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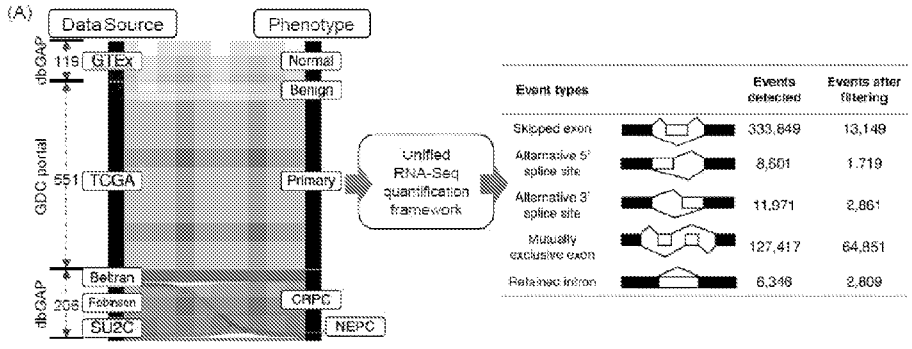

(57) Abstract: Methods and processes to identify neoplastic tissue antigens derived from alternative splicing (AS) are described, in accordance with various embodiments of the invention. Also described are novel tumor antigens that are useful as targets in various immunotherapeutic approaches to treating cancer as well as novel engineered T cell Receptors (TCRs) and chimeric antigen receptors (CARs) that target these antigenic peptides.

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COMPOSITIONS AND METHODS COMPRISING SPLICING-DERIVED ANTIGENS FOR TREATING CANCER

BACKGROUND OF THE INVENTION

[0001] This application is claims benefit of priority of U.S. Provisional Application No. 62/976,654, filed February 14, 2020 which is hereby incorporated by reference in its entirety.

[0002] This invention was made with government support under Grant Numbers CA092131, CA220238 and CA232979 awarded by the National Institutes of Health. The government has certain rights in the invention.

I. Field of the Invention

[0003] This invention relates to the field of cancer therapies.

II. Background

[0004] Cancer immunotherapy has gained tremendous momentum in the past decade. The clinical effectiveness of checkpoint inhibitors, such as neutralizing antibodies against PD-1 and CTLA-4, is thought to result from their ability to reactivate tumor-specific T cells. Meanwhile, adoptive cell therapies use genetically modified T-cell receptors (TCRs) or synthetic chimeric antigen receptor T cells (CAR-T) for tumor-specific antigen recognition. The finding that cancer cells express specific T-cell-reactive antigens has galvanized epitope discovery in recent years. Nevertheless, the identification of tumor antigens remains a major challenge. Although somatic mutation-derived antigens have been successfully targeted by cancer therapies, this approach remains largely ineffective for tumors with low or moderate mutation loads. Thus, there is a need for the identification and characterization of novel tumor antigens that are useful targets in cancer immunotherapies.

SUMMARY OF THE INVENTION

[0005] Described herein are novel tumor antigens that are useful as targets in various immunotherapeutic approaches to treating cancer as well as novel engineered T cell Receptors (TCRs) and chimeric antigen receptors (CARs) that target these antigenic peptides.

[0006] Aspects of the disclosure relate to a peptide comprising at least 70% sequence identity to a peptide of SEQ ID NO:1-19. In some aspects, the peptide comprises or consists

of a sequence that is, is at least, or is at most 60%, 61%, 62%, 63%, 64%, 65%, 66%, 67%, 68%, 69%, 70%, 71%, 72%, 73%, 74%, 75%, 76%, 77%, 78%, 79%, 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 88%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% (or any derivable range therein) identical to the sequence of one of SEQ ID NOS:1-19. Further aspects of the disclosure relate to a peptide comprising at least 6 contiguous amino acids from an alternatively spliced polypeptide, wherein the at least 6 contiguous amino acids comprises an alternative splice site junction of the polypeptide or wherein the peptide comprises at least 6 contiguous amino acids from an alternatively spliced exon; and wherein the alternatively spliced peptide, exon, or junction is one that is derived from an alternative splice event (AS event) identified in Table 1a, 1b, 1c, or 1d. The disclosure also describes a molecular complex comprising a peptide of the disclosure and a major histocompatibility complex (MHC) molecule. Further aspects relate to compositions comprising the peptide, nucleic acids encoding the peptide, and vectors comprising nucleic acids encoding the peptide. Also disclosed are cells comprising the peptide and methods of making and using the peptide.

[0007] Further aspects relate to an in vitro isolated dendritic cell comprising a peptide, nucleic acid, or vector of the disclosure. Further aspects relate to a method of making a cell comprising transferring a nucleic acid or expression vector of the disclosure into a cell. In some aspects, the disclosure relates to an *in vitro* method for making a dendritic cell vaccine comprising contacting a mature dendritic cell *in vitro* with a peptide of the disclosure. Further aspects relate to an *in vitro* composition comprising a dendritic cell and a peptide of the disclosure. Further aspects relate to an engineered T-cell Receptor (TCR) or chimeric antigen receptor (CAR) that specifically recognizes a peptide of the disclosure. Also provided are cells comprising the TCR or CARs of the disclosure. Further aspects relate to an antibody or antigen binding fragment thereof that specifically recognizes a peptide or molecular complex of the disclosure. Further aspects relate to a method of treating or preventing cancer in a subject comprising administering a peptide, molecular complex, composition, dendritic cell, nucleic acid, expression vector, peptide-specific binding molecule, TCR, or an antibody or antigen binding fragment of the disclosure. Further aspects relate to a method of stimulating an immune response in a subject, the method comprising administering an effective amount of a peptide, molecular complex, composition, nucleic acid or expression vector, cell, peptide-specific binding molecule, antibody, antigen binding fragment, or TCR of the disclosure.

[0008] The disclosure also describes a peptide-specific binding molecule, wherein the molecule specifically binds to a peptide or molecular complex of the disclosure. In some

embodiments, the the binding molecule is an antibody, a T cell receptor (TCR), TCR mimc antibody, scFV, camellid, aptamer, or DARPIN.

[0009] Further method aspects of the disclosure relate to a method of producing cancer-specific immune effector cells comprising: (a) obtaining a starting population of immune effector cells; and (b) contacting the starting population of immune effector cells with a peptide or molecular complex of the disclosure, thereby generating peptide-specific immune effector cells. Also provided are immune effector cells produced according to methods of the disclosure.

[0010] Further aspects relate to a method for prognosing a patient or for detecting T cell responses in a patient, the method comprising: contacting a biological sample from the patient with the peptide or molecular complex of the disclosure. Also disclosed is a method comprising contacting a composition of the disclosure with a composition comprising T cells and detecting T cells with bound peptide and/or MHC polypeptide by detecting a detection tag.

[0011] The peptide may be a peptide of one of SEQ ID NOS:1-19. In some embodiments, the peptide comprises SEQ ID NO:1. In some embodiments, the peptide comprises SEQ ID NO:2. In some embodiments, the peptide comprises SEQ ID NO:3. In some embodiments, the peptide comprises SEQ ID NO:4. In some embodiments, the peptide comprises SEQ ID NO:5. In some embodiments, the peptide comprises SEQ ID NO:6. In some embodiments, the peptide comprises SEQ ID NO:7. In some embodiments, the peptide comprises SEQ ID NO:8. In some embodiments, the peptide comprises SEQ ID NO:9. In some embodiments, the peptide comprises SEQ ID NO:10. In some embodiments, the peptide comprises SEQ ID NO:11. In some embodiments, the peptide comprises SEQ ID NO:12. In some embodiments, the peptide comprises SEQ ID NO:13. In some embodiments, the peptide comprises SEQ ID NO:14. In some embodiments, the peptide comprises SEQ ID NO:15. In some embodiments, the peptide comprises SEQ ID NO:16. In some embodiments, the peptide comprises SEQ ID NO:17. In some embodiments, the peptide comprises SEQ ID NO:18. In some embodiments, the peptide comprises SEQ ID NO:19. The peptide may be at least 6 contiguous amino acids of one of SEQ ID NOS:1-19. In some embodiments, the peptide is, is at least, or is at most 5, 6, 7, 8, 9, 10, or 11 (or any derivable range therein) contiguous amino acids of one of SEQ ID NOS:1-19. In some embodiments, the peptide is 13 amino acids or fewer in length. In some embodiments, the peptide is, is more than, or is less than 15, 14, 13, 12, 11, 10, or 9 amino acids in length (or any derivable range therein). In some embodiments, the peptide consists of 9 amino acids. In some embodiments, the peptide consists of 6, 7, 8, 9, 10, 11, 12, 13, 14, or 15 amino acids. The peptide may be further defined as an immunogenic peptide. The term

"immunogenic" in reference to a peptide refers to a peptide that can induce an immune response in vivo. In some embodiments, the peptide is modified. The modification may be, for example, conjugation to a molecule. Molecules include antibodies, lipids, adjuvants, and/or detection moieties. The peptide may have 1, 2, 3, 4, 5, or 6 substitutions relative to a peptide of one of SEQ ID NOS:1-19.

[0012] In some embodiments, the AS event is selected from an AS event in Table 1a. In some embodiments, the AS event is selected from an AS event in Table 1b. In some embodiments, the AS event is selected from an AS event in Table 1c. In some embodiments, the AS event is selected from an AS event in Table 1d. In some embodiments, the disclosure relates to a CAR that targets a peptide of the disclosure, wherein the peptide comprises an AS event from table 1a. In some embodiments, the disclosure relates to a CAR that targets a peptide of the disclosure, wherein the peptide comprises an AS event from table 1b. In some embodiments, the disclosure relates to a CAR that targets a peptide of the disclosure, wherein the peptide comprises an AS event from table 1c. In some embodiments, the disclosure relates to a CAR that targets a peptide of the disclosure, wherein the peptide comprises an AS event from table 1d. In some embodiments, the disclosure relates to a TCR that targets a peptide of the disclosure, wherein the peptide comprises an AS event from table 1a. In some embodiments, the disclosure relates to a TCR that targets a peptide of the disclosure, wherein the peptide comprises an AS event from table 1b. In some embodiments, the disclosure relates to a TCR that targets a peptide of the disclosure, wherein the peptide comprises an AS event from table 1c. In some embodiments, the disclosure relates to a TCR that targets a peptide of the disclosure, wherein the peptide comprises an AS event from table 1d.

[0013] In some embodiments, the peptide comprises at least 10 amino acids. In some embodiments, the peptide consists of 10 amino acids. In some embodiments, the peptide is less than 20 amino acids in length. In some embodiments, the peptide comprises at least, at most, exactly, or about 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, or 50 amino acids (or any derivable range therein). In some embodiments, the peptide consists of 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, or 50 amino acids.

[0014] In some embodiments, the peptide is modified. Modifications include conjutation to a molecule, such as an antibody, lipid, adjuvant, or a detection moiety.

[0015] In some embodiments, the disclosure relates to a composition comprising a peptide of the disclosure, wherein the composition is formulated as a vaccine. In some embodiments,

the composition further comprises an adjuvant. The composition may be formulated for parenteral administration, intravenous injection, intramuscular injection, inhalation, or subcutaneous injection.

[0016] In some embodiments, the TCR comprises a modification or is chimeric. In some embodiments, the variable region of the TCR is fused to a TCR constant region that is different from the constant region of the cloned TCR that specifically binds to a peptide of the disclosure.

[0017] In some embodiments, the nucleic acid of the disclosure comprises a cDNA encoding the TCR. In some embodiments, the TCR alpha and beta genes are on the same nucleic acid and/or on the same vector.

[0018] In some embodiments, a cell of the disclosure comprises a stem cell, a progenitor cell, or a T cell. In some embodiments, the cell comprises a hematopoietic stem or progenitor cell, a T cell, or an induced pluripotent stem cell (iPSC). In some embodiments, the cell is isolated from a cancer patient. In some embodiments, is a HLA-A type. In some embodiments, the cell is a HLA-A*03:01 type. In some embodiments, the cell comprises at least one TCR and at least one CAR and wherein the TCR and CAR each recognize a different peptide. For example, embodiments of the disclosure relate to a cell that comprises a TCR that targets one peptide of the disclosure and a CAR that targets a different peptide of the disclosure. In some embodiments, the dendritic cell comprises a monocyte-derived dendritic cell.

[0019] In some embodiments, the composition of the disclosure has been determined to be serum-free, mycoplasma-free, endotoxin-free, and/or sterile.

[0020] In some embodiments, the method further comprises culturing the cell in media, incubating the cell at conditions that allow for the division of the cell, screening the cell, and/or freezing the cell. In some embodiments, the method further comprises isolating the expressed peptide or polypeptide from a cell of the disclosure.

[0021] In some embodiments, the cancer comprises prostate cancer. In some embodiments, the cancer comprises breast cancer. In some embodiments, the cancer comprises lung cancer. In some embodiments, the subject has previously been treated for the cancer. In some embodiments, the subject has been determined to be resistant to the previous treatment. In some embodiments, the method further comprises the administration of an additional therapy. In some embodiments, the additional therapy comprises an immunotherapy, chemotherapy, or an additional therapy described herein. In some embodiments, the cancer comprises stage I, II, III, or IV cancer. In some embodiments, the cancer comprises metastatic and/or recurrent cancer.

