvryqcycy grgigewhcq
     601 plqtypsssg pvevfitetp sqpnshpiqw napqpshisk yilrwrpkns vgrwkeatip
     661 ghlnsytikg lkpgvvyegq lisiqqyghq evtrfdfttt ststpvtsnt vtgettpfsp
     721 lvatsesvte itassfvvsw vsasdtvsgf rveyelseeg depqyldlps tatsvnipdl
     781 lpgrkyivnv yqisedgeqs lilstsqtta pdappdptvd qvddtsivvr wsrpqapitg
     841 yrivyspsve gsstelnlpe tansvtlsdl qpgvqyniti yaveenqest pvviqqettg
     901 tprsdtvpsp rdlqfvevtd vkvtimwtpp esavtgyrvd vipvnlpgeh gqrlpisrnt
     961 faevtglspg vtyyfkvfav shgreskplt aqqttkldap tnlqfvnetd stvlvrwtpp
    1021 raqitgyrlt vgltrrgqpr qynvgpsvsk yplrnlqpas eytvslvaik gnqespkatg
    1081 vfttlqpgss ippyntevte ttivitwtpa prigfklgvr psqggeapre vtsdsgsivv
    1141 sgltpgveyv ytiqvlrdgq erdapivnkv vtplspptnl hleanpdtgv ltvswerstt
    1201 pditgyritt tptngqqgns leevvhadqs sctfdnlspg leynvsvytv kddkesvpis
    1261 dtiipavppp tdlrftnigp dtmrvtwapp psidltnflv ryspvkneed vaelsispsd
    1321 navvltnllp gteyvvsvss vyeqhestpl rgrqktglds ptgidfsdit ansftvhwia
    1381 pratitgyri rhhpehfsgr predrvphsr nsitltnltp gteyvvsiva lngreespll
    1441 igqqstvsdv prdlevvaat ptslliswda pavtvryyri tygetggnsp vqeftvpgsk
    1501 statisglkp gvdytitvya vtgrgdspas skpisinyrt eidkpsqmqv tdvqdnsisv
    1561 kwlpssspvt gyrvtttpkn gpgptktkta gpdqtemtie glqptveyvv svyaqnpsge
    1621 sqplvqtavt tipaptdlkf tqvtptslsa qwtppnvqlt gyrvrvtpke ktgpmkeinl
    1681 apdsssvvvs glmvatkyev svyalkdtlt srpaqgvvtt lenvspprra rvtdatetti
    1741 tiswrtktet itgfqvdavp angqtpiqrt ikpdvrsyti tglqpgtdyk iylytlndna
    1801 rsspvvidas taidapsnlr flattpnsll vswqpprari tgyiikyekp gspprevvpr
    1861 prpgvteati tglepgteyt iyvialknnq ksepligrkk tdelpqlvtl phpnlhgpei
    1921 ldvpstvqkt pfvthpgydt gngiqlpgts gqqpsvgqqm ifeehgfrrt tppttatpir
    1981 hrprpyppnv gqealsqtti swapfqdtse yiischpvgt deeplqfrvp gtstsatltg
    2041 ltrgatynii vealkdqqrh kvreevvtvg nsvneglnqp tddscfdpyt vshyavgdew
    2101 ermsesgfkl lcqclgfgsg hfrcdssrwc hdngvnykig ekwdrqgeng qmmsctclgn
    2161 gkgefkcdph eatcyddgkt yhvgeqwqke ylgaicsctc fgggrgwrcd ncrrpggeps
    2221 pegttgqsyn qysqryhqrt ntnvncpiec fmpldvqadr edsre
```

Fibronectin 1, isoform 11 precursor, NP_001293061.1

```
       1 mlrgpgpgll llavqclgta vpstgasksk rqaqqmvqpq spvavsqskp gcydngkhyq
      61 inqqwertyl gnalvctcyg gsrgfncesk peaeetcfdk ytgntyrvgd tyerpkdsmi
     121 wdctcigagr grisctianr cheggqsyki gdtwrrphet ggymlecvcl gngkgewtck
     181 piaekcfdha agtsyvvget wekpyqgwmm vdctclgegs gritctsrnr cndqdtrtsy
     241 rigdtwskkd nrgnllqcic tgngrgewkc erhtsvqtts sgsgpftdvr aavyqpqphp
     301 qpppyghcvt dsgvvysvgm qwlktqgnkq mlctclgngv scqetavtqt yggnsngepc
     361 vlpftyngrt fyscttegrq dghlwcstts nyeqdqkysf ctdhtvlvqt rggnsngalc
     421 hfpflynnhn ytdctsegrr dnmkwcgttq nydadqkfgf cpmaaheeic ttnegvmyri
     481 gdqwdkqhdm ghmmrctcvg ngrgewtcia ysqlrdqciv dditynvndt fhkrheeghm
     541 lnctcfgqgr grwkcdpvdq cqdsetgtfy qigdswekyv hgvryqcycy grgigewhcq
     601 plqtypsssg pvevfitetp sqpnshpiqw napqpshisk yilrwrpkns vgrwkeatip
     661 ghlnsytikg lkpgvvyegq lisiqqyghq evtrfdfttt ststpvtsnt vtgettpfsp
     721 lvatsesvte itassfvvsw vsasdtvsgf rveyelseeg depqyldlps tatsvnipdl
     781 lpgrkyivnv yqisedgeqs lilstsqtta pdappdptvd qvddtsivvr wsrpqapitg
     841 yrivyspsve gsstelnlpe tansvtlsdl qpgvqyniti yaveenqest pvviqqettg
     901 tprsdtvpsp rdlqfvevtd vkvtimwtpp esavtgyrvd vipvnlpgeh gqrlpisrnt
```

961 faevtglspg vtyyfkvfav shgreskplt aqqttkldap tnlqfvnetd stvlvrwtpp
1021 raqitgyrlt vgltrrgqpr qynvgpsvsk yplrnlqpas eytvslvaik gnqespkatg
1081 vfttlqpgss ippyntevte ttivitwtpa prigfklgvr psqggeapre vtsdsgsivv
1141 sgltpgveyv ytiqvlrdgq erdapivnkv vtplspptnl hleanpdtgv ltvswerstt
1201 pditgyritt tptngqqgns leevvhadqs sctfdnlspg leynvsvytv kddkesvpis
1261 dtiipavppp tdlrftnigp dtmrvtwapp psidltnflv ryspvkneed vaelsispsd
1321 navvltnllp gteyvvsvss vyeqhestpl rgrqktglds ptgidfsdit ansftvhwia
1381 pratitgyri rhhpehfsgr predrvphsr nsitltnltp gteyvvsiva lngreespll
1441 igqqstvsdv prdlevvaat ptslliswda pavtvryyri tygetggnsp vqeftvpgsk
1501 statisglkp gvdytitvya vtgrgdspas skpisinyrt eidkpsqmqv tdvqdnsisv
1561 kwlpssspvt gyrvtttpkn gpgptktkta gpdqtemtie glqptveyvv svyaqnpsge
1621 sqplvqtavt tipaptdlkf tqvtptslsa qwtppnvqlt gyrvrvtpke ktgpmkeinl
1681 apdsssvvvs glmvatkyev svyalkdtlt srpaqgvvtt lenvspprra rvtdatetti
1741 tiswrtktet itgfqvdavp angqtpiqrt ikpdvrsyti tglqpgtdyk iylytlndna
1801 rsspvvidas taidapsnlr flattpnsll vswqpprari tgyiikyekp gspprevvpr
1861 prpgvteati tglepgteyt iyvialknnq ksepligrkk tvqktpfvth pgydtgngiq
1921 lpgtsgqqps vgqqmifeeh gfrrttpptt atpirhrprp yppnvgqeal sqttiswapf
1981 qdtseyiisc hpvgtdeepl qfrvpgtsts atltgltrga tyniivealk dqqrhkvree
2041 vvtvgnsvne glnqptddsc fdpytvshya vgdewermse sgfkllcqcl gfgsghfrcd
2101 ssrwchdngv nykigekwdr qgengqmmsc tclgngkgef kcdpheatcy ddgktyhvge
2161 qwqkeylgai csctcfggqr gwrcdncrrp ggepspegtt gqsynqysqr yhqrtntnvn
2221 cpiecfmpld vqadredsre

Major histocompatibility complex, class II, DR beta 1, precursor, NP_001230894.1
1 mvclrlpggs cmavltvtlm vlssplalag dtrprfleys tsechffngt ervryldryf
61 hnqeenvrfd sdvgefravt elgrpdaeyw nsqkdlleqk rgrvdnycrh nygvvesftv
121 qrrvhpkvtv ypsktqplqh hnllvcsvsg fypgsievrw frngqeektg vvstglihng
181 dwtfqtlvml etvprsgevy tcqvehpsvt spltvewrar sesaqskmls gvggfvlgll
241 flgaglfiyf rnqkghsglq prgfls

Major histocompatibility complex, class II, DR beta 1, precursor, NP_001346122.1
1 mvclklpggs cmaaltvtlm vlssplalag dtqprflwqg kykchffngt ervqflerlf
61 ynqeefvrfd sdvgeyravt elgrpvaesw nsqkdiledr rgqvdtvcrh nygvgesftv
121 qrrvhpevtv ypaktqplqh hnllvcsvsg fypgsievrw frngqeekag vvstgliqng
181 dwtfqtlvml etvprsgevy tcqvehpsvm spltvewrar sesaqskmls gvggfvlgll
241 flgaglfiyf rnqkghsglq ptgfls

Major histocompatibility complex, class II, DR beta 1, precursor, NP_001346123.1
1 mvclkfpggs cmaaltvtlm vlssplalag dtrprfleqv khechffngt ervrfldryf
61 yhqeeyvrfd sdvgeyravt elgrpdaeyw nsqkdlleqr raevdtycrh nygvvesftv
121 qrrvypevtv ypaktqplqh hnllvcsvng fypgsievrw frngqeektg vvstgliqng
181 dwtfqtlvml etvprsgevy tcqvehpslt spltvewrar sesaqskmls gvggfvlgll
241 flgaglfiyf rnqkghsglq ptgfls

Major histocompatibility complex, class II, DR beta 1, precursor, NP_002115.2
1 mvclklpggs cmtaltvtlm vlssplalsg dtrprflwqp krechffngt ervrfldryf
61 ynqeesvrfd sdvgefravt elgrpdaeyw nsqkdileqa raavdtycrh nygvvesftv
121 qrrvqpkvtv ypsktqplqh hnllvcsvsg fypgsievrw flngqeekag mvstgliqng
181 dwtfqtlvml etvprsgevy tcqvehpsvt spltvewrar sesaqskmls gvggfvlgll
241 flgaglfiyf rnqkghsglq ptgfls

Major histocompatibility complex, class II, DR beta 5, precursor, NP_002116.2
1 mvclklpggs ymakltvtlm vlssplalag dtrprflqqd kyechffngt ervrflhrdi
61 ynqeedlrfd sdvgeyravt elgrpdaeyw nsqkdfledr raavdtycrh nygvgesftv

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      121 qrrvepkvtv ypartqtlqh hnllvcsvng fypgsievrw frnsqeekag vvstgliqng
      181 dwtfqtlvml etvprsgevy tcqvehpsvt spltvewraq sesaqskmls gvggfvlgll
      241 flgaglfiyf knqkghsglh ptglvs

Hydroxysteroid 17-beta dehydrogenase 3, NP_000188.1
        1 mgdvleqffi ltgllvclac lakcvrfsrc vllnywkvlp ksflrsmgqw avitgagdgi
       61 gkaysfelak rglnvvlisr tlekleaiat eierttgrsv kiiqadftkd diyehikekl
      121 agleigilvn nvgmlpnllp shflnapdei qslihcnits vvkmtqlilk hmesrqkgli
      181 lnissgialf pwplysmysa skafvcafsk alqeeykake viiqvltpya vstamtkyln
      241 tnvitktade fvkeslnyvt iggetcgcla heilagflsl ipawafysga fqrlllthyv
      301 aylklntkvr

Insulin degrading enzyme, isoform 1, NP_004960.2
        1 mryrlawllh palpstfrsv lgarlppper lcgfqkktys kmnnpaikri gnhitksped
       61 kreyrglela ngikvllisd pttdkssaal dvhigslsdp pniaglshfc ehmlflgtkk
      121 ypkeneysqf lsehagssna ftsgehtnyy fdvshehleg aldrfaqffl cplfdesckd
      181 revnavdseh eknvmndawr lfqlekatgn pkhpfskfgt gnkytletrp nqegidvrqe
      241 llkfhsayys snlmavcvlg reslddltnl vvklfseven knvplpefpe hpfqeehlkq
      301 lykivpikdi rnlyvtfpip dlqkyyksnp ghylghligh egpgsllsel kskgwvntlv
      361 ggqkegargf mffiinvdlt eegllhvedi ilhmfqyiqk lraegpqewv fqeckdlnav
      421 afrfkdkerp rgytskiagi lhyypleevl taeylleefr pdliemvldk lrpenvrvai
      481 vsksfegktd rteewygtqy kqeaipdevi kkwqnadlng kfklptknef iptnfeilpl
      541 ekeatpypal ikdtamsklw fkqddkfflp kaclnfeffs pfayvdplhc nmaylylell
      601 kdslneyaya aelaglsydl qntiygmyls vkgyndkqpi llkkiiekma tfeidekrfe
      661 iikeaymrsl nnfraeqphq hamyylrllm tevawtkdel kealddvtlp rlkafipqll
      721 srlhieallh gnitkqaalg imqmvedtli ehahtkpllp sqlvryrevq lpdrgwfvyq
      781 qrnevhnncg ieiyyqtdmq stsenmflel fcqiisepcf ntlrtkeqlg yivfsgprra
      841 ngiqglrfii qsekpphyle srveaflitm eksiedmtee afqkhiqala irrldkpkkl
      901 saecakywge iisqqynfdr dntevaylkt ltkediikfy kemlavdapr rhkvsvhvla
      961 remdscpvvg efpcqndinl sqapalpqpe viqnmtefkr glplfplvkp hinfmaakl

Insulin degrading enzyme, isoform 2, NP_001159418.1
        1 msklwfkqdd kfflpkacln feffspfayv dplhcnmayl ylellkdsln eyayaaelag
       61 lsydlqntiy gmylsvkgyn dkqpillkki iekmatfeid ekrfeiikea ymrslnnfra
      121 eqphqhamyy lrllmtevaw tkdelkeald dvtlprlkaf ipqllsrlhi eallhgnitk
      181 qaalgimqmv edtliehaht kpllpsqlvr yrevqlpdrg wfvyqqrnev hnncgieiyy
      241 qtdmqstsen mflelfcqii sepcfntlrt keqlgyivfs gprrangiqg lrfiiqsekp
      301 phylesrvea flitmeksie dmteeafqkh iqalairrld kpkklsaeca kywgeiisqq
      361 ynfdrdntev aylktltked iikfykemla vdaprrhkvs vhvlaremds cpvvgefpcq
      421 ndinlsqapa lpqpeviqnm tefkrglplf plvkphinfm aakl

Insulin degrading enzyme, isoform 3, NP_001309722.1
        1 mryrlawllh palpstfrsv lgarlppper lcgfqkktys kmnnpaikri gnhitksped
       61 kreyrglela ngikvllisd pttdkssaal dvhigslsdp pniaglshfc ehmlflgtkk
      121 ypkeneysqf lsehagssna ftsgehtnyy fdvshehleg aldrfaqffl cplfdesckd
      181 revnavdseh eknvmndawr lfqlekatgn pkhpfskfgt gnkytletrp nqegidvrqe
      241 llkfhsayys snlmavcvlg reslddltnl vvklfseven knvplpefpe hpfqeehlkq
      301 lykivpikdi rnlyvtfpip dlqkyyksnp ghylghligh egpgsllsel kskgwvntlv
      361 ggqkegargf mffiinvdlt eegllhvedi ilhmfqyiqk lraegpqewv fqeckdlnav
      421 afrfkdkerp rgytskiagi lhyypleevl taeylleefr pdliemvldk lrpenvrvai
      481 vsksfegktd rteewygtqy kqeaipdevi kkwqnadlng kfklptknef iptnfeilpl
      541 ekeatpypal ikdtamsklw fkqddkfflp kaclnfeffs ryiyadplhc nmtylfirll
      601 kddlkeytya arlsglsygi asgmnaills vkgyndkqpi llkkiiekma tfeidekrfe
      661 iikeaymrsl nnfraeqphq hamyylrllm tevawtkdel kealddvtlp rlkafipqll
      721 srlhieallh gnitkqaalg imqmvedtli ehahtkpllp sqlvryrevq lpdrgwfvyq
      781 qrnevhnncg ieiyyqtdmq stsenmflel fcqiisepcf ntlrtkeqlg yivfsgprra
      841 ngiqglrfii qsekpphyle srveaflitm eksiedmtee afqkhiqala irrldkpkkl
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901 saecakywge iisqqynfdr dntevaylkt ltkediikfy kemlavdapr rhkvsvhvla
961 remdscpvvg efpcqndinl sqapalpqpe viqnmtefkr glplfplvkp hinfmaakl

Insulin degrading enzyme, isoform 4, NP_001309723.1
1 mryrlawllh palpstfrsv lgarlppper lcgfqkktys kmnnpaikri gnhitksped
61 kreyrglela ngikvllisd pttdkssaal dvhigslsdp pniaglshfc ehmlflgtkk
121 ypkeneysqf lsehagssna ftsgehtnyy fdvshehleg aldrfaqffl cplfdesckd
181 revnavdseh eknvmndawr lfqlekatgn pkhpfskfgt greslddltn lvvklfseve
241 nknvplpefp ehpfqeehlk qlykivpikd irnlyvtfpi pdlqkyyksn pghylghlig
301 hegpgsllse lkskgwvntl vgggqkegarg fmffiinvdl teegllhved iilhmfqyiq
361 klraegpqew vfqeckdlna vafrfkdker prgytskiag ilhyypleev ltaeylleef
421 rpdliemvld klrpenvrva ivsksfegkt drteewygtq ykqeaipdev ikkwqnadln
481 gkfklptkne fiptnfeilp lekeatpypa likdtamskl wfkqddkffl pkaclnfeff
541 spfayvdplh cnmaylylel lkdslneyay aaelaglsyd lqntiygmyl svkgyndkqp
601 illkkiiekm atfeidekrf eiikeaymrs lnnfraeqph qhamyylrll mtevawtkde
661 lkealddvtl prlkafipql lsrlhieall hgnitkqaal gimqmvedtl iehahtkpll
721 psqlvryrev qlpdrgwfvy qqrnevhnnc gieiyyqtdm qstsenmfle lfcqiisepc
781 fntlrtkeql gyivfsgprr angiqglrfi iqsekpphyl esrveaflit meksiedmte
841 eafqkhiqal airrldkpkk lsaecakywg eiisqqynfd rdntevaylk tltkediikf
901 ykemlavdap rrhkvsvhvl aremdscpvv gefpcqndin lsqapalpqp eviqnmtefk
961 rglplfplvk phinfmaakl

Insulin degrading enzyme, isoform 5, NP_001309724.1, NP_001309725.1
1 mnnpaikrig nhitkspedk reyrglelan gikvllisdp ttdkssaald vhigslsdpp
61 niaglshfce hmlflgtkky pkeneysqfl sehagssnaf tsgehtnyyf dvshehlega
121 ldrfaqfflc plfdesckdr evnavdsehe knvmndawrl fqlekatgnp khpfskfgtg
181 nkytletrpn qegidvrqel lkfhsayyss nlmavcvlgr eslddltnlv vklfsevenk
241 nvplpefpeh pfqeehlkql ykivpikdir nlyvtfpipd lqkyyksnpg hylghlighe
301 gpgsllselk skgwvntlvg gqkegargfm ffiinvdlte egllhvedii lhmfqyiqkl
361 raegpqewvf qeckdlnava frfkdkerpr gytskiagil hyypleevlt aeylleefrp
421 dliemvldkl rpenvrvaiv sksfegktdr teewygtqyk qeaipdevik kwqnadlngk
481 fklptknefi ptnfeilple keatpypali kdtamsklwf kqddkfflpk aclnfeffsp
541 fayvdplhcn maylylellk dslneyayaa elaglsydlq ntiygmylsv kgyndkqpil
601 lkkiiekmat feidekrfei ikeaymrsln nfraeqphqh amyylrllmt evawtkdelk
661 ealddvtlpr lkafipqlls rlhieallhg nitkqaalgi mqmvedtlie hahtkpllps
721 qlvryrevql pdrgwfvyqq rnevhnncgi eiyyqtdmqs tsenmflelf cqiisepcfn
781 tlrtkeqlgy ivfsgprran giqglrfiiq sekpphyles rveaflitme ksiedmteea
841 fqkhiqalai rrldkpkkls aecakywgei isqqynfdrd ntevaylktl tkediikfyk
901 emlavdaprr hkvsvhvlar emdscpvvge fpcqndinls qapalpqpev iqnmtefkrg
961 lplfplvkph infmaakl

Insulin degrading enzyme, isoform 6, NP_001309726.1
1 msklwfkqdd kfflpkacln feffsryiya dplhcnmtyl firllkddlk eytyaarlsg
61 lsygiasgmn aillsvkgyn dkqpillkki iekmatfeid ekrfeiikea ymrslnnfra
121 eqphqhamyy lrllmtevaw tkdelkeald dvtlprlkaf ipqllsrlhi eallhgnitk
181 qaalgimqmv edtliehaht kpllpsqlvr yrevqlpdrg wfvyqqrnev hnncgieiyy
241 qtdmqstsen mflelfcqii sepcfntlrt keqlgyivfs gprrangiqg lrfiiqsekp
301 phylesrvea flitmeksie dmteeafqkh iqalairrld kpkklsaeca kywgeiisqq
361 ynfdrdntev aylktltked iikfykemla vdaprrhkvs vhvlaremds cpvvgefpcq
421 ndinlsqapa lpqpeviqnm tefkrglplf plvkphinfm aakl

Indoleamine 2,3-dioxygenase 1, NP_002155.1
1 mahamenswt iskeyhidee vgfalpnpqe nlpdfyndwm fiakhlpdli esgqlrerve
61 klnmlsidhl tdhksqrlar lvlgcitmay vwgkghgdvr kvlprniavp ycqlskklel
121 ppilvyadcv lanwkkkdpn kpltyenmdv lfsfrdgdcs kgfflvslv eiaaasaikv
181 iptvfkamqm qerdtllkal leiascleka lqvfhqihdh vnpkaffsvl riylsgwkgn
241 pqlsdglvye gfwedpkefa ggsagqssvf qcfdvllgiq qtaggghaaq flqdmrrymp

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      301 pahrnflcsl esnpsvrefv lskgdaglre aydacvkalv slrsyhlqiv tkyilipasq
      361 qpkenktsed pskleakgtg gtdlmnflkt vrstteksll keg

Insulin like growth factor binding protein 5, precursor, NP_000590.1
        1 mvlltavlll laayagpaqs lgsfvhcepc dekalsmcpp splgcelvke pgcgccmtca
       61 laegqscgvy tercaqglrc lprqdeekpl hallhgrgvc lneksyreqv kierdsrehe
      121 epttsemaee tyspkifrpk htriselkae avkkdrrkkl tqskfvggae ntahpriisa
      181 pemrqeseqg pcrrhmeasl qelkasprmv pravylpncd rkgfykrkqc kpsrgrkrgi
      241 cwcvdkygmk lpgmeyvdgd fqchtfdssn ve

Insulin like growth factor binding protein 7, isoform 1 precursor,
NP_001544.1
        1 merpslrall lgaaglllll lplssssssd tcgpcepasc pplpplgcll getrdacgcc
       61 pmcargegep cggggagrgy capgmecvks rkrrkgkaga aaggpgvsgv cvcksrypvc
      121 gsdgttypsg cqlraasqra esrgekaitq vskgtceqgp sivtppkdiw nvtgaqvyls
      181 cevigiptpv liwnkvkrgh ygvqrtellp gdrdnlaiqt rggpekhevt gwvlvsplsk
      241 edageyecha snsqgqasas akitvvdalh eipvkkgega el

Insulin like growth factor binding protein 7, isoform 2 precursor,
NP_001240764.1
        1 merpslrall lgaaglllll lplssssssd tcgpcepasc pplpplgcll getrdacgcc
       61 pmcargegep cggggagrgy capgmecvks rkrrkgkaga aaggpgvsgv cvcksrypvc
      121 gsdgttypsg cqlraasqra esrgekaitq vskgtceqgp sivtppkdiw nvtgaqvyls
      181 cevigiptpv liwnkvkrgh ygvqrtellp gdrdnlaiqt rggpekhevt gwvlvsplsk
      241 edageyecha snsqgqasas akitvvdalh eipvkkgtq


Potassium two pore domain channel subfamily K member 1, NP_002236.1
        1 mlqslagssc vrlverhrsa wcfgflvlgy llylvfgavv fssvelpyed llrqelrklk
       61 rrfleehecl seqqleqflg rvleasnygv svlsnasgnw nwdftsalff astvlsttgy
      121 ghtvplsdgg kafciiysvi gipftllflt avvqritvhv trrpvlyfhi rwgfskqvva
      181 ivhavllgfv tvscfffipa avfsvleddw nflesfyfcf islstiglgd yvpgegynqk
      241 frelykigit cylllgliam lvvletfcel helkkfrkmf yvkkdkdedq vhiiehdqls
      301 fssitdqaag mkedqkqnep fvatqssacv dgpanh

Lysosomal associated membrane protein 3, precursor, NP_055213.2
        1 mprqlsaaaa lfaslavilh dgsqmrakaf petrdysqpt aaatvqdikk pvqqpakqap
       61 hqtlaarfmd ghitfqtaat vkiptttpat tkntattspi tytlvttqat pnnshtappv
      121 tevtvgpsla pyslpptitp pahttgtsss tvshttgntt qpsnqttlpa tlsialhkst
      181 tgqkpvqpth apgttaaahn ttrtaapast vpgptlapqp ssvktgiyqv lngsrlcika
      241 emgiqlivqd kesvfsprry fnidpnatqa sgncgtrksn lllnfqggfv nltftkdees
      301 yyisevgayl tvsdpetiyq gikhavvmfq tavghsfkcv seqslqlsah lqvkttdvql
      361 qafdfeddhf gnvdecssdy tivlpvigai vvglclmgmg vykirlrcqs sgyqri

MAGE family member B2, NP_002355.2
        1 mprgqksklr arekrrkard etrglnvpqv teaeeeeapc csssvsggaa ssspaagipq
       61 epqrapttaa aaaagvsstk skkgakshqg eknasssqas tstkspsedp ltrksgslvq
      121 fllykykikk svtkgemlki vgkrfrehfp eilkkasegl svvfglelnk vnpnghtytf
      181 idkvdltdee sllsswdfpr rkllmpllgv iflngnsate eeiweflnml gvydgeehsv
      241 fgepwklitk dlvqekyley kqvpssdppr fqflwgpray aetskmkvle flakvngttp
      301 cafpthyeea lkdeekagv

Mitogen-activated protein kinase 13, NP_002745.1
        1 mslirkkgfy kqdvnktawe lpktyvspth vgsgaygsvc saidkrsgek vaikklsrpf
       61 qseifakray rellllkhmq henviglldv ftpasslrnf ydfylvmpfm qtdlqkimgm
      121 efseekiqyl vyqmlkglky ihsagvvhrd lkpgnlavne dcelkildfg larhadaemt
      181 gyvvtrwyra pevilswmhy nqtvdiwsvg cimaemltgk tlfkgkdyld qltqilkvtg
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      241 vpgtefvqkl ndkaaksyiq slpqtprkdf tqlfpraspq aadllekmle ldvdkrltaa
      301 qalthpffep frdpeeetea qqpfddsleh ekltvdewkq hiykeivnfs piarkdsrrr
      361 sgmkl

Macrophage receptor with collagenous structure, NP_006761.1
        1 mrnkkilked ellsetqqaa fhqiamepfe invpkpkrrn gvnfslavvv iylilltaga
       61 gllvvqvlnl qarlrvlemy flndtlaaed spsfsllqsa hpgehlaqga srlqvlqaql
      121 twvrvshehl lqrvdnftqn pgmfrikgeq gapglqghkg amgmpgapgp pgppaekgak
      181 gamgrdgatg psgpqgppgv kgeaglqgpq gapgkqgatg tpgpqgekgs kgdggligpk
      241 getgtkgekg dlglpgskgd rgmkgdagvm gppgaqgskg dfgrpgppgl agfpgakgdq
      301 gqpglqgvpg ppgavghpga kgepgsagsp graglpgspg spgatglkgs kgdtglqgqq
      361 grkgesgvpg pagvkgeqgs pglagpkgap gqagqkgdqg vkgsspgeqgv kgekgergen
      421 svsvrivgss nrgraevyys gtwgticdde wqnsdaivfc rmlgyskgra lykvgagtgq
      481 iwldnvqcrg testlwsctk nswghhdcsh eedagvecsv

Malic enzyme 1, NADP-dependent malic enzyme, NP_002386.1
        1 mepeaprrrh thqrgylltr nphlnkdlaf tleerqqlni hgllppsfns qeiqvlrvvk
       61 nfehlnsdfd rylllmdlqd rneklfyrvl tsdiekfmpi vytptvglac qqyslvfrkp
      121 rglfitihdr ghiasvlnaw pedvikaivv tdgerilglg dlgcngmgip vgklalytac
      181 ggmnpqeclp vildvgtene ellkdplyig lrqrrvrgse yddfldefme avsskygmnc
      241 liqfedfanv nafrllnkyr nqyctfnddi qgtasvavag llaalritkn klsdqtilfq
      301 gageaalgia hlivmaleke glpkekaikk iwlvdskgli vkgrasltqe kekfahehee
      361 mknleaivqe ikptaligva aiggafseqi lkdmaafner piifalsnpt skaecsaeqc
      421 ykitkgraif asgspfdpvt lpngqtlypg qgnnsyvfpg valgvvacgl rqitdniflt
      481 taeviaqqvs dkhleegrly pplntirdvs lkiaekivkd ayqektatvy pepqnkeafv
      541 rsqmystdyd qilpdcyswp eevqkiqtkv dq

Migration and invasion inhibitory protein, NP_068752.2
        1 mveaeelaql rllnlellrq lwvgqdavrr svaraasess lessssynse tpstpetsst
       61 slstscprgr ssvwgppdac rgdlrdvars gvaslppakc qhqeslgrpr phsapslgts
      121 slrdpepsgr lgdpgpqeaq tprsilaqqs klskprvtfs eesavpkrsw rlrpylgydw
      181 iagsldtsss itsqpeaffs klqefretnk eecicshpep qlpglressg sgveedhecv
      241 ycyrvnrrlf pvpvdpgtpc rlcrtprdqq gpgtlaqpah vrvsiplsil epphryhihr
      301 rksfdasdtl alprhcllgw difppkseks saprnldlws svsaeaqhqk lsgtsspfhp
      361 aspmqmlppt ptwsvpqvpr phvprqkp

Matrix metallopeptidase 12, macrophage metalloelastase preproprotein,
NP_002417.2
        1 mkfllilllq atasgalpln sstsleknnv lfgerylekf ygleinklpv tkmkysgnlm
       61 kekiqemqhf lglkvtgqld tstlemmhap rcgvpdvhhf rempggpvwr khyityrinn
      121 ytpdmnredv dyairkafqv wsnvtplkfs kintgmadil vvfargahgd fhafdgkggi
      181 lahafgpgsg iggdahfded efwtthsggt nlfltavhei ghslglghss dpkavmfpty
      241 kyvdintfrl saddirgiqs lygdpkenqr lpnpdnsepa lcdpnlsfda vttvgnkiff
      301 fkdrffwlkv serpktsvnl isslwptlps gieaayeiea rnqvflfkdd kywlisnlrp
      361 epnypksihs fgfpnfvkki daavfnprfy rtyffvdnqy wryderrqmm dpgypklitk
      421 nfqgigpkid avfysknkyy yffqgsnqfe ydfllqritk tlksnswfgc

Matrix metallopeptidase 7, matrilysin preproprotein, NP_002414.1
        1 mrltvlcavc llpgslalpl pqeaggmsel qweqaqdylk rfylydsetk nansleaklk
       61 emqkffglpi tgmlnsrvie imqkprcgvp dvaeyslfpn spkwtskvvt yrivsytrdl
      121 phitvdrlvs kalnmwgkei plhfrkvvwg tadimigfar gahgdsypfd gpgntlahaf
      181 apgtglggda hfdederwtd gsslginfly aathelghsl gmghssdpna vmyptygngd
      241 pqnfklsqdd ikgiqklygk rsnsrkk

Myelin protein zero like 1, myelin protein zero-like protein 1 isoform a
precursor, NP_003944.1
        1 maasagagav iaapdsrrwl wsvlaaalgl ltagvsalev ytpkeifvan gtqgkltckf
```

```
       61 kststtgglt svswsfqpeg adttvsffhy sqgqvylgny ppfkdriswa gdldkkdasi
      121 nienmqfihn gtyicdvknp pdivvqpghi rlyvvekenl pvfpvwvvvg ivtavvlglt
      181 llismilavl yrrknskrdy tgcstsesls pvkqaprksp sdteglvksl psgshqgpvi
      241 yaqldhsggh hsdkinkses vvyadirkn
```

Myelin protein zero like 1, myelin protein zero-like protein 1 isoform b precursor, NP_078845.3

```
        1 maasagagav iaapdsrrwl wsvlaaalgl ltagvsalev ytpkeifvan gtqgkltckf
       61 kststtgglt svswsfqpeg adttvsffhy sqgqvylgny ppfkdriswa gdldkkdasi
      121 nienmqfihn gtyicdvknp pdivvqpghi rlyvvekenl pvfpvwvvvg ivtavvlglt
      181 llismilavl yrrknskrdy tgaqsymhs
```

Myelin protein zero like 1, myelin protein zero-like protein 1 isoform c precursor, NP_001139663.1

```
        1 maasagagav iaapdsrrwl wsvlaaalgl ltagvsalev ytpkeifvan gtqgkltckf
       61 kststtgglt svswsfqpeg adttvsgpvi yaqldhsggh hsdkinkses vvyadirkn
```

Macrophage scavenger receptor 1, macrophage scavenger receptor types I and II isoform type 1, NP_619729.1

```
        1 meqwdhfhnq qedtdscses vkfdarsmta llppnpknsp slqeklksfk aalialyllv
       61 favlipligi vaaqllkwet kncsvsstna nditqsltgk gndseeemrf qevfmehmsn
      121 mekriqhild meanlmdteh fqnfsmttdq rfndillqls tlfssvqghg naideisksl
      181 islnttlldl qlnienlngk iqentfkqqe eiskleervy nvsaeimamk eeqvhleqei
      241 kgevkvlnni tndlrlkdwe hsqtlrnitl iqgppgppge kgdrgptges gprgfpgpig
      301 ppglkgdrga igfpgsrglp gyagrpgnsg pkgqkgekgs gntltpftkv rlvggsgphe
      361 grveilhsgq wgticddrwe vrvgqvvcrs lgypgvqavh kaahfgqgtg piwlnevfcf
      421 gressieeck irqwgtracs hsedagvtct l
```

Macrophage scavenger receptor 1, macrophage scavenger receptor types I and II isoform type 2, NP_002436.1

```
        1 meqwdhfhnq qedtdscses vkfdarsmta llppnpknsp slqeklksfk aalialyllv
       61 favlipligi vaaqllkwet kncsvsstna nditqsltgk gndseeemrf qevfmehmsn
      121 mekriqhild meanlmdteh fqnfsmttdq rfndillqls tlfssvqghg naideisksl
      181 islnttlldl qlnienlngk iqentfkqqe eiskleervy nvsaeimamk eeqvhleqei
      241 kgevkvlnni tndlrlkdwe hsqtlrnitl iqgppgppge kgdrgptges gprgfpgpig
      301 ppglkgdrga igfpgsrglp gyagrpgnsg pkgqkgekgs gntlrpvqlt dhiragps
```

Macrophage scavenger receptor 1, macrophage scavenger receptor types I and II isoform type 3, NP_619730.1

```
        1 meqwdhfhnq qedtdscses vkfdarsmta llppnpknsp slqeklksfk aalialyllv
       61 favlipligi vaaqllkwet kncsvsstna nditqsltgk gndseeemrf qevfmehmsn
      121 mekriqhild meanlmdteh fqnfsmttdq rfndillqls tlfssvqghg naideisksl
      181 islnttlldl qlnienlngk iqentfkqqe eiskleervy nvsaeimamk eeqvhleqei
      241 kgevkvlnni tndlrlkdwe hsqtlrnitl iqgppgppge kgdrgptges gprgfpgpig
      301 ppglkgdrga igfpgsrglp gyagrpgnsg pkgqkgekgs gntlstgpiw lnevfcfgre
      361 ssieeckirq wgtracshse dagvtctl
```

Myoneurin, isoform A, NP_001172047.1, NP_061127.1

```
        1 mqyshhcehl lerlnkqrea gflcdctivi gefqfkahrn vlasfseyfg aiyrstsenn
       61 vfldqsqvka dgfqkllefi ytgtlnldsw nvkeihqaad ylkveevvtk ckikmedfaf
      121 ianpssteis sitgnielnq qtclltlrdy nnreksevst dliqanpkqg alakkssqtk
      181 kkkkafnspk tgqnktvqyp sdilenasve lfldanklpt pvveqvaqin dnseleltsv
      241 ventfpaqdi vhtvtvkrkr gksqpncalk ehsmsniasv kspyeaensg eeldqryska
      301 kpmcntcgkv fseasslrrh mrihkgvkpy vchlcgkaft qcnqlkthvr thtgekpykc
      361 elcdkgfaqk cqlvfhsrmh hgeekpykcd vcnlqfatss nlkiharkhs gekpyvcdrc
      421 gqrfaqastl tyhvrrhtge kpyvcdtcgk afavssslit hsrkhtgekp yicgicgksf
      481 issgelnkhf rshtgerpfi celcgnsytd iknlkkhktk vhsgadktld ssaedhtlse
```

```
      541 qdsiqkspls etmdvkpsdm tlplalplgt edhhmllpvt dtqsptsdtl lrstvngyse
      601 pqliflqqly

Myoneurin, isoform B, NP_001172048.1
        1 mqyshhcehl lerlnkqrea gflcdctivi gefqfkahrn vlasfseyfg aiyrstsenn
       61 vfldqsqvka dgfqkllefi ytgtlnldsw nvkeihqaad ylkveevvtk ckikmedfaf
      121 ianpssteis sitgnielnq qtclltlrdy nnreksevst dliqanpkqg alakkssqtk
      181 kkkkafnspk tgqnktvqyp sdilenasve lfldanklpt pvveqvaqin dnseleltsv
      241 ventfpaqdi vhtvtvkrkr gksqpncalk ehsmsniasv kspyeaensg eeldqryska
      301 kpmcntcgkv fseasslrrh mrihkgvkpy vchlcgkaft qcnqlkthvr thtgekpykc
      361 elcdkgfaqk cqlvfhsrmh hgeekpykcd vcnlqfatss nlkiharkhs gekpyvcdrc
      421 gqrfaqastl tyhvrrhtge kpyvcdtcgk afavssslit hsrkhtgekp yicgicgksf
      481 issgelnkhf rshtgadktl dssaedhtls eqdsiqkspl setmdvkpsd mtlplalplg
      541 tedhhmllpv tdtqsptsdt llrstvngys epqliflqql y

N-acetylglucosamine kinase, isoform 1, NP_060037.3
        1 mrtrtgsqla arevtgsgav prqlegrrcq agrdanggts sdgsssmaai yggvegggtr
       61 sevllvsedg kilaeadgls tnhwligtdk cverinemvn rakrkagvdp lvplrslgls
      121 lsggdqedag rilieelrdr fpylsesyli ttdaagsiat atpdggvvli sgtgsncrli
      181 npdgsesgcg gwghmmgdeg saywiahqav kivfdsidnl eaaphdigyv kqamfhyfqv
      241 pdrlgilthl yrdfdkcrfa gfcrkiaega qqgdplsryi frkagemlgr hivavlpeid
      301 pvlfqgkigl pilcvgsvwk swellkegfl laltqgreiq aqnffssftl mklrhssalg
      361 gaslgarhig hllpmdysan aiafysytfs

N-acetylglucosamine kinase, isoform 2, NP_001317354.1, NP_001317355.1
        1 mvnrakrkag vdplvplrsl glslsggdqe dagrilieel rdrfpylses ylittdaags
       61 iatatpdggv vlisgtgsnc rlinpdgses gcggwghmmg degsaywiah qavkivfdsi
      121 dnleaaphdi gyvkqamfhy fqvpdrlgil thlyrdfdkc rfagfcrkia egaqqgdpls
      181 ryifrkagem lgrhivavlp eidpvlfqgk iglpilcvgs vwkswellke gfllaltqgr
      241 eiqaqnffss ftlmklrhss alggaslgar highllpmdy sanaiafysy tfs

Napsin A aspartic peptidase, preproprotein, NP_004842.1
        1 mspppllqpl llllpllnve psgatlirip lhrvqpgrri lnllrgwrep aelpklgaps
       61 pgdkpifvpl snyrdvqyfg eiglgtppqn ftvafdtgss nlwvpsrrch ffsvpcwlhh
      121 rfdpkasssf qangtkfaiq ygtgrvdgil sedkltiggi kgasvifgea lwepslvfaf
      181 ahfdgilglg fpilsvegvr ppmdvlveqg lldkpvfsfy lnrdpeepdg gelvlggsdp
      241 ahyippltfv pvtvpaywqi hmervkvgpg ltlcakgcaa ildtgtslit gpteeiralh
      301 aaiggiplla geyiilcsei pklpavsfll ggvwfnltah dyviqttrng vrlclsgfqa
      361 ldvpppagpf wilgdvflgt yvavfdrgdm kssarvglar artrgadlgw getaqaqfpg

Nuclear transcription factor Y subunit gamma, isoform 1, NP_001136060.1
        1 msteggfggt sssdaqqslq sfwprvmeei rnltvkdfrv qelplarikk imkldedvkm
       61 isaeapvlfa kaaqifitel tlrawihted nkrrtlqrnd iamaitkfdq fdflidivpr
      121 delkppkrqe evrqsvtpae pvqyyftlaq qptavqvqgq qqgqqttsst ttiqpgqiii
      181 aqpqqgqttp vtmqvgegqq vqivqaqpqg qaqqaqsgtg qtmqvmqqii tntgeiqqip
      241 vqlnagqlqy irlaqpvsgt qvvqgqiqtl atnaqqgqrn asqgkprrcl ketlqitqte
      301 vqqgqqqfsq ftdgqqlyqi qqvtmpagqd laqpmfiqsa nqpsdgqapq vtgd

Nuclear transcription factor Y subunit gamma, isoform 2, NP_055038.2
        1 msteggfggt sssdaqqslq sfwprvmeei rnltvkdfrv qelplarikk imkldedvkm
       61 isaeapvlfa kaaqifitel tlrawihted nkrrtlqrnd iamaitkfdq fdflidivpr
      121 delkppkrqe evrqsvtpae pvqyyftlaq qptavqvqgq qqgqqttsst ttiqpgqiii
      181 aqpqqgqttp vtmqvgegqq vqivqaqpqg qaqqaqsgtg qtmqvmqqii tntgeiqqip
      241 vqlnagqlqy irlaqpvsgt qvvqgqiqtl atnaqqitqt evqqgqqqfs qftdgqqlyq
      301 iqqvtmpagq dlaqpmfiqs anqpsdgqap qvtgd

Nuclear transcription factor Y subunit gamma, isoform 3, NP_001136059.1
```

```
        1 msteggfggt sssdaqqslq sfwprvmeei rnltvkdfrv qelplarikk imkldedvkm
       61 isaeapvlfa kaaqifitel tlrawihted nkrrtlqrnd iamaitkfdq fdflidivpr
      121 delkppkrqe evrqsvtpae pvqyyftlaq qptavqvqgq qqgqqttsst ttiqpgqiii
      181 aqpqqgqttp vtmqvgegqq vqivqaqpqg qaqqaqsgtg qtmqvmqqii tntgeiqqip
      241 vqlnagqlqy irlaqpvsgt qvvqgqiqtl atnaqqitqt evqqgqqqfs qftdgqlyqi
      301 qqvtmpagqd laqpmfiqsa nqpsdgqapq vtgd

Nuclear transcription factor Y subunit gamma, isoform 4, NP_001136061.1
        1 msteggfggt sssdaqqslq sfwprvmeei rnltvkdfrv qelplarikk imkldedvkr
       61 ndiamaitkf dqfdflidiv prdelkppkr qeevrqsvtp aepvqyyftl aqqptavqvq
      121 gqqqgqqtts stttiqpgqi iiaqpqqgqt tpvtmqvgeg qqvqivqaqp qgqaqqaqsg
      181 tgqtmqvmqq iitntgeiqq ipvqlnagql qyirlaqpvs gtqvvqgqiq tlatnaqqit
      241 qtevqqgqqq fsqftdgqql yqiqqvtmpa gqdlaqpmfi qsanqpsdgq apqvtgd

Nuclear transcription factor Y subunit gamma, isoform 5, NP_001136062.1
        1 msteggfggt sssdaqqslq sfwprvmeei rnltvkdfrv qelplarikk imkldedvkm
       61 isaeapvlfa kaaqifitel tlrawihted nkrrtlqrnd iamaitkfdq fdflidivpr
      121 delkppkrqe evrqsvtpae pvqyyftlaq qptavqvqgq qqgqqttsst ttiqpgqiii
      181 aqpqqgqtmq vmqqiitntg eiqqipvqln agqlqyirla qpvsgtqvvq gqiqtlatna
      241 qqitqtevqq gqqqfsqftd gqqlyqiqqv tmpagqdlaq pmfiqsanqp sdgqapqvtg
      301 d

Nuclear transcription factor Y subunit gamma, isoform 6, NP_001295043.1
        1 msteggfggt sssdaqqslq sfwprvmeei rnltvkdfrv qelplarikk imkldedvkm
       61 isaeapvlfa kaaqifitel tlrawihted nkrrtlqrnd iamaitkfdq fdflidivpr
      121 delkppkrqe evrqsvtpae pvqyyftlaq qptavqvqgq qqgqqttsst ttiqpgqiii
      181 aqpqqgqttp vtmqvgegqq vqivqaqpqg qaqqaqsgtg qtmqvmqqii tntgeiqqip
      241 vqlnagqlqy irlaqpvsgt qvvqgqiqtl atnaqqgqrn asqgkprrcl ketlqitqte
      301 vqqgqqqfsq ftdgqrnsvq qarvseltge aeprevkatg nstpctsslp tthppshrag
      361 ascvccsqpq qsstspppsd alqwvvvevs gtpnqlethr elhaplpgmt slsplhpsqq
      421 lyqiqqvtmp agqdlaqpmf iqsanqpsdg qapqvtgd

Nuclear transcription factor Y subunit gamma, isoform 7, NP_001295044.1
        1 msteggfggt sssdaqqslq sfwprvmeei rnltvkdfrv qelplarikk imkldedvkm
       61 isaeapvlfa kaaqifitel tlrawihted nkrrtlqrnd iamaitkfdq fdflidivpr
      121 delkppkrqe evrqsvtpae pvqyyftlaq qptavqvqgq qqgqqttsst ttiqpgqiii
      181 aqpqqgqttp vtmqvgegqq vqivqaqpqg qaqqaqsgtg qtmqvmqqii tntgeiqqip
      241 vqlnagqlqy irlaqpvsgt qvvqgqiqtl atnaqqitqt evqqgqqqfs qftdgqrnsv
      301 qqarvseltg eaeprevkat gnstpctssl ptthppshra gascvccsqp qqsstsppps
      361 dalqwvvvev sgtpnqleth relhaplpgm tslsplhpsq qlyqiqqvtm pagqdlaqpm
      421 fiqsanqpsd gqapqvtgd

NFKB repressing factor, isoform 1, NP_001166958.1
        1 mgfmlplifr ysprlmekil qmaegidige mpsydlvlsk pskgqkrhls tcdgqnppkk
       61 qagskfharp rfepvhfvas sskderqedp ygpqtkevne qthfasmprd iyqdytqdsf
      121 siqdgnsqyc dssgfiltkd qpvtanmyfd sgnpapstts qqansqstpe pspsqtfpes
      181 vvaekqyfie kltatiwknl snpemtsgsd kinytymltr ciqacktnpe yiyaplkeip
      241 padipknkkl ltdgyacevr cqniylttgy agskngsrdr atelavkllq krievrvvrr
      301 kfkhtfgedl vvcqigmssy efppalkppe dlvvlgkdas gqpifnasak hwtnfviten
      361 andaigilnn sasfnkmsie ykyemmpnrt wrcrvflqdh claegygtkk tskhaaadea
      421 lkilqktqpt ypsvkssqch tgssprgsgk kkdikdlvvy enssnpvctl ndtaqfnrmt
      481 veyvyermtg lrwkckvile seviaeavgv kktvkyeaag eavktlkktq ptvinnlkkg
      541 avedvisrne iqgrsaeeay kqqikednig nqllrkmgwt ggglgksgeg irepisvkeq
      601 hkreglgldv ervnkiakrd ieqiirnyar seshtdltfs reltnderkq ihqiaqkygl
      661 kskshgvghd rylvvgrkrr kedlldqlkq egqvghyelv mpqan

NFKB repressing factor, isoform 2, NP_001166959.1, NP_060014.2
```

```
      1 mekilqmaeg idigempsyd lvlskpskgq krhlstcdgq nppkkqagsk fharprfepv
     61 hfvassskde rqedpygpqt kevneqthfa smprdiyqdy tqdsfsiqdg nsqycdssgf
    121 iltkdqpvta nmyfdsgnpa psttsqqans qstpepspsq tfpesvvaek qyfiekltat
    181 iwknlsnpem tsgsdkinyt ymltrciqac ktnpeyiyap lkeippadip knkkllltdgy
    241 acevrcqniy lttgyagskn gsrdratela vkllqkriev rvvrrkfkht fgedlvvcqi
    301 gmssyefppa lkppedlvvl gkdasgqpif nasakhwtnf vitenandai gilnnsasfn
    361 kmsieykyem mpnrtwrcrv flqdhclaeg ygtkktskha aadealkilq ktqptypsvk
    421 ssqchtgssp rgsgkkkdik dlvvyenssn pvctlndtaq fnrmtveyvy ermtglrwkc
    481 kvilesevia eavgvkktvk yeaageavkt lkktqptvin nlkkgavedv isrneiqgrs
    541 aeeaykqqik ednignqllr kmgwtggglg ksgegirepi svkeqhkreg lgldvervnk
    601 iakrdieqii rnyarsesht dltfsreltn derkqihqia qkyglksksh gvghdrylvv
    661 grkrrkedll dqlkqegqvg hyelvmpqan
```

Plasminogen activator, urokinase, urokinase-type plasminogen activator isoform 1 preproprotein, NP_002649.1

```
      1 mrallarlll cvlvvsdskg snelhqvpsn cdclnggtcv snkyfsnihw cncpkkfggq
     61 hceidksktc yegnghfyrg kastdtmgrp clpwnsatvl qqtyhahrsd alqlglgkhn
    121 ycrnpdnrrr pwcyvqvglk plvqecmvhd cadgkkpssp peelkfqcgq ktlrprfkii
    181 ggefttienq pwfaaiyrrh rggsvtyvcg gslispcwvi sathcfidyp kkedyivylg
    241 rsrlnsntqg emkfevenli lhkdysadtl ahhndiallk irskegrcaq psrtiqticl
    301 psmyndpqfg tsceitgfgk enstdylype qlkmtvvkli shrecqqphy ygsevttkml
    361 caadpqwktd scqgdsggpl vcslqgrmtl tgivswgrgc alkdkpgvyt rvshflpwir
    421 shtkeengla l
```

Plasminogen activator, urokinase, urokinase-type plasminogen activator isoform 2, NP_001138503.1

```
      1 mvfhlrtrye qancdclngg tcvsnkyfsn ihwcncpkkf ggqhceidks ktcyegnghf
     61 yrgkastdtm grpclpwnsa tvlqqtyhah rsdalqlglg khnycrnpdn rrrpwcyvqv
    121 glkplvqecm vhdcadgkkp ssppeelkfq cgqktlrprf kiiggeftti enqpwfaaiy
    181 rrhrggsvty vcggslispc wvisathcfi dypkkedyiv ylgrsrlnsn tqgemkfeve
    241 nlilhkdysa dtlahhndia llkirskegr caqpsrtiqt iclpsmyndp qfgtsceitg
    301 fgkenstdyl ypeqlkmtvv klishrecqq phyygsevtt kmlcaadpqw ktdscqgdsg
    361 gplvcslqgr mtltgivswg rgcalkdkpg vytrvshflp wirshtkeen glal
```

Plasminogen activator, urokinase, urokinase-type plasminogen activator isoform 3, NP_001306120.1

```
      1 mgrpclpwns atvlqqtyha hrsdalqlgl gkhnycrnpd nrrrpwcyvq vglkplvqec
     61 mvhdcadgkk pssppeelkf qcgqktlrpr fkiiggeftt ienqpwfaai yrrhrggsvt
    121 yvcggslisp cwvisathcf idypkkedyi vylgrsrlns ntqgemkfev enlilhkdys
    181 adtlahhndi allkirskeg rcaqpsrtiq ticlpsmynd pqfgtsceit gfgkenstdy
    241 lypeqlkmtv vklishrecq qphyygsevt tkmlcaadpq wktdscqgds ggplvcslqg
    301 rmtltgivsw grgcalkdkp gvytrvshfl pwirshtkee nglal
```

Receptor tyrosine kinase like orphan receptor 1, inactive tyrosine-protein kinase transmembrane receptor ROR1 isoform 1 precursor, NP_005003.2

```
      1 mhrprrrgtr ppllallaal llaargaaaq etelsvsael vptsswniss elnkdsyltl
     61 depmnnitts lgqtaelhck vsgnppptir wfkndapvvq eprrlsfrst iygsrlrirn
    121 ldttdtgyfq cvatngkevv sstgvlfvkf gppptaspgy sdeyeedgfc qpyrgiacar
    181 fignrtvyme slhmqgeien qitaaftmig tsshlsdkcs qfaipslchy afpycdetss
    241 vpkprdlcrd eceilenvlc qteyifarsn pmilmrlklp ncedlpqpes peaancirig
    301 ipmadpinkn hkcynstgvd yrgtvsvtks grqcqpwnsq yphthtftal rfpelngghs
    361 ycrnpgnqke apwcftlden fksdlcdipa cdskdskekn kmeilyilvp svaiplaial
    421 lfficvcrn nqksssapvq rqpkhvrgqn vemsmlnayk pkskakelpl savrfmeelg
    481 ecafgkiykg hlylpgmdha qlvaiktlkd ynnpqqwtef qqeaslmael hhpnivcllg
    541 avtqeqpvcm lfeyinqgdl heflimrsph sdvgcssded gtvkssldhg dflhiaiqia
    601 agmeylsshf fvhkdlaarn iligeqlhvk isdlglsrei ysadyyrvqs ksllpirwmp
    661 peaimygkfs sdsdiwsfgv vlweifsfgl qpyygfsnqe viemvrkrql lpcsedcppr
```

```
721 myslmtecwn eipsrrprfk dihvrlrswe glsshtsstt psggnattqt tslsaspvsn
781 lsnprypnym fpsqgitpqg qiagfigppi pqnqrfipin gypippgyaa fpaahyqptg
841 pprviqhcpp pksrspssas gststghvts lpssgsnqea nipllphmsi pnhpggmgit
901 vfgnksqkpy kidskqasll gdanihghte smisael
```

Receptor tyrosine kinase like orphan receptor 1, inactive tyrosine-protein kinase transmembrane receptor ROR1 isoform 2 precursor, NP_001077061.1

```
  1 mhrprrrgtr ppllallaal llaargaaaq etelsvsael vptsswniss elnkdsyltl
 61 depmnnitts lgqtaelhck vsgnppptir wfkndapvvq eprrlsfrst iygsrlrirn
121 ldttdtgyfq cvatngkevv sstgvlfvkf gppptaspgy sdeyeedgfc qpyrgiacar
181 fignrtvyme slhmqgeien qitaaftmig tsshlsdkcs qfaipslchy afpycdetss
241 vpkprdlcrd eceilenvlc qteyifarsn pmilmrlklp ncedlpqpes peaancirig
301 ipmadpinkn hkcynstgvd yrgtvsvtks grqcqpwnsq yphthtftal rfpelngghs
361 ycrnpgnqke apwcftlden fksdlcdipa cgk
```

Runt related transcription factor 1, runt-related transcription factor 1 isoform AML1a, NP_001116079.1

```
  1 mripvdasts rrftppstal spgkmsealp lgapdagaal agklrsgdrs mvevladhpg
 61 elvrtdspnf lcsvlpthwr cnktlpiafk vvalgdvpdg tlvtvmagnd enysaelrna
121 taamknqvar fndlrfvgrs grgksftlti tvftnppqva tyhraikitv dgpreprrhr
181 qklddqtkpg slsfserlse leqlrrtamr vsphhpaptp npraslnhst afnpqpqsqm
241 qeedtapwrc
```

Runt related transcription factor 1, runt-related transcription factor 1 isoform AML1b, NP_001001890.1

```
  1 mripvdasts rrftppstal spgkmsealp lgapdagaal agklrsgdrs mvevladhpg
 61 elvrtdspnf lcsvlpthwr cnktlpiafk vvalgdvpdg tlvtvmagnd enysaelrna
121 taamknqvar fndlrfvgrs grgksftlti tvftnppqva tyhraikitv dgpreprrhr
181 qklddqtkpg slsfserlse leqlrrtamr vsphhpaptp npraslnhst afnpqpqsqm
241 qdtrqiqpsp pwsydqsyqy lgsiaspsvh patpispgra sgmttlsael ssrlstapdl
301 tafsdprqfp alpsisdprm hypgaftysp tpvtsgigig msamgsatry htylpppypg
361 ssqaqggpfq asspsyhlyy gasagsyqfs mvggersppr ilppctnast gsallnpslp
421 nqsdvveaeg shsnsptnma psarleeavw rpy
```

Runt related transcription factor 1, runt-related transcription factor 1 isoform AML1c, NP_001745.2

```
  1 masdsifesf psypqcfmre cilgmnpsrd vhdastsrrf tppstalspg kmsealplga
 61 pdagaalagk lrsgdrsmve vladhpgelv rtdspnflcs vlpthwrcnk tlpiafkvva
121 lgdvpdgtlv tvmagndeny saelrnataa mknqvarfnd lrfvgrsgrg ksftltitvf
181 tnppqvatyh raikitvdgp reprrhrqkl ddqtkpgsls fserlseleq lrrtamrvsp
241 hhpaptpnpr aslnhstafn pqpqsqmqdt rqiqpsppws ydqsyqylgs iaspsvhpat
301 pispgrasgm ttlsaelssr lstapdltaf sdprqfpalp sisdprmhyp gaftysptpv
361 tsgigigmsa mgsatryhty lpppypgssq aqggpfqass psyhlyygas agsyqfsmvg
421 gerspprilp pctnastgsa llnpslpnqs dvveaegshs nsptnmapsa rleeavwrpy
```

Surfactant protein A1, pulmonary surfactant-associated protein A1 isoform 1 precursor, NP_001158116.1, NP_001158119.1, NP_005402.3

```
  1 mwlcplalnl ilmaasgavc evkdvcvgsp gipgtpgshg lpgrdgrdgl kgdpgppgpm
 61 gppgempcpp gndglpgapg ipgecgekge pgergppglp ahldeelqat lhdfrhqilq
121 trgalslqgs imtvgekvfs sngqsitfda iqeacaragg riavprnpee neaiasfvkk
181 yntyayvglt egpspgdfry sdgtpvnytn wyrgepagrg keqcvemytd gqwndrncly
241 srlticef
```

Surfactant protein A1, pulmonary surfactant-associated protein A1 isoform 2 precursor, NP_001087239.2

```
  1 mrpcqvpgaa tgpramwlcp lalnlilmaa sgavcevkdv cvgspgipgt pgshglpgrd
 61 grdglkgdpg ppgpmgppge mpcppgndgl pgapgipgec gekgepgerg ppglpahlde
```

```
      121 elqatlhdfr hqilqtrgal slqgsimtvg ekvfssngqs itfdaiqeac araggriavp
      181 rnpeeneaia sfvkkyntya yvgltegpsp gdfrysdgtp vnytnwyrge pagrgkeqcv
      241 emytdgqwnd rnclysrlti cef


Surfactant protein A1, pulmonary surfactant-associated protein A1 isoform 3
precursor, NP_001158117.1
        1 mrpcqvpgaa tgpramwlcp lalnlilmaa sgavcevkdv cvgtpgipge cgekgepger
       61 gppglpahld eelqatlhdf rhqilqtrga lslqgsimtv gekvfssngq sitfdaiqea
      121 caraggriav prnpeeneai asfvkkynty ayvgltegps pgdfrysdgt pvnytnwyrg
      181 epagrgkeqc vemytdgqwn drnclysrlt icef

Surfactant protein A1, pulmonary surfactant-associated protein A1 isoform 4
precursor, NP_001158118.1
        1 mwlcplalnl ilmaasgavc evkdvcvgtp gipgecgekg epgergppgl pahldeelqa
       61 tlhdfrhqil qtrgalslqg simtvgekvf ssngqsitfd aiqeacarag griavprnpe
      121 eneaiasfvk kyntyayvgl tegpspgdfr ysdgtpvnyt nwyrgepagr gkeqcvemyt
      181 dgqwndrncl ysrlticef

Surfactant protein A2, pulmonary surfactant-associated protein A2 isoform 1
precursor, NP_001092138.1, NP_001307742.1
        1 mwlcplaltl ilmaasgaac evkdvcvgsp gipgtpgshg lpgrdgrdgv kgdpgppgpm
       61 gppgetpcpp gnnglpgapg vpgergekge agergppglp ahldeelqat lhdfrhqilq
      121 trgalslqgs imtvgekvfs sngqsitfda iqeacaragg riavprnpee neaiasfvkk
      181 yntyayvglt egpspgdfry sdgtpvnytn wyrgepagrg keqcvemytd gqwndrncly
      241 srlticef

Surfactant protein A2, pulmonary surfactant-associated protein A2 isoform 2
precursor, NP_001307743.1
        1 mpgaatgpra mwlcplaltl ilmaasgaac evkdvcvgsp gipgtpgshg lpgrdgrdgv
       61 kgdpgppgpm gppgetpcpp gnnglpgapg vpgergekge agergppglp ahldeelqat
      121 lhdfrhqilq trgalslqgs imtvgekvfs sngqsitfda iqeacaragg riavprnpee
      181 neaiasfvkk yntyayvglt egpspgdfry sdgtpvnytn wyrgepagrg keqcvemytd
      241 gqwndrncly srlticef

Surfactant protein B, pulmonary surfactant-associated protein B precursor,
NP_000533.3, NP_942140.2
        1 mhqagypgcr gamaeshllq wllllptlc gpgtaawtts slacaqgpef wcqsleqalq
       61 cralghclqe vwghvgaddl cqecedivhi lnkmakeaif qdtmrkfleq ecnvlplkll
      121 mpqcnqvldd yfplvidyfq nqtdsngicm hlglcksrqp epeqepgmsd plpkplrdpl
      181 pdplldklvl pvlpgalqar pgphtqdlse qqfpiplpyc wlcralikri qamipkgala
      241 vavaqvcrvv plvaggicqc laerysvill dtllgrmlpq lvcrlvlrcs mddsagprsp
      301 tgewlprdse chlcmsvttq agnsseqaip qamlqacvgs wldrekckqf veqhtpqllt
      361 lvprgwdaht tcqalgvcgt mssplqcihs pdl

Surfactant protein C, pulmonary surfactant-associated protein C isoform 1
precursor, NP_001165881.1, NP_003009.2
        1 mdvgskevlm esppdysaap rgrfgipccp vhlkrllivv vvvvlivvvi vgallmglhm
       61 sqkhtemvle msigapeaqq rlalsehlvt tatfsigstg lvvydyqqll iaykpapgtc
      121 cyimkiapes ipslealtrk vhnfqmecsl qakpavptsk lgqaegrdag sapsggdpaf
      181 lgmavstlcg evplyyi

Surfactant protein C, pulmonary surfactant-associated protein C isoform 2
precursor, NP_001165828.1, NP_001304707.1, NP_001304709.1
        1 mdvgskevlm esppdysaap rgrfgipccp vhlkrllivv vvvvlivvvi vgallmglhm
       61 sqkhtemvle msigapeaqq rlalsehlvt tatfsigstg lvvydyqqll iaykpapgtc
      121 cyimkiapes ipslealtrk vhnfqakpav ptsklgqaeg rdagsapsgg dpaflgmavs
```

```
      181 tlcgevplyy i

Surfactant protein C, pulmonary surfactant-associated protein C isoform 3
precursor, NP_001304708.1
        1 mdvgskevlm esppvlemsi gapeaqqrla lsehlvttat fsigstglvv ydyqqlliay
       61 kpapgtccyi mkiapesips lealtrkvhn fqmecslqak pavptsklgq aegrdagsap
      121 sggdpaflgm avstlcgevp lyyi

Surfactant protein D, pulmonary surfactant-associated protein D precursor,
NP_003010.4
        1 mllfllsalv lltqplgyle aemktyshrt mpsactlvmc ssvesglpgr dgrdgregpr
       61 gekgdpglpg aagqagmpgq agpvgpkgdn gsvgepgpkg dtgpsgppgp pgvpgpagre
      121 gplgkqgnig pqgkpgpkge agpkgevgap gmqgsagarg lagpkgergv pgergvpgnt
      181 gaagsagamg pqgspgargp pglkgdkgip gdkgakgesg lpdvaslrqq vealqgqvqh
      241 lqaafsqykk velfpngqsv gekifktagf vkpfteaqll ctqaggqlas prsaaenaal
      301 qqlvvaknea aflsmtdskt egkftyptge slvysnwapg epnddggsed cveiftngkw
      361 ndracgekrl vvcef

Solute carrier family 2 member 5, solute carrier family 2, facilitated
glucose transporter member 5 isoform 1, NP_001315548.1, NP_003030.1
        1 meqqdqsmke grltlvlala tliaafgssf qygynvaavn spallmqqfy netyygrtge
       61 fmedfpltll wsvtvsmfpf ggfigsllvg plvnkfgrkg allfnnifsi vpailmgcsr
      121 vatsfeliii srllvgicag vssnvvpmyl gelapknlrg algvvpqlfi tvgilvaqif
      181 glrnllanvd gwpillgltg vpaalqllll pffpespryl liqkkdeaaa kkalqtlrgw
      241 dsvdrevaei rqedeaekaa gfisvlklfr mrslrwqlls iivlmggqql sgvnaiyyya
      301 dqiylsagvp eehvqyvtag tgavnvvmtf cavfvvellg rrlllllgfs icliaccvlt
      361 aalalqdtvs wmpyisivcv isyvighalg pspipallit eiflqssrps afmvggsvhw
      421 lsnftvglif pfiqeglgpy sfivfavicl lttiyifliv petkaktfie inqiftkmnk
      481 vsevypekee lkelppvtse q

Solute carrier family 2 member 5, solute carrier family 2, facilitated
glucose transporter member 5 isoform 2, NP_001129057.1
        1 meqqdqsmke grltlvlala tliaafgssf qygynvaavn spallmqqfy netyygrtge
       61 fmedfpltll wsvtvsmfpf ggfigsllvg plvnkfgrkg allfnnifsi vpailmgcsr
      121 vatsfeliii srllvgicag vssnvvpmyl gelapknlrg algvvpqlfi tvgilvaqif
      181 glrnllanvd gefrtsrehp hpftttlgpl lvfqshhhrt glsadwsllt gwmslggpsc
      241 pept

Solute carrier family 2 member 5, solute carrier family 2, facilitated
glucose transporter member 5 isoform 3, NP_001315549.1
        1 mgttwllstp qhwtgefmed fpltllwsvt vsmfpfggfi gsllvgplvn kfgrkgallf
       61 nnifsivpai lmgcsrvats feliiisrll vgicagvssn vvpmylgela pknlrgalgv
      121 vpqlfitvgi lvaqifglrn llanvdgwpi llgltgvpaa lqllllpffp esprylliqk
      181 kdeaaakkal qtlrgwdsvd revaeirqed eaekaagfis vlklfrmrsl rwqllsiivl
      241 mggqqlsgvn aiyyyadqiy lsagvpeehv qyvtagtgav nvvmtfcavf vvellgrrll
      301 lllgfsicli accvltaala lqdtvswmpy isivcvisyv ighalgpspi palliteifl
      361 qssrpsafmv ggsvhwlsnf tvglifpfiq eglgpysfiv faviclltti yiflivpetk
      421 aktfieinqi ftkmnkvsev ypekeelkel ppvtseq

Solute carrier family 2 member 5, solute carrier family 2, facilitated
glucose transporter member 5 isoform 4, NP_001315550.1
        1 mylgelapkn lrgalgvvpq lfitvgilva qifglrnlla nvdgwpillg ltgvpaalql
       61 lllpffpesp rylliqkkde aaakkalqtl rgwdsvdrev aeirqedeae kaagfisvlk
      121 lfrmrslrwq llsiivlmgg qqlsgvnaiy yyadqiylsa gvpeehvqyv tagtgavnvv
      181 mtfcavfvve llgrrlllll gfsicliacc vltaalalqd tvswmpyisi vcvisyvigh
      241 algpspipal liteiflqss rpsafmvggs vhwlsnftvg lifpfiqegl gpysfivfav
      301 iclltiyif livpetkakt fieinqiftk mnkvsevype keelkelppv tseq
```