[0022] Treating in the methods of the disclosue may comprise one or more of reducing tumor size; increasing the overall survival rate; reducing the risk of recurrence of the cancer; reducing the risk of progression; and/or increasing the chance of progression-free survival, relapse-free survival, and/or recurrence-free survival.

[0023] Also described are compositions comprising at least one MHC polypeptide and the peptides described herein and above.

[0024] In some embodiments, the compositions of the disclosure are formulated as a vaccine. In some embodiments, the compositions and methods of the disclosure provide for prophylactic therapies to prevent cancer. In some embodiments, the compositions and methods of the disclosure provide for therapeutic therapies to treat existing cancers, such as for the treatment of patients with a cancerous tumor. In some embodiments, the composition further comprises an adjuvant. Adjuvants are known in the art and include, for example, TLR agonists and aluminum salts.

[0025] In some embodiments, the dendritic cell comprises a mature dendritic cell. In some embodiments, the cell is a cell with an HLA type selected from HLA-A, HLA-B, or HLA-C.

[0026] In some embodiments the methods of the disclosure further comprise screening the dendritic cell for one or more cellular properties. In some embodiments, the method further comprises contacting the cell with one or more cytokines or growth factors. In some embodiments, the one or more cytokines or growth factors comprises GM-CSF. In some embodiments, the cellular property comprises cell surface expression of one or more of CD86, HLA, and CD14. In some embodiments, the dendritic cell is derived from a CD34+ hematopoietic stem or progenitor cell.

[0027] In some embodiments, the dendritic cell is derived from a peripheral blood monocyte (PBMC). In some embodiments, the dendritic cells is isolated from PBMCs. In some embodiments, the dendritic cells are cells in which the DCs are derived from are isolated by leukaphereses.

[0028] In some embodiments, the composition further comprises one or more cytokines, growth factors, or adjuvants. In some embodiments, the composition comprises GM-CSF. In some embodiments, the peptide and GM-CSF are linked. In some embodiments, the composition is determined to be serum-free, mycoplasma-free, endotoxin-free, and sterile. In some embodiments, the peptide is on the surface of the dendritic cell. In some embodiments, the peptide is bound to a MHC molecule on the surface of the dendritic cell. In some embodiments, the composition is enriched for dendritic cells expressing CD86 on the surface of the cell. In some embodiments, the dendritic cell is derived from a CD34+ hematopoietic

stem or progenitor cell. In some embodiments, the dendritic cell is derived from a peripheral blood monocyte (PBMC). In some embodiments, the dendritic cells or cells in which the DCs are derived are isolated by leukaphereses.

[0029] In some embodiments of the disclosure, the cell comprises a stem cell, a progenitor cell, or a T cell. In some embodiments, the cell comprises a hematopoietic stem or progenitor cell, a T cell, or an induced pluripotent stem cell (iPSC).

[0030] In some embodiments, the method comprises administering a cell or a composition comprising a cell and wherein the cell comprises an autologous or allogenic cell. In some embodiments, the cell comprises a non-autologous cell. In some embodiments, contacting in the methods of the disclosure is further defined as co-culturing the starting population of immune effector cells with antigen presenting cells (APCs), artificial antigen presenting cells (aAPCs), or an artificial antigen presenting surface (aAPSs); wherein the APCs, aAPCs, or the aAPSs present the peptide on their surface. In some embodiments, the APCs are dendritic cells. The immune effector cells may be T cells, peripheral blood lymphocytes, NK cells, invariant NK cells, and/or NKT cells. In some embodiments, the immune effector cells have been differentiated from mesenchymal stem cell (MSC) or induced pluripotent stem (iPS) cells. The T cells may be CD8+ T cells, CD4+ T cells, or γδ T cells. The T cells may be cytotoxic T lymphocytes (CTLs). Obtaining in the method embodiments may comprise isolating the starting population of immune effector cells from peripheral blood mononuclear cells (PBMCs). In some embodiments, the starting population of immune effector cells is obtained from a subject. In some embodiments, the subject is a human. The subject may also be a non-human primate, a laboratory research animal, a rat, a mouse, a pig, a monkey, a guine pig, a rabbit, or a horse, for example. In some embodiments, the subject is a mammal. The subject may be one that has a cancer and/or has been diagnosed with a cancer. In some embodiments, the cancer comprises tumor cells that are positive for expression of the peptide. In some embodiments, the cancer comprises prostate cancer. In some embodiments, the cancer comprises a cancer that is positive for expression of the peptide. In some embodiments, the subject has been determined to have a cancer that is positive for expression of the peptide.In some embodiments, the method further comprises introducing the peptide or a nucleic acid encoding the peptide into the dendritic cells prior to the co-culturing. The peptide or nucleic acids encoding the peptide may be introduced by electroporation. In some embodiments, the peptide or nucleic acids encoding the peptide are introduced by adding the peptide or nucleic acid encoding the peptide to the dendritic cell culture media. The immune effector cells may be co-cultured with a second population of dendritic cells into which the peptide or the nucleic

acid encoding the peptide has been introduced. In some embodiments, a population of CD8 or CD4-positive and peptide MHC tetramer-positive T cells are purified from the immune effector cells following the co-culturing. In some embodiments, a clonal population of peptide-specific immune effector cells are generated by limiting or serial dilution followed by expansion of individual clones by a rapid expansion protocol. In some embodiments, the method further comprises cloning of a T cell receptor (TCR) from the clonal population of peptide-specific immune effector cells. Cloning of the TCR may comprise cloning of a TCR alpha and a beta chain. The TCR may be cloned using a 5'-Rapid amplification of cDNA ends (RACE) method. The cloned TCR may be is subcloned into an expression vector. The expression vector may be a retroviral or lentiviral vector. In some embodiments, a host cell is transduced with the expression vector to generate an engineered cell that expresses the TCR. The host cell may be an immune cell. In some embodiments, the immune cell is a T cell and the engineered cell is an engineered T cell. In some embodiments, the T cell is a CD8+ T cell, CD4+ T cell, or γδ T cell and the engineered cell is an engineered T cell. In some embodiments, the starting population of immune effector cells is obtained from a subject with cancer and the host cell is allogeneic or autologous to the subject.

[0031] The cancer may be one that is positive for expression of the peptide and/or the subject may be one that has been determined to have a biological sample that is positive for the peptide. In some embodiments, . a population of CD8 or CD4-positive and peptide MHC tetramer-positive engineered T cells are purified from the transduced host cells. In some embodiments, a clonal population of peptide-specific engineered T cells are generated by limiting or serial dilution followed by expansion of individual clones by a rapid expansion protocol.

[0032] In embodiments of the disclosure, the biological sample may comprise a blood sample, a fraction of a blood sample, a tissue sample, a biopsy, or a tumor sample. In some embodiments, he biological sample comprises lymphocytes. In some embodiments, the biological sample comprises a fractionated sample comprising lymphocytes. In some embodiments, the peptide is linked to a solid support. In some embodiments, the peptide is conjugated to the solid support or is bound to an antibody that is conjugated to the solid support. In some embodiments, the solid support comprises a microplate, a bead, a glass surface, a slide, or a cell culture dish. In some embodiments, detecting T cell responses comprises detecting the binding of the peptide to the T cell or TCR. In some embodiments, detecting T cell responses comprises an ELISA, ELISPOT, or a tetramer assay.

[0033] In some embodiments, the MHC polypeptide is and/or peptide is conjugated to a detection tag. In some embodiments, the MHC polypeptide and peptide are operatively linked to form a peptide-MHC complex. In some embodiments, the MHC polypeptide and peptide are operatively linked through a peptide bond. In some embodiments, the MHC polypeptide and peptide are operatively linked through van der Waals forces. In some embodiments, at least two peptide-MHC complexes are operatively linked to each other. In some embodiments, at least 3 or 4 peptide-MHC complexes are operatively linked to each other. In some embodiments, the average ratio of MHC polypeptides to peptides is 1:1 to 4:1.

[0034] Method embodiments of the disclosure may further comprise counting the number of T cells bound with peptide and/or MHC. The composition comprising T cells may be isolated from a patient having or suspected of having a cancer. The cancer may comprise a peptide-specific cancer. The cancer may be prostate, breast, or lung cancer. In some embodiments, the peptide is selected from a peptide of one of SEQ ID NOS:1-19. In some embodiments, the method further comprises sorting the number of T cells bound with peptide and/or MHC. In some embodiments, the method further comprises sequencing one or more TCR genes from T cells bound with peptide and/or MHC. In some embodiments, the method further comprises grouping of lymphocyte interactions by paratope hotspots (GLIPH) analysis.

[0035] The disclosure also describes kits comprising a peptide of the disclosure in a container. The peptide may be comprised in a pharmaceutical preparation. The pharmaceutical preparation may be formulated for parenteral administration or inhalation. The peptide may be comprised in a cell culture media.

[0036] Further embodiments are disclosed in US Patent Application Nos.: 62/934914 and 62/932751, which are incorporated by reference, and may be combined with the embodiments described herein.

[0037] Throughout this application, the term "about" is used according to its plain and ordinary meaning in the area of cell and molecular biology to indicate that a value includes the standard deviation of error for the device or method being employed to determine the value.

[0038] The use of the word "a" or "an" when used in conjunction with the term "comprising" may mean "one," but it is also consistent with the meaning of "one or more," "at least one," and "one or more than one."

[0039] As used herein, the terms "or" and "and/or" are utilized to describe multiple components in combination or exclusive of one another. For example, "x, y, and/or z" can refer to "x" alone, "y" alone, "z" alone, "x, y, and z," "(x and y) or z," "x or (y and z)," or "x or y or

z." It is specifically contemplated that x, y, or z may be specifically excluded from an embodiment.

[0040] The words "comprising" (and any form of comprising, such as "comprise" and "comprises"), "having" (and any form of having, such as "have" and "has"), "including" (and any form of including, such as "includes" and "include"), "characterized by" (and any form of including, such as "characterized as"), or "containing" (and any form of containing, such as "contains" and "contain") are inclusive or open-ended and do not exclude additional, unrecited elements or method steps.

[0041] The compositions and methods for their use can "comprise," "consist essentially of," or "consist of" any of the ingredients or steps disclosed throughout the specification. The phrase "consisting of" excludes any element, step, or ingredient not specified. The phrase "consisting essentially of" limits the scope of described subject matter to the specified materials or steps and those that do not materially affect its basic and novel characteristics. It is contemplated that embodiments described in the context of the term "comprising" may also be implemented in the context of the term "consisting of" or "consisting essentially of."

[0042] It is specifically contemplated that any limitation discussed with respect to one embodiment of the invention may apply to any other embodiment of the invention. Furthermore, any composition of the invention may be used in any method of the invention, and any method of the invention may be used to produce or to utilize any composition of the invention. Aspects of an embodiment set forth in the Examples are also embodiments that may be implemented in the context of embodiments discussed elsewhere in a different Example or elsewhere in the application, such as in the Summary of Invention, Detailed Description of the Embodiments, Claims, and description of Figure Legends.

[0043] Other objects, features and advantages of the present invention will become apparent from the following detailed description. It should be understood, however, that the detailed description and the specific examples, while indicating specific embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] The following drawings form part of the present specification and are included to further demonstrate certain aspects of the present invention. The invention may be better

understood by reference to one or more of these drawings in combination with the detailed description of specific embodiments presented herein.

[0045] **FIG. 1A-B**. A global, exon-level analysis of alternative pre-mRNA splicing in normal prostate and prostate cancers identifies patterns of exon usage in RNA-binding proteins. (A) Schematic with alluvial plot depicting the data processing workflow combining RNA-Seq data from various prostate tissue disease states (left panel) and summary table depicting various exon events detected by rMATS-turbo before and after filtering for splice junction reads coverage, PSI range and commonality (right panel). The alluvial plot depicts the sorting of patient RNA-Seq datasets from individual studies on the left into prostate phenotypes on the right. (B) Scatter plot depiction of an unsupervised principle component analysis of exon usage matrices from eight different prostate datasets representing healthy tissue, tumor-adjacent benign tissue, primary prostate cancer, metastatic castration-resistant prostate cancer (mCRPC), and treatment- associated neuroendocrine prostate cancer (NEPC).

[0046] **FIG. 2A-D**. Pathway Enrichment-Guided Activity Study of Alternative Splicing (PEGASAS) analysis identifies exon correlates of oncogenic signaling in prostate cancers. (A) Workflow diagram describing PEGASAS correlation of gene signature score with exon usage. Each sample is scored for a gene expression signature of interest. Gene signature scores are correlated with exon usage matrices to identify pathway-correlated exon incorporation changes. (B) Heatmap of the correlation coefficients of the exon changes correlated with gene signatures in the GSEA Hallmark sets as generated by PEGASAS. The ten signatures that returned the highest number of exon correlates are shown here. Each row depicts the results of the correlation to a single Hallmark signature. Each column represents a single exon. The color represents the strength and direction of the correlation (red positive, blue negative) of a single exon with each pathway. Columns are sorted by hierarchical clustering. Rows are ranked by total number of exon correlates passing statistical metrics for each pathway (# Events, bar chart). The gene ontology term with the highest enrichment for the genes containing pathway correlated exons and the corresponding p-value is also depicted. The p-values correspond to the gene ontology enrichment and are not a measure of significance of pathway-exon correlation. (C) Hive plot depiction of exons correlated with selected prostate cancer-related gene signatures and the biological processes associated with genes containing those exons. All pathway-correlated exons are displayed on the left axis. Seven well-known prostate cancer driver pathways are represented as nodes on the middle axis. The area of these nodes reflects the number of exons correlated with each pathway. The right axis depicts four summary gene ontology terms. The width of the edges connecting the nodes on the middle axis to the nodes

on the right axis is proportional to the enrichment of each pathway for each biological process. The size of the nodes on the right axis is proportional to the total number of exons associated with each biological process. (D) Area- proportional Venn diagram depicting the intersection of Myc-, E2F-, and MTOR-correlated exons in prostate cancer. Exons must share the same correlation direction (positive or negative) to appear in the intersection.

[0047] **FIG. 3A-F**. Exon incorporation events correlated with Myc activity are strongly enriched in RNA-binding proteins and are conserved in prostate and breast cancers. (A) Heatmap depiction of exon usage of 1,039 Myc-correlated exons across prostate cancer datasets in healthy tissue, primary, metastatic adenocarcinoma, and neuroendocrine prostate cancers. Columns represent samples ordered by disease phenotype and sorted by Myc Targets V2 signature score within each group. The Myc score annotation is colored from white (low) to black (high) based on the rank-transformed signature score of patient samples across the data sets. Rows represent exon inclusion events ordered by hierarchical clustering. (B) Scatterplots depicting examples of cassette exons in SRSF3 and HRAS transcripts whose incorporation is negatively correlated with Myc gene signature score. (C) Sashimi plots depicting average cassette exon incorporation levels of exons in SRSF3 and HRAS in prostate cancer datasets separated by cancer phenotype. Sashimi plots depict density of exon-including and exon-skipping reads as determined by rMATS-turbo analysis. (D) Workflow diagram for performing pathway-guided alternative splicing analysis on normal and cancerous breast and lung tissues. Each sample is scored for the Myc Targets V2 signature and correlated with the exon usage matrix to identify pathway- correlated exon incorporation changes. (E) Venn diagram indicating the intersection between Myc-correlated exon sets in prostate cancers with breast and lung adenocarcinomas. Exons must share the same correlation direction (positive or negative) to appear in the intersection. (F) REVIGO chart depicting the gene ontology of genes containing the 492 Myc-correlated exons from the triple intersection described above.

[0048] **FIG. 4A-E**. Enforced expression of activated AKT1 and doxycycline-regulated c-Myc initiates AR-negative prostate adenocarcinoma in human prostate cells. (A) Workflow diagram for derivation of Myc/myrAKT1 transformed human prostate cells from benign epithelium. (B) Depiction of lentiviral vectors used to enforce doxycycline-regulated expression of Myc and constitutive expression of myrAKT1. Histologic sections of transduced organoids. (C) Photomicrographs and fluorescent overlay of recovered grafts and tumor outgrowth after lentiviral transduction and subcutaneous implantation in NSG mice. “UT” = untreated, “C” = c- Myc transduction (GFP), “A” = myrAKT1 transduction (RFP), “CA” = dual transduction with c- Myc and myrAKT1 (GFP & RFP merge depicted as yellow). (D)

H&E stain of histologic sections of recovered grafts and tumor outgrowths. (E) Photomicrographs of cell lines ICA-1, ICA-2, and ICA-3 derived from tumor outgrowths growing as suspended rafts in tissue culture.

[0049] **FIG. 5A-D**. Myc loss in the engineered cell lines produces a senescent-like phenotype and strongly affects the expression of RNA binding proteins. (A) Western blot of lysates from ICA1 cells withdrawn from doxycycline in a time course examining Myc expression and changes in proteins related to cell cycle state. Each of the three cell lines was examined in this manner and the data shown are representative of all three. (B) Volcano plot of gene-level expression changes after Myc withdrawal. Genes downregulated upon Myc loss appear on the left-hand side of the plot. Gene expression changes with the Cuffdiff q-value < 0.05 appear red. (C) Selected top gene ontology terms from the gene ontology analysis of Myc-dependent gene expression changes displaying strong enrichment for RNA binding. CC: Cellular Component, MF: Molecular Function, BP: Biological Process. (D) Comparison of Myc Targets V2 signature score levels in engineered cell lines in the presence and absence of doxycycline.

[0050] **FIG. 6A-F**. Exon-level splicing analysis of c-Myc/myrAKT1 transformed human prostate cells identifies Myc-dependent exon incorporation events in splicing regulatory proteins. Summary table of exon incorporation changes occurring after Myc withdrawal. (B) Heatmap depicting changes in exon incorporation of 1,970 Myc-dependent cassette exons in three independent engineered cell lines. (C) Sashimi plots depicting the change in splice junction RNA-Seq reads in SRSF3 and HRAS exons in the engineered cell lines following Myc withdrawal. Sashimi plots depict density of exon-including and exon-skipping reads as determined by rMATS-turbo analysis. (D) REVIGO scatter plot depicting gene ontology terms enriched among genes containing exons whose incorporation is responsive to Myc withdrawal. Semantic distance is a measurement of relatedness between gene ontology terms calculated by REVIGO. Representative gene ontology terms have been selected to describe each cluster. Dashed line indicates adjusted p = 0.05. (E) Venn diagram depicting the overlap between Myc-dependent exons (purple) and Myc-correlated exons identified in patient tissues (green). Exons must change incorporation level with Myc in the same direction as the correlation (positive or negative) in order to appear in the intersection of the two sets. (F) Heatmap depicting the annotated outcome of exon changes in validated Myc-dependent exons. The annotation identifies exons likely to produce premature termination codons (orange) or frameshifts (green).

[0051] **FIG. 7A-B**. Comparison of count-based and ratio-based isoform-level analyses of prostate RNA-Seq datasets. (A) Unsupervised analysis of count-based isoform expression from a combined prostate cancer dataset (left panel). The same methodology applied to the ratio-based alternative splicing approach from Figure 1B in the main text is shown for comparison (right panel). (B) Silhouette width-based comparison of clustering fitness for each of the principle component analyses shown above. Mets, metastatic.

[0052] **FIG. 8**. Gene signature analysis identifies a common set of exons correlated with Myc, E2F, or mTOR pathways. Violin plot depiction of gene signature scores of AR, Myc Targets V2, and mTOR sets across prostate cancer datasets. Dashed lines indicate averages across datasets profiling a disease phenotype (normal prostate, benign prostate, primary prostate cancer, mCRPC, and NEPC).

[0053] **FIG. 9A-E**. Validation of Myc signature score and exon conservation across phylogeny and tumor type. (A) Box-and-whisker plot depiction of Myc signature scores in benign prostate tissues and primary prostate cancers stratified by Myc status. Samples with genomic amplifications of the Myc locus or single-gene overexpression are compared to samples without these alterations and adjacent benign tissues. (B) Kaplan-Meier disease-free survival plots of prostate cancers stratified by Myc signature score (first panel), Myc amplification status (second panel), or single-gene Myc expression (third panel). (C) Unsupervised two-way hierarchical clustering heatmap depiction of exon usage of 1,039 Myc-correlated exons across prostate cancer datasets in healthy tissue, and in primary, metastatic, and neuroendocrine prostate cancers. Columns depict patient samples. The Myc score annotation is colored from white (low) to black (high) based on the rank-transformed signature score of patient samples across the data sets. Rows represent exon inclusion events. Both are ordered by hierarchical clustering. (D) UCSC Genome Browser tracks depicting ultraconservation of Myc-regulated exons in SRSF3 (top panel) and HRAS (bottom panel) from humans to lamprey. (E) Heatmap of Myc-correlated exons in the prostate meta-dataset alongside tissues from normal breast and lung as well as breast and lung adenocarcinomas. Dashed line indicates separation between two cancer types. The Myc score annotation is colored from white (low) to black (high) based on the rank-transformed signature of patient samples across the datasets.

[0054] **FIG. 10A-D**. Establishment of engineered human tumor model with regulated Myc expression. (A) Representative scatterplot from florescence-activated cell sorting isolation of CD49f-high/Trop2-high basal cells from total dissociated benign human prostate. (B) Florescent photomicrograph of doubly transduced prostate organoids as well as single and

untransduced controls. "UT" = untreated, "C" = c-Myc transduction (GFP), "A" = myrAKT1 (RFP), "CA" = c-Myc and myrAKT1 (merge = yellow). (C) Photomicrograph of fixed organoids to show histology. Hematoxylin and eosin staining. (D) Immunohistochemical staining of transformed xenograft outgrowth compared to normal prostate tissue controls.

[0055] **FIG. 11A-C**. Characterization of the response to Myc withdrawal in vitro. (A) Immunoblot of Myc expression levels in engineered cell line ICA1 in response to doxycycline titration. Data are representative of all three cell lines. (B) Growth response of ICA1 cell line in response to doxycycline titration as measured in a luciferase-based assay. (C) Stacked column chart depicting the change in cell cycle distribution over time after doxycycline withdrawal as measured by flow cytometry.

[0056] **FIG. 12**. Individual exon incorporation changes in response to Myc withdrawal. Semi-quantitative immunoblot of SRSF3 protein levels in response to Myc withdrawal for 24 h. Quantitation is the average reduction in SRSF3 levels measured in each cell line over the three independent replicates shown.

DETAILED DESCRIPTION OF THE INVENTION

[0057] The inventors sought to define the landscape of alternative pre-mRNA splicing in prostate cancers and the relationship of exon choice to known cancer driver alterations. To do so, the inventors compiled a meta-dataset comprised of 876 RNA-Seq samples from five publicly available sources representing a range of prostate phenotypes from normal tissue to drug resistant metastases. The inventors subjected these samples to exon-level analysis with rMATS-turbo, purpose-built software designed for large-scale analyses of splicing, and identified 13,149 high-confidence cassette exon events with variable incorporation across samples. The inventors discovered that Myc signaling was correlated with incorporation of a set of 1,039 cassette exons enriched in genes encoding RNA binding proteins. Using a human prostate epithelial transformation assay, the inventors confirmed the Myc regulation of 147 of these exons, many of which introduced frameshifts or encoded premature stop codons. Our results connect changes in alternative pre-mRNA splicing to oncogenic alterations common in prostate and many other cancers. The inventors also establish a role for Myc in regulating RNA splicing by controlling the incorporation of nonsense mediated decay- determinant exons in genes encoding RNA binding proteins.

I. Applications of antigenic peptides

[0058] Various embodiments are directed to development of and use of antigenic peptides that have been identified from neoplastic tissue. In many embodiments, antigenic peptides are produced by chemical synthesis or by molecular expression in a host cell. Peptides can be purified and utilized in a variety of applications including (but not limited to) assays to determine peptide immunogenicity, assays to determine recognition by T cells, peptide vaccines for treatment of cancer, development of modified TCRs of T cells, development of antibodies, and development of CAR-T cells to recognize extracellular peptides.

[0059] Peptides can be synthesized chemically by a number of methods. One common method is to use solid-phase peptide synthesis (SPPS). Generally, SPPS is performed by repeating cycles of alternate N-terminal deprotection and coupling reactions, building peptides from the c-terminus to the n-terminus. The c-terminus of the first amino acid is coupled the resin, wherein then the amine is deprecated and then coupled with the free acid of the second amino acid. This cycle repeats until the peptide is synthesized.

[0060] Peptides can also be synthesized utilizing molecular tools and a host cell. Nucleic acid sequences corresponding with antigenic peptides can be synthesized. In some embodiments, synthetic nucleic acids synthesized in *in vitro* synthesizers (e.g., phosphoramidite synthesizer), bacterial recombination system, or other suitable methods. Furthermore, synthesized nucleic acids can be purified and lyophilized, or kept stored in a biological system (e.g., bacteria, yeast). For use in a biological system, synthetic nucleic acid molecules can be inserted into a plasmid vector, or similar. A plasmid vector can also be an expression vector, wherein a suitable promoter and a suitable 3'-polyA tail is combined with the transcript sequence.

[0061] Embodiments are also directed to expression vectors and expression systems that produce antigenic peptides or proteins. These expression systems can incorporate an expression vector to express transcripts and proteins in a suitable expression system. Typical expression systems include bacterial (e.g., *E. coli*), insect (e.g., SF9), yeast (e.g., *S. cerevisiae*), animal (e.g., CHO), or human (e.g., HEK 293) cell lines. RNA and/or protein molecules can be purified from these systems using standard biotechnology production procedures.

[0062] Assays to determine immunogenicity and/or TCR binding can be performed. One such as is the dextramer flow cytometery assay. Generally, custom-made HLA-matched MHC Class I dextramer:peptide (pMHC) complexes are developed or purchased (Immudex, Copenhagen, Denmark). T cells from peripheral blood mononuclear cells (PBMCs) or tumor-infiltrating lymphocytes (TILs) are incubated the pMHC complexes and stained, which are then

run through a flow cytometer to determine if the peptide is capable of binding a TCR of a T cell.