Sperm associated antigen 9, C-Jun-amino-terminal kinase-interacting protein 4 isoform 1, NP_001124000.1

```
   1 meledgvvyq eepggsgavm servsglags iyreferlig rydeevvkel mplvvavlen
  61 ldsvfaqdqe hqvelellrd dneqlitqye rekalrkhae ekfiefedsq eqekkdlqtr
 121 veslesqtrq lelkaknyad qisrleerea elkkeynalh qrhtemihny mehlertklh
 181 qlsgsdqles tahsrirker pislgifplp agdglltpda qkggetpgse qwkfqelsqp
 241 rshtslkvsn spepqkaveq edelsdvsqg gskattpast ansdvatipt dtplkeeneg
 301 fvkvtdapnk seiskhievq vaqetrnvst gsaeneekse vqaiiestpe ldmdkdlsgy
 361 kgsstptkgi enkafdrnte slfeelssag sgligdvdeg adllgmgrev enlilentql
 421 letknalniv kndliakvde ltcekdvlqg eleavkqakl kleeknrele eelrkaraea
 481 edarqkakdd ddsdiptaqr krftrvemar vlmernqyke rlmelqeavr wtemirasre
 541 npamqekkrs siwqffsrlf ssssnttkkp eppvnlkyna ptshvtpsvk krsstlsqlp
 601 gdkskafdfl seeteaslas rreqkreqyr qvkahvqked grvqafgwsl pqkykqvtng
 661 qgenkmknlp vpvylrplde kdtsmklwca vgvnlsggkt rdggsvvgas vfykdvagld
 721 tegskqrsas qssldkldqe lkeqqkelkn qeelsslvwi ctsthsatkv liidavqpgn
 781 ildsftvcns hvlciasvpg aretdypage dlsesgqvdk aslcgsmtsn ssaetdsllg
 841 gitvvgcsae gvtgaatsps tngaspvmdk ppemeaense vdenvptaee ateategnag
 901 saedtvdisq tgvytehvft dplgvqiped lspvyqssnd sdaykdqisv lpneqdlvre
 961 eaqkmssllp tmwlgaqngc lyvhssvaqw rkclhsiklk dsilsivhvk givlvaladg
1021 tlaifhrgvd gqwdlsnyhl ldlgrphhsi rcmtvvhdkv wcgyrnkiyv vqpkamkiek
1081 sfdahprkes qvrqlawvgd gvwvsirlds tlrlyhahty qhlqdvdiep yvskmlgtgk
1141 lgfsfvrita lmvscnrlwv gtgngviisi pltetnktsg vpgnrpgsvi rvygdensdk
1201 vtpgtfipyc smahaqlcfh ghrdavkffv avpgqvispq ssssgtdltg dkagpsaqep
1261 gsqtplksml visggegyid frmgdegges ellgedlple psvtkaersh livwqvmygn
1321 e
```

Sperm associated antigen 9, C-Jun-amino-terminal kinase-interacting protein 4 isoform 2, NP_001123999.1

```
   1 meledgvvyq eepggsgavm servsglags iyreferlig rydeevvkel mplvvavlen
  61 ldsvfaqdqe hqvelellrd dneqlitqye rekalrkhae ekfiefedsq eqekkdlqtr
 121 veslesqtrq lelkaknyad qisrleerea elkkeynalh qrhtemihny mehlertklh
 181 qlsgsdqles tahsrirker pislgifplp agdglltpda qkggetpgse qwkfqelsqp
 241 rshtslkdel sdvsqggska ttpastansd vatiptdtpl keenegfvkv tdapnkseis
 301 khievqvaqe trnvstgsae neeksevqai iestpeldmd kdlsgykgss tptkgienka
 361 fdrnteslfe elssagsgli gdvdegadll gmgrevenli lentqlletk nalnivkndl
 421 iakvdeltce kdvlqgelea vkqaklklee knreleeelr karaeaedar qkakdddsd
 481 iptaqrkrft rvemarvlme rnqykerlme lqeavrwtem irasrenpam qekkrssiwq
 541 fvptrfsrlf ssssnttkkp eppvnlkyna ptshvtpsvk krsstlsqlp gdkskafdfl
 601 seeteaslas rreqkreqyr qvkahvqked grvqafgwsl pqkykqvtng qgenkmknlp
 661 vpvylrplde kdtsmklwca vgvnlsggkt rdggsvvgas vfykdvagld tegskqrsas
 721 qssldkldqe lkeqqkelkn qeelsslvwi ctsthsatkv liidavqpgn ildsftvcns
 781 hvlciasvpg aretdypage dlsesgqvdk aslcgsmtsn ssaetdsllg gitvvgcsae
 841 gvtgaatsps tngaspvmdk ppemeaense vdenvptaee ateategnag saedtvdisq
 901 tgvytehvft dplgvqiped lspvyqssnd sdaykdqisv lpneqdlvre eaqkmssllp
 961 tmwlgaqngc lyvhssvaqw rkclhsiklk dsilsivhvk givlvaladg tlaifhrgvd
1021 gqwdlsnyhl ldlgrphhsi rcmtvvhdkv wcgyrnkiyv vqpkamkiek sfdahprkes
1081 qvrqlawvgd gvwvsirlds tlrlyhahty qhlqdvdiep yvskmlgtgk lgfsfvrita
1141 lmvscnrlwv gtgngviisi pltetnktsg vpgnrpgsvi rvygdensdk vtpgtfipyc
1201 smahaqlcfh ghrdavkffv avpgqvispq ssssgtdltg dkagpsaqep gsqtplksml
1261 visggegyid frmgdegges ellgedlple psvtkaersh livwqvmygn e
```

Sperm associated antigen 9, C-Jun-amino-terminal kinase-interacting protein 4 isoform 3, NP_003962.3

```
   1 meledgvvyq eepggsgavm servsglags iyreferlig rydeevvkel mplvvavlen
  61 ldsvfaqdqe hqvelellrd dneqlitqye rekalrkhae ekfiefedsq eqekkdlqtr
 121 veslesqtrq lelkaknyad qisrleerea elkkeynalh qrhtemihny mehlertklh
```

```
 181 qlsgsdqles tahsrirker pislgifplp agdglltpda qkggetpgse qwkfqelsqp
 241 rshtslkdel sdvsqggska ttpastansd vatiptdtpl keenegfvkv tdapnkseis
 301 khievqvaqe trnvstgsae neeksevqai iestpeldmd kdlsgykgss tptkgienka
 361 fdrnteslfe elssagsgli gdvdegadll gmgrevenli lentqlletk nalnivkndl
 421 iakvdeltce kdvlqgelea vkqaklklee knreleeelr karaeaedar qkakdddsd
 481 iptaqrkrft rvemarvlme rnqykerlme lqeavrwtem irasrenpam qekkrssiwq
 541 ffsrlfssss nttkkpeppv nlkynaptsh vtpsvkkrss tlsqlpgdks kafdflseet
 601 easlasrreq kreqyrqvka hvqkedgrvq afgwslpqky kqvtngqgen kmknlpvpvy
 661 lrpldekdts mklwcavgvn lsggktrdgg svvgasvfyk dvagldtegs kqrsasqssl
 721 dkldqelkeq qkelknqeel sslvwictst hsatkvliid avqpgnilds ftvcnshvlc
 781 iasvpgaret dypagedlse sgqvdkaslc gsmtsnssae tdsllggitv vgcsaegvtg
 841 aatspstnga spvmdkppem eaensevden vptaeeatea tegnagsaed tvdisqtgvy
 901 tehvftdplg vqipedlspv yqssndsday kdqisvlpne qdlvreeaqk mssllptmwl
 961 gaqngclyvh ssvaqwrkcl hsiklkdsil sivhvkgivl valadgtlai fhrgvdgqwd
1021 lsnyhlldlg rphhsircmt vvhdkvwcgy rnkiyvvqpk amkieksfda hprkesqvrq
1081 lawvgdgvwv sirldstlrl yhahtyqhlq dvdiepyvsk mlgtgklgfs fvritalmvs
1141 cnrlwvgtgn gviisiplte tnktsgvpgn rpgsvirvyg densdkvtpg tfipycsmah
1201 aqlcfhghrd avkffvavpg qvispqssss gtdltgdkag psaqepgsqt plksmlvisg
1261 gegyidfrmg deggesellg edlplepsvt kaershlivw qvmygne
```

Sperm associated antigen 9, C-Jun-amino-terminal kinase-interacting protein 4 isoform 4, NP_001238900.1

```
   1 mspgcmllfv fgfvggavvi nsailvslsv lllvhfsist gvpaltqnlp rilrkerpis
  61 lgifplpagd glltpdaqkg getpgseqwk fqelsqprsh tslkdelsdv sqggskattp
 121 astansdvat iptdtplkee negfvkvtda pnkseiskhi evqvaqetrn vstgsaenee
 181 ksevqaiies tpeldmdkdl sgykgsstpt kgienkafdr nteslfeels sagsgligdv
 241 degadllgmg revenlilen tqlletknal nivkndliak vdeltcekdv lqgeleavkq
 301 aklkleeknr eleeelrkar aeaedarqka kddddsdipt aqrkrftrve marvlmernq
 361 ykerlmelqe avrwtemira srenpamqek krssiwqffs rlfssssntt kkpeppvnlk
 421 ynaptshvtp svkkrsstls qlpgdkskaf dflseeteas lasrreqkre qyrqvkahvq
 481 kedgrvqafg wslpqkykqv tngqgenkmk nlpvpvylrp ldekdtsmkl wcavgvnlsg
 541 gktrdggsvv gasvfykdva gldtegskqr sasqssldkl dqelkeqqke lknqeelssl
 601 vwictsthsa tkvliidavq pgnildsftv cnshvlcias vpgaretdyp agedlsesgq
 661 vdkaslcgsm tsnssaetds llggitvvgc saegvtgaat spstngaspv mdkppemeae
 721 nsevdenvpt aeeateateg nagsaedtvd isqtgvyteh vftdplgvqi pedlspvyqs
 781 sndsdaykdq isvlpneqdl vreeaqkmss llptmwlgaq ngclyvhssv aqwrkclhsi
 841 klkdsilsiv hvkgivlval adgtlaifhr gvdgqwdlsn yhlldlgrph hsircmtvvh
 901 dkvwcgyrnk iyvvqpkamk ieksfdahpr kesqvrqlaw vgdgvwvsir ldstlrlyha
 961 htyqhlqdvd iepyvskmlg tgklgfsfvr italmvscnr lwvgtgngvi isipltetvi
1021 lhqgrllglr anktsgvpgn rpgsvirvyg densdkvtpg tfipycsmah aqlcfhghrd
1081 avkffvavpg qvispqssss gtdltgdkag psaqepgsqt plksmlvisg gegyidfrmg
1141 deggesellg edlplepsvt kaershlivw qvmygne
```

SGT1 homolog, MIS12 kinetochore complex assembly cochaperone, protein SGT1 homolog isoform A, NP_006695.1

```
   1 maaaaagtat sqrffqsfsd alidedpqaa leeltkaleq kpddaqyycq raychillgn
  61 ycvavadakk slelnpnnst amlrkgicey heknyaaale tftegqklds adanfsvwik
 121 rcqeaqngse sevwthqski kydwyqtesq vvitlmiknv qkndvnvefs ekelsalvkl
 181 psgedynlkl ellhpiipeq stfkvlstki eiklkkpeav rweklegqgd vptpkqfvad
 241 vknlypsssp ytrnwdklvg eikeeeknek legdaalnrl fqqiysdgsd evkramnksf
 301 mesggtvlst nwsdvgkrkv einppddmew kky
```

SGT1 homolog, MIS12 kinetochore complex assembly cochaperone, protein SGT1 homolog isoform B, NP_001124384.1

```
   1 maaaaagtat sqrffqsfsd alidedpqaa leeltkaleq kpddaqyycq raychillgn
  61 ycvavadakk slelnpnnst amlrkgicey heknyaaale tftegqkldi etgfhrvgqa
 121 glqlltssdp paldsqsagi tgadanfsvw ikrcqeaqng sesevwthqs kikydwyqte
```

```
      181 sqvvitlmik nvqkndvnve fsekelsalv klpsgedynl klellhpiip eqstfkvlst
      241 kieiklkkpe avrweklegq gdvptpkqfv advknlypss spytrnwdkl vgeikeeekn
      301 eklegdaaln rlfqqiysdg sdevkramnk sfmesggtvl stnwsdvgkr kveinppddm
      361 ewkky

SGT1 homolog, MIS12 kinetochore complex assembly cochaperone, protein SGT1
homolog isoform C, NP_001307760.1
        1 mlsqkevava dakkslelnp nnstamlrkg iceyheknya aaletftegq kldsadanfs
       61 vwikrcqeaq ngsesevwth qskikydwyq tesqvvitlm iknvqkndvn vefsekelsa
      121 lvklpsgedy nlklellhpi ipeqstfkvl stkieiklkk peavrwekle gqgdvptpkq
      181 fvadvknlyp ssspytrnwd klvgeikeee kneklegdaa lnrlfqqiys dgsdevkram
      241 nksfmesggt vlstnwsdvg krkveinppd dmewkky

Sulfotransferase family 1C member 2, sulfotransferase 1C2 isoform a,
NP_001047.1
        1 maltsdlgkq iklkevegtl lqpatvdnws qiqsfeakpd dllictypka gttwiqeivd
       61 mieqngdvek cqraiiqhrh pfiewarppq psgvekakam psprilkthl stqllppsfw
      121 ennckflyva rnakdcmvsy yhfqrmnhml pdpgtweeyf etfingkvvw gswfdhvkgw
      181 wemkdrhqil flfyedikrd pkheirkvmq fmgkkvdetv ldkivqetsf ekmkenpmtn
      241 rstvsksild qsissfmrkg tvgdwknhft vaqnerfdei yrrkmegtsi nfcmel

Sulfotransferase family 1C member 2, sulfotransferase 1C2 isoform b,
NP_789795.1
        1 maltsdlgkq iklkevegtl lqpatvdnws qiqsfeakpd dllictypka gttwiqeivd
       61 mieqngdvek cqraiiqhrh pfiewarppq psetgfhhva qaglkllsss nppastsqsa
      121 kitdllppsf wennckflyv arnakdcmvs yyhfqrmnhm lpdpgtweey fetfingkvv
      181 wgswfdhvkg wwemkdrhqi lflfyedikr dpkheirkvm qfmgkkvdet vldkivqets
      241 fekmkenpmt nrstvsksil dqsissfmrk gtvgdwknhf tvaqnerfde iyrrkmegts
      301 infcmel

Transmembrane protein 52B, isoform 1, NP_694567.1
        1 mswrpqpcci sscclttdwv hlwyiwllvv igallllcgl tslcfrcccl srqqngedgg
       61 pppcevtvia fdhdstlqst itslqsvfgp aarrilavah shsslgqlps sldtlpgyee
      121 alhmsrftva mcgqkapdlp pvpeekqlpp tekestrivd swn

Transmembrane protein 52B, isoform 2 precursor, NP_001073283.1
        1 mgvrvhvvaa sallyfills gtrceencgn pehclttdwv hlwyiwllvv igallllcgl
       61 tslcfrcccl srqqngedgg pppcevtvia fdhdstlqst itslqsvfgp aarrilavah
      121 shsslgqlps sldtlpgyee alhmsrftva mcgqkapdlp pvpeekqlpp tekestrivd
      181 swn

Exportin 7, NP_055839.3
        1 madhvqslaq lenlckqlye ttdtttrlqa ekalveftns pdclskcqll lergsssysq
       61 llaatcltkl vsrtnnplpl eqridirnyv lnylatrpkl atfvtqaliq lyaritklgw
      121 fdcqkddyvf rnaitdvtrf lqdsveycii gvtilsqltn einqadtthp ltkhrkiass
      181 frdsslfdif tlscnllkqa sgknlnlnde sqhgllmqll klthnclnfd figtstdess
      241 ddlctvqipt swrsafldss tlqlffdlyh sippsfsplv lsclvqiasv rrslfnnaer
      301 akflshlvdg vkrilenpqs lsdpnnyhef crllarlksn yqlgelvkve nypevirlia
      361 nftvtslqhw efapnsvhyl lslwqrlaas vpyvkateph mletytpevt kayitsrles
      421 vhiilrdgle dpledtglvq qqldqlstig rceyektcal lvqlfdqsaq syqellqsas
      481 aspmdiavqe grltwlvyii gaviggrvsf astdeqdamd gelvcrvlql mnltdsrlaq
      541 agneklelam lsffeqfrki yigdqvqkss klyrrlsevl glndetmvls vfigkiitnl
      601 kywgrcepit sktlqllndl sigyssvrkl vklsavqfml nnhtsehfsf lginnqsnlt
      661 dmrcrttfyt algrllmvdl gededqyeqf mlpltaafea vaqmfstnsf neqeakrtlv
      721 glvrdlrgia fafnaktsfm mlfewiypsy mpilqraiel wyhdpacttp vlklmaelvh
      781 nrsqrlqfdv sspngillfr etskmitmyg nriltlgevp kdqvyalklk gisicfsmlk
      841 aalsgsyvnf gvfrlygdda ldnalqtfik lllsiphsdl ldypklsqsy ysllevltqd
```

```
 901 hmnfiaslep hvimyilssi segltaldtm vctgccscld hivtylfkql srstkkrttp
 961 lnqesdrflh imqqhpemiq qmlstvlnii ifedcrnqws msrpllglil lnekyfsdlr
1021 nsivnsqppe kqqamhlcfe nlmegiernl ltknrdrftq nlsafrrevn dsmknstygv
1081 nsndmms
```

YES proto-oncogene 1, Src family tyrosine kinase, tyrosine-protein kinase Yes, NP_005424.1

```
   1 mgcikskenk spaikyrpen tpepvstsvs hygaepttvs pcpsssakgt avnfsslsmt
  61 pfggssgvtp fggasssfsv vpssypaglt ggvtifvaly dyearttedl sfkkgerfqi
 121 inntegdwwe arsiatgkng yipsnyvapa dsiqaeewyf gkmgrkdaer lllnpgnqrg
 181 iflvresett kgayslsird wdeirgdnvk hykirkldng gyyittraqf dtlqklvkhy
 241 tehadglchk lttvcptvkp qtqglakdaw eipreslrle vklgqgcfge vwmgtwngtt
 301 kvaiktlkpg tmmpeaflqe aqimkklrhd klvplyavvs eepiyivtef mskgslldfl
 361 kegdgkylkl pqlvdmaaqi adgmayierm nyihrdlraa nilvgenlvc kiadfglarl
 421 iedneytarq gakfpikwta peaalygrft iksdvwsfgi lqtelvtkgr vpypgmvnre
 481 vleqvergyr mpcpqgcpes lhelmnlcwk kdpderptfe yiqsfledyf tatepqyqpg
 541 enl
```

Coiled-coil domain containing 80, coiled-coil domain-containing 80 precursor, NP_955805.1, NP_955806.1

```
   1 mtwrmgprft mllamwlvcg sephphatir gshggrkvpl vspdssrpar flrhtgrsrg
  61 ierstleepn lqplqrrrsv pvlrlarpte pparsdinga avrpeqrpaa rgspremird
 121 egssarsrml rfpsgssspn ilasfagknr vwvisaphas egyyrlmmsl lkddvycela
 181 erhiqqivlf hqageeggkv rritsegqil eqpldpslip klmsflklek gkfgmvllkk
 241 tlqveerypy pvrleamyev idqgpirrie kirqkgfvqk ckasgvegqv vaegndgggg
 301 agrpslgsek kkedprraqv pptresrvkv lrklaatapa lpqppstpra ttlppapatt
 361 vtrstsravt vaarpmttta fpttqrpwtp spshrppttt evitarrpsv senlyppsrk
 421 dqhrerpqtt rrpskatsle sftnapptti sepstraagp grfrdnrmdr rehghrdpnv
 481 vpgppkpake kppkkkaqdk ilsneyeeky dlsrptasql edelqvgnvp lkkakeskkh
 541 eklekpekek kkkmknenad kllksekqmk ksekkskqek ekskkkkggk teqdgyqkpt
 601 nkhftqspkk svadllgsfe gkrrlllita pkaennmyvq qrdeylesfc kmatrkisvi
 661 tifgpvnnst mkidhfqldn ekpmrvvdde dlvdqrlise lrkeygmtyn dffmvltdvd
 721 lrvkqyyevp itmksvfdli dtfqsrikdm ekqkkegivc kedkkqslen flsrfrwrrr
 781 llvisapnde dwaysqqlsa lsgqacnfgl rhitilkllg vgeevggvle lfpingssvv
 841 eredvpahlv kdirnyfqvs peyfsmllvg kdgnvkswyp spmwsmvivy dlidsmqlrr
 901 qemaiqqslg mrcpedeyag ygyhsyhqgy qdgyqddyrh hesyhhgypy
```

Acrosin-binding protein precursor NP_115878.2

```
   1 mrkpaagflp sllkvlllpl apaaaqdstq astpgsplsp teyerffall tptwkaettc
  61 rlrathgcrn ptlvqldqye nhglvpdgav csnlpyaswf esfcqfthyr csnhvyyakr
 121 vlcsqpvsil spntlkeiea saevspttmt spisphftvt erqtfqpwpe rlsnnveell
 181 qsslslggqe qapehkqeqg vehrqeptqe hkqeegqkqe eqeeeqeeeg kqeegqgtke
 241 greavsqlqt dsepkfhses lssnpssfap rvrevestpm imeniqelir saqeidemne
 301 iydensywrn qnpgsllqlp hteallvlcy siventciit ptakawkyme eeilgfgksv
 361 cdslgrrhms tcalcdfcsl kleqchseas lqrqqcdtsh ktpfvsplla sqslsignqv
 421 gspesgrfyg ldlygglhmd fwcarlatkg cedvrvsgwl qteflsfqdg dfptkicdtd
 481 yiqypnycsf ksqqclmrnr nrkvsrmrcl qnetysalsp gksedvvlrw sqefstltlg
 541 qfg
```

Alpha-fetoprotein, isoform 1 NP_001125.1

```
   1 mkwvesifli fllnftesrt lhrneygias ildsyqctae isladlatif faqfvqeaty
  61 kevskmvkda ltaiekptgd eqssgclenq lpafleelch ekeilekygh sdccsqseeg
 121 rhncflahkk ptpasiplfq vpepvtscea yeedretfmn kfiyeiarrh pflyaptill
 181 waarydkiip scckaenave cfqtkaatvt kelresslln qhacavmknf gtrtfqaitv
 241 tklsqkftkv nfteiqklvl dvahvhehcc rgdvldclqd gekimsyics qqdtlsnkit
 301 eccklttler gqciihaend ekpeglspnl nrflgdrdfn qfssgeknif lasfvheysr
 361 rhpqlavsvi lrvakgyqel lekcfqtenp lecqdkgeee lqkyiqesqa lakrscglfq
```

```
       421 klgeyylqna flvaytkkap qltsselmai trkmaataat ccqlsedkll acgegaadii
       481 ighlcirhem tpvnpgvgqc ctssyanrrp cfsslvvdet yvppafsddk fifhkdlcqa
       541 qgvalqtmkq eflinlvkqk pqiteeqlea viadfsglle kccqgqeqev cfaeegqkli
       601 sktraalgv

Alpha-fetoprotein, isoform 2 NP_001341646.1
         1 mnkfiyeiar rhpflyapti llwaarydki ipscckaena vecfqtkaat vtkelressl
        61 lnqhacavmk nfgtrtfqai tvtklsqkft kvnfteiqkl vldvahvheh ccrgdvldcl
       121 qdgerimsyi csqqdtlsnk iteccklttl ergqciihae ndekpeglsp nlnrflgdrd
       181 fnqfssgekn iflasfvhey srrhpqlavs vilrvakgyq ellekcfqte nplecqdkge
       241 eelqkyiqes qalakrscgl fqklgeyylq naflvaytkk apqltsselm aitrkmaata
       301 atccqlsedk llacgegaad iiighlcirh emtpvnpgvg qcctssyanr rpcfsslvvd
       361 etyvppafsd dkfifhkdlc qaqgvalqtm kqeflinlvk qkpqiteeql eaviadfsgl
       421 lekccqgqeq evcfaeegqk lisktraalg v

Absent in melanoma 1 protein NP_001615.2
         1 mplsppaqgd pgepspcrpp kkhttfhlwr skkkqqpapp dcgvfvphpl papagearal
        61 dvvdgkyvvr dsqefplhcg esqffhttse algslllesg ifkksraqpp ednrrkpvlg
       121 klgtlftagr rrnsrngles ptrsnakpls pkdvvaspkl peresersrs qssqlkqtdt
       181 seegsprenp reaegelpes ggpaappdae lsprwsssaa avavqqchen dspqleplea
       241 egepfpdatt takqlhsspg nssrqenaet parspgedas pgagheqeaf lgvrgapgsp
       301 tqerpagglg eapngapsvc aeegslgprn arsqppkgas dlpgeppaeg aahtassaqa
       361 dctarpkgha hpakvltldi ylsktegaqv depvvitpra edcgdwddme krssgrrsgr
       421 rrgsqkstds pgadaelpes aarddavfdd evapnaasdn asaekkvksp raaldggvas
       481 aaspeskpsp gtkgqlrges drskqpppas sptkrkgrsr aleavpappa sgprapakes
       541 ppkrvpdpsp vtkgtaaesg eeaaraipre lpvkssslp eikpehkrgp lpnhfngrae
       601 ggrsrelgra agapgasdad glkprnhfgv grstvttkvt lpakpkhvel nlktpknlds
       661 lgnehnpfsq pvhkgntatk islfenkrtn ssprhtdirg qrntpasskt fvgraklnla
       721 kkakemeqpe kkvmpnspqn gvlvketaie tkvtvseeei lpatrgmngd ssenqalgpq
       781 pnqddkadvq tdagclsepv asalipvkdh kllekedsea adskslvlen vtdtaqdipt
       841 tvdtkdlppt ampkpqhtfs dsqspaessp gpslslsapa pgdvpkdtcv qspissfpct
       901 dlkvsenhkg cvlpvsrqnn ekmpllelgg ettpplster speavgsecp srvlvqvrsf
       961 vlpvestqdv ssqvipesse vrevqlptch snepevvsva scappqeevl gnehshctae
      1021 laaksgpqvi ppasektlpi qaqsqgsrtp lmaessptns pssgnhlatp qrpdqtvtng
      1081 qdspasllni sagsddsvfd sssdmekfte iikqmdsavc mpmkrkkarm pnspaphfam
      1141 ppihedhlek vfdpkvftfg lgkkkesqpe mspalhlmqn ldtksklrpk rasaeqsvlf
      1201 kslhtntngn seplvmpein dkenrdvtng gikrsrleks alfssllssl pqdkifspsv
      1261 tsvntmttaf stsqngslsq ssvsqptteg appcglnkeq snllpdnslk vfnfnsssts
      1321 hsslkspshm ekypqkektk edldsrsnlh lpetkfsels klknddmeka nhiesviksn
      1381 lpncansdtd fmglfkssry dpsisfsgms lsdtmtlrgs vqnklnprpg kvviysepdv
      1441 sekcievfsd iqdcsswsls pvilikvvrg cwilyeqpnf eghsipleeg elelsglwgi
      1501 edilerheea esdkpvvigs irhvvqdyrv shidlftepe glgilssyfd dteemqgfgv
      1561 mqktcsmkvh wgtwliyeep gfqgvpfile pgeypdlsfw dteeayigsm rplkmggrkv
      1621 efptdpkvvv yekpffegkc veletgmcsf vmeggeteea tgddhlpfts vgsmkvlrgi
      1681 wvayekpgft ghqylleege yrdwkawggy ngelqslrpi lgdfsnahmi myseknfgsk
      1741 gssidvlgiv anlketgygv ktqsinvlsg vwvayenpdf tgeqyildkg fytsfedwgg
      1801 knckissvqp icldsftgpr rrnqihlfse pqfqghsqsf eettsqidds fstkscrvsg
      1861 gswvvydgen ftgnqyvlee ghypclsamg cppgatfksl rfidvefsep tiilferedf
      1921 kgkkielnae tvnlrslgfn tqirsvqvig giwvtyeygs yrgrqfllsp aevpnwyefs
      1981 gcrqigslrp fvqkriyfrl rnkatglfms tngnledlkl lriqvmedvg addqiwiyqe
      2041 gcikcriaed ccltivgslv tsgsklglal dqnadsqfws lksdgriysk lkpnlvldik
      2101 ggtqydqnhi ilntvskekf tqvweamvly t

A-kinase anchoring protein 4, isoform 1 NP_003877.2
         1 mmaysdttmm sddidwlrsh rgvckvdlyn pegqqdqdrk vicfvdvstl nvedkdykda
        61 assssegnln lgsleekeii vikdtekkdq sktegsvclf kqapsdpvsv lnwllsdlqk
       121 yalgfqhals pststckhkv gdtegeyhra ssencysvya dqvnidylmn rpqnlrlemt
```

```
       181 aakntnnnqs psappakpps tqravispdg ecsiddlsfy vnrlsslviq mahkeikekl
       241 egkskclhhs icpspgnker isprtpaski asemayeave ltaaemrgtg eesreggqks
       301 flyselsnks ksgdkqmsqr eskefadsis kglmvyanqv asdmmvslmk tlkvhssgkp
       361 ipasvvlkrv llrhtkeivs dlidscmknl hnitgvlmtd sdfvsavkrn lfnqwkqnat
       421 dimeamlkrl vsaligeeke tksqslsyas lkagshdpkc rnqslefstm kaemkerdkg
       481 kmksdpcksl tsaekvgehi lkegltiwnq kqgnsckvat kacsnkdekg ekinastdsl
       541 akdlivsalk liqyhltqqt kgkdtceedc pgstmgymaq stqyekcggg qsakalsvkq
       601 leshrapgps tcqkenqhld sqkmdmsniv lmliqkllne npfkcedpce genkcsepra
       661 skaasmsnrs dkaeeqcqeh qeldctsgmk qangqfidkl vesvmklcli makysndgaa
       721 laeleeqaas ankpnfrgtr cihsgampqn yqdslghevi vnnqcstnsl qkqlqavlqw
       781 iaasqfnvpm lyfmgdkdgq leklpqvsak aaekgysvgg llqevmkfak erqpdeavgk
       841 varkqlldwl lanl

A-kinase anchoring protein 4, isoform 2 NP_647450.1
         1 msddidwlrs hrgvckvdly npegqqdqdr kvicfvdvst lnvedkdykd aassssegnl
        61 nlgsleekei ivikdtekkd qsktegsvcl fkqapsdpvs vlnwllsdlq kyalgfqhal
       121 spststckhk vgdtegeyhr assencysvy adqvnidylm nrpqnlrlem taakntnnnq
       181 spsappakpp stqravispd gecsiddlsf yvnrlsslvi qmahkeikek legkskclhh
       241 sicpspgnke risprtpask iasemayeav eltaaemrgt geesreggqk sflyselsnk
       301 sksgdkqmsq reskefadsi skglmvyanq vasdmmvslm ktlkvhssgk pipasvvlkr
       361 vllrhtkeiv sdlidscmkn lhnitgvlmt dsdfvsavkr nlfnqwkqna tdimeamlkr
       421 lvsaligeek etksqslsya slkagshdpk crnqslefst mkaemkerdk gkmksdpcks
       481 ltsaekvgeh ilkegltiwn qkqgnsckva tkacsnkdek gekinastds lakdlivsal
       541 kliqyhltqq tkgkdtceed cpgstmgyma qstqyekcgg gqsakalsvk qleshrapgp
       601 stcqkenqhl dsqkmdmsni vlmliqklln enpfkcedpc egenkcsepr askaasmsnr
       661 sdkaeeqcqe hqeldctsgm kqangqfidk lvesvmklcl imakysndga alaeleeqaa
       721 sankpnfrgt rcihsgampq nyqdslghev ivnnqcstns lqkqlqavlq wiaasqfnvp
       781 mlyfmgdkdg qleklpqvsa kaaekgysvg gllqevmkfa kerqpdeavg kvarkqlldw
       841 llanl

ALK tryrosine kinase receptor, isoform 1 NP_004295.2
         1 mgaigllwll plllstaavg sgmgtgqrag spaagpplqp replsysrlq rkslavdfvv
        61 pslfrvyard lllppsssel kagrpeargs laldcapllr llgpapgvsw tagspapaea
       121 rtlsrvlkgg svrklrrakq lvlelgeeai legcvgppge aavgllqfnl selfswwirq
       181 gegrlrirlm pekkasevgr egrlsaaira sqprllfqif gtghsslesp tnmpspspdy
       241 ftwnltwimk dsfpflshrs ryglecsfdf pceleysppl hdlrnqswsw rripseeasq
       301 mdlldgpgae rskemprgsf lllntsadsk htilspwmrs ssehctlavs vhrhlqpsgr
       361 yiaqllphne aareillmpt pgkhgwtvlq grigrpdnpf rvaleyissg nrslsavdff
       421 alkncsegts pgskmalqss ftcwngtvlq lgqacdfhqd caqgedesqm crklpvgfyc
       481 nfedgfcgwt qgtlsphtpq wqvrtlkdar fqdhqdhall lsttdvpase satvtsatfp
       541 apiksspcel rmswlirgvl rgnvslvlve nktgkeqgrm vwhvaayegl slwqwmvlpl
       601 ldvsdrfwlq mvawwgqgsr aivafdnisi sldcyltisg edkilqntap ksrnlfernp
       661 nkelkpgens prqtpifdpt vhwlfttcga sgphgptqaq cnnayqnsnl svevgsegpl
       721 kgiqiwkvpa tdtysisgyg aaggkggknt mmrshgvsvl gifnlekddm lyilvgqqge
       781 dacpstnqli qkvcigennv ieeeirvnrs vhewaggggg gggatyvfkm kdgvpvplii
       841 aaggggrayg aktdtfhper lennssvlgl ngnsgaaggg ggwndntsll wagkslqega
       901 tgghscpqam kkwgwetrgg fgggggggcss ggggggyigg naasnndpem dgedgvsfis
       961 plgilytpal kvmeghgevn ikhylncshc evdechmdpe shkvicfcdh gtvlaedgvs
      1021 civsptpeph lplslilsvv tsalvaalvl afsgimivyr rkhqelqamq melqspeykl
      1081 sklrtstimt dynpnycfag ktssisdlke vprknitlir glghgafgev yegqvsgmpn
      1141 dpsplqvavk tlpevcseqd eldflmeali iskfnhqniv rcigvslqsl prfillelma
      1201 ggdlksflre trprpsqpss lamldllhva rdiacgcqyl eenhfihrdi aarnclltcp
      1261 gpgrvakigd fgmardiyra syyrkggcam lpvkwmppea fmegiftskt dtwsfgvllw
      1321 eifslgympy psksnqevle fvtsggrmdp pkncpgpvyr imtqcwqhqp edrpnfaiil
      1381 erieyctqdp dvintalpie ygplveeeek vpvrpkdpeg vppllvsqqa kreeerspaa
      1441 ppplpttssg kaakkptaae isvrvprgpa vegghvnmaf sqsnppselh kvhgsrnkpt
      1501 slwnptygsw ftekptkknn piakkephdr gnlglegsct vppnvatgrl pgaslleps
```

```
1561 sltanmkevp lfrlrhfpcg nvnygyqqqg lpleaatapg aghyedtilk sknsmnqpgp

ALK tyrosin kinese receptor, isoform 2 NP_001340694.1
   1 mqmelqspey klsklrtsti mtdynpnycf agktssisdl kevprknitl irglghgafg
  61 evyegqvsgm pndpsplqva vktlpevcse qdeldflmea liiskfnhqn ivrcigvslq
 121 slprfillel maggdlksfl retrprpsqp sslamldllh vardiacgcq yleenhfihr
 181 diaarncllt cpgpgrvaki gdfgmardiy rasyyrkggc amlpvkwmpp eafmegifts
 241 ktdtwsfgvl lweifslgym pypsksnqev lefvtsggrm dppkncpgpv yrimtqcwqh
 301 qpedrpnfai ilerieyctq dpdvintalp ieygplveee ekvpvrpkdp egvppllvsq
 361 qakreeersp aappplptts sgkaakkpta aeisvrvprg pavegghvnm afsqsnppse
 421 lhkvhgsrnk ptslwnptyg swftekptkk nnpiakkeph drgnlglegs ctvppnvatg
 481 rlpgasllle pssltanmke vplfrlrhfp cgnvnygyqq qglpleaata pgaghyedti
 541 lksknsmnqp gp

Angiopoietin-2, isoform a NP_001138.1
   1 mwqivfftls cdlvlaaayn nfrksmdsig kkqyqvqhgs csytfllpem dncrsssspy
  61 vsnavqrdap leyddsvqrl qvlenimenn tqwlmkleny iqdnmkkemv eiqqnavqnq
 121 tavmieigtn llnqtaeqtr kltdveaqvl nqttrlelql lehslstnkl ekqildqtse
 181 inklqdknsf lekkvlamed khiiqlqsik eekdqlqvlv skqnsiieel ekkivtatvn
 241 nsvlqkqqhd lmetvnnllt mmstsnsakd ptvakeeqis frdcaevfks ghttngiytl
 301 tfpnsteeik aycdmeaggg gwtiiqrred gsvdfqrtwk eykvgfgnps geywlgnefv
 361 sqltnqqryv lkihlkdweg neayslyehf ylsseelnyr ihlkgltgta gkissisqpg
 421 ndfstkdgdn dkcickcsqm ltggwwfdac gpsnlngmyy pqrqntnkfn gikwyywkgs
 481 gyslkattmm irpadf

Angiopoietin-2, isoform b NP_001112359.1
   1 mwqivfftls cdlvlaaayn nfrksmdsig kkqyqvqhgs csytfllpem dncrsssspy
  61 vsnavqrdap leyddsvqrl qvlenimenn tqwlmkleny iqdnmkkemv eiqqnavqnq
 121 tavmieigtn llnqtaeqtr kltdveaqvl nqttrlelql lehslstnkl ekqildqtse
 181 inklqdknsf lekkvlamed khiiqlqsik eekdqlqvlv skqnsiieel ekkivtatvn
 241 nsvlqkqqhd lmetvnnllt mmstsnskdp tvakeeqisf rdcaevfksg httngiytlt
 301 fpnsteeika ycdmeagggg wtiiqrredg svdfqrtwke ykvgfgnpsg eywlgnefvs
 361 qltnqqryvl kihlkdwegn eayslyehfy lsseelnyri hlkgltgtag kissisqpgn
 421 dfstkdgdnd kcickcsqml tggwwfdacg psnlngmyyp qrqntnkfng ikwyywkgsg
 481 yslkattmmi rpadf

Angiopoietin-2, isoform c NP_001112360.1
   1 mwqivfftls cdlvlaaayn nfrksmdsig kkqyqvqhgs csytfllpem dncrsssspy
  61 vsnavqrdap leyddsvqrl qvlenimenn tqwlmkvlnq ttrlelqlle hslstnklek
 121 qildqtsein klqdknsfle kkvlamedkh iiqlqsikee kdqlqvlvsk qnsiieelek
 181 kivtatvnns vlqkqqhdlm etvnnlltmm stsnsakdpt vakeeqisfr dcaevfksgh
 241 ttngiytltf pnsteeikay cdmeaggggw tiiqrredgs vdfqrtwkey kvgfgnpsge
 301 ywlgnefvsq ltnqqryvlk ihlkdwegne ayslyehfyl sseelnyrih lkgltgtagk
 361 issisqpgnd fstkdgdndk cickcsqmlt ggwwfdacgp snlngmyypq rqntnkfngi
 421 kwyywkgsgy slkattmmir padf

Angiopoietin-1, isoform 1 precursor NP_001137.2
   1 mtvflsfafl aailthigcs nqrrspensg rrynriqhgq caytfilpeh dgncresttd
  61 qyntnalqrd aphvepdfss qklqhlehvm enytqwlqkl enyivenmks emaqiqqnav
 121 qnhtatmlei gtsllsqtae qtrkltdvet qvlnqtsrle iqllenslst yklekqllqq
 181 tneilkihek nsllehkile megkhkeeld tlkeekenlq glvtrqtyii qelekqlnra
 241 ttnnsvlqkq qlelmdtvhn lvnlctkegv llkggkreee kpfrdcadvy qagfnksgiy
 301 tiyinnmpep kkvfcnmdvn gggwtviqhr edgsldfqrg wkeykmgfgn psgeywlgne
 361 fifaitsqrq ymlrielmdw egnraysqyd rfhignekqn yrlylkghtg tagkqsslil
 421 hgadfstkda dndncmckca lmltggwwfd acgpsnlngm fytagqnhgk lngikwhyfk
 481 gpsyslrstt mmirpldf
```

Angiopoietin-1, isoform 2 precursor NP_001186788.1

```
   1 mtvflsfafl aailthigcs nqrrspensg rrynriqhgq caytfilpeh dgncresttd
  61 qyntnalqrd aphvepdfss qklqhlehvm enytqwlqkl enyivenmks emaqiqqnav
 121 qnhtatmlei gtslsqtae qtrkltdvet qvlnqtsrle iqllenslst yklekqllqq
 181 tneilkihek nslehkile megkhkeeld tlkeekenlq glvtrqtyii qelekqlnra
 241 ttnnsvlqkq qlelmdtvhn lvnlctkevl lkggkreeek pfrdcadvyq agfnksgiyt
 301 iyinnmpepk kvfcnmdvng ggwtviqhre dgsldfqrgw keykmgfgnp sgeywlgnef
 361 ifaitsqrqy mlrielmdwe gnraysqydr fhignekqny rlylkghtgt agkqsslilh
 421 gadfstkdad ndncmckcal mltggwwfda cgpsnlngmf ytagqnhgkl ngikwhyfkg
 481 psyslrsttm mirpldf
```

Angiopoietin-1, isoform 3 precursor NP_001300980.1

```
   1 megkhkeeld tlkeekenlq glvtrqtyii qelekqlnra ttnnsvlqkq qlelmdtvhn
  61 lvnlctkegv llkggkreee kpfrdcadvy qagfnksgiy tiyinnmpep kkvfcnmdvn
 121 gggwtviqhr edgsldfqrg wkeykmgfgn psgeywlgne fifaitsqrq ymlrielmdw
 181 egnraysqyd rfhignekqn yrlylkghtg tagkqsslil hgadfstkda dndncmckca
 241 lmltggwwfd acgpsnlngm fytagqnhgk lngikwhyfk gpsyslrstt mmirpldf
```

Ankyrin repeat domain-containing protein 30A NP_443723.2

```
   1 mtkrkktinl niqdaqkrta lhwacvnghe evvtflvdrk cqldvldgeh rtplmkalqc
  61 hqeacanili dsgadinlvd vygntalhya vyseilsvva kllshgavie vhnkasltpl
 121 llsitkrseq ivefllikna nanavnkykc talmlavchg sseivgmllq qnvdvfaadi
 181 cgvtaehyav tcgfhhiheq imeyirklsk nhqntnpegt sagtpdeaap laertpdtae
 241 slvektpdea aplvertpdt aeslvektpd eaaslvegts dkiqclekat sgkfeqsaee
 301 tpreitspak etsekftwpa kgrprkiawe kkedtpreim spaketsekf twaakgrprk
 361 iawekketpv ktgcvarvts nktkvlekgr skmiacptke sstkasandq rfpseskqee
 421 deeyscdsrs lfessakiqv cipesiyqkv meinreveep pkkpsafkpa iemqnsvpnk
 481 afelkneqtl radpmfppes kqkdyeensw dseslcetvs qkdvclpkat hqkeidking
 541 kleespnkdg llkatcgmkv siptkalelk dmqtfkaepp gkpsafepat emqksvpnka
 601 lelkneqtlr adeilpsesk qkdyeenswd teslcetvsq kdvclpkaah qkeidkingk
 661 legspvkdgl lkancgmkvs iptkalelmd mqtfkaeppe kpsafepaie mqksvpnkal
 721 elkneqtlra deilpseskq kdyeesswds eslcetvsqk dvclpkathq keidkingkl
 781 eespdndgfl kapcrmkvsi ptkalelmdm qtfkaeppek psafepaiem qksvpnkale
 841 lkneqtlrad qmfpseskqk kveenswdse slretvsqkd vcvpkathqk emdkisgkle
 901 dstslskild tvhscerare lqkdhceqrt gkmeqmkkkf cvlkkklsea keiksqlenq
 961 kvkweqelcs vrltlnqeee krrnadilne kireelgrie eqhrkelevk qqleqalriq
1021 dielksvesn lnqvshthen enyllhencm lkkeiamlkl eiatlkhqyq ekenkyfedi
1081 kilkeknael qmtlklkees ltkrasqysg qlkvliaent mltsklkekq dkeileaeie
1141 shhprlasav qdhdqivtsr ksqepafhia gdaclqrkmn vdvsstiynn evlhqplsea
1201 qrkskslkin lnyagdalre ntlvsehaqr dqretqcqmk eaehmyqneq dnvnkhteqq
1261 esldqklfql qsknmwlqqq lvhahkkadn kskitidihf lerkmqhhll kekneeifny
1321 nnhlknriyq yekekaeten s
```

Androgen receptor, isoform 1 NP_000035.2

```
   1 mevqlglgrv yprppsktyr gafqnlfqsv reviqnpgpr hpeaasaapp gasllllqqq
  61 qqqqqqqqqq qqqqqqqqqq etsprqqqqq qgedgspqah rrgptgylvl deeqqpsqpq
 121 salechperg cvpepgaava askglpqqlp appdeddsaa pstlslgpt fpglsscsad
 181 lkdilseast mqllqqqqqe avsegsssgr areasgapts skdnylggts tisdnakelc
 241 kavsvsmglg vealehlspg eqlrgdcmya pllgvppavr ptpcaplaec kgsllddsag
 301 kstedtaeys pfkggytkgl egeslgcsgs aaagssgtle lpstlslyks galdeaaayq
 361 srdyynfpla lagppppppp phpharikle npldygsawa aaaaqcrygd laslhgagaa
 421 gpgsgspsaa assswhtlft aeegqlygpc gggggggggg gggggggggg gggeagavap
 481 ygytrppqgl agqesdftap dvwypggmvs rvpypsptcv ksemgpwmds ysgpygdmrl
 541 etardhvlpi dyyfppqktc licgdeasgc hygaltcgsc kvffkraaeg kqkylcasrn
 601 dctidkfrrk ncpscrlrkc yeagmtlgar klkklgnlkl qeegeasstt spteettqkl
 661 tvshiegyec qpiflnvlea iepgvvcagh dnnqpdsfaa llsslnelge rqlvhvvkwa
 721 kalpgfrnlh vddqmaviqy swmglmvfam gwrsftnvns rmlyfapdlv fneyrmhksr
```

```
781 mysqcvrmrh lsqefgwlqi tpqeflcmka lllfsiipvd glknqkffde lrmnyikeld
841 riiackrknp tscsrrfyql tkllldsvqpi arelhqftfd llikshmvsv dfpemmaeii
901 svqvpkilsg kvkpiyfhtq

Androgen receptor, isoform 2 NP_001011645.1
  1 milwlhslet ardhvlpidy yfppqktcli cgdeasgchy galtcgsckv ffkraaegkq
 61 kylcasrndc tidkfrrknc pscrlrkcye agmtlgarkl kklgnlklqe egeassttsp
121 teettqkltv shiegyecqp iflnvleaie pgvvcaghdn nqpdsfaall sslnelgerq
181 lvhvvkwaka lpgfrnlhvd dqmaviqysw mglmvfamgw rsftnvnsrm lyfapdlvfn
241 eyrmhksrmy sqcvrmrhls qefgwlqitp qeflcmkall lfsiipvdgl knqkffdelr
301 mnyikeldri iackrknpts csrrfyqltk lldsvqpiar elhqftfdll ikshmvsvdf
361 pemmaeiisv qvpkilsgkv kpiyfhtq

Androgen receptor, isoform 3 NP_001334990.1
  1 mevqlglgrv yprppsktyr gafqnlfqsv reviqnpgpr hpeaasaapp gasllllqqq
 61 qqqqqqqqqq qqqqqqqqqq etsprqqqqq qgedgspqah rrgptgylvl deeqqpsqpq
121 salechperg cvpepgaava askglpqqlp appdeddsaa pstlsllgpt fpglsscsad
181 lkdilseast mqllqqqqqe avsegsssgr areasgapts skdnylggts tisdnakelc
241 kavsvsmglg vealehlspg eqlrgdcmya pllgvppavr ptpcaplaec kgsllddsag
301 kstedtaeys pfkggytkgl egeslgcsgs aaagssgtle lpstlslyks galdeaaayq
361 srdyynfpla lagppppppp phpharikle npldygsawa aaaaqcrygd laslhgagaa
421 gpgsgspsaa assswhtlft aeegqlygpc gggggggggg gggggggggg gggeagavap
481 ygytrppqgl agqesdftap dvwypggmvs rvpypsptcv ksemgpwmds ysgpygdmrl
541 etardhvlpi dyyfppqktc licgdeasgc hygaltcgsc kvffkraaeg kqkylcasrn
601 dctidkfrrk ncpscrlrkc yeagmtlgek frvgnckhlk mtrp

Androgen receptor, isoform 4 NP_001334992.1
  1 mevqlglgrv yprppsktyr gafqnlfqsv reviqnpgpr hpeaasaapp gasllllqqq
 61 qqqqqqqqqq qqqqqqqqqq etsprqqqqq qgedgspqah rrgptgylvl deeqqpsqpq
121 salechperg cvpepgaava askglpqqlp appdeddsaa pstlsllgpt fpglsscsad
181 lkdilseast mqllqqqqqe avsegsssgr areasgapts skdnylggts tisdnakelc
241 kavsvsmglg vealehlspg eqlrgdcmya pllgvppavr ptpcaplaec kgsllddsag
301 kstedtaeys pfkggytkgl egeslgcsgs aaagssgtle lpstlslyks galdeaaayq
361 srdyynfpla lagppppppp phpharikle npldygsawa aaaaqcrygd laslhgagaa
421 gpgsgspsaa assswhtlft aeegqlygpc gggggggggg gggggggggg gggeagavap
481 ygytrppqgl agqesdftap dvwypggmvs rvpypsptcv ksemgpwmds ysgpygdmrl
541 etardhvlpi dyyfppqktc licgdeasgc hygaltcgsc kvffkraaeg kqkylcasrn
601 dctidkfrrk ncpscrlrkc yeagmtlgaa vvvserilrv fgvsewlp

Androgen receptor, isoform 5 NP_001334993.1
  1 mevqlglgrv yprppsktyr gafqnlfqsv reviqnpgpr hpeaasaapp gasllllqqq
 61 qqqqqqqqqq qqqqqqqqqq etsprqqqqq qgedgspqah rrgptgylvl deeqqpsqpq
121 salechperg cvpepgaava askglpqqlp appdeddsaa pstlsllgpt fpglsscsad
181 lkdilseast mqllqqqqqe avsegsssgr areasgapts skdnylggts tisdnakelc
241 kavsvsmglg vealehlspg eqlrgdcmya pllgvppavr ptpcaplaec kgsllddsag
301 kstedtaeys pfkggytkgl egeslgcsgs aaagssgtle lpstlslyks galdeaaayq
361 srdyynfpla lagppppppp phpharikle npldygsawa aaaaqcrygd laslhgagaa
421 gpgsgspsaa assswhtlft aeegqlygpc gggggggggg gggggggggg gggeagavap
481 ygytrppqgl agqesdftap dvwypggmvs rvpypsptcv ksemgpwmds ysgpygdmrn
541 trrkrlwkli irsinscics pretevpvrq qk

ATPase H+ transporting accessory protein 1 NP_001174.2
  1 mmaamatarv rmgprcaqal wrmpwlpvfl slaaaaaaaa aeqqvplvlw ssdrdlwapa
 61 adtheghits dlqlstyldp alelgprnvl lflqdklsie dftayggvfg nkqdsafsnl
121 enaldlapss lvlpavdwya vstlttylqe klgasplhvd latlrelkln aslpalllir
181 lpytassglm aprevltgnd evigqvlstl ksedvpytaa ltavrpsrva rdvavvaggl
241 grqllqkqpv spvihppvsy ndtaprilfw aqnfsvaykd qwedltpltf gvqelnltgs
```

```
      301 fwndsfarls ltyerlfgtt vtfkfilanr lypvsarhwf tmerlevhsn gsvayfnasq
      361 vtgpsiysfh ceyvsslskk gsllvartqp spwqmmlqdf qiqafnvmge qfsyasdcas
      421 ffspgiwmgl ltslfmlfif tyglhmilsl ktmdrfddhk gptisltqiv

B melanoma antigen 1 precursor NP_001178.1
        1 maaravflal saqllqarlm keespvvswr lepedgtalc fif

BCR/ABL fusion protein e14ab NG_050673.1
        1 gcacctgcag ggagggcagg cagctagcct gaaggctgat ccccccttcc tgttagcact
       61 tttgatggga ctagtggact ttggttcaga aggaagagct atgcttgtta gggcctcttg
      121 tctcctccca ggagtggaca aggtgggtta ggagcagttt ctccctgagt ggctgctgct
      181 gggtggttga ggagatgcac ggcttctgtt cctagtcaca aggctgcagc agacgctcct
      241 cagatgctct gtgccttgga tctggcccca ctcccgtcct cccagccctc ctctcctcca
      301 gctacctgcc agccggcact tttggtcaag ctgttttgca ttcactgttg cacatatgct
      361 cagtcacaca cacagcatac gctatgcaca tgtgtccaca cacaccccac ccacatccca
      421 catcaccccg acccccctctg ctgtccttgg aaccttatta cacttcgagt cactggtttg
      481 cctgtattgt gaaaccagct ggatcctgag atccccaaga cagaaatcat gatgagtatg
      541 tttttggccc atgacactgg cttaccttgt gccaggcaga tggcagccac acagtgtcca
      601 ccggatggtt gattttgaag cagagttagc ttgtcacctg cctccctttc ccgggacaac
      661 agaagctgac ctctttgatc tcttgcgcag atgatgagtc tccggggctc tatgggtttc
      721 tgaatgtcat cgtccactca gccactggat ttaagcagag ttcaagtaag tactggtttg
      781 gggaggaggg ttgcagcggc cgagccaggg tctccaccca ggaaggactc atcgggcagg
      841 gtgtggggaa acagggaggt tgttcagatg accacgggac acctttgacc ctggccgctg
      901 tggagtgttt gtgctggttg atgccttctg ggtgtggaat tgtttttccc ggagtggcct
      961 ctgccctctc ccctagcctg tctcagatcc tgggagctgg tgagctgccc cctgcaggtg
     1021 gatcgagtaa ttgcaggggt ttggcaagga ctttgacaga catccccagg ggtgcccggg
     1081 agtgtggggt ccaagccagg agggctgtca gcagtgcacc ttcaccccac agcagagcag
     1141 atttggctgc tctgtcgagc tggatggata ctacttttt tttcctttcc ctctaagtgg
     1201 gggtctcccc cagctactgg agctgtcaga acagtgaagg ctggtaacac atgagttgca
     1261 ctgtgtaagt ttctcgaggc cgggcgcagt ggctcatgcc tgtaatccca gcactttggg
     1321 aggctgaggc aggtggatcg cttgagctca ggagttggag accagcctga ccaacatggt
     1381 gaaaccctgt gtctactaaa aatacaaaga ttagccgggc taggcagtgg gcacctgtaa
     1441 tcacaactgc ttgggaggct gagggaagag aatcgcttga acccaggagg cggaggttgc
     1501 agtgagccga gcttgtgcca ctgcattcca gcctgggcga cagagcaaga ctccgcctca
     1561 aaaaaaaaaa aaaaaagttc ctagaaacag caaaatgtgg agacagaaag cttaccaggg
     1621 attgttgggg aatggggttg ggagagagga ctaactgcag atgaacccaa gggggacttt
     1681 ttaggtgaga gcagtgtcgt gaaaagactg tggtgctgtt tgcgctcaca tttacatttc
     1741 ctaaaattct ttaaacccta cacttggaat ggatgaatta catgacatgc agattgcacc
     1801 ttcataacat aatctttctc ctgggccccc gtctctggct gcctcataaa cgctggtgtt
     1861 tccctcgtgg gcctccctgc atccctgcat ctcctcccgg gtcctgtctg tgagcaatac
     1921 agcgtgacac cctacgctgc cccgtggtcc cgggcttgtc tctccttgcc tccctgttac
     1981 ctttctttct atctcttcct tgccccgtgc actcaacctt gcatccccaa accaaaccta
     2041 ttattcatgg accccaaact tgttcctctt atgtcctgtc cctttgaggg gcaccaccat
     2101 ccacccgcat ggccaagcca gaaaccgtgg tctgctctcc ctccgttaaa tgccattctc
     2161 catcagtgag gcttcttagt catctctggc tgcctggcca ggccctggct gtggcctcct
     2221 ccctggtctt tgtagctctg gatatccctg cagaaagggt ccccactacc aggcctctcc
     2281 atccccagtc tcaggtagtt tttctaaaat gcaaacccca ccctgcaact taccgcccac
     2341 agcccagccc actcttctcc aggcctcgcc tccctccctt ccccctgcac cccacgactt
     2401 ctccagcact gagctgcttc ctgtgcccca cagtggcctg gagtcccctt tgccttaact
     2461 ctttgcccca tagtacagcg gggtctgctc tgattgtagg ggcttcccac atcccccagg
     2521 atggctgccc tctgctgtgg catcactgtg taacaatggc gtgtacacct ctctgtcccc
     2581 accagtgcag ggcccttctc atcgtagggg ctttagctgg ggtttgtgga tcgactgagt
     2641 gaacgaatgt tgtgggaagt cccgtttccc agccgcaccc agggaaattc cacagagcgg
     2701 gcaggggcat cgcatgaggt gctggtgttc acgccagacc acaattaggt gtttaatttt
     2761 taaaaagaaa gttacaacct tttttttta ttttatttt ttctgattct gcaaataaca
     2821 cctgctctta cagaccatgt gggtgatgtg gaaaagacct gtgaccttct ccatgtccac
     2881 ttctccccac agatctgtac tgcaccctgg aggtggattc ctttgggtat tttgtgaata
```

```
2941 aagcaaagac gcgcgtctac agggacacag ctgagcca

Serine/threonine-protein kinase B-raf, isoform 1 NP_004324.2
   1 maalsggggg gaepgqalfn gdmepeagag agaaassaad paipeevwni kqmikltqeh
  61 iealldkfgg ehnppsiyle ayeeytskld alqqreqqll eslgngtdfs vsssasmdtv
 121 tsssssslsv lpsslsvfqn ptdvarsnpk spqkpivrvf lpnkqrtvvp arcgvtvrds
 181 lkkalmmrgl ipeccavyri qdgekkpigw dtdiswltge elhvevlenv pltthnfvrk
 241 tfftlafcdf crkllfqgfr cqtcgykfhq rcstevplmc vnydqldllf vskffehhpi
 301 pqeeaslaet altsgsspsa pasdsigpqi ltspspsksi pipqpfrpad edhrnqfgqr
 361 drsssapnvh intiepvnid dlirdqgfrg dggsttglsa tppaslpgsl tnvkalqksp
 421 gpqrerksss ssedrnrmkt lgrrdssddw eipdgqitvg qrigsgsfgt vykgkwhgdv
 481 avkmlnvtap tpqqlqafkn evgvlrktrh vnillfmgys tkpqlaivtq wcegsslyhh
 541 lhiietkfem iklidiarqt aqgmdylhak siihrdlksn niflhedltv kigdfglatv
 601 ksrwsgshqf eqlsgsilwm apevirmqdk npysfqsdvy afgivlyelm tgqlpysnin
 661 nrdqiifmvg rgylspdlsk vrsncpkamk rlmaeclkkk rderplfpqi lasiellars
 721 lpkihrsase pslnragfqt edfslyacas pktpiqaggy gafpvh

Serine/threonine-protein kinase B-raf, isoform 2 NP_001341538.1
   1 maalsggggg gaepgqalfn gdmepeagag agaaassaad paipeevwni kqmikltqeh
  61 iealldkfgg ehnppsiyle ayeeytskld alqqreqqll eslgngtdfs vsssasmdtv
 121 tsssssslsv lpsslsvfqn ptdvarsnpk spqkpivrvf lpnkqrtvvp arcgvtvrds
 181 lkkalmmrgl ipeccavyri qdgekkpigw dtdiswltge elhvevlenv pltthnfvrk
 241 tfftlafcdf crkllfqgfr cqtcgykfhq rcstevplmc vnydqldllf vskffehhpi
 301 pqeeaslaet altsgsspsa pasdsigpqi ltspspsksi pipqpfrpad edhrnqfgqr
 361 drsssapnvh intiepvnid dlirdqgfrg dggsttglsa tppaslpgsl tnvkalqksp
 421 gpqrerksss ssedrnrmkt lgrrdssddw eipdgqitvg qrigsgsfgt vykgkwhgdv
 481 avkmlnvtap tpqqlqafkn evgvlrktrh vnillfmgys tkpqlaivtq wcegsslyhh
 541 lhiietkfem iklidiarqt aqgmdylhak siihrdlksn niflhedltv kigdfglatv
 601 ksrwsgshqf eqlsgsilwm apevirmqdk npysfqsdvy afgivlyelm tgqlpysnin
 661 nrdqiifmvg rgylspdlsk vrsncpkamk rlmaeclkkk rderplfpqi lasiellars
 721 lpkihrsase pslnragfqt edfslyacas pktpiqaggy gefaafk

Carbonic anhydrase 9 precursor NP_001207.2
   1 maplcpspwl pllipapapg ltvqlllsll llvpvhpqrl prmqedsplg ggssgeddpl
  61 geedlpseed spreedppge edlpgeedlp geedlpevkp kseeegslkl edlptveapg
 121 dpqepqnnah rdkegddqsh wryggdppwp rvspacagrf qspvdirpql aafcpalrpl
 181 ellgfqlppl pelrlrnngh svqltlppgl emalgpgrey ralqlhlhwg aagrpgseht
 241 veghrfpaei hvvhlstafa rvdealgrpg glavlaafle egpeensaye qllsrleeia
 301 eegsetqvpg ldisallpsd fsryfqyegs lttppcaqgv iwtvfnqtvm lsakqlhtls
 361 dtlwgpgdsr lqlnfratqp lngrvieasf pagvdsspra aepvqlnscl aagdilalvf
 421 gllfavtsva flvqmrrqhr rgtkggvsyr paevaetga

G/mitotic-specific cyclin-B1, isoform 1 NP_114172.1
   1 malrvtrnsk inaenkakin magakrvpta paatskpglr prtalgdign kvseqlqakm
  61 pmkkeakpsa tgkvidkklp kplekvpmlv pvpvsepvpe pepepepepv keeklspepi
 121 lvdtaspspm etsgcapaee dlcqafsdvi lavndvdaed gadpnlcsey vkdiyaylrq
 181 leeeqavrpk yllgrevtgn mrailidwlv qvqmkfrllq etmymtvsii drfmqnncvp
 241 kkmlqlvgvt amfiaskyee myppeigdfa fvtdntytkh qirqmemkil ralnfglgrp
 301 lplhflrras kigevdveqh tlakylmelt mldydmvhfp psqiaagafc lalkildnge
 361 wtptlqhyls yteesllpvm qhlaknvvmv nqgltkhmtv knkyatskha kistlpqlns
 421 alvqdlakav akv

G/mitotic-specific cyclin-B1, isoform 2 NP_001341773.1
   1 malrvtrnsk inaenkakin magakrvpta paatskpglr prtalgdign kvseqlqakm
  61 pmkkeakpsa tgkvidkklp kplekvpmlv pvpvsepvpe pepepepepv keeklspepi
 121 lvdtaspspm etsgcapaee dlcqafsdvi lavndvdaed gadpnlcsey vkdiyaylrq
 181 leeeqavrpk yllgrevtgn mrailidwlv qvqmkfrllq etmymtvsii drfmqnncvp
```

241 kkmlqlvgvt amfiaskyee myppeigdfa fvtdntytkh qirqmemkil ralnfglgrp
301 lplhflrras kigevdveqh tlakylmelt mldydmvhfp psqiaagafc lalkildnge
361 wtvknkyats khakistlpq lnsalvqdla kavakv

G/mitotic-specific cyclin-B1, isoform 3 NP_001341774.1
1 malrvtrnsk inaenkakin magakrvpta paatskpglr prtalgdign kvseqlqakm
61 pmkkeakpsa tgkvidkklp kplekvpmlv pvpvsepvpe pepepepepv keeklspepi
121 lvdtaspspm etsgcapaee dlcqafsdvi lavndvdaed gadpnlcsey vkdiyaylrq
181 lenncvpkkm lqlvgvtamf iaskyeemyp peigdfafvt dntytkhqir qmemkilral
241 nfglgrplpl hflrraskig evdveqhtla kylmeltmld ydmvhfppsq iaagafclal
301 kildngewtp tlqhylsyte esllpvmqhl aknvvmvnqg ltkhmtvknk yatskhakis
361 tlpqlnsalv qdlakavakv

CD276, isoform a precursor NP_001019907.1
1 mlrrrgspgm gvhvgaalga lwfcltgale vqvpedpvva lvgtdatlcc sfspepgfsl
61 aqlnliwqlt dtkqlvhsfa egqdqgsaya nrtalfpdll aqgnaslrlq rvrvadegsf
121 tcfvsirdfg saavslqvaa pyskpsmtle pnkdlrpgdt vtitcssyqg ypeaevfwqd
181 gqgvpltgnv ttsqmaneqg lfdvhsilrv vlgangtysc lvrnpvlqqd ahssvtitpq
241 rsptgavevq vpedpvvalv gtdatlrcsf spepgfslaq lnliwqltdt kqlvhsfteg
301 rdqgsayanr talfpdllaq gnaslrlqrv rvadegsftc fvsirdfgsa avslqvaapy
361 skpsmtlepn kdlrpgdtvt itcssyrgyp eaevfwqdgq gvpltgnvtt sqmaneqglf
421 dvhsvlrvvl gangtysclv rnpvlqqdah gsvtitgqpm tfppealwvt vglsvclial
481 lvalafvcwr kikqsceeen agaedqdgeg egsktalqpl khsdskeddg qeia

CD276, isoform b precursor NP_001316557.1, NP_079516.1
1 mlrrrgspgm gvhvgaalga lwfcltgale vqvpedpvva lvgtdatlcc sfspepgfsl
61 aqlnliwqlt dtkqlvhsfa egqdqgsaya nrtalfpdll aqgnaslrlq rvrvadegsf
121 tcfvsirdfg saavslqvaa pyskpsmtle pnkdlrpgdt vtitcssyrg ypeaevfwqd
181 gqgvpltgnv ttsqmaneqg lfdvhsvlrv vlgangtysc lvrnpvlqqd ahgsvtitgq
241 pmtfppealw vtvglsvcli allvalafvc wrkikqscee enagaedqdg egegsktalq
301 plkhsdsked dgqeia

CD276, isoform c NP_001316558.1
1 mtlepnkdlr pgdtvtitcs syqgypeaev fwqdgqgvpl tgnvttsqma neqglfdvhs
61 ilrvvlgang tysclvrnpv lqqdahssvt itpqrsptga vevqvpedpv valvgtdatl
121 rcsfspepgf slaqlnliwq ltdtkqlvhs ftegrdqgsa yanrtalfpd llaqgnaslr
181 lqrvrvadeg sftcfvsird fgsaavslqv aapyskpsmt lepnkdlrpg dtvtitcssy
241 rgypeaevfw qdgqgvpltg nvttsqmane qglfdvhsvl rvvlgangty sclvrnpvlq
301 qdahgsvtit gqpmtfppea lwvtvglsvc liallvalaf vcwrkikqsc eeenagaedq
361 dgegegskta lqplkhsdsk eddgqeia

Carcinoembryonic antigen-related cell adhesion molecule 3, isoform 1 precursor NP_001806.2
1 mgppsasphr ecipwqglll tasllnfwnp pttaklties mplsvaegke vlllvhnlpq
61 hlfgyswykg ervdgnsliv gyvigtqqat pgaaysgret iytnaslliq nvtqndigfy
121 tlqviksdlv neeatgqfhv yqenapglpv gavagivtgv lvgvalvaal vcflllaktg
181 rtsiqrdlke qqpqalapgr gpshssafsm splstaqapl pnprtaasiy eellkhdtni
241 ycrmdhkaev as

Carcinoembryonic antigen-related cell adhesion molecule 3, isoform 2 precursor NP_001264092.1
1 mgppsasphr ecipwqglll tasllnfwnp pttaklties mplsvaegke vlllvhnlpq
61 hlfgyswykg ervdgnsliv gyvigtqqat pgaaysgret iytnaslliq nvtqndigfy
121 tlqviksdlv neeatgqfhv yqenapglpv gavagivtgv lvgvalvaal vcflllaktg
181 rpwslpqlcl ldvpslhcpg pptqpqdssf hl

Carcinoembryonic antigen-related cell adhesion molecule 5, isoform 1 preprotein NP_001278413.1, NP_004354.3

```
        1 mespsapphr wcipwqrlll taslltfwnp pttaklties tpfnvaegke vlllvhnlpq
       61 hlfgyswykg ervdgnrqii gyvigtqqat pgpaysgrei iypnaslliq niiqndtgfy
      121 tlhviksdlv neeatgqfrv ypelpkpsis snnskpvedk davaftcepe tqdatylwwv
      181 nnqslpvspr lqlsngnrtl tlfnvtrndt asykcetqnp vsarrsdsvi lnvlygpdap
      241 tisplntsyr sgenlnlsch aasnppaqys wfvngtfqqs tqelfipnit vnnsgsytcq
      301 ahnsdtglnr ttvttitvya eppkpfitsn nsnpvededa valtcepeiq nttylwwvnn
      361 qslpvsprlq lsndnrtltl lsvtrndvgp yecgiqnels vdhsdpviln vlygpddpti
      421 spsytyyrpg vnlslschaa snppaqyswl idgniqqhtq elfisnitek nsglytcqan
      481 nsasghsrtt vktitvsael pkpsissnns kpvedkdava ftcepeaqnt tylwwvngqs
      541 lpvsprlqls ngnrtltlfn vtrndarayv cgiqnsvsan rsdpvtldvl ygpdtpiisp
      601 pdssylsgan lnlschsasn pspqyswrin gipqqhtqvl fiakitpnnn gtyacfvsnl
      661 atgrnnsivk sitvsasgts pglsagatvg imigvlvgva li
```