[0063] Pepetide embodiments include those in the following table:

Sequence	SEQ ID NO:
SLAIGGVTEA	1
LLLGIAKLLKV	2
HLMEENMIVYV	3
LLAEQPDQV	4
LVLISIVICV	5
LLAEQPDQV	6
ALVANLPLL	7
FTVTVTEPPV	8
ALAGKPLSL	9
FILTYWTPS	10
STMYYLWML	11
VSTMYYLWML	12
FLSELEPPAP	13
TLVLALVANL	14
STMYYLWML	15
FLSELEPPA	16
FLAIVFFASIV	17
STMYYLWML	18
KVWTETLIEA	19

[0064] A peptide as described herein (e.g., a peptide of SEQ ID NOS:1-19) may be used for immunotherapy of a cancer. For example, a peptide of the disclosure may be contacted with or used to stimulate a population of T cells to induce proliferation of the T cells that recognize or bind said peptide. In other embodiments, a peptide of the disclosure may be administered to a subject, such as a human patient, to enhance the immune response of the subject against a cancer.

[0065] A peptide of the disclosure may be included in an active immunotherapy (e.g., a cancer vaccine) or a passive immunotherapy (e.g., an adoptive immunotherapy). Active immunotherapies include immunizing a subject with a purified peptide antigen or an immunodominant peptide (native or modified); alternatively, antigen presenting cells pulsed with a peptide of the disclosure (or transfected with genes encoding an antigen comprising the peptide) may be administered to a subject. The peptide may be modified or contain one or more mutations such as, e.g., a substitution mutation. Passive immunotherapies include adoptive immunotherapies. Adoptive immunotherapies generally involve administering cells

to a subject, wherein the cells (e.g., cytotoxic T cells) have been sensitized in vitro to a peptide of the disclosure (see, e.g., US 7910109).

[0066] In some embodiments, flow cytometry may be used in the adoptive immunotherapy for rapid isolation of human tumor antigen-specific T-cell clones by using, e.g., T-cell receptor (TCR) Vβ antibodies in combination with carboxyfluorescein succinimidyl ester (CFSE)-based proliferation assay. See, e.g., Lee et al., J. Immunol. Methods, 331:13-26, 2008, which is incorporated by reference for all purposes. In some embodiments, tetramer-guided cell sorting may be used such as, e.g., the methods described in Pollack, et al., J Immunother Cancer. 2014; 2: 36, which is herein incorporated by reference for all purposes. Various culture protocols are also known for adoptive immunotherapy and may be used in embodiments of the disclosure. In some embodiments, cells may be cultured in conditions which do not require the use of antigen presenting cells (e.g., Hida et al., Cancer Immunol. Immunotherapy, 51:219-228, 2002, which is incorporated by reference). In other embodiments, T cells may be expanded under culture conditions that utilize antigen presenting cells, such as dendritic cells (Nestle et al., 1998, incorporated by reference), and in some embodiments artificial antigen presenting cells may be used for this purpose (Maus et al., 2002 incorporated by reference). Additional methods for adoptive immunotherapy are disclosed in Dudley et al. (2003), which is incorporated by reference, that may be used with embodiments of the current disclosure. Various methods are known and may be used for cloning and expanding human antigen-specific T cells (see, e.g., Riddell et al., 1990, which is herein incorporated by reference).

[0067] In certain embodiments, the following protocol may be used to generate T cells that selectively recognize peptides of the disclosure. Peptide-specific T-cell lines may be generated from normal donors or HLA-restricted normal donors and patients using methods previously reported (Hida et al., 2002). Briefly, PBMCs (1 × 105 cells/well) can be stimulated with about 10 μg/ml of each peptide in quadruplicate in a 96-well, U-bottom-microculture plate (Corning Incorporated, Lowell, MA) in about 200 μl of culture medium. The culture medium may consist of 50% AIM-V medium (Invitrogen), 50% RPMI1640 medium (Invitrogen), 10% human AB serum (Valley Biomedical, Winchester, VA), and 100 IU/ml of interleukin-2 (IL-2). Cells may be restimulated with the corresponding peptide about every 3 days. After 5 stimulations, T cells from each well may be washed and incubated with T2 cells in the presence or absence of the corresponding peptide. After about 18 hours, the production of interferon (IFN)-γ may be determined in the supernatants by ELISA. T cells that secret large amounts of IFN-γ may be further expanded by a rapid expansion protocol (Riddell et al., 1990; Yee et al., 2002b).

[0068] In some embodiments, an immunotherapy may utilize a peptide of the disclosure that is associated with a cell penetrator, such as a liposome or a cell penetrating peptide (CPP). Antigen presenting cells (such as dendritic cells) pulsed with peptides may be used to enhance antitumour immunity (Celluzzi et al., 1996; Young et al., 1996). Liposomes and CPPs are described in further detail below. In some embodiments, an immunotherapy may utilize a nucleic acid encoding a peptide of the disclosure, wherein the nucleic acid is delivered, e.g., in a viral vector or non-viral vector.

[0069] In some embodiments, a peptide of the disclosure may be used in an immunotherapy to treat cancer in a mammalian subject, such as a human patient.

III. Engineered T Cell Receptors

[0070] T-cell receptors comprise two different polypeptide chains, termed the T-cell receptor α (TCRα) and β (TCRβ) chains, linked by a disulfide bond. These α:β heterodimers are very similar in structure to the Fab fragment of an immunoglobulin molecule, and they account for antigen recognition by most T cells. A minority of T cells bear an alternative, but structurally similar, receptor made up of a different pair of polypeptide chains designated γ and δ. Both types of T-cell receptor differ from the membrane-bound immunoglobulin that serves as the B-cell receptor: a T-cell receptor has only one antigen-binding site, whereas a B-cell receptor has two, and T-cell receptors are never secreted, whereas immunoglobulin can be secreted as antibody.

[0071] Both chains of the T-cell receptor have an amino-terminal variable (V) region with homology to an immunoglobulin V domain, a constant (C) region with homology to an immunoglobulin C domain, and a short hinge region containing a cysteine residue that forms the interchain disulfide bond. Each chain spans the lipid bilayer by a hydrophobic transmembrane domain, and ends in a short cytoplasmic tail.

[0072] The three-dimensional structure of the T-cell receptor has been determined. The structure is indeed similar to that of an antibody Fab fragment, as was suspected from earlier studies on the genes that encoded it. The T-cell receptor chains fold in much the same way as those of a Fab fragment, although the final structure appears a little shorter and wider. There are, however, some distinct differences between T-cell receptors and Fab fragments. The most striking difference is in the Cα domain, where the fold is unlike that of any other immunoglobulin-like domain. The half of the domain that is juxtaposed with the Cβ domain forms a β sheet similar to that found in other immunoglobulin-like domains, but the other half of the domain is formed of loosely packed strands and a short segment of α helix. The

intramolecular disulfide bond, which in immunoglobulin-like domains normally joins two β strands, in a Cα domain joins a β strand to this segment of α helix.

[0073] There are also differences in the way in which the domains interact. The interface between the V and C domains of both T-cell receptor chains is more extensive than in antibodies, which may make the hinge joint between the domains less flexible. And the interaction between the Cα and Cβ domains is distinctive in being assisted by carbohydrate, with a sugar group from the Cα domain making a number of hydrogen bonds to the Cβ domain. Finally, a comparison of the variable binding sites shows that, although the complementarity-determining region (CDR) loops align fairly closely with those of antibody molecules, there is some displacement relative to those of the antibody molecule. This displacement is particularly marked in the Vα CDR2 loop, which is oriented at roughly right angles to the equivalent loop in antibody V domains, as a result of a shift in the β strand that anchors one end of the loop from one face of the domain to the other. A strand displacement also causes a change in the orientation of the Vβ CDR2 loop in two of the seven Vβ domains whose structures are known. As yet, the crystallographic structures of seven T-cell receptors have been solved to this level of resolution.

[0074] Embodiments of the disclosure relate to engineered T cell receptors. The term "engineered" refers to T cell receptors that have TCR variable regions grafted onto TCR constant regions to make a chimeric polypeptide that binds to peptides and antigens of the disclosure. In certain embodiments, the TCR comprises intervening sequences that are used for cloning, enhanced expression, detection, or for therapeutic control of the construct, but are not present in endogenous TCRs, such as multiple cloning sites, linker, hinge sequences, modified hinge sequences, modified transmembrane sequences, a detection polypeptide or molecule, or therapeutic controls that may allow for selection or screening of cells comprising the TCR.

[0075] In some embodiments, the TCR comprises non-TCR sequences. Accordingly, certain embodiments relate to TCRs with sequences that are not from a TCR gene. In some embodiments, the TCR is chimeric, in that it contains sequences normally found in a TCR gene, but contains sequences from at least two TCR genes that are not necessarily found together in nature.

IV. Antibodies

[0076] Aspects of the disclosure relate to antibodies that target the peptides of the disclosure, or fragments thereof. The term "antibody" refers to an intact immunoglobulin of any isotype, or a fragment thereof that can compete with the intact antibody for specific binding

to the target antigen, and includes chimeric, humanized, fully human, and bispecific antibodies. As used herein, the terms "antibody" or "immunoglobulin" are used interchangeably and refer to any of several classes of structurally related proteins that function as part of the immune response of an animal, including IgG, IgD, IgE, IgA, IgM, and related proteins, as well as polypeptides comprising antibody CDR domains that retain antigen-binding activity.

[0077] The term "antigen" refers to a molecule or a portion of a molecule capable of being bound by a selective binding agent, such as an antibody. An antigen may possess one or more epitopes that are capable of interacting with different antibodies.

[0078] The term "epitope" includes any region or portion of molecule capable eliciting an immune response by binding to an immunoglobulin or to a T-cell receptor. Epitope determinants may include chemically active surface groups such as amino acids, sugar side chains, phosphoryl or sulfonyl groups, and may have specific three-dimensional structural characteristics and/or specific charge characteristics. Generally, antibodies specific for a particular target antigen will preferentially recognize an epitope on the target antigen within a complex mixture.

[0079] The epitope regions of a given polypeptide can be identified using many different epitope mapping techniques are well known in the art, including: x-ray crystallography, nuclear magnetic resonance spectroscopy, site-directed mutagenesis mapping, protein display arrays, see, e.g., Epitope Mapping Protocols, (Johan Rockberg and Johan Nilvebrant, Ed., 2018) Humana Press, New York, N.Y, incorporated herein by reference in its entirety. Such techniques are known in the art and described in, e.g., U.S. Pat. No. 4,708,871; Geysen et al. Proc. Natl. Acad. Sci. USA 81:3998-4002 (1984); Geysen et al. Proc. Natl. Acad. Sci. USA 82:178-182 (1985); Geysen et al. Molec. Immunol. 23:709-715 (1986), each of which are specifically incorporated herein by reference in their entirety. Additionally, antigenic regions of proteins can also be predicted and identified using standard antigenicity and hydropathy plots.

[0080] The term "immunogenic sequence" means a molecule that includes an amino acid sequence of at least one epitope such that the molecule is capable of stimulating the production of antibodies in an appropriate host. The term "immunogenic composition" means a composition that comprises at least one immunogenic molecule (e.g., an antigen or carbohydrate).

[0081] An intact antibody is generally composed of two full-length heavy chains and two full-length light chains, but in some instances may include fewer chains, such as antibodies naturally occurring in camelids that may comprise only heavy chains. Antibodies as disclosed

herein may be derived solely from a single source or may be "chimeric," that is, different portions of the antibody may be derived from two different antibodies. For example, the variable or CDR regions may be derived from a rat or murine source, while the constant region is derived from a different animal source, such as a human. The antibodies or binding fragments may be produced in hybridomas, by recombinant DNA techniques, or by enzymatic or chemical cleavage of intact antibodies. Unless otherwise indicated, the term "antibody" includes derivatives, variants, fragments, and muteins thereof, examples of which are described below (Sela-Culang et al., Front Immunol. 2013; 4: 302; 2013), incorporated herein by reference in its entirety.

[0082] The term "light chain" includes a full-length light chain and fragments thereof having sufficient variable region sequence to confer binding specificity. A full-length light chain has a molecular weight of around 25,000 Daltons and includes a variable region domain (abbreviated herein as VL), and a constant region domain (abbreviated herein as CL). There are two classifications of light chains, identified as kappa (κ) and lambda (λ). The term "VL fragment" means a fragment of the light chain of a monoclonal antibody that includes all or part of the light chain variable region, including CDRs. A VL fragment can further include light chain constant region sequences. The variable region domain of the light chain is at the amino-terminus of the polypeptide.

[0083] The term "heavy chain" includes a full-length heavy chain and fragments thereof having sufficient variable region sequence to confer binding specificity. A full-length heavy chain has a molecular weight of around 50,000 Daltons and includes a variable region domain (abbreviated herein as VH), and three constant region domains (abbreviated herein as CH1, CH2, and CH3). The term "VH fragment" means a fragment of the heavy chain of a monoclonal antibody that includes all or part of the heavy chain variable region, including CDRs. A VH fragment can further include heavy chain constant region sequences. The number of heavy chain constant region domains will depend on the isotype. The VH domain is at the amino-terminus of the polypeptide, and the CH domains are at the carboxy-terminus, with the CH3 being closest to the —COOH end. The isotype of an antibody can be IgM, IgD, IgG, IgA, or IgE and is defined by the heavy chains present of which there are five classifications: mu (μ), delta (δ), gamma (γ), alpha (α), or epsilon (ε) chains, respectively. IgG has several subtypes, including, but not limited to, IgG1, IgG2, IgG3, and IgG4. IgM subtypes include IgM1 and IgM2. IgA subtypes include IgA1 and IgA2.

A. Types of Antibodies

[0084] Antibodies can be whole immunoglobulins of any isotype or classification, chimeric antibodies, or hybrid antibodies with specificity to two or more antigens. They may also be fragments (e.g., F(ab')2, Fab', Fab, Fv, and the like), including hybrid fragments. An immunoglobulin also includes natural, synthetic, or genetically engineered proteins that act like an antibody by binding to specific antigens to form a complex. The term antibody includes genetically engineered or otherwise modified forms of immunoglobulins.

[0085] The term "monomer" means an antibody containing only one Ig unit. Monomers are the basic functional units of antibodies. The term "dimer" means an antibody containing two Ig units attached to one another via constant domains of the antibody heavy chains (the Fc, or fragment crystallizable, region). The complex may be stabilized by a joining (J) chain protein. The term "multimer" means an antibody containing more than two Ig units attached to one another via constant domains of the antibody heavy chains (the Fc region). The complex may be stabilized by a joining (J) chain protein.

[0086] The term "bivalent antibody" means an antibody that comprises two antigen-binding sites. The two binding sites may have the same antigen specificities or they may be bi-specific, meaning the two antigen-binding sites have different antigen specificities.

[0087] Bispecific antibodies are a class of antibodies that have two paratopes with different binding sites for two or more distinct epitopes. In some embodiments, bispecific antibodies can be biparatopic, wherein a bispecific antibody may specifically recognize a different epitope from the same antigen. In some embodiments, bispecific antibodies can be constructed from a pair of different single domain antibodies termed "nanobodies". Single domain antibodies are sourced and modified from cartilaginous fish and camelids. Nanobodies can be joined together by a linker using techniques typical to a person skilled in the art; such methods for selection and joining of nanobodies are described in PCT Publication No. WO2015044386A1, No. WO2010037838A2, and Bever et al., Anal Chem. 86:7875–7882 (2014), each of which are specifically incorporated herein by reference in their entirety.

[0088] Bispecific antibodies can be constructed as: a whole IgG, Fab'2, Fab'PEG, a diabody, or alternatively as scFv. Diabodies and scFvs can be constructed without an Fc region, using only variable domains, potentially reducing the effects of anti-idiotypic reaction. Bispecific antibodies may be produced by a variety of methods including, but not limited to, fusion of hybridomas or linking of Fab' fragments. See, e.g., Songsivilai and Lachmann, Clin. Exp. Immunol. 79:315-321 (1990); Kostelny et al., J. Immunol. 148:1547-1553 (1992), each of which are specifically incorporated by reference in their entirety.

[0089] In certain aspects, the antigen-binding domain may be multispecific or heterospecific by multimerizing with VH and VL region pairs that bind a different antigen. For example, the antibody may bind to, or interact with, (a) a cell surface antigen, (b) an Fc receptor on the surface of an effector cell, or (c) at least one other component. Accordingly, aspects may include, but are not limited to, bispecific, trispecific, tetraspecific, and other multispecific antibodies or antigen-binding fragments thereof that are directed to epitopes and to other targets, such as Fc receptors on effector cells.

[0090] In some embodiments, multispecific antibodies can be used and directly linked via a short flexible polypeptide chain, using routine methods known in the art. One such example is diabodies that are bivalent, bispecific antibodies in which the VH and VL domains are expressed on a single polypeptide chain, and utilize a linker that is too short to allow for pairing between domains on the same chain, thereby forcing the domains to pair with complementary domains of another chain creating two antigen binding sites. The linker functionality is applicable for embodiments of triabodies, tetrabodies, and higher order antibody multimers. (see, e.g., Hollinger et al., Proc Natl. Acad. Sci. USA 90:6444-6448 (1993); Polijak et al., Structure 2:1121-1123 (1994); Todorovska et al., J. Immunol. Methods 248:47-66 (2001)), each of which are specifically incorporated herein by reference in their entirety.

[0091] Bispecific diabodies, as opposed to bispecific whole antibodies, may also be advantageous because they can be readily constructed and expressed in E. coli. Diabodies (and other polypeptides such as antibody fragments) of appropriate binding specificities can be readily selected using phage display (WO94/13804, which is incorporated herein by reference in its entirety) from libraries. If one arm of the diabody is kept constant, for instance, with a specificity directed against a protein, then a library can be made where the other arm is varied and an antibody of appropriate specificity selected. Bispecific whole antibodies may be made by alternative engineering methods as described in Ridgeway et al., (Protein Eng., 9:616-621, 1996) and Krah et al., (N Biotechnol. 39:167-173, 2017), each of which is hereby incorporated by reference in their entirety.

[0092] Heteroconjugate antibodies are composed of two covalently linked monoclonal antibodies with different specificities. See, e.g., U.S. Patent No. 6,010,902, incorporated herein by reference in its entirety.

[0093] The part of the Fv fragment of an antibody molecule that binds with high specificity to the epitope of the antigen is referred to herein as the "paratope." The paratope consists of the amino acid residues that make contact with the epitope of an antigen to facilitate antigen recognition. Each of the two Fv fragments of an antibody is composed of the two variable

domains, VH and VL, in dimerized configuration. The primary structure of each of the variable domains includes three hypervariable loops separated by, and flanked by, Framework Regions (FR). The hypervariable loops are the regions of highest primary sequences variability among the antibody molecules from any mammal. The term hypervariable loop is sometimes used interchangeably with the term "Complementarity Determining Region (CDR)." The length of the hypervariable loops (or CDRs) varies between antibody molecules. The framework regions of all antibody molecules from a given mammal have high primary sequence similarity/consensus. The consensus of framework regions can be used by one skilled in the art to identify both the framework regions and the hypervariable loops (or CDRs) which are interspersed among the framework regions. The hypervariable loops are given identifying names which distinguish their position within the polypeptide, and on which domain they occur. CDRs in the VL domain are identified as L1, L2, and L3, with L1 occurring at the most distal end and L3 occurring closest to the CL domain. The CDRs may also be given the names CDR-1, CDR-2, and CDR-3. The L3 (CDR-3) is generally the region of highest variability among all antibody molecules produced by a given organism. The CDRs are regions of the polypeptide chain arranged linearly in the primary structure, and separated from each other by Framework Regions. The amino terminal (N-terminal) end of the VL chain is named FR1. The region identified as FR2 occurs between L1 and L2 hypervariable loops. FR3 occurs between L2 and L3 hypervariable loops, and the FR4 region is closest to the CL domain. This structure and nomenclature is repeated for the VH chain, which includes three CDRs identified as H1, H2 and H3. The majority of amino acid residues in the variable domains, or Fv fragments (VH and VL), are part of the framework regions (approximately 85%). The three dimensional, or tertiary, structure of an antibody molecule is such that the framework regions are more internal to the molecule and provide the majority of the structure, with the CDRs on the external surface of the molecule.

[0094] Several methods have been developed and can be used by one skilled in the art to identify the exact amino acids that constitute each of these regions. This can be done using any of a number of multiple sequence alignment methods and algorithms, which identify the conserved amino acid residues that make up the framework regions, therefore identifying the CDRs that may vary in length but are located between framework regions. Three commonly used methods have been developed for identification of the CDRs of antibodies: Kabat (as described in T. T. Wu and E. A. Kabat, "AN ANALYSIS OF THE SEQUENCES OF THE VARIABLE REGIONS OF BENCE JONES PROTEINS AND MYELOMA LIGHT CHAINS AND THEIR IMPLICATIONS FOR ANTIBODY COMPLEMENTARITY," J Exp Med, vol.

132, no. 2, pp. 211–250, Aug. 1970, which is incorporated herein by reference in its entirety); Chothia (as described in C. Chothia et al., "Conformations of immunoglobulin hypervariable regions," Nature, vol. 342, no. 6252, pp. 877–883, Dec. 1989, which is incorporated herein by reference in its entirety); and IMGT (as described in M.-P. Lefranc et al., "IMGT unique numbering for immunoglobulin and T cell receptor variable domains and Ig superfamily V-like domains," Developmental & Comparative Immunology, vol. 27, no. 1, pp. 55–77, Jan. 2003, which is incorporated herein by reference in its entirety). These methods each include unique numbering systems for the identification of the amino acid residues that constitute the variable regions. In most antibody molecules, the amino acid residues that actually contact the epitope of the antigen occur in the CDRs, although in some cases, residues within the framework regions contribute to antigen binding.

[0095] One skilled in the art can use any of several methods to determine the paratope of an antibody. These methods include: 1) Computational predictions of the tertiary structure of the antibody/epitope binding interactions based on the chemical nature of the amino acid sequence of the antibody variable region and composition of the epitope. 2) Hydrogen-deuterium exchange and mass spectroscopy 3) Polypeptide fragmentation and peptide mapping approaches in which one generates multiple overlapping peptide fragments from the full length of the polypeptide and evaluates the binding affinity of these peptides for the epitope. 4) Antibody Phage Display Library analysis in which the antibody Fab fragment encoding genes of the mammal are expressed by bacteriophage in such a way as to be incorporated into the coat of the phage. This population of Fab expressing phage are then allowed to interact with the antigen which has been immobilized or may be expressed in by a different exogenous expression system. Non-binding Fab fragments are washed away, thereby leaving only the specific binding Fab fragments attached to the antigen. The binding Fab fragments can be readily isolated and the genes which encode them determined. This approach can also be used for smaller regions of the Fab fragment including Fv fragments or specific VH and VL domains as appropriate.

[0096] In certain aspects, affinity matured antibodies are enhanced with one or more modifications in one or more CDRs thereof that result in an improvement in the affinity of the antibody for a target antigen as compared to a parent antibody that does not possess those alteration(s). Certain affinity matured antibodies will have nanomolar or picomolar affinities for the target antigen. Affinity matured antibodies are produced by procedures known in the art, e.g., Marks et al., Bio/Technology 10:779 (1992), which is incorporated herein by reference in its entirety, describes affinity maturation by VH and VL domain shuffling, random

mutagenesis of CDR and/or framework residues employed in phage display is described by Rajpal et al., PNAS. 24: 8466-8471 (2005) and Thie et al., Methods Mol Biol. 525:309-22 (2009) in conjugation with computation methods as demonstrated in Tiller et al., Front. Immunol. 8:986 (2017), each of which are specifically incorporated herein by reference in their entirety.

[0097] Chimeric immunoglobulins are the products of fused genes derived from different species; "humanized" chimeras generally have the framework region (FR) from human immunoglobulins and one or more CDRs are from a non-human source.

[0098] In certain aspects, portions of the heavy and/or light chain are identical or homologous to corresponding sequences from another particular species or belonging to a particular antibody class or subclass, while the remainder of the chain(s) is identical or homologous to corresponding sequences in antibodies derived from another species or belonging to another antibody class or subclass, as well as fragments of such antibodies, so long as they exhibit the desired biological activity. U.S. Pat. No. 4,816,567; and Morrison et al., Proc. Natl. Acad. Sci. USA 81:6851 (1984). For methods relating to chimeric antibodies, see, e.g., U.S. Pat. No. 4,816,567; and Morrison et al., Proc. Natl. Acad. Sci. USA 81:6851-6855 (1985), each of which are specifically incorporated herein by reference in their entirety. CDR grafting is described, for example, in U.S. Pat. Nos. 6,180,370, 5,693,762, 5,693,761, 5,585,089, and 5,530,101, which are all hereby incorporated by reference for all purposes.

[0099] In some embodiments, minimizing the antibody polypeptide sequence from the non-human species optimizes chimeric antibody function and reduces immunogenicity. Specific amino acid residues from non-antigen recognizing regions of the non-human antibody are modified to be homologous to corresponding residues in a human antibody or isotype. One example is the "CDR-grafted" antibody, in which an antibody comprises one or more CDRs from a particular species or belonging to a specific antibody class or subclass, while the remainder of the antibody chain(s) is identical or homologous to a corresponding sequence in antibodies derived from another species or belonging to another antibody class or subclass. For use in humans, the V region composed of CDR1, CDR2, and partial CDR3 for both the light and heavy chain variance region from a non-human immunoglobulin, are grafted with a human antibody framework region, replacing the naturally occurring antigen receptors of the human antibody with the non-human CDRs. In some instances, corresponding non-human residues replace framework region residues of the human immunoglobulin. Furthermore, humanized antibodies may comprise residues that are not found in the recipient antibody or in the donor antibody to further refine performance. The humanized antibody may also comprise at least a

portion of an immunoglobulin constant region (Fc), typically that of a human immunoglobulin. See, e.g., Jones et al., Nature 321:522 (1986); Riechmann et al., Nature 332:323 (1988); Presta, Curr. Op. Struct. Biol. 2:593 (1992); Vaswani and Hamilton, Ann. Allergy, Asthma and Immunol. 1:105 (1998); Harris, Biochem. Soc. Transactions 23; 1035 (1995); Hurle and Gross, Curr. Op. Biotech. 5:428 (1994); Verhoeyen et al., Science 239:1534-36 (1988), each of which are specifically incorporated herein by reference in their entirety.

[0100] Intrabodies are intracellularly localized immunoglobulins that bind to intracellular antigens as opposed to secreted antibodies, which bind antigens in the extracellular space.

[0101] Polyclonal antibody preparations typically include different antibodies against different determinants (epitopes). In order to produce polyclonal antibodies, a host, such as a rabbit or goat, is immunized with the antigen or antigen fragment, generally with an adjuvant and, if necessary, coupled to a carrier. Antibodies to the antigen are subsequently collected from the sera of the host. The polyclonal antibody can be affinity purified against the antigen rendering it monospecific.