Carcinoembryonic antigen-related cell adhesion molecule 5, isoform 2 preprotein NP_001295327.1

```
        1 mespsapphr wcipwqrlll taslltfwnp pttaklties tpfnvaegke vlllvhnlpq
       61 hlfgyswykg ervdgnrqii gyvigtqqat pgpaysgrei iypnaslliq niiqndtgfy
      121 tlhviksdlv neeatgqfrv ypelpkpsis snnskpvedk davaftcepe tqdatylwwv
      181 nnqslpvspr lqlsngnrtl tlfnvtrndt asykcetqnp vsarrsdsvi lnvlygpdap
      241 tisplntsyr sgenlnlsch aasnppaqys wfvngtfqqs tqelfipnit vnnsgsytcq
      301 ahnsdtglnr ttvttitvye ppkpfitsnn snpvededav altcepeiqn ttylwwvnnq
      361 slpvsprlql sndnrtltll svtrndvgpy ecgiqnelsv dhsdpvilnv lygpddptis
      421 psytyyrpgv nlslschaas nppaqyswli dgniqqhtqe lfisnitekn sglytcqann
      481 sasghsrttv ktitvsaelp kpsissnnsk pvedkdavaf tcepeaqntt ylwwvngqsl
      541 pvsprlqlsn gnrtltlfnv trndarayvc giqnsvsanr sdpvtldvly gpdtpiispp
      601 dssylsganl nlschsasnp spqyswring ipqqhtqvlf iakitpnnng tyacfvsnla
      661 tgrnnsivks itvsasgtsp glsagatvgi migvlvgval i
```

Baculoviral IAP repeat containing 2, isoform 1 NP_001157.1, NP_001243092.1

```
        1 mhktasqrlf pgpsyqniks imedstilsd wtnsnkqkmk ydfscelyrm stystfpagv
       61 pvserslara gfyytgvndk vkcfccglml dnwklgdspi qkhkqlypsc sfiqnlvsas
      121 lgstskntsp mrnsfahsls ptlehsslfs gsysslspnp lnsravedis ssrtnpysya
      181 msteearflt yhmwpltfls pselaragfy yigpgdrvac facggklsnw epkddamseh
      241 rrhfpncpfl ensletlrfs isnlsmqtha armrtfmywp ssvpvqpeql asagfyyvgr
      301 nddvkcfccd gglrcwesgd dpwvehakwf prceflirmk gqefvdeiqg ryphlleqll
      361 stsdttgeen adppiihfgp gesssedavm mntpvvksal emgfnrdlvk qtvqskiltt
      421 genyktvndi vsallnaede kreeekekqa eemasddlsl irknrmalfq qltcvlpild
      481 nllkanvink qehdiikqkt qiplqareli dtilvkgnaa anifknclke idstlyknlf
      541 vdknmkyipt edvsglslee qlrrlqeert ckvcmdkevs vvfipcghlv vcqecapslr
      601 kcpicrgiik gtvrtfls
```

Baculoviral IAP repeat containing 2, isoform 2 NP_001243095.1

```
        1 mstystfpag vpvserslar agfyytgvnd kvkcfccglm ldnwklgdsp iqkhkqlyps
       61 csfiqnlvsa slgstsknts pmrnsfahsl sptlehsslf sgsysslspn plnsravedi
      121 sssrtnpysy amsteearfl tyhmwpltfl spselaragf yyigpgdrva cfacggklsn
      181 wepkddamse hrrhfpncpf lensletlrf sisnlsmqth aarmrtfmyw pssvpvqpeq
      241 lasagfyyvg rnddvkcfcc dgglrcwesg ddpwvehakw fprceflirm kgqefvdeiq
      301 gryphlleql lstsdttgee nadppiihfg pgesssedav mmntpvvksa lemgfnrdlv
      361 kqtvqskilt tgenyktvnd ivsallnaed ekreeekekq aeemasddls lirknrmalf
      421 qqltcvlpil dnllkanvin kqehdiikqk tqiplqarel idtilvkgna aanifknclk
      481 eidstlyknl fvdknmkyip tedvsglsle eqlrrlqeer tckvcmdkev svvfipcghl
      541 vvcqecapsl rkcpicrgii kgtvrtfls
```

Chondrosarcoma-associated gene 2/3 protein, isoform X1 XP_006724920.1

```
        1 mwmgliqlve gvkrkdqgfl ekefyhktni kmrceflacw paftvlgeaw rdqvdwsrll
```

```
       61 rdtglvkmsr kprassplsn nhpptpkrrg sgrhplnpgp ealskfprqp grekgpikev
      121 pgtkgsp

Chondrosarcoma-associated gene 2/3 protein, isoform X2 XP_016885512.1
        1 mwmgliqlve gvkrkdqgfl ekefyhktni kmrceflacw paftvlgeaw rdqvdwsrll
       61 rdtglvkmsr kprassplsn nhpptpkrfp rqpgrekgpi kevpgtkgsp

Chondroitin sulfate proteoglycan 4 precursor NP_001888.2
        1 mqsgprpplp apglalaltl tmlarlasaa sffgenhlev pvataltdid lqlqfstsqp
       61 eallllaagp adhlllqlys grlqvrlvlg qeelrlqtpa etllsdsiph tvvltvvegw
      121 atlsvdgfln assavpgapl evpyglfvgg tgtlglpylr gtsrplrgcl haatlngrsl
      181 lrpltpdvhe gcaeefsasd dvalgfsgph slaafpawgt qdegtleftl ttqsrqapla
      241 fqaggrrgdf iyvdifeghl ravvekgqgt vllhnsvpva dgqphevsvh inahrleisv
      301 dqypthtsnr gvlsyleprg slllggldae asrhlqehrl gltpeatnas llgcmedlsv
      361 ngqrrglrea lltrnmaagc rleeeeyedd ayghyeafst lapeawpame lpepcvpepg
      421 lppvfanftq lltisplvva eggtawlewr hvqptldlme aelrksqvlf svtrgarhge
      481 leldipgaqa rkmftlldvv nrkarfihdg sedtsdqlvl evsvtarvpm psclrrgqty
      541 llpiqvnpvn dpphiifphg slmvilehtq kplgpevfqa ydpdsacegl tfqvlgtssg
      601 lpverrdqpg epatefscre leagslvyvh rggpaqdltf rvsdglqasp patlkvvair
      661 paiqihrstg lrlaqgsamp ilpanlsvet navgqdvsvl frvtgalqfg elqkqgaggv
      721 egaewwatqa fhqrdveqgr vrylstdpqh haydtvenla levqvgqeil snlsfpvtiq
      781 ratvwmlrle plhtqntqqe tlttahleat leeagpsppt fhyevvqapr kgnlqlqgtr
      841 lsdgqgftqd diqagrvtyg ataraseave dtfrfrvtap pyfsplytfp ihiggdpdap
      901 vltnvllvvp eggegvlsad hlfvkslnsa sylyevmerp rhgrlawrgt qdkttmvtsf
      961 tnedllrgrl vyqhddsett eddipfvatr qgessgdmaw eevrgvfrva iqpvndhapv
     1021 qtisrifhva rggrrllttd dvafsdadsg fadaqlvltr kdllfgsiva vdeptrpiyr
     1081 ftqedlrkrr vlfvhsgadr gwiqlqvsdg qhqatallev qasepylrva ngsslvvpqg
     1141 gqgtidtavl hldtnldirs gdevhyhvta gprwgqlvra gqpatafsqq dlldgavlys
     1201 hngslsprdt mafsveagpv htdatlqvti alegplaplk lvrhkkiyvf qgeaaeirrd
     1261 qleaaqeavp padivfsvks ppsagylvmv srgaladepp sldpvqsfsq eavdtgrvly
     1321 lhsrpeawsd afsldvasgl gaplegvlve levlpaaipl eaqnfsvpeg gsltlappll
     1381 rvsgpyfptl lglslqvlep pqhgalqked gpqartlsaf swrmveeqli ryvhdgsetl
     1441 tdsfvlmana semdrqshpv aftvtvlpvn dqppilttnt glqmwegata pipaealrst
     1501 dgdsgsedlv ytieqpsngr vvlrgapgte vrsftqaqld gglvlfshrg tldggfrfrl
     1561 sdgehtspgh ffrvtaqkqv llslkgsqtl tvcpgsvqpl ssqtlrasss agtdpqllly
     1621 rvvrgpqlgr lfhaqqdstg ealvnftqae vyagnilyeh emppepfwea hdtlelqlss
     1681 ppardvaatl avavsfeaac pqrpshlwkn kglwvpegqr aritvaalda snllasvpsp
     1741 qrsehdvlfq vtqfpsrgql lvseeplhag qphflqsqla agqlvyahgg ggtqqdgfhf
     1801 rahlqgpaga svagpqtsea faitvrdvne rppqpqasvp lrltrgsrap israqlsvvd
     1861 pdsapgeiey evqraphngf lslvggglgp vtrftqadvd sgrlafvang ssvagifqls
     1921 msdgaspplp mslavdilps aievqlrapl evpqalgrss lsqqqlrvvs dreepeaayr
     1981 liqgpqyghl lvggrptsaf sqfqidqgev vfaftnfsss hdhfrvlala rgvnasavvn
     2041 vtvrallhvw aggpwpqgat lrldptvlda gelanrtgsv prfrllegpr hgrvvrvpra
     2101 rtepggsqlv eqftqqdled grlglevgrp egrapgpagd sltlelwaqg vppavasldf
     2161 atepynaarp ysvallsvpe aarteagkpe sstptgepgp masspepava kggflsflea
     2221 nmfsviipmc lvllllalil pllfylrkrn ktgkhdvqvl takprnglag dtetfrkvep
     2281 gqaipltavp gqgpppggqp dpellqfcrt pnpalkngqy wv

Cancer/testis antigen 2 isoform LAGE-1a NP_758965.2
        1 mqaegrgtgg stgdadgpgg pgipdgpggn aggpgeagat ggrgprgaga arasgprgga
       61 prgphggaas aqdgrcpcga rrpdsrllel hitmpfsspm eaelvrrils rdaaplprpg
      121 avlkdftvsg nllfirltaa dhrqlqlsis sclqqlsllm witqcflpvf laqapsgqrr

Cancer/testis antigen 2 isoform LAGE-1b NP_066274.2
        1 mqaegrgtgg stgdadgpgg pgipdgpggn aggpgeagat ggrgprgaga arasgprgga
       61 prgphggaas aqdgrcpcga rrpdsrllel hitmpfsspm eaelvrrils rdaaplprpg
      121 avlkdftvsg nllfmsvrdq dregagrmrv vgwglgsasp egqkardlrt pkhkvseqrp
```

```
      181 gtpgppppeg aqgdgcrgva fnvmfsaphi

Transcriptional repressor CTCFL, isoform 1 NP_001255969.1, NP_001255970.1,
NP_542185.2
        1 maateisvls eqftkikele lmpekglkee ekdgvcrekd hrspseleae rtsgafqdsv
       61 leeevelvla pseesekyil tlqtvhftse avelqdmsll siqqqegvqv vvqqpgpgll
      121 wleegprqsl qqcvaisiqq elyspqemev lqfhaleenv mvasedskla vslaettgli
      181 kleeeqeknq llaertkeql ffvetmsgde rsdeivltvs nsnveeqedq ptagqadaek
      241 akstknqrkt kgakgtfhcd vcmftssrms sfnrhmktht sekphlchlc lktfrtvtll
      301 rnhvnthtgt rpykcndcnm afvtsgelvr hrrykhthek pfkcsmckya sveasklkrh
      361 vrshtgerpf qccqcsyasr dtyklkrhmr thsgekpyec hichtrftqs gtmkihilqk
      421 hgenvpkyqc phcatiiark sdlrvhmrnl haysaaelkc rycsavfher yaliqhqkth
      481 knekrfkckh csyackqerh mtahirthtg ekpftclscn kcfrqkqlln ahfrkyhdan
      541 fiptvykcsk cgkgfsrwin lhrhsekcgs geaksaasgk grrtrkrkqt ilkeatkgqk
      601 eaakgwkeaa ngdeaaaeea sttkgeqfpg emfpvacret tarvkeevde gvtcemllnt
      661 mdk

Transcriptional repressor CTCFL, isoform 2 NP_001255971.1
        1 maateisvls eqftkikele lmpekglkee ekdgvcrekd hrspseleae rtsgafqdsv
       61 leeevelvla pseesekyil tlqtvhftse avelqdmsll siqqqegvqv vvqqpgpgll
      121 wleegprqsl qqcvaisiqq elyspqemev lqfhaleenv mvasedskla vslaettgli
      181 kleeeqeknq llaertkeql ffvetmsgde rsdeivltvs nsnveeqedq ptagqadaek
      241 akstknqrkt kgakgtfhcd vcmftssrms sfnrhmktht sekphlchlc lktfrtvtll
      301 rnhvnthtgt rpykcndcnm afvtsgelvr hrrykhthek pfkcsmckya sveasklkrh
      361 vrshtgerpf qccqcsyasr dtyklkrhmr thsgekpyec hichtrftqs gtmkihilqk
      421 hgenvpkyqc phcatiiark sdlrvhmrnl haysaaelkc rycsavfher yaliqhqkth
      481 knekrfkckh csyackqerh mtahirthtg ekpftclscn kcfrqkqlln ahfrkyhdan
      541 fiptvykcsk cgkgfsrwin lhrhsekcgs geaksaasgk grrtrkrkqt ilkeatkgqk
      601 eaakgwkeaa ngdaaaeeas ttkgeqfpge mfpvacrett arvkeevdeg vtcemllntm
      661 dk

Transcriptional repressor CTCFL, isoform 3 NP_001255972.1
        1 maateisvls eqftkikele lmpekglkee ekdgvcrekd hrspseleae rtsgafqdsv
       61 leeevelvla pseesekyil tlqtvhftse avelqdmsll siqqqegvqv vvqqpgpgll
      121 wleegprqsl qqcvaisiqq elyspqemev lqfhaleenv mvasedskla vslaettgli
      181 kleeeqeknq llaertkeql ffvetmsgde rsdeivltvs nsnveeqedq ptagqadaek
      241 akstknqrkt kgakgtfhcd vcmftssrms sfnrhmktht sekphlchlc lktfrtvtll
      301 rnhvnthtgt rpykcndcnm afvtsgelvr hrrykhthek pfkcsmckya sveasklkrh
      361 vrshtgerpf qccqcsyasr dtyklkrhmr thsgekpyec hichtrftqs gtmkihilqk
      421 hgenvpkyqc phcatiiark sdlrvhmrnl haysaaelkc rycsavfher yaliqhqkth
      481 knekrfkckh csyackqerh mtahirthtg ekpftclscn kcfrqkqlln ahfrkyhdan
      541 fiptvykcsk cgkgfsrwin lhrhsekcgs geaksaasgk grrtrkrkqt ilkeatkgqk
      601 eaakgwkeaa ngdeaaaeea sttkgeqfpg emfpvacret tarvkeevde gvtcemllnt
      661 mdnsagctgr mmlvsawllg rpqetynqgr rrrgsrrvtw

Transcriptional repressor CTCFL, isoform 4 NP_001255973.1
        1 maateisvls eqftkikele lmpekglkee ekdgvcrekd hrspseleae rtsgafqdsv
       61 leeevelvla pseesekyil tlqtvhftse avelqdmsll siqqqegvqv vvqqpgpgll
      121 wleegprqsl qqcvaisiqq elyspqemev lqfhaleenv mvasedskla vslaettgli
      181 kleeeqeknq llaertkeql ffvetmsgde rsdeivltvs nsnveeqedq ptagqadaek
      241 akstknqrkt kgakgtfhcd vcmftssrms sfnrhmktht sekphlchlc lktfrtvtll
      301 rnhvnthtgt rpykcndcnm afvtsgelvr hrrykhthek pfkcsmckya sveasklkrh
      361 vrshtgerpf qccqcsyasr dtyklkrhmr thsgekpyec hichtrftqs gtmkihilqk
      421 hgenvpkyqc phcatiiark sdlrvhmrnl haysaaelkc rycsavfher yaliqhqkth
      481 knekrfkckh csyackqerh mtahirthtg ekpftclscn kcfrqkqlln ahfrkyhdan
      541 fiptvykcsk cgkgfsrwin lhrhsekcgs geaksaasgk grrtrkrkqt ilkeatkgqk
      601 eaakgwkeaa ngdgvisahr nlcllgssds hasvsgagit darhhawliv llflvemgfy
```

```
661 hvshs

Transcriptional repressor CTCFL, isoform 5 NP_001255974.1
  1 maateisvls eqftkikele lmpekglkee ekdgvcrekd hrspseleae rtsgafqdsv
 61 leeevelvla pseesekyil tlqtvhftse avelqdmsll siqqqegvqv vvqqpgpgll
121 wleegprqsl qqcvaisiqq elyspqemev lqfhaleenv mvasedskla vslaettgli
181 kleeeqeknq llaertkeql ffvetmsgde rsdeivltvs nsnveeqedq ptagqadaek
241 akstknqrkt kgakgtfhcd vcmftssrms sfnrhmktht sekphlchlc lktfrtvtll
301 rnhvnthtgt rpykcndcnm afvtsgelvr hrrykhthek pfkcsmckya sveasklkrh
361 vrshtgerpf qccqcsyasr dtyklkrhmr thsgekpyec hichtrftqs gtmkihilqk
421 hgenvpkyqc phcatiiark sdlrvhmrnl haysaaelkc rycsavfher yaliqhqkth
481 knekrfkckh csyackqerh mtahirthtg ekpftclscn kcfrqkqlln ahfrkyhdan
541 fiptvykcsk cgkgfsrwil wvgnsevael ggpgsgpllr lqsgcppglh hpkaglgped
601 plpgqlrhtt agtglssllq gplcraa

Transcriptional repressor CTCFL, isoform 6 NP_001255975.1
  1 maateisvls eqftkikele lmpekglkee ekdgvcrekd hrspseleae rtsgafqdsv
 61 leeevelvla pseesekyil tlqtvhftse avelqdmsll siqqqegvqv vvqqpgpgll
121 wleegprqsl qqcvaisiqq elyspqemev lqfhaleenv mvasedskla vslaettgli
181 kleeeqeknq llaertkeql ffvetmsgde rsdeivltvs nsnveeqedq ptagqadaek
241 akstknqrkt kgakgtfhcd vcmftssrms sfnrhmktht sekphlchlc lktfrtvtll
301 rnhvnthtgt rpykcndcnm afvtsgelvr hrrykhthek pfkcsmckya sveasklkrh
361 vrshtgerpf qccqcsyasr dtyklkrhmr thsgvhmrnl haysaaelkc rycsavfher
421 yaliqhqkth knekrfkckh csyackqerh mtahirthtg ekpftclscn kcfrqkqlln
481 ahfrkyhdan fiptvykcsk cgkgfsrwin lhrhsekcgs geaksaasgk grrtrkrkqt
541 ilkeatkgqk eaakgwkeaa ngdeaaaeea sttkgeqfpg emfpvacret tarvkeevde
601 gvtcemllnt mdk

Transcriptional repressor CTCFL, isoform 7 NP_001255976.1
  1 maateisvls eqftkikele lmpekglkee ekdgvcrekd hrspseleae rtsgafqdsv
 61 leeevelvla pseesekyil tlqtvhftse avelqdmsll siqqqegvqv vvqqpgpgll
121 wleegprqsl qqcvaisiqq elyspqemev lqfhaleenv mvasedskla vslaettgli
181 kleeeqeknq llaertkeql ffvetmsgde rsdeivltvs nsnveeqedq ptagqadaek
241 akstknqrkt kgakgtfhcd vcmftssrms sfnrhmktht sekphlchlc lktfrtvtll
301 rnhvnthtgt rpykcndcnm afvtsgelvr hrrykhthek pfkcsmckya sveasklkrh
361 vrshtgerpf qccqcsyasr dtyklkrhmr thsgekpyec hichtrftqs gtmkihilqk
421 hgenvpkyqc phcatiiark sdlrvhmrnl haysaaelkc rycsavfher yaliqhqkth
481 knekrfkckh csyackqerh mtahirthtg ekpftclscn kcfrqkqlln ahfrkyhdan
541 fiptvykcsk cgkgfsrwit skwsglkpqt fit

Transcriptional repressor CTCFL, isoform 8 NP_001255977.1
  1 maateisvls eqftkikele lmpekglkee ekdgvcrekd hrspseleae rtsgafqdsv
 61 leeevelvla pseesekyil tlqtvhftse avelqdmsll siqqqegvqv vvqqpgpgll
121 wleegprqsl qqcvaisiqq elyspqemev lqfhaleenv mvasedskla vslaettgli
181 kleeeqeknq llaertkeql ffvetmsgde rsdeivltvs nsnveeqedq ptagqadaek
241 akstknqrkt kgakgtfhcd vcmftssrms sfnrhmktht sekphlchlc lktfrtvtll
301 rnhvnthtgt rpykcndcnm afvtsgelvr hrrykhthek pfkcsmckya sveerhmtah
361 irthtgekpf tclscnkcfr qkqllnahfr kyhdanfipt vykcskcgkg fsrwilwvgn
421 sevaelggpg sgpllrlqsg cppglhhpka glgpedplpg qlrhttagtg lssllqgplc
481 raa

Transcriptional repressor CTCFL, isoform 9 NP_001255978.1
  1 msgdersdei vltvsnsnve eqedqptagq adaekakstk nqrktkgakg tfhcdvcmft
 61 ssrmssfnrh mkthtsekph lchlclktfr tvtllrnhvn thtgtrpykc ndcnmafvts
121 gelvrhrryk hthekpfkcs mckyasveas klkrhvrsht gerpfqccqc syasrdtykl
181 krhmrthsge kpyechicht rftqsgtmki hilqkhgenv pkyqcphcat iiarksdlrv
241 hmrnlhaysa aelkcrycsa vfheryaliq hqkthknekr fkckhcsyac kqerhmtahi
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      301 rthtgekpft clscnkcfrq kqllnahfrk yhdanfiptv ykcskcgkgf srwinlhrhs
      361 ekcgsgeaks aasgkgrrtr krkqtilkea tkgqkeaakg wkeaangdgv isahrnlcll
      421 gssdshasvs gagitdarhh awlivllflv emgfyhvshs

Transcriptional repressor CTCFL, isoform 10 NP_001255979.1
        1 msgdersdei vltvsnsnve eqedqptagq adaekakstk nqrktkgakg tfhcdvcmft
       61 ssrmssfnrh mkthtsekph lchlclktfr tvtllrnhvn thtgtrpykc ndcnmafvts
      121 gelvrhrryk hthekpfkcs mckyasveas klkrhvrsht gerpfqccqc syasrdtykl
      181 krhmrthsge kpyechicht rftqsgtmki hilqkhgenv pkyqcphcat iiarksdlrv
      241 hmrnlhaysa aelkcrycsa vfheryaliq hqkthknekr fkckhcsyac kqerhmtahi
      301 rthtgekpft clscnkcfrq kqllnahfrk yhdanfiptv ykcskcgkgf srwilwvgns
      361 evaelggpgs gpllrlqsgc ppglhhpkag lgpedplpgq lrhttagtgl ssllqgplcr
      421 aa

Transcriptional repressor CTCFL, isoform 11 NP_001255980.1, NP_001255981.1
        1 maateisvls eqftkikele lmpekglkee ekdgvcrekd hrspseleae rtsgafqdsv
       61 leeevelvla pseesekyil tlqtvhftse avelqdmsll siqqqegvqv vvqqpgpgll
      121 wleegprqsl qqcvaisiqq elyspqemev lqfhaleenv mvasedskla vslaettgli
      181 kleeeqeknq llaertkeql ffvetmsgde rsdeivltvs nsnveeqedq ptagqadaek
      241 akstknqrkt kgakgtfhcd vcmftssrms sfnrhmktht sekphlchlc lktfrtvtll
      301 rnhvnthtgt rpykcndcnm afvtsgelvr hrrykhthek pfkcsmckya svevkpfldl
      361 klhgilveaa vqvtpsvtns ricykqafyy sykiyagnnm hsll

Transcriptional repressor CTCFL, isoform 12 NP_001255983.1
        1 mftssrmssf nrhmkthtse kphlchlclk tfrtvtllrn hvnthtgtrp ykcndcnmaf
       61 vtsgelvrhr rykhthekpf kcsmckyasv easklkrhvr shtgerpfqc cqcsyasrdt
      121 yklkrhmrth sgekpyechi chtrftqsgt mkihilqkhg envpkyqcph catiiarksd
      181 lrvhmrnlha ysaaelkcry csavfherya liqhqkthkn ekrfkckhcs yackqerhmt
      241 ahirthtgek pftclscnkc frqkqllnah frkyhdanfi ptvykcskcg kgfsrwinlh
      301 rhsekcgsge aksaasgkgr rtrkrkqtil keatkgqkea akgwkeaang dgvisahrnl
      361 cllgssdsha svsgagitda rhhawlivll flvemgfyhv shs

Transcriptional repressor CTCFL, isoform 13 NP_001255984.1
        1 mftssrmssf nrhmkthtse kphlchlclk tfrtvtllrn hvnthtgtrp ykcndcnmaf
       61 vtsgelvrhr rykhthekpf kcsmckyasv easklkrhvr shtgerpfqc cqcsyasrdt
      121 yklkrhmrth sgekpyechi chtrftqsgt mkihilqkhg envpkyqcph catiiarksd
      181 lrvhmrnlha ysaaelkcry csavfherya liqhqkthkn ekrfkckhcs yackqerhmt
      241 ahirthtgek pftclscnkc frqkqllnah frkyhdanfi ptvykcskcg kgfsrwvly

Cytochrome P450 1B1 NP_000095.2
        1 mgtslspndp wplnplsiqq ttllllllsvl atvhvgqrll rqrrrqlrsa ppgpfawpli
       61 gnaaavgqaa hlsfarlarr ygdvfqirlg scpivvlnge raihqalvqq gsafadrpaf
      121 asfrvvsggr smafghyseh wkvqrraahs mmrnfftrqp rsrqvleghv lsearelval
      181 lvrgsadgaf ldprpltvva vanvmsavcf gcryshddpe frellshnee fgrtvgagsl
      241 vdvmpwlqyf pnpvrtvfre feqlnrnfsn fildkflrhc eslrpgaapr dmmdafilsa
      301 ekkaagdshg ggarldlenv patitdifga sqdtlstalq wllllftryp dvqtrvqael
      361 dqvvgrdrlp cmgdqpnlpy vlaflyeamr fssfvpvtip hattantsvl gyhipkdtvv
      421 fvnqwsvnhd plkwpnpenf dparfldkdg linkdltsrv mifsvgkrrc igeelskmql
      481 flfisilahq cdfranpnep akmnfsyglt ikpksfkvnv tlresmelld savqnlqake
      541 tcq

Epidermal growth factor receptor, isoform a precursor NP_005219.2
        1 mrpsgtagaa llallaalcp asraleekkv cqgtsnkltq lgtfedhfls lqrmfnncev
       61 vlgnleityv qrnydlsflk tiqevagyvl ialntverip lenlqiirgn myyensyala
      121 vlsnydankt glkelpmrnl qeilhgavrf snnpalcnve siqwrdivss dflsnmsmdf
      181 qnhlgscqkc dpscpngscw gageencqkl tkiicaqqcs grcrgkspsd cchnqcaagc
      241 tgpresdclv crkfrdeatc kdtcpplmly npttyqmdvn pegkysfgat cvkkcprnyv
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 301 vtdhgscvra cgadsyemee dgvrkckkce gpcrkvcngi gigefkdsls inatnikhfk
 361 nctsisgdlh ilpvafrgds fthtppldpq eldilktvke itgflliqaw penrtdlhaf
 421 enleiirgrt kqhgqfslav vslnitslgl rslkeisdgd viisgnknlc yantinwkkl
 481 fgtsgqktki isnrgensck atgqvchalc spegcwgpep rdcvscrnvs rgrecvdkcn
 541 llegeprefv enseciqchp eclpqamnit ctgrgpdnci qcahyidgph cvktcpagvm
 601 genntlvwky adaghvchlc hpnctygctg pglegcptng pkipsiatgm vgallllvv
 661 algiglfmrr rhivrkrtlr rllqerelve pltpsgeapn qallrilket efkkikvlgs
 721 gafgtvykgl wipegekvki pvaikelrea tspkankeil deayvmasvd nphvcrllgi
 781 cltstvqlit qlmpfgclld yvrehkdnig sqyllnwcvq iakgmnyled rrlvhrdlaa
 841 rnvlvktpqh vkitdfglak llgaeekeyh aeggkvpikw malesilhri ythqsdvwsy
 901 gvtvwelmtf gskpydgipa seissilekg erlpqppict idvymimvkc wmidadsrpk
 961 freliiefsk mardpqrylv iqgdermhlp sptdsnfyra lmdeedmddv vdadeylipq
1021 qgffsspsts rtpllsslsa tsnnstvaci drnglqscpi kedsflqrys sdptgalted
1081 siddtflpvp eyinqsvpkr pagsvqnpvy hnqplnpaps rdphyqdphs tavgnpeyln
1141 tvqptcvnst fdspahwaqk gshqisldnp dyqqdffpke akpngifkgs taenaeylrv
1201 apqssefiga
```

Epidermal growth factor receptor, isoform b precursor NP_958439.1

```
   1 mrpsgtagaa llallaalcp asraleekkv cqgtsnkltq lgtfedhfls lqrmfnncev
  61 vlgnleityv qrnydlsflk tiqevagyvl ialntverip lenlqiirgn myyensyala
 121 vlsnydankt glkelpmrnl qeilhgavrf snnpalcnve siqwrdivss dflsnmsmdf
 181 qnhlgscqkc dpscpngscw gageencqkl tkiicaqqcs grcrgkspsd cchnqcaagc
 241 tgpresdclv crkfrdeatc kdtcpplmly npttyqmdvn pegkysfgat cvkkcprnyv
 301 vtdhgscvra cgadsyemee dgvrkckkce gpcrkvcngi gigefkdsls inatnikhfk
 361 nctsisgdlh ilpvafrgds fthtppldpq eldilktvke itgflliqaw penrtdlhaf
 421 enleiirgrt kqhgqfslav vslnitslgl rslkeisdgd viisgnknlc yantinwkkl
 481 fgtsgqktki isnrgensck atgqvchalc spegcwgpep rdcvscrnvs rgrecvdkcn
 541 llegeprefv enseciqchp eclpqamnit ctgrgpdnci qcahyidgph cvktcpagvm
 601 genntlvwky adaghvchlc hpnctygs
```

Epidermal growth factor receptor, isoform c precursor NP_958440.1

```
   1 mrpsgtagaa llallaalcp asraleekkv cqgtsnkltq lgtfedhfls lqrmfnncev
  61 vlgnleityv qrnydlsflk tiqevagyvl ialntverip lenlqiirgn myyensyala
 121 vlsnydankt glkelpmrnl qeilhgavrf snnpalcnve siqwrdivss dflsnmsmdf
 181 qnhlgscqkc dpscpngscw gageencqkl tkiicaqqcs grcrgkspsd cchnqcaagc
 241 tgpresdclv crkfrdeatc kdtcpplmly npttyqmdvn pegkysfgat cvkkcprnyv
 301 vtdhgscvra cgadsyemee dgvrkckkce gpcrkvcngi gigefkdsls inatnikhfk
 361 nctsisgdlh ilpvafrgds fthtppldpq eldilktvke itgls
```

Epidermal growth factor receptor, isoform d precursor NP_958441.1

```
   1 mrpsgtagaa llallaalcp asraleekkv cqgtsnkltq lgtfedhfls lqrmfnncev
  61 vlgnleityv qrnydlsflk tiqevagyvl ialntverip lenlqiirgn myyensyala
 121 vlsnydankt glkelpmrnl qeilhgavrf snnpalcnve siqwrdivss dflsnmsmdf
 181 qnhlgscqkc dpscpngscw gageencqkl tkiicaqqcs grcrgkspsd cchnqcaagc
 241 tgpresdclv crkfrdeatc kdtcpplmly npttyqmdvn pegkysfgat cvkkcprnyv
 301 vtdhgscvra cgadsyemee dgvrkckkce gpcrkvcngi gigefkdsls inatnikhfk
 361 nctsisgdlh ilpvafrgds fthtppldpq eldilktvke itgflliqaw penrtdlhaf
 421 enleiirgrt kqhgqfslav vslnitslgl rslkeisdgd viisgnknlc yantinwkkl
 481 fgtsgqktki isnrgensck atgqvchalc spegcwgpep rdcvscrnvs rgrecvdkcn
 541 llegeprefv enseciqchp eclpqamnit ctgrgpdnci qcahyidgph cvktcpagvm
 601 genntlvwky adaghvchlc hpnctygpgn eslkamlfcl fklsscnqsn dgsvshqsgs
 661 paaqesclgw ipsllpsefq lgwggcshlh awpsasviit assch
```

Epidermal growth factor receptor, isoform e precursor NP_001333826.1

```
   1 mrpsgtagaa llallaalcp asraleekkv cqgtsnkltq lgtfedhfls lqrmfnncev
  61 vlgnleityv qrnydlsflk tiqevagyvl ialntverip lenlqiirgn myyensyala
 121 vlsnydankt glkelpmrnl qgqkcdpscp ngscwgagee ncqkltkiic aqqcsgrcrg
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 181 kspsdcchnq caagctgpre sdclvcrkfr deatckdtcp plmlynptty qmdvnpegky
 241 sfgatcvkkc prnyvvtdhg scvracgads yemeedgvrk ckkcegpcrk vcngigigef
 301 kdslsinatn ikhfknctsi sgdlhilpva frgdsfthtp pldpqeldil ktvkeitgfl
 361 liqawpenrt dlhafenlei irgrtkqhgq fslavvslni tslglrslke isdgdviisg
 421 nknlcyanti nwkklfgtsg qktkiisnrg ensckatgqv chalcspegc wgpeprdcvs
 481 crnvsrgrec vdkcnllege prefvensec iqchpeclpq amnitctgrg pdnciqcahy
 541 idgphcvktc pagvmgennt lvwkyadagh vchlchpnct ygctgpgleg cptngpkips
 601 iatgmvgall lllvvalgig lfmrrrhivr krtlrrllqe relvepltps geapnqallr
 661 ilketefkki kvlgsgafgt vykglwipeg ekvkipvaik elreatspka nkeildeayv
 721 masvdnphvc rllgicltst vqlitqlmpf gclldyvreh kdnigsqyll nwcvqiakgm
 781 nyledrrlvh rdlaarnvlv ktpqhvkitd fglakllgae ekeyhaeggk vpikwmales
 841 ilhriythqs dvwsygvtvw elmtfgskpy dgipaseiss ilekgerlpq ppictidvym
 901 imvkcwmida dsrpkfreli iefskmardp qrylviqgde rmhlpsptds nfyralmdee
 961 dmddvvdade ylipqqgffs spstsrtpll sslsatsnns tvacidrngl qscpikedsf
1021 lqryssdptg altedsiddt flpvpgewlv wkqscsstss thsaaaslqc psqvlppasp
1081 egetvadlqt q

Epidermal growth factor receptor, isoform f precursor NP_001333827.1
   1 mrpsgtagaa llallaalcp asraleekkv cqgtsnkltq lgtfedhfls lqrmfnncev
  61 vlgnleityv qrnydlsflk tiqevagyvl ialntverip lenlqiirgn myyensyala
 121 vlsnydankt glkelpmrnl qeilhgavrf snnpalcnve siqwrdivss dflsnmsmdf
 181 qnhlgscqkc dpscpngscw gageencqkl tkiicaqqcs grcrgkspsd cchnqcaagc
 241 tgpresdclv crkfrdeatc kdtcpplmly npttyqmdvn pegkysfgat cvkkcprnyv
 301 vtdhgscvra cgadsyemee dgvrkckkce gpcrkvcngi gigefkdsls inatnikhfk
 361 nctsisgdlh ilpvafrgds fthtppldpq eldilktvke itgflliqaw penrtdlhaf
 421 enleiirgrt kqhgqfslav vslnitslgl rslkeisdgd viisgnknlc yantinwkkl
 481 fgtsgqktki isnrgensck atgqvchalc spegcwgpep rdcvscrnvs rgrecvdkcn
 541 llegeprefv enseciqchp eclpqamnit ctgrgpdnci qcahyidgph cvktcpagvm
 601 genntlvwky adaghvchlc hpnctygctg pglegcptng pkipsiatgm vgalllllvv
 661 algiglfmrr rhivrkrtlr rllqerelve pltpsgeapn qallrilket efkkikvlgs
 721 gafgtvykgl wipegekvki pvaikelrea tspkankeil deayvmasvd nphvcrllgi
 781 cltstvqlit qlmpfgclld yvrehkdnig sqyllnwcvq iakgmnyled rrlvhrdlaa
 841 rnvlvktpqh vkitdfglak llgaeekeyh aeggkvpikw malesilhri ythqsdvwsy
 901 gvtvwelmtf gskpydgipa seissilekg erlpqppict idvymimvkc wmidadsrpk
 961 freliiefsk mardpqrylv iqgdermhlp sptdsnfyra lmdeedmddv vdadeylipq
1021 qgffsspsts rtpllsslsa tsnnstvaci drnglqscpi kedsflqrys sdptgalted
1081 siddtflpvp gewlvwkqsc sstssthsaa aslqcpsqvl ppaspegetv adlqtq

Epidermal growth factor receptor, isoform g precursor NP_001333828.1
   1 mrpsgtagaa llallaalcp asraleekkv cqgtsnkltq lgtfedhfls lqrmfnncev
  61 vlgnleityv qrnydlsflk tiqevagyvl ialntverip lenlqiirgn myyensyala
 121 vlsnydankt glkelpmrnl qgqkcdpscp ngscwgagee ncqkltkiic aqqcsgrcrg
 181 kspsdcchnq caagctgpre sdclvcrkfr deatckdtcp plmlynptty qmdvnpegky
 241 sfgatcvkkc prnyvvtdhg scvracgads yemeedgvrk ckkcegpcrk vcngigigef
 301 kdslsinatn ikhfknctsi sgdlhilpva frgdsfthtp pldpqeldil ktvkeitgfl
 361 liqawpenrt dlhafenlei irgrtkqhgq fslavvslni tslglrslke isdgdviisg
 421 nknlcyanti nwkklfgtsg qktkiisnrg ensckatgqv chalcspegc wgpeprdcvs
 481 crnvsrgrec vdkcnllege prefvensec iqchpeclpq amnitctgrg pdnciqcahy
 541 idgphcvktc pagvmgennt lvwkyadagh vchlchpnct ygctgpgleg cptngpkips
 601 iatgmvgall lllvvalgig lfmrrrhivr krtlrrllqe relvepltps geapnqallr
 661 ilketefkki kvlgsgafgt vykglwipeg ekvkipvaik elreatspka nkeildeayv
 721 masvdnphvc rllgicltst vqlitqlmpf gclldyvreh kdnigsqyll nwcvqiakgm
 781 nyledrrlvh rdlaarnvlv ktpqhvkitd fglakllgae ekeyhaeggk vpikwmales
 841 ilhriythqs dvwsygvtvw elmtfgskpy dgipaseiss ilekgerlpq ppictidvym
 901 imvkcwmida dsrpkfreli iefskmardp qrylviqgde rmhlpsptds nfyralmdee
 961 dmddvvdade ylipqqgffs spstsrtpll sslsatsnns tvacidrngl qscpikedsf
1021 lqryssdptg altedsiddt flpvpeyinq svpkrpagsv qnpvyhnqpl npapsrdphy
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1081 qdphstavgn peylntvqpt cvnstfdspa hwaqkgshqi sldnpdyqqd ffpkeakpng
1141 ifkgstaena eylrvapqss efiga

Epidermal growth factor receptor, isoform h NP_001333829.1
   1 mfnncevvlg nleityvqrn ydlsflktiq evagyvlial ntveriplen lqiirgnmyy
  61 ensyalavls nydanktglk elpmrnlqei lhgavrfsnn palcnvesiq wrdivssdfl
 121 snmsmdfqnh lgscqkcdps cpngscwgag eencqkltki icaqqcsgrc rgkspsdcch
 181 nqcaagctgp resdclvcrk frdeatckdt cpplmlynpt tyqmdvnpeg kysfgatcvk
 241 kcprnyvvtd hgscvracga dsyemeedgv rkckkcegpc rkvcngigig efkdslsina
 301 tnikhfknct sisgdlhilp vafrgdsfth tppldpqeld ilktvkeitg flliqawpen
 361 rtdlhafenl eiirgrtkqh gqfslavvsl nitslglrsl keisdgdvii sgnknlcyan
 421 tinwkklfgt sgqktkiisn rgensckatg qvchalcspe gcwgpeprdc vscrnvsrgr
 481 ecvdkcnlle geprefvens eciqchpecl pqamnitctg rgpdnciqca hyidgphcvk
 541 tcpagvmgen ntlvwkyada ghvchlchpn ctygctgpgl egcptngpki psiatgmvga
 601 lllllvvalg iglfmrrrhi vrkrtlrrll qerelveplt psgeapnqal lrilketefk
 661 kikvlgsgaf gtvykglwip egekvkipva ikelreatsp kankeildea yvmasvdnph
 721 vcrllgiclt stvqlitqlm pfgclldyvr ehkdnigsqy llnwcvqiak gmnyledrrl
 781 vhrdlaarnv lvktpqhvki tdfglakllg aeekeyhaeg gkvpikwmal esilhriyth
 841 qsdvwsygvt vwelmtfgsk pydgipasei ssilekgerl pqppictidv ymimvkcwmi
 901 dadsrpkfre liiefskmar dpqrylviqg dermhlpspt dsnfyralmd eedmddvvda
 961 deylipqqgf fsspstsrtp llsslsatsn nstvacidrn glqscpiked sflqryssdp
1021 tgaltedsid dtflpvpeyi nqsvpkrpag svqnpvyhnq plnpapsrdp hyqdphstav
1081 gnpeylntvq ptcvnstfds pahwaqkgsh qisldnpdyq qdffpkeakp ngifkgstae
1141 naeylrvapq ssefiga

Epidermal growth factor receptor, isoform i precursor NP_001333870.1
   1 mrpsgtagaa llallaalcp asraleekkg nyvvtdhgsc vracgadsye meedgvrkck
  61 kcegpcrkvc ngigigefkd slsinatnik hfknctsisg dlhilpvafr gdsfthtppl
 121 dpqeldilkt vkeitgflli qawpenrtdl hafenleiir grtkqhgqfs lavvslnits
 181 lglrslkeis dgdviisgnk nlcyantinw kklfgtsgqk tkiisnrgen sckatgqvch
 241 alcspegcwg peprdcvscr nvsrgrecvd kcnllegepr efvenseciq chpeclpqam
 301 nitctgrgpd nciqcahyid gphcvktcpa gvmgenntlv wkyadaghvc hlchpnctyg
 361 ctgpglegcp tngpkipsia tgmvgallll lvvalgiglf mrrrhivrkr tlrrllqere
 421 lvepltpsge apnqallril ketefkkikv lgsgafgtvy kglwipegek vkipvaikel
 481 reatspkank eildeayvma svdnphvcrl lgicltstvq litqlmpfgc lldyvrehkd
 541 nigsqyllnw cvqiakgmny ledrrlvhrd laarnvlvkt pqhvkitdfg lakllgaeek
 601 eyhaeggkvp ikwmalesil hriythqsdv wsygvtvwel mtfgskpydg ipaseissil
 661 ekgerlpqpp ictidvymim vkcwmidads rpkfreliie fskmardpqr ylviqgderm
 721 hlpsptdsnf yralmdeedm ddvvdadeyl ipqqgffssp stsrtpllss lsatsnnstv
 781 acidrnglqs cpikedsflq ryssdptgal tedsiddtfl pvpeyinqsv pkrpagsvqn
 841 pvyhnqplnp apsrdphyqd phstavgnpe ylntvqptcv nstfdspahw aqkgshqisl
 901 dnpdyqqdff pkeakpngif kgstaenaey lrvapqssef iga

Epithelial cell adhesion molecule NP_002345.2
   1 mappqvlafg lllaaatatf aaaqeecvce nyklavncfv nnnrqcqcts vgaqntvics
  61 klaakclvmk aemngsklgr rakpegalqn ndglydpdcd esglfkakqc ngtsmcwcvn
 121 tagvrrtdkd teitcservr tywiiielkh karekpydsk slrtalqkei ttryqldpkf
 181 itsilyennv itidlvqnss qktqndvdia dvayyfekdv kgeslfhskk mdltvngeql
 241 dldpgqtliy yvdekapefs mqglkagvia vivvvviavv agivvlvisr kkrmakyeka
 301 eikemgemhr elna

Ephrin type-A receptor 2, isoform 1 precursor NP_004422.2
   1 melqaaracf allwgcalaa aaaaqgkevv lldfaaagge lgwlthpygk gwdlmqnimn
  61 dmpiymysvc nvmsgdqdnw lrtnwvyrge aerifielkf tvrdcnsfpg gasscketfn
 121 lyyaesdldy gtnfqkrlft kidtiapdei tvssdfearh vklnveersv gpltrkgfyl
 181 afqdigacva llsvrvyykk cpellqglah fpetiagsda pslatvagtc vdhavvppgg
 241 eeprmhcavd gewlvpigqc lcqagyekve dacqacspgf fkfeasespc lecpehtlps
```

```
 301 pegatscece egffrapqdp asmpctrpps aphyltavgm gakvelrwtp pqdsggredi
 361 vysvtceqcw pesgecgpce asvrysepph gltrtsvtvs dlephmnytf tvearngvsg
 421 lvtsrsfrta svsinqtepp kvrlegrstt slsvswsipp pqqsrvwkye vtyrkkgdsn
 481 synvrrtegf svtlddlapd ttylvqvqal tqegqgagsk vhefqtlspe gsgnlavigg
 541 vavgvvlllv lagvgffihr rrknqrarqs pedvyfskse qlkplktyvd phtyedpnqa
 601 vlkftteihp scvtrqkvig agefgevykg mlktssgkke vpvaiktlka gytekqrvdf
 661 lgeagimgqf shhniirleg viskykpmmi iteymengal dkflrekdge fsvlqlvgml
 721 rgiaagmkyl anmnyvhrdl aarnilvnsn lvckvsdfgl srvleddpea tyttsggkip
 781 irwtapeais yrkftsasdv wsfgivmwev mtygerpywe lsnhevmkai ndgfrlptpm
 841 dcpsaiyqlm mqcwqqerar rpkfadivsi ldklirapds lktladfdpr vsirlpstsg
 901 segvpfrtvs ewlesikmqq ytehfmaagy taiekvvqmt nddikrigvr lpghqkriay
 961 sllglkdqvn tvgipi
```

Ephrin type-A receptor 2, isoform 2 NP_001316019.1

```
   1 mqnimndmpi ymysvcnvms gdqdnwlrtn wvyrgeaeri fielkftvrd cnsfpggass
  61 cketfnlyya esdldygtnf qkrlftkidt iapdeitvss dfearhvkln veersvgplt
 121 rkgfylafqd igacvallsv rvyykkcpel lqglahfpet iagsdapsla tvagtcvdha
 181 vvppggeepr mhcavdgewl vpigqclcqa gyekvedacq acspgffkfe asespclecp
 241 ehtlpspega tsceceegff rapqdpasmp ctrppsaphy ltavgmgakv elrwtppqds
 301 ggredivysv tceqcwpesg ecgpceasvr ysepphgltr tsvtvsdlep hmnytftvea
 361 rngvsglvts rsfrtasvsi nqteppkvrl egrsttslsv swsipppqqs rvwkyevtyr
 421 kkgdsnsynv rrtegfsvtl ddlapdttyl vqvqaltqeg qgagskvhef qtlspegsgn
 481 laviggvavg vvlllvlagv gffihrrrkn qrarqspedv yfskseqlkp lktyvdphty
 541 edpnqavlkf tteihpscvt rqkvigagef gevykgmlkt ssgkkevpva iktlkagyte
 601 kqrvdflgea gimgqfshhn iirlegvisk ykpmmiitey mengaldkfl rekdgefsvl
 661 qlvgmlrgia agmkylanmn yvhrdlaarn ilvnsnlvck vsdfglsrvl eddpeatytt
 721 sggkipirwt apeaisyrkf tsasdvwsfg ivmwevmtyg erpywelsnh evmkaindgf
 781 rlptpmdcps aiyqlmmqcw qqerarrpkf adivsildkl irapdslktl adfdprvsir
 841 lpstsgsegv pfrtvsewle sikmqqyteh fmaagytaie kvvqmtnddi krigvrlpgh
 901 qkriaysllg lkdqvntvgi pi
```

Receptor-tyrosine-protein kinase erbB-2, isoform a precursor NP_004439.2

```
   1 melaalcrwg lllallppga astqvctgtd mklrlpaspe thldmlrhly qgcqvvqgnl
  61 eltylptnas lsflqdiqev qgyvliahnq vrqvplqrlr ivrgtqlfed nyalavldng
 121 dplnnttpvt gaspgglrel qlrslteilk ggvliqrnpq lcyqdtilwk difhknnqla
 181 ltlidtnrsr achpcspmck gsrcwgesse dcqsltrtvc aggcarckgp lptdccheqc
 241 aagctgpkhs dclaclhfnh sgicelhcpa lvtyntdtfe smpnpegryt fgascvtacp
 301 ynylstdvgs ctlvcplhnq evtaedgtqr cekcskpcar vcyglgmehl revravtsan
 361 iqefagckki fgslaflpes fdgdpasnta plqpeqlqvf etleeitgyl yisawpdslp
 421 dlsvfqnlqv irgrilhnga ysltlqglgi swlglrslre lgsglalihh nthlcfvhtv
 481 pwdqlfrnph qallhtanrp edecvgegla chqlcarghc wgpgptqcvn csqflrgqec
 541 veecrvlqgl preyvnarhc lpchpecqpq ngsvtcfgpe adqcvacahy kdppfcvarc
 601 psgvkpdlsy mpiwkfpdee gacqpcpinc thscvdlddk gcpaeqrasp ltsiisavvg
 661 illvvvlgvv fgilikrrqq kirkytmrrl lqetelvepl tpsgampnqa qmrilketel
 721 rkvkvlgsga fgtvykgiwi pdgenvkipv aikvlrents pkankeilde ayvmagvgsp
 781 yvsrllgicl tstvqlvtql mpygclldhv renrgrlgsq dllnwcmqia kgmsyledvr
 841 lvhrdlaarn vlvkspnhvk itdfglarll dideteyhad ggkvpikwma lesilrrrft
 901 hqsdvwsygv tvwelmtfga kpydgipare ipdllekger lpqppictid vymimvkcwm
 961 idsecrprfr elvsefsrma rdpqrfvviq nedlgpaspl dstfyrslle dddmgdlvda
1021 eeylvpqqgf fcpdpapgag gmvhhrhrss strsgggdlt lglepseeea prsplapseg
1081 agsdvfdgdl gmgaakglqs lpthdpsplq rysedptvpl psetdgyvap ltcspqpeyv
1141 nqpdvrpqpp spregplpaa rpagatlerp ktlspgkngv vkdvfafgga venpeyltpq
1201 ggaapqphpp pafspafdnl yywdqdpper gappstfkgt ptaenpeylg ldvpv
```

Receptor-tyrosine-protein kinase erbB-2, isoform b NP_001005862.1

```
   1 mklrlpaspe thldmlrhly qgcqvvqgnl eltylptnas lsflqdiqev qgyvliahnq
  61 vrqvplqrlr ivrgtqlfed nyalavldng dplnnttpvt gaspgglrel qlrslteilk
```

```
 121 ggvliqrnpq lcyqdtilwk difhknnqla ltlidtnrsr achpcspmck gsrcwgesse
 181 dcqsltrtvc aggcarckgp lptdccheqc aagctgpkhs dclaclhfnh sgicelhcpa
 241 lvtyntdtfe smpnpegryt fgascvtacp ynylstdvgs ctlvcplhnq evtaedgtqr
 301 cekcskpcar vcyglgmehl revravtsan iqefagckki fgslaflpes fdgdpasnta
 361 plqpeqlqvf etleeitgyl yisawpdslp dlsvfqnlqv irgrilhnga ysltlqglgi
 421 swlglrslre lgsglalihh nthlcfvhtv pwdqlfrnph qallhtanrp edecvgegla
 481 chqlcarghc wgpgptqcvn csqflrgqec veecrvlqgl preyvnarhc lpchpecqpq
 541 ngsvtcfgpe adqcvacahy kdppfcvarc psgvkpdlsy mpiwkfpdee gacqpcpinc
 601 thscvdlddk gcpaeqrasp ltsiisavvg illvvvlgvv fgilikrrqq kirkytmrrl
 661 lqetelvepl tpsgampnqa qmrilketel rkvkvlgsga fgtvykgiwi pdgenvkipv
 721 aikvlrents pkankeilde ayvmagvgsp yvsrllgicl tstvqlvtql mpygclldhv
 781 renrgrlgsq dllnwcmqia kgmsyledvr lvhrdlaarn vlvkspnhvk itdfglarll
 841 dideteyhad ggkvpikwma lesilrrrft hqsdvwsygv tvwelmtfga kpydgipare
 901 ipdllekger lpqppictid vymimvkcwm idsecrprfr elvsefsrma rdpqrfvviq
 961 nedlgpaspl dstfyrslle dddmgdlvda eeylvpqqgf fcpdpapgag gmvhhrhrss
1021 strsgggdlt lglepseeea prsplapseg agsdvfdgdl gmgaakglqs lpthdpsplq
1081 rysedptvpl psetdgyvap ltcspqpeyv nqpdvrpqpp spregplpaa rpagatlerp
1141 ktlspgkngv vkdvfafgga venpeyltpq ggaapqphpp pafspafdnl yywdqdpper
1201 gappstfkgt ptaenpeylg ldvpv
```

Receptor-tyrosine-protein kinase erbB-2, isoform c NP_001276865.1

```
   1 mprgswkpqv ctgtdmklrl paspethldm lrhlyqgcqv vqgnleltyl ptnaslsflq
  61 diqevqgyvl iahnqvrqvp lqrlrivrgt qlfednyala vldngdplnn ttpvtgaspg
 121 glrelqlrsl teilkggvli qrnpqlcyqd tilwkdifhk nnqlaltlid tnrsrachpc
 181 spmckgsrcw gessedcqsl trtvcaggca rckgplptdc cheqcaagct gpkhsdclac
 241 lhfnhsgice lhcpalvtyn tdtfesmpnp egrytfgasc vtacpynyls tdvgsctlvc
 301 plhnqevtae dgtqrcekcs kpcarvcygl gmehlrevra vtsaniqefa gckkifgsla
 361 flpesfdgdp asntaplqpe qlqvfetlee itgylyisaw pdslpdlsvf qnlqvirgri
 421 lhngaysltl qglgiswlgl rslrelgsgl alihhnthlc fvhtvpwdql frnphqallh
 481 tanrpedecv geglachqlc arghcwgpgp tqcvncsqfl rgqecveecr vlqglpreyv
 541 narhclpchp ecqpqngsvt cfgpeadqcv acahykdppf cvarcpsgvk pdlsympiwk
 601 fpdeegacqp cpincthscv dlddkgcpae qraspltsii savvgillvv vlgvvfgili
 661 krrqqkirky tmrrllqete lvepltpsga mpnqaqmril ketelrkvkv lgsgafgtvy
 721 kgiwipdgen vkipvaikvl rentspkank eildeayvma gvgspyvsrl lgicltstvq
 781 lvtqlmpygc lldhvrenrg rlgsqdllnw cmqiakgmsy ledvrlvhrd laarnvlvks
 841 pnhvkitdfg larlldidet eyhadggkvp ikwmalesil rrrfthqsdv wsygvtvwel
 901 mtfgakpydg ipareipdll ekgerlpqpp ictidvymim vkcwmidsec rprfrelvse
 961 fsrmardpqr fvviqnedlg paspldstfy rslledddmg dlvdaeeylv pqqgffcpdp
1021 apgaggmvhh rhrssstrsg ggdltlglep seeeaprspl apsegagsdv fdgdlgmgaa
1081 kglqslpthd psplqrysed ptvplpsetd gyvapltcsp qpeyvnqpdv rpqppspreg
1141 plpaarpaga tlerpktlsp gkngvvkdvf afggavenpe yltpqggaap qphpppafsp
1201 afdnlyywdq dppergapps tfkgtptaen peylgldvpv
```

Receptor-tyrosine-protein kinase erbB-2, isoform d NP_001276866.1

```
   1 melaalcrwg lllallppga astqvctgtd mklrlpaspe thldmlrhly qgcqvvqgnl
  61 eltylptnas lsflqdiqev qgyvliahnq vrqvplqrlr ivrgtqlfed nyalavldng
 121 dplnnttpvt gaspgglrel qlrslteilk ggvliqrnpq lcyqdtilwk difhknnqla
 181 ltlidtnrsr achpcspmck gsrcwgesse dcqsltrtvc aggcarckgp lptdccheqc
 241 aagctgpkhs dclaclhfnh sgicelhcpa lvtyntdtfe smpnpegryt fgascvtacp
 301 ynylstdvgs ctlvcplhnq evtaedgtqr cekcskpcar vcyglgmehl revravtsan
 361 iqefagckki fgslaflpes fdgdpasnta plqpeqlqvf etleeitgyl yisawpdslp
 421 dlsvfqnlqv irgrilhnga ysltlqglgi swlglrslre lgsglalihh nthlcfvhtv
 481 pwdqlfrnph qallhtanrp edecvgegla chqlcarghc wgpgptqcvn csqflrgqec
 541 veecrvlqgl preyvnarhc lpchpecqpq ngsvtcfgpe adqcvacahy kdppfcvarc
 601 psgvkpdlsy mpiwkfpdee gacqpcpinc thscvdlddk gcpaeqrasp ltsiisavvg
 661 illvvvlgvv fgilikrrqq kirkytmrrl lqetelvepl tpsgampnqa qmrilketel
 721 rkvkvlgsga fgtvykgiwi pdgenvkipv aikvlrents pkankeilde ayvmagvgsp
```

```
 781 yvsrllgicl tstvqlvtql mpygclldhv renrgrlgsq dllnwcmqia kgmsyledvr
 841 lvhrdlaarn vlvkspnhvk itdfglarll dideteyhad ggkvpikwma lesilrrrft
 901 hqsdvwsygv tvwelmtfga kpydgipare ipdllekger lpqppictid vymimvkcwm
 961 idsecrprfr elvsefsrma rdpqrfvviq nedlgpaspl dstfyrslle dddmgdlvda
1021 eeylvpqqgf fcpdpapgag gmvhhrhrss strnm
```

Receptor-tyrosine-protein kinase erbB-2, isoform e NP_001276867.1

```
   1 mklrlpaspe thldmlrhly qgcqvvqgnl eltylptnas lsflqdiqev qgyvliahnq
  61 vrqvplqrlr ivrgtqlfed nyalavldng dplnnttpvt gaspgglrel qlrslteilk
 121 ggvliqrnpq lcyqdtilwk difhknnqla ltlidtnrsr achpcspmck gsrcwgesse
 181 dcqsltrtvc aggcarckgp lptdccheqc aagctgpkhs dclaclhfnh sgicelhcpa
 241 lvtyntdtfe smpnpegryt fgascvtacp ynylstdvgs ctlvcplhnq evtaedgtqr
 301 cekcskpcar vcyglgmehl revravtsan iqefagckki fgslaflpes fdgdpasnta
 361 plqpeqlqvf etleeitgyl yisawpdslp dlsvfqnlqv irgrilhnga ysltlqglgi
 421 swlglrslre lgsglalihh nthlcfvhtv pwdqlfrnph qallhtanrp edecvgegla
 481 chqlcarghc wgpgptqcvn csqflrgqec veecrvlqgl preyvnarhc lpchpecqpq
 541 ngsvtcfgpe adqcvacahy kdppfcvarc psgvkpdlsy mpiwkfpdee gacqpcpinc
 601 ths
```

Receptor tyrosine-protein kinase erbB-4, isoform JM-a/CVT-1 precursor NP_005226.1

```
   1 mkpatglwvw vsllvaagtv qpsdsqsvca gtenklssls dleqqyralr kyyencevvm
  61 gnleitsieh nrdlsflrsv revtgyvlva lnqfrylple nlriirgtkl yedryalaif
 121 lnyrkdgnfg lqelglknlt eilnggvyvd qnkflcyadt ihwqdivrnp wpsnltlvst
 181 ngssgcgrch ksctgrcwgp tenhcqtltr tvcaeqcdgr cygpyvsdcc hrecaggcsg
 241 pkdtdcfacm nfndsgacvt qcpqtfvynp ttfqlehnfn akytygafcv kkcphnfvvd
 301 ssscvracps skmeveengi kmckpctdic pkacdgigtg slmsaqtvds snidkfinct
 361 kingnliflv tgihgdpyna ieaidpekln vfrtvreitg flniqswppn mtdfsvfsnl
 421 vtiggrvlys glslllilkqq gitslqfqsl keisagniyi tdnsnlcyyh tinwttlfst
 481 inqrivirdn rkaenctaeg mvcnhlcssd gcwgpgpdqc lscrrfsrgr iciescnlyd
 541 gefrefengs icvecdpqce kmedglltch gpgpdnctkc shfkdgpncv ekcpdglqga
 601 nsfifkyadp drechpchpn ctqgcngpts hdciyypwtg hstlpqhart pliaagvigg
 661 lfilvivglt favyvrrksi kkkralrrfl etelvepltp sgtapnqaql rilketelkr
 721 vkvlgsgafg tvykgiwvpe getvkipvai kilnettgpk anvefmdeal imasmdhphl
 781 vrllgvclsp tiqlvtqlmp hgclleyvhe hkdnigsqll lnwcvqiakg mmyleerrlv
 841 hrdlaarnvl vkspnhvkit dfglarlleg dekeynadgg kmpikwmale cihyrkfthq
 901 sdvwsygvti welmtfggkp ydgiptreip dllekgerlp qppictidvy mvmvkcwmid
 961 adsrpkfkel aaefsrmard pqrylviqgd drmklpspnd skffqnllde edledmmdae
1021 eylvpqafni pppiytsrar idsnrseigh spppaytpms gnqfvyrdgg faaeqgvsvp
1081 yraptstipe apvaqgatae ifddsccngt lrkpvaphvq edsstqrysa dptvfapers
1141 prgeldeegy mtpmrdkpkq eylnpveenp fvsrrkngdl qaldnpeyhn asngppkaed
1201 eyvneplyln tfantlgkae ylknnilsmp ekakkafdnp dywnhslppr stlqhpdylq
1261 eystkyfykq ngrirpivae npeylsefsl kpgtvlpppp yrhrntvv
```

Receptor tyrosine-protein kinase erbB-4, isoform JM-a/CVT-2 precursor NP_001036064.1

```
   1 mkpatglwvw vsllvaagtv qpsdsqsvca gtenklssls dleqqyralr kyyencevvm
  61 gnleitsieh nrdlsflrsv revtgyvlva lnqfrylple nlriirgtkl yedryalaif
 121 lnyrkdgnfg lqelglknlt eilnggvyvd qnkflcyadt ihwqdivrnp wpsnltlvst
 181 ngssgcgrch ksctgrcwgp tenhcqtltr tvcaeqcdgr cygpyvsdcc hrecaggcsg
 241 pkdtdcfacm nfndsgacvt qcpqtfvynp ttfqlehnfn akytygafcv kkcphnfvvd
 301 ssscvracps skmeveengi kmckpctdic pkacdgigtg slmsaqtvds snidkfinct
 361 kingnliflv tgihgdpyna ieaidpekln vfrtvreitg flniqswppn mtdfsvfsnl
 421 vtiggrvlys glslllilkqq gitslqfqsl keisagniyi tdnsnlcyyh tinwttlfst
 481 inqrivirdn rkaenctaeg mvcnhlcssd gcwgpgpdqc lscrrfsrgr iciescnlyd
 541 gefrefengs icvecdpqce kmedglltch gpgpdnctkc shfkdgpncv ekcpdglqga
 601 nsfifkyadp drechpchpn ctqgcngpts hdciyypwtg hstlpqhart pliaagvigg
```

```
 661 lfilvivglt favyvrrksi kkkralrrfl etelvepltp sgtapnqaql rilketelkr
 721 vkvlgsgafg tvykgiwvpe getvkipvai kilnettgpk anvefmdeal imasmdhphl
 781 vrllgvclsp tiqlvtqlmp hgclleyvhe hkdnigsqll lnwcvqiakg mmyleerrlv
 841 hrdlaarnvl vkspnhvkit dfglarlleg dekeynadgg kmpikwmale cihyrkfthq
 901 sdvwsygvti welmtfggkp ydgiptreip dllekgerlp qppictidvy mvmvkcwmid
 961 adsrpkfkel aaefsrmard pqrylviqgd drmklpspnd skffqnllde edledmmdae
1021 eylvpqafni pppiytsrar idsnrnqfvy rdggfaaeqg vsvpyrapts tipeapvaqg
1081 ataeifddsc cngtlrkpva phvqedsstq rysadptvfa persprgeld eegymtpmrd
1141 kpkqeylnpv eenpfvsrrk ngdlqaldnp eyhnasngpp kaedeyvnep lylntfantl
1201 gkaeylknni lsmpekakka fdnpdywnhs lpprstlqhp dylqeystky fykqngrirp
1261 ivaenpeyls efslkpgtvl ppppyrhrnt vv
```

Prolyl endopeptidase FAP, isoform 1 NP_004451.2

```
   1 mktwvkivfg vatsavlall vmcivlrpsr vhnseentmr altlkdilng tfsyktffpn
  61 wisgqeylhq sadnnivlyn ietgqsytil snrtmksvna snyglspdrq fvylesdysk
 121 lwrysytaty yiydlsngef vrgnelprpi qylcwspvgs klayvyqnni ylkqrpgdpp
 181 fqitfngren kifngipdwv yeeemlatky alwwspngkf layaefndtd ipviaysyyg
 241 deqyprtini pypkagaknp vvrifiidtt ypayvgpqev pvpamiassd yyfswltwvt
 301 dervclqwlk rvqnvsvlsi cdfredwqtw dcpktqehie esrtgwaggf fvstpvfsyd
 361 aisyykifsd kdgykhihyi kdtvenaiqi tsgkweaini frvtqdslfy ssnefeeypg
 421 rrniyrisig syppskkcvt chlrkercqy ytasfsdyak yyalvcygpg ipistlhdgr
 481 tdqeikilee nkelenalkn iqlpkeeikk levdeitlwy kmilppqfdr skkyplliqv
 541 yggpcsqsvr svfavnwisy laskegmvia lvdgrgtafq gdkllyavyr klgvyevedq
 601 itavrkfiem gfidekriai wgwsyggyvs slalasgtgl fkcgiavapv ssweyyasvy
 661 terfmglptk ddnlehykns tvmaraeyfr nvdyllihgt addnvhfqns aqiakalvna
 721 qvdfqamwys dqnhglsgls tnhlythmth flkqcfslsd
```

Prolyl endopeptidase FAP, isoform 2 NP_001278736.1

```
   1 mktwvkivfg vatsavlall vmcivlrpsr vhnseentmr altlkdilng tfsyktffpn
  61 wisgqeylhq sadnnivlyn ietgqsytil snrtmlwrys ytatyyiydl sngefvrgne
 121 lprpiqylcw spvgsklayv yqnniylkqr pgdppfqitf ngrenkifng ipdwvyeeem
 181 latkyalwws pngkflayae fndtdipvia ysyygdeqyp rtinipypka gaknpvvrif
 241 iidttypayv gpqevpvpam iassdyyfsw ltwvtdervc lqwlkrvqnv svlsicdfre
 301 dwqtwdcpkt qehieesrtg waggffvstp vfsydaisyy kifsdkdgyk hihyikdtve
 361 naiqitsgkw eainifrvtq dslfyssnef eeypgrrniy risigsypps kkcvtchlrk
 421 ercqyytasf sdyakyyalv cygpgipist lhdgrtdqei kileenkele nalkniqlpk
 481 eeikklevde itlwykmilp pqfdrskkyp lliqvyggpc sqsvrsvfav nwisylaske
 541 gmvialvdgr gtafqggdkll yavyrklgvy evedqitavr kfiemgfide kriaiwgwsy
 601 ggyvsslala sgtglfkcgi avapvsswey yasvyterfm glptkddnle hyknstvmar
 661 aeyfrnvdyl lihgtaddnv hfqnsaqiak alvnaqvdfq amwysdqnhg lsglstnhly
 721 thmthflkqc fslsd
```

Glutamate carboxypeptidase 2, isoform 1 NP_004467.1

```
   1 mwnllhetds avatarrprw lcagalvlag gffllgflfg wfikssneat nitpkhnmka
  61 fldelkaeni kkflynftqi phlagteqnf qlakqiqsqw kefgldsvel ahydvllsyp
 121 nkthpnyisi inedgneifn tslfeppppg yenvsdivpp fsafspqgmp egdlvyvnya
 181 rtedffkler dmkincsgki viarygkvfr gnkvknaqla gakgvilysd padyfapgvk
 241 sypdgwnlpg ggvqrgniln lngagdpltp gypaneyayr rgiaeavglp sipvhpigyy
 301 daqkllekmg gsappdsswr gslkvpynvg pgftgnfstq kvkmhihstn evtriynvig
 361 tlrgavepdr yvilgghrds wvfggidpqs gaavvheivr sfgtlkkegw rprrtilfas
 421 wdaeefgllg stewaeensr llqergvayi nadssiegny tlrvdctplm yslvhnltke
 481 lkspdegfeg kslyeswtkk spspefsgmp risklgsgnd fevffqrlgi asgrarytkn
 541 wetnkfsgyp lyhsvyetye lvekfydpmf kyhltvaqvr ggmvfelans ivlpfdcrdy
 601 avvlrkyadk iysismkhpq emktysvsfd slfsavknft eiaskfserl qdfdksnpiv
 661 lrmmndqlmf lerafidplg lpdrpfyrhv iyapsshnky agesfpgiyd alfdieskvd
 721 pskawgevkr qiyvaaftvq aaaetlseva
```