[0102] Monoclonal antibodies or "mAb" refer to an antibody obtained from a population of homogeneous antibodies from an exclusive parental cell, e.g., the population is identical except for naturally occurring mutations that may be present in minor amounts. Each monoclonal antibody is directed against a single antigenic determinant.

B. Functional Antibody Fragments and Antigen-Binding Fragments

1. Antigen-Binding Fragments

[0103] Certain aspects relate to antibody fragments, such as antibody fragments that bind to a peptide of the disclosure. The term functional antibody fragment includes antigen-binding fragments of an antibody that retain the ability to specifically bind to an antigen. These fragments are constituted of various arrangements of the variable region heavy chain (VH) and/or light chain (VL); and in some embodiments, include constant region heavy chain 1 (CHl) and light chain (CL). In some embodiments, they lack the Fc region constituted of heavy chain 2 (CH2) and 3 (CH3) domains. Embodiments of antigen binding fragments and the modifications thereof may include: (i) the Fab fragment type constituted with the VL, VH, CL, and CHl domains; (ii) the Fd fragment type constituted with the VH and CHl domains; (iii) the Fv fragment type constituted with the VH and VL domains; (iv) the single domain fragment type, dAb, (Ward, 1989; McCafferty et al., 1990; Holt et al., 2003, each incorporated by reference in its entirety) constituted with a single VH or VL domain; (v) isolated

complementarity determining region (CDR) regions. Such terms are described, for example, in Harlow and Lane, Antibodies: A Laboratory Manual, Cold Spring Harbor Laboratory, NY (1989); Molec. Biology and Biotechnology: A Comprehensive Desk Reference (Myers, R. A. (ed.), New York: VCH Publisher, Inc.); Huston et al., Cell Biophysics, 22:189-224 (1993); Pluckthun and Skerra, Meth. Enzymol., 178:497-515 (1989) and in Day, E. D., Advanced Immunochemistry, 2d ed., Wiley-Liss, Inc. New York, N.Y. (1990); Antibodies, 4:259-277 (2015), each of which are incorporated by reference.

[0104] Antigen-binding fragments also include fragments of an antibody that retain exactly, at least, or at most 1, 2, or 3 complementarity determining regions (CDRs) from a light chain variable region. Fusions of CDR-containing sequences to an Fc region (or a CH2 or CH3 region thereof) are included within the scope of this definition including, for example, scFv fused, directly or indirectly, to an Fc region are included herein.

[0105] The term Fab fragment means a monovalent antigen-binding fragment of an antibody containing the VL, VH, CL and CH1 domains. The term Fab′ fragment means a monovalent antigen-binding fragment of a monoclonal antibody that is larger than a Fab fragment. For example, a Fab′ fragment includes the VL, VH, CL and CH1 domains and all or part of the hinge region. The term F(ab′)2 fragment means a bivalent antigen-binding fragment of a monoclonal antibody comprising two Fab′ fragments linked by a disulfide bridge at the hinge region. An F(ab′)2 fragment includes, for example, all or part of the two VH and VL domains, and can further include all or part of the two CL and CH1 domains.

[0106] The term Fd fragment means a fragment of the heavy chain of a monoclonal antibody, which includes all or part of the VH, including the CDRs. An Fd fragment can further include CH1 region sequences.

[0107] The term Fv fragment means a monovalent antigen-binding fragment of a monoclonal antibody, including all or part of the VL and VH, and absent of the CL and CH1 domains. The VL and VH include, for example, the CDRs. Single-chain antibodies (sFv or scFv) are Fv molecules in which the VL and VH regions have been connected by a flexible linker to form a single polypeptide chain, which forms an antigen-binding fragment. Single chain antibodies are discussed in detail in International Patent Application Publication No. WO 88/01649 and U.S. Pat. Nos. 4,946,778 and 5,260,203, the disclosures of which are herein incorporated by reference. The term $(scFv)_2$ means bivalent or bispecific sFv polypeptide chains that include oligomerization domains at their C-termini, separated from the sFv by a hinge region. The oligomerization domain comprises self-associating a-helices, e.g., leucine

zippers, which can be further stabilized by additional disulfide bonds. $(scFv)_2$ fragments are also known as "miniantibodies" or "minibodies."

[0108] single domain antibody is an antigen-binding fragment containing only a VH or the VL domain. In some instances, two or more VH regions are covalently joined with a peptide linker to create a bivalent domain antibody. The two VH regions of a bivalent domain antibody may target the same or different antigens.

2. Fragment Crystallizable Region, Fc

[0109] An Fc region contains two heavy chain fragments comprising the CH2 and CH3 domains of an antibody. The two heavy chain fragments are held together by two or more disulfide bonds and by hydrophobic interactions of the CH3 domains. The term "Fc polypeptide" as used herein includes native and mutein forms of polypeptides derived from the Fc region of an antibody. Truncated forms of such polypeptides containing the hinge region that promotes dimerization are included.

C. Polypeptides with antibody CDRs & Scaffolding Domains that Display the CDRs

[0110] Antigen-binding peptide scaffolds, such as complementarity-determining regions (CDRs), are used to generate protein-binding molecules in accordance with the embodiments. Generally, a person skilled in the art can determine the type of protein scaffold on which to graft at least one of the CDRs. It is known that scaffolds, optimally, must meet a number of criteria such as: good phylogenetic conservation; known three-dimensional structure; small size; few or no post-transcriptional modifications; and/or be easy to produce, express, and purify. Skerra, J Mol Recognit, 13:167-87 (2000), which is incorporated herein by reference in its entirety.

[0111] The protein scaffolds can be sourced from, but not limited to: fibronectin type III FN3 domain (known as "monobodies"), fibronectin type III domain 10, lipocalin, anticalin, Z-domain of protein A of Staphylococcus aureus, thioredoxin A or proteins with a repeated motif such as the "ankyrin repeat", the "armadillo repeat", the "leucine-rich repeat" and the "tetratricopeptide repeat". Such proteins are described in US Patent Publication Nos. 2010/0285564, 2006/0058510, 2006/0088908, 2005/0106660, and PCT Publication No. WO2006/056464, each of which are specifically incorporated herein by reference in their entirety. Scaffolds derived from toxins from scorpions, insects, plants, mollusks, etc., and the protein inhibiters of neuronal NO synthase (PIN) may also be used.

D. Antibody Binding

[0112] The term "selective binding agent" refers to a molecule that binds to an antigen. Non-limiting examples include antibodies, antigen-binding fragments, scFv, Fab, Fab', F(ab')2, single chain antibodies, peptides, peptide fragments and proteins.

[0113] The term "binding" refers to a direct association between two molecules, due to, for example, covalent, electrostatic, hydrophobic, and ionic and/or hydrogen-bond interactions, including interactions such as salt bridges and water bridges. "Immunologically reactive" means that the selective binding agent or antibody of interest will bind with antigens present in a biological sample. The term "immune complex" refers the combination formed when an antibody or selective binding agent binds to an epitope on an antigen.

1. Affinity/Avidity

[0114] The term "affinity" refers the strength with which an antibody or selective binding agent binds an epitope. In antibody binding reactions, this is expressed as the affinity constant (Ka or ka sometimes referred to as the association constant) for any given antibody or selective binding agent. Affinity is measured as a comparison of the binding strength of the antibody to its antigen relative to the binding strength of the antibody to an unrelated amino acid sequence. Affinity can be expressed as, for example, 20- fold greater binding ability of the antibody to its antigen then to an unrelated amino acid sequence. As used herein, the term "avidity" refers to the resistance of a complex of two or more agents to dissociation after dilution. The terms "immunoreactive" and "preferentially binds" are used interchangeably herein with respect to antibodies and/or selective binding agent.

[0115] There are several experimental methods that can be used by one skilled in the art to evaluate the binding affinity of any given antibody or selective binding agent for its antigen. This is generally done by measuring the equilibrium dissociation constant (KD or Kd), using the equation KD = koff / kon = [A][B]/[AB]. The term koff is the rate of dissociation between the antibody and antigen per unit time, and is related to the concentration of antibody and antigen present in solution in the unbound form at equilibrium. The term kon is the rate of antibody and antigen association per unit time, and is related to the concentration of the bound antigen-antibody complex at equilibrium. The units used for measuring the KD are mol/L (molarity, or M), or concentration. The Ka of an antibody is the opposite of the KD, and is determined by the equation Ka = 1/KD. Examples of some experimental methods that can be used to determine the KD value are: enzyme-linked immunosorbent assays (ELISA), isothermal titration calorimetry (ITC), fluorescence anisotropy, surface plasmon resonance

(SPR), and affinity capillary electrophoresis (ACE). The affinity constant (Ka) of an antibody is the opposite of the KD, and is determined by the equation Ka = 1/ KD.

[0116] Antibodies deemed useful in certain embodiments may have an affinity constant (Ka) of about, at least about, or at most about 10^6, 10^7, 10^8,10^9, or 10^{10} M or any range derivable therein. Similarly, in some embodiments, antibodies may have a dissociation constant of about, at least about or at most about 10^{-6}, 10^{-7}, 10^{-8}, 10^{-9}, 10^{-10} M, or any range derivable therein. These values are reported for antibodies discussed herein and the same assay may be used to evaluate the binding properties of such antibodies. An antibody of the invention is said to "specifically bind" its target antigen when the dissociation constant (KD) is $\leqq 10^{-8}$ M. The antibody specifically binds antigen with "high affinity" when the KD is $\leqq 5\times10^{-9}$ M, and with "very high affinity" when the KD is $\leqq 5\times10^{-10}$ M.

1. Epitope Specificity

[0117] The epitope of an antigen is the specific region of the antigen for which an antibody has binding affinity. In the case of protein or polypeptide antigens, the epitope is the specific residues (or specified amino acids or protein segment) that the antibody binds with high affinity. An antibody does not necessarily contact every residue within the protein. Nor does every single amino acid substitution or deletion within a protein necessarily affect binding affinity. For purposes of this specification and the accompanying claims, the terms "epitope" and "antigenic determinant" are used interchangeably to refer to the site on an antigen to which B and/or T cells respond or recognize. Polypeptide epitopes can be formed from both contiguous amino acids and noncontiguous amino acids juxtaposed by tertiary folding of a polypeptide. An epitope typically includes at least 3, and typically 5-10 amino acids in a unique spatial conformation.

[0118] Epitope specificity of an antibody can be determined in a variety of ways. One approach, for example, involves testing a collection of overlapping peptides of about 15 amino acids spanning the full sequence of the protein and differing in increments of a small number of amino acids (e.g., 3 to 30 amino acids). The peptides are immobilized in separate wells of a microtiter dish. Immobilization can be accomplished, for example, by biotinylating one terminus of the peptides. This process may affect the antibody affinity for the epitope, therefore different samples of the same peptide can be biotinylated at the N and C terminus and immobilized in separate wells for the purposes of comparison. This is useful for identifying end-specific antibodies. Optionally, additional peptides can be included terminating at a particular amino acid of interest. This approach is useful for identifying end-specific antibodies

to internal fragments. An antibody or antigen-binding fragment is screened for binding to each of the various peptides. The epitope is defined as a segment of amino acids that is common to all peptides to which the antibody shows high affinity binding.

2. Modification of Antibody Antigen-Binding Domains

[0119] It is understood that the antibodies of the present invention may be modified, such that they are substantially identical to the antibody polypeptide sequences, or fragments thereof, and still bind the epitopes of the present invention. Polypeptide sequences are "substantially identical" when optimally aligned using such programs as Clustal Omega, IGBLAST, GAP or BESTFIT using default gap weights, they share at least 80% sequence identity, at least 90% sequence identity, at least 95% sequence identity, at least 96% sequence identity, at least 97% sequence identity, at least 98% sequence identity, or at least 99% sequence identity or any range therein.

[0120] As discussed herein, minor variations in the amino acid sequences of antibodies or antigen-binding regions thereof are contemplated as being encompassed by the present invention, providing that the variations in the amino acid sequence maintain at least 75%, more preferably at least 80%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98% and most preferably at least 99% sequence identity. In particular, conservative amino acid replacements are contemplated.

[0121] Conservative replacements are those that take place within a family of amino acids that are related in their side chains. Genetically encoded amino acids are generally divided into families based on the chemical nature of the side chain; e.g., acidic (aspartate, glutamate), basic (lysine, arginine, histidine), nonpolar (alanine, valine, leucine, isoleucine, proline, phenylalanine, methionine, tryptophan), and uncharged polar (glycine, asparagine, glutamine, cysteine, serine, threonine, tyrosine). For example, it is reasonable to expect that an isolated replacement of a leucine moiety with an isoleucine or valine moiety, or a similar replacement of an amino acid with a structurally related amino acid in the same family, will not have a major effect on the binding or properties of the resulting molecule, especially if the replacement does not involve an amino acid within a framework site. Whether an amino acid change results in a functional peptide can readily be determined by assaying the specific activity of the polypeptide derivative. Standard ELISA, Surface Plasmon Resonance (SPR), or other antibody binding assays can be performed by one skilled in the art to make a quantitative comparison of antigen binging affinity between the unmodified antibody and any polypeptide derivatives with conservative substitutions generated through any of several methods available to one skilled in the art.