Glutamate carboxypeptidase 2, isoform 2 NP_001014986.1
1 mwnllhetds avatarrprw lcagalvlag gffllgflfg wfikssneat nitpkhnmka
61 fldelkaeni kkflynftqi phlagteqnf qlakqiqsqw kefgldsvel ahydvllsyp
121 nkthpnyisi inedgneifn tslfeppppg yenvsdivpp fsafspqgmp egdlvyvnya
181 rtedffkler dmkincsgki viarygkvfr gnkvknaqla gakgvilysd padyfapgvk
241 sypdgwnlpg ggvqrgniln lngagdpltp gypaneyayr rgiaeavglp sipvhpigyy
301 daqkllekmg gsappdsswr gslkvpynvg pgftgnfstq kvkmhihstn evtriynvig
361 tlrgavepdr yvilgghrds wvfggidpqs gaavvheivr sfgtlkkegw rprrtilfas
421 wdaeefgllg stewaeensr llqergvayi nadssiegny tlrvdctplm yslvhnltke
481 lkspdegfeg kslyeswtkk spspefsgmp risklgsgnd fevffqrlgi asgrarytkn
541 wetnkfsgyp lyhsvyetye lvekfydpmf kyhltvaqvr ggmvfelans ivlpfdcrdy
601 avvlrkyadk iysismkhpq emktysvsfd slfsavknft eiaskfserl qdfdkskhvi
661 yapsshnkya gesfpgiyda lfdieskvdp skawgevkrq iyvaaftvqa aaetlseva

Glutamate carboxypeptidase 2, isoform 3 NP_001180400.1
1 mtagssyplf laayactgcl aerlgwfiks sneatnitpk hnmkafldel kaenikkfly
61 nftqiphlag teqnfqlakq iqsqwkefgl dsvelahydv llsypnkthp nyisiinedg
121 neifntslfe ppppgyenvs divppfsafs pqgmpegdlv yvnyartedf fklerdmkin
181 csgkiviary gkvfrgnkvk naqlagakgv ilysdpadyf apgvksypdg wnlpgggvqr
241 gnilnlngag dpltpgypan eyayrrgiae avglpsipvh pigyydaqkl lekmggsapp
301 dsswrgslkv pynvgpgftg nfstqkvkmh ihstnevtri ynvigtlrga vepdryvilg
361 ghrdswvfgg idpqsgaavv heivrsfgtl kkegwrprrt ilfaswdaee fgllgstewa
421 eensrllqer gvayinadss iegnytlrvd ctplmyslvh nltkelkspd egfegkslye
481 swtkkspspe fsgmpriskl gsgndfevff qrlgiasgra rytknwetnk fsgyplyhsv
541 yetyelvekf ydpmfkyhlt vaqvrggmvf elansivlpf dcrdyavvlr kyadkiysis
601 mkhpqemkty svsfdslfsa vknfteiask fserlqdfdk snpivlrmmn dqlmfleraf
661 idplglpdrp fyrhviyaps shnkyagesf pgiydalfdi eskvdpskaw gevkrqiyva
721 aftvqaaaet lseva

Glutamate carboxypeptidase 2, isoform 4 NP_001180401.1
1 mtagssyplf laayactgcl aerlgwfiks sneatnitpk hnmkafldel kaenikkfly
61 nftqiphlag teqnfqlakq iqsqwkefgl dsvelahydv llsypnkthp nyisiinedg
121 neifntslfe ppppgyenvs divppfsafs pqgmpegdlv yvnyartedf fklerdmkin
181 csgkiviary gkvfrgnkvk naqlagakgv ilysdpadyf apgvksypdg wnlpgggvqr
241 gnilnlngag dpltpgypan eyayrrgiae avglpsipvh pigyydaqkl lekmggsapp
301 dsswrgslkv pynvgpgftg nfstqkvkmh ihstnevtri ynvigtlrga vepdryvilg
361 ghrdswvfgg idpqsgaavv heivrsfgtl kkegwrprrt ilfaswdaee fgllgstewa
421 eensrllqer gvayinadss iegnytlrvd ctplmyslvh nltkelkspd egfegkslye
481 swtkkspspe fsgmpriskl gsgndfevff qrlgiasgra rytknwetnk fsgyplyhsv
541 yetyelvekf ydpmfkyhlt vaqvrggmvf elansivlpf dcrdyavvlr kyadkiysis
601 mkhpqemkty svsfdslfsa vknfteiask fserlqdfdk skhviyapss hnkyagesfp
661 giydalfdie skvdpskawg evkrqiyvaa ftvqaaaetl seva

Glutamate carboxypeptidase 2, isoform 5 NP_001180402.1
1 mggsappdss wrgslkvpyn vgpgftgnfs tqkvkmhihs tnevtriynv igtlrgavep
61 dryvilgghr dswvfggidp qsgaavvhei vrsfgtlkke gwrprrtilf aswdaeefgl
121 lgstewaeen srllqergva yinadssieg nytlrvdctp lmyslvhnlt kelkspdegf
181 egkslyeswt kkspspefsg mprisklgsg ndfevffqrl giasgraryt knwetnkfsg
241 yplyhsvyet yelvekfydp mfkyhltvaq vrggmvfela nsivlpfdcr dyavvlrkya
301 dkiysismkh pqemktysvs fdslfsavkn fteiaskfse rlqdfdksnp ivlrmmndql
361 mflerafidp lglpdrpfyr hviyapsshn kyagesfpgi ydalfdiesk vdpskawgev
421 krqiyvaaft vqaaaetlse va

Glutamate carboxypeptidase 2, isoform 6 NP_001338165.1
1 mkafldelka enikkflynf tqiphlagte qnfqlakqiq sqwkefglds velahydvll
61 sypnkthpny isiinedgne ifntslfepp ppgyenvsdi vppfsafspq gmpegdlvyv
121 nyartedffk lerdmkincs gkiviarygk vfrgnkvkna qlagakgvil ysdpadyfap

```
      181 gvksypdgwn lpgggvqrgn ilnlngagdp ltpgypaney ayrrgiaeav glpsipvhpi
      241 gyydaqklle kmggsappds swrgslkvpy nvgpgftgnf stqkvkmhih stnevtriyn
      301 vigtlrgave pdryvilggh rdswvfggid pqsgaavvhe ivrsfgtlkk egwrprrtil
      361 faswdaeefg llgstewaee nsrllqergv ayinadssie gnytlrvdct plmyslvhnl
      421 tkelkspdeg fegkslyesw tkkspspefs gmprisklgs gndfevffqr lgiasgrary
      481 tknwetnkfs gyplyhsvye tyelvekfyd pmfkyhltva qvrggmvfel ansivlpfdc
      541 rdyavvlrky adkiysismk hpqemktysv sfdslfsavk nfteiaskfs erlqdfdksk
      601 hviyapsshn kyagesfpgi ydalfdiesk vdpskawgev krqiyvaaft vqaaaetlse
      661 va

Fos-related antigen 1, isoform 1 NP_005429.1
        1 mfrdfgepgp ssgngggygg paqppaaaqa aqqkfhlvps intmsgsqel qwmvqphflg
       61 pssyprplty pqysppqprp gviralgppp gvrrrpceqi speeeerrrv rrernklaaa
      121 kcrnrrkelt dflqaetdkl edeksglqre ieelqkqker lelvleahrp ickipegake
      181 gdtgstsgts sppapcrpvp cislspgpvl epealhtptl mttpsltpft pslvftypst
      241 pepcasahrk sssssgdpss dplgsptlla l

Fos-related antigen 1, isoform 2 NP_001287773.1
        1 mfrdfgepgp ssgngggygg paqppaaaqa aqqkfhlvps intmsgsqel qwmvqphflg
       61 pssyprplty pqysppqprp gviralgppp gvrrrpceqe tdkledeksg lqreieelqk
      121 qkerlelvle ahrpickipe gakegdtgst sgtssppapc rpvpcislsp gpvlepealh
      181 tptlmttpsl tpftpslvft ypstpepcas ahrksssssg dpssdplgsp tllal

Fos-related antigen 1, isoform 3 NP_001287784.1
        1 mfrdfgepgp ssgngggygg paqppaaaqa aqqkfhlvps intmsgsqel qwmvqphflg
       61 pssyprplty pqysppqprp gviralgppp gvrrrpceqp ggrgappska raeqagcgqv
      121 qepeegtdrl paggd

Fos-related antigen 1, isoform 4 NP_001287785.1
        1 mfrdfgepgp ssgngggygg paqppaaaqa aqqispeeee rrrvrrernk laaakcrnrr
       61 keltdflqae tdkledeksg lqreieelqk qkerlelvle ahrpickipe gakegdtgst
      121 sgtssppapc rpvpcislsp gpvlepealh tptlmttpsl tpftpslvft ypstpepcas
      181 ahrksssssg dpssdplgsp tllal

Fos-related antigen 1, isoform 5 NP_001287786.1
        1 mfrdfgepgp ssgngggygg paqppaaaqa aqqetdkled eksglqreie elqkqkerle
       61 lvleahrpic kipegakegd tgstsgtssp papcrpvpci slspgpvlep ealhtptlmt
      121 tpsltpftps lvftypstpe pcasahrkss sssgdpssdp lgsptllal

G antigen 1 NP_001035753.1
        1 mswrgrstyy wprprryvqp pemigpmrpe qfsdevepat peegepatqr qdpaaaqege
       61 degasagqgp kpeadsqeqg hpqtgceced gpdgqemdpp npeevktpee gegqsqc

G antigen 12I NP_001465.1
        1 mswrgrstyy wprprryvqp pemigpmrpe qfsdevepat peegepatqr qdpaaaqege
       61 degasagqgp kpeadsqeqg hpqtgceced gpdgqemdpp npeevktpee gekqsqc

Galectin-1 NP_002296.1
        1 macglvasnl nlkpgeclrv rgevapdaks fvlnlgkdsn nlclhfnprf nahgdantiv
       61 cnskdggawg teqreavfpf qpgsvaevci tfdqanltvk lpdgyefkfp nrlnleainy
      121 maadgdfkik cvafd

Galectin-3 isoform 1 NP_002297.2
        1 madnfslhda lsgsgnpnpq gwpgawgnqp agaggypgas ypgaypgqap pgaypgqapp
       61 gaypgapgay pgapapgvyp gppsgpgayp ssgqpsatga ypatgpygap agplivpynl
      121 plpggvvprm litilgtvkp nanrialdfq rgndvafhfn prfnennrrv ivcntkldnn
      181 wgreerqsvf pfesgkpfki qvlvepdhfk vavndahllq ynhrvkklne isklgisgdi
```

```
      241 dltsasytmi

Galectin-3, isoform 3 NP_001344607.1
        1 mhsktpcgcf kpwkmadnfs lhdalsgsgn pnpqgwpgaw gnqpagaggy pgasypgayp
       61 gqappgaypg qappgaypga pgaypgapap gvypgppsgp gaypssgqps atgaypatgp
      121 ygapagpliv pynlplpggv vprmlitilg tvkpnanria ldfqrgndva fhfnprfnen
      181 nrrvivcntk ldnnwgreer qsvfpfesgk pfkiqvlvep dhfkvavnda hllqynhrvk
      241 klneisklgi sgdidltsas ytmi

Galectin-9 short NP_002299.2
        1 mafsgsqapy lspavpfsgt iqgglqdglq itvngtvlss sgtrfavnfq tgfsgndiaf
       61 hfnprfedgg yvvcntrqng swgpeerkth mpfqkgmpfd lcflvqssdf kvmvngilfv
      121 qyfhrvpfhr vdtisvngsv qlsyisfqpp gvwpanpapi tqtvihtvqs apgqmfstpa
      181 ippmmyphpa ypmpfittil gglypsksil lsgtvlpsaq rfhinlcsgn hiafhlnprf
      241 denavvrntq idnswgseer slprkmpfvr gqsfsvwilc eahclkvavd gqhlfeyyhr
      301 lrnlptinrl evggdiqlth vqt

Galectin-9 long NP_033665.1
        1 mafsgsqapy lspavpfsgt iqgglqdglq itvngtvlss sgtrfavnfq tgfsgndiaf
       61 hfnprfedgg yvvcntrqng swgpeerkth mpfqkgmpfd lcflvqssdf kvmvngilfv
      121 qyfhrvpfhr vdtisvngsv qlsyisfqnp rtvpvqpafs tvpfsqpvcf pprprgrrqk
      181 ppgvwpanpa pitqtvihtv qsapgqmfst paippmmyph paypmpfitt ilgglypsks
      241 illsgtvlps aqrfhinlcs gnhiafhlnp rfdenavvrn tqidnswgse erslprkmpf
      301 vrgqsfsvwi lceahclkva vdgqhlfeyy hrlrnlptin rlevggdiql thvqt

Galectin-9 isoform 3 NP_001317092.1
        1 mafsgsqapy lspavpfsgt iqgglqdglq itvngtvlss sgtrfavnfq tgfsgndiaf
       61 hfnprfedgg yvvcntrqng swgpeerkth mpfqkgmpfd lcflvqssdf kvmvngilfv
      121 qyfhrvpfhr vdtisvngsv qlsyisfqpp gvwpanpapi tqtvihtvqs apgqmfstpa
      181 ippmmyphpa ypmpfittil gglypsksil lsgtvlpsaq rcgscvklta srwpwmvstc
      241 lnttia

Premelanosome protein, isoform 1 preprotein NP_001186983.1
        1 mdlvlkrcll hlavigalla vgatkvprnq dwlgvsrqlr tkawnrqlyp ewteaqrldc
       61 wrggqvslkv sndgptliga nasfsialnf pgsqkvlpdg qviwvnntii ngsqvwggqp
      121 vypqetddac ifpdggpcps gswsqkrsfv yvwktwgqyw qvlggpvsgl sigtgramlg
      181 thtmevtvyh rrgsrsyvpl ahsssaftit dqvpfsvsvs qlraldggnk hflrnqpltf
      241 alqlhdpsgy laeadlsytw dfgdssgtli sralvvthty lepgpvtaqv vlqaaiplts
      301 cgsspvpgtt dghrptaeap nttagqvptt evvgttpgqa ptaepsgtts vqvpttevis
      361 tapvqmptae stgmtpekvp vsevmgttla emstpeatgm tpaevsivvl sgttaaqvtt
      421 tewvettare lpipepegpd assimstesi tgslgplldg tatlrlvkrq vpldcvlyry
      481 gsfsvtldiv qgiesaeilq avpsgegdaf eltvscqggl pkeacmeiss pgcqppaqrl
      541 cqpvlpspac qlvlhqilkg gsgtyclnvs ladtnslavv stqlimpvpg illtgqeagl
      601 gqvplivgil lvlmavvlas liyrrrlmkq dfsvpqlphs sshwlrlpri fcscpigens
      661 pllsgqqv

Premelanosome protein, isoform 2 precursor NP_001186982.1
        1 mdlvlkrcll hlavigalla vgatkgsqvw ggqpvypqet ddacifpdgg pcpsgswsqk
       61 rsfvyvwktw gqywqvlggp vsglsigtgr amlgthtmev tvyhrrgsrs yvplahsssa
      121 ftitdqvpfs vsvsqlrald ggnkhflrnq pltfalqlhd psgylaeadl sytwdfgdss
      181 gtlisralvv thtylepgpv taqvvlqaai pltscgsspv pgttdghrpt aeapnttagq
      241 vpttevvgtt pgqaptaeps gttsvqvptt evistapvqm ptaestgmtp ekvpvsevmg
      301 ttlaemstpe atgmtpaevs ivvlsgttaa qvtttewvet tarelpipep egpdassims
      361 tesitgslgp lldgtatlrl vkrqvpldcv lyrygsfsvt ldivqgiesa eilqavpsge
      421 gdafeltvsc qgglpkeacm eisspgcqpp aqrlcqpvlp spacqlvlhq ilkggsgtyc
      481 lnvsladtns lavvstqlim pgqeaglgqv plivgillvl mavvlasliy rrrlmkqdfs
      541 vpqlphsssh wlrlprifcs cpigenspll sgqqv
```

Premelanosome protein, isoform 3 preprotein NP_008859.1

```
        1 mdlvlkrcll hlavigalla vgatkvprnq dwlgvsrqlr tkawnrqlyp ewteaqrldc
       61 wrggqvslkv sndgptliga nasfsialnf pgsqkvlpdg qviwvnntii ngsqvwggqp
      121 vypqetddac ifpdggpcps gswsqkrsfv yvwktwgqyw qvlggpvsgl sigtgramlg
      181 thtmevtvyh rrgsrsyvpl ahsssaftit dqvpfsvsvs qlraldggnk hflrnqpltf
      241 alqlhdpsgy laeadlsytw dfgdssgtli sralvvthty lepgpvtaqv vlqaaiplts
      301 cgsspvpgtt dghrptaeap nttagqvptt evvgttpgqa ptaepsgtts vqvpttevis
      361 tapvqmptae stgmtpekvp vsevmgttla emstpeatgm tpaevsivvl sgttaaqvtt
      421 tewvettare lpipepegpd assimstesi tgslgplldg tatlrlvkrq vpldcvlyry
      481 gsfsvtldiv qgiesaeilq avpsgegdaf eltvscqggl pkeacmeiss pgcqppaqrl
      541 cqpvlpspac qlvlhqilkg gsgtyclnvs ladtnslavv stqlimpgqe aglgqvpliv
      601 gillvlmavv lasliyrrrl mkqdfsvpql phssshwlrl prifcscpig enspllsgqq
      661 v
```

Premelanosome protein, isoform 4 preprotein NP_001307050.1

```
        1 mdlvlkrcll hlavigalla vgatkvprnq dwlgvsrqlr tkawnrqlyp ewteaqrldc
       61 wrggqvslkv sndgptliga nasfsialnf pgsqkvlpdg qviwvnntii ngsqvwggqp
      121 vypqetddac ifpdggpcps gswsqkrsfv yvwktwgqyw qvlggpvsgl sigtgramlg
      181 thtmevtvyh rrgsrsyvpl ahsssaftit dqvpfsvsvs qlraldggnk hflrnqpltf
      241 alqlhdpsgy laeadlsytw dfgdssgtli sralvvthty lepgpvtaqv vlqaaiplts
      301 cgsspvpgtt dghrptaeap nttagqvptt evvgttpgqa ptaepsgtts vqvpttevis
      361 tapvqmptae staaqvttte wvettarelp ipepegpdas simstesitg slgplldgta
      421 tlrlvkrqvp ldcvlyrygs fsvtldivqg iesaeilqav psgegdafel tvscqgglpk
      481 eacmeisspg cqppaqrlcq pvlpspacql vlhqilkggs gtyclnvsla dtnslavvst
      541 qlimpvpgil ltgqeaglgq vplivgillv lmavvlasli yrrrlmkqdf svpqlphsss
      601 hwlrlprifc scpigenspl lsgqqv
```

Premelanosome protein, isoform 5 preprotein NP_001307051.1

```
        1 mdlvlkrcll hlavigalla vgatkvprnq dwlgvsrqlr tkawnrqlyp ewteaqrldc
       61 wrggqvslkv sndgptliga nasfsialnf pgsqkvlpdg qviwvnntii ngsqvwggqp
      121 vypqetddac ifpdggpcps gswsqkrsfv yvwktwgqyw qvlggpvsgl sigtgramlg
      181 thtmevtvyh rrgsrsyvpl ahsssaftit dqvpfsvsvs qlraldggnk hflrnqpltf
      241 alqlhdpsgy laeadlsytw dfgdssgtli sralvvthty lepgpvtaqv vlqaaiplts
      301 cgsspvpgtt dghrptaeap nttagqvptt evvgttpgqa ptaepsgtts vqvpttevis
      361 tapvqmptae staaqvttte wvettarelp ipepegpdas simstesitg slgplldgta
      421 tlrlvkrqvp ldcvlyrygs fsvtldivqg iesaeilqav psgegdafel tvscqgglpk
      481 eacmeisspg cqppaqrlcq pvlpspacql vlhqilkggs gtyclnvsla dtnslavvst
      541 qlimpgqeag lgqvplivgi llvlmavvla sliyrrrlmk qdfsvpqlph ssshwlrlpr
      601 ifcscpigen spllsgqqv
```

Glutamate receptor ionotropic,NMDA 2A, isoform 1 precursor NP_000824.1, NP_001127879.1

```
        1 mgrvgywtll vlpallvwrg papsaaaekg ppalniavml ghshdvtere lrtlwgpeqa
       61 aglpldvnvv allmnrtdpk slithvcdlm sgarihglvf gddtdqeava qmldfissht
      121 fvpilgihgg asmimadkdp tstffqfgas iqqqatvmlk imqdydwhvf slvttifpgy
      181 refisfvktt vdnsfvgwdm qnvitldtsf edaktqvqlk kihssvilly cskdeavlil
      241 searslgltg ydffwivpsl vsgntelipk efpsglisvs yddwdyslea rvrdgigilt
      301 taassmlekf syipeakasc ygqmerpevp mhtlhpfmvn vtwdgkdlsf teegyqvhpr
      361 lvvivlnkdr ewekvgkwen htlslrhavw pryksfsdce pddnhlsivt leeapfvive
      421 didpltetcv rntvpcrkfv kinnstnegm nvkkcckgfc idilkklsrt vkftydlylv
      481 tngkhgkkvn nvwngmigev vyqravmavg sltineerse vvdfsvpfve tgisvmvsrs
      541 ngtvspsafl epfsasvwvm mfvmllivsa iavfvfeyfs pvgynrnlak gkaphgpsft
      601 igkaiwllwg lvfnnsvpvq npkgttskim vsvwaffavi flasytanla afmiqeefvd
      661 qvtglsdkkf qrphdysppf rfgtvpngst ernirnnypy mhqymtkfnq kgvedalvsl
      721 ktgkldafiy daavlnykag rdegcklvti gsgyifattg ygialqkgsp wkrqidlall
      781 qfvgdgemee letlwltgic hneknevmss qldidnmagv fymlaaamal slitfiwehl
```

```
 841 fywklrfcft gvcsdrpgll fsisrgiysc ihgvhieekk kspdfnltgs qsnmlkllrs
 901 aknissmsnm nssrmdspkr aadfiqrgsl imdmvsdkgn lmysdnrsfq gkesifgdnm
 961 nelqtfvanr qkdnlnnyvf qgqhpltlne snpntvevav steskansrp rqlwkksvds
1021 irqdslsqnp vsqrdeatae nrthslkspr ylpeemahsd isetsnratc hrepdnsknh
1081 ktkdnfkrsv askypkdcse vertylktks ssprdkiyti dgekepgfhl dppqfvenvt
1141 lpenvdfpdp yqdpsenfrk gdstlpmnrn plhneeglsn ndqyklyskh ftlkdkgsph
1201 setseryrqn sthcrsclsn mptysghftm rspfkcdacl rmgnlydide dqmlqetgnp
1261 atgeqvyqqd waqnnalqlq knklrisrqh sydnivdkpr eldlsrpsrs islkdrerll
1321 egnfygslfs vpsskl sgkk sslfpqgled skrsksllpd htsdnpflhs hrddqrlvig
1381 rcpsdpykhs lpsqavndsy lrsslrstas ycsrdsrghn dvyisehvmp yaanknnmys
1441 tprvlnscsn rrvykkmpsi esdv
```

Glutamate receptor ionotropic,NMDA 2A, isoform 2 precursor NP_001127880.1

```
   1 mgrvgywtll vlpallvwrg papsaaaekg ppalniavml ghshdvtere lrtlwgpeqa
  61 aglpldvnvv allmnrtdpk slithvcdlm sgarihglvf gddtdqeava qmldfissht
 121 fvpilgihgg asmimadkdp tstffqfgas iqqqatvmlk imqdydwhvf slvttifpgy
 181 refisfvktt vdnsfvgwdm qnvitldtsf edaktqvqlk kihssvilly cskdeavlil
 241 searslgltg ydffwivpsl vsgntelipk efpsglisvs yddwdyslea rvrdgigilt
 301 taassmlekf syipeakasc ygqmerpevp mhtlhpfmvn vtwdgkdlsf teegyqvhpr
 361 lvvivlnkdr ewekvgkwen htlslrhavw pryksfsdce pddnhlsivt leeapfvive
 421 didpltetcv rntvpcrkfv kinnstnegm nvkkcckgfc idilkklsrt vkftydlylv
 481 tngkhgkkvn nvwngmigev vyqravmavg sltineerse vvdfsvpfve tgisvmvsrs
 541 ngtvspsafl epfsasvwvm mfvmllivsa iavfvfeyfs pvgynrnlak gkaphgpsft
 601 igkaiwllwg lvfnnsvpvq npkgttskim vsvwaffavi flasytanla afmiqeefvd
 661 qvtglsdkkf qrphdysppf rfgtvpngst ernirnnypy mhqymtkfnq kgvedalvsl
 721 ktgkldafiy daavlnykag rdegcklvti gsgyifattg ygialqkgsp wkrqidlall
 781 qfvgdgemee letlwltgic hneknevmss qldidnmagv fymlaaamal slitfiwehl
 841 fywklrfcft gvcsdrpgll fsisrgiysc ihgvhieekk kspdfnltgs qsnmlkllrs
 901 aknissmsnm nssrmdspkr aadfiqrgsl imdmvsdkgn lmysdnrsfq gkesifgdnm
 961 nelqtfvanr qkdnlnnyvf qgqhpltlne snpntvevav steskansrp rqlwkksvds
1021 irqdslsqnp vsqrdeatae nrthslkspr ylpeemahsd isetsnratc hrepdnsknh
1081 ktkdnfkrsv askypkdcse vertylktks ssprdkiyti dgekepgfhl dppqfvenvt
1141 lpenvdfpdp yqdpsenfrk gdstlpmnrn plhneeglsn ndqyklyskh ftlkdkgsph
1201 setseryrqn sthcrsclsn mptysghftm rspfkcdacl rmgnlydide dqmlqetgmt
1261 nawllgdapr tltntrchpr r
```

Metabotropic glutamate receptor 3 precursor NP_000831.2

```
   1 mkmltrlqvl tlalfskgfl lslgdhnflr reikiegdlv lgglfpinek gtgteecgri
  61 nedrgiqrle amlfaidein kddyllpgvk lgvhildtcs rdtyaleqsl efvrasltkv
 121 deaeymcpdg syaiqenipl liagviggsy ssvsiqvanl lrlfqipqis yastsaklsd
 181 ksrydyfart vppdfyqaka maeilrffnw tyvstvaseg dygetgieaf eqearlrnic
 241 iataekvgrs nirksydsvi rellqkpnar vvvlfmrsdd sreliaaasr anasftwvas
 301 dgwgaqesii kgsehvayga itlelasqpv rqfdryfqsl npynnhrnpw frdfweqkfq
 361 cslqnkrnhr rvcdkhlaid ssnyeqeski mfvvnavyam ahalhkmqrt lcpnttklcd
 421 amkildgkkl ykdyllkinf tapfnpnkda dsivkfdtfg dgmgrynvfn fqnvggkysy
 481 lkvghwaetl sldvnsihws rnsvptsqcs dpcapnemkn mqpgdvccwi cipcepyeyl
 541 adeftcmdcg sgqwptadlt gcydlpedyi rwedawaigp vtiaclgfmc tcmvvtvfik
 601 hnntplvkas grelcyillf gvglsycmtf ffiakpspvi calrrlglgs sfaicysall
 661 tktnciarif dgvkngaqrp kfispssqvf iclglilvqi vmvsvwlile apgtrrytla
 721 ekretvilkc nvkdssmlis ltydvilvil ctvyafktrk cpenfneakf igftmyttci
 781 iwlaflpify vtssdyrvqt ttmcisvsls gfvvlgclfa pkvhiilfqp qknvvthrlh
 841 lnrfsvsgtg ttysqssast yvptvcngre vldsttssl
```

HPV E6 concoprotein, NP_041325.1

```
   1 mhqkrtamfq dpqerprklp qlctelqtti hdiilecvyc kqqllrrevy dfafrdlciv
  61 yrdgnpyavc dkclkfyski seyrhycysl ygttleqqyn kplcdllirc incqkplcpe
 121 ekqrhldkkq rfhnirgrwt grcmsccrss rtrretql
```

HPV E7 Oncoprotein, NP_041326.1
1 mhgdtptlhe ymldlqpett dlycyeqlnd sseeedeidg pagqaepdra hynivtfcck
61 cdstlrlcvq sthvdirtle dllmgtlgiv cpicsqkp

GTPase HRas, isoform 1 NP_001123914.1, NP_005334.1
1 mteyklvvvg aggvgksalt iqliqnhfvd eydptiedsy rkqvvidget clldildtag
61 qeeysamrdq ymrtgegflc vfainntksf edihqyreqi krvkdsddvp mvlvgnkcdl
121 aartvesrqa qdlarsygip yietsaktrq gvedafytlv reirqhklrk lnppdesgpg
181 cmsckcvls

GTPase HRas, isoform 3 NP_001304983.1
1 mtcpwcwwgt svtwlhalwn lgrlrtspea tasptsrprp rpgraaalal apapgpsgtp
61 rdpcdpaapr agvedafytl vreirqhklr klnppdesgp gcmsckcvls

GTPase HRas, isoform 2 NP_789765.1
1 mteyklvvvg aggvgksalt iqliqnhfvd eydptiedsy rkqvvidget clldildtag
61 qeeysamrdq ymrtgegflc vfainntksf edihqyreqi krvkdsddvp mvlvgnkcdl
121 aartvesrqa qdlarsygip yietsaktrq gsrsgsssss gtlwdppgpm

Vascular endothelial growth factor receptor 2 precursor NP_002244.1
1 mqskvllava lwlcvetraa svglpsvsld lprlsiqkdi ltikanttlq itcrgqrdld
61 wlwpnnqsgs eqrvevtecs dglfcktlti pkvigndtga ykcfyretdl asviyvyvqd
121 yrspfiasvs dqhgvvyite nknktvvipc lgsisnlnvs lcarypekrf vpdgnriswd
181 skkgftipsy misyagmvfc eakindesyq simyivvvvg yriydvvlsp shgielsvge
241 klvlnctart elnvgidfnw eypsskhqhk klvnrdlktq sgsemkkfls tltidgvtrs
301 dqglytcaas sglmtkknst fvrvhekpfv afgsgmeslv eatvgervri pakylgyppp
361 eikwykngip lesnhtikag hvltimevse rdtgnytvil tnpiskekqs hvvslvvyvp
421 pqigekslis pvdsyqygtt qtltctvyai ppphhihwyw qleeecanep sqavsvtnpy
481 pceewrsved fqggnkievn knqfaliegk nktvstlviq aanvsalykc eavnkvgrge
541 rvisfhvtrg peitlqpdmq pteqesvslw ctadrstfen ltwyklgpqp lpihvgelpt
601 pvcknldtlw klnatmfsns tndilimelk naslqdqgdy vclaqdrktk krhcvvrqlt
661 vlervaptit gnlenqttsi gesievscta sgnpppqimw fkdnetlved sgivlkdgnr
721 nltirrvrke deglytcqac svlgcakvea ffiiegaqek tnleiiilvg taviamffwl
781 llviilrtvk ranggelktg ylsivmdpde lpldehcerl pydaskwefp rdrlklgkpl
841 grgafgqvie adafgidkta tcrtvavkml kegathsehr almselkili highhlnvvn
901 llgactkpgg plmvivefck fgnlstylrs krnefvpykt kgarfrqgkd yvgaipvdlk
961 rrldsitssq ssassgfvee kslsdveeee apedlykdfl tlehlicysf qvakgmefla
1021 srkcihrdla arnillsekn vvkicdfgla rdiykdpdyv rkgdarlplk wmapetifdr
1081 vytiqsdvws fgvllweifs lgaspypgvk ideefcrrlk egtrmrapdy ttpemyqtml
1141 dcwhgepsqr ptfselvehl gnllqanaqq dgkdyivlpi setlsmeeds glslptspvs
1201 cmeeeevcdp kfhydntagi sqylqnskrk srpvsvktfe dipleepevk vipddnqtds
1261 gmvlaseelk tledrtklsp sfggmvpsks resvasegsn qtsgyqsgyh sddtdttvys
1321 seeaellkli eigvqtgsta qilqpdsgtt lssppv

Mast/stem cell growth acor receptor KIT, isoform 1 precursor NP_000213.1
1 mrgargawdf lcvlllllrv qtgssqpsvs pgepsppsih pgksdlivrv gdeirllctd
61 pgfvkwtfei ldetnenkqn ewitekaeat ntgkytctnk hglsnsiyvf vrdpaklflv
121 drslygkedn dtlvrcpltd pevtnyslkg cqgkplpkdl rfipdpkagi miksvkrayh
181 rlclhcsvdq egksvlsekf ilkvrpafka vpvvsvskas yllregeeft vtctikdvss
241 svystwkren sqtklqekyn swhhgdfnye rqatltissa rvndsgvfmc yanntfgsan
301 vtttlevvdk gfinifpmin ttvfvndgen vdliveyeaf pkpehqqwiy mnrtftdkwe
361 dypksenesn iryvselhlt rlkgteggty tflvsnsdvn aaiafnvyvn tkpeiltydr
421 lvngmlqcva agfpeptidw yfcpgteqrc sasvlpvdvq tlnssgppfg klvvqssids
481 safkhngtve ckayndvgkt sayfnfafkg nnkeqihpht lftplligfv ivagmmciiv
541 miltykylqk pmyevqwkvv eeingnnyvy idptqlpydh kwefprnrls fgktlgagaf
601 gkvveatayg liksdaamtv avkmlkpsah lterealmse lkvlsylgnh mnivnllgac

```
661 tiggptlvit eyccygdlln flrrkrdsfi cskqedhaea alyknllhsk esscsdstne
721 ymdmkpgvsy vvptkadkrr svrigsyier dvtpaimedd elaldledll sfsyqvakgm
781 aflaskncih rdlaarnill thgritkicd fglardiknd snyvvkgnar lpvkwmapes
841 ifncvytfes dvwsygiflw elfslgsspy pgmpvdskfy kmikegfrml spehapaemy
901 dimktcwdad plkrptfkqi vqliekqise stnhiysnla ncspnrqkpv vdhsvrinsv
961 gstasssqpl lvhddv
```

Mast/stem cell growth acor receptor KIT, isoform 2 precursor NP_001087241.1

```
  1 mrgargawdf lcvlllllrv qtgssqpsvs pgepsppsih pgksdlivrv gdeirllctd
 61 pgfvkwtfei ldetnenkqn ewitekaeat ntgkytctnk hglsnsiyvf vrdpaklflv
121 drslygkedn dtlvrcpltd pevtnyslkg cqgkplpkdl rfipdpkagi miksvkrayh
181 rlclhcsvdq egksvlsekf ilkvrpafka vpvvsvskas yllregeeft vtctikdvss
241 svystwkren sqtklqekyn swhhgdfnye rqatltissa rvndsgvfmc yanntfgsan
301 vtttlevvdk gfinifpmin ttvfvndgen vdliveyeaf pkpehqqwiy mnrtftdkwe
361 dypksenesn iryvselhlt rlkgteggty tflvsnsdvn aaiafnvyvn tkpeiltydr
421 lvngmlqcva agfpeptidw yfcpgteqrc sasvlpvdvq tlnssgppfg klvvqssids
481 safkhngtve ckayndvgkt sayfnfafke qihphtlftp lligfvivag mmciivmilt
541 ykylqkpmye vqwkvveein gnnyvyidpt qlpydhkwef prnrlsfgkt lgagafgkvv
601 eataygliks daamtvavkm lkpsahlter ealmselkvl sylgnhmniv nllgactigg
661 ptlviteycc ygdllnflrr krdsficskq edhaeaalyk nllhskessc sdstneymdm
721 kpgvsyvvpt kadkrrsvri gsyierdvtp aimeddelal dledllsfsy qvakgmafla
781 skncihrdla arnillthgr itkicdfgla rdikndsnyv vkgnarlpvk wmapesifnc
841 vytfesdvws ygiflwelfs lgsspypgmp vdskfykmik egfrmlspeh apaemydimk
901 tcwdadplkr ptfkqivqli ekqisestnh iysnlancsp nrqkpvvdhs vrinsvgsta
961 sssqpllvhd dv
```

Plasma kallikrein isoform 1 preprotein NP_001639.1

```
  1 mwvpvvfltl svtwigaapl ilsrivggwe cekhsqpwqv lvasrgravc ggvlvhpqwv
 61 ltaahcirnk svillgrhsl fhpedtgqvf qvshsfphpl ydmsllknrf lrpgddsshd
121 lmllrlsepa eltdavkvmd lptqepalgt tcyasgwgsi epeefltpkk lqcvdlhvis
181 ndvcaqvhpq kvtkfmlcag rwtggkstcs gdsggplvcn gvlqgitswg sepcalperp
241 slytkvvhyr kwikdtivan p
```

Plasma kallikrein isoform 3 preprotein NP_001025218.1

```
  1 mwvpvvfltl svtwigaapl ilsrivggwe cekhsqpwqv lvasrgravc ggvlvhpqwv
 61 ltaahcirnk svillgrhsl fhpedtgqvf qvshsfphpl ydmsllknrf lrpgddsshd
121 lmllrlsepa eltdavkvmd lptqepalgt tcyasgwgsi epeefltpkk lqcvdlhvis
181 ndvcaqvhpq kvtkfmlcag rwtggkstcs wviliteltm palpmvlhgs lvpwrggv
```

Plasma kallikrein isoform 4 preprotein NP_001025219.1

```
  1 mwvpvvfltl svtwigaapl ilsrivggwe cekhsqpwqv lvasrgravc ggvlvhpqwv
 61 ltaahcirkp gddsshdlml lrlsepaelt davkvmdlpt qepalgttcy asgwgsiepe
121 efltpkklqc vdlhvisndv caqvhpqkvt kfmlcagrwt ggkstcsgds ggplvcngvl
181 qgitswgsep calperpsly tkvvhyrkwi kdtivanp
```

Tyrosine-protein kinase LCK, isoform a NP_001036236.1, NP_005347.3

```
  1 mgcgcsshpe ddwmenidvc enchypivpl dgkgtllirn gsevrdplvt yegsnppasp
 61 lqdnlvialh syepshdgdl gfekgeqlri leqsgewwka qslttgqegf ipfnfvakan
121 slepepwffk nlsrkdaerq llapgnthgs fliresesta gsfslsvrdf dqnqgevvkh
181 ykirnldngg fyispritfp glhelvrhyt nasdglctrl srpcqtqkpq kpwwedewev
241 pretlklver lgagqfgevw mgyynghtkv avkslkqgsm spdaflaean lmkqlqhqrl
301 vrlyavvtqe piyiiteyme ngslvdflkt psgikltink lldmaaqiae gmafieerny
361 ihrdlraani lvsdtlscki adfglarlie dneytarega kfpikwtape ainygtftik
421 sdvwsfgill teivthgrip ypgmtnpevi qnlergyrmv rpdncpeely qlmrlcwker
481 pedrptfdyl rsvledffta tegqyqpqp
```

Tyrosine-protein kinase LCK, isoform b NP_001317397.1

```
      1 mgcgcsshpe ddwmenidvc enchypivpl dgkgtllirn gsevrdplvt yegsnppasp
     61 lqdnlvialh syepshdgdl gfekgeqlri leqsgewwka qslttgqegf ipfnfvakan
    121 slepepwffk nlsrkdaerq llapgnthgs fliresesta gsfslsvrdf dqnqgevvkh
    181 ykirnldngg fyispritfp glhelvrhyt ryynghtkva vkslkqgsms pdaflaeanl
    241 mkqlqhqrlv rlyavvtqep iyiiteymen gslvdflktp sgikltinkl ldmaaqiaeg
    301 mafieernyi hrdlraanil vsdtlsckia dfglarlied neytaregak fpikwtapea
    361 inygtftiks dvwsfgillt eivthgripy pgmtnpeviq nlergyrmvr pdncpeelyq
    421 lmrlcwkerp edrptfdylr svledfftat egqyqpqp

Legumain preprotein NP_001008530.1, NP_005597.3
      1 mvwkvavfls valgigavpi ddpedggkhw vvivagsngw ynyrhqadac hayqiihrng
     61 ipdeqivvmm yddiaysedn ptpgivinrp ngtdvyqgvp kdytgedvtp qnflavlrgd
    121 aeavkgigsg kvlksgpqdh vfiyftdhgs tgilvfpned lhvkdlneti hymykhkmyr
    181 kmvfyieace sgsmmnhlpd ninvyattaa npressyacy ydekrstylg dwysvnwmed
    241 sdvedltket lhkqyhlvks htntshvmqy gnktistmkv mqfqgmkrka sspvplppvt
    301 hldltpspdv pltimkrklm ntndleesrq lteeiqrhld arhlieksvr kivsllaase
    361 aeveqllser apltghscyp eallhfrthc fnwhsptyey alrhlyvlvn lcekpyplhr
    421 iklsmdhvcl ghy

Macrophage migration inhibitory factor NP_002406.1
      1 mpmfivntnv prasvpdgfl seltqqlaqa tgkppqyiav hvvpdqlmaf ggssepcalc
     61 slhsigkigg aqnrsyskll cgllaerlri spdrvyinyy dmnaanvgwn nstfa

MAGE family member A1 NP_004979.3
      1 msleqrslhc kpeealeaqq ealglvcvqa atssssplvl gtleevptag stdppqspqg
     61 asafpttinf trqrqpsegs ssreeegpst scileslfra vitkkvadlv gflllkyrar
    121 epvtkaemle sviknykhcf peifgkases lqlvfgidvk eadptghsyv lvtclglsyd
    181 gllgdnqimp ktgfliivlv miamegghap eeeiweelsv mevydgrehs aygeprkllt
    241 qdlvqekyle yrqvpdsdpa ryeflwgpra laetsyvkvl eyvikvsarv rfffpslrea
    301 alreeeegv

Melanoma-associated antigen 10 NP_001011543.2, NP_001238757.1, NP_066386.2
      1 mprapkrqrc mpeedlqsqs etgglegaqa plaveedass ststsssfps sfpsssssss
     61 sscyplipst peevsaddet pnppqsaqia csspsvvasl pldqsdegss sqkeespstl
    121 qvlpdseslp rseidekvtd lvqfllfkyq mkepitkaei lesvirnyed hfpllfseas
    181 ecmllvfgid vkevdptghs fvlvtslglt ydgmlsdvqs mpktgilili lsiifiegyc
    241 tpeeviweal nmmglydgme hliygeprkl ltqdwvqeny leyrqvpgsd paryeflwgp
    301 rahaeirkms llkflakvng sdprsfplwy eealkdeeer aqdriattdd ttamasasss
    361 atgsfsype

Melanoma-associated antigen 12 NP_001159858.1, NP_001159859.1, NP_005358.2
      1 mpleqrsqhc kpeegleaqg ealglvgaqa pateeqetas ssstlvevtl revpaaesps
     61 pphspqgast lpttinytlw sqsdegssne eqegpstfpd letsfqvals rkmaelvhfl
    121 llkyrarepf tkaemlgsvi rnfqdffpvi fskaseylql vfgievvevv righlyilvt
    181 clglsydgll gdnqivpktg lliivlaiia kegdcapeek iweelsvlea sdgredsvfa
    241 hprklltqdl vqenyleyrq vpgsdpacye flwgpralve tsyvkvlhhl lkisggphis
    301 ypplhewafr egee

Melanoma-associated antigen 2 NP_001269430.1, NP_001269431.1, NP_001269433.1,
NP_001269434.1, NP_005352.1, NP_786884.1, NP_786885.1
      1 mpleqrsqhc kpeeglearg ealglvgaqa pateeqqtas ssstlvevtl gevpaadsps
     61 pphspqgass fsttinytlw rqsdegssnq eeegprmfpd lesefqaais rkmvelvhfl
    121 llkyrarepv tkaemlesvl rncqdffpvi fskaseylql vfgievvevv pishlyilvt
    181 clglsydgll gdnqvmpktg lliivlaiia iegdcapeek iweelsmlev fegredsvfa
    241 hprkllmqdl vqenyleyrq vpgsdpacye flwgpralie tsyvkvlhht lkiggephis
    301 ypplheralr egee
```

MAGE family member A3 NP_005353.1
1 mpleqrsqhc kpeeglearg ealglvgaqa pateeqeaas ssstlvevtl gevpaaespd
61 ppqspqgass lpttmnyplw sqsyedssnq eeegpstfpd lesefqaals rkvaelvhfl
121 llkyrarepv tkaemlgsvv gnwqyffpvi fskassslql vfgielmevd pighlyifat
181 clglsydgll gdnqimpkag lliivlaiia regdcapeek iweelsvlev fegredsilg
241 dpkklltqhf vqenyleyrq vpgsdpacye flwgpralve tsyvkvlhhm vkisggphis
301 ypplhewvlr egee

Melanoma-associated antigen 4 NP_001011548.1, NP_001011549.1, NP_001011550.1, NP_002353.3
1 msseqksqhc kpeegveaqe ealglvgaqa ptteeqeaav sssplvpgt leevpaaesa
61 gppqspqgas alpttisftc wrqpnegsss qeeegpstsp daeslfreal snkvdelahf
121 llrkyrakel vtkaemlerv iknykrcfpv ifgkaseslk mifgidvkev dpasntytlv
181 tclglsydgl lgnnqifpkt glliivlgti amegdsasee eiweelgvmg vydgrehtvy
241 geprkllqtqd wvqenyleyr qvpgsnpary eflwgprala etsyvkvleh vvrvnarvri
301 aypslreaal leeeegv

Melanoma-associated antigen 6 NP_005354.1, NP_787064.1
1 mpleqrsqhc kpeeglearg ealglvgaqa pateeqeaas ssstlvevtl gevpaaespd
61 ppqspqgass lpttmnyplw sqsyedssnq eeegpstfpd lesefqaals rkvaklvhfl
121 llkyrarepv tkaemlgsvv gnwqyffpvi fskasdslql vfgielmevd pighvyifat
181 clglsydgll gdnqimpktg fliiilaiia kegdcapeek iweelsvlev fegredsifg
241 dpkklltqyf vqenyleyrq vpgsdpacye flwgpralie tsyvkvlhhm vkisggpris
301 ypllhewalr egee

Melanoma-associated antigen 9 NP_005356.1
1 msleqrsphc kpdedleaqg edlglmgaqe ptgeeeetts ssdskeeevs aagssppqs
61 pqggasssis vyytlwsqfd egsssqeeee psssvdpaql efmfqealkl kvaelvhfll
121 hkyrvkepvt kaemlesvik nykryfpvif gkasefmqvi fgtdvkevdp aghsyilvta
181 lglscdsmlg dghsmpkaal liivlgvilt kdncapeevi wealsvmgvy vgkehmfyge
241 prkllqtqdwv qenyleyrqv pgsdpahyef lwgskahaet syekvinylv mlnarepicy
301 pslyeevlge eqegv

Melanoma-associated antigen C2 NP_057333.1
1 mppvpgvpfr nvdndsptsv eledwvdaqh ptdeeeeeas sasstlylvf spssfstsss
61 lilggpeeee vpsgvipnlt esipssppqg ppqgpsqspl ssccssfsws sfseesssqk
121 gedtgtcqgl pdsessftyt ldekvaelve flllkyeaee pvteaemlmi vikykdyfpv
181 ilkrarefme llfglaliev gpdhfcvfan tvgltdegsd degmpensll iiilsvifik
241 gncaseeviw evlnavgvya grehfvygep relltkvwvq ghyleyrevp hssppyyefl
301 wgprahsesi kkkvleflak lnntvpssfp swykdalkdv eervqatidt addatvmase
361 slsvmssnvs fse

Melanoma-associated antigen D1, isoform a NP_001005333.1
1 maqkmdcgag llgfqnpdac ravchplpqp pastlplsaf ptlcdppysq lrdppavlsc
61 yctplgaspa paeasvedsa llmqtlmeai qiseapptnq ataaaspqss qpptanemad
121 iqvsaaaarp ksafkvqnat tkgpngvydf sqahnakdvp ntqpkaafks qnatpkgpna
181 aydfsqaatt gelaanksem afkaqnattk vgpnatynfs qslnandlan srpktpfkaw
241 ndttkaptad tqtqnvnqak matsqadiet dpgisepdga taqtsadgsq aqnlesrtii
301 rgkrtrkinn lnveenssgd qrraplaagt wrsapvpvtt qnppgappnv lwqtplawqn
361 psgwqnqtar qtpparqspp arqtppawqn pvawqnpviw pnpviwqnpv iwpnpivwpg
421 pvvwpnplaw qnppgwqtpp gwqtppgwqg ppdwqgppdw plppdwplpp dwplptdwpl
481 ppdwipadwp ippdwqnlrp spnlrpspns rasqnpgaaq prdvallqer anklvkylml
541 kdytkvpikr semlrdiire ytdvypeiie racfvlekkf giqlkeidke ehlyilistp
601 eslagilgtt kdtpklglll vilgvifmng nraseavlwe alrkmglrpg vrhpllgdlr
661 klltyefvkq kyldyrrvpn snppeyeflw glrsyhetsk mkvlrfiaev qkrdprdwta
721 qfmeaadeal daldaaaaea earaeartrm gigdeavsgp wswddiefel ltwdeegdfg
781 dpwsripftf waryhqnars rfpqtfagpi igpggtasan faanfgaigf fwve

Melanoma-associated antigen D1, isoform b NP_001005332.1, NP_008917.3

```
   1 maqkmdcgag llgfqaeasv edsallmqtl meaiqiseap ptnqataaas pqssqpptan
  61 emadiqvsaa aarpksafkv qnattkgpng vydfsqahna kdvpntqpka afksqnatpk
 121 gpnaaydfsq aattgelaan ksemafkaqn attkvgpnat ynfsqslnan dlansrpktp
 181 fkawndttka ptadtqtqnv nqakmatsqa dietdpgise pdgataqtsa dgsqaqnles
 241 rtiirgkrtr kinnlnveen ssgdqrrapl aagtwrsapv pvttqnppga ppnvlwqtpl
 301 awqnpsgwqn qtarqtppar qspparqtpp awqnpvawqn pviwpnpviw qnpviwpnpi
 361 vwpgpvvwpn plawqnppgw qtppgwqtpp gwqgppdwqg ppdwplppdw plppdwplpt
 421 dwplppdwip adwpippdwq nlrpspnlrp spnsrasqnp gaaqprdval lqeranklvk
 481 ylmlkdytkv pikrsemlrd iireytdvyp eiieracfvl ekkfgiqlke idkeehlyil
 541 istpeslagi lgttkdtpkl glllvilgvi fmngnrasea vlwealrkmg lrpgvrhpll
 601 gdlrkklltye fvkqkyldyr rvpnsnppey eflwglrsyh etskmkvlrf iaevqkrdpr
 661 dwtaqfmeaa dealdaldaa aaeaearaea rtrmgigdea vsgpwswddi efelltwdee
 721 gdfgdpwsri pftfwaryhq narsrfpqtf agpiigpggt asanfaanfg aigffwve
```

Mitogen-activated protein kinase kinase kinase 5 NP_005914.1

```
   1 msteadegit fsvppfapsg fctipeggic rrggaaavge geehqlpppp pgsfwnvesa
  61 aapgigcpaa tssssatrgr gssvgggsrr ttvayvinea sqgqlvvaes ealqslreac
 121 etvgatletl hfgkldfget tvldrfynad iavvemsdaf rqpslfyhlg vresfsmann
 181 iilycdtnsd slqslkeiic qkntmctgny tfvpymitph nkvyccdssf mkgltelmqp
 241 nfelllgpic lplvdrfiql lkvaqasssq yfresilndi rkarnlytgk elaaelarir
 301 qrvdnievlt adivinllls yrdiqdydsi vklvetlekl ptfdlashhh vkfhyafaln
 361 rrnlpgdrak aldimipmvq segqvasdmy clvgriykdm fldsnftdte srdhgaswfk
 421 kafeseptlq sginyavlll aaghqfessf elrkvgvkls sllgkkgnle klqsywevgf
 481 flgasvland hmrviqasek lfklktpawy lksivetili ykhfvkltte qpvakqelvd
 541 fwmdflveat ktdvtvvrfp vlileptkiy qpsylsinne veektisiwh vlpddkkgih
 601 ewnfsassvr gvsiskfeer ccflyvlhns ddfqiyfcte lhckkffemv ntiteekgrs
 661 teegdcesdl leydyeyden gdrvvlgkgt ygivyagrdl snqvriaike iperdsrysq
 721 plheeialhk hlkhknivqy lgsfsengfi kifmeqvpgg slsallrskw gplkdneqti
 781 gfytkqileg lkylhdnqiv hrdikgdnvl intysgvlki sdfgtskrla ginpctetft
 841 gtlqymapei idkgprgygk aadiwslgct iiematgkpp fyelgepqaa mfkvgmfkvh
 901 peipesmsae akafilkcfe pdpdkracan dllvdeflkv sskkkktqpk lsalsagsne
 961 ylrsislpvp vlvedtssss eygsvspdte lkvdpfsfkt rakscgerdv kgirtlflgi
1021 pdenfedhsa ppspeekdsg ffmlrkdser ratlhrilte dqdkivrnlm eslaqgaeep
1081 klkwehittl iaslrefvrs tdrkiiattl sklkleldfd shgisqvqvv lfgfqdavnk
1141 vlrnhnikph wmfaldsiir kavqtaitil vpelrphfsl asesdtadqe dldveddhee
1201 qpsnqtvrrp qaviedavat sgvstlsstv shdsqsahrs lnvqlgrmki etnrlleelv
1261 rkekelqall hraieekdqe ikhlklksqp ieipelpvfh lnssgtnted seltdwlrvn
1321 gadedtisrf laedytlldv lyyvtrddlk clrlrggmlc tlwkaiidfr nkqt
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Mitogen-activated protein kinase kinase kinase 9, isoform 1 NP_149132.2

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   1 mepsrallgc lasaaaaapp gedgagagae eeeeeeeeaa aavgpgelgc daplpywtav
  61 feyeaagede ltlrlgdvve vlskdsqvsg degwwtgqln qrvgifpsny vtprsafssr
 121 cqpggedpsc yppiqlleid faeltleeii giggfgkvyr afwigdevav kaarhdpded
 181 isqtienvrq eaklfamlkh pniialrgvc lkepnlclvm efarggplnr vlsgkrippd
 241 ilvnwavqia rgmnylhdea ivpiihrdlk ssnililqkv engdlsnkil kitdfglare
 301 whrttkmsaa gtyawmapev irasmfskgs dvwsygvllw elltgevpfr gidglavayg
 361 vamnklalpi pstcpepfak lmedcwnpdp hsrpsftnil dqlttieesg ffempkdsfh
 421 clqdnwkhei qemfdqlrak ekelrtweee ltraalqqkn qeellrrreq elaereidil
 481 erelniiihq lcqekprvkk rkgkfrksrl klkdgnrisl psdfqhkftv qasptmdkrk
 541 slinsrsspp asptiiprlr aiqltpgess ktwgrssvvp keegeeeekr apkkkgrtwg
 601 pgtlgqkela sgdegspqrr ekanglstps esphfhlglk slvdgykqws ssapnlvkgp
 661 rsspalpgft slmemallaa swvvpidiee dedsegpgsg esrlqhspsq sylcipfprg
 721 edgdgpssdg iheeptpvns atstpqltpt nslkrggahh rrcevallgc gavlaatglg
 781 fdlleagkcq llpleepepp areekkrreg lfqrssrprr stsppsrklf kkeepmlllg
 841 dpsasltlls lssisecnst rslllrsdsde ivvyempvsp veapplspct hnplvnvrve
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 901 rfkrdpnqsl tpthvtlttp sqpsshrrtp sdgalkpetl lasrspssng lspspgagml
 961 ktpspsrdpg efprlpdpnv vfpptprrwn tqqdstlerp ktleflprpr psanrqrldp
1021 wwfvspshar stspanssst etpsnldscf asssstveer pglpallpfq agplpptert
1081 lldldaegqs qdstvplcra elnthrpapy eiqqefws

Mitogen-activated protein kinase kinase kinase 9, isoform 2 NP_001271159.1
   1 mepsrallgc lasaaaaapp gedgagagae eeeeeeeeaa aavgpgelgc daplpywtav
  61 feyeaagede ltlrlgdvve vlskdsqvsg degwwtgqln qrvgifpsny vtprsafssr
 121 cqpggedpsc yppiqlleid faeltleeii giggfgkvyr afwigdevav kaarhdpded
 181 isqtienvrq eaklfamlkh pniialrgvc lkepnlclvm efarggplnr vlsgkrippd
 241 ilvnwavqia rgmnylhdea ivpiihrdlk ssnililqkv engdlsnkil kitdfglare
 301 whrttkmsaa gtyawmapev irasmfskgs dvwsygvllw elltgevpfr gidglavayg
 361 vamnklalpi pstcpepfak lmedcwnpdp hsrpsftnil dqlttieesg ffempkdsfh
 421 clqdnwkhei qemfdqlrak ekelrtweee ltraalqqkn qeellrrreq elaereidil
 481 erelniiihq lcqekprvkk rkgkfrksrl klkdgnrisl psdfqhkftv qasptmdkrk
 541 slinsrsspp asptiiprlr aiqltpgess ktwgrssvvp keegeeeekr apkkkgrtwg
 601 pgtlgqkela sgdegspqrr ekanglstps esphfhlglk slvdgykqws ssapnlvkgp
 661 rsspalpgft slmemededs egpgsgesrl qhspsqsylc ipfprgedgd gpssdgihee
 721 ptpvnsatst pqltptnslk rggahhrrce vallgcgavl aatglgfdll eagkcqllpl
 781 eepepparee kkrreglfqr ssrprrstsp psrklfkkee pmlllgdpsa sltllslssi
 841 secnstrsll rsdsdeivvy empvspveap plspcthnpl vnvrverfkr dpnqsltpth
 901 vtlttpsqps shrrtpsdga lkpetllasr spssnglsps pgagmlktps psrdpgefpr
 961 lpdpnvvfpp tprrwntqqd stlerpktle flprprpsan rqrldpwwfv spsharstsp
1021 anssstetps nldscfasss stveerpglp allpfqagpl pptertlldl daegqsqdst
1081 vplcraelnt hrpapyeiqq efws

Mitogen-activated protein kinase kinase kinase 9, isoform 3 NP_001271160.1
   1 meltgleval vlilqkveng dlsnkilkit dfglarewhr ttkmsaagty awmapevira
  61 smfskgsdvw sygvllwell tgevpfrgid glavaygvam nklalpipst cpepfaklme
 121 dcwnpdphsr psftnildql ttieesgffe mpkdsfhclq dnwkheiqem fdqlrakeke
 181 lrtweeeltr aalqqknqee llrrreqela ereidilere lniiihqlcq ekprvkkrkg
 241 kfrksrlklk dgnrislpsd fqhkftvqas ptmdkrksli nsrssppasp tiiprlraiq
 301 cetvsqiswg qntqghlspa lsshrlvqac sihnfchlss tmciymhilt pgessktwgr
 361 ssvvpkeege eeekrapkkk grtwgpgtlg qkelasgdeg lkslvdgykq wsssapnlvk
 421 gprsspalpg ftslmemall aaswvvpidi eededsegpg sgesrlqhsp sqsylcipfp
 481 rgedgdgpss dgiheeptpv nsatstpqlt ptnslkrgga hhrrcevall gcgavlaatg
 541 lgfdlleagk cqllpleepe ppareekkrr eglfqrssrp rrstsppsrk lfkkeepmll
 601 lgdpsasltl lslssisecn strsllrsds deivvyempv spveapplsp cthnplvnvr
 661 verfkrdpnq sltpthvtlt tpsqpsshrr tpsdgalkpe tllasrspss nglspspgag
 721 mlktpspsrd pgefprlpdp nvvfpptprr wntqqdstle rpktleflpr prpsanrqrl
 781 dpwwfvspsh arstspanss stetpsnlds cfasssstve erpglpallp fqagplppte
 841 rtlldldaeg qsqdstvplc raelnthrpa pyeiqqefws

Mitogen-activated protein kinase kinase kinase 9, isoform 4 NP_001271161.1
   1 msaagtyawm apevirasmf skgsdvwsyg vllwelltge vpfrgidgla vaygvamnkl
  61 alpipstcpe pfaklmedcw npdphsrpsf tnildqltti eesgffempk dsfhclqdnw
 121 kheiqemfdq lrakekelrt weeeltraal qqknqeellr rreqelaere idilerelni
 181 iihqlcqekp rvkkrkgkfr ksrlklkdgn rislpsdfqh kftvqasptm dkrkslinsr
 241 ssppasptii prlraiqcet vsqiswgqnt qghlspalss hrlvqacsih nfchlsstmc
 301 iymhiltpge ssktwgrssv vpkeegeeee krapkkkgrt wgpgtlgqke lasgdeglks
 361 lvdgykqwss sapnlvkgpr sspalpgfts lmemallaas wvvpidieed edsegpgsge
 421 srlqhspsqs ylcipfprge dgdgpssdgi heeptpvnsa tstpqltptn slkrggahhr
 481 rcevallgcg avlaatglgf dlleagkcql lpleepeppa reekkrregl fqrssrprrs
 541 tsppsrklfk keepmlllgd psasltllsl ssisecnstr sllrsdsdei vvyempvspv
 601 eapplspcth nplvnvrver fkrdpnqslt pthvtlttps qpsshrrtps dgalkpetll
 661 asrspssngl spspgagmlk tpspsrdpge fprlpdpnvv fpptprrwnt qqdstlerpk
 721 tleflprprp sanrqrldpw wfvspshars tspanssste tpsnldscfa sssstveerp
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      781 glpallpfqa gplpptertl ldldaegqsq dstvplcrae lnthrpapye iqqefws

Mitogen-activated protin kinase 1 NP_002736.3, NP_620407.1
        1 maaaaaagag pemvrgqvfd vgprytnlsy igegaygmvc saydnvnkvr vaikkispfe
       61 hqtycqrtlr eikillrfrh eniigindii raptieqmkd vyivqdlmet dlykllktqh
      121 lsndhicyfl yqilrglkyi hsanvlhrdl kpsnlllntt cdlkicdfgl arvadpdhdh
      181 tgflteyvat rwyrapeiml nskgytksid iwsvgcilae mlsnrpifpg khyldqlnhi
      241 lgilgspsqe dlnciinlka rnyllslphk nkvpwnrlfp nadskaldll dkmltfnphk
      301 rieveqalah pyleqyydps depiaeapfk fdmelddlpk eklkelifee tarfqpgyrs

Melan-A NP_005502.1
        1 mpredahfiy gypkkghghs yttaeeaagi giltvilgvl lligcwycrr rngyralmdk
       61 slhvgtqcal trrcpqegfd hrdskvslqe kncepvvpna ppayeklsae qspppysp

Melanotransferrin, isoform 1 preprotein NP_005920.2
        1 mrgpsgalwl llalrtvlgg mevrwcatsd peqhkcgnms eafreagiqp sllcvrgtsa
       61 dhcvqliaaq eadaitldgg aiyeagkehg lkpvvgevyd qevgtsyyav avvrrsshvt
      121 idtlkgvksc htginrtvgw nvpvgylves grlsvmgcdv lkavsdyfgg scvpgagets
      181 yseslcrlcr gdssgegvcd kspleryydy sgafrclaeg agdvafvkhs tvlentdgkt
      241 lpswgqalls qdfellcrdg sradvtewrq chlarvpaha vvvradtdgg lifrllnegq
      301 rlfshegssf qmfsseaygq kdllfkdsts elvpiatqty eawlgheylh amkgllcdpn
      361 rlppylrwcv lstpeiqkcg dmavafrrqr lkpeiqcvsa kspqhcmeri qaeqvdavtl
      421 sgediytagk tyglvpaage hyapedssns yyvvavvrrd sshaftldel rgkrschagf
      481 gspagwdvpv galiqrgfir pkdcdvltav seffnascvp vnnpknypss lcalcvgdeq
      541 grnkcvgnsq eryygyrgaf rclvenagdv afvrhttvfd ntnghnsepw aaelrsedye
      601 llcpngarae vsqfaacnla qipphavmvr pdtniftvyg lldkaqdlfg ddhnkngfkm
      661 fdssnyhgqd llfkdatvra vpvgekttyr gwlgldyvaa legmssqqcs gaaapapgap
      721 llplllpala arllppal

Melanotransferrin, isoform 2 precursor NP_201573.1
        1 mrgpsgalwl llalrtvlgg mevrwcatsd peqhkcgnms eafreagiqp sllcvrgtsa
       61 dhcvqliaaq eadaitldgg aiyeagkehg lkpvvgevyd qevgtsyyav avvrrsshvt
      121 idtlkgvksc htginrtvgw nvpvgylves grlsvmgcdv lkavsdyfgg scvpgagets
      181 yseslcrlcr gdssgegvcd kspleryydy sgafrclaeg agdvafvkhs tvlentdesp
      241 srrqtwtrse eeegecpahe earrtmrssa gqawkwapvh rpqdesdkge fgkraksrdm
      301 lg

Baculoviral IAP repeat containing 7, isoform alpha NP_647478.1
        1 mgpkdsakcl hrgpqpshwa agdgptqerc gprslgspvl gldtcrawdh vdgqilgqlr
       61 plteeeeeeg agatlsrgpa fpgmgseelr lasfydwplt aevppellaa agffhtghqd
      121 kvrcffcygg lqswkrgddp wtehakwfps cqfllrskgr dfvhsvqeth sqllgswdpw
      181 eepedaapva psvpasgype lptprrevqs esaqepggvs paeaqrawwv leppgardve
      241 aqlrrlqeer tckvcldrav sivfvpcghl vcaecapglq lcpicrapvr srvrtfls

Baculoviral IAP repeat containing 7, isoform beta NP_071444.1
        1 mgpkdsakcl hrgpqpshwa agdgptqerc gprslgspvl gldtcrawdh vdgqilgqlr
       61 plteeeeeeg agatlsrgpa fpgmgseelr lasfydwplt aevppellaa agffhtghqd
      121 kvrcffcygg lqswkrgddp wtehakwfps cqfllrskgr dfvhsvqeth sqllgswdpw
      181 eepedaapva psvpasgype lptprrevqs esaqepgard veaqlrrlqe ertckvcldr
      241 avsivfvpcg hlvcaecapg lqlcpicrap vrsrvrtfls

Neutrophil collagenase, isoform 1 preprotein NP_002415.1
        1 mfslktlpfl lllhvqiska fpvsskeknt ktvqdylekf yqlpsnqyqs trkngtnviv
       61 eklkemqrff glnvtgkpne etldmmkkpr cgvpdsggfm ltpgnpkwer tnltyrirny
      121 tpqlseaeve raikdafelw svaspliftr isqgeadini afyqrdhgdn spfdgpngil
      181 ahafqpgqgi ggdahfdaee twtntsanyn lflvaahefg hslglahssd pgalmypnya
      241 fretsnyslp qddidgiqai yglssnpiqp tgpstpkpcd psltfdaitt lrgeilffkd
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      301 ryfwrrhpql qrvemnfisl fwpslptgiq aayedfdrdl iflfkgnqyw alsgydilqg
      361 ypkdisnygf pssvqaidaa vfyrsktyff vndqfwrydn qrqfmepgyp ksisgafpgi
      421 eskvdavfqq ehffhvfsgp ryyafdliaq rvtrvargnk wlncryg

Neutrophil collagenase, isoform 2 NP_001291370.1, NP_001291371.1
        1 mqqipqeksi ndylekfyql psnqyqstrk ngtnvivekl kemqrffgln vtgkpneetl
       61 dmmkkprcgv pdsggfmltp gnpkwertnl tyrirnytpq lseaeverai kdafelwsva
      121 spliftrisq geadiniafy qrdhgdnspf dgpngilaha fqpgqgiggd ahfdaeetwt
      181 ntsanynlfl vaahefghsl glahssdpga lmypnyafre tsnyslpqdd idgiqaiygl
      241 ssnpiqptgp stpkpcdpsl tfdaittlrg eilffkdryf wrrhpqlqrv emnfislfwp
      301 slptgiqaay edfdrdlifl fkgnqywals gydilqgypk disnygfpss vqaidaavfy
      361 rsktyffvnd qfwrydnqrq fmepgypksi sgafpgiesk vdavfqqehf fhvfsgpryy
      421 afdliaqrvt rvargnkwln cryg

Mesothelin, isoform 1 preprotein NP_001170826.1, NP_005814.2
        1 malptarpll gscgtpalgs llfllfslgw vqpsrtlage tgqeaapldg vlanppniss
       61 lsprqllgfp caevsglste rvrelavala qknvklsteq lrclahrlse ppedldalpl
      121 dlllflnpda fsgpqactrf fsritkanvd llprgaperq rllpaalacw gvrgsllsea
      181 dvralgglac dlpgrfvaes aevllprlvs cpgpldqdqq eaaraalqgg gppygppstw
      241 svstmdalrg llpvlgqpii rsipqgivaa wrqrssrdps wrqpertilr prfrrevekt
      301 acpsgkkare ideslifykk weleacvdaa llatqmdrvn aipftyeqld vlkhkldely
      361 pqgypesviq hlgylflkms pedirkwnvt sletlkalle vnkghemspq vatlidrfvk
      421 grgqldkdtl dtltafypgy lcslspeels svppssiwav rpqdldtcdp rqldvlypka
      481 rlafqnmngs eyfvkiqsfl ggaptedlka lsqqnvsmdl atfmklrtda vlpltvaevq
      541 kllgphvegl kaeerhrpvr dwilrqrqdd ldtlglglqg gipngylvld lsmqealsgt
      601 pcllgpgpvl tvlalllast la

Mesothelin, isoform 2 preprotein NP_037536.2
        1 malptarpll gscgtpalgs llfllfslgw vqpsrtlage tgqeaapldg vlanppniss
       61 lsprqllgfp caevsglste rvrelavala qknvklsteq lrclahrlse ppedldalpl
      121 dlllflnpda fsgpqactrf fsritkanvd llprgaperq rllpaalacw gvrgsllsea
      181 dvralgglac dlpgrfvaes aevllprlvs cpgpldqdqq eaaraalqgg gppygppstw
      241 svstmdalrg llpvlgqpii rsipqgivaa wrqrssrdps wrqpertilr prfrrevekt
      301 acpsgkkare ideslifykk weleacvdaa llatqmdrvn aipftyeqld vlkhkldely
      361 pqgypesviq hlgylflkms pedirkwnvt sletlkalle vnkghemspq aprrplpqva
      421 tlidrfvkgr gqldkdtldt ltafypgylc slspeelssv ppssiwavrp qdldtcdprq
      481 ldvlypkarl afqnmngsey fvkiqsflgg aptedlkals qqnvsmdlat fmklrtdavl
      541 pltvaevqkl lgphveglka eerhrpvrdw ilrqrqddld tlglglqggi pngylvldls
      601 mqealsgtpc llgpgpvltv lalllastla

Mucin-1, isoform 1 precursor NP_002447.4
        1 mtpgtqspff lllltvltv vtgsghasst pggeketsat qrssvpsste knalstgvsf
       61 fflsfhisnl qfnssledps tdyyqelqrd isemflqiyk qggflglsni kfrpgsvvvq
      121 ltlafregti nvhdvetqfn qykteaasry nltisdvsvs dvpfpfsaqs gagvpgwgia
      181 llvlvcvlva laivyliala vcqcrrknyg qldifpardt yhpmseypty hthgryvpps
      241 stdrspyekv sagnggssls ytnpavaats anl

Mucin-1, isoform 2 precursor NP_001018016.1
        1 mtpgtqspff lllltvlta ttapkpatvv tgsghasstp ggeketsatq rssvpsstek
       61 nafnssledp stdyyqelqr disemflqiy kqggflglsn ikfrpgsvvv qltlafregt
      121 invhdvetqf nqykteaasr ynltisdvsv sdvpfpfsaq sgagvpgwgi allvlvcvlv
      181 alaivylial avcqcrrkny gqldifpard tyhpmseypt yhthgryvpp sstdrspyek
      241 vsagnggssl sytnpavaat sanl

Mucin-1, isoform 3 precursor NP_001018017.1
        1 mtpgtqspff lllltvltv vtgsghasst pggeketsat qrssvpsste knafnssled
       61 pstdyyqelq rdisemflqi ykqggflgls nikfrpgsvv vqltlafreg tinvhdvetq
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      121 fnqykteaas rynltisdvs vsdvpfpfsa qsgagvpgwg iallvlvcvl valaivylia
      181 lavcqcrrkn ygqldifpar dtyhpmseyp tyhthgryvp psstdrspye kvsagnggss
      241 lsytnpavaa tsanl

Mucin-1, isoform 5 precursor NP_001037855.1
        1 mtpgtqspff llllltvltv vtgsghasst pggeketsat qrssvpsste knaipapttt
       61 kscretflkc fcrfinkgvf waspilssvs dvpfpfsaqs gagvpgwgia llvlvcvlva
      121 laivyliala vcqcrrknyg qldifpardt yhpmseypty hthgryvpps stdrspyekv
      181 sagnggssls ytnpavaats anl

Mucin-1, isoform 6 precursor NP_001037856.1
        1 mtpgtqspff llllltvltv vtgsghasst pggeketsat qrssvpsste knafnssled
       61 pstdyyqelq rdisemavcq crrknygqld ifpardtyhp mseyptyhth gryvppsstd
      121 rspyekvsag nggsslsytn pavaatsanl

Mucin-1, isoform 7 precursor NP_001037857.1
        1 mtpgtqspff lllllvlta ttapkpatvv tgsghasstp ggeketsatq rssvpsstek
       61 nafnssledp stdyyqelqr disemavcqc rrknygqldi fpardtyhpm seyptyhthg
      121 ryvppsstdr spyekvsagn ggsslsytnp avaatsanl

Mucin-1, isoform 8 precursor NP_001037858.1
        1 mtpgtqspff lllllvltv vtgsghasst pggeketsat qrssvpsste knaipapttt
       61 kscretflkc fcrfinkgvf waspilssvw gwgarlghra agaglcsgca ghclshclgc
      121 lsvppkelra aghlsspgyl psyervphlp hpwalcap

Mucin-1, isoform 9 precursor NP_001191214.1
        1 mtpgtqspff lllllvltv vtgsghasst pggeketsat qrssvpsste knavsmtssv
       61 lsshspgsgs sttqgqdvtl apatepasgs aatwgqdvts vpvtrpalgs ttppahdvts
      121 apdnkpapgs tappahgvts apdtrpapgs tappahgvts apdnrpalgs tappvhnvts
      181 asgsasgsas tlvhngtsar atttpaskst pfsipshhsd tpttlashst ktdassthhs
      241 tvppltssnh stspqlstgv sffflsfhis nlqfnssled pstdyyqelq rdisemflqi
      301 ykqggflgls nikfrpgsvv vqltlafreg tinvhdvetq fnqykteaas rynltisdvs
      361 vsdvpfpfsa qsgagvpgwg iallvlvcvl valaivylia lavcqcrrkn ygqldifpar
      421 dtyhpmseyp tyhthgryvp psstdrspye kvsagnggss lsytnpavaa tsanl

Mucin-1, isoform 10 precursor NP_001191215.1
        1 mtpgtqspff lllllvlta ttapkpatvv tgsghasstp ggeketsatq rssvpsstek
       61 navsmtssvl sshspgsgss ttqgqdvtla patepasgsa atwgqdvtsv pvtrpalgst
      121 tppahdvtsa pdnkpapgst appahgvtsa pdtrpapgst appahgvtsa pdnrpalgst
      181 appvhnvtsa sgsasgsast lvhngtsara tttpaskstp fsipshhsdt pttlashstk
      241 tdassthhst vppltssnhs tspqlstgvs ffflsfhisn lqfnssledp stdyyqelqr
      301 disemflqiy kqggflglsn ikfrpgsvvv qltlafregt invhdvetqf nqykteaasr
      361 ynltisdvsv sdvpfpfsaq sgagvpgwgi allvlvcvlv alaivylial avcqcrrkny
      421 gqldifpard tyhpmseypt yhthgryvpp sstdrspyek vsagnggssl sytnpavaat
      481 sanl

Mucin-1, isoform 11 precursor NP_001191216.1
        1 mtpgtqspff lllllvlta ttapkpatvv tgsghasstp ggeketsatq rssvpsstek
       61 nalstgvsff flsfhisnlq fnssledpst dyyqelqrdi semflqiykq ggflglsnik
      121 frpgsvvvql tlafregtin vhdvetqfnq ykteaasryn ltisdvsvsd vpfpfsaqsg
      181 agvpgwgial lvlvcvlval aivylialav cqcrrknygq ldifpardty hpmseyptyh
      241 thgryvppss tdrspyekvs agnggsslsy tnpavaatsa nl

Mucin-1, isoform 12 precursor NP_001191217.1
        1 mtpgtqspff lllllvlta ttapkpatvv tgsghasstp ggeketsatq rssvpsstek
       61 nafnssledp stdyyqelqr disemflqiy kqggflglsn ikfrpgsvvv qltlafregt
      121 invhdvetqf nqykteaasr ynltisdvsv wgwgarlghr aagaglcsgc aghclshclg
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      181 clsvppkelr aaghlsspgy lpsyervphl phpwalcap

Mucin-1, isoform 13 precursor NP_001191218.1
        1 mtpgtqspff lllllltvlta ttapkpatvv tgsghasstp ggeketsatq rssvpsstek
       61 naiykqggfl glsnikfrpg svvvqltlaf regtinvhdv etqfnqykte aasrynltis
      121 dvsvsdvpfp fsaqsgagvp gwgiallvlv cvlvalaivy lialavcqcr rknygqldif
      181 pardtyhpms eyptyhthgr yvppsstdrs pyekvsagng gsslsytnpa vaatsanl

Mucin-1, isoform 14 precursor NP_001191219.1
        1 mtpgtqspff lllllltvltg geketsatqr ssvpsstekn aiykqggflg lsnikfrpgs
       61 vvvqltlafr egtinvhdve tqfnqyktea asrynltisd vsvsdvpfpf saqsgagvpg
      121 wgiallvlvc vlvalaivyl ialavcqcrr knygqldifp ardtyhpmse yptyhthgry
      181 vppsstdrsp yekvsagngg sslsytnpav aatsanl

Mucin-1, isoform 15 precursor NP_001191220.1
        1 mtpgtqspff lllllltvlta ttapkpatvv tgsghasstp ggeketsatq rssvpsstek
       61 naflqiykqg gflglsnikf rpgsvvvqlt lafregtinv hdvetqfnqy kteaasrynl
      121 tisdvsvsdv pfpfsaqsga gvpgwgiall vlvcvlvala ivylialavc qcrrknygql
      181 difpardtyh pmseyptyht hgryvppsst drspyekvsa gnggsslsyt npavaatsan
      241 l

Mucin-1, isoform 16 precursor NP_001191221.1
        1 mtpgtqspff lllllltvlta ttapkpatvv tgsghasstp ggeketsatq rssvpsstek
       61 naipaptttk scretflkwp gsvvvqltla fregtinvhd vetqfnqykt eaasrynlti
      121 sdvsvsdvpf pfsaqsgagv pgwgiallvl vcvlvalaiv ylialavcqc rrknygqldi
      181 fpardtyhpm seyptyhthg ryvppsstdr spyekvsagn ggsslsytnp avaatsanl

Mucin-1, isoform 17 precursor NP_001191222.1
        1 mtpgtqspff lllllltvltv vtgsghasst pggeketsat qrssvpsste knalstgvsf
       61 fflsfhisnl qfnssledps tdyyqelqrd isemflqiyk qggflglsni kfrpgsvvvq
      121 ltlafregti nvhdvetqfn qykteaasry nltisdvsgc lsvppkelra aghlsspgyl
      181 psyervphlp hpwalcap

Mucin-1, isoform 18 precursor NP_001191223.1
        1 mtpgtqspff lllllltvltv vtgsghasst pggeketsat qrssvpsste knaipapttt
       61 kscretflkw pgsvvvqltl afregtinvh dvetqfnqyk teaasrynlt isdvsvsdvp
      121 fpfsaqsgag vpgwgiallv lvcvlvalai vylialavcq crrknygqld ifpardtyhp
      181 mseyptyhth gryvppsstd rspyekvsag nggsslsytn pavaatsanl

Mucin-1, isoform 19 precursor NP_001191224.1
        1 mtpgtqspff lllllltvlta ttapkpatvv tgsghasstp ggeketsatq rssvpsstek
       61 nafnssledp stdyyqelqr disemsgagv pgwgiallvl vcvlvalaiv ylialavcqc
      121 rrknygqldi fpardtyhpm seyptyhthg ryvppsstdr spyekvsagn ggsslsytnp
      181 avaatsanl

Mucin-1, isoform 20 precursor NP_001191225.1
        1 mtpgtqspff lllllltvlta ttapkpatvv tgsghasstp ggeketsatq rssvpsstek
       61 naipaptttk scretflkcf crfinkgvfw aspilssvsd vpfpfsaqsg agvpgwgial
      121 lvlvcvlval aivylialav cqcrrknygq ldifpardty hpmseyptyh thgryvppss
      181 tdrspyekvs agnggsslsy tnpavaatsa nl

Mucin-1, isoform 21 precursor NP_001191226.1
        1 mtpgtqspff lllllltvlta ttapkpatvv tgsghasstp ggeketsatq rssvpsstek
       61 nalstgvsff flsfhisnlq fnssledpst dyyqelqrdi semavcqcrr knygqldifp
      121 ardtyhpmse yptyhthgry vppsstdrsp yekvsagngg sslsytnpav aatsanl

N-myc proto-oncogene protein, isoform 1 NP_001280157.1, NP_005369.2
```

```
        1 mpscststmp gmicknpdle fdslqpcfyp deddfyfggp dstppgediw kkfellptpp
       61 lspsrgfaeh sseppswvte mllenelwgs paeedafglg glggltpnpv ilqdcmwsgf
      121 sareklerav seklqhgrgp ptagstaqsp gagaaspagr ghggaagagr agaalpaela
      181 hpaaecvdpa vvfpfpvnkr epapvpaapa sapaagpava sgagiaapag apgvapprpg
      241 grqtsggdhk alstsgedtl sdsddeddee edeeeeidvv tvekrrsssn tkavttftit
      301 vrpknaalgp graqsselil krclpihqqh nyaapspyve sedappqkki kseasprplk
      361 svippkaksl sprnsdseds errrnhnile rqrrndlrss fltlrdhvpe lvknekaakv
      421 vilkkateyv hslqaeehql llekeklqar qqqllkkieh artc

N-myc proto-oncogene protein, isoform 2 NP_001280160.1
        1 mrgapgncvg aeqalarrkr aqtvairghp rppgppgdtr aesppdplqs agddeddeee
       61 deeeeidvvt vekrrsssnt kavttftitv rpknaalgpg raqsselilk rclpihqqhn
      121 yaapspyves edappqkkik seasprplks vippkaksls prnsdsedse rrrnhniler
      181 qrrndlrssf ltlrdhvpel vknekaakvv ilkkateyvh slqaeehqll lekeklqarq
      241 qqllkkieha rtc

N-myc proto-oncogene protein, isoform 3 NP_001280162.1
        1 mrgapgncvg aeqalarrkr aqtvairghp rppgppgdtr aesppdplqs agvlevgagp
       61 rlprppregs tpgiktngae rspqspagrr adaellhvhh aghdlqeprp rv

Cancer/testis antigen 1B NP_001318.1
        1 mqaegrgtgg stgdadgpgg pgipdgpggn aggpgeagat ggrgprgaga arasgpggga
       61 prgphggaas glngccrcga rgpesrllef ylampfatpm eaelarrsla qdapplpvpg
      121 vllkeftvsg niltirltaa dhrqlqlsis sclqqlslm witqcflpvf laqppsgqrr

Opioid growth factor receptor NP_031372.2
        1 mddpdcdstw eedeedaeda ededcedgea agardadagd edeeseepra arpssfqsrm
       61 tgsrnwratr dmcryrhnyp dlverdcngd tpnlsfyrne irflpngcfi edilqnwtdn
      121 ydlllednhsy iqwlfplrep gvnwhakplt lrevevfkss qeiqerlvra yelmlgfygi
      181 rledrgtgtv graqnyqkrf qnlnwrshnn lritrilksl gelglehfqa plvrffleet
      241 lvrrelpgvr qsaldyfmfa vrcrhqrrql vhfawehfrp rckfvwgpqd klrrfkpssl
      301 phplegsrkv eeegspgdpd heastqgrtc gpehskgggr vdegpqprsv epqdagpler
      361 sqgdeagghg edrpeplspk eskkrklels rreqpptepg pqsaseveki alnlegcals
      421 qgslrtgtqe vggqdpgeav qpcrqplgar vadkvrkrrk vdegagdsaa vasggaqtla
      481 lagspapsgh pkaghsengv eedtegrtgp kegtpgspse tpgpspagpa gdepaespse
      541 tpgprpagpa gdepaespse tpgprpagpa gdepaespse tpgpspagpt rdepaespse
      601 tpgprpagpa gdepaespse tpgprpagpa gdepaespse tpgpspagpt rdepakagea
      661 aelqdaeves saksgkp

P antigen family member 4 NP_001305806.1, NP_008934.1
        1 msarvrsrsr grgdgqeapd vvafvapges qqeepptdnq diepgqereg tppieerkve
       61 gdcqemdlek trsergdgsd vkektppnpk haktkeagdg qp

Paired box protein Pax-3, isoform PAX3a NP_000429.2
        1 mttlagavpr mmrpgpgqny prsgfplevs tplgqgrvnq lggvfingrp lpnhirhkiv
       61 emahhgirpc visrqlrvsh gcvskilcry qetgsirpga iggskpkqvt tpdvekkiee
      121 ykrenpgmfs weirdkllkd avcdrntvps vssisrilrs kfgkgeeeea dlerkeaees
      181 ekkakhsidg ilsergkrwr lgrrtcwvtw rasas

Paired box protein Pax-3, isoform PAX3i NP_001120838.1
        1 mttlagavpr mmrpgpgqny prsgfplevs tplgqgrvnq lggvfingrp lpnhirhkiv
       61 emahhgirpc visrqlrvsh gcvskilcry qetgsirpga iggskpkqvtt pdvekkieey
      121 krenpgmfsw eirdkllkda vcdrntvpsv ssisrilrsk fgkgeeeead lerkeaeese
      181 kkakhsidgi lserasapqs degsdidsep dlplkrkqrr srttftaeql eelerafert
      241 hypdiytree laqrakltea rvqvwfsnrr arwrkqagan qlmafnhlip ggfpptampt
      301 lptyqlsets yqptsipqav sdpsstvhrp qplppstvhq stipsnpdss sayclpstrh
      361 gfssytdsfv ppsgpsnpmn ptignglspq vmglltnhgg vphqpqtdya lspltgglep
```