[0122] Fragments or analogs of antibodies or immunoglobulin molecules can be readily prepared by those skilled in the art. Preferred amino- and carboxy-termini of fragments or analogs occur near boundaries of functional domains. Structural and functional domains can be identified by comparison of the nucleotide and/or amino acid sequence data to public or proprietary sequence databases. Preferably, computerized comparison methods are used to identify sequence motifs or predicted protein conformation domains that occur in other proteins of known structure and/or function. Standard methods to identify protein sequences that fold into a known three-dimensional structure are available to those skilled in the art; Dill and McCallum., Science 338:1042-1046 (2012), which is incorporated herein by reference in its entirety. Several algorithms for predicting protein structures and the gene sequences that encode these have been developed, and many of these algorithms can be found at the National Center for Biotechnology Information (on the World Wide Web at ncbi.nlm.nih.gov/guide/proteins/) and at the Bioinformatics Resource Portal (on the World Wide Web at expasy.org/proteomics). Thus, the foregoing examples demonstrate that those of skill in the art can recognize sequence motifs and structural conformations that may be used to define structural and functional domains in accordance with the invention.

[0123] Framework modifications can be made to antibodies to decrease immunogenicity, for example, by "backmutating" one or more framework residues to a corresponding germline sequence.

[0124] It is also contemplated that the antigen-binding domain may be multi-specific or multivalent by multimerizing the antigen-binding domain with VH and VL region pairs that bind either the same antigen (multi-valent) or a different antigen (multi-specific).

V. Proteinaceous Compositions

[0125] As used herein, a "protein" "peptide" or "polypeptide" refers to a molecule comprising at least five amino acid residues. As used herein, the term "wild-type" refers to the endogenous version of a molecule that occurs naturally in an organism. In some embodiments, wild-type versions of a protein or polypeptide are employed, however, in many embodiments of the disclosure, a modified protein or polypeptide is employed to generate an immune response. The terms described above may be used interchangeably. A "modified protein" or "modified polypeptide" or a "variant" refers to a protein or polypeptide whose chemical structure, particularly its amino acid sequence, is altered with respect to the wild-type protein or polypeptide. In some embodiments, a modified/variant protein or polypeptide has at least

one modified activity or function (recognizing that proteins or polypeptides may have multiple activities or functions). It is specifically contemplated that a modified/variant protein or polypeptide may be altered with respect to one activity or function yet retain a wild-type activity or function in other respects, such as immunogenicity.

[0126] Where a protein is specifically mentioned herein, it is in general a reference to a native (wild-type) or recombinant (modified) protein or, optionally, a protein in which any signal sequence has been removed. The protein may be isolated directly from the organism of which it is native, produced by recombinant DNA/exogenous expression methods, or produced by solid phase peptide synthesis (SPPS) or other in vitro methods. In particular embodiments, there are isolated nucleic acid segments and recombinant vectors incorporating nucleic acid sequences that encode a polypeptide (e.g., an antibody or fragment thereof). The term "recombinant" may be used in conjunction with a polypeptide or the name of a specific polypeptide, and this generally refers to a polypeptide produced from a nucleic acid molecule that has been manipulated in vitro or that is a replication product of such a molecule.

[0127] In certain embodiments the size of a peptide, protein, or polypeptide (wild-type or modified), such as a peptide or protein of the disclosure comprising a peptide of one of SEQ ID NOS:1-19 may comprise, but is not limited to, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 275, 300, 325, 350, 375, 400, 425, 450, 475, 500, 525, 550, 575, 600, 625, 650, 675, 700, 725, 750, 775, 800, 825, 850, 875, 900, 925, 950, 975, 1000, 1100, 1200, 1300, 1400, 1500, 1750, 2000, 2250, 2500 amino acid residues or greater, and any range derivable therein. It is contemplated that polypeptides may be mutated by truncation, rendering them shorter than their corresponding wild-type form, also, they might be altered by fusing or conjugating a heterologous protein or polypeptide sequence with a particular function (e.g., for targeting or localization, for enhanced immunogenicity, for purification purposes, etc.).

[0128] The polypeptides, proteins, or polynucleotides encoding such polypeptides or proteins of the disclosure may include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, or 50 (or any derivable range therein) or more variant amino acids or nucleic acid substitutions and/or be at least, at most, or be 60%, 61%, 62%, 63%, 64%, 65%, 66%, 67%, 68%, 69%, 70%, 71%, 72%, 73%, 74%, 75%, 76%, 77%, 78%, 79%, 80%, 81%,

82%, 83%, 84%, 85%, 86%, 87%, 88%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% (or any derivable range therein) similar, identical, or homologous in sequence to at least, or at most 3, 4, 5, 6, 7, 8, or 9 contiguous amino acids of a peptide of one of SEQ ID NOS:1-19 or nucleic acids encoding a peptide of one of SEQ ID NO:1-19. In certain embodiments, the peptide or polypeptide is not naturally occurring and/or is in a combination of peptides or polypeptides.

[0129] In some embodiments, the protein or polypeptide may comprise amino acids 1 to 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20 (or any derivable range therein) of a peptide of one of SEQ ID NOS:1-19. In some embodiments, the peptides of the disclosure comprise at least, at most, or exactly 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, or 50 (or any derivable range therein) amino acids flanking the carboxy and/or flanking the amino end of a peptide comprising or consisting of 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20 contiguous amino acids of a peptide of one of SEQ ID NOS:1-19.

[0130] In some embodiments, the protein may comprise, polypeptide may comprise, or nucleic acid may encode for a protein or polypeptide that comprises 1, 2, 3, 44, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20 (or any derivable range therein) contiguous amino acids of a peptide of one of SEQ ID NOS:1-19.

[0131] In some embodiments, the protein may comprise, polypeptide may comprise, or nucleic acid may encode for a protein or polypeptide that comprises at least, at most, or exactly 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20 (or any derivable range therein) contiguous amino acids of a peptide of one of SEQ ID NOS:1-19 that are at least, at most, or exactly 60%, 61%, 62%, 63%, 64%, 65%, 66%, 67%, 68%, 69%, 70%, 71%, 72%, 73%, 74%, 75%, 76%, 77%, 78%, 79%, 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 88%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% (or any derivable range therein) similar, identical, or homologous to a peptide of one of SEQ ID NOS:1-19.

[0132] In some aspects there is a polypeptide (or a nucleic acid molecule encoding such a polypeptide) starting at position 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20 of a peptide of one of SEQ ID NOS:1-19 and comprising at least, at most, or exactly 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, or 19 (or any derivable range therein) contiguous amino acids of a peptide of one of SEQ ID NOS:1-19.

[0133] It is contemplated that in compositions of the disclosure, there is between about 0.001 mg and about 10 mg of total polypeptide, peptide, and/or protein per ml. The

concentration of protein in a composition can be about, at least about or at most about 0.001, 0.010, 0.050, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0 mg/ml or more (or any range derivable therein).

[0134] The following is a discussion of changing the amino acid subunits of a protein to create an equivalent, or even improved, second-generation variant polypeptide or peptide. For example, certain amino acids may be substituted for other amino acids in a protein or polypeptide sequence with or without appreciable loss of interactive binding capacity with structures such as, for example, antigen-binding regions of antibodies or binding sites on substrate molecules. Since it is the interactive capacity and nature of a protein that defines that protein's functional activity, certain amino acid substitutions can be made in a protein sequence and in its corresponding DNA coding sequence, and nevertheless produce a protein with similar or desirable properties. It is thus contemplated by the inventors that various changes may be made in the DNA sequences of genes which encode proteins without appreciable loss of their biological utility or activity.

[0135] The term "functionally equivalent codon" is used herein to refer to codons that encode the same amino acid, such as the six different codons for arginine. Also considered are "neutral substitutions" or "neutral mutations" which refers to a change in the codon or codons that encode biologically equivalent amino acids.

[0136] Amino acid sequence variants of the disclosure can be substitutional, insertional, or deletion variants. A variation in a polypeptide of the disclosure may affect 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, or more non-contiguous or contiguous amino acids of the protein or polypeptide, as compared to wild-type (or any range derivable therein). A variant can comprise an amino acid sequence that is at least 50%, 60%, 70%, 80%, or 90%, including all values and ranges there between, identical to any sequence provided or referenced herein. A variant can include 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, or more substitute amino acids.

[0137] It also will be understood that amino acid and nucleic acid sequences may include additional residues, such as additional N- or C-terminal amino acids, or 5′ or 3′ sequences, respectively, and yet still be essentially identical as set forth in one of the sequences disclosed herein, so long as the sequence meets the criteria set forth above, including the maintenance of biological protein activity where protein expression is concerned. The addition of terminal sequences particularly applies to nucleic acid sequences that may, for example, include various non-coding sequences flanking either of the 5′ or 3′ portions of the coding region.

[0138] Deletion variants typically lack one or more residues of the native or wild type protein. Individual residues can be deleted or a number of contiguous amino acids can be deleted. A stop codon may be introduced (by substitution or insertion) into an encoding nucleic acid sequence to generate a truncated protein.

[0139] Insertional mutants typically involve the addition of amino acid residues at a non-terminal point in the polypeptide. This may include the insertion of one or more amino acid residues. Terminal additions may also be generated and can include fusion proteins which are multimers or concatemers of one or more peptides or polypeptides described or referenced herein.

[0140] Substitutional variants typically contain the exchange of one amino acid for another at one or more sites within the protein or polypeptide, and may be designed to modulate one or more properties of the polypeptide, with or without the loss of other functions or properties. Substitutions may be conservative, that is, one amino acid is replaced with one of similar chemical properties. "Conservative amino acid substitutions" may involve exchange of a member of one amino acid class with another member of the same class. Conservative substitutions are well known in the art and include, for example, the changes of: alanine to serine; arginine to lysine; asparagine to glutamine or histidine; aspartate to glutamate; cysteine to serine; glutamine to asparagine; glutamate to aspartate; glycine to proline; histidine to asparagine or glutamine; isoleucine to leucine or valine; leucine to valine or isoleucine; lysine to arginine; methionine to leucine or isoleucine; phenylalanine to tyrosine, leucine or methionine; serine to threonine; threonine to serine; tryptophan to tyrosine; tyrosine to tryptophan or phenylalanine; and valine to isoleucine or leucine. Conservative amino acid substitutions may encompass non-naturally occurring amino acid residues, which are typically incorporated by chemical peptide synthesis rather than by synthesis in biological systems. These include peptidomimetics or other reversed or inverted forms of amino acid moieties.

[0141] Alternatively, substitutions may be "non-conservative", such that a function or activity of the polypeptide is affected. Non-conservative changes typically involve substituting an amino acid residue with one that is chemically dissimilar, such as a polar or charged amino acid for a nonpolar or uncharged amino acid, and vice versa. Non-conservative substitutions may involve the exchange of a member of one of the amino acid classes for a member from another class.

[0142] One skilled in the art can determine suitable variants of polypeptides as set forth herein using well-known techniques. One skilled in the art may identify suitable areas of the molecule that may be changed without destroying activity by targeting regions not believed to

be important for activity. The skilled artisan will also be able to identify amino acid residues and portions of the molecules that are conserved among similar proteins or polypeptides. In further embodiments, areas that may be important for biological activity or for structure may be subject to conservative amino acid substitutions without significantly altering the biological activity or without adversely affecting the protein or polypeptide structure.

[0143] In making such changes, the hydropathy index of amino acids may be considered. The hydropathy profile of a protein is calculated by assigning each amino acid a numerical value ("hydropathy index") and then repetitively averaging these values along the peptide chain. Each amino acid has been assigned a value based on its hydrophobicity and charge characteristics. They are: isoleucine (+4.5); valine (+4.2); leucine (+3.8); phenylalanine (+2.8); cysteine/cysteine (+2.5); methionine (+1.9); alanine (+1.8); glycine (−0.4); threonine (−0.7); serine (−0.8); tryptophan (−0.9); tyrosine (−1.3); proline (1.6); histidine (−3.2); glutamate (−3.5); glutamine (−3.5); aspartate (−3.5); asparagine (−3.5); lysine (−3.9); and arginine (−4.5). The importance of the hydropathy amino acid index in conferring interactive biologic function on a protein is generally understood in the art (Kyte et al., J. Mol. Biol. 157:105-131 (1982)). It is accepted that the relative hydropathic character of the amino acid contributes to the secondary structure of the resultant protein or polypeptide, which in turn defines the interaction of the protein or polypeptide with other molecules, for example, enzymes, substrates, receptors, DNA, antibodies, antigens, and others. It is also known that certain amino acids may be substituted for other amino acids having a similar hydropathy index or score, and still retain a similar biological activity. In making changes based upon the hydropathy index, in certain embodiments, the substitution of amino acids whose hydropathy indices are within ±2 is included. In some aspects of the invention, those that are within ±1 are included, and in other aspects of the invention, those within ±0.5 are included.