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421 tttvsascsq rldhmkslds lptsqsycpp tysttgysmd pvtgyqygqy gqsafhylkp
481 dia

Paired box protein Pax-3, isoform PAX3b NP_039230.1
  1 mttlagavpr mmrpgpgqny prsgfplevs tplgqgrvnq lggvfingrp lpnhirhkiv
 61 emahhgirpc visrqlrvsh gcvskilcry qetgsirpga iggskpkqvt tpdvekkiee
121 ykrenpgmfs weirdkllkd avcdrntvps vssisrilrs kfgkgeeeea dlerkeaees
181 ekkakhsidg ilsergkalv sgvssh

Paired box protein Pax-3, isoform PAX3 NP_852122.1
  1 mttlagavpr mmrpgpgqny prsgfplevs tplgqgrvnq lggvfingrp lpnhirhkiv
 61 emahhgirpc visrqlrvsh gcvskilcry qetgsirpga iggskpkqvt tpdvekkiee
121 ykrenpgmfs weirdkllkd avcdrntvps vssisrilrs kfgkgeeeea dlerkeaees
181 ekkakhsidg ilserasapq sdegsdidse pdlplkrkqr rsrttftaeq leelerafer
241 thypdiytre elaqraklte arvqvwfsnr rarwrkqaga nqlmafnhli pggfpptamp
301 tlptyqlset syqptsipqa vsdpsstvhr pqplppstvh qstipsnpds ssayclpstr
361 hgfssytdsf vppsgpsnpm nptignglsp qvmglltnhg gvphqpqtdy alspltggle
421 ptttvsascs qrldhmksld slptsqsycp ptysttgysm dpvtgyqygq ygqskpwtf

Paired box protein Pax-3, isoform PAX3d NP_852123.1
  1 mttlagavpr mmrpgpgqny prsgfplevs tplgqgrvnq lggvfingrp lpnhirhkiv
 61 emahhgirpc visrqlrvsh gcvskilcry qetgsirpga iggskpkqvt tpdvekkiee
121 ykrenpgmfs weirdkllkd avcdrntvps vssisrilrs kfgkgeeeea dlerkeaees
181 ekkakhsidg ilserasapq sdegsdidse pdlplkrkqr rsrttftaeq leelerafer
241 thypdiytre elaqraklte arvqvwfsnr rarwrkqaga nqlmafnhli pggfpptamp
301 tlptyqlset syqptsipqa vsdpsstvhr pqplppstvh qstipsnpds ssayclpstr
361 hgfssytdsf vppsgpsnpm nptignglsp qvmglltnhg gvphqpqtdy alspltggle
421 ptttvsascs qrldhmksld slptsqsycp ptysttgysm dpvtgyqygq ygqsafhylk
481 pdia

Paired box protein Pax-3, isoform PAX3e NP_852124.1
  1 mttlagavpr mmrpgpgqny prsgfplevs tplgqgrvnq lggvfingrp lpnhirhkiv
 61 emahhgirpc visrqlrvsh gcvskilcry qetgsirpga iggskpkqvt tpdvekkiee
121 ykrenpgmfs weirdkllkd avcdrntvps vssisrilrs kfgkgeeeea dlerkeaees
181 ekkakhsidg ilserasapq sdegsdidse pdlplkrkqr rsrttftaeq leelerafer
241 thypdiytre elaqraklte arvqvwfsnr rarwrkqaga nqlmafnhli pggfpptamp
301 tlptyqlset syqptsipqa vsdpsstvhr pqplppstvh qstipsnpds ssayclpstr
361 hgfssytdsf vppsgpsnpm nptignglsp qvmglltnhg gvphqpqtdy alspltggle
421 ptttvsascs qrldhmksld slptsqsycp ptysttgysm dpvtgyqygq ygqsafhylk
481 pdiawfqill ntfdkssgee edleq

Paired box protein Pax-3, isoform PAX3h NP_852125.1
  1 mttlagavpr mmrpgpgqny prsgfplevs tplgqgrvnq lggvfingrp lpnhirhkiv
 61 emahhgirpc visrqlrvsh gcvskilcry qetgsirpga iggskpkqvt tpdvekkiee
121 ykrenpgmfs weirdkllkd avcdrntvps vssisrilrs kfgkgeeeea dlerkeaees
181 ekkakhsidg ilserasapq sdegsdidse pdlplkrkqr rsrttftaeq leelerafer
241 thypdiytre elaqraklte arvqvwfsnr rarwrkqaga nqlmafnhli pggfpptamp
301 tlptyqlset syqptsipqa vsdpsstvhr pqplppstvh qstipsnpds ssayclpstr
361 hgfssytdsf vppsgpsnpm nptignglsp qvpfiissqi slgfksf

Paired box protein Pax-3, isoform PAX3g NP_852126.1
  1 mttlagavpr mmrpgpgqny prsgfplevs tplgqgrvnq lggvfingrp lpnhirhkiv
 61 emahhgirpc visrqlrvsh gcvskilcry qetgsirpga iggskpkqvt tpdvekkiee
121 ykrenpgmfs weirdkllkd avcdrntvps vssisrilrs kfgkgeeeea dlerkeaees
181 ekkakhsidg ilserasapq sdegsdidse pdlplkrkqr rsrttftaeq leelerafer
241 thypdiytre elaqraklte arvqvwfsnr rarwrkqaga nqlmafnhli pggfpptamp
301 tlptyqlset syqptsipqa vsdpsstvhr pqplppstvh qstipsnpds ssayclpstr
```

```
      361 hgfssytdsf vppsgpsnpm nptignglsp qvpfiissqi srk

Paired box protein Pax-5, isoform 1 NP_057953.1
        1 mdleknyptp rtsrtghggv nqlggvfvng rplpdvvrqr ivelahqggvr pcdisrqlrv
       61 shgcvskilg ryyetgsikp gviggskpkv atpkvvekia eykrqnptmf aweirdrlla
      121 ervcdndtvp svssinriir tkvqqppnqp vpasshsivs tgsvtqvssv stdsagssys
      181 isgilgitsp sadtnkrkrd egiqespvpn ghslpgrdfl rkqmrgdlft qqqlevldrv
      241 ferqhysdif tttepikpeq tteysamasl agglddmkan lasptpadig ssvpgpqsyp
      301 ivtgrdlast tlpgypphvp pagqgsysap tltgmvpgse fsgspyshpq yssyndswrf
      361 pnpgllgspy yysaaargaa ppaaataydr h

Paired box protein Pax-5, isoform 2 NP_001267476.1
        1 mdleknyptp rtsrtghggv nqlggvfvng rplpdvvrqr ivelahqggvr pcdisrqlrv
       61 shgcvskilg ryyetgsikp gviggskpkv atpkvvekia eykrqnptmf aweirdrlla
      121 ervcdndtvp svssinriir tkvqqppnqp vpasshsivs tgsvtqvssv stdsagssys
      181 isgilgitsp sadtnkrkrd egiqespvpn ghslpgrdfl rkqmrgdlft qqqlevldrv
      241 ferqhysdif tttepikpeq tteysamasl agglddmkan lasptpadig ssvpgpqsyp
      301 ivtgsefsgs pyshpqyssy ndswrfpnpg llgspyyysa aargaappaa ataydrh

Paired box protein Pax-5, isoform 3 NP_001267477.1
        1 mdleknyptp rtsrtghggv nqlggvfvng rplpdvvrqr ivelahqggvr pcdisrqlrv
       61 shgcvskilg ryyetgsikp gviggskpkv atpkvvekia eykrqnptmf aweirdrlla
      121 ervcdndtvp svssinriir tkvqqppnqp vpasshsivs tgsvtqvssv stdsagssys
      181 isgilgitsp sadtnkrkrd egiqespvpn ghslpgrdfl rkqmrgdlft qqqlevldrv
      241 ferqhysdif tttepikpeq tteysamasl agglddmkan lasptpadig ssvpgpqsyp
      301 ivtgrdlast tlpgypphvp pagqgsysap tltgmvpgsp yyysaaarga appaaatayd
      361 rh

Paired box protein Pax-5, isoform 4 NP_001267478.1
        1 mdleknyptp rtsrtghggv nqlggvfvng rplpdvvrqr ivelahqggvr pcdisrqlrv
       61 shgcvskilg ryyetgsikp gviggskpkv atpkvvekia eykrqnptmf aweirdrlla
      121 ervcdndtvp svssinriir tkvqqppnqp vpasshsivs tgsvtqvssv stdsagssys
      181 isgilgitsp sadtnkrkrd egiqespvpn ghslpgrdfl rkqmrgdlft qqqlevldrv
      241 ferqhysdif tttepikpeq gvsfpgvpta tlsiprtttp ggsptrgcla pptiialppe
      301 epphlqpplp mtvtdpwsqa gtkh

Paired box protein Pax-5, isoform 5 NP_001267479.1
        1 mdleknyptp rtsrtghggv nqlggvfvng rplpdvvrqr ivelahqggvr pcdisrqlrv
       61 shgcvskilg ryyetgsikp gviggskpkv atpkvvekia eykrqnptmf aweirdrlla
      121 ervcdndtvp svssinriir tkvqqppnqp vpasshsivs tgsvtqvssv stdsagssys
      181 isgilgitsp sadtnkrkrd egiqespvpn ghslpgrdfl rkqmrgdlft qqqlevldrv
      241 ferqhysdif tttepikpeq apptiialpp eepphlqppl pmtvtdpwsq agtkh

Paired box protein Pax-5, isoform 6 NP_001267480.1
        1 mfaweirdrl laervcdndt vpsvssinri irtkvqqppn qpvpasshsi vstgsvtqvs
       61 svstdsagss ysisgilgit spsadtnkrk rdegiqespv pnghslpgrd flrkqmrgdl
      121 ftqqqlevld rvferqhysd ifttttepikp eqtteysama slaggldmk anlasptpad
      181 igssvpgpqs ypivtgspyy ysaaargaap paaataydrh

Paired box protein Pax-5, isoform 7 NP_001267481.1
        1 mdleknyptp rtsrtghggv nqlggvfvng rplpdvvrqr ivelahqggvr pcdisrqlrv
       61 shgcvskilg ryyetgsikp gviggskpkv atpkvvekia eykrqnptmf aweirdrlla
      121 ervcdndtvp svssinriir tkvqqppnqp vpasshsivs tgsvtqvssv stdsagssys
      181 isgilgitsp sadtnkrkrd egiqespvpn ghslpgrdfl rkqmrgdlft qqqlevldrv
      241 ferqhysdif tttepikpeq tteysamasl aggldmkan lasptpadig ssvpgpqsyp
      301 ivtgspyyys aaargaappa aataydrh
```

Paired box protein Pax-5, isoform 8 NP_001267482.1
```
   1 mdleknyptp rtsrtghggv nqlggvfvng rplpdvvrqr ivelahqgvr pcdisrqlrv
  61 shgcvskilg ryyetgsikp gviggskpkv atpkvvekia eykrqnptmf aweirdrlla
 121 ervcdndtvp svssinriir tkvqqppnqp vpasshsigi qespvpnghs lpgrdflrkq
 181 mrgdlftqqq levldrvfer qhysdifttt epikpeqtte ysamaslagg lddmkanlas
 241 ptpadigssv pgpqsypivt grdlasttlp gypphvppag qgsysaptlt gmvpgspyyy
 301 saaargaapp aaataydrh
```

Paired box protein Pax-5, isoform 9 NP_001267483.1
```
   1 mdleknyptp rtsrtghggv nqlggvfvng rplpdvvrqr ivelahqgvr pcdisrqlrv
  61 shgcvskilg ryyetgsikp gviggskpkv atpkvvekia eykrqnptmf aweirdrlla
 121 ervcdndtvp svssinriir tkvqqppnqp vpasshsigi qespvpnghs lpgrdflrkq
 181 mrgdlftqqq levldrvfer qhysdifttt epikpeqtte ysamaslagg lddmkanlas
 241 ptpadigssv pgpqsypivt grdlasttlp gypphvppag qgsysaptlt gmvpgsefsg
 301 spyshpqyss yndswrfpnp gllgspyyys aaargaappa aataydrh
```

Paired box protein Pax-5, isoform 10 NP_001267484.1
```
   1 mdleknyptp rtsrtghggv nqlggvfvng rplpdvvrqr ivelahqgvr pcdisrqlrv
  61 shgcvskilg riirtkvqqp pnqpvpassh sivstgsvtq vssvstdsag ssysisgilg
 121 itspsadtnk rkrdegiqes pvpnghslpg rdflrkqmrg dlftqqqlev ldrvferqhy
 181 sdiftttepi kpeqtteysa maslaggldd mkanlasptp adigssvpgp qsypivtgse
 241 fsgspyshpq yssyndswrf pnpgllgspy yysaaargaa ppaaataydr h
```

Paired box protein Pax-5, isoform 11 NP_001267485.1
```
   1 mfaweirdrl laervcdndt vpsvssinri irtkvqqppn qpvpasshsi vstgsvtqvs
  61 svstdsagss ysisgilgit spsadtnkrk rdegiqespv pnghslpgrd flrkqmrgdl
 121 ftqqqlevld rvferqhysd iftttepikp eqtteysama slaggldmk anlasptpad
 181 igssvpgpqs ypivtgrdla sttlpgypph vppagqgsys aptltgmvpg sefsgspysh
 241 pqyssyndsw rfpnpgllgs pyyysaaarg aappaaatay drh
```

Platelet-derived growth factor receptor beta, isoform 1 NP_002600.1
```
   1 mrlpgampal alkgellls llllepqis qglvvtppgp elvlnvsstf vltcsgsapv
  61 vwermsqepp qemakaqdgt fssvltltnl tgldtgeyfc thndsrglet derkrlyifv
 121 pdptvgflpn daeelfiflt eiteitipcr vtdpqlvvtl hekkgdvalp vpydhqrgfs
 181 gifedrsyic kttigdrevd sdayyvyrlq vssinvsvna vqtvvrqgen itlmcivign
 241 evvnfewtyp rkesgrlvep vtdflldmpy hirsilhips aeledsgtyt cnvtesvndh
 301 qdekainitv vesgyvrllg evgtlqfael hrsrtlqvvf eayppptvlw fkdnrtlgds
 361 sageialstr nvsetryvse ltlvrvkvae aghytmrafh edaevqlsfq lqinvpvrvl
 421 elseshpdsg eqtvrcrgrg mpqpniiwsa crdlkrcpre lpptllgnss eeesqletnv
 481 tyweeeqefe vvstlrlqhv drplsvrctl rnavgqdtqe vivvphslpf kvvvisaila
 541 lvvltiisli ilimlwqkkp ryeirwkvie svssdgheyi yvdpmqlpyd stwelprdql
 601 vlgrtlgsga fgqvveatah glshsqatmk vavkmlksta rssekqalms elkimshlgp
 661 hlnvvnllga ctkggpiyii teycrygdlv dylhrnkhtf lqhhsdkrrp psaelysnal
 721 pvglplpshv sltgesdggy mdmskdesvd yvpmldmkgd vkyadiessn ymapydnyvp
 781 sapertcrat linespvlsy mdlvgfsyqv angmeflask ncvhrdlaar nvlicegklv
 841 kicdfglard imrdsnyisk gstflplkwm apesifnsly ttlsdvwsfg illweiftlg
 901 gtpypelpmn eqfynaikrg yrmaqpahas deiyeimqkc weekfeirpp fsqlvlller
 961 llgegykkky qqvdeeflrs dhpailrsqa rlpgfhglrs pldtssvlyt avqpnegdnd
1021 yiiplpdpkp evadegpleg spslasstln evntsstisc dsplepqdep epepqlelqv
1081 epepeleqlp dsgcpaprae aedsfl
```

Platelet-derived growth factor receptor beta, isoform 2 NP_001341945.1
```
   1 msqeppqema kaqdgtfssv ltltnltgld tgeyfcthnd srgletderk rlyifvpdpt
  61 vgflpndaee lfiflteite itipcrvtdp qlvvtlhekk gdvalpvpyd hqrgfsgife
 121 drsyicktti gdrevdsday yvyrlqvssi nvsvnavqtv vrqgenitlm civignevvn
 181 fewtyprkes grlvepvtdf lldmpyhirs ilhipsaele dsgtytcnvt esvndhqdek
 241 ainitvvesg yvrllgevgt lqfaelhrsr tlqvvfeayp pptvlwfkdn rtlgdssage
```

```
 301 ialstrnvse tryvseltlv rvkvaeaghy tmrafhedae vqlsfqlqin vpvrvlelse
 361 shpdsgeqtv rcrgrgmpqp niiwsacrdl krcprelppt llgnsseees qletnvtywe
 421 eeqefevvst lrlqhvdrpl svrctlrnav gqdtqevivv phslpfkvvv isailalvvl
 481 tiisliilim lwqkkpryei rwkviesvss dgheyiyvdp mqlpydstwe lprdqlvlgr
 541 tlgsgafgqv veatahglsh sqatmkvavk mlkstarsse kqalmselki mshlgphlnv
 601 vnllgactkg gpiyiiteyc rygdlvdylh rnkhtflqhh sdkrrppsae lysnalpvgl
 661 plpshvsltg esdggymdms kdesvdyvpm ldmkgdvkya diessnymap ydnyvpsape
 721 rtcratline spvlsymdlv gfsyqvangm eflaskncvh rdlaarnvli cegklvkicd
 781 fglardimrd snyiskgstf lplkwmapes ifnslyttls dvwsfgillw eiftlggtpy
 841 pelpmneqfy naikrgyrma qpahasdeiy eimqkcweek feirppfsql vlllerllge
 901 gykkkyqqvd eeflrsdhpa ilrsqarlpg fhglrspldt ssvlytavqp negdndyiip
 961 lpdpkpevad egplegspsl asstlnevnt sstiscdspl epqdepepep qlelqvepep
1021 eleqlpdsgc papraeaeds fl
```

Platelet-derived growth factor receptor beta, isoform 3 NP_001341946.1

```
   1 mitnvaflvs lrteatsakp plgtgrwilm ptmstdsrvs plsglmlsrv ssinvsvnav
  61 qtvvrqgeni tlmcivigne vvnfewtypr kesgrlvepv tdflldmpyh irsilhipsa
 121 eledsgtytc nvtesvndhq dekainitvv esgyvrllge vgtlqfaelh rsrtlqvvfe
 181 ayppptvlwf kdnrtlgdss ageialstrn vsetryvsel tlvrvkvaea ghytmrafhe
 241 daevqlsfql qinvpvrvle lseshpdsge qtvrcrgrgm pqpniiwsac rdlkrcprel
 301 pptllgnsse eesqletnvt yweeeqefev vstlrlqhvd rplsvrctlr navgqdtqev
 361 ivvphslpfk vvvisailal vvltiislii limlwqkkpr yeirwkvies vssdgheyiy
 421 vdpmqlpyds twelprdqlv lgrtlgsgaf gqvveatahg lshsqatmkv avkmlkstar
 481 ssekqalmse lkimshlgph lnvvnllgac tkggpiyiit eycrygdlvd ylhrnkhtfl
 541 qhhsdkrrpp saelysnalp vglplpshvs ltgesdggym dmskdesvdy vpmldmkgdv
 601 kyadiessny mapydnyvps apertcratl inespvlsym dlvgfsyqva ngmeflaskn
 661 cvhrdlaarn vlicegklvk icdfglardi mrdsnyiskg stflplkwma pesifnslyt
 721 tlsdvwsfgi llweiftlgg tpypelpmne qfynaikrgy rmaqpahasd eiyeimqkcw
 781 eekfeirppf sqlvlllerl lgegykkkyq qvdeeflrsd hpailrsqar lpgfhglrsp
 841 ldtssvlyta vqpnegdndy iiplpdpkpe vadegplegs pslasstlne vntsstiscd
 901 splepqdepe pepqlelqve pepeleqlpd sgcpapraea edsfl
```

Placenta-specific protein 1 precursor NP_001303816.1, NP_001303817.1, NP_001303818.1, NP_068568.1

```
   1 mkvfkfiglm illtsafsag sgqspmtvlc sidwfmvtvh pfmlnndvcv hfhelhlglg
  61 cppnhvqpha yqftyrvtec girakavsqd mviysteihy sskgtpskfv ipvscaapqk
 121 spwltkpcsm rvasksrata qkdekcyevf slsqssqrpn cdcppcvfse eehtqvpchq
 181 agaqeaqplq pshfldised wslhtddmig sm
```

Melanoma antigen preferentially expressed in tumors, isoform a NP_001278644.1, NP_001278645.1, NP_006106.1, NP_996836.1, NP_996837.1, NP_996838.1, NP_996839.1

```
   1 merrrlwgsi qsryismsvw tsprrlvela gqsllkdeal aiaalellpr elfpplfmaa
  61 fdgrhsqtlk amvqawpftc lplgvlmkgq hlhletfkav ldgldvllaq evrprrwklq
 121 vldlrknshq dfwtvwsgnr aslysfpepe aaqpmtkkrk vdglsteaeq pfipvevlvd
 181 lflkegacde lfsyliekvk rkknvlrlcc kklkifampm qdikmilkmv qldsiedlev
 241 tctwklptla kfspylgqmi nlrrlllshi hassyispek eeqyiaqfts qflslqclqa
 301 lyvdslfflr grldqllrhv mnpletlsit ncrlsegdvm hlsqspsvsq lsvlslsgvm
 361 ltdvspeplq allerasatl qdlvfdecgi tddqllallp slshcsqltt lsfygnsisi
 421 salqslqhl iglsnlthvl ypvplesyed ihgtlhlerl aylharlrel lcelgrpsmv
 481 wlsanpcphc gdrtfydpep ilcpcfmpn
```

Melanoma antigen preferentially expressed in tumors, isoform b NP_001278646.1, NP_001278648.1, NP_001305055.1, NP_001305056.1

```
   1 msvwtsprrl velagqsllk dealaiaale llprelfppl fmaafdgrhs qtlkamvqaw
  61 pftclplgvl mkgqhlhlet fkavldgldv llaqevrprr wklqvldlrk nshqdfwtvw
 121 sgnraslysf pepeaaqpmt kkrkvdglst eaeqpfipve vlvdlflkeg acdelfsyli
```

```
      181 ekvkrkknvl rlcckklkif ampmqdikmi lkmvqldsie dlevtctwkl ptlakfspyl
      241 gqminlrrll lshihassyi spekeeqyia qftsqflslq clqalyvdsl fflrgrldql
      301 lrhvmnplet lsitncrlse gdvmhlsqsp svsqlsvlsl sgvmltdvsp eplqallera
      361 satlqdlvfd ecgitddqll allpslshcs qlttlsfygn sisisalqsl lqhliglsnl
      421 thvlypvple syedihgtlh lerlaylhar lrellcelgr psmvwlsanp cphcgdrtfy
      481 dpepilcpcf mpn

Phosphatidylinositol 3,4,5-triphosphate-dependent Rac exchanger 2 protein,
isoform a NP_079146.2
        1 msedsrgdsr aesakdlekq lrlrvcvlse lqkterdyvg tleflvsafl hrmnqcaask
       61 vdknvteetv kmlfsniedi lavhkeflkv veeclhpepn aqqevgtcfl hfkdkfriyd
      121 eycsnhekaq klllelnkir tirtfllncm llggrkntdv plegylvtpi qrickyplil
      181 kellkrtprk hsdyaavmea lqamkavcsn ineakrqmek levleewqsh iegwegsnit
      241 dtctemlmcg vllkissgni qervfflfdn llvyckrkhr rlknskastd ghrylfrgri
      301 ntevmevenv ddgtadfhss ghivvngwki hntaknkwfv cmaktpeekh ewfeailker
      361 errkglklgm eqdtwvmise qgeklykmmc rqgnlikdrk rklttfpkcf lgsefvswll
      421 eigeihrpee gvhlgqalle ngiihhvtdk hqfkpeqmly rfryddgtfy prnemqdvis
      481 kgvrlycrlh slftpvirdk dyhlrtyksv vmanklidwl iaqgdcrtre eamifgvglc
      541 dngfmhhvle ksefkdepll frffsdeeme gsnmkhrlmk hdlkvvenvi aksllksne
      601 gsygfgledk nkvpiiklve kgsnaemagm evgkkifain gdlvfmrpfn evdcflkscl
      661 nsrkplrvlv stkpretvki pdsadglgfq irgfgpsvvh avgrgtvaaa aglhpgqcii
      721 kvnginvske thasviahvt acrkyrrptk qdsiqwvyns iesaqedlqk shskppgdea
      781 gdafdckvee vidkfntmai idgkkehvsl tvdnvhleyg vvyeydstag ikcnvvekmi
      841 epkgffslta kilealaksd ehfvqnctsl nslneviptd lqskfsalcs eriehlcqri
      901 ssykkfsrvl knrawptfkq akskisplhs sdfcptnchv nvmevsypkt stslgsafgv
      961 qldsrkhnsh dkenksseqg klspmvyiqh tittmaapsg lslgqqdghg lryllkeedl
     1021 etqdiyqkll gklqtalkev emcvcqiddl lssityspkl erktsegiip tdsdnekger
     1081 nskrvcfnva gdeqedsghd tisnrdsysd cnsnrnsias ftsicssqcs syfhsdemds
     1141 gdelplsvri shdkqdkihs clehlfsqvd sitnllkgqa vvrafdqtky ltpgrglqef
     1201 qqemepklsc pkrlrlhikq dpwnlpssvr tlaqnirkfv eevkcrllla lleysdsetq
     1261 lrrdmvfcqt lvatvcafse qlmaalnqmf dnskenemet weasrrwldq ianagvlfhf
     1321 qsllspnltd eqamledtlv alfdlekvsf yfkpseeepl vanvpltyqa egsrqalkvy
     1381 fyidsyhfeq lpqrlknggg fkihpvlfaq alesmegyyy rdnvsveefq aqinaaslek
     1441 vkqynqklra fyldksnspp nstskaayvd klmrplnald elyrlvasfi rskrtaacan
     1501 tacsasgvgl lsvsselcnr lgachiimcs sgvhrctlsv tleqaiilar shglppryim
     1561 qatdvmrkqg arvqntaknl gvrdrtpqsa prlyklcepp ppagee

Phosphatidylinositol 3,4,5-triphosphate-dependent Rac exchanger 2 protein,
isoform b NP_079446.3
        1 msedsrgdsr aesakdlekq lrlrvcvlse lqkterdyvg tleflvsafl hrmnqcaask
       61 vdknvteetv kmlfsniedi lavhkeflkv veeclhpepn aqqevgtcfl hfkdkfriyd
      121 eycsnhekaq klllelnkir tirtfllncm llggrkntdv plegylvtpi qrickyplil
      181 kellkrtprk hsdyaavmea lqamkavcsn ineakrqmek levleewqsh iegwegsnit
      241 dtctemlmcg vllkissgni qervfflfdn llvyckrkhr rlknskastd ghrylfrgri
      301 ntevmevenv ddgtadfhss ghivvngwki hntaknkwfv cmaktpeekh ewfeailker
      361 errkglklgm eqdtwvmise qgeklykmmc rqgnlikdrk rklttfpkcf lgsefvswll
      421 eigeihrpee gvhlgqalle ngiihhvtdk hqfkpeqmly rfryddgtfy prnemqdvis
      481 kgvrlycrlh slftpvirdk dyhlrtyksv vmanklidwl iaqgdcrtre eamifgvglc
      541 dngfmhhvle ksefkdepll frffsdeeme gsnmkhrlmk hdlkvvenvi aksllksne
      601 gsygfgledk nkvpiiklve kgsnaemagm evgkkifain gdlvfmrpfn evdcflkscl
      661 nsrkplrvlv stkpretvki pdsadglgfq irgfgpsvvh avgrgtvaaa aglhpgqcii
      721 kvnginvske thasviahvt acrkyrrptk qdsiqwvyns iesaqedlqk shskppgdea
      781 gdafdckvee vidkfntmai idgkkehvsl tvdnvhleyg vvyeydstag ikcnvvekmi
      841 epkgffslta kilealaksd ehfvqnctsl nslneviptd lqskfsalcs eriehlcqri
      901 ssykkvqase rfynftarha vwehsfdlhs vsstfpvpvt mefllpppl lgisqdgrqh
      961 cipedlpsqe mllaerapv
```

Protamine-2, isoform 1 NP_002753.2
1 mvryrvrsls ershevyrqq lhgqeqghhg qeeqglspeh vevyerthgq shyrrrhcsr
61 rrlhrihrrq hrscrrrkrr scrhrrrhrr gcrtrkrtcr rh

Protamine-2, isoform 2 NP_001273285.1
1 mvryrvrsls ershevyrqq lhgqeqghhg qeeqglspeh vevyerthgq shyrrrhcsr
61 rrlhrihrrq hrscrrrkrr scrhrrrhrr eslgdplnqn flsqkaaepg rehaegtklp
121 gpltpswklr ksrpkhqvrp

Protamine-2, isoform 3 NP_001273286.1
1 mvryrvrsls ershevyrqq lhgqeqghhg qeeqglspeh vevyerthgq shyrrrhcsr
61 rrlhrihrrq hrscrrh

Protamine-2, isoform 4 NP_001273287.1
1 mvryrvrsls ershevyrqq lhgqeqghhg qeeqglspeh vevyerthgq shyrrrhcsr
61 rrlhrihrrq hrscrrrkrr scrhrrrhrr epgrehaegt klpgpltpsw klrksrpkhq
121 vrp

Protamine-2, isoform 5 NP_001273288.1
1 mvryrvrsls ershevyrqq lhgqeqghhg qeeqglspeh vevyerthgq shyrrrhcsr
61 rrlhrihrrq hrscrrrkrr scrhrrrhrr glpapppcpa cp

Progranulin NP_002078.1
1 mwtlvswval taglvagtrc pdgqfcpvac cldpggasys ccrplldkwp ttlsrhlggp
61 cqvdahcsag hsciftvsgt ssccpfpeav acgdghhccp rgfhcsadgr scfqrsgnns
121 vgaiqcpdsq fecpdfstcc vmvdgswgcc pmpqascced rvhccphgaf cdlvhtrcit
181 ptgthplakk lpaqrtnrav alsssvmcpd arsrcpdgst ccelpsgkyg ccpmpnatcc
241 sdhlhccpqd tvcdliqskc lskenattdl ltklpahtvg dvkcdmevsc pdgytccrlq
301 sgawgccpft qavccedhih ccpagftcdt qkgtceqgph qvpwmekapa hlslpdpqal
361 krdvpcdnvs scpssdtccq ltsgewgccp ipeavccsdh qhccpqgytc vaegqcqrgs
421 eivaglekmp arraslshpr digcdqhtsc pvgqtccpsl ggswaccqlp havccedrqh
481 ccpagytcnv karscekevv saqpatflar sphvgvkdve cgeghfchdn qtccrdnrqg
541 waccpyrqgv ccadrrhccp agfrcaargt kclrreaprw daplrdpalr qll

Myeloblastin precursor NP_002768.3
1 mahrppspal asvllallls gaaraaeivg gheaqphsrp ymaslqmrgn pgshfcggtl
61 ihpsfvltaa hclrdipqrl vnvvlgahnv rtqeptqqhf svaqvflnny daenklndvl
121 liqlsspanl sasvatvqlp qqdqpvphgt qclamgwgrv gahdppaqvl qelnvtvvtf
181 fcrphnictf vprrkagicf gdsggplicd giiqgidsfv iwgcatrlfp dfftrvalyv
241 dwirstlrrv eakgrp

Prostate stem cell antigen preportein NP_005663.2
1 maglalqpgt allcysckaq vsnedclqve nctqlgeqcw tariravgll tviskgcsln
61 cvddsqdyyv gkknitccdt dlcnasgaha lqpaaailal lpalglllwg pgql

Ras-related C3 botulinum toxin substrate 1 isoform Rac1b NP_061485.1
1 mqaikcvvvg dgavgktcll isyttnafpg eyiptvfdny sanvmvdgkp vnlglwdtag
61 qedydrlrpl sypqtvgety gkditsrgkd kpiadvflic fslvspasfe nvrakwypev
121 rhhcpntpii lvgtkldlrd dkdtieklke kkltpitypq glamakeiga vkylecsalt
181 qrglktvfde airavlcppp vkkrkrkcll l

Regenerating islet-derived protein 3-alpha precursor NP_002571.1,
NP_620354.1, NP_620355.1
1 mlppmalpsv swmllsclml lsqvqgeepq relpsarirc pkgskaygsh cyalflspks
61 wtdadlacqk rpsgnlvsvl sgaegsfvss lvksignsys yvwiglhdpt qgtepngegw
121 ewsssdvmny fawernpsti sspghcasls rstaflrwkd yncnvrlpyv ckftd

Regulator of G-protein signaling 5, isoform 1 NP_003608.1
1 mckglaalph sclerakeik iklgillqkp dsvgdlvipy nekpekpakt qktsldealq
61 wrdsldkllq nnyglasfks flksefseen lefwiacedy kkikspakma ekakqiyeef
121 iqteapkevn idhftkditm knlvepslss fdmaqkriha lmekdslprf vrsefyqeli
181 k

Regulator of G-protein signaling 5, isoform 2 NP_001182232.1, NP_001241677.1
1 maekakqiye efiqteapke vnidhftkdi tmknlvepsl ssfdmaqkri halmekdslp
61 rfvrsefyqe lik

Regulator of G-protein signaling 5, isoform 3 NP_001241678.1
1 mckglaalph sclerakeik iklgillqkp dsvgdlvipy nekpekpakt qktsldealq
61 wrdsldkllq nnyglasfks flksefseen lefwiacedy kkikspakma ekakqiyeef
121 iqteapkevg lwvnidhftk ditmknlvep slssfdmaqk rihalmekds lprfvrsefy
181 qelik

Rho-related GTP-binding protein RhoC precursor NP_001036143.1,
NP_001036144.1, NP_786886.1
1 maairkklvi vgdgacgktc llivfskdqf pevyvptvfe nyiadievdg kqvelalwdt
61 agqedydrlr plsypdtdvi lmcfsidspd slenipekwt pevkhfcpnv piilvgnkkd
121 lrqdehtrre lakmkqepvr seegrdmanr isafgylecs aktkegvrev fematraglq
181 vrknkrrrgc pil

Sarcoma antigen 1 NP_061136.2
1 mqasplqtsq ptppeelhaa ayvftndgqq mrsdevnlva tghqskkkhs rkskrhsssk
61 rrksmsswld kqedaavths iceerinngq pvadnvlsta ppwpdatiah nireermeng
121 qsrtdkvlst appqlvhmaa agipsmstrd lhstvthnir eermengqpq pdnvlstgpt
181 glinmaatpi pamsardlya tvthnvceqk menvqpapdn vlltlrprri nmtdtgispm
241 strdpyatit ynvpeekmek gqpqpdnils tastglinva gagtpaistn glystvphnv
301 ceekmendqp qpnnvlstvq pviiyltatg ipgmntrdqy atithnvcee rvvnnqplps
361 nalstvlpgl aylatadmpa mstrdqhati ihnlreekkd nsqptpdnvl savtpelinl
421 agagippmst rdqyatvnhh vhearmengq rkqdnvlsnv lsglinmaga sipamssrdl
481 yatithsvre ekmesgkpqt dkvisndapq lghmaaggip smstkdlyat vtqnvheerm
541 ennqpqpsyd lstvlpglty ltvagipams trdqyatvth nvheekikng qaasdnvfst
601 vppafinmaa tgvssmstrd qyaavthnir eekinnsqpa pgnilstapp wlrhmaaagi
661 sstitrdlyv tathsvheek mtngqqapdn slstvppgci nlsgagiscr strdlyatvi
721 hdiqeeemen dqtppdgfls nsdspelinm tghcmppnal dsfshdftsl skdellykpd
781 snefavgtkn ysvsagdppv tvmslvetvp ntpqispama kkinddikyq lmkevrrfgq
841 nyerifille evqgsmkvkr qfveftikea arfkkvvliq qlekalkeid shchlrkvkh
901 mrkr

Squamous cell carcinoma antigen recognized by T-cells 3 NP_055521.1
1 mataaetsas epeaeskagp kadgeedevk aartrrkvls ravaaatykt mgpawdqqee
61 gvsesdgdey amassaessp geyeweydee eeknqleier leeqlsinvy dynchvdlir
121 llrlegeltk vrmarqkmse ifplteelwl ewlhdeisma qdgldrehvy dlfekavkdy
181 icpniwleyg qysvggigqk gglekvrsvf eralssvglh mtkglalwea yrefesaive
241 aarlekvhsl frrqlaiply dmeatfaeye ewsedpipes viqnynkalq qlekykpyee
301 allqaeaprl aeyqayidfe mkigdpariq liferalven clvpdlwiry sqyldrqlkv
361 kdlvlsvhnr airncpwtva lwsryllame rhgvdhqvis vtfekalnag fiqatdyvei
421 wqayldylrr rvdfkqdssk eleelraaft raleylkqev eerfnesgdp scvimqnwar
481 iearlcnnmq karelwdsim trgnakyanm wleyynlera hgdtqhcrka lhravqctsd
541 ypehvcevll tmertegsle dwdiavqkte trlarvneqr mkaaekeaal vqqeeekaeq
601 rkraraekka lkkkkkirgp ekrgadedde kewgddeeeq pskrrrvens ipaagetqnv
661 evaagpagkc aavdveppsk qkekaaslkr dmpkvlhdss kdsitvfvsn lpysmqepdt
721 klrplfeacg evvqirpifs nrgdfrgycy vefkeeksal qalemdrksv egrpmfvspc
781 vdksknpdfk vfrystslek hklfisglpf sctkeeleei ckahgtvkdl rlvtnragkp
841 kglayveyen esqasqavmk mdgmtikeni ikvaisnppq rkvpekpetr kapggpmllp

```
      901 qtygargkgr tqlsllpral qrpsaaapqa engpaaapav aapaateapk msnadfaklf
      961 lrk

Secretory leukocyte protein inhibitor NP_003055.1
        1 mkssglfpfl vllalgtlap wavegsgksf kagvcppkks aqclrykkpe cqsdwqcpgk
       61 krccpdtcgi kcldpvdtpn ptrrkpgkcp vtygqclmln ppnfcemdgq ckrdlkccmg
      121 mcgkscvspv ka

Transcription factor SOX-10 NP_008872.1
        1 maeeqdlsev elspvgseep rclspgsaps lgpdgggggs glraspgpge lgkvkkeqqd
       61 geadddkfpv cireavsqvl sgydwtlvpm pvrvngasks kphvkrpmna fmvwaqaarr
      121 kladqyphlh naelsktlgk lwrllnesdk rpfieeaerl rmqhkkdhpd ykyqprrrkn
      181 gkaaqgeaec pggeaeqggt aaiqahyksa hldhrhpgeg spmsdgnpeh psgqshgppt
      241 ppttpktelq sgkadpkrdg rsmgeggkph idfgnvdige ishevmsnme tfdvaeldqy
      301 lppnghpghv ssysaagygl gsalavasgh sawiskppgv alptvsppgv dakaqvktet
      361 agpqgpphyt dqpstsqiay tslslphygs afpsisrpqf dysdhqpsgp yyghsgqasg
      421 lysafsymgp sqrplytais dpspsgpqsh spthweqpvy ttlsrp

Sperm surface protein Sp17 NP_059121.1
        1 msipfsnthy ripqgfgnll egltreilre qpdnipafaa ayfesllekr ektnfdpaew
       61 gskvedrfyn nhafeeqepp eksdpkqees qisgkeeets vtildsseed kekeevaavk
      121 iqaafrghia reeakkmktn slqneekeen k

Protein SSX2, isoform a NP_003138.3
        1 mngddafarr ptvgaqipek iqkafddiak yfskeewekm kasekifyvy mkrkyeamtk
       61 lgfkatlppf mcnkraedfq gndldndpnr gnqverpqmt fgrlqgispk impkkpaeeg
      121 ndseevpeas gpqndgkelc ppgkpttsek ihersgnrea qekeerrgta hrwssqnthn
      181 igrfslstsm gavhgtpkti thnrdpkggn mpgptdcvre nsw

Protein SSX2, isoform b NP_783629.1
        1 mngddafarr ptvgaqipek iqkafddiak yfskeewekm kasekifyvy mkrkyeamtk
       61 lgfkatlppf mcnkraedfq gndldndpnr gnqverpqmt fgrlqgispk impkkpaeeg
      121 ndseevpeas gpqndgkelc ppgkpttsek ihersgpkrg ehawthrlre rkqlviyeei
      181 sdpeedde

Protein SSX2, isoform c NP_001265626.1
        1 mngddafarr ptvgaqipek iqkafddiak yfskeewekm kasekifyvy mkrkyeamtk
       61 lgfkatlppf mcnkraedfq gndldndpnr gnqverpqmt fgrlqgispk impkkpaeeg
      121 ndseevpeas gpqndgkelc ppgkpttsek ihersgnrea qekeerrgta hrwssqnthn
      181 igpkrgehaw thrlrerkql viyeeisdpe edde

Lactosylceramide alpha-2,3-sialyltransferase, isoform 1 NP_003887.3
        1 mrtkaagcae rrplqprtea aaapagramp seytyvklrs dcsrpslqwy traqskmrrp
       61 slllkdilkc tllvfgvwil yilklnytte ecdmkkmhyv dpdhvkraqk yaqqvlqkec
      121 rpkfaktsma llfehrysvd llpfvqkapk dseaeskydp pfgfrkfssk vqtllellpe
      181 hdlpehlkak tcrrcvvigs ggilhglelg htlnqfdvvi rlnsapvegy sehvgnktti
      241 rmtypegapl sdleyysndl fvavlfksvd fnwlqamvkk etlpfwvrlf fwkqvaekip
      301 lqpkhfriln pviiketafd ilqysepqsr fwgrdknvpt igviavvlat hlcdevslag
      361 fgydlnqprt plhyfdsqcm aamnfqtmhn vttetkfllk lvkegvvkdl sggidref

Lactosylceramide alpha-2,3-sialyltransferase, isoform 2 NP_001035902.1
        1 masvpmpsey tyvklrsdcs rpslqwytra qskmrrpsll lkdilkctll vfgvwilyil
       61 klnytteecd mkkmhyvdpd hvkraqkyaq qvlqkecrpk faktsmallf ehrysvdllp
      121 fvqkapkdse aeskydppfg frkfsskvqt llellpehdl pehlkaktcr rcvvigsggi
      181 lhglelghtl nqfdvvirln sapvegyseh vgnkttirmt ypegaplsdl eyysndlfva
      241 vlfksvdfnw lqamvkketl pfwvrlffwk qvaekiplqp khfrilnpvi iketafdilq
      301 ysepqsrfwg rdknvptigv iavvlathlc devslagfgy dlnqprtplh yfdsqcmaam
```

```
      361 nfqtmhnvtt etkfllklvk egvvkdlsgg idref

Lactosylceramide alpha-2,3-sialyltransferase, isoform 3 NP_001341152.1,
NP_001341153.1, NP_001341155.1, NP_001341162.1, NP_001341163.1,
NP_001341177.1
        1 mallfehrys vdllpfvqka pkdseaesky dppfgfrkfs skvqtllell pehdlpehlk
       61 aktcrrcvvi gsggilhgle lghtlnqfdv virlnsapve gysehvgnkt tirmtypega
      121 plsdleyysn dlfvavlfks vdfnwlqamv kketlpfwvr lffwkqvaek iplqpkhfri
      181 lnpviiketa fdilqysepq srfwgrdknv ptigviavvl athlcdevsl agfgydlnqp
      241 rtplhyfdsq cmaamnfqtm hnvttetkfl lklvkegvvk dlsggidref

Lactosylceramide alpha-2,3-sialyltransferase, isoform 4 NP_001341156.1,
NP_001341158.1, NP_001341167.1
        1 mpseytyvkl rsdcsrpslq wytraqskmr rpslllkdil kctllvfgvw ilyilklnyt
       61 teecdmkkmh yvdpdhvkra qkyaqqvlqk ecrpkfakts mallfehrys vdllpfvqka
      121 pkdseaesky dppfgfrkfs skvqtllell pehdlpehlk aktcrrcvvi gsggilhgle
      181 lghtlnqfdv virlnsapve gysehvgnkt tirmtypega plsdleyysn dlfvavlfks
      241 vdfnwlqamv kketlpfwvr lffwkqvaek iplqpkhfri lnpviiketa fdilqysepq
      301 srfwgrdknv ptigviavvl athlcdevsl agfgydlnqp rtplhyfdsq cmaamnfqtm
      361 hnvttetkfl lklvkegvvk dlsggidref

Lactosylceramide alpha-2,3-sialyltransferase, isoform 5 NP_001341176.1
        1 mtypegapls dleyysndlf vavlfksvdf nwlqamvkke tlpfwvrlff wkqvaekipl
       61 qpkhfrilnp viiketafdi lqysepqsrf wgrdknvpti gviavvlath lcdevslagf
      121 gydlnqprtp lhyfdsqcma amnfqtmhnv ttetkfllkl vkegvvkdls ggidref

Alpha-N-acetylneuraminide alpha-2,8-sialyltransferase, isoform 1 NP_003025.1
        1 mspcgrarrq tsrgamavla wkfprtrlpm gasalcvvvl cwlyifpvyr lpnekeivqg
       61 vlqqgtawrr nqtaarafrk qmedccdpah lfamtkmnsp mgksmwydge flysftidns
      121 tyslfpqatp fqlplkkcav vgnggilkks gcgrqidean fvmrcnlppl sseytkdvgs
      181 ksqlvtanps iirqrfqnll wsrktfvdnm kiynhsyiym pafsmktgte pslrvyytls
      241 dvganqtvlf anpnflrsig kfwksrgiha krlstglflv saalglceev aiygfwpfsv
      301 nmheqpishh yydnvlpfsg fhampeeflq lwylhkigal rmqldpcedt slqpts

Alpha-N-acetylneuraminide alpha-2,8-sialyltransferase, isoform 2
NP_001291379.1
        1 mtgsfythsp ltiqltlssh rcnlpplsse ytkdvgsksq lvtanpsiir qrfqnllwsr
       61 ktfvdnmkiy nhsyiympaf smktgtepsl rvyytlsdvg anqtvlfanp nflrsigkfw
      121 ksrgihakrl stglflvsaa lglceevaiy gfwpfsvnmh eqpishhyyd nvlpfsgfha
      181 mpeeflqlwy lhkigalrmq ldpcedtslq pts

Survivin, isoform 1 NP_001159.2
        1 mgaptlppaw qpflkdhris tfknwpfleg cactpermae agfihcpten epdlaqcffc
       61 fkelegwepd ddpieehkkh ssgcaflsvk kqfeeltlge flkldrerak nkiaketnnk
      121 kkefeetaek vrraieqlaa md

Survivin, isoform 2 NP_001012270.1
        1 mgaptlppaw qpflkdhris tfknwpfleg cactpermae agfihcpten epdlaqcffc
       61 fkelegwepd ddpmqrkpti rrknlrklrr kcavpssswl pwieasgrsc lvpewlhhfq
      121 glfpgatslp vgplams

Survivin, isoform 3 NP_001012271.1
        1 mgaptlppaw qpflkdhris tfknwpfleg cactpermae agfihcpten epdlaqcffc
       61 fkelegwepd ddpigpgtva yacntstlgg rggritreeh kkhssgcafl svkkqfeelt
      121 lgeflkldre raknkiaket nnkkkefeet aekvrraieq laamd

T-box 4, isoform 1 NP_001308049.1
```

```
     1 mlqdkglses eeafrapgpa lgeasaanap epalaapgls gaalgsppgp gadvvaaaaa
    61 eqtienikvg lhekelwkkf heagtemiit kagrrmfpsy kvkvtgmnpk tkyillidiv
   121 paddhrykfc dnkwmvagka epampgrlyv hpdspatgah wmrqlvsfqk lkltnnhldp
   181 fghiilnsmh kyqprlhivk adennafgsk ntafcthvfp etsfisvtsy qnhkitqlki
   241 ennpfakgfr gsddsdlrva rlqskeypvi sksimrqrli spqlsatpdv gpllgthqal
   301 qhyqhengah sqlaepqdlp lstfptqrds slfyhclkrr adgtrhldlp ckrsyleaps
   361 svgedhyfrs pppydqqmls psycsevtpr eacmysgsgp eiagvsgvdd lpppplscnm
   421 wtsvspytsy svqtmetvpy qpfpthftat tmmprlptls aqssqppgna hfsvynqlsq
   481 sqvrergpsa sfprerglpq gcerkppsph lnaaneflys qtfslsress lqyhsgmgtv
   541 enwtdg
```

T-box 4, isoform 2 NP_060958.2

```
     1 mlqdkglses eeafrapgpa lgeasaanap epalaapgls gaalgsppgp gadvvaaaaa
    61 eqtienikvg lhekelwkkf heagtemiit kagrrmfpsy kvkvtgmnpk tkyillidiv
   121 paddhrykfc dnkwmvagka epampgrlyv hpdspatgah wmrqlvsfqk lkltnnhldp
   181 fghiilnsmh kyqprlhivk adennafgsk ntafcthvfp etsfisvtsy qnhkitqlki
   241 ennpfakgfr gsddsdlrva rlqskeypvi sksimrqrli spqlsatpdv gpllgthqal
   301 qhyqhengah sqlaepqdlp lstfptqrds slfyhclkrr dgtrhldlpc krsyleapss
   361 vgedhyfrsp ppydqqmlsp sycsevtpre acmysgsgpe iagvsgvddl pppplscnmw
   421 tsvspytsys vqtmetvpyq pfpthftatt mmprlptlsa qssqppgnah fsvynqlsqs
   481 qvrergpsas fprerglpqg cerkppsphl naaneflysq tfslsressl qyhsgmgtve
   541 nwtdg
```

Angiopoietin-1 receptor, isoform 1 NP_000450.2

```
     1 mdslaslvlc gvslllsgtv egamdlilin slplvsdaet sltciasgwr phepitigrd
    61 fealmnqhqd plevtqdvtr ewakkvvwkr ekaskingay fcegrvrgea irirtmkmrq
   121 qasflpatlt mtvdkgdnvn isfkkvlike edaviykngs fihsvprhev pdilevhlph
   181 aqpqdagvys aryiggnlft saftrlivrr ceaqkwgpec nhlctacmnn gvchedtgec
   241 icppgfmgrt cekacelhtf grtckercsg qegcksyvfc lpdpygcsca tgwkglqcne
   301 achpgfygpd cklrcscnng emcdrfqgcl cspgwqglqc eregiprmtp kivdlpdhie
   361 vnsgkfnpic kasgwplptn eemtlvkpdg tvlhpkdfnh tdhfsvaift ihrilppdsg
   421 vwvcsvntva gmvekpfnis vkvlpkplna pnvidtghnf avinissepy fgdgpikskk
   481 llykpvnhye awqhiqvtne ivtlnylepr teyelcvqlv rrgeggeghp gpvrrfttas
   541 iglppprgln llpksqttln ltwqpifpss eddfyvever rsvqksdqqn ikvpgnltsv
   601 llnnlhpreq yvvrarvntk aqgewsedlt awtlsdilpp qpenikisni thssaviswt
   661 ildgysissi tirykvqgkn edqhvdvkik natitqyqlk glepetayqv difaennigs
   721 snpafshelv tlpesqapad lgggkmllia ilgsagmtcl tvllafliil qlkranvqrr
   781 maqafqnvre epavqfnsgt lalnrkvknn pdptiypvld wndikfqdvi gegnfgqvlk
   841 arikkdglrm daaikrmkey askddhrdfa gelevlcklg hhpniinllg acehrgylyl
   901 aieyaphgnl ldflrksrvl etdpafaian stastlssqq llhfaadvar gmdylsqkqf
   961 ihrdlaarni lvgenyvaki adfglsrgqe vyvkktmgrl pvrwmaiesl nysvyttnsd
  1021 vwsygvllwe ivslggtpyc gmtcaelyek lpqgyrlekp lncddevydl mrqcwrekpy
  1081 erpsfaqilv slnrmleerk tyvnttlyek ftyagidcsa eeaa
```

Angiopoietin-1 receptor, isoform 2 NP_001277006.1

```
     1 mdslaslvlc gvslllsgtv egamdlilin slplvsdaet sltciasgwr phepitigrd
    61 fealmnqhqd plevtqdvtr ewakkvvwkr ekaskingay fcegrvrgea irirtmkmrq
   121 qasflpatlt mtvdkgdnvn isfkkvlike edaviykngs fihsvprhev pdilevhlph
   181 aqpqdagvys aryiggnlft saftrlivrr ceaqkwgpec nhlctacmnn gvchedtgec
   241 icppgfmgrt cekacelhtf grtckercsg qegcksyvfc lpdpygcsca tgwkglqcne
   301 giprmtpkiv dlpdhievns gkfnpickas gwplptneem tlvkpdgtvl hpkdfnhtdh
   361 fsvaiftihr ilppdsgvwv csvntvagmv ekpfnisvkv lpkplnapnv idtghnfavi
   421 nissepyfgd gpikskklly kpvnhyeawq hiqvtneivt lnyleprtey elcvqlvrrg
   481 eggeghpgpv rrfttasigl ppprglnllp ksqttlnltw qpifpssedd fyveverrsv
   541 qksdqqnikv pgnltsvlln nlhpreqyvv rarvntkaqg ewsedltawt lsdilppqpe
   601 nikisniths saviswtild gysissitir ykvqgknedq hvdvkiknat itqyqlkgle
   661 petayqvdif aennigssnp afshelvtlp esqapadlgg gkmlliailg sagmtcltvl
```

```
 721 lafliilqlk ranvqrrmaq afqnvreepa vqfnsgtlal nrkvknnpdp tiypvldwnd
 781 ikfqdvigeg nfgqvlkari kkdglrmdaa ikrmkeyask ddhrdfagel evlcklghhp
 841 niinllgace hrgylylaie yaphgnlldf lrksrvletd pafaiansta stlssqqllh
 901 faadvargmd ylsqkqfihr dlaarnilvg enyvakiadf glsrgqevyv kktmgrlpvr
 961 wmaieslnys vyttnsdvws ygvllweivs lggtpycgmt caelyeklpq gyrlekplnc
1021 ddevydlmrq cwrekpyerp sfaqilvsln rmleerktyv nttlyekfty agidcsaeea
1081 a
```

Angiopoietin-1 receptor, isoform 3 NP_001277007.1

```
   1 mdslaslvlc gvslllsasf lpatltmtvd kgdnvnisfk kvlikeedav iykngsfihs
  61 vprhevpdil evhlphaqpq dagvysaryi ggnlftsaft rlivrrceaq kwgpecnhlc
 121 tacmnngvch edtgecicpp gfmgrtceka celhtfgrtc kercsgqegc ksyvfclpdp
 181 ygcscatgwk glqcnegipr mtpkivdlpd hievnsgkfn pickasgwpl ptneemtlvk
 241 pdgtvlhpkd fnhtdhfsva iftihrilpp dsgvwvcsvn tvagmvekpf nisvkvlpkp
 301 lnapnvidtg hnfaviniss epyfgdgpik skkllykpvn hyeawqhiqv tneivtlnyl
 361 eprteyelcv qlvrrgegge ghpgpvrrft tasiglpppr glnllpksqt tlnltwqpif
 421 psseddfyve verrsvqksd qqnikvpgnl tsvllnnlhp reqyvvrarv ntkaqgewse
 481 dltawtlsdi lppqpeniki snithssavi swtildgysi ssitirykvq gknedqhvdv
 541 kiknatitqy qlkglepeta yqvdifaenn igssnpafsh elvtlpesqa padlgggkml
 601 liailgsagm tcltvllafl iilqlkranv qrrmaqafqn reepavqfns gtlalnrkvk
 661 nnpdptiypv ldwndikfqd vigegnfgqv lkarikkdgl rmdaaikrmk eyaskddhrd
 721 fagelevlck lghhpniinl lgacehrgyl ylaieyaphg nlldflrksr vletdpafai
 781 anstastlss qqllhfaadv argmdylsqk qfihrdlaar nilvgenyva kiadfglsrg
 841 qevyvkktmg rlpvrwmaie slnysvyttn sdvwsygvll weivslggtp ycgmtcaely
 901 eklpqgyrle kplncddevy dlmrqcwrek pyerpsfaqi lvslnrmlee rktyvnttly
 961 ekftyagidc saeeaa
```

Telomerase reverse transcriptase, isoform 1 NP_937983.2

```
   1 mpraprcrav rsllrshyre vlplatfvrr lgpqgwrlvq rgdpaafral vaqclvcvpw
  61 darpppaaps frqvsclkel varvlqrlce rgaknvlafg falldgargg ppeafttsvr
 121 sylpntvtda lrgsgawgll lrrvgddvlv hllarcalfv lvapscayqv cgpplyqlga
 181 atqarpppha sgprrrlgce rawnhsvrea gvplglpapg arrrggsasr slplpkrprr
 241 gaapepertp vgqgswahpg rtrgpsdrgf cvvsparpae eatslegals gtrhshpsvg
 301 rqhhagppst srpprpwdtp cppvyaetkh flyssgdkeq lrpsfllssl rpsltgarrl
 361 vetiflgsrp wmpgtprrlp rlpqrywqmr plflellgnh aqcpygvllk thcplraavt
 421 paagvcarek pqgsvaapee edtdprrlvq llrqhsspwq vygfvraclr rlvppglwgs
 481 rhnerrflrn tkkfislgkh aklslqeltw kmsvrdcawl rrspgvgcvp aaehrlreei
 541 lakflhwlms vyvvellrsf fyvtettfqk nrlffyrksv wsklqsigir qhlkrvqlre
 601 lseaevrqhr earpalltsr lrfipkpdgl rpivnmdyvv gartfrrekr aerltsrvka
 661 lfsvlnyera rrpgllgasv lglddihraw rtfvlrvraq dpppelyfvk vdvtgaydti
 721 pqdrltevia siikpqntyc vrryavvqka ahghvrkafk shvstltdlq pymrqfvahl
 781 qetsplrdav vieqssslne assglfdvfl rfmchhavri rgksyvqcqg ipqgsilstl
 841 lcslcygdme nklfagirrd glllrlvddf llvtphltha ktflrtlvrg vpeygcvvnl
 901 rktvvnfpve dealggtafv qmpahglfpw cgllldtrtl evqsdyssya rtsirasltf
 961 nrgfkagrnm rrklfgvlrl kchslfldlq vnslqtvctn iykilllqay rfhacvlqlp
1021 fhqqvwknpt fflrvisdta slcysilkak nagmslgakg aagplpseav qwlchqafll
1081 kltrhrvtyv pllgslrtaq tqlsrklpgt tltaleaaan palpsdfkti ld
```

Telomerase reverse transcriptase, isoform 2 NP_001180305.1

```
   1 mpraprcrav rsllrshyre vlplatfvrr lgpqgwrlvq rgdpaafral vaqclvcvpw
  61 darpppaaps frqvsclkel varvlqrlce rgaknvlafg falldgargg ppeafttsvr
 121 sylpntvtda lrgsgawgll lrrvgddvlv hllarcalfv lvapscayqv cgpplyqlga
 181 atqarpppha sgprrrlgce rawnhsvrea gvplglpapg arrrggsasr slplpkrprr
 241 gaapepertp vgqgswahpg rtrgpsdrgf cvvsparpae eatslegals gtrhshpsvg
 301 rqhhagppst srpprpwdtp cppvyaetkh flyssgdkeq lrpsfllssl rpsltgarrl
 361 vetiflgsrp wmpgtprrlp rlpqrywqmr plflellgnh aqcpygvllk thcplraavt
 421 paagvcarek pqgsvaapee edtdprrlvq llrqhsspwq vygfvraclr rlvppglwgs
```

```
 481 rhnerrflrn tkkfislgkh aklslqeltw kmsvrdcawl rrspgvgcvp aaehrlreei
 541 lakflhwlms vyvvellrsf fyvtettfqk nrlffyrksv wsklqsigir qhlkrvqlre
 601 lseaevrqhr earpalltsr lrfipkpdgl rpivnmdyvv gartfrrekr aerltsrvka
 661 lfsvlnyera rrpgllgasv lglddihraw rtfvlrvraq dpppelyfvk vdvtgaydti
 721 pqdrltevia siikpqntyc vrryavvqka ahghvrkafk shvstltdlq pymrqfvahl
 781 qetsplrdav vieqssslne assglfdvfl rfmchhavri rgksyvqcqg ipqgsilstl
 841 lcslcygdme nklfagirrd glllrlvddf llvtphltha ktflsyarts irasltfnrg
 901 fkagrnmrrk lfgvlrlkch slfldlqvns lqtvctniyk illlqayrfh acvlqlpfhq
 961 qvwknptffl rvisdtaslc ysilkaknag mslgakgaag plpseavqwl chqafllklt
1021 rhrvtyvpll gslrtaqtql srklpgttlt aleaaanpal psdfktild
```

Cellular tumor antigen p53, isoform a NP_000537.3, NP_001119584.1

```
   1 meepqsdpsv epplsqetfs dlwkllpenn vlsplpsqam ddlmlspddi eqwftedpgp
  61 deaprmpeaa ppvapapaap tpaapapaps wplsssvpsq ktyqgsygfr lgflhsgtak
 121 svtctyspal nkmfcqlakt cpvqlwvdst pppgtrvram aiykqsqhmt evvrrcphhe
 181 rcsdsdglap pqhlirvegn lrveylddrn tfrhsvvvpy eppevgsdct tihynymcns
 241 scmggmnrrp iltiitleds sgnllgrnsf evrvcacpgr drrteeenlr kkgephhelp
 301 pgstkralpn ntssspqpkk kpldgeyftl qirgrerfem frelnealel kdaqagkepg
 361 gsrahsshlk skkgqstsrh kklmfktegp dsd
```

Cellular tumor antigen p53, isoform b NP_001119586.1

```
   1 meepqsdpsv epplsqetfs dlwkllpenn vlsplpsqam ddlmlspddi eqwftedpgp
  61 deaprmpeaa ppvapapaap tpaapapaps wplsssvpsq ktyqgsygfr lgflhsgtak
 121 svtctyspal nkmfcqlakt cpvqlwvdst pppgtrvram aiykqsqhmt evvrrcphhe
 181 rcsdsdglap pqhlirvegn lrveylddrn tfrhsvvvpy eppevgsdct tihynymcns
 241 scmggmnrrp iltiitleds sgnllgrnsf evrvcacpgr drrteeenlr kkgephhelp
 301 pgstkralpn ntssspqpkk kpldgeyftl qdqtsfqken c
```

Cellular tumor antigen p53, isoform c NP_001119585.1

```
   1 meepqsdpsv epplsqetfs dlwkllpenn vlsplpsqam ddlmlspddi eqwftedpgp
  61 deaprmpeaa ppvapapaap tpaapapaps wplsssvpsq ktyqgsygfr lgflhsgtak
 121 svtctyspal nkmfcqlakt cpvqlwvdst pppgtrvram aiykqsqhmt evvrrcphhe
 181 rcsdsdglap pqhlirvegn lrveylddrn tfrhsvvvpy eppevgsdct tihynymcns
 241 scmggmnrrp iltiitleds sgnllgrnsf evrvcacpgr drrteeenlr kkgephhelp
 301 pgstkralpn ntssspqpkk kpldgeyftl qmlldlrwcy flinss
```

Cellular tumor antigen p53, isoform d NP_001119587.1

```
   1 mfcqlaktcp vqlwvdstpp pgtrvramai ykqsqhmtev vrrcphherc sdsdglappq
  61 hlirvegnlr veylddrntf rhsvvvpyep pevgsdctti hynymcnssc mggmnrrpil
 121 tiitledssg nllgrnsfev rvcacpgrdr rteeenlrkk gephhelppg stkralpnnt
 181 ssspqpkkkp ldgeyftlqi rgrerfemfr elnealelkd aqagkepggs rahsshlksk
 241 kgqstsrhkk lmfktegpds d
```

Cellular tumor antigen p53, isoform e NP_001119588.1

```
   1 mfcqlaktcp vqlwvdstpp pgtrvramai ykqsqhmtev vrrcphherc sdsdglappq
  61 hlirvegnlr veylddrntf rhsvvvpyep pevgsdctti hynymcnssc mggmnrrpil
 121 tiitledssg nllgrnsfev rvcacpgrdr rteeenlrkk gephhelppg stkralpnnt
 181 ssspqpkkkp ldgeyftlqd qtsfqkenc
```

Cellular tumor antigen p53, isoform f NP_001119589.1

```
   1 mfcqlaktcp vqlwvdstpp pgtrvramai ykqsqhmtev vrrcphherc sdsdglappq
  61 hlirvegnlr veylddrntf rhsvvvpyep pevgsdctti hynymcnssc mggmnrrpil
 121 tiitledssg nllgrnsfev rvcacpgrdr rteeenlrkk gephhelppg stkralpnnt
 181 ssspqpkkkp ldgeyftlqm lldlrwcyfl inss
```

Cellular tumor antigen p53, isoform g NP_001119590.1, NP_001263689.1, NP_001263690.1

```
      1 mddlmlspdd ieqwftedpg pdeaprmpea appvapapaa ptpaapapap swplsssvps
     61 qktyqgsygf rlgflhsgta ksvtctyspa lnkmfcqlak tcpvqlwvds tpppgtrvra
    121 maiykqsqhm tevvrrcphh ercsdsdgla ppqhlirveg nlrveylddr ntfrhsvvvp
    181 yeppevgsdc ttihynymcn sscmggmnrr piltiitled ssgnllgrns fevrvcacpg
    241 rdrrteeenl rkkgephhel ppgstkralp nntssspqpk kkpldgeyft lqirgrerfe
    301 mfrelneale lkdaqagkep ggsrahsshl kskkgqstsr hkklmfkteg pdsd
```

Cellular tumor antigen p53, isoform h NP_001263624.1

```
      1 mddlmlspdd ieqwftedpg pdeaprmpea appvapapaa ptpaapapap swplsssvps
     61 qktyqgsygf rlgflhsgta ksvtctyspa lnkmfcqlak tcpvqlwvds tpppgtrvra
    121 maiykqsqhm tevvrrcphh ercsdsdgla ppqhlirveg nlrveylddr ntfrhsvvvp
    181 yeppevgsdc ttihynymcn sscmggmnrr piltiitled ssgnllgrns fevrvcacpg
    241 rdrrteeenl rkkgephhel ppgstkralp nntssspqpk kkpldgeyft lqmlldlrwc
    301 yflinss
```

Cellular tumor antigen p53, isoform i NP_001263625.1

```
      1 mddlmlspdd ieqwftedpg pdeaprmpea appvapapaa ptpaapapap swplsssvps
     61 qktyqgsygf rlgflhsgta ksvtctyspa lnkmfcqlak tcpvqlwvds tpppgtrvra
    121 maiykqsqhm tevvrrcphh ercsdsdgla ppqhlirveg nlrveylddr ntfrhsvvvp
    181 yeppevgsdc ttihynymcn sscmggmnrr piltiitled ssgnllgrns fevrvcacpg
    241 rdrrteeenl rkkgephhel ppgstkralp nntssspqpk kkpldgeyft lqdqtsfqke
    301 nc
```

Cellular tumor antigen p53, isoform j NP_001263626.1

```
      1 maiykqsqhm tevvrrcphh ercsdsdgla ppqhlirveg nlrveylddr ntfrhsvvvp
     61 yeppevgsdc ttihynymcn sscmggmnrr piltiitled ssgnllgrns fevrvcacpg
    121 rdrrteeenl rkkgephhel ppgstkralp nntssspqpk kkpldgeyft lqirgrerfe
    181 mfrelneale lkdaqagkep ggsrahsshl kskkgqstsr hkklmfkteg pdsd
```

Cellular tumor antigen p53, isoform k NP_001263627.1

```
      1 maiykqsqhm tevvrrcphh ercsdsdgla ppqhlirveg nlrveylddr ntfrhsvvvp
     61 yeppevgsdc ttihynymcn sscmggmnrr piltiitled ssgnllgrns fevrvcacpg
    121 rdrrteeenl rkkgephhel ppgstkralp nntssspqpk kkpldgeyft lqdqtsfqke
    181 nc
```

Cellular tumor antigen p53, isoform l NP_001263628.1

```
      1 maiykqsqhm tevvrrcphh ercsdsdgla ppqhlirveg nlrveylddr ntfrhsvvvp
     61 yeppevgsdc ttihynymcn sscmggmnrr piltiitled ssgnllgrns fevrvcacpg
    121 rdrrteeenl rkkgephhel ppgstkralp nntssspqpk kkpldgeyft lqmlldlrwc
    181 yflinss
```

Dopachrome tautomerase, isoform 1 NP_001913.2

```
      1 msplwwgfll sclgckilpg aqgqfprvcm tvdslvnkec cprlgaesan vcgsqqgrgq
     61 ctevradtrp wsgpyilrnq ddrelwprkf fhrtckctgn fagyncgdck fgwtgpncer
    121 kkppvirqni hslspqereq flgaldlakk rvhpdyvitt qhwlgllgpn gtqpqfancs
    181 vydffvwlhy ysvrdtllgp grpyraidfs hqgpafvtwh ryhllclerd lqrlignesf
    241 alpywnfatg rnecdvctdq lfgaarpddp tlisrnsrfs swetvcdsld dynhlvtlcn
    301 gtyegllrrn qmgrnsmklp tlkdirdcls lqkfdnppff qnstfsfrna legfdkadgt
    361 ldsqvmslhn lvhsflngtn alphsaandp ifvvlhsftd aifdewmkrf nppadawpqe
    421 lapighnrmy nmvpffppvt neelfltsdq lgysyaidlp vsveetpgwp ttllvvmgtl
    481 valvglfvll aflqyrrlrk gytplmethl sskryteea
```

Dopachrome tautomerase, isoform 2 NP_001123361.1

```
      1 msplwwgfll sclgckilpg aqgqfprvcm tvdslvnkec cprlgaesan vcgsqqgrgq
     61 ctevradtrp wsgpyilrnq ddrelwprkf fhrtckctgn fagyncgdck fgwtgpncer
    121 kkppvirqni hslspqereq flgaldlakk rvhpdyvitt qhwlgllgpn gtqpqfancs
    181 vydffvwlhy ysvrdtllgp grpyraidfs hqgpafvtwh ryhllclerd lqrlignesf
```

```
      241 alpywnfatg rnecdvctdq lfgaarpddp tlisrnsrfs swetvcdsld dynhlvtlcn
      301 gtyegllrrn qmgrnsmklp tlkdirdcls lqkfdnppff qnstfsfrna legfdkadgt
      361 ldsqvmslhn lvhsflngtn alphsaandp ifvvisnrll ynattnileh vrkekatkel
      421 pslhvlvlhs ftdaifdewm krfnppadaw pqelapighn rmynmvpffp pvtneelflt
      481 sdqlgysyai dlpvsveetp gwpttllvvm gtlvalvglf vllaflqyrr lrkgytplme
      541 thlsskryte ea

Dopachrome tautomerase, isoform 3 NP_001309111.1, NP_001309112.1,
NP_001309113.1, NP_001309114.1
        1 mgrnsmklpt lkdirdclsl qkfdnppffq nstfsfrnal egfdkadgtl dsqvmslhnl
       61 vhsflngtna lphsaandpi fvvlhsftda ifdewmkrfn ppadawpqel apighnrmyn
      121 mvpffppvtn eelfltsdql gysyaidlpv sveetpgwpt tllvvmgtlv alvglfvlla
      181 flqyrrlrkg ytplmethls skryteea

Dopachrome tautomerase, isoform 4, NP_001309115.1
        1 mllgiqrqmk crlrsdvtkr leedehvnth spmrrgnfag yncgdckfgw tgpncerkkp
       61 pvirqnihsl spqereqflg aldlakkrvh pdyvittqhw lgllgpngtq pqfancsvyd
      121 ffvwlhyysv rdtllgpgrp yraidfshqg pafvtwhryh llclerdlqr lignesfalp
      181 ywnfatgrne cdvctdqlfg aarpddptli srnsrfsswe tvcdslddyn hlvtlcngty
      241 egllrrnqmg rnsmklptlk dirdclslqk fdnppffqns tfsfrnaleg fdkadgtlds
      301 qvmslhnlvh sflngtnalp hsaandpifv vlhsftdaif dewmkrfnpp adawpqelap
      361 ighnrmynmv pffppvtnee lfltsdqlgy syaidlpvsv eetpgwpttl lvvmgtlval
      421 vglfvllafl qyrrlrkgyt plmethlssk ryteea

Transformation/transcription domain associated protein, isoform 1
NP_001231509.1
        1 mafvatqgat vvdqttlmkk ylqfvaaltd vntpdetklk mmqevsenfe nvtsspqyst
       61 flehiiprfl tflqdgevqf lqekpaqqlr klvleiihri ptnehlrpht knvlsvmfrf
      121 leteneenvl iclriiielh kqfrppitqe ihhfldfvkq iykelpkvvn ryfenpqvip
      181 entvpppemv gmittiavkv nperedsetr thsiiprgsl slkvlaelpi ivvlmyqlyk
      241 lnihnvvaef vplimntiai qvsaqarqhk lynkelyadf iaaqiktlsf layiiriyqe
      301 lvtkysqqmv kgmlqllsnc paetahlrke lliaakhilt telrnqfipc mdklfdesil
      361 igsgytaret lrplaystla dlvhhvrqhl plsdlslavq lfakniddes lpssiqtmsc
      421 klllnlvdci rskseqesgn grdvlmrmle vfvlkfhtia ryqlsaifkk ckpqselgav
      481 eaalpgvpta paapgpapsp apvpappppp pppppatpvt papvppfekq gekdkedkqt
      541 fqvtdcrslv ktlvcgvkti twgitsckap geaqfipnkq lqpketqiyi klvkyamqal
      601 diyqvqiagn gqtyirvanc qtvrmkeeke vlehfagvft mmnpltfkei fqttvpymve
      661 risknyalqi vansflanpt tsalfatilv eylldrlpem gsnvelsnly lklfklvfgs
      721 vslfaaeneq mlkphlhkiv nssmelaqta kepynyflll ralfrsiggg shdllyqefl
      781 pllpnllqgl nmlqsglhkq hmkdlfvelc ltvpvrlssl lpylpmlmdp lvsalngsqt
      841 lvsqglrtle lcvdnlqpdf lydhiqpvra elmqalwrtl rnpadsishv ayrvlgkfgg
      901 snrkmlkesq klhyvvtevq gpsitvefsd ckaslqlpme kaietaldcl ksantepyyr
      961 rqawevikcf lvammsledn khalyqllah pnftektipn viishrykaq dtparktfeq
     1021 altgafmsav ikdlrpsalp fvaslirhyt mvavaqqcgp fllpcyqvgs qpstamfhse
     1081 engskgmdpl vlidaiaicm ayeekelcki gevalavifd vasiilgske racqlplfsy
     1141 iverlcaccy eqawyaklgg vvsikflmer lpltwvlqnq qtflkallfv mmdltgevsn
     1201 gavamakttl eqllmrcatp lkdeeraeei vaaqeksfhh vthdlvrevt spnstvrkqa
     1261 mhslqvlaqv tgksvtvime phkevlqdmv ppkkhllrhq panaqiglme gntfcttlqp
     1321 rlftmdlnvv ehkvfytell nlceaedsal tklpcykslp slvplriaal nalaacnylp
     1381 qsrekiiaal fkalnstnse lqeageacmr kflegatiev dqihthmrpl lmmlgdyrsl
     1441 tlnvvnrlts vtrlfpnsfn dkfcdqmmqh lrkwmevvvi thkggqrsdg nesisecgrc
     1501 plspfcqfee mkicsaiinl fhlipaapqt lvkpllevvm kteramliea gspfreplik
     1561 fltrhpsqtv elfmmeatln dpqwsrmfms flkhkdarpl rdvlaanpnr fitlllpgga
     1621 qtavrpgsps tstmrldlqf qaikiisiiv knddswlasq hslvsqlrrv wvsenfqerh
     1681 rkenmaatnw kepkllaycl lnyckrnygd iellfqllra ftgrflcnmt flkeymeeei
     1741 pknysiaqkr alffrfvdfn dpnfgdelka kvlqhilnpa flysfekgeg eqllgppnpe
     1801 gdnpesitsv fitkvldpek qadmldslri yllqyatllv ehaphhihdn nknrnsklrr
```

```
1861 lmtfawpcll skacvdpack ysghlllahi iakfaihkki vlqvfhsllk ahamearaiv
1921 rqamailtpa vparmedghq mlthwtrkii veeghtvpql vhilhlivqh fkvyypvrhh
1981 lvqhmvsamq rlgftpsvti eqrrlavdls evvikwelqr ikdqqpdsdm dpnssgegvn
2041 svsssikrgl svdsaqevkr frtatgaisa vfgrsqslpg adsllakpid kqhtdtvvnf
2101 lirvacqvnd ntntagspge vlsrrcvnll ktalrpdmwp kselklqwfd kllmtveqpn
2161 qvnygnictg levlsflltv lqspailssf kplqrgiaac mtcgntkvlr avhsllsrlm
2221 sifptepsts svaskyeele clyaavgkvi yegltnyeka tnanpsqlfg tlmilksacs
2281 nnpsyidrli svfmrslqkm vrehlnpqaa sgsteatsgt selvmlslel vktrlavmsm
2341 emrknfiqai ltslieksрd akilravvki veewvknnsp maanqtptlr eksillvkmm
2401 tyiekrfped lelnaqfldl vnyvyrdetl sgseltakle paflsglrca qplirakffe
2461 vfdnsmkrrv yerllyvtcs qnweamgnhf wikqcielll avcekstpig tscqgamlps
2521 itnvinlads hdraafamvt hvkqeprere nseskeedve idielapgdq tstpktkels
2581 ekdignqlhm ltnrhdkfld tlrevktgal lsafvqlchi sttlaektwv qlfprlwkil
2641 sdrqqhalag eispflcsgs hqvqrdcqps alncfveams qcvppipirp cvlkylgkth
2701 nlwfrstlml ehqafekgls lqikpkqtte fyeqesitpp qqeildslae lysllqeedm
2761 waglwqkrck ysetataiay eqhgffeqaq esyekamdka kkehersnas paifpeyqlw
2821 edhwircske lnqwealtey gqskghinpy lvlecawrvs nwtamkealv qvevscpkem
2881 awkvnmyrgy laichpeeqq lsfierlvem asslairewr rlphvvshvh tpllqaaqqi
2941 ielqeaaqin aglqptnlgr nnslhdmktv vktwrnrlpi vsddlshwss ifmwrqhhyq
3001 gkptwsgmhs ssivtayens sqhdpssnna mlgvhasasa iiqygkiark qglvnvaldi
3061 lsrihtiptv pivdcfqkir qqvkcylqla gvmgknecmq gleviestnl kyftkemtae
3121 fyalkgmfla qinkseeank afsaavqmhd vlvkawamwg dylenifvke rqlhlgvsai
3181 tcylhacrhq nesksrkyla kvlwllsfdd dkntladavd kycigvppiq wlawipqllt
3241 clvgsegkll lnlisqvgrv ypqavyfpir tlyltlkieq reryksdpgp iratapmwrc
3301 srimhmqrel hptllssleg ivdqmvwfre nwheevlrql qqglakcysv afeksgavsd
3361 akitphtlnf vkklvstfgv glenvsnvst mfssaasesl arraqataqd pvfqklkgqf
3421 ttdfdfsvpg smklhnlisk lkkwikilea ktkqlpkffl ieekcrflsn fsaqtaevei
3481 pgeflmpkpt hyyikiarfm prveivqkhn taarrlyirg hngkiypylv mndacltesr
3541 reervlqllr llnpclekrk ettkrhlfft vprvvavspq mrlvednpss lslveiykqr
3601 cakkgiehdn pisryydrla tvqargtqas hqvlrdilke vqsnmvprsm lkewalhtfp
3661 natdywtfrk mftiqlalig faefvlhlnr lnpemlqiaq dtgklnvayf rfdindatgd
3721 ldanrpvpfr ltpniseflt tigvsgplta smiavarcfa qpnfkvdgil ktvlrdeiia
3781 whkktqedts splsaagqpe nmdsqqlvsl vqkavtaimt rlhnlaqfeg geskvntlva
3841 aansldnlcr mdpawhpwl
```

Transformation/transcription domain associated protein, isoform 2 NP_003487.1

```
   1 mafvatqgat vvdqttlmkk ylqfvaaltd vntpdetklk mmqevsenfe nvtsspqyst
  61 flehiiprfl tflqdgevqf lqekpaqqlr klvleiihri ptnehlrpht knvlsvmfrf
 121 leteneenvl iclriiielh kqfrppitqe ihhfldfvkq iykelpkvvn ryfenpqvip
 181 entvpppemv gmittiavkv nperedsetr thsiiprgsl slkvlaelpi ivvlmyqlyk
 241 lnihnvvaef vplimntiai qvsaqarqhk lynkelyadf iaaqiktlsf layiiriyqe
 301 lvtkysqqmv kgmlqllsnc paetahlrke lliaakhilt telrnqfipc mdklfdesil
 361 igsgytaret lrplaystla dlvhhvrqhl plsdlslavq lfakniddes lpssiqtmsc
 421 klllnlvdci rskseqesgn grdvlmrmle vfvlkfhtia ryqlsaifkk ckpqselgav
 481 eaalpgvpta paapgpapsp apvpappppp pppppatpvt papvppfekq gekdkedkqt
 541 fqvtdcrslv ktlvcgvkti twgitsckap geaqfipnkq lqpketqiyi klvkyamqal
 601 diyqvqiagn gqtyirvanc qtvrmkeeke vlehfagvft mmnpltfkei fqttvpymve
 661 risknyalqi vansflanpt tsalfatilv eylldrlpem gsnvelsnly lklfklvfgs
 721 vslfaaeneq mlkphlhkiv nssmelaqta kepynyflll ralfrsiggg shdllyqefl
 781 pllpnllqgl nmlqsglhkq hmkdlfvelc ltvpvrlssl lpylpmlmdp lvsalngsqt
 841 lvsqglrtle lcvdnlqpdf lydhiqpvra elmqalwrtl rnpadsishv ayrvlgkfgg
 901 snrkmlkesq klhyvvtevq gpsitvefsd ckaslqlpme kaietaldcl ksantepyyr
 961 rqawevikcf lvammsledn khalyqllah pnftektipn viishrykaq dtparktfeq
1021 altgafmsav ikdlrpsalp fvaslirhyt mvavaqqcgp fllpcyqvgs qpstamfhse
1081 engskgmdpl vlidaiaicm ayeekelcki gevalavifd vasiilgske racqlplfsy
1141 iverlcaccy eqawyaklgg vvsikflmer lpltwvlqnq qtflkallfv mmdltgevsn
1201 gavamakttl eqllmrcatp lkdeeraeei vaaqeksfhh vthdlvrevt spnstvrkqa
```

```
1261 mhslqvlaqv tgksvtvime phkevlqdmv ppkkhllrhq panaqiglme gntfcttlqp
1321 rlftmdlnvv ehkvfytell nlceaedsal tklpcykslp slvplriaal nalaacnylp
1381 qsrekiiaal fkalnstnse lqeageacmr kflegatiev dqihthmrpl lmmlgdyrsl
1441 tlnvvnrlts vtrlfpnsfn dkfcdqmmqh lrkwmevvvi thkggqrsdg nemkicsaii
1501 nlfhlipaap qtlvkpllev vmkteramli eagspfrepl ikfltrhpsq tvelfmmeat
1561 lndpqwsrmf msflkhkdar plrdvlaanp nrfitlllpg gaqtavrpgs pststmrldl
1621 qfqaikiisi ivknddswla sqhslvsqlr rvwvsenfqe rhrkenmaat nwkepkllay
1681 cllnyckrny gdiellfqll raftgrflcn mtflkeymee eipknysiaq kralffrfvd
1741 fndpnfgdel kakvlqhiln paflysfekg egeqllgppn pegdnpesit svfitkvldp
1801 ekqadmldsl riyllqyatl lvehaphhih dnnknrnskl rrlmtfawpc llskacvdpa
1861 ckysghllla hiiakfaihk kivlqvfhsl lkahameara ivrqamailt pavparmedg
1921 hqmlthwtrk iiveeghtvp qlvhilhliv qhfkvyypvr hhlvqhmvsa mqrlgftpsv
1981 tieqrrlavd lsevvikwel qrikdqqpds dmdpnssgeg vnsvsssikr glsvdsaqev
2041 krfrtatgai savfgrsqsl pgadsllakp idkqhtdtvv nflirvacqv ndntntagsp
2101 gevlsrrcvn llktalrpdm wpkselklqw fdkllmtveq pnqvnygnic tglevlsfll
2161 tvlqspails sfkplqrgia acmtcgntkv lravhsllsr lmsifpteps tssvaskyee
2221 leclyaavgk viyegltnye katnanpsql fgtlmilksa csnnpsyidr lisvfmrslq
2281 kmvrehlnpq aasgsteats gtselvmlsl elvktrlavm smemrknfiq ailtslieks
2341 pdakilravv kiveewvknn spmaanqtpt lreksillvk mmtyiekrfp edlelnaqfl
2401 dlvnyvyrde tlsgseltak lepaflsglr caqplirakf fevfdnsmkr rvyerllyvt
2461 csqnweamgn hfwikqciel llavcekstp igtscqgaml psitnvinla dshdraafam
2521 vthvkqepre renseskeed veidielapg dqtstpktke lsekdignql hmltnrhdkf
2581 ldtlrevktg allsafvqlc histtlaekt wvqlfprlwk ilsdrqqhal ageispflcs
2641 gshqvqrdcq psalncfvea msqcvppipi rpcvlkylgk thnlwfrstl mlehqafekg
2701 lslqikpkqt tefyeqesit ppqqeildsl aelysllqee dmwaglwqkr ckysetatai
2761 ayeqhgffeq aqesyekamd kakkehersn aspaifpeyq lwedhwircs kelnqwealt
2821 eygqskghin pylvlecawr vsnwtamkea lvqvevscpk emawkvnmyr gylaichpee
2881 qqlsfierlv emasslaire wrrlphvvsh vhtpllqaaq qiielqeaaq inaglqptnl
2941 grnnslhdmk tvvktwrnrl pivsddlshw ssifmwrqhh yqaivtayen ssqhdpssnn
3001 amlgvhasas aiiqygkiar kqglvnvald ilsrihtipt vpivdcfqki rqqvkcylql
3061 agvmgknecm qgleviestn lkyftkemta efyalkgmfl aqinkseean kafsaavqmh
3121 dvlvkawamw gdylenifvk erqlhlgvsa itcylhacrh qnesksrkyl akvlwllsfd
3181 ddkntladav dkycigvppi qwlawipqll tclvgsegkl llnlisqvgr vypqavyfpi
3241 rtlyltlkie qreryksdpg piratapmwr csrimhmqre lhptllssle givdqmvwfr
3301 enwheevlrq lqqglakcys vafeksgavs dakitphtln fvkklvstfg vglenvsnvs
3361 tmfssaases larraqataq dpvfqklkgq fttdfdfsvp gsmklhnlis klkkwikile
3421 aktkqlpkff lieekcrfls nfsaqtaeve ipgeflmpkp thyyikiarf mprveivqkh
3481 ntaarrlyir ghngkiypyl vmndacltes rreervlqll rllnpclekr kettkrhlff
3541 tvprvvavsp qmrlvednps slslveiykq rcakkgiehd npisryydrl atvqargtqa
3601 shqvlrdilk evqsnmvprs mlkewalhtf pnatdywtfr kmftiqlali gfaefvlhln
3661 rlnpemlqia qdtgklnvay frfdindatg dldanrpvpf rltpnisefl ttigvsgplt
3721 asmiavarcf aqpnfkvdgi lktvlrdeii awhkktqedt ssplsaagqp enmdsqqlvs
3781 lvqkavtaim trlhnlaqfe ggeskvntlv aaansldnlc rmdpawhpwl
```

Tyrosinase precursor NP_000363.1

```
   1 mllavlycll wsfqtsaghf pracvssknl mekeccppws gdrspcgqls grgscqnill
  61 snaplgpqfp ftgvddresw psvfynrtcq csgnfmgfnc gnckfgfwgp ncterrllvr
 121 rnifdlsape kdkffayltl akhtissdyv ipigtygqmk ngstpmfndi niydlfvwmh
 181 yyvsmdallg gseiwrdidf aheapaflpw hrlfllrweq eiqkltgden ftipywdwrd
 241 aekcdictde ymggqhptnp nllspasffs swqivcsrle eynshqslcn gtpegplrrn
 301 pgnhdksrtp rlpssadvef clsltqyesg smdkaanfsf rntlegfasp ltgiadasqs
 361 smhnalhiym ngtmsqvqgs andpifllhh afvdsifeqw lrrhrplqev ypeanapigh
 421 nresymvpfi plyrngdffi sskdlgydys ylqdsdpdsf qdyiksyleq asriwswllg
 481 aamvgavlta llaglvsllc rhkrkqlpee kqpllmeked yhslyqshl
```

Vascular endothelial growth factor A, isoform a NP_001020537.2

```
   1 mtdrqtdtap spsyhllpgr rrtvdaaasr gqgpepapgg gvegvgargv alklfvqllg
```

```
       61 csrfggavvr ageaepsgaa rsassgreep qpeegeeeee keeergpqwr lgarkpgswt
      121 geaavcadsa paarapqala rasgrggrva rrgaeesgpp hspsrrgsas ragpgraset
      181 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
      241 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      301 sflqhnkcec rpkkdrarqe kksvrgkgkg qkrkrkksry kswsvyvgar cclmpwslpg
      361 phpcgpcser rkhlfvqdpq tckcsckntd srckarqlel nertcrcdkp rr

Vascular endothelial growth factor A, isoform b NP_003367.4
        1 mtdrqtdtap spsyhllpgr rrtvdaaasr gqgpepapgg gvegvgargv alklfvqllg
       61 csrfggavvr ageaepsgaa rsassgreep qpeegeeeee keeergpqwr lgarkpgswt
      121 geaavcadsa paarapqala rasgrggrva rrgaeesgpp hspsrrgsas ragpgraset
      181 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
      241 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      301 sflqhnkcec rpkkdrarqe kksvrgkgkg qkrkrkksry kswsvpcgpc serrkhlfvq
      361 dpqtckcsck ntdsrckarq lelnertcrc dkprr

Vascular endothelial growth factor A, isoform c NP_001020538.2
        1 mtdrqtdtap spsyhllpgr rrtvdaaasr gqgpepapgg gvegvgargv alklfvqllg
       61 csrfggavvr ageaepsgaa rsassgreep qpeegeeeee keeergpqwr lgarkpgswt
      121 geaavcadsa paarapqala rasgrggrva rrgaeesgpp hspsrrgsas ragpgraset
      181 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
      241 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      301 sflqhnkcec rpkkdrarqe kksvrgkgkg qkrkrkksrp cgpcserrkh lfvqdpqtck
      361 cscckntdsrc karqlelner tcrcdkprr

Vascular endothelial growth factor A, isoform d NP_001020539.2
        1 mtdrqtdtap spsyhllpgr rrtvdaaasr gqgpepapgg gvegvgargv alklfvqllg
       61 csrfggavvr ageaepsgaa rsassgreep qpeegeeeee keeergpqwr lgarkpgswt
      121 geaavcadsa paarapqala rasgrggrva rrgaeesgpp hspsrrgsas ragpgraset
      181 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
      241 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      301 sflqhnkcec rpkkdrarqe npcgpcserr khlfvqdpqt ckcsckntds rckarqleln
      361 ertcrcdkpr r

Vascular endothelial growth factor A, isoform e NP_001020540.2
        1 mtdrqtdtap spsyhllpgr rrtvdaaasr gqgpepapgg gvegvgargv alklfvqllg
       61 csrfggavvr ageaepsgaa rsassgreep qpeegeeeee keeergpqwr lgarkpgswt
      121 geaavcadsa paarapqala rasgrggrva rrgaeesgpp hspsrrgsas ragpgraset
      181 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
      241 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      301 sflqhnkcec rpkkdrarqe npcgpcserr khlfvqdpqt ckcsckntds rckm

Vascular endothelial growth factor A, isoform f NP_001020541.2
        1 mtdrqtdtap spsyhllpgr rrtvdaaasr gqgpepapgg gvegvgargv alklfvqllg
       61 csrfggavvr ageaepsgaa rsassgreep qpeegeeeee keeergpqwr lgarkpgswt
      121 geaavcadsa paarapqala rasgrggrva rrgaeesgpp hspsrrgsas ragpgraset
      181 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
      241 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      301 sflqhnkcec rpkkdrarqe kcdkprr

Vascular endothelial growth factor A, isoform g NP_001028928.1
        1 mtdrqtdtap spsyhllpgr rrtvdaaasr gqgpepapgg gvegvgargv alklfvqllg
       61 csrfggavvr ageaepsgaa rsassgreep qpeegeeeee keeergpqwr lgarkpgswt
      121 geaavcadsa paarapqala rasgrggrva rrgaeesgpp hspsrrgsas ragpgraset
      181 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
      241 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      301 sflqhnkcec rpkkdrarqe npcgpcserr khlfvqdpqt ckcsckntds rckarqleln
```

```
      361 ertcrsltrk d

Vascular endothelial growth factor A, isoform h NP_001165093.1
        1 mtdrqtdtap spsyhllpgr rrtvdaaasr gqgpepapgg gvegvgargv alklfvqllg
       61 csrfggavvr ageaepsgaa rsassgreep qpeegeeeee keeergpqwr lgarkpgswt
      121 geaavcadsa paarapqala rasgrggrva rrgaeesgpp hspsrrgsas ragpgraset
      181 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
      241 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      301 sflqhnkcec rcdkprr

Vascular endothelial growth factor A, isoform i NP_001165094.1
        1 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
       61 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      121 sflqhnkcec rpkkdrarqe kksvrgkgkg qkrkrkksry kswsvyvgar cclmpwslpg
      181 phpcgpcser rkhlfvqdpq tckcsckntd srckarqlel nertcrcdkp rr

Vascular endothelial growth factor A, isoform j NP_001165095.1
        1 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
       61 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      121 sflqhnkcec rpkkdrarqe kksvrgkgkg qkrkrkksry kswsvpcgpc serrkhlfvq
      181 dpqtckcsck ntdsrckarq lelnertcrc dkprr


Vascular endothelial growth factor A, isoform k NP_001165096.1
        1 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
       61 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      121 sflqhnkcec rpkkdrarqe kksvrgkgkg qkrkrkksrp cgpcserrkh lfvqdpqtck
      181 cscckntdsrc karqlelner tcrcdkprr

Vascular endothelial growth factor A, isoform l NP_001165097.1
        1 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
       61 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      121 sflqhnkcec rpkkdrarqe npcgpcserr khlfvqdpqt ckcscckntds rckarqleln
      181 ertcrcdkpr r

Vascular endothelial growth factor A, isoform m NP_001165098.1
        1 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
       61 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      121 sflqhnkcec rpkkdrarqe npcgpcserr khlfvqdpqt ckcscckntds rckm

Vascular endothelial growth factor A, isoform n NP_001165099.1
        1 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
       61 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      121 sflqhnkcec rpkkdrarqe kcdkprr

Vascular endothelial growth factor A, isoform o NP_001165100.1
        1 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
       61 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      121 sflqhnkcec rpkkdrarqe npcgpcserr khlfvqdpqt ckcscckntds rckarqleln
      181 ertcrsltrk d

Vascular endothelial growth factor A, isoform p NP_001165101.1
        1 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
       61 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      121 sflqhnkcec rcdkprr

Vascular endothelial growth factor A, isoform q NP_001191313.1
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        1 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
       61 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      121 sflqhnkcec rpkkdrarqe kksvrgkgkg qkrkrkksry kswsvcdkpr r

Vascular endothelial growth factor A, isoform r NP_001191314.1
        1 mtdrqtdtap spsyhllpgr rrtvdaaasr gqgpepapgg gvegvgargv alklfvqllg
       61 csrfggavvr ageaepsgaa rsassgreep qpeegeeeee keeergpqwr lgarkpgswt
      121 geaavcadsa paarapqala rasgrggrva rrgaeesgpp hspsrrgsas ragpgraset
      181 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
      241 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      301 sflqhnkcec rpkkdrarqe kksvrgkgkg qkrkrkksry kswsvcdkpr r


Vascular endothelial growth factor A, isoform s NP_001273973.1
        1 maegggqnhh evvkfmdvyq rsychpietl vdifqeypde ieyifkpscv plmrcggccn
       61 deglecvpte esnitmqimr ikphqgqhig emsflqhnkc ecrpkkdrar qenpcgpcse
      121 rrkhlfvqdp qtckcscknt dsrckarqle lnertcrcdk prr

Vascular endothelial growth factor A, isoform VEGF-Ax precursor
NP_001303939.1
1 mnfllswvhw slalllylhh akwsqaapma egggqnhhev vkfmdvyqrs ychpietlvd
       61 ifqeypdeie yifkpscvpl mrcggccnde glecvptees nitmqimrik phqgqhigem
      121 sflqhnkcec rpkkdrarqe npcgpcserr khlfvqdpqt ckcsckntds rckarqleln
      181 ertcrcdkpr rsagqeegas lrvsgtrslt rkd

WD repeat-containing protein 46, isoform 1 NP_005443.3
        1 metapkpgkd vppkkdklqt krkkprrywe eetvpttaga spgpprnkkn relrpqrpkn
       61 ayilkksris kkpqvpkkpr ewknpesqrg lsgtqdpfpg papvpvevvq kfcridksrk
      121 lphskaktrs rlevaeaeee etsikaarse lllaeepgfl egedgedtak icqadiveav
      181 diasaakhfd lnlrqfgpyr lnysrtgrhl afggrrghva aldwvtkklm ceinvmeavr
      241 dirflhseal lavaqnrwlh iydnqgielh cirrcdrvtr leflpfhfll atasetgflt
      301 yldvsvgkiv aalnaragrl dvmsqnpyna vihlghsngt vslwspamke plakilchrg
      361 gvravavdst gtymatsgld hqlkifdlrg tyqplstrtl phgaghlafs qrgllvagmg
      421 dvvniwagqg kasppsleqp ylthrlsgpv hglqfcpfed vlgvghtggi tsmlvpgage
      481 pnfdglesnp yrsrkqrqew evkallekvp aelicldpra laevdvisle qgkkeqierl
      541 gydpqakapf qpkpkqkgrs staslvkrkr kvmdeehrdk vrqslqqqhh keakakptga
      601 rpsaldrfvr

WD repeat-containing protein 46, isoform 2 NP_001157739.1
        1 metapkpgkd vppkkdklqt krkkprewkn pesqrglsgt qdpfpgpapv pvevvqkfcr
       61 idksrklphs kaktrsrlev aeaeeeetsi kaarsellla eepgfleged gedtakicqa
      121 diveavdias aakhfdlnlr qfgpyrlnys rtgrhlafgg rrghvaaldw vtkklmcein
      181 vmeavrdirf lhseallava qnrwlhiydn qgielhcirr cdrvtrlefl pfhfllatas
      241 etgfltyldv svgkivaaln aragrldvms qnpynavihl ghsngtvslw spamkeplak
      301 ilchrggvra vavdstgtym atsgldhqlk ifdlrgtyqp lstrtlphga ghlafsqrgl
      361 lvagmgdvvn iwagqgkasp psleqpylth rlsgpvhglq fcpfedvlgv ghtggitsml
      421 vpgagepnfd glesnpyrsr kqrqewevka llekvpaeli cldpralaev dvisleqgkk
      481 eqierlgydp qakapfqpkp kqkgrsstas lvkrkrkvmd eehrdkvrqs lqqqhhkeak
      541 akptgarpsa ldrfvr

Wilms tumor protein, isoform A NP_000369.4
        1 mdflllqdpa stcvpepasq htlrsgpgcl qqpeqqgvrd pggiwaklga aeasaerlqg
       61 rrsrgasgse pqqmgsdvrd lnallpavps lgggggcalp vsgaaqwapv ldfappgasa
      121 ygslggpapp papppppppp phsfikqeps wggaepheeq clsaftvhfs gqftgtagac
      181 rygpfgpppp sqassgqarm fpnapylpsc lesqpairnq gystvtfdgt psyghtpshh
      241 aaqfpnhsfk hedpmgqqgs lgeqqysvpp pvygchtptd sctgsqalll rtpyssdnly
      301 qmtsqlecmt wnqmnlgatl kghstgyesd nhttpilcga qyrihthgvf rgiqdvrrvp
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      361 gvaptlvrsa setsekrpfm caypgcnkry fklshlqmhs rkhtgekpyq cdfkdcerrf
      421 srsdqlkrhq rrhtgvkpfq cktcqrkfsr sdhlkthtrt htgekpfscr wpscqkkfar
      481 sdelvrhhnm hqrnmtklql al

Wilms tumor protein, isoform B NP_077742.3
        1 mdflllqdpa stcvpepasq htlrsgpgcl qqpeqqgvrd pggiwaklga aeasaerlqg
       61 rrsrgasgse pqqmgsdvrd lnallpavps lgggggcalp vsgaaqwapv ldfappgasa
      121 ygslggpapp papppppppp phsfikqeps wggaepheeq clsaftvhfs gqftgtagac
      181 rygpfgpppp sqassgqarm fpnapylpsc lesqpairnq gystvtfdgt psyghtpshh
      241 aaqfpnhsfk hedpmgqqgs lgeqqysvpp pvygchtptd sctgsqalll rtpyssdnly
      301 qmtsqlecmt wnqmnlgatl kgvaagssss vkwtegqsnh stgyesdnht tpilcgaqyr
      361 ihthgvfrgi qdvrrvpgva ptlvrsaset sekrpfmcay pgcnkryfkl shlqmhsrkh
      421 tgekpyqcdf kdcerrfsrs dqlkrhqrrh tgvkpfqckt cqrkfsrsdh lkthtrthtg
      481 ekpfscrwps cqkkfarsde lvrhhnmhqr nmtklqlal

Wilms tumor protein, isoform D NP_077744.4
        1 mdflllqdpa stcvpepasq htlrsgpgcl qqpeqqgvrd pggiwaklga aeasaerlqg
       61 rrsrgasgse pqqmgsdvrd lnallpavps lgggggcalp vsgaaqwapv ldfappgasa
      121 ygslggpapp papppppppp phsfikqeps wggaepheeq clsaftvhfs gqftgtagac
      181 rygpfgpppp sqassgqarm fpnapylpsc lesqpairnq gystvtfdgt psyghtpshh
      241 aaqfpnhsfk hedpmgqqgs lgeqqysvpp pvygchtptd sctgsqalll rtpyssdnly
      301 qmtsqlecmt wnqmnlgatl kgvaagssss vkwtegqsnh stgyesdnht tpilcgaqyr
      361 ihthgvfrgi qdvrrvpgva ptlvrsaset sekrpfmcay pgcnkryfkl shlqmhsrkh
      421 tgekpyqcdf kdcerrfsrs dqlkrhqrrh tgvkpfqckt cqrkfsrsdh lkthtrthtg
      481 ktsekpfscr wpscqkkfar sdelvrhhnm hqrnmtklql al

Wilms tumor protein, isoform E NP_001185480.1
        1 mekgystvtf dgtpsyghtp shhaaqfpnh sfkhedpmgq qgslgeqqys vpppvygcht
       61 ptdsctgsqa lllrtpyssd nlyqmtsqle cmtwnqmnlg atlkgvaags sssvkwtegq
      121 snhstgyesd nhttpilcga qyrihthgvf rgiqdvrrvp gvaptlvrsa setsekrpfm
      181 caypgcnkry fklshlqmhs rkhtgekpyq cdfkdcerrf srsdqlkrhq rrhtgvkpfq
      241 cktcqrkfsr sdhlkthtrt htgekpfscr wpscqkkfar sdelvrhhnm hqrnmtklql
      301 al

Wilms tumor protein, isoform F NP_001185481.1
        1 mekgystvtf dgtpsyghtp shhaaqfpnh sfkhedpmgq qgslgeqqys vpppvygcht
       61 ptdsctgsqa lllrtpyssd nlyqmtsqle cmtwnqmnlg atlkghstgy esdnhttpil
      121 cgaqyrihth gvfrgiqdvr rvpgvaptlv rsasetsekr pfmcaypgcn kryfklshlq
      181 mhsrkhtgek pyqcdfkdce rrfsrsdqlk rhqrrhtgvk pfqcktcqrk fsrsdhlkth
      241 trthtgktse kpfscrwpsc qkkfarsdel vrhhnmhqrn mtklqlal

X antigen family member 1, isoform a NP_001091063.2
        1 mespkkknqq lkvgilhlgs rqkkiriqlr sqcatwkvic kscisqtpgi nldlgsgvkv
       61 kiipkeehck mpeageeqpq v

X antigen family member 1, isoform d NP_001091065.1
        1 mespkkknqq lkvgilhlgs rqkkiriqlr sqvlgremrd megdlqelhq sntgdksgfg
       61 frrqgednt

X-linked inhibitor of apoptosis NP_001158.2, NP_001191330.1
        1 mtfnsfegsk tcvpadinke eefveefnrl ktfanfpsgs pvsastlara gflytgegdt
       61 vrcfschaav drwqygdsav grhrkvspnc rfingfylen satqstnsgi qngqykveny
      121 lgsrdhfald rpsethadyl lrtgqvvdis dtiyprnpam yseearlksf qnwpdyahlt
      181 prelasagly ytgigdqvqc fccggklknw epcdrawseh rrhfpncffv lgrnlnirse
      241 sdavssdrnf pnstnlprnp smadyearif tfgtwiysvn keqlaragfy algegdkvkc
      301 fhcgggltdw kpsedpweqh akwypgckyl leqkgqeyin nihlthslee clvrttektp
      361 sltrriddti fqnpmvqeai rmgfsfkdik kimeekiqis gsnykslevl vadlvnaqkd
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421 smqdessqts lqkeisteeq lrrlqeeklc kicmdrniai vfvpcghlvt ckqcaeavdk
481 cpmcytvitf kqkifms

EQUIVALENTS

[00402] It is to be understood that while the disclosure has been described in conjunction with the detailed description thereof, the foregoing description is intended to illustrate and not limit the scope of the invention, which is defined by the scope of the appended claims. Other aspects, advantages, and modifications are within the scope of the following claims:

CLAIMS

We claim:

1. A method of obtaining or generating a subject response profile, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen;

b) contacting the bacterial cells or beads of the library with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; and

e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate a subject response profile.

2. The method of claim 1, wherein the subject response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

3. A method of obtaining or generating a target response profile, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen;

b) contacting the bacterial cells or beads of the library with antigen presenting cells (APCs) from a subject who exhibits or previously exhibited a response to cancer, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; and

e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate a target response profile.

4. The method of claim 3, wherein the subject exhibits or previously exhibited at least one beneficial response to cancer.

5. The method of claim 4, wherein the beneficial response comprises a positive clinical response, e.g., one or more positive clinical endpoints, to a cancer therapy or combination of therapies.

6. The method of claim 4, wherein the beneficial response comprises a spontaneous response to a cancer.

7. The method of claim 4, wherein the beneficial response comprises clearance of a cancer, e.g., a level of one or more clinical measures associated with clearance of a cancer.

8. The method of claim 4, wherein the beneficial response comprises a lack of a relapse, recurrence, and/or metastasis of a cancer, e.g., over a defined period of time (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 weeks, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 years).

9. The method of claim 4, wherein the beneficial response comprises a positive cancer prognosis.

10. The method of claim 4, wherein the beneficial response comprises a lack of measurable toxic responses or side effects to a cancer therapy or combination of therapies.

11. The method of claim 3, wherein the subject exhibits or previously exhibited at least one deleterious or non-beneficial response to cancer.

12. The method of claim 11, wherein the deleterious response comprises a negative clinical response and/or a failure to respond, to a cancer therapy or combination of therapies.

13. The method of claim 11, wherein the deleterious response comprises a lack of clearance of a cancer, e.g., a level of one or more clinical measures associated with lack of clearance of a cancer.

14. The method of claim 11, wherein the deleterious response comprises at least one relapse, recurrence, and/or metastasis of a cancer.

15. The method of claim 11, wherein the deleterious response comprises a negative cancer prognosis.

16. The method of claim 11, wherein the deleterious response comprises one or more toxic responses or side effects (e.g., one or more measurable toxic responses or side effects) to a cancer therapy or combination of therapies.

17. The method of any one of claims 3-16, wherein the library used to obtain the target response profile is the same library used to obtain a subject response profile according to claim 1.

18. The method of any one of claims 3-17, further comprising the step of repeating steps a) through e) with antigen presenting cells (APCs) and/or lymphocytes from additional subjects, to obtain a population-based or composite target response profile.

19. The method of any one of claims 2-18, wherein the target response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

20. A method of identifying a subject as a candidate for cancer therapy, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators;

e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate a subject response profile; and

f) comparing the subject response profile to a target response profile to select the subject as a candidate subject for initiation, continuation, modification, discontinuation or non-initiation of a cancer therapy.

21. The method of claim 20, wherein the subject response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

22. The method of claim 20 or 21, further comprising generating the target response profile by a method comprising:

g) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a target subject, wherein the APCs internalize the bacterial cells or beads;

h) contacting the APCs with lymphocytes from the target subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

i) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; and

j) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate the target response profile.

23. The method of claim 22, wherein the target response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

24. The method of any one of claims 20-23, wherein the target response profile is from one or more target subjects who exhibit or previously exhibited at least one beneficial response to cancer.

25. The method of claim 24, wherein the beneficial response comprises a positive clinical response to a cancer therapy or combination of therapies.

26. The method of claim 24, wherein the beneficial response comprises a spontaneous response to a cancer.

27. The method of claim 24, wherein the beneficial response comprises clearance of a cancer, e.g., a level of one or more clinical measures associated with clearance of a cancer.

28. The method of claim 24, wherein the beneficial response comprises a lack of a relapse, recurrence, and/or metastasis of a cancer, e.g., over a defined period of time (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 weeks, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 years).

29. The method of claim 24, wherein the beneficial response comprises a positive cancer prognosis.

30. The method of claim 24, wherein the beneficial response comprises a lack of one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses or side effects) to a cancer therapy or combination of therapies.

31. The method of any one of claims 20-23, wherein the target response profile is from one or more target subjects who exhibit or previously exhibited one or more deleterious and/or non-beneficial response to cancer.

32. The method of claim 31, wherein the deleterious and/or non-beneficial response comprises a negative clinical response and/or a failure to respond, to a cancer therapy or combination of therapies.

33. The method of claim 31, wherein the deleterious and/or non-beneficial response comprises a lack of clearance of a cancer, e.g., a level of one or more clinical measures associated with lack of clearance of a cancer.

34. The method of claim 31, wherein the deleterious and/or non-beneficial response comprises at least one relapse, recurrence, and/or metastasis of a cancer.

35. The method of claim 31, wherein the deleterious and/or non-beneficial response comprises a negative cancer prognosis.

36. The method of claim 31, wherein the deleterious and/or non-beneficial response comprises one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses and/or side effects) to a cancer therapy or combination of therapies.

37 The method of any of claims 20-36, further comprising selecting the candidate subject for initiation of a cancer therapy or combination of cancer therapies.

38. The method of any of claims 20-36, further comprising selecting the candidate subject for continuation of a cancer therapy or combination of cancer therapies.

39. The method of claim 37 or claim 38, comprising selecting the subject as a candidate subject (i) if the subject response profile is similar to the target response profile from a target subject who exhibits or previously exhibited one or more beneficial responses to the cancer therapy or combination, and/or (ii) if the subject response profile is dissimilar to the target response profile from a target subject who exhibits or previously exhibited one or more deleterious responses to the cancer therapy or combination.

40. The method of any of claims 20-36, further comprising selecting the candidate subject for modification of a cancer therapy.

41. The method of any of claims 20-36, further comprising selecting the candidate subject for discontinuation or non-initiation of a cancer therapy.

42. The method of claim 40 or 41, comprising selecting the subject as a candidate subject for modification, discontinuation, and/or non-initiation of a cancer therapy (i) if the subject response profile is similar to the target response profile from a target subject who exhibits or previously exhibited one or more deleterious responses to the cancer therapy, and/or (ii) if the subject response profile is dissimilar to the target response profile from a target subject who exhibits or previously exhibited one or more beneficial responses to the cancer therapy.

43. The method of any one of claims 37-39, further comprising administering the cancer therapy or combination of cancer therapies to the candidate subject.

44. The method of any one of claims 40-42, further comprising modifying the cancer therapy administered to the candidate subject.

45. The method of any one of claims 40-42, further comprising discontinuing or not initiating the cancer therapy to the candidate subject.

46. A method of selecting tumor antigens, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level)e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators;

e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate a subject response profile;

f) comparing the subject response profile to a target response profile; and

g) selecting one or more tumor antigens based on the comparison.

47. The method of claim 46, wherein the subject response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

48. The method of claim 46 or 47, further comprising generating the target response profile by a method comprising:

h) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a target subject, wherein the APCs internalize the bacterial cells or beads;

i) contacting the APCs with lymphocytes from the target subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

j) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; and

k) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate the target response profile.

49. The method of claim 48, wherein the target response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

50. The method of any one of claims 46-49, wherein the target response profile is from one or more target subjects who exhibit or previously exhibited one or more beneficial response to cancer.

51. The method of claim 50, wherein the beneficial response comprises a positive clinical response to a cancer therapy or combination of therapies.

52. The method of claim 50, wherein the beneficial response comprises a spontaneous response to a cancer.

53. The method of claim 50, wherein the beneficial response comprises clearance of a cancer, e.g., a level of one or more clinical measures associated with clearance of a cancer.

54. The method of claim 50, wherein the beneficial response comprises a relapse, recurrence, and/or metastasis of a cancer e.g., over a defined period of time (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 weeks, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 years).

55. The method of claim 50, wherein the beneficial response comprises a positive cancer prognosis.

56. The method of claim 50, wherein the beneficial response comprises a lack of one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses and/or side effects) to a cancer therapy or combination of therapies.

57. The method of any one of claims 46-49, wherein the target response profile is from one or more target subjects who exhibit or previously exhibited one or more deleterious or non-beneficial response to cancer.

58. The method of claim 57, wherein the deleterious and/or non-beneficial response comprises a negative clinical response and/or a failure to respond, to a cancer therapy or combination of therapies.

59. The method of claim 57, wherein the deleterious and/or non-beneficial response comprises a lack of clearance of a cancer, e.g., a level of one or more clinical measures associated with lack of clearance of a cancer.

60. The method of claim 57, wherein the deleterious and/or non-beneficial response comprises at least one relapse, recurrence, and/or metastasis of a cancer.

61. The method of claim 57, wherein the deleterious and/or non-beneficial response comprises a negative cancer prognosis.

62. The method of claim 57, wherein the deleterious and/or non-beneficial response comprises one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses and/or side effects) to a cancer therapy or combination of therapies.

63. The method of any one of claims 46-62, comprising selecting one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with a beneficial response to cancer, and/or selecting one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with deleterious or not beneficial responses to cancer.

64. The method of any one of claims 46-62, comprising selecting one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with deleterious or not beneficial responses to cancer, and/or selecting one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with beneficial responses to cancer.

65. The method of claim 63, further comprising administering to the first subject an immunogenic composition comprising one or more of the selected antigens or immunogenic fragments thereof.

66. The method of claim 64, further comprising administering to the first subject an immunogenic composition that does not comprise one or more of the selected antigens or immunogenic fragments thereof.

67. The method of claims 65 or 66, further comprising administering to the first subject a cancer therapy or combination of therapies.

68. A method of inducing an immune response in a subject , the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or

measuring) a level (e.g., an increased level or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators;

e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate a subject response profile;

f) comparing the subject response profile to a target response profile;

g) selecting one or more tumor antigens based on the comparison; and

h) administering to the subject an immunogenic composition comprising one or more of the selected antigens or immunogenic fragment thereof.

69. The method of claim 68, wherein the subject response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

70. The method of claim 68 or 69, further comprising generating the target response profile by a method comprising:

i) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a target subject, wherein the APCs internalize the bacterial cells or beads;

j) contacting the APCs with lymphocytes from the target subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

k) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; and

l) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate the target response profile.

71. The method of claim 70, wherein the target response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

72. The method of any one of claims 68-71, wherein the target response profile is from one or more target subjects who exhibit or previously exhibited at least one beneficial response to cancer.

73. The method of claim 72, wherein the beneficial response comprises a positive clinical response to a cancer therapy or combination of therapies.

74. The method of claim 72, wherein the beneficial response comprises a spontaneous response to a cancer.

75. The method of claim 72, wherein the beneficial response comprises clearance of a cancer, e.g., a level of one or more clinical measures associated with clearance of a cancer.

76. The method of claim 72, wherein the beneficial response comprises a lack of a relapse, recurrence, and/or metastasis of a cancer, e.g., over a defined period of time (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 weeks, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 years).

77. The method of claim 72, wherein the beneficial response comprises a positive cancer prognosis.

78. The method of claim 72, wherein the beneficial response comprises a lack of one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses or side effects) to a cancer therapy or combination of therapies.

79. The method of any one of claims 68-78, comprising selecting and administering (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with one or more beneficial responses to cancer, and/or (i) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with one or more deleterious or not beneficial responses to cancer.

80. A method of inducing an immune response in a subject, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators;

e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate a subject response profile;

f) comparing the subject response profile to a target response profile;

g) selecting one or more tumor antigens based on the comparison; and

h) administering to the subject an immunogenic composition that does not comprise one or more of the selected antigens or immunogenic fragment thereof.

81. The method of claim 80, wherein the subject response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

82. The method of claim 80 or 81, further comprising generating the target response profile by a method comprising:

i) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a target subject, wherein the APCs internalize the bacterial cells or beads;

j) contacting the APCs with lymphocytes from the target subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

k) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators; and

l) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain or generate the target response profile.

83. The method of claim 82, wherein the target response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

84. The method of any one of claims 80-83, wherein the target response profile is from one or more target subjects who exhibit or previously exhibited one or more deleterious and/or non-beneficial response to cancer.

85. The method of claim 84, wherein the deleterious and/or non-beneficial response comprises a negative clinical response and/or a failure to respond, to a cancer therapy or combination of therapies.

86. The method of claim 84, wherein the deleterious and/or non-beneficial response comprises a lack of clearance of a cancer, e.g., a level of one or more clinical measures associated with lack of clearance of a cancer.

87. The method of claim 84, wherein the deleterious and/or non-beneficial response comprises at least one relapse, recurrence, and/or metastasis of a cancer.

88. The method of claim 84, wherein the deleterious and/or non-beneficial response comprises a negative cancer prognosis.

89. The method of claim 84, wherein the deleterious and/or non-beneficial response comprises one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses and/or side effects) to a cancer therapy or combination of therapies.

90. The method of any one of claims 80-89, comprising selecting one or more tumor antigens that increase expression or secretion of immune mediators associated with deleterious or not beneficial responses to cancer, and/or one or more tumor antigens that inhibit and/or suppress expression or secretion of immune mediators associated with beneficial responses to cancer.

91. The method of any one of claims 56-90, further comprising administering to the subject a cancer therapy or combination of therapies.

92. A method of selecting tumor antigens, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by one or more tumor antigens presented by one or more APCs by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators;

e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain a subject response profile; and

f) selecting from among the identified tumor antigens one or more antigens that increase a level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer, and/or selecting one or more tumor antigens that inhibit and/or suppress a level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer.

93. The method of claim 92, further comprising comparing the subject response profile to a target response profile, and selecting one or more tumor antigens based on the comparison.

94. The method of claim 93, wherein the target response profile is from one or more target subjects who exhibit or previously exhibited at least one beneficial response to cancer.

95. The method of claim 94, wherein the beneficial response comprises a positive clinical response to a cancer therapy or combination of therapies.

96. The method of claim 94, wherein the beneficial response comprises a spontaneous response to a cancer.

97. The method of claim 94, wherein the beneficial response comprises clearance of a cancer, e.g., a level of one or more clinical measures associated with clearance of a cancer.

98. The method of claim 94, wherein the beneficial response comprises a lack of a relapse, recurrence, and/or metastasis of a cancer, e.g., over a defined period of time (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 weeks, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 years).

99. The method of claim 94, wherein the beneficial response comprises a positive cancer prognosis.

100. The method of claim 94, wherein the beneficial response comprises a lack of one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses or side effects) to a cancer therapy or combination of therapies.

101. The method of any one of claims 92-101, further comprising administering to the subject an immunogenic composition comprising one or more of the selected antigens or immunogenic fragments thereof.

102. A method of selecting tumor antigens, the method comprises

a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by one or more tumor antigens presented by one or more APCs by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators;

e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain a subject response profile; and

f) selecting from among the identified tumor antigens (i) one or more antigens that increase a level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress a level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer.

103. The method of claim 102, further comprising comparing the subject response profile to a target response profile, and selecting one or more tumor antigens based on the comparison.

104. The method of claim 103, wherein the target response profile is from one or more target subjects who exhibit or previously exhibited one or more deleterious and/or non-beneficial response to cancer.

105. The method of claim 104, wherein the deleterious and/or non-beneficial response comprises a negative clinical response and/or a failure to respond, to a cancer therapy or combination of therapies.

106. The method of claim 104, wherein the deleterious and/or non-beneficial response comprises a lack of clearance of a cancer, e.g., a level of one or more clinical measures associated with lack of clearance of a cancer.

107. The method of claim 104, wherein the deleterious and/or non-beneficial response comprises at least one relapse, recurrence, and/or metastasis of a cancer.

108. The method of claim 104, wherein the deleterious and/or non-beneficial response comprises a negative cancer prognosis.

109. The method of claim 104, wherein the deleterious and/or non-beneficial response comprises one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses and/or side effects) to a cancer therapy or combination of therapies.

110. The method of any one of claims 102-109, further comprising administering to the subject an immunogenic composition that does not comprise one or more of the selected antigens or immunogenic fragments thereof.

111. The method of claim 101 or 110, further comprising administering to the subject a cancer therapy or combination of therapies.

112. A method of inducing an immune response in a subject, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing (e.g., detecting or

measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators;

e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on a level of expression and/or secretion of one or more immune mediators, to obtain a subject response profile;

f) selecting from among the identified tumor antigens (i) one or more antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one deleterious or non-beneficial response to cancer; and

g) administering to the subject an immunogenic composition comprising one or more of the selected antigens or immunogenic fragment thereof.

113. The method of claim 112, further comprising comparing the subject response profile to a target response profile and selecting one or more tumor antigens based on the comparison, prior to administration of the immunogenic composition.

114. The method of claim 113, wherein the target response profile is from one or more target subjects who exhibit or previously exhibited at least one beneficial response to cancer.

115. The method of claim 113, wherein the beneficial response comprises a positive clinical response to a cancer therapy or combination of therapies.

116. The method of claim 113, wherein the beneficial response comprises a spontaneous response to a cancer.

117. The method of claim 113, wherein the beneficial response comprises clearance of a cancer, e.g., a level of one or more clinical measures associated with clearance of a cancer.

118. The method of claim 113, wherein the beneficial response comprises a lack of a relapse, recurrence, and/or metastasis of a cancer, e.g., over a defined period of time (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 weeks, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 years).

119. The method of claim 113, wherein the beneficial response comprises a positive cancer prognosis.

120. The method of claim 113, wherein the beneficial response comprises a lack of one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses or side effects) to a cancer therapy or combination of therapies.

121. A method of inducing an immune response in a subject, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a tumor antigen presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens presented by one or more APCs, e.g., by assessing e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control). of expression and/or secretion of one or more immune mediators;

e) identifying one or more tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, to obtain a subject response profile;

f) comparing the subject response profile to a target response profile;

g) selecting from among the identified tumor antigens (i) one or more antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer; and

h) administering to the subject an immunogenic composition that does not comprise one or more of the selected antigens or immunogenic fragment thereof.

122. The method of claim 121, further comprising comparing the subject response profile to a target response profile and selecting one or more tumor antigens based on the comparison.

123. The method of claim 122, wherein the target response profile is from one or more target subjects who exhibit or previously exhibited one or more deleterious and/or non-beneficial response to cancer.

124. The method of claim 122, wherein the deleterious and/or non-beneficial response comprises a negative clinical response and/or a failure to respond, to a cancer therapy or combination of therapies.

125. The method of claim 122, wherein the deleterious and/or non-beneficial response comprises a lack of clearance of a cancer, e.g., a level of one or more clinical measures associated with lack of clearance of a cancer.

126. The method of claim 122, wherein the deleterious and/or non-beneficial response comprises at least one relapse, recurrence, and/or metastasis of a cancer.

127. The method of claim 122, wherein the deleterious and/or non-beneficial response comprises a negative cancer prognosis.

128. The method of claim 122, wherein the deleterious and/or non-beneficial response comprises one or more toxic responses and/or side effects (e.g., one or more measurable toxic responses and/or side effects) to a cancer therapy or combination of therapies.

129. The method of any one of claims 112, 113, 121 or 122, further comprising administering to the subject a cancer therapy or combination of therapies.

130. A method of identifying tumor antigens, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell of a subject;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators; and

e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, wherein stimulation, inhibition and/or suppression indicate that the polypeptide is a tumor antigen.

131. A method of selecting tumor antigens, the method comprising:

a) providing a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell expressed in a cancer or tumor cell of a subject;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators;

e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, wherein stimulation, inhibition and/or suppression indicate that the polypeptide is a tumor antigen; and

f) selecting from among the identified tumor antigens (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer.

132. The method of claim 131, further comprising selecting from among the identified polypeptides one of more polypeptides that have a minimal effect on level of expression and/or secretion of one of more immune mediators.

133. A method of selecting potential tumor antigens, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell expressed in a cancer or tumor cell of a subject;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators;

e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, and identifying one or more polypeptides that stimulate, inhibit, and/or suppress as a tumor antigen; and

f) selecting from among the identified polypeptides one or more polypeptides that have a minimal effect on level of expression and/or secretion of one or more immune mediators.

134. The method of claim 133, further comprising repeating steps b) through e), or steps c) through e), with lymphocytes from the subject that have undergone one or more previous rounds of exposure to APCs.

135. The method of claim 133 or 134, further comprising selecting from among the identified tumor antigens (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial responses to cancer.

136. The method of any of claims 133-135, further comprising administering to the subject an immunogenic composition comprising one or more of the selected tumor antigens or selected polypeptides, or immunogenic fragments thereof.

137. The method of any of claims 133-135, further comprising administering to the subject an immunogenic composition comprising a combination of one or more of the selected tumor antigens and selected polypeptides, or immunogenic fragments thereof.

138. The method of claim 136 or 137, further comprising administering to the subject a cancer therapy or combination of therapies.

139. A method of selecting tumor antigens, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell expressed in a cancer or tumor cell of a subject;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators;

e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, and identifying one or more polypeptides that stimulate, inhibit, and/or suppress as a tumor antigen; and

f) selecting from among the identified tumor antigens (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer.

140. The method of claim 139, further comprising administering to the subject an immunogenic composition that does not comprise one or more of the selected tumor antigens or immunogenic fragments thereof.

141. The method of claim 140, further comprising administering to the subject a cancer therapy or combination of therapies.

142. The method of any one of claims 1-141, wherein the APCs are human APCs isolated from the subject.

143. The method of any one of claims 1-142, wherein the bacterial cells further comprise a cytolysin polypeptide.

144. The method of claim 143, wherein the cytolysin polypeptide is listeriolysin O (LLO).

145. The method of any one of claims 1-144, wherein the APCs are provided in an array, and wherein the APCs in each location of the array are contacted with a set of bacterial cells, each set comprising a different tumor antigen.

146. The method of any one of claims 1-145, wherein the APCs and lymphocytes are isolated from peripheral blood.

147. The method of any one of claims 1-145, wherein the APCs comprise immortalized cells.

148. The method of any one of claims 1-147, wherein the lymphocytes are derived from a cancer or tumor.

149. The method of any one of claims 1-148, wherein the tumor antigens comprise full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor.

150. The method of any one of claims 1-148, wherein the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding mutations, splice variants, or translocations present in a cancer or tumor.

151. The method of any one of claims 1-148, wherein the tumor antigens comprise full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor.

152. The method of any one of claims 1-148, wherein the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoded by a virus or other infectious agent present in a cancer or tumor.

153. The method of any one of claims 1-148, wherein the tumor antigens comprise full length polypeptides encoding autoantigens associated with a cancer or tumor.

154. The method of any one of claims 1-148, wherein the tumor antigens comprise polypeptides that are fragments of full length polypeptides encoding autoantigens associated with a cancer or tumor.

155. A method of inducing an immune response in a subject, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell of a subject;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators;

e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, and identifying a polypeptide that stimulates, inhibits and/or suppresses as a tumor antigen;

f) selecting from among the identified tumor antigens (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer, and/or (ii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial responses to cancer; and

g) administering to the subject an immunogenic composition comprising one or more of the selected antigens or immunogenic fragment thereof.

156. A method of inducing an immune response in a subject, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell of a subject;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators;

e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, wherein stimulation, inhibition and/or suppression indicate that the polypeptide is a tumor antigen;

f) selecting from among the identified polypeptides one or more polypeptides that have a minimal effect on level of expression and/or secretion of one or more immune mediators; and

g) administering to the subject an immunogenic composition comprising one or more of the selected polypeptides or immunogenic fragment thereof.

157. A method of inducing an immune response in a subject, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell of a subject;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control), of expression and/or secretion of one or more immune mediators;

e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators,

wherein stimulation, inhibition and/or suppression indicate that the polypeptide is a tumor antigen;

f) selecting from among the identified tumor antigens and polypeptides (i) one or more polypeptides that have a minimal effect on level of expression and/or secretion of one or more immune mediators, (ii) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer; and/or (iii) one or more tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer; and

g) administering to the subject an immunogenic composition comprising one or more of the selected tumor antigens and polypeptides, or immunogenic fragments thereof.

158. A method of inducing an immune response in a subject, the method comprising:

a) obtaining, providing, or generating a library comprising bacterial cells or beads, wherein each bacterial cell or bead of the library comprises a different heterologous polypeptide comprising one or more mutations, splice variants, or translocations expressed in a cancer or tumor cell of a subject;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from the subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the subject, under conditions suitable for activation of lymphocytes by a polypeptide presented by one or more APCs;

d) determining whether one or more lymphocytes are activated by, or not responsive to, one or more polypeptides presented by one or more APCs, e.g., by assessing (e.g., detecting or measuring) a level (e.g., an increased or decreased level, relative to a control) of expression and/or secretion of one or more immune mediators;

e) identifying one or more polypeptides that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, and identifying a polypeptide that stimulates, inhibits and/or suppresses as a tumor antigen;

f) selecting from among the identified tumor antigens (i) one or more tumor antigens that increase level of expression and/or secretion of one or more immune mediators associated with at least one deleterious and/or non-beneficial response to cancer, and/or (ii) one or more tumor

antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators associated with at least one beneficial response to cancer; and

g) administering to the subject an immunogenic composition that does not comprise one or more of the selected antigens or immunogenic fragment thereof.

159. The method of any one of claims 156-158, further comprising administering to the subject a cancer therapy or combination of therapies.

160. The method of any one of claims 1-159, wherein the plurality of tumor antigens comprises at least 1, 3, 5, 10, 15, 20, 25, 30, 50, 100, 150, 250, 500, 750, 1000 or more different tumor antigens, or portions thereof.

161. The method of any one of claims 1-160, wherein determining whether one or more lymphocytes are activated by, or not responsive to, one or more tumor antigens comprises measuring a level of one or more immune mediators.

162. The method of any one of claims 1-161, wherein the one or more immune mediators are selected from the group consisting of cytokines, soluble mediators, and cell surface markers expressed by the lymphocytes.

163. The method of any one of claims 1-162, wherein the one or more immune mediators are cytokines.

164. The method of claim 163, wherein the one or more cytokines are selected from the group consisting of TRAIL, IFN-gamma, IL-12p70, IL-2, TNF-alpha, MIP1-alpha, MIP1-beta, CXCL9, CXCL10, MCP1, RANTES, IL-1 beta, IL-4, IL-6, IL-8, IL-9, IL-10, IL-13, IL-15, CXCL11, IL-3, IL-5, IL-17, IL-18, IL-21, IL-22, IL-23A, IL-24, IL-27, IL-31, IL-32, TGF-beta, CSF, GM-CSF, TRANCE (also known as RANK L), MIP3-alpha, and fractalkine.

165. The method of any one of claims 1-164, wherein the one or more immune mediators are soluble mediators.

166. The method of claim 165, wherein the one or more soluble mediators are selected from the group consisting of granzyme A, granzyme B, sFas, sFasL, perforin, and granulysin.

167. The method of any one of claims 1-164, wherein the one or more immune mediators are cell surface markers.

168. The method of claim 167, wherein the one or more cell surface markers are selected from the group consisting of CD107a, CD107b, CD25, CD69, CD45RA, CD45RO, CD137 (4-1BB), CD44, CD62L, CD27, CCR7, CD154 (CD40L), KLRG-1, CD71, HLA-DR,

CD122 (IL-2RB), CD28, IL7Ra (CD127), CD38, CD26, CD134 (OX-40), CTLA-4 (CD152), LAG-3, TIM-3 (CD366), CD39, PD1 (CD279), FoxP3, TIGIT, CD160, BTLA, 2B4 (CD244), and KLRG1.

169. The method of any one of claims 1-168, wherein the lymphocytes comprise CD4+ T cells.

170. The method of any one of claims 1-168, wherein the lymphocytes comprise CD8+ T cells.

171. The method of any one of claims 1-168, wherein the lymphocytes comprise NKT cells, gamma-delta T cells, or NK cells.

172. The method of any one of claims 1-168, wherein the lymphocytes comprise any combination of CD4+ T cells, CD8+ T cells, NKT cells, gamma-delta T cells, and NK cells.

173. The method of any one of claims 1-172, wherein lymphocyte activation is determined by assessing a level of one or more expressed or secreted immune mediators that is at least 20%, 40%, 60%, 80%, 100%, 120%, 140%, 160%, 180%, or 200% higher or lower than a control level.

174. The method of any one of claims 1-172, wherein lymphocyte activation is determined by assessing a level of one or more expressed or secreted immune mediators that is at least one, two, or three standard deviations greater or lower than the mean of a control level.

175. The method of any one of claims 1-172, wherein lymphocyte activating is determined by assessing a level of one or more expressed or secreted immune mediators that is at least 1, 2, 3, 4 or 5 median absolute deviations (MADs) greater or lower than a median response level to a control.

176. The method of any one of claims 1-172, wherein lymphocyte non-responsiveness is determined by assessing a level of one or more expressed or secreted immune mediators that is within 5%, 10%,15%, or 20% of a control level.

177. The method of any one of claims 1-172, wherein lymphocyte non-responsiveness is determined by assessing a level of one or more expressed or secreted immune mediators that is less than one or two standard deviation higher or lower than the mean of a control level.

178. The method of any one of claims 1-172, wherein lymphocyte non-responsiveness is determined by assessing a level of one or more expressed or secreted immune mediators that is

less than one or two median absolute deviation (MAD) higher or lower than a median response level to a control.

179. The method of any one of claims 1-178, wherein the subject response profile comprises one or more different tumor antigens that increase level of expression and/or secretion of one or more immune mediators.

180. The method of any one of claims 1-178, wherein the subject response profile comprises one or more different tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators.

181. The method of any one of claims 1-178, wherein the subject response profile comprises one or more different tumor antigens that have a minimal effect on level of expression and/or secretion of one or more immune mediators.

182. The method of any one of claims 1-178, wherein the subject response profile comprises a combination of one or more different tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators.

183. The method of any one of claims 1-182, wherein the target response profile comprises one or more different tumor antigens that increase level of expression and/or secretion of one or more immune mediators.

184. The method of any one of claims 1-182, wherein the target response profile comprises one or more different tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators.

185. The method of any one of claims 1-182, wherein the target response profile comprises one or more different tumor antigens that have a minimal effect on level of expression and/or secretion of one or more immune mediators.

186. The method of any one of claims 1-182, wherein the target response profile comprises a combination of one or more different tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators.

187. The method of any one of claims 1-182, wherein the target response profile comprises an average number of different tumor antigens that increase level of expression and/or secretion of one or more immune mediators, from a population of subjects who respond

clinically to the cancer therapy, or from subjects who fail to respond clinically to the cancer therapy.

188. The method of any one of claims 1-182, wherein the target response profile comprises an average number of different tumor antigens that inhibit and/or suppress level of expression and/or secretion of one or more immune mediators, from a population of subjects who respond clinically to the cancer therapy, or from subjects who fail to respond clinically to the cancer therapy.

189. The method of any one of claims 1-182, wherein the target response profile comprises an average number of different tumor antigens that have a minimal effect on level of expression and/or secretion of one or more immune mediators, from a population of subjects who respond clinically to the cancer therapy, or from subjects who fail to respond clinically to the cancer therapy.

190. The method of any one of claims 1-182, wherein the target response profile comprises a combination of different tumor antigens that stimulate, inhibit and/or suppress, and/or have a minimal effect on level of expression and/or secretion of one or more immune mediators, from a population of subjects who respond clinically to the cancer therapy, or from a population of subjects who fail to respond clinically to the cancer therapy.

191. The method of any one of claims 1-190, wherein the subject response profile is similar to the target response profile if the number of tumor antigens of the subject response profile differs by no more than 1, 2, 3, 4, 5, or 10 from the number of antigens of the target response profile.

192. The method of any one of claims 1-191, wherein the subject response profile comprises the number of different tumor antigens for each of a plurality of cytokines expressed and/or secreted by activated and/or non-responsive lymphocytes.

193. The method of claim 192, wherein the target response profile comprises the number of antigens for each of the corresponding plurality of cytokines.

194. The method of 192, wherein the target response profile comprises an average number of antigens for each of the corresponding plurality of cytokines expressed and/or secreted by activated and/or non-responsive lymphocytes from a population of subjects who respond clinically to the cancer therapy.

195. The method of claim 192, wherein the target response profile comprises an average number of antigens for each of the corresponding plurality of cytokines expressed and/or secreted by activated and/or non-responsive lymphocytes from a population of subjects who fail to respond clinically to the cancer therapy.

196. The method of claim 192, wherein the target response profile comprises a combination of antigens for each of the corresponding plurality of cytokines expressed and/or secreted by activated and/or non-responsive lymphocytes from a population of subjects who respond clinically to the cancer therapy, or from a population of subjects who fail to respond clinically to the cancer therapy.

197. The method of any one of claims 1-190, wherein the subject response profile is similar to the target response profile if the number of tumor antigens for at least two of the plurality of cytokines of the subject response profile differs by no more than 1, 2, 3, 4, 5, or 10 from the number of antigens for the corresponding plurality of cytokines of the target response profile.

198. The method of any one of claims 1-197, wherein a subject exhibits at least one measure or indication of clinical responsiveness to the cancer therapy.

199. The method of any one of claims 1-197, wherein a subject exhibits at least one measure or indication of failure of clinical responsiveness to the cancer therapy.

200. The method of any one of claims 1-199, wherein the cancer therapy comprises immune checkpoint blockade therapy.

201. The method of claim 200, wherein the immune checkpoint blockade therapy comprises administration of pembrolizumab, nivolumab, ipilimumab, atezolizumab, avelumab, durvalumab, tremelimumab, or cemiplimab.

202. The method of claim 200 or 201, wherein the immune checkpoint blockade therapy comprises administration of two or more immune checkpoint inhibitors.

203. The method of any one of claims 1-202, wherein the cancer therapy comprises immune suppression blockade therapy.

204. The method of claim 203, wherein the immune suppression blockade therapy comprises administration of Vista (B7-H5, v-domain Ig suppressor of T cell activation) inhibitors, Lag-3 (lymphocyte-activation gene 3, CD223) inhibitors, IDO (indolemamine-pyrrole-2,3,-dioxygenase-1,2) inhibitors, or KIR receptor family (killer cell immunoglobulin-like

receptor) inhibitors, CD47 inhibitors, or Tigit (T cell immunoreceptor with Ig and ITIM domain) inhibitors.

205. The method of claim 203 or 204, wherein the immune suppression blockade therapy comprises administration of two or more immune suppression inhibitors.

206. The method of any one of claims 1-205, wherein the cancer therapy comprises immune activation therapy.

207. The method of claim 206, wherein the immune activation therapy comprises administration of CD40 agonists, GITR (glucocorticoid-induced TNF-R-related protein, CD357) agonists, OX40 (CD134) agonists, 4-1BB (CD137) agonists, ICOS (inducible T cell stimulator, CD278) agonists, IL-2 (interleukin 2) agonists, or interferon agonists.

208. The method of claim 206 or 207, wherein immune activation comprises administration of two or more immune activators.

209. The method of any one of claims 1-208, wherein the cancer therapy comprises adjuvant therapy.

210. The method of claim 209, where the adjuvant therapy comprises administration of a TLR agonist (e.g., CpG or Poly I:C), STING agonist, non-specific stimulus of innate immunity, dendritic cells, GM-CSF, IL-12, IL-7, Flt-3, or other cytokines.

211. The method of any one of claims 1-210, wherein the cancer therapy comprises oncolytic virus therapy.

212. The method of claim 211, wherein the oncolytic viral therapy comprises administration of talimogene leherparepvec.

213. The method of any one of claims 1-212, wherein the cancer therapy comprises administration of one or more chemotherapeutic agents.

214. The method of any one of claims 1-213, wherein the cancer therapy comprises radiation.

215. The method of any one of claims 1-214, wherein the cancer therapy comprises surgical excision.

216. The method of any one of claims 1-215, wherein the cancer therapy comprises cell-based therapy.

217. The method of claim 216, wherein the cell-based therapy comprises administration of dendritic cells, chimeric antigen receptor T (CAR-T) cells, T cell receptor-transduced cells, tumor infiltrating lymphocytes (TIL), or natural killer (NK) cells.

218. The method of any one of claims 1-217, wherein the cancer therapy comprises localized hyperthermia or hypothermia.

219. The method of any one of claims 1-218, wherein the cancer therapy comprises administration of one or more anti-tumor antibodies.

220. The method of claim 219, wherein the anti-tumor antibodies comprise bi-specific antibodies.

221. The method of any one of claims 1-220, wherein the cancer therapy comprises administration of one or more anti-angiogenic agents.

222. The method of any one of claims 1-221, wherein the cancer therapy comprises any combination of immune checkpoint blockade, immune suppression blockade, immune activation, adjuvant, oncolytic virus, chemotherapeutic, radiation, surgical, cell-based, hyperthermia, hypothermia, anti-tumor antibody, and anti-angiogenic therapies.

223. A method of inducing an immune response in a subject with one or more selected antigens, the method comprising:

a) obtaining, providing or generating a library comprising bacterial cells or beads comprising a plurality of tumor antigens, wherein each bacterial cell or bead of the library comprises a different tumor antigen;

b) contacting the bacterial cells or beads with antigen presenting cells (APCs) from a first subject, wherein the APCs internalize the bacterial cells or beads;

c) contacting the APCs with lymphocytes from the first subject, under conditions suitable for stimulation or inhibition and/or suppression of lymphocytes by a tumor antigen presented by one or more APCs;

d) identifying one or more stimulatory tumor antigens that stimulate lymphocytes and identifying one or more non-stimulatory tumor antigens that do not stimulate lymphocytes, to produce a subject response profile;

e) comparing the subject response profile to a target response profile, wherein the target response profile is from a second subject who responds clinically to a cancer therapy, and wherein the target response profile comprises one or more identified stimulatory tumor antigens

that stimulate lymphocytes and comprises one or more identified non-stimulatory tumor antigens that do not stimulate lymphocytes;

f) selecting one or more antigens, wherein the one or more antigens are identified as non-stimulatory in the subject response profile and the same one or more antigens are identified as stimulatory in the target response profile; and

g) administering to the first subject an immunogenic composition comprising one or more of the selected antigens.

224. The method of claim 223, further comprising administering a cancer therapy to the subject.

225. The method of claim 223 or 224 wherein the subject response profile comprises a representation of the level of expression and/or secretion of the one or more immune mediators associated with the plurality of tumor antigens.

226. An immunogenic composition of the invention, comprising one or more antigens of the target response profile obtained or generated according to any one of claims 1-225.

227. An immunogenic composition of the invention, comprising one or more antigens selected according to any one of claims 1-225.

228. An immunogenic composition comprising (i) one or more heparanase polypeptides or immunogenic fragments thereof and (ii) a SMAD4 polypeptide or immunogenic fragment thereof.

229. The immunogenic composition of claim 228, wherein the one or more heparanase polypeptides or fragments and the SMAD4 polypeptide or fragment are each 8-29 amino acids in length.

230. The immunogenic composition of claim 229 or 229, wherein the heparanase polypeptides comprise the amino acid sequence of SEQ ID NO:6 or SEQ ID NO:7.

231. The immunogenic composition of any one of claims 228-230, wherein the SMAD4 polypeptide comprises the amino acid sequence of SEQ ID NO:8.

232. The immunogenic composition of any one of claims 228-231, comprising one or more immunogenic fragments consisting of about 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% of the total number of amino acids of SEQ ID NO:6, SEQ ID NO:7, or SEQ ID NO:8.

233. The immunogenic composition of any one of claims 228-232, comprising one or more immunogenic fragments consisting of SEQ ID NO:6, SEQ ID NO:7, or SEQ ID NO:8 lacking about 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, or more amino acids.

234. The immunogenic composition of any one of claims 228-233, wherein the one or more heparanse polypeptides comprises an amino acid sequence at least 85%, 90%, 95%, 97%, or 99% identical to SEQ ID NO:6 or SEQ ID NO:7.

235. The immunogenic composition of any one of claims 228-234, wherein the SMAD4 polypeptide comprises an amino acid sequence at least 85%, 90%, 95%, 97%, or 99% identical to SEQ ID NO:8.

236. An immunogenic composition comprising a heparanase isoform 1 polypeptide or immunogenic fragment, a heparanase isoform 2 polypeptide or immunogenic fragment, and a SMAD4 polypeptide or immunogenic fragment.

237. The immunogenic composition of claim 236, wherein the heparanase isoform 1 polypeptide or immunogenic fragment, the heparanase isoform 2 polypeptide or immunogenic fragment and the SMAD4 polypeptide or immunogenic fragment are each 8-29 amino acids in length.

238. The immunogenic composition of claim 236 or 237, wherein the heparanase isoform 1 polypeptide comprises the amino acid sequence of SEQ ID NO:1 and the heparanase isoform 2 polypeptide comprises the amino acid sequence of SEQ ID NO:2.

239. The immunogenic composition of any one of claims 236-238, wherein the SMAD4 polypeptide comprises the amino acid sequence of SEQ ID NO:3.

240. The immunogenic composition of any one of claims 236-239, comprising one or more immunogenic fragments consisting of about 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% of the total number of amino acids of SEQ ID NO:6, SEQ ID NO:7, or SEQ ID NO:8.

241. The immunogenic composition of any one of claims 236-240, comprising one or more immunogenic fragments consisting of SEQ ID NO:6, SEQ ID NO:7, or SEQ ID NO:8 lacking about 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, or more amino acids.

242. The immunogenic composition of any one of claims 236-241, wherein the heparanase isoform 1 polypeptide comprises an amino acid sequence at least 85%, 90%, 95%, 97%, or 99% identical to SEQ ID NO:6 and wherein the heparanase isoform 1 polypeptide

comprises an amino acid sequence at least 85%, 90%, 95%, 97%, or 99% identical to SEQ ID NO:7.

243. The immunogenic composition of any one of claims 236-242, wherein the SMAD4 polypeptide comprises an amino acid sequence at least 85%, 90%, 95%, 97%, or 99% identical to SEQ ID NO:8.

244. The immunogenic composition of any one of claims 288-242, further comprising an adjuvant.

245. A method of treating cancer, comprising administering to a subject the immunogenic composition of any one of claims 228-244.

246. The method of claim 245, wherein the subject has or is at risk of cancer, and/or exhibits one or more signs or symptoms of cancer, and/or exhibits one or more risk factors for cancer.

247. The method of claim 245 or 246, wherein the cancer is colorectal cancer, melanoma, or lung cancer.

248. A method of inducing an immune response in a subject, comprising administering to a subject the immunogenic composition of any one of claims 228-244.

249. The method of claim 248, wherein the immune response comprises activation of one or more lymphocytes.

250. The method of claim 249, wherein the one or more lymphocytes comprise CD4+ T cells.

251. The method of claim 249 or 250, wherein the one or more lymphocytes comprise CD8+ T cells.

252. The method of any one of claims 249-251, wherein the one or more lymphocytes comprise NKT cells, gamma-delta T cells, or NK cells.

253. The method of any one of claims 249-252, wherein the one or more lymphocytes comprise any combination of CD4+ T cells, CD8+ T cells, NKT cells, gamma-delta T cells, and NK cells.

254. The method of claim 248, wherein the immune response comprises an increased expression and/or secretion of one or more immune mediators relative to a control.

255. The method of claim 254, wherein the lymphocyte signaling molecule is selected from among immune mediators.

256. The method of claim 254 or 255, wherein the one or more immune mediators are cytokines.

257. The method of claim 255 or 256, wherein the one or more cytokines are selected from TRAIL, IFN-gamma, IL-12p70, IL-2, TNF-alpha, MIP1-alpha, MIP1-beta, CXCL9, CXCL10, MCP1, RANTES, IL-1 beta, IL-4, IL-6, IL-8, IL-9, IL-10, IL-13, IL-15, CXCL11, IL-3, IL-5, IL-17, IL-18, IL-21, IL-22, IL-23A, IL-24, IL-27, IL-31, IL-32, TGF-beta, CSF, GM-CSF, TRANCE (also known as RANK L), MIP3-alpha, MCP1, and fractalkine.

258. The method of claim 254 or 255, wherein the one or more immune mediators are soluble mediators.

259. The method of claim 255 or 258, wherein the one or more soluble mediators are selected from granzyme A, granzyme B, sFas, sFasL, perforin, and granulysin.

260. The method of claim 254 or 255, wherein the one or more immune mediators are cell surface markers.

261. The method of claim 255 or 260, wherein the one or more cell surface markers are selected from CD107a, CD107b, CD25, CD69, CD45RA, CD45RO, CD137 (4-1BB), CD44, CD62L, CD27, CCR7, CD154 (CD40L), KLRG-1, CD71, HLA-DR, CD122 (IL-2RB), CD28, IL7Ra (CD127), CD38, CD26, CD134 (OX-40), CTLA-4 (CD152), LAG-3, TIM-3 (CD366), CD39, PD1 (CD279), FoxP3, TIGIT, CD160, BTLA, 2B4 (CD244), and KLRG1.

262. The method of any one of claims 248-261, wherein a level of one or more expressed or secreted immune mediators that is at least 20%, 40%, 60%, 80%, 100%, 120%, 140%, 160%, 180%, or 200% higher than a control level.

263. The method of any one of claims 248-261, wherein a level of one or more expressed or secreted immune mediators that is at least one, two, or three standard deviations higher than the mean of a control level indicates lymphocyte activation.

264. The method of any one of claims 248-261, wherein a level of one or more expressed or secreted immune mediators that is at least 1, 2, 3, 4 or 5 median absolute deviations (MADs) higher or lower than a median response level to a control indicates lymphocyte activation.

265. The method of claim 248, wherein the immune response comprises a humoral response and/or a cellular response.

266. The method of claim 254, wherein the humoral response comprises an increase in magnitude of response or fold rise from baseline of antigen specific immunoglobulin G (IgG) levels and/or of antigen specific neutralizing antibody levels.

267. The method of claim 265 or 266, wherein the humoral response comprises a 4-fold or greater rise in IgG titer from baseline.

268. The method of any one of claims 265-267, wherein the humoral response comprises a 2-fold or greater rise in 50% neutralizing antibody titer from baseline.

269. The method of any one of claims 265-268, wherein the cellular response comprises secretion of granzyme B (GrB).

270. Th method of any one of claims 265-269, wherein the cellular response comprises an increase in magnitude of response or fold rise from baseline of granzyme B (GrB) levels.

271. The method of any one of claims 265-270, wherein the cellular response comprises an increase in IFN-gamma secretion for T cells.

272. The method of any one of claims 248-271, wherein the subject has or is at risk of cancer, and/or exhibits one or more signs or symptoms of cancer, and/or exhibits one or more risk factors for cancer.

273. The method of claim 272, wherein the cancer is colorectal cancer, melanoma, or lung cancer.

274. A method for manufacturing an immunogenic composition, the method comprising combining one or more antigens identified by the method of claims 1-255 and a carrier.

275. The method of claim 274, wherein the antigen is produced using recombinant DNA technology in a suitable host cell.

276. The method of claim 274 or 275, comprising formulating the immunogenic composition as a pharmaceutical composition.

277. A method for manufacturing an immunogenic composition for administration to a subject in need thereof, the method comprising:

a. providing, preparing, or obtaining a plurality of antigenic compositions comprising a plurality of antigens, each composition comprising a different antigen;

b. providing, preparing, or obtaining a target response profile, wherein the target response profile comprises a representation of the level of expression and/or secretion of one or

more immune mediators associated (e.g., determined, measured, observed) with the plurality of antigens;

c. providing, preparing, or obtaining a subject response profile, wherein the subject response profile comprises a representation of the level of expression and/or secretion of one or more immune mediators associated (e.g., determined, measured, observed) with the plurality of antigens;

d. comparing the target response profile to the subject response profile;

e. selecting one or more antigens based on the comparison; and

f. formulating at least a portion of one or more antigenic compositions comprising the one or more selected antigens as a pharmaceutical composition.

278. The method of claim 277, wherein the selecting step comprises selecting one or more antigens that increase expression or secretion of immune mediators associated with a beneficial response to cancer, and/or one or more antigens that inhibit and/or suppress expression or secretion of immune mediators associated with deleterious or not beneficial responses to cancer.

279. The method of claim 277 or 278, wherein the plurality of antigenic compositions are solution, lyophilized, or on a synthetic matrix.

280. A method of manufacturing an immunogenic composition for administration to a subject in need thereof, the method comprising:

preparing one or more antigens, or fragments thereof, identified by the method of any one of claims 1-225;

combining one or more antigens, or fragments thereof, wherein the one or more antigens or fragments thereof are selected according to the subject's response profile; and

formulating the immunogenic composition as a pharmaceutical composition.

281. A method of manufacturing an immunogenic composition for administration to a subject in need thereof, the method comprising:

preparing one or more antigens, or fragments thereof, identified by the method of any one of claims 1-225;

combining one or more antigens, or fragments thereof, wherein the one or more antigens or fragments thereof are selected according to whether or not the one or more antigens have been

shown to stimulate, inhibit and/or suppress and/or have minimal effect on level of expression and/or secretion of one or more immune mediators by the subject's lymphocytes; and

formulating the immunogenic composition as a pharmaceutical composition.

282. A method of manufacturing an immunogenic composition for administration to a subject in need thereof, the method comprising:

preparing one or more antigens, or fragments thereof, identified by the method of any one of claims 1-225;

combining one or more antigens, or fragments thereof, wherein the one or more antigens or fragments thereof are selected according to the subject's response profile; and

formulating the immunogenic composition as a pharmaceutical composition.

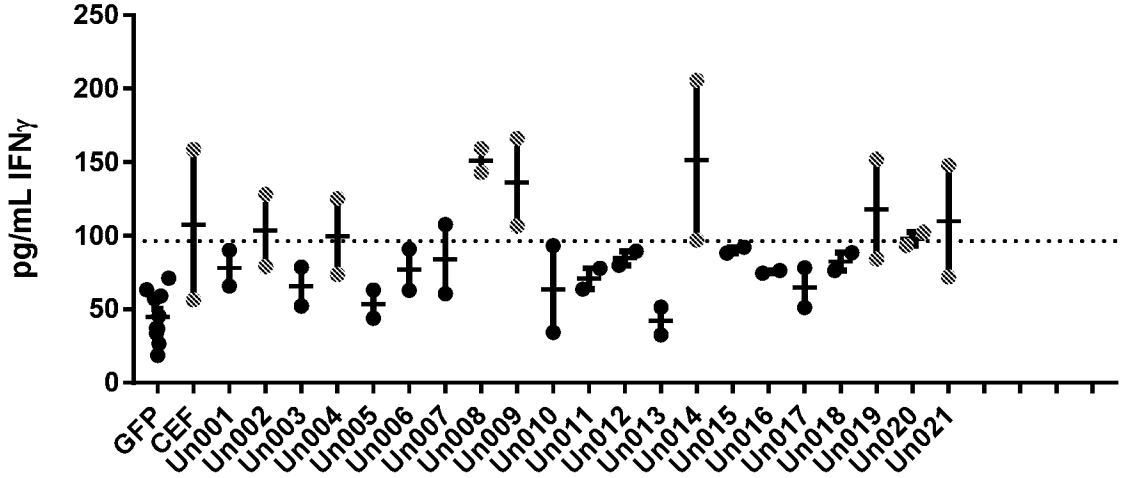


Figure 1. Multiple TAAs are recognized by T cells from a representative melanoma patient who received immune checkpoint blockade therapy.

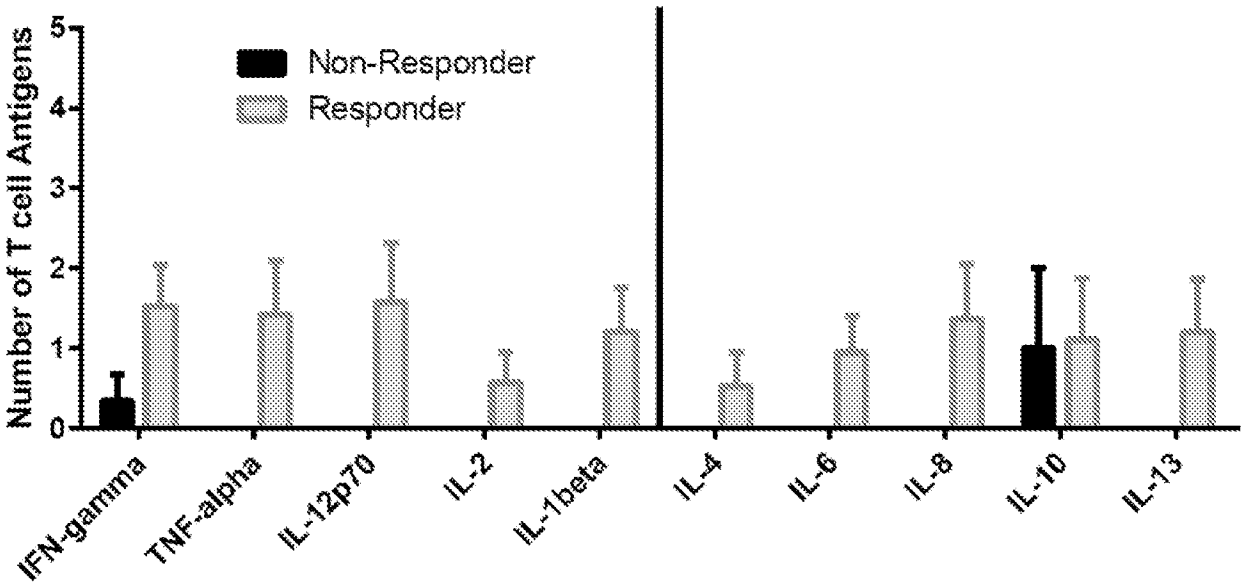


Figure 2. $CD4^+$ T cell responses predict response to immune checkpoint blockade.

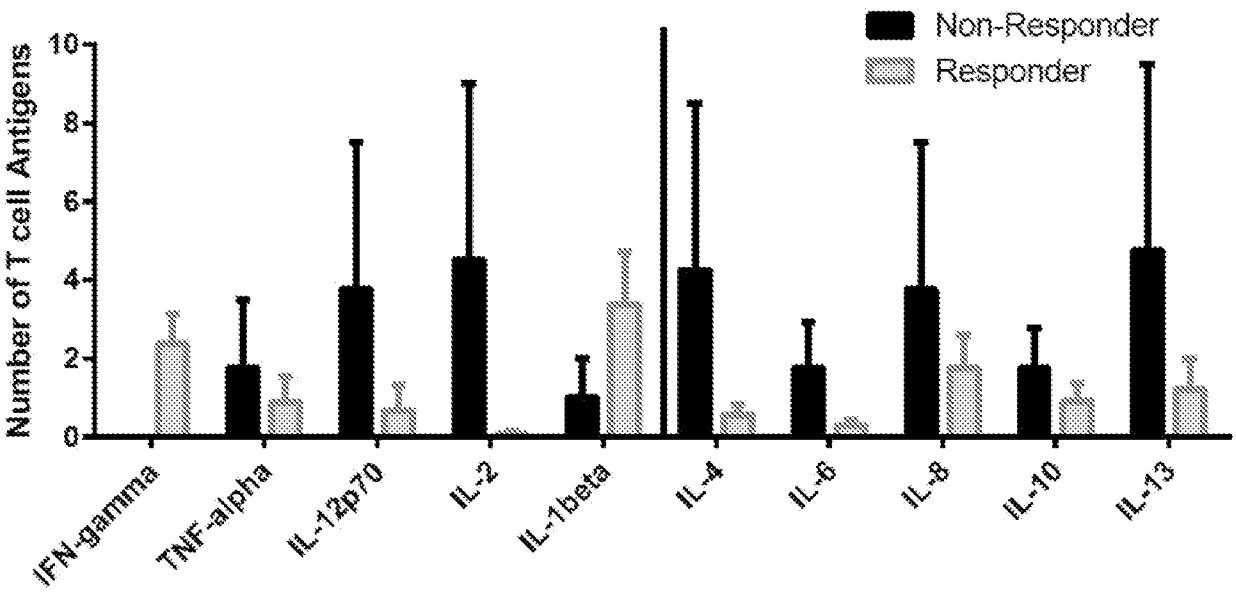


Figure 3. IFN-γ-secreting $CD8^+$ T cells predict response to immune checkpoint blockade.

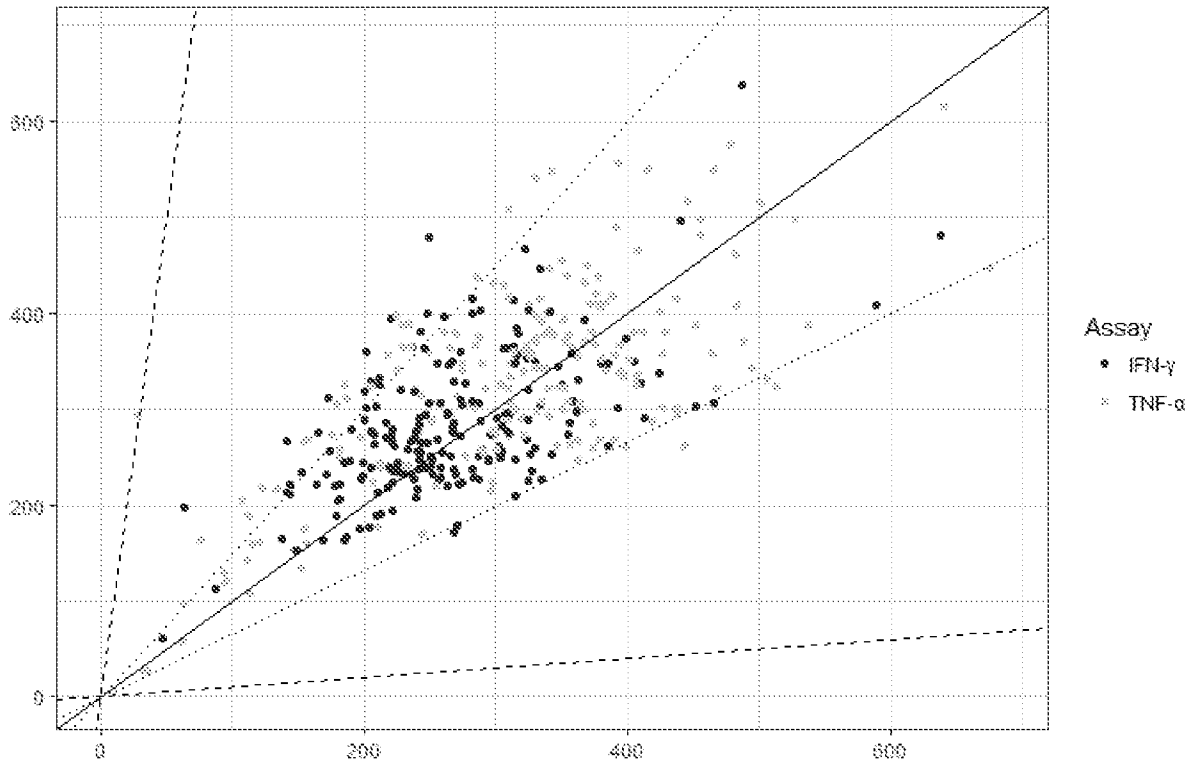


Figure 4. Good alignment between replicate measurements for each cytokine.

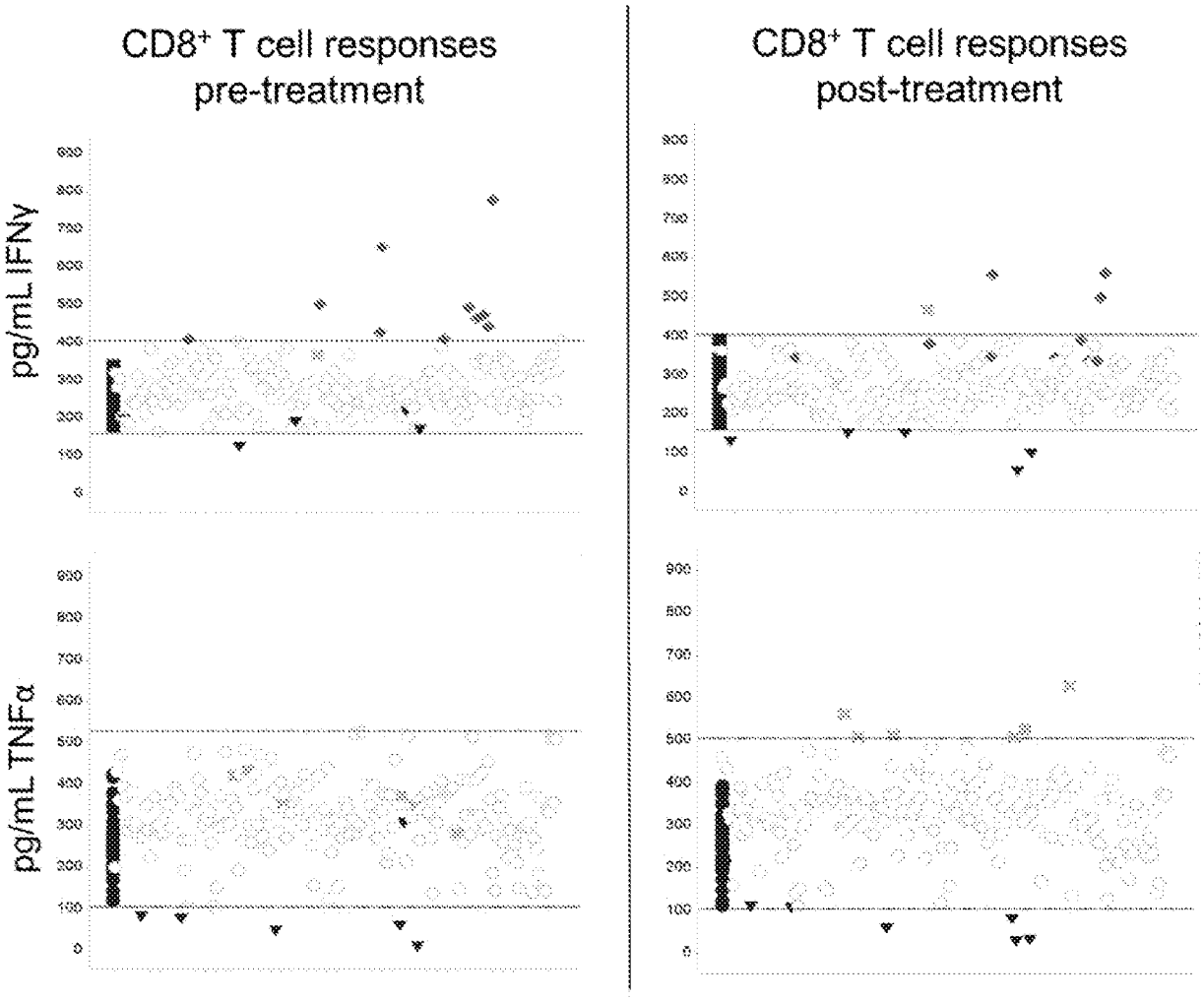


Figure 5. Multiple suppressive or inhibitory neoantigens identified through $CD8^+$ T cell responses pre- and post-checkpoint blockade therapy.

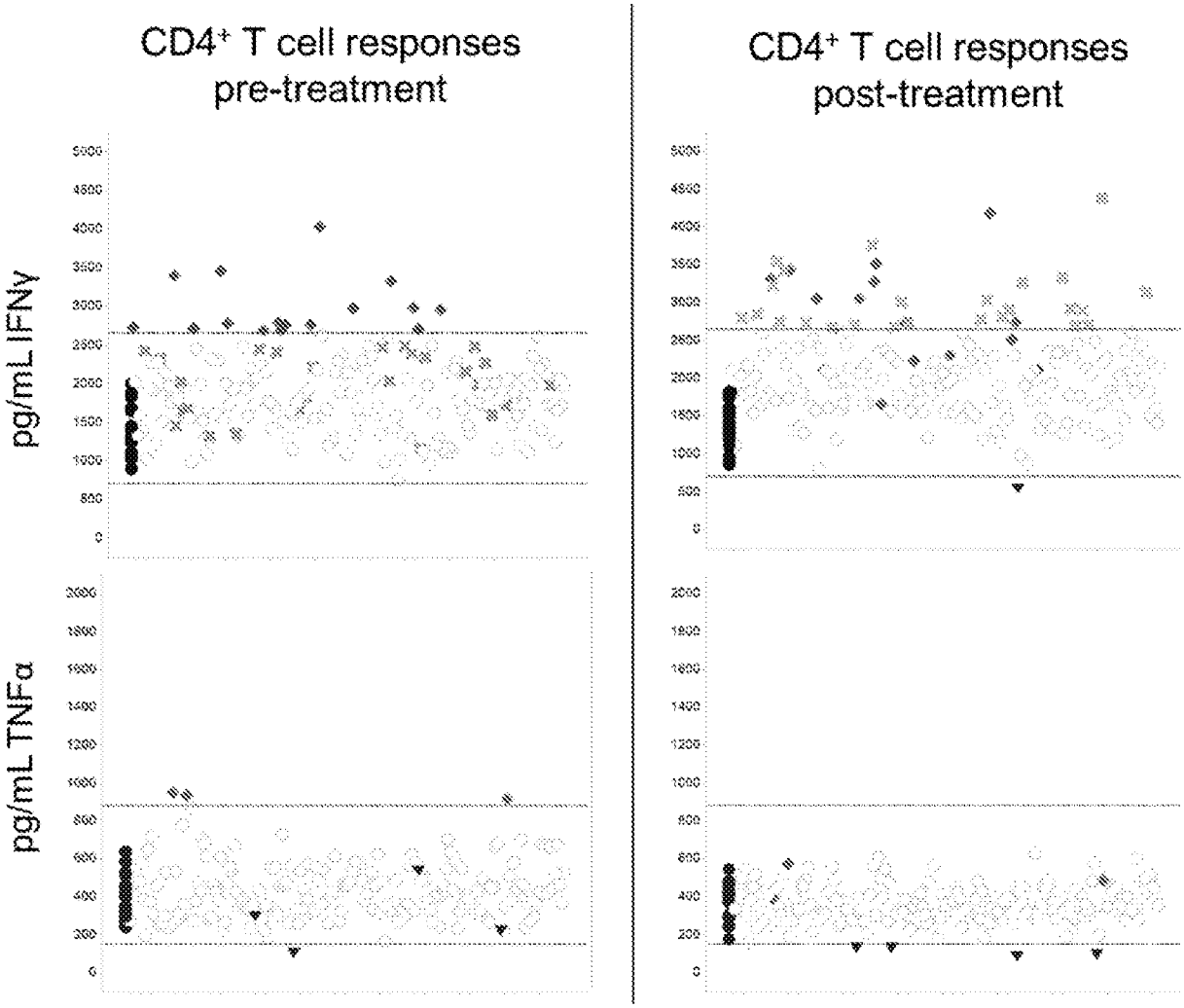


Figure 6. Increased breadth of $CD4^+$ T cell IFN-γ responses to neoantigens post-checkpoint blockade therapy.

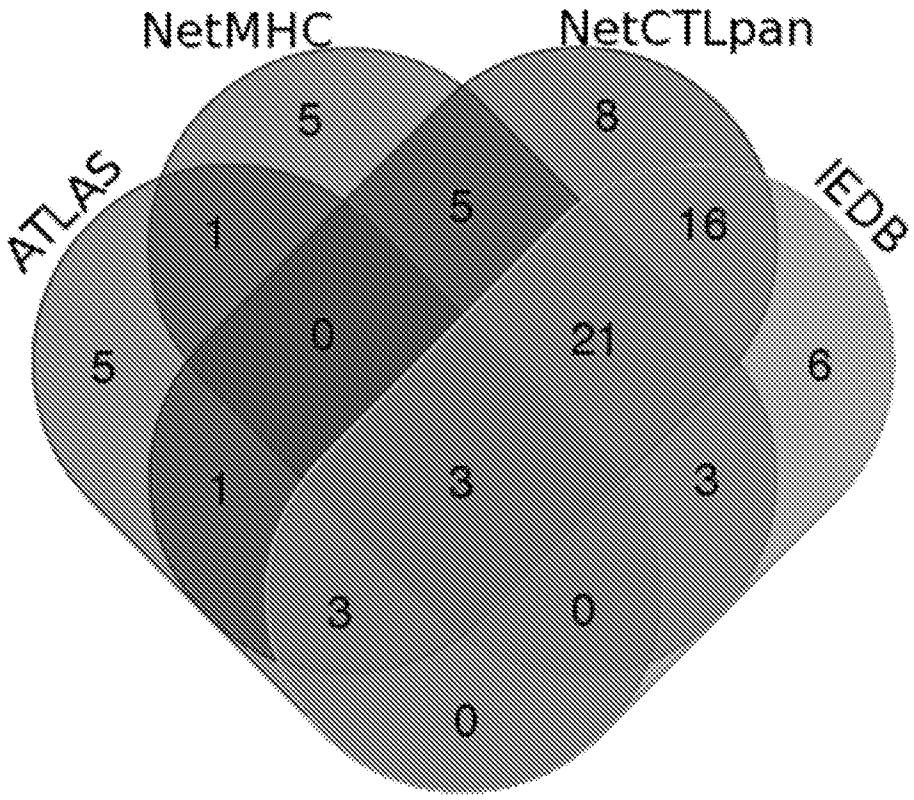


Figure 7. Limited overlap between $CD8^+$-specific T cell neoantigens identified by methods of the disclosure (ATLAS) and epitope prediction algorithms.

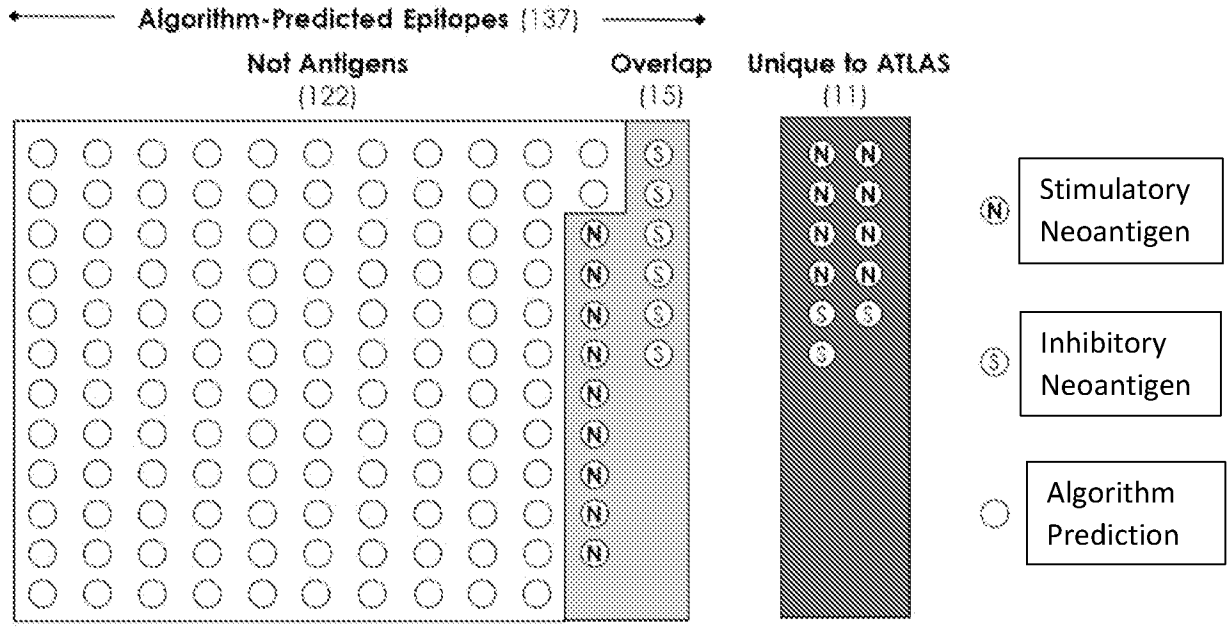


Figure 8. Epitope prediction algorithms had a high false positive rate, missed relevant antigens, and failed to identify suppressive and/or inhibitory antigens.

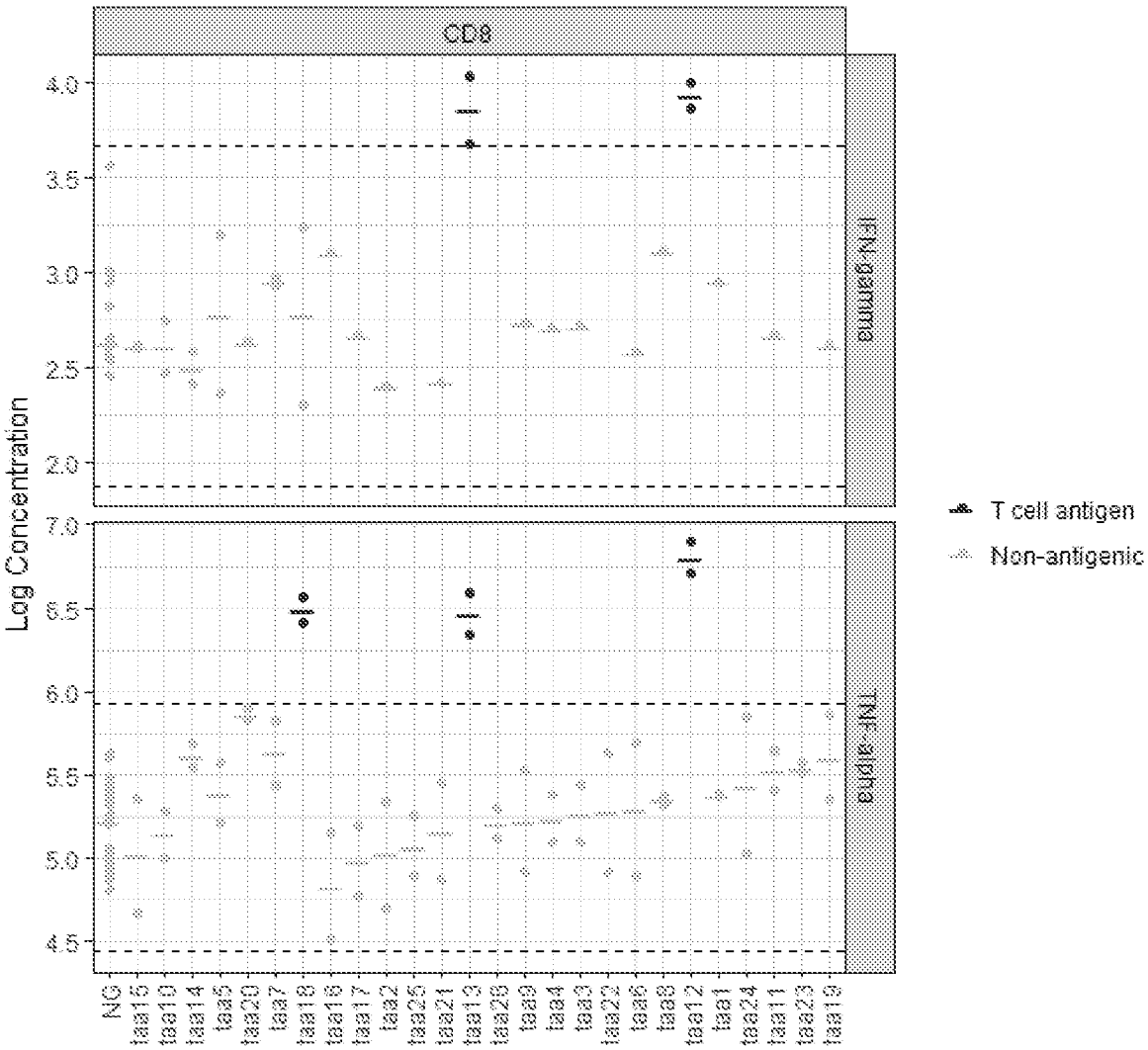


Figure 9. $CD8^+$ T cell responses of a representative colorectal cancer patient to library of TAAs.

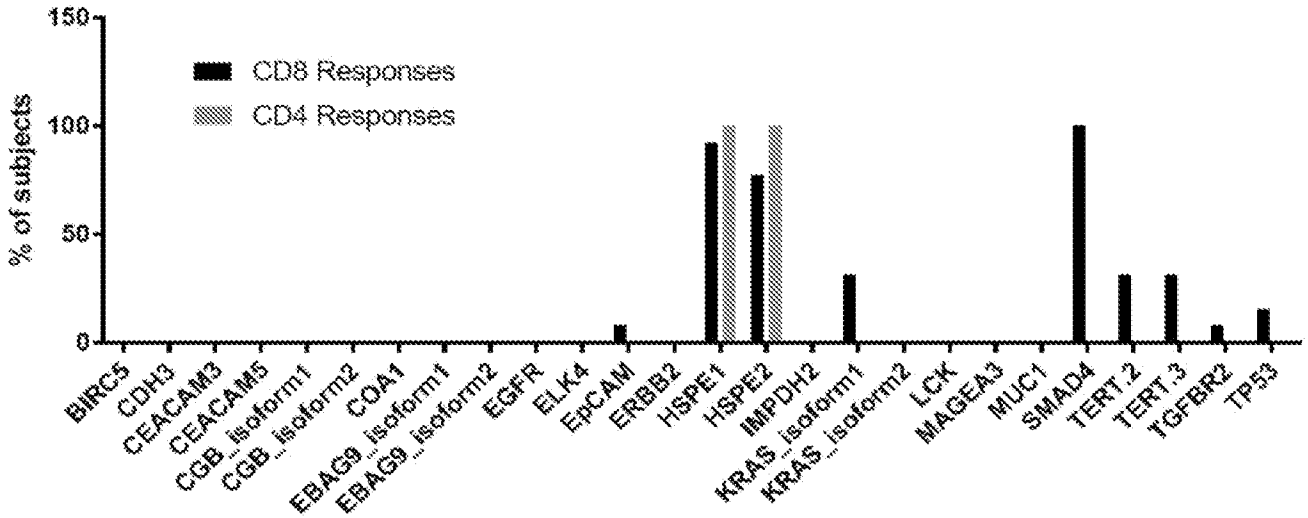


Figure 10. CD4+ and CD8+ T cell responses of a cohort of colorectal cancer patients.

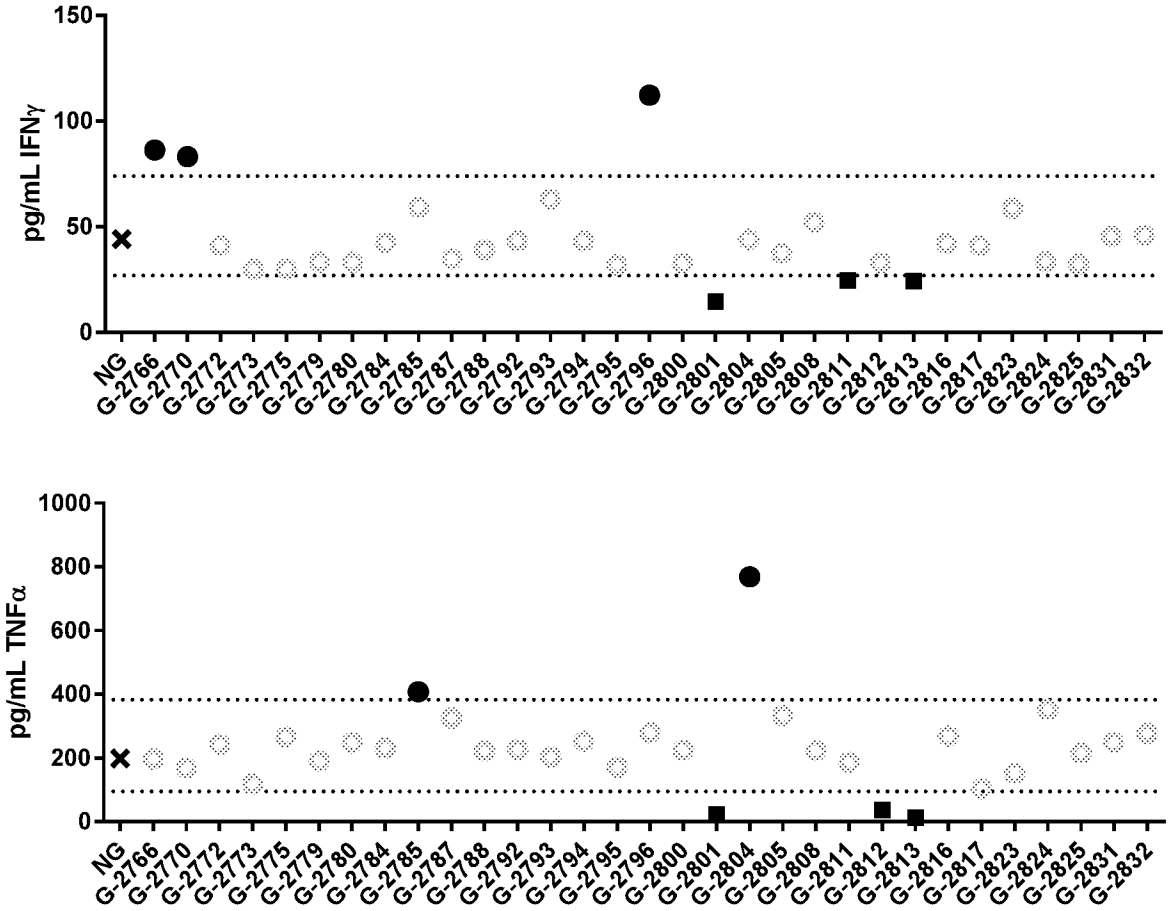

150
100
50
0
pg/mL IFNγ
NG
G-2766
G-2770
G-2772
G-2773
G-2775
G-2779
G-2780
G-2784
G-2785
G-2787
G-2788
G-2792
G-2793
G-2794
G-2795
G-2796
G-2800
G-2801
G-2804
G-2805
G-2808
G-2811
G-2812
G-2813
G-2816
G-2817
G-2823
G-2824
G-2825
G-2831
G-2832
1000
800
600
400
200
0
pg/mL TNFα
NG
G-2766
G-2770
G-2772
G-2773
G-2775
G-2779
G-2780
G-2784
G-2785
G-2787
G-2788
G-2792
G-2793
G-2794
G-2795
G-2796
G-2800
G-2801
G-2804
G-2805
G-2808
G-2811
G-2812
G-2813
G-2816
G-2817
G-2823
G-2824
G-2825
G-2831
G-2832

Figure 11

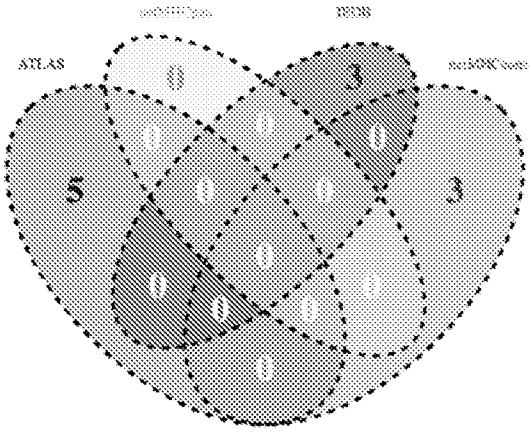


Figure 12A

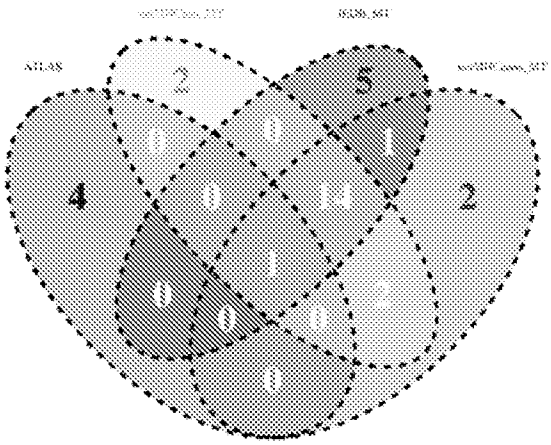


Figure 12B

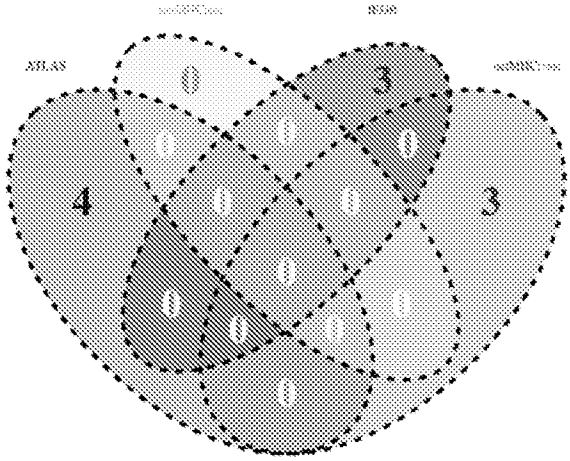


Figure 13A

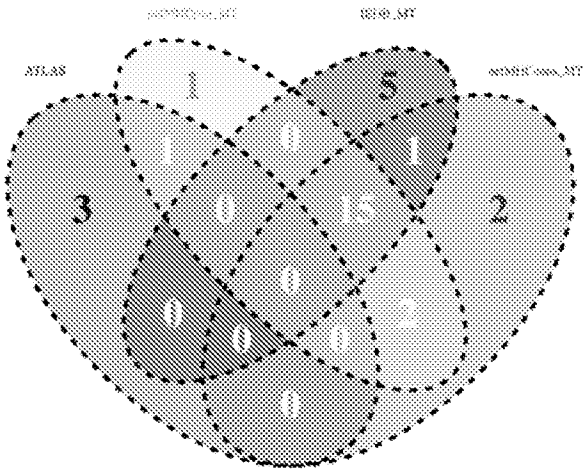


Figure 13B

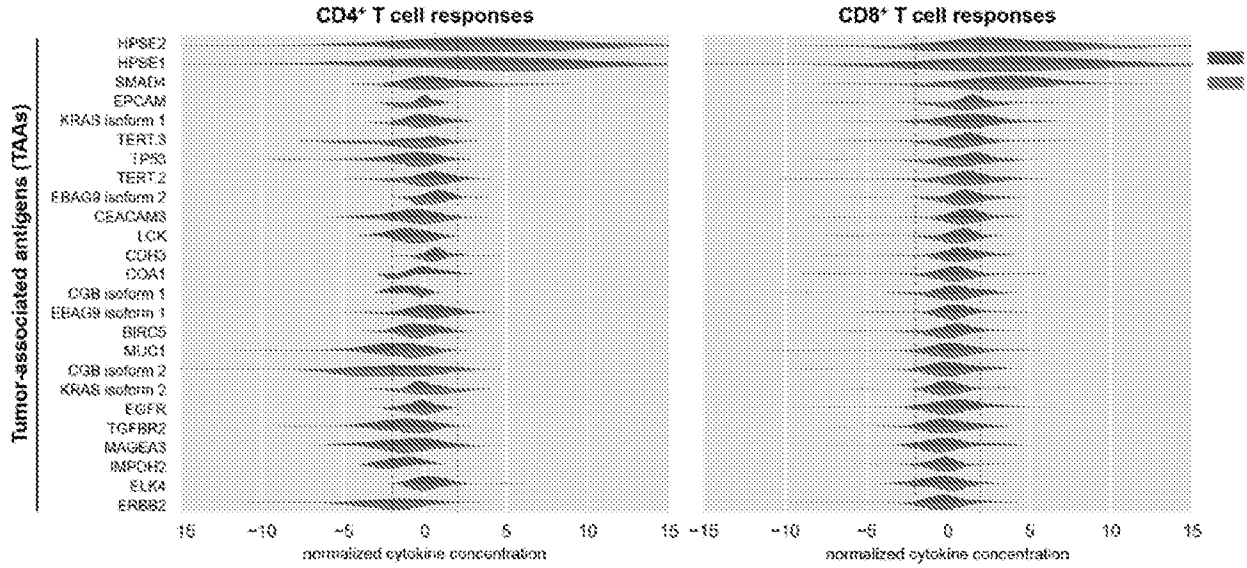

CD4+ T cell responses
CD8+ T cell responses
Tumor-associated antigens (TAAs)
HPSE2
HPSE1
SMAD4
EPCAM
KRAS isoform 1
TERT.3
TP53
TERT.2
EBAG9 isoform 2
CEACAM5
LCK
CDH3
COA1
CGB isoform 1
EBAG9 isoform 1
BIRC5
MUC1
CGB isoform 2
KRAS isoform 2
EGFR
TGFBR2
MAGEA3
IMPDH2
ELK4
ERBB2
15 −10 −5 0 5 10 15
normalized cytokine concentration
−15 −10 −5 0 5 10 15
normalized cytokine concentration

Figure 14

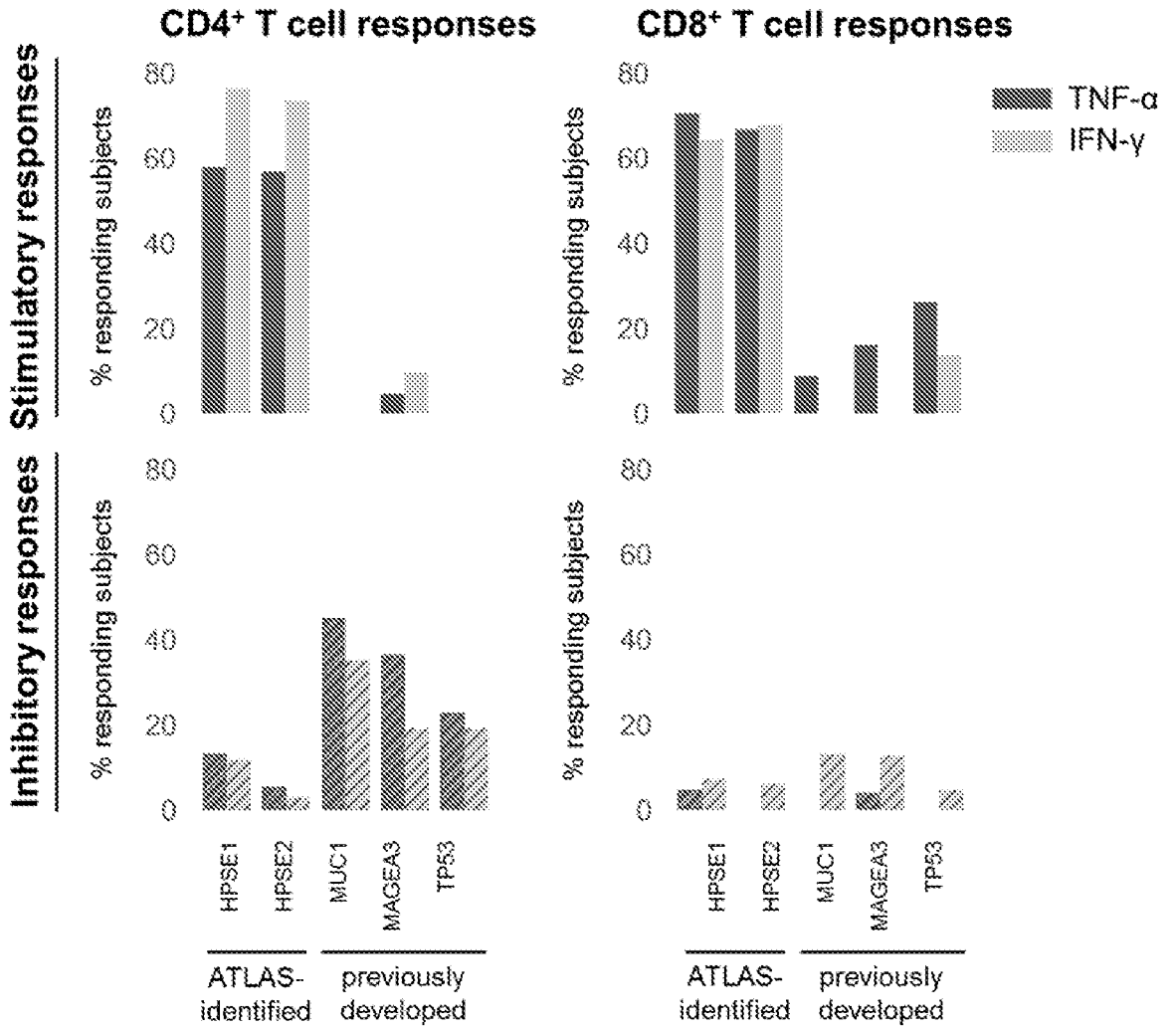

CD4+ T cell responses
CD8+ T cell responses
Stimulatory responses
Inhibitory responses
% responding subjects
0
20
40
60
80
TNF-α
IFN-γ
HPSE1
HPSE2
MUC1
MAGEA3
TP53
ATLAS-identified
previously developed

Figure 15A

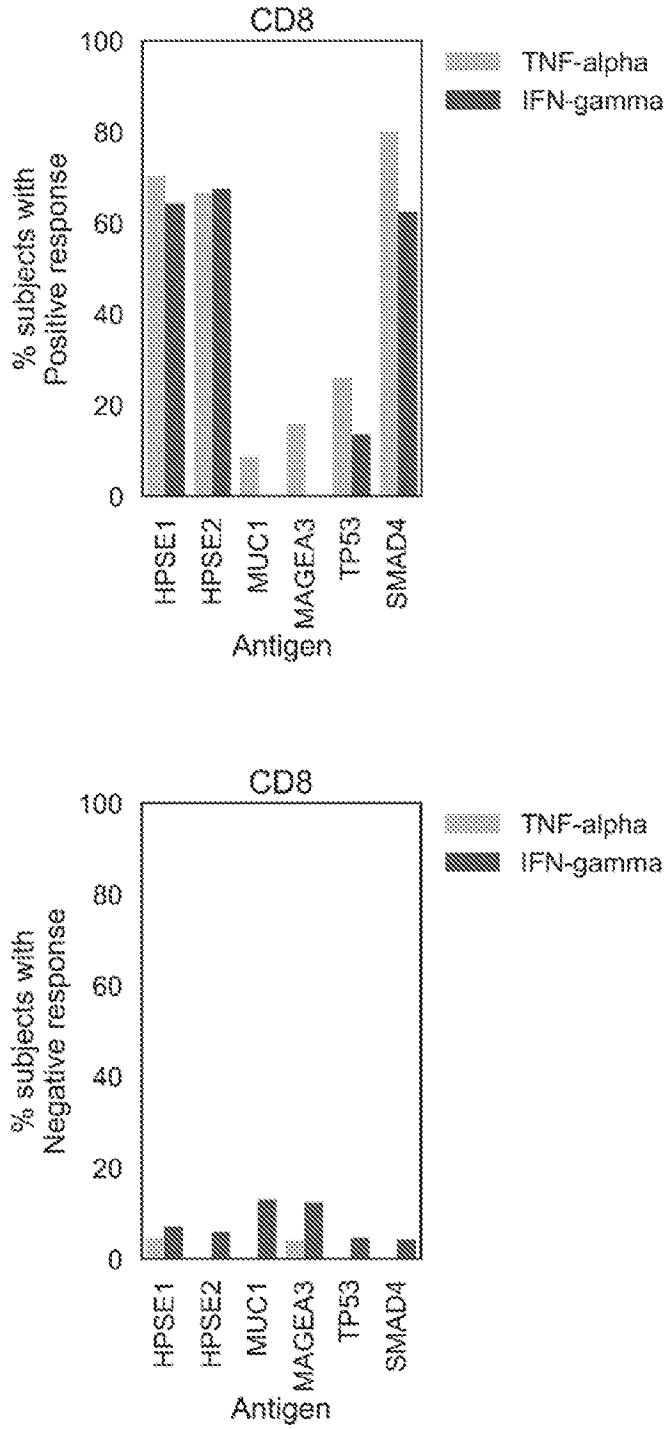

CD8
% subjects with Positive response
100
80
60
40
20
0
TNF-alpha
IFN-gamma
HPSE1
HPSE2
MUC1
MAGEA3
TP53
SMAD4
Antigen
CD8
% subjects with Negative response
100
80
60
40
20
0
TNF-alpha
IFN-gamma
HPSE1
HPSE2
MUC1
MAGEA3
TP53
SMAD4
Antigen

Figure 15B

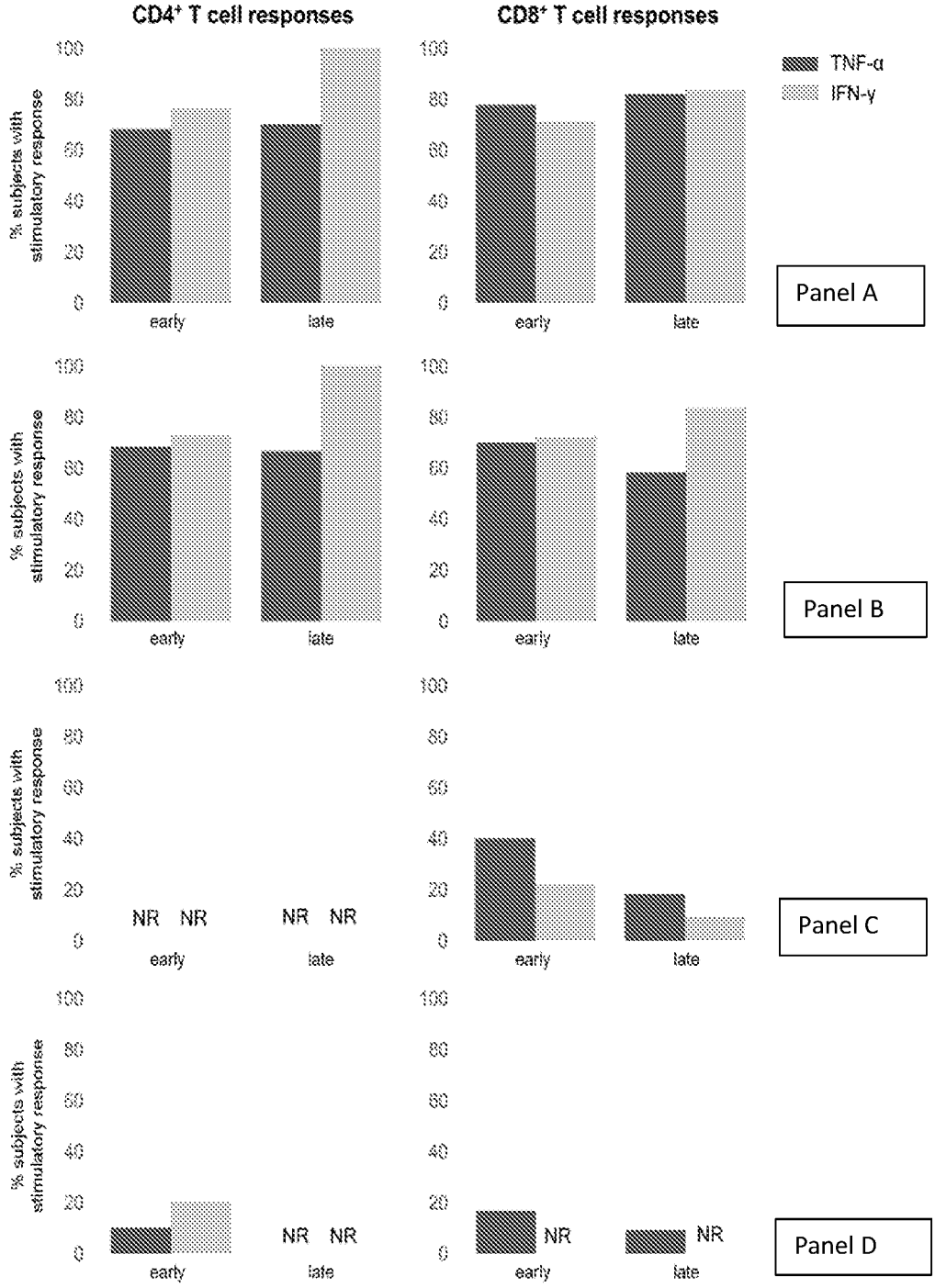

CD4+ T cell responses
CD8+ T cell responses
TNF-α
IFN-γ
% subjects with stimulatory response
0
20
40
60
80
100
early
late
NR
Panel A
Panel B
Panel C
Panel D

Figure 16

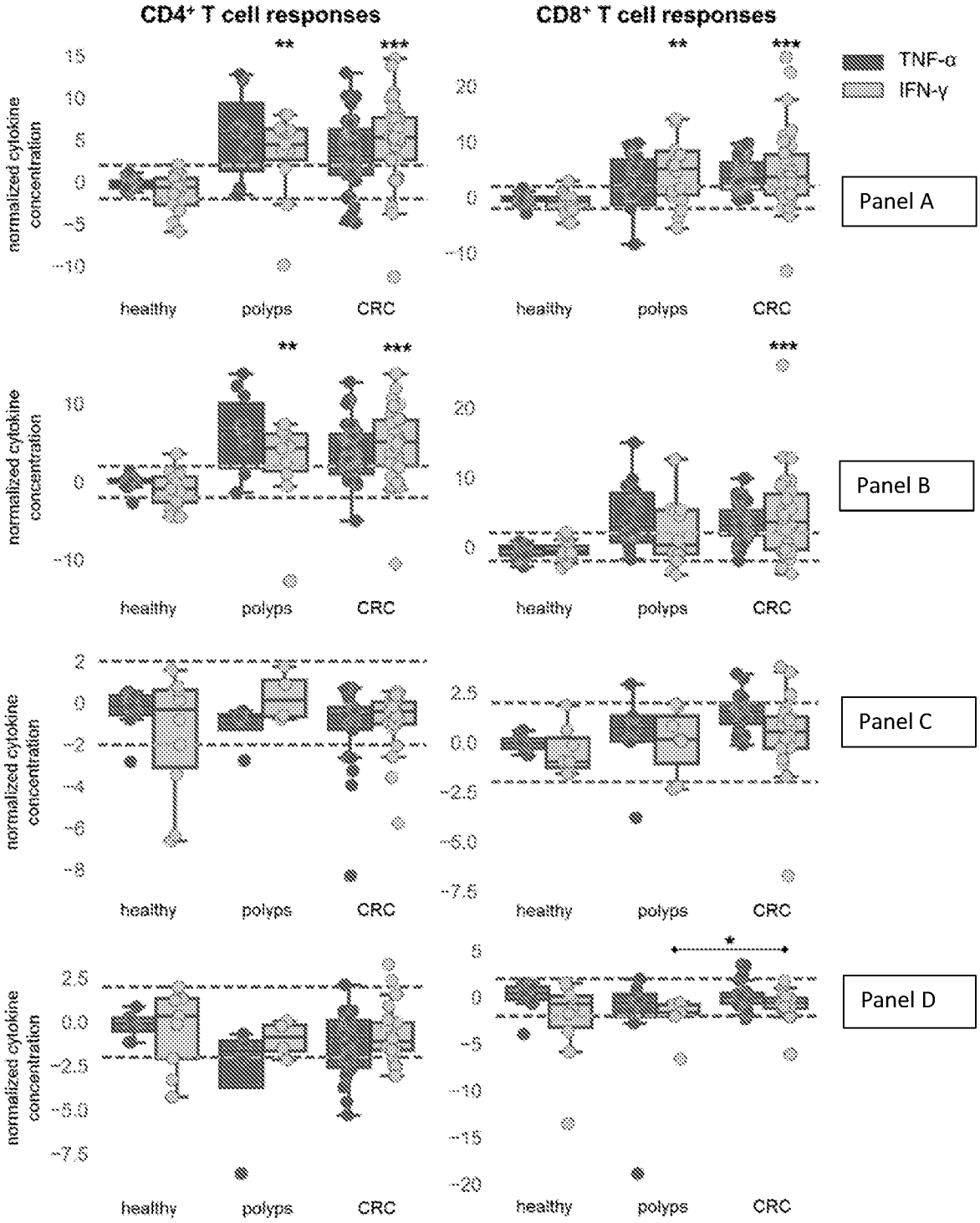

CD4+ T cell responses
CD8+ T cell responses
TNF-α
IFN-γ
normalized cytokine concentration
healthy
polyps
CRC
Panel A
Panel B
Panel C
Panel D

Figure 17

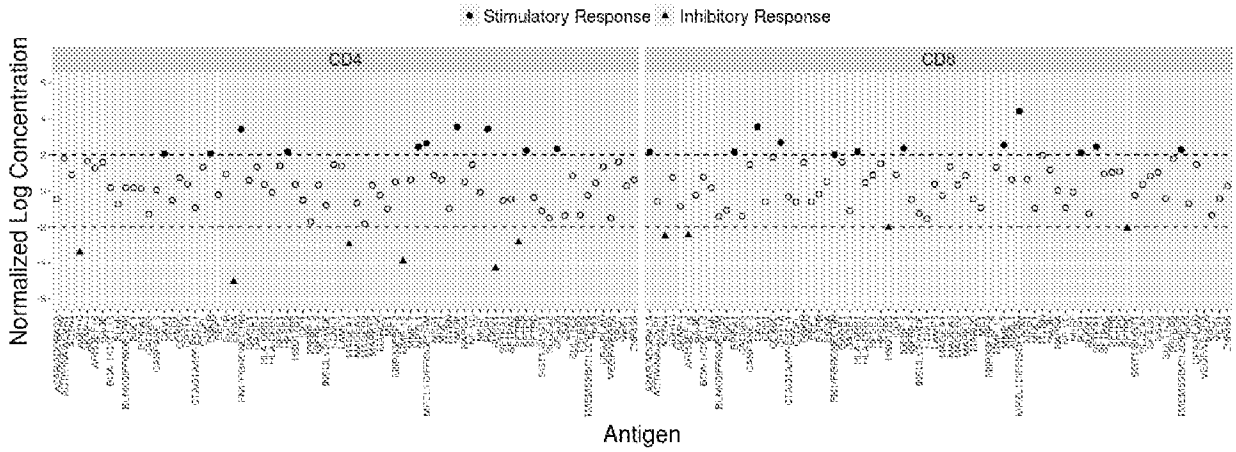

Stimulatory Response
Inhibitory Response
CD4
CD8
Normalized Log Concentration
Antigen

Figure 18

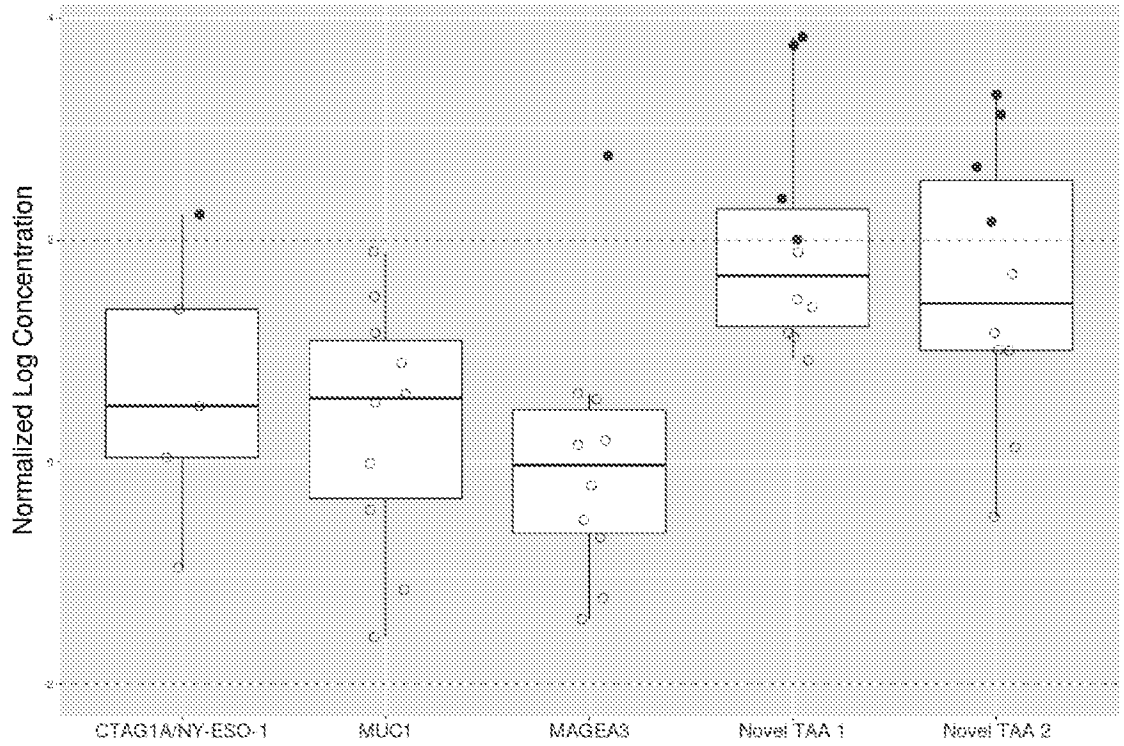

Normalized Log Concentration
CTAG1A/NY-ESO-1
MUC1
MAGEA3
Novel TAA 1
Novel TAA 2

Figure 19

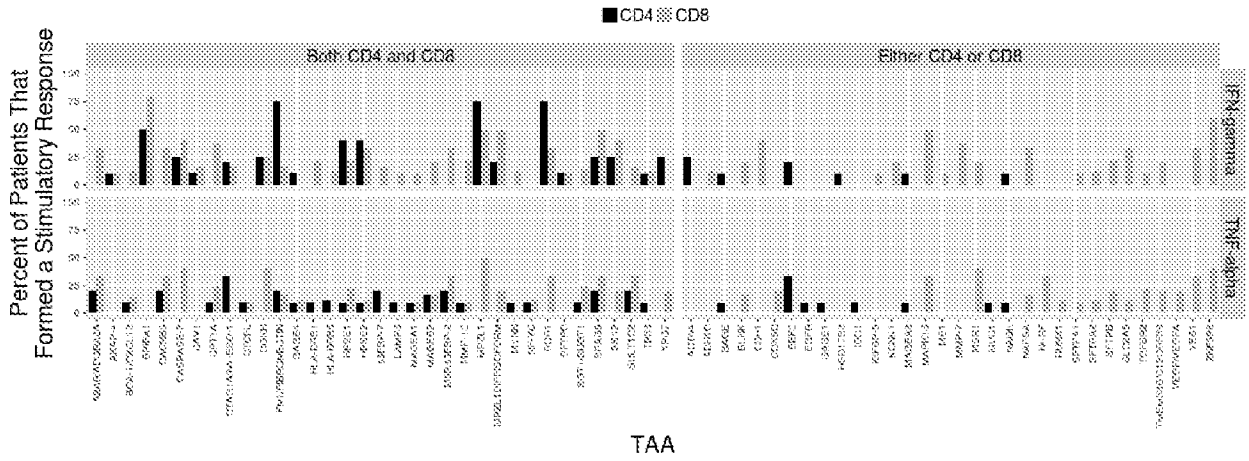

CD4 CD8
Both CD4 and CD8
Either CD4 or CD8
IFN-gamma
TNF-alpha
Percent of Patients That Formed a Stimulatory Response
TAA

Figure 20

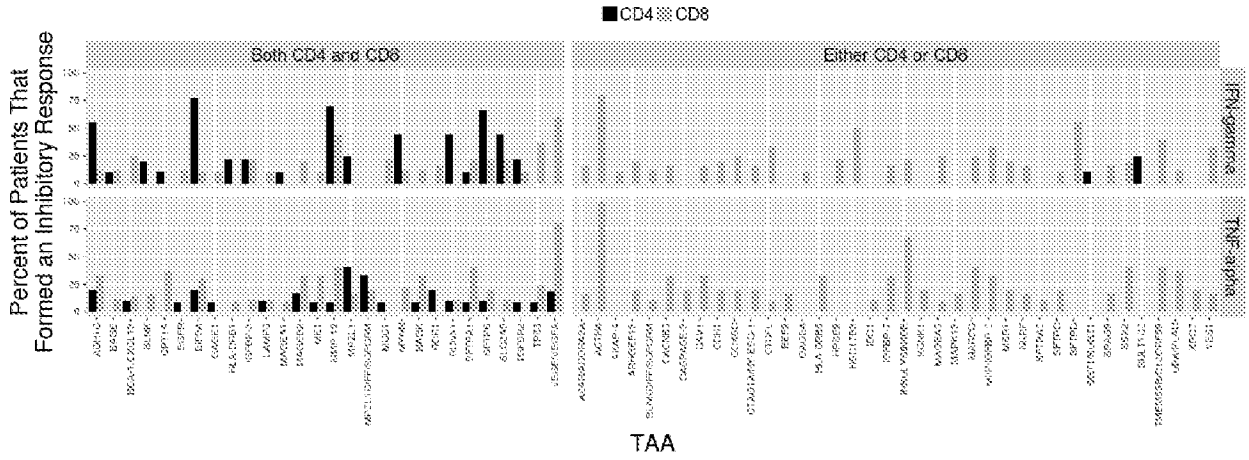

CD4 CD8
Both CD4 and CD8
Either CD4 or CD6
IFN-gamma
TNF-alpha
Percent of Patients That Formed an Inhibitory Response
TAA

Figure 21

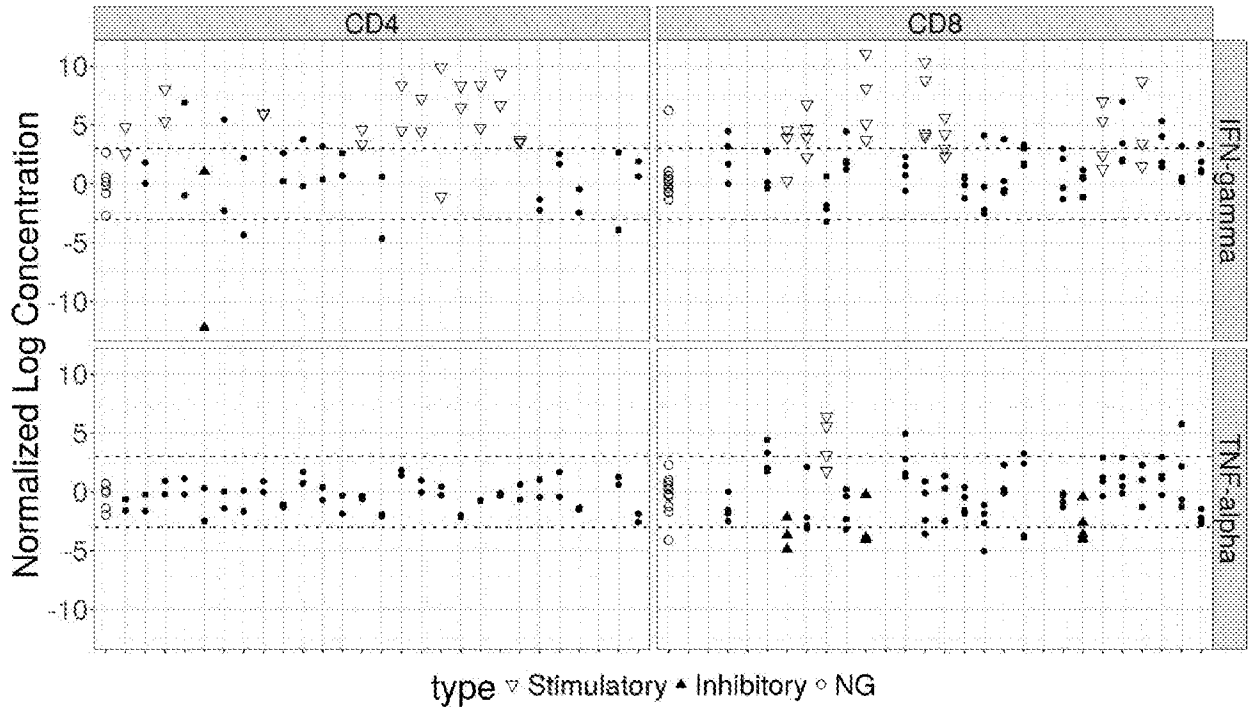

CD4
CD8
IFN-gamma
TNF-alpha
Normalized Log Concentration
10
5
0
-5
-10
type ▽ Stimulatory ▲ Inhibitory ○ NG

Figure 22

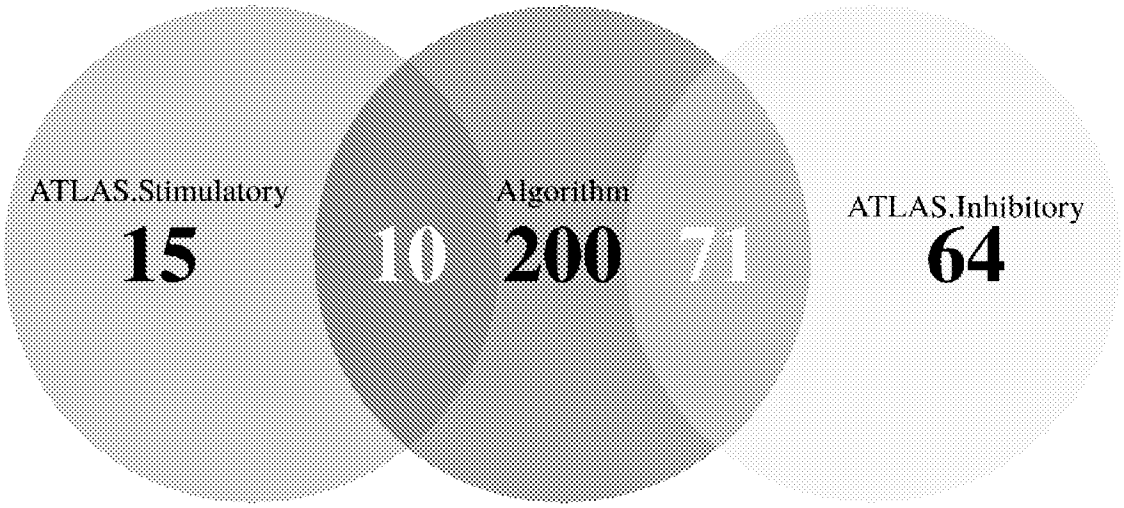


Figure 23A

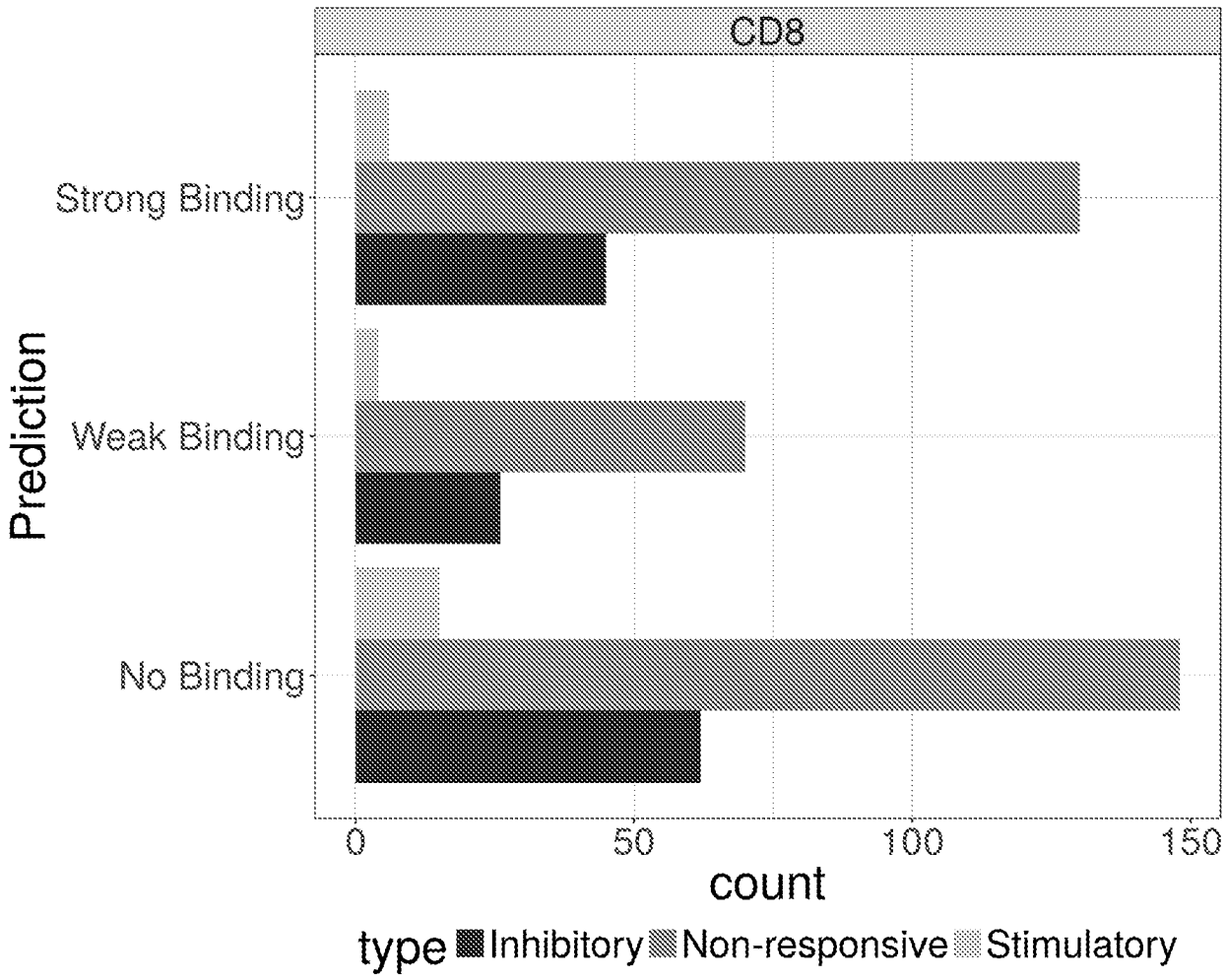


Figure 23B

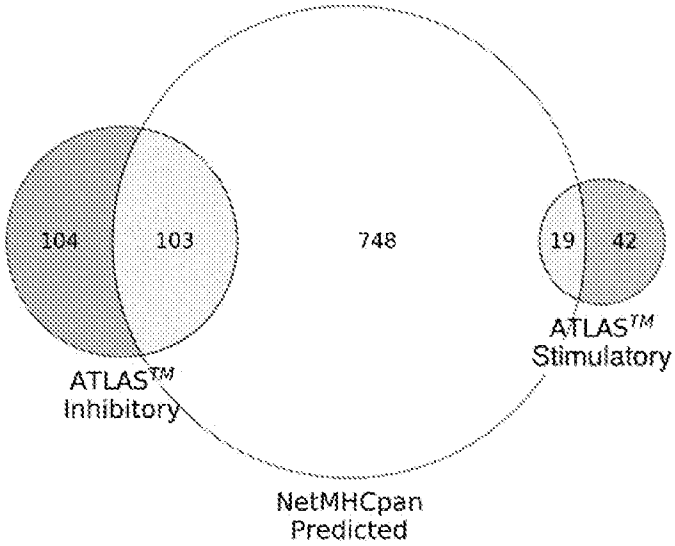


Figure 23C

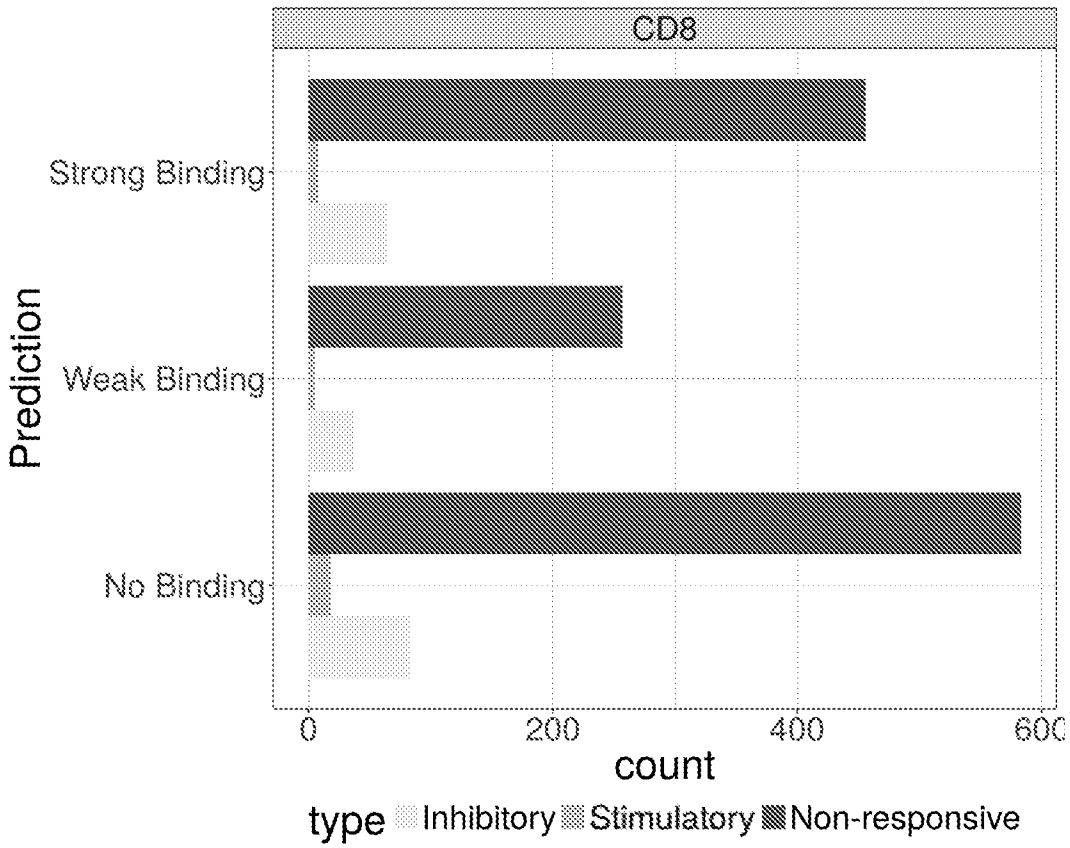


Figure 23D

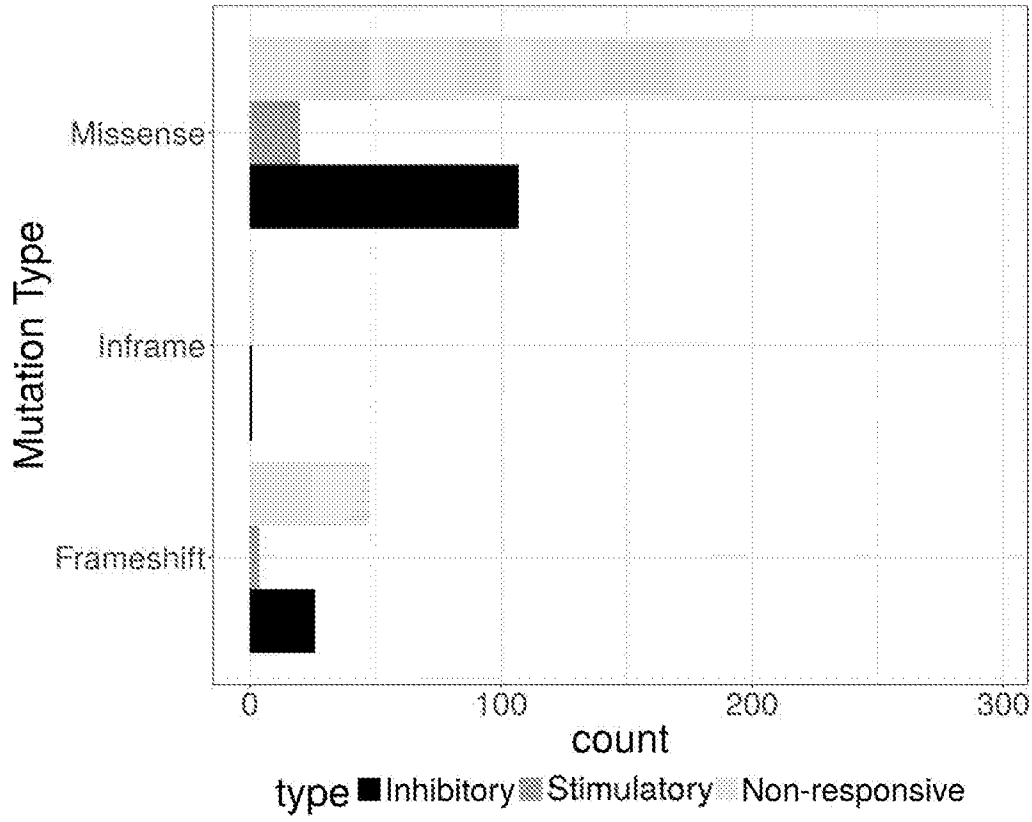

Mutation Type
Missense
Inframe
Frameshift
0
100
200
300
count
type
Inhibitory
Stimulatory
Non-responsive

Figure 24A

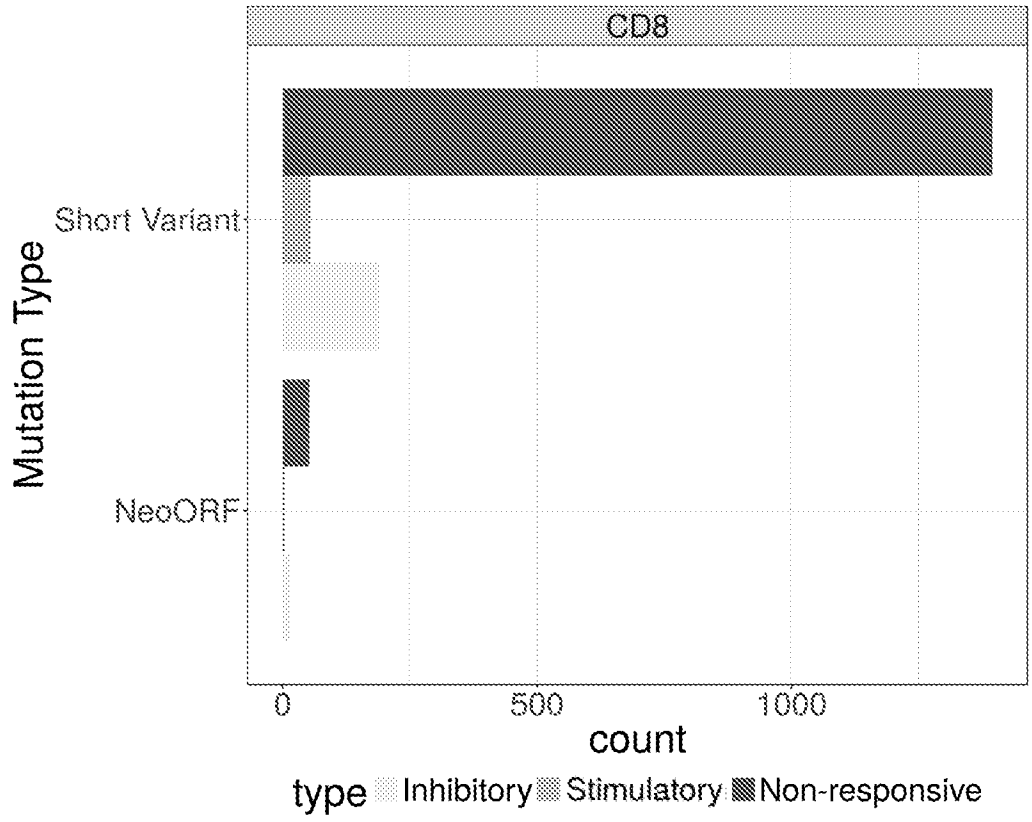

CD8
Short Variant
NeoORF
Mutation Type
0
500
1000
count
type
Inhibitory
Stimulatory
Non-responsive

Figure 24B

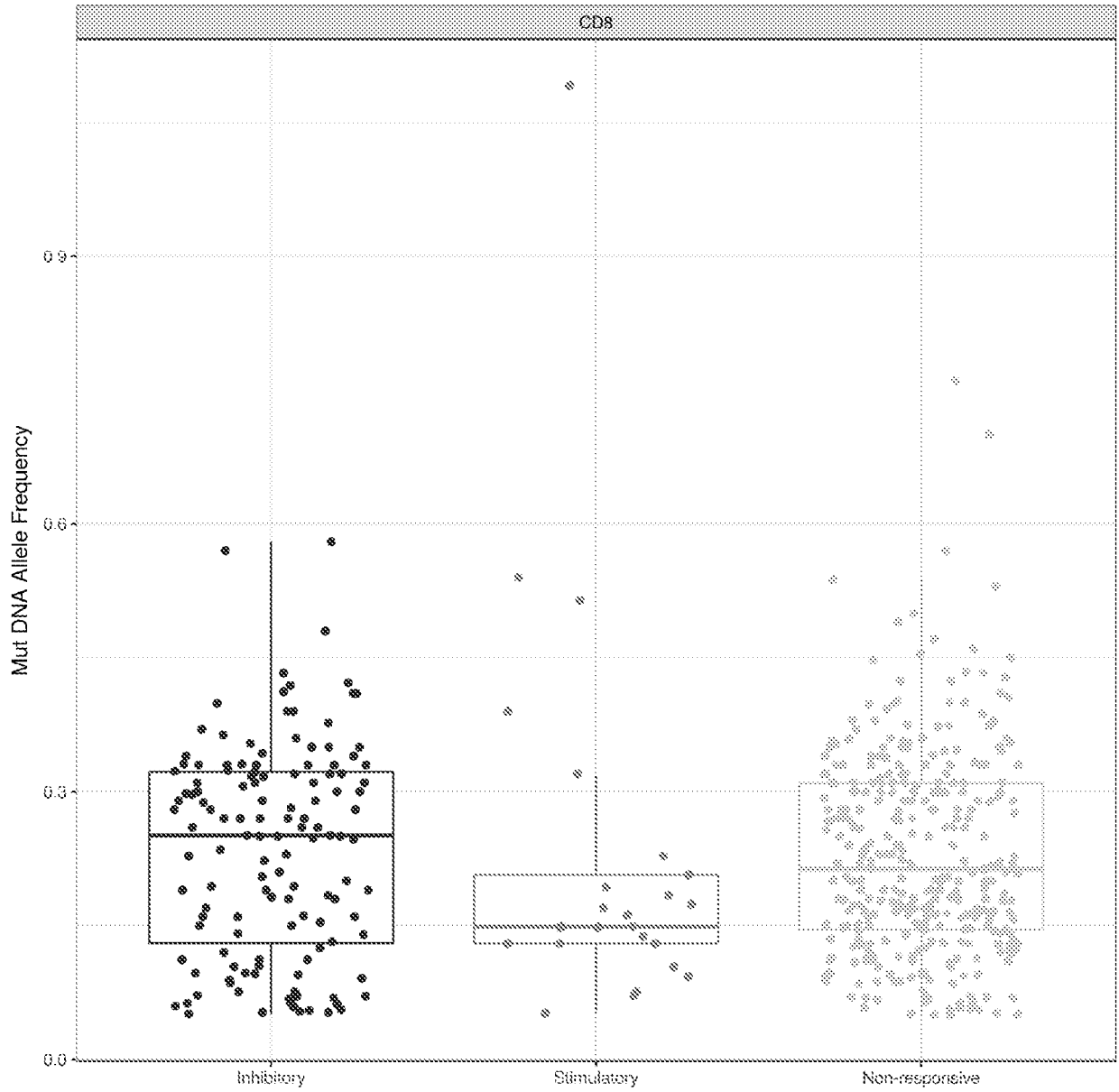

CD8
Mut DNA Allele Frequency
0.9
0.6
0.3
0.0
Inhibitory
Stimulatory
Non-responsive

Figure 25A

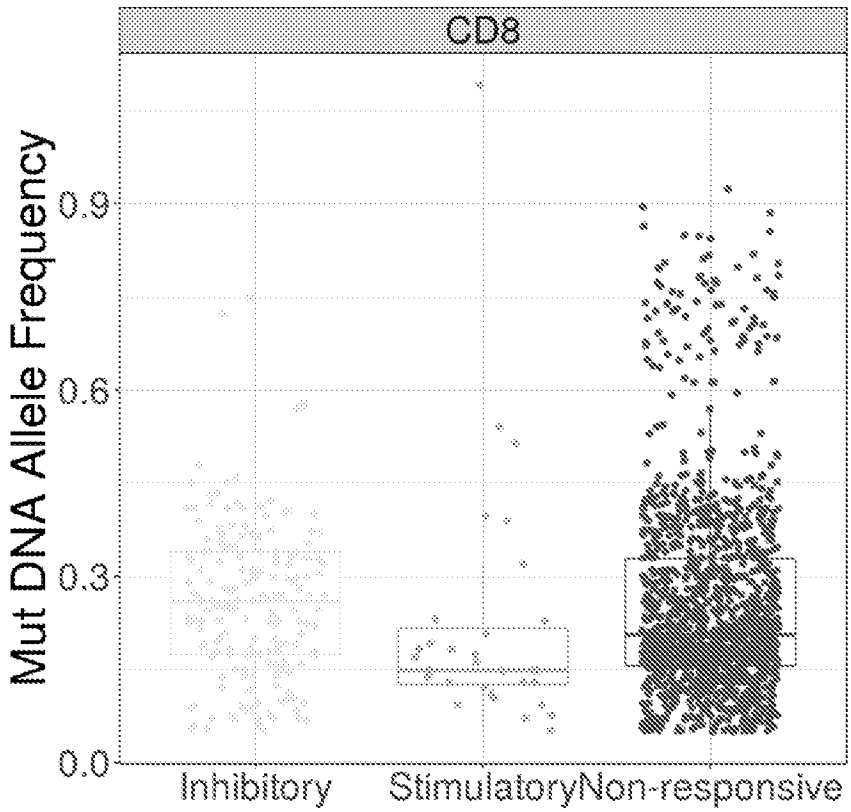

CD8
Mut DNA Allele Frequency
0.9
0.6
0.3
0.0
Inhibitory
Stimulatory
Non-responsive

Figure 25B

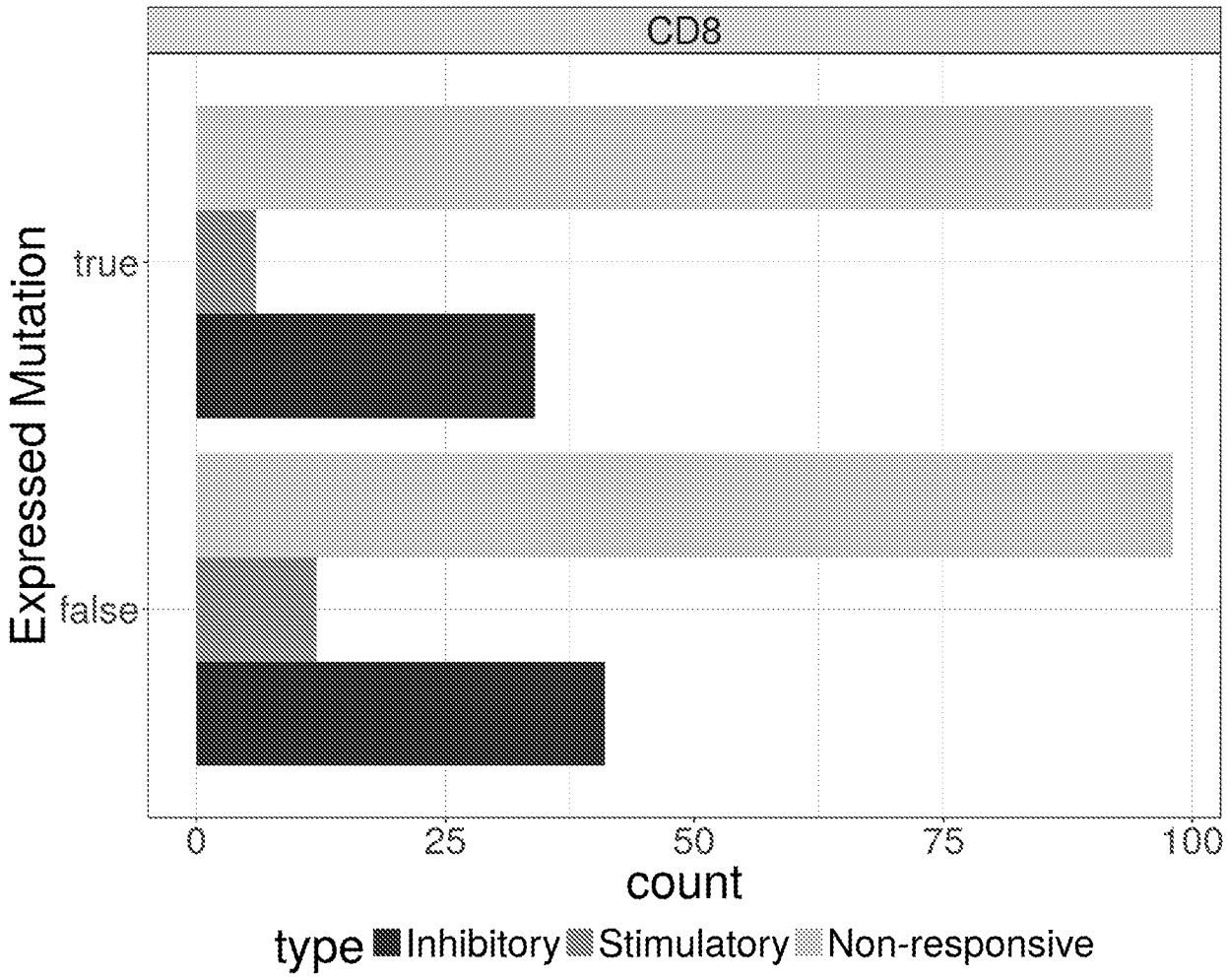

CD8
Expressed Mutation
true
false
0
25
50
75
100
count
type
Inhibitory
Stimulatory
Non-responsive

Figure 26A

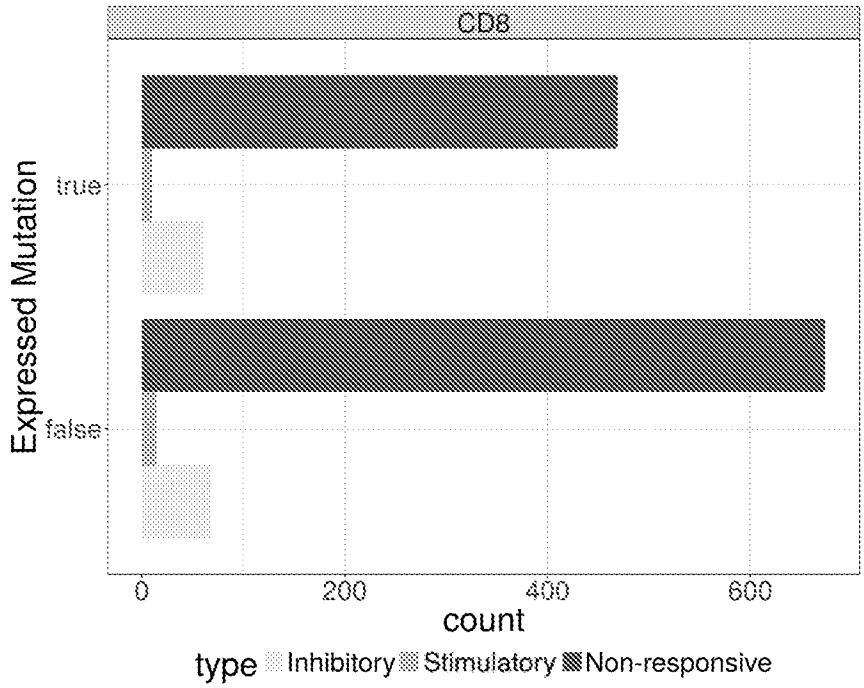

CD8
Expressed Mutation
true
false
0
200
400
600
count
type
Inhibitory
Stimulatory
Non-responsive

Figure 26B

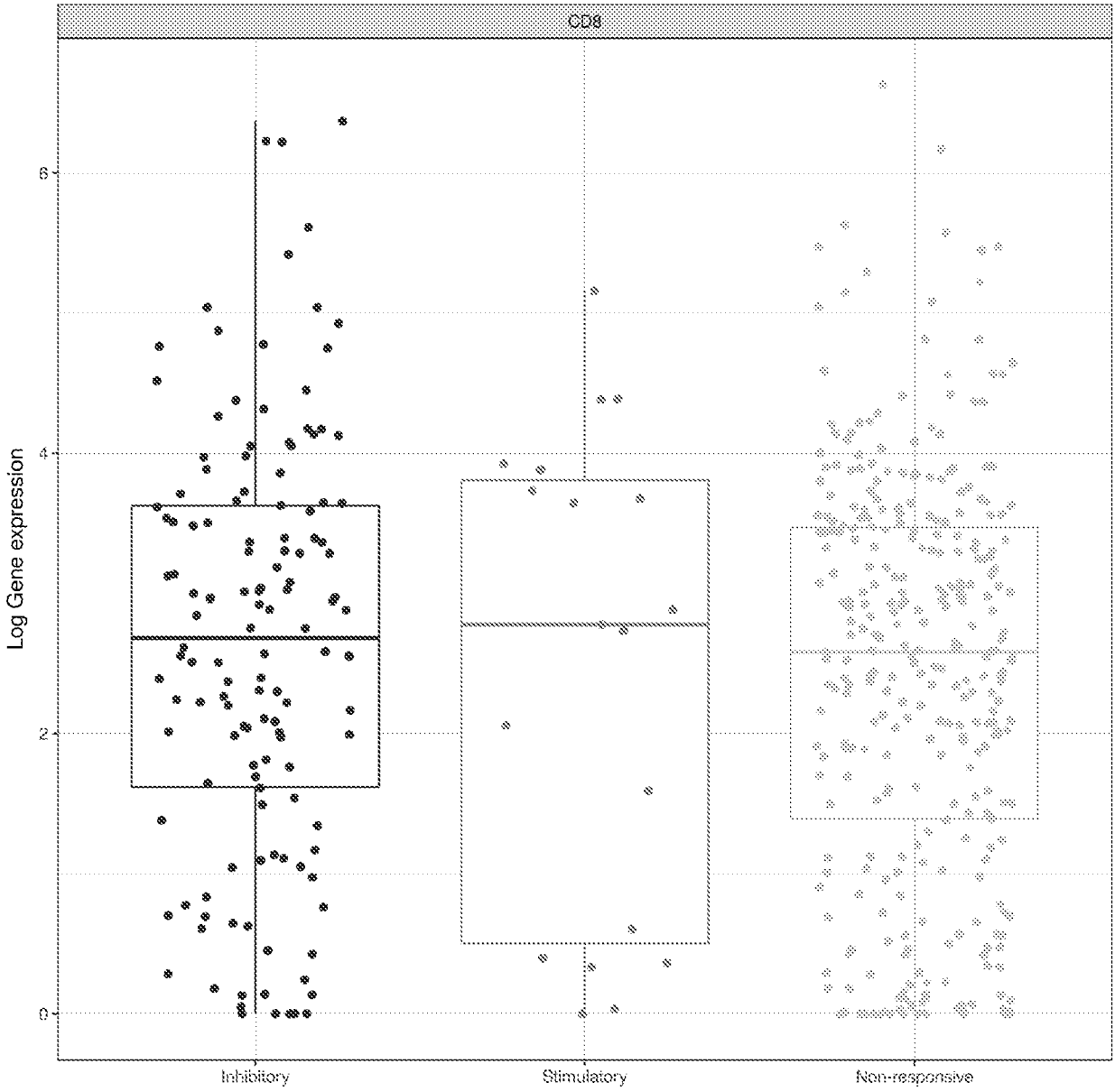

CD8
Log Gene expression
6
4
2
0
Inhibitory
Stimulatory
Non-responsive

Figure 27A

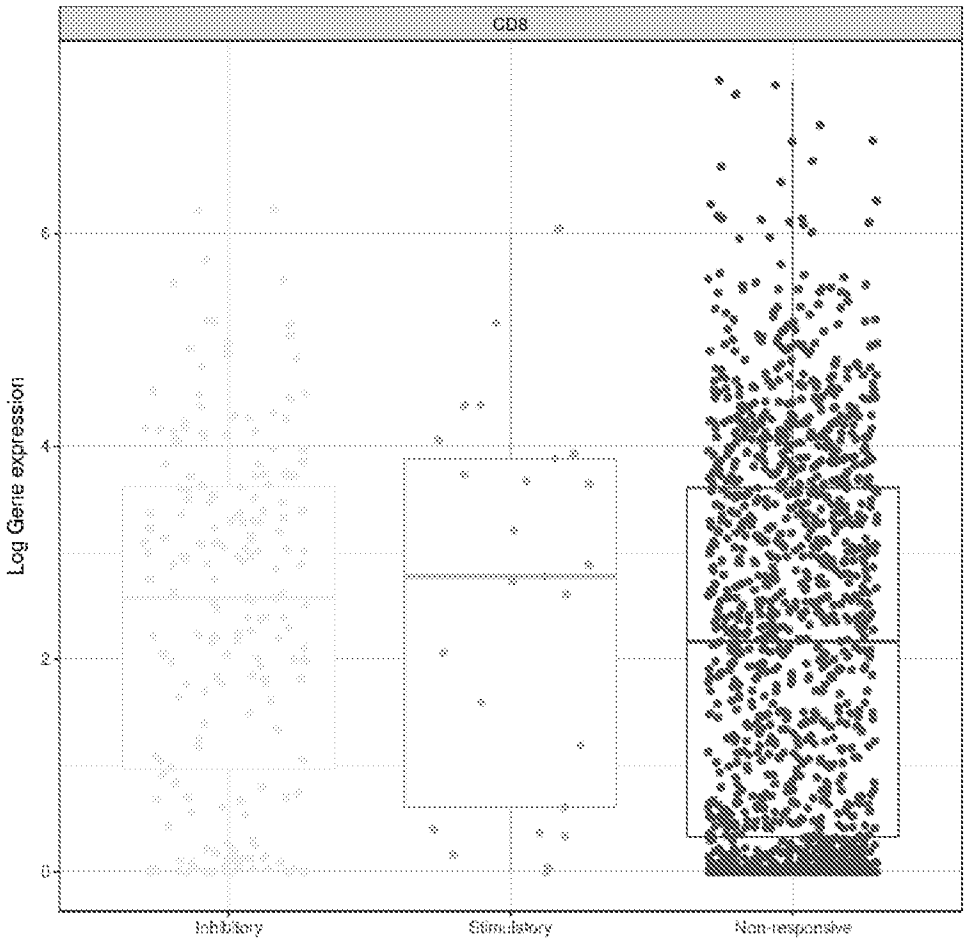

CD8
Log Gene expression
6
4
2
0
Inhibitory
Stimulatory
Non-responsive

Figure 27B

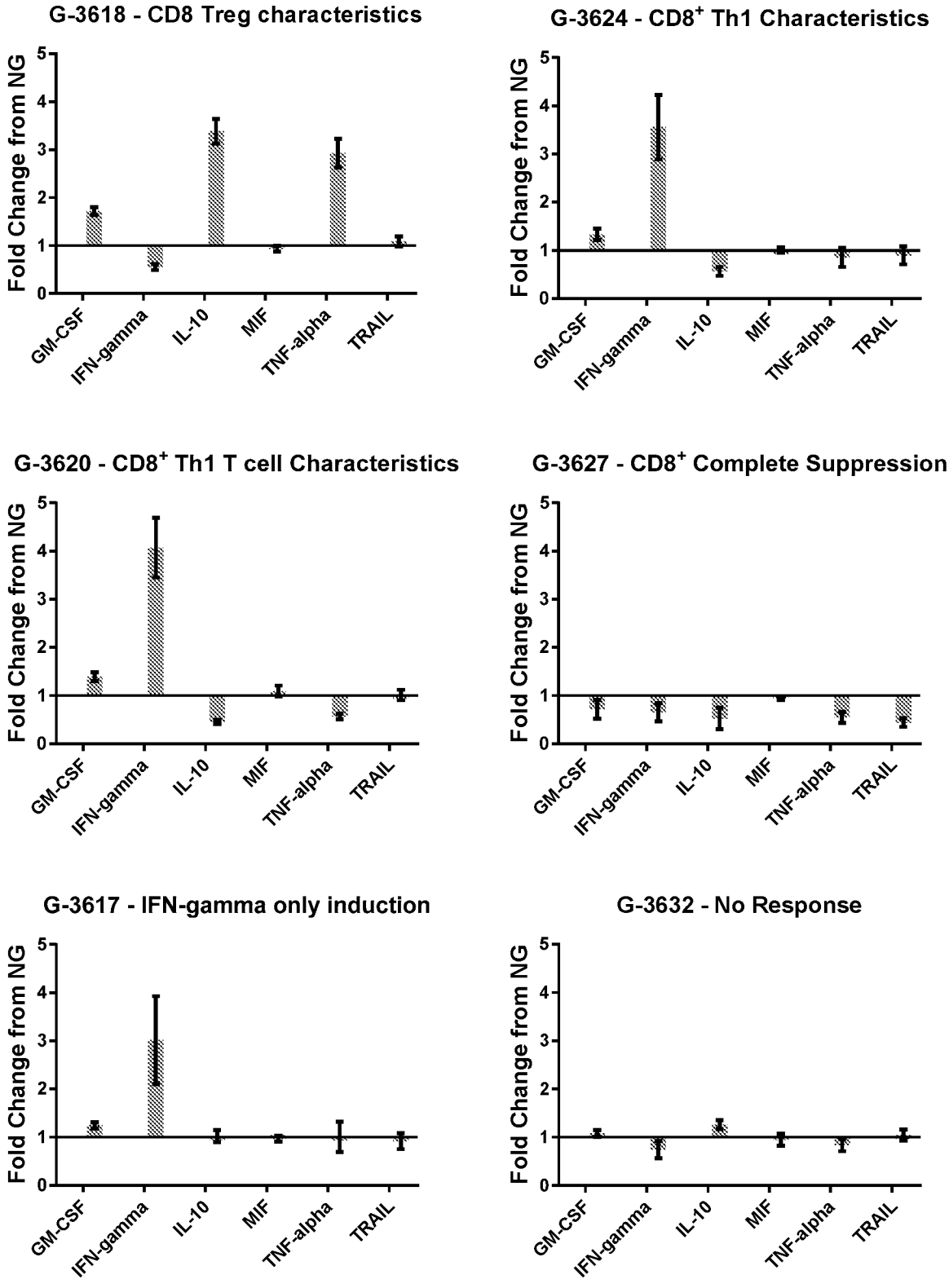

G-3618 - CD8 Treg characteristics
G-3624 - CD8+ Th1 Characteristics
G-3620 - CD8+ Th1 T cell Characteristics
G-3627 - CD8+ Complete Suppression
G-3617 - IFN-gamma only induction
G-3632 - No Response
Fold Change from NG
0
1
2
3
4
5
GM-CSF
IFN-gamma
IL-10
MIF
TNF-alpha
TRAIL

Figure 28

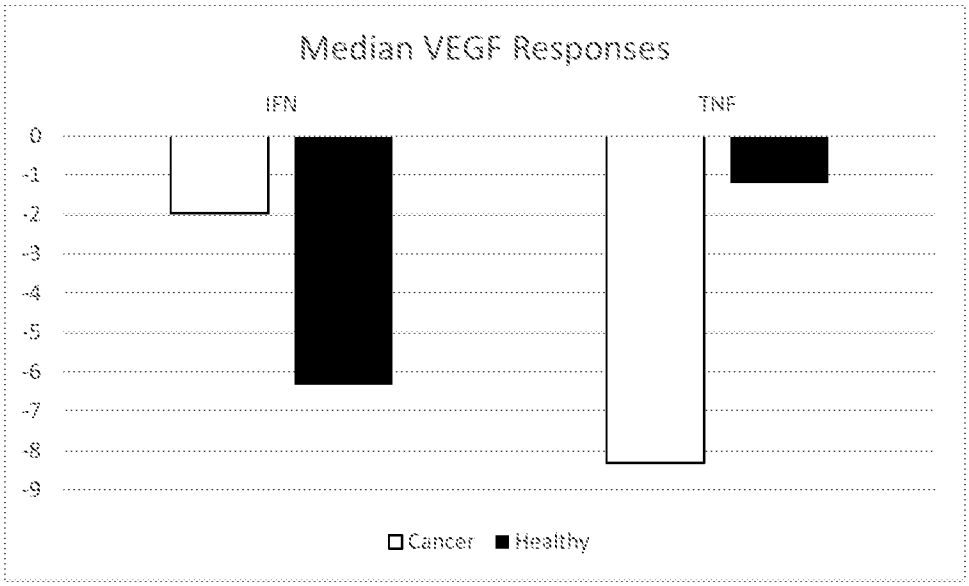


Figure 29