[0144] It also is understood in the art that the substitution of like amino acids can be effectively made based on hydrophilicity. U.S. Patent 4,554,101, incorporated herein by reference, states that the greatest local average hydrophilicity of a protein, as governed by the hydrophilicity of its adjacent amino acids, correlates with a biological property of the protein. In certain embodiments, the greatest local average hydrophilicity of a protein, as governed by the hydrophilicity of its adjacent amino acids, correlates with its immunogenicity and antigen binding, that is, as a biological property of the protein. The following hydrophilicity values have been assigned to these amino acid residues: arginine (+3.0); lysine (+3.0); aspartate (+3.0±1); glutamate (+3.0±1); serine (+0.3); asparagine (+0.2); glutamine (+0.2); glycine (0); threonine (−0.4); proline (−0.5±1); alanine (−0.5); histidine (−0.5); cysteine (−1.0); methionine

(−1.3); valine (−1.5); leucine (−1.8); isoleucine (−1.8); tyrosine (−2.3); phenylalanine (−2.5); and tryptophan (−3.4). In making changes based upon similar hydrophilicity values, in certain embodiments, the substitution of amino acids whose hydrophilicity values are within ±2 are included, in other embodiments, those which are within ±1 are included, and in still other embodiments, those within ±0.5 are included. In some instances, one may also identify epitopes from primary amino acid sequences based on hydrophilicity. These regions are also referred to as "epitopic core regions." It is understood that an amino acid can be substituted for another having a similar hydrophilicity value and still produce a biologically equivalent and immunologically equivalent protein.

[0145] Additionally, one skilled in the art can review structure-function studies identifying residues in similar polypeptides or proteins that are important for activity or structure. In view of such a comparison, one can predict the importance of amino acid residues in a protein that correspond to amino acid residues important for activity or structure in similar proteins. One skilled in the art may opt for chemically similar amino acid substitutions for such predicted important amino acid residues.

[0146] One skilled in the art can also analyze the three-dimensional structure and amino acid sequence in relation to that structure in similar proteins or polypeptides. In view of such information, one skilled in the art may predict the alignment of amino acid residues of a polypeptide with respect to its three-dimensional structure. One skilled in the art may choose not to make changes to amino acid residues predicted to be on the surface of the protein, since such residues may be involved in important interactions with other molecules. Moreover, one skilled in the art may generate test variants containing a single amino acid substitution at each desired amino acid residue. These variants can then be screened using standard assays for binding and/or activity, thus yielding information gathered from such routine experiments, which may allow one skilled in the art to determine the amino acid positions where further substitutions should be avoided either alone or in combination with other mutations. Various tools available to determine secondary structure can be found on the world wide web at expasy.org/proteomics/protein_structure.

[0147] In some embodiments of the invention, amino acid substitutions are made that: (1) reduce susceptibility to proteolysis, (2) reduce susceptibility to oxidation, (3) alter binding affinity for forming protein complexes, (4) alter ligand or antigen binding affinities, and/or (5) confer or modify other physicochemical or functional properties on such polypeptides. For example, single or multiple amino acid substitutions (in certain embodiments, conservative amino acid substitutions) may be made in the naturally occurring sequence. Substitutions can

be made in that portion of the antibody that lies outside the domain(s) forming intermolecular contacts. In such embodiments, conservative amino acid substitutions can be used that do not substantially change the structural characteristics of the protein or polypeptide (e.g., one or more replacement amino acids that do not disrupt the secondary structure that characterizes the native antibody).

VI. Nucleic Acids

[0148] In certain embodiments, nucleic acid sequences can exist in a variety of instances such as: isolated segments and recombinant vectors of incorporated sequences or recombinant polynucleotides encoding one or both chains of an antibody, or a fragment, derivative, mutein, or variant thereof, polynucleotides sufficient for use as hybridization probes, PCR primers or sequencing primers for identifying, analyzing, mutating or amplifying a polynucleotide encoding a polypeptide, anti-sense nucleic acids for inhibiting expression of a polynucleotide, and complementary sequences of the foregoing described herein. Nucleic acids that encode the epitope to which certain of the antibodies provided herein are also provided. Nucleic acids encoding fusion proteins that include these peptides are also provided. The nucleic acids can be single-stranded or double-stranded and can comprise RNA and/or DNA nucleotides and artificial variants thereof (e.g., peptide nucleic acids).

[0149] The term "polynucleotide" refers to a nucleic acid molecule that either is recombinant or has been isolated from total genomic nucleic acid. Included within the term "polynucleotide" are oligonucleotides (nucleic acids 100 residues or less in length), recombinant vectors, including, for example, plasmids, cosmids, phage, viruses, and the like. Polynucleotides include, in certain aspects, regulatory sequences, isolated substantially away from their naturally occurring genes or protein encoding sequences. Polynucleotides may be single- stranded (coding or antisense) or double- stranded, and may be RNA, DNA (genomic, cDNA or synthetic), analogs thereof, or a combination thereof. Additional coding or non-coding sequences may, but need not, be present within a polynucleotide.

[0150] In this respect, the term "gene," "polynucleotide," or "nucleic acid" is used to refer to a nucleic acid that encodes a protein, polypeptide, or peptide (including any sequences required for proper transcription, post-translational modification, or localization). As will be understood by those in the art, this term encompasses genomic sequences, expression cassettes, cDNA sequences, and smaller engineered nucleic acid segments that express, or may be adapted to express, proteins, polypeptides, domains, peptides, fusion proteins, and mutants. A nucleic acid encoding all or part of a polypeptide may contain a contiguous nucleic acid sequence encoding all or a portion of such a polypeptide. It also is contemplated that a

particular polypeptide may be encoded by nucleic acids containing variations having slightly different nucleic acid sequences but, nonetheless, encode the same or substantially similar protein.

[0151] In certain embodiments, there are polynucleotide variants having substantial identity to the sequences disclosed herein; those comprising at least 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% or higher sequence identity, including all values and ranges there between, compared to a polynucleotide sequence provided herein using the methods described herein (e.g., BLAST analysis using standard parameters). In certain aspects, the isolated polynucleotide will comprise a nucleotide sequence encoding a polypeptide that has at least 90%, preferably 95% and above, identity to an amino acid sequence described herein, over the entire length of the sequence; or a nucleotide sequence complementary to said isolated polynucleotide.

[0152] The nucleic acid segments, regardless of the length of the coding sequence itself, may be combined with other nucleic acid sequences, such as promoters, polyadenylation signals, additional restriction enzyme sites, multiple cloning sites, other coding segments, and the like, such that their overall length may vary considerably. The nucleic acids can be any length. They can be, for example, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 75, 100, 125, 175, 200, 250, 300, 350, 400, 450, 500, 750, 1000, 1500, 3000, 5000 or more nucleotides in length, and/or can comprise one or more additional sequences, for example, regulatory sequences, and/or be a part of a larger nucleic acid, for example, a vector. It is therefore contemplated that a nucleic acid fragment of almost any length may be employed, with the total length preferably being limited by the ease of preparation and use in the intended recombinant nucleic acid protocol. In some cases, a nucleic acid sequence may encode a polypeptide sequence with additional heterologous coding sequences, for example to allow for purification of the polypeptide, transport, secretion, post-translational modification, or for therapeutic benefits such as targeting or efficacy. As discussed above, a tag or other heterologous polypeptide may be added to the modified polypeptide-encoding sequence, wherein "heterologous" refers to a polypeptide that is not the same as the modified polypeptide.

A. Hybridization

[0153] The nucleic acids that hybridize to other nucleic acids under particular hybridization conditions. Methods for hybridizing nucleic acids are well known in the art. See, e.g., Current Protocols in Molecular Biology, John Wiley and Sons, N.Y. (1989), incorporated by reference,

6.3.1-6.3.6. As defined herein, a moderately stringent hybridization condition uses a prewashing solution containing 5× sodium chloride/sodium citrate (SSC), 0.5% SDS, 1.0 mM EDTA (pH 8.0), hybridization buffer of about 50% formamide, 6×SSC, and a hybridization temperature of 55° C. (or other similar hybridization solutions, such as one containing about 50% formamide, with a hybridization temperature of 42° C), and washing conditions of 60° C. in 0.5×SSC, 0.1% SDS. A stringent hybridization condition hybridizes in 6×SSC at 45° C., followed by one or more washes in 0.1×SSC, 0.2% SDS at 68° C. Furthermore, one of skill in the art can manipulate the hybridization and/or washing conditions to increase or decrease the stringency of hybridization such that nucleic acids comprising nucleotide sequence that are at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98% or at least 99% identical to each other typically remain hybridized to each other.

[0154] The parameters affecting the choice of hybridization conditions and guidance for devising suitable conditions are set forth by, for example, Sambrook, Fritsch, and Maniatis (Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y., chapters 9 and 11 (1989); Current Protocols in Molecular Biology, Ausubel et al., eds., John Wiley and Sons, Inc., sections 2.10 and 6.3-6.4 (1995), both of which are herein incorporated by reference in their entirety for all purposes) and can be readily determined by those having ordinary skill in the art based on, for example, the length and/or base composition of the DNA.

B. Mutation

[0155] Changes can be introduced by mutation into a nucleic acid, thereby leading to changes in the amino acid sequence of a polypeptide (e.g., an antibody or antibody derivative) that it encodes. Mutations can be introduced using any technique known in the art. In one embodiment, one or more particular amino acid residues are changed using, for example, a site-directed mutagenesis protocol. In another embodiment, one or more randomly selected residues are changed using, for example, a random mutagenesis protocol. However it is made, a mutant polypeptide can be expressed and screened for a desired property.

[0156] Mutations can be introduced into a nucleic acid without significantly altering the biological activity of a polypeptide that it encodes. For example, one can make nucleotide substitutions leading to amino acid substitutions at non-essential amino acid residues. Alternatively, one or more mutations can be introduced into a nucleic acid that selectively

changes the biological activity of a polypeptide that it encodes. For example, the mutation can quantitatively or qualitatively change the biological activity. Examples of quantitative changes include increasing, reducing or eliminating the activity. Examples of qualitative changes include altering the antigen specificity of an antibody.

C. Probes

[0157] In another aspect, nucleic acid molecules are suitable for use as primers or hybridization probes for the detection of nucleic acid sequences. A nucleic acid molecule can comprise only a portion of a nucleic acid sequence encoding a full-length polypeptide, for example, a fragment that can be used as a probe or primer or a fragment encoding an active portion of a given polypeptide.

[0158] In another embodiment, the nucleic acid molecules may be used as probes or PCR primers for specific antibody sequences. For instance, a nucleic acid molecule probe may be used in diagnostic methods or a nucleic acid molecule PCR primer may be used to amplify regions of DNA that could be used, inter alia, to isolate nucleic acid sequences for use in producing variable domains of antibodies. In a preferred embodiment, the nucleic acid molecules are oligonucleotides. In a more preferred embodiment, the oligonucleotides are from highly variable regions of the heavy and light chains of the antibody of interest. In an even more preferred embodiment, the oligonucleotides encode all or part of one or more of the CDRs.

[0159] Probes based on the desired sequence of a nucleic acid can be used to detect the nucleic acid or similar nucleic acids, for example, transcripts encoding a polypeptide of interest. The probe can comprise a label group, e.g., a radioisotope, a fluorescent compound, an enzyme, or an enzyme co-factor. Such probes can be used to identify a cell that expresses the polypeptide.

VII. Antibody Production

A. Antibody Production

[0160] Methods for preparing and characterizing antibodies for use in diagnostic and detection assays, for purification, and for use as therapeutics are well known in the art as disclosed in, for example, U.S. Pat. Nos. 4,011,308; 4,722,890; 4,016,043; 3,876,504; 3,770,380; and 4,372,745, each of which are specifically incorporated herein by reference in their entirety. (see, e.g., Antibodies: A Laboratory Manual, Cold Spring Harbor Laboratory, 1988; incorporated herein by reference). These antibodies may be polyclonal or monoclonal

antibody preparations, monospecific antisera, human antibodies, hybrid or chimeric antibodies, such as humanized antibodies, altered antibodies, F(ab')2 fragments, Fab fragments, Fv fragments, single-domain antibodies, dimeric or trimeric antibody fragment constructs, minibodies, or functional fragments thereof which bind to the antigen in question. In certain aspects, polypeptides, peptides, and proteins and immunogenic fragments thereof for use in various embodiments can also be synthesized in solution or on a solid support in accordance with conventional techniques. See, for example, Stewart and Young, (1984); Tarn et al, (1983); Merrifield, (1986); and Barany and Merrifield (1979), each incorporated herein by reference.

[0161] Briefly, a polyclonal antibody is prepared by immunizing an animal with an antigen or a portion thereof and collecting antisera from that immunized animal. The antigen may be altered compared to an antigen sequence found in nature. In some embodiments, a variant or altered antigenic peptide or polypeptide is employed to generate antibodies. Inocula are typically prepared by dispersing the antigenic composition in a physiologically tolerable diluent to form an aqueous composition. Antisera is subsequently collected by methods known in the arts, and the serum may be used as-is for various applications or else the desired antibody fraction may be purified by well-known methods, such as affinity chromatography (Harlow and Lane, Antibodies: A Laboratory Manual 1988, which is incorporated herein by reference in its entirety).

[0162] Methods of making monoclonal antibodies are also well known in the art (Kohler and Milstein, 1975; Harlow and Lane, 1988, U.S. Patent 4,196,265, herein incorporated by reference in its entirety for all purposes). Typically, this technique involves immunizing a suitable animal with a selected immunogenic composition, e.g., a purified or partially purified protein, polypeptide, peptide or domain. Resulting antibody-producing B-cells from the immunized animal, or all dissociated splenocytes, are then induced to fuse with cells from an immortalized cell line to form hybridomas. Myeloma cell lines suited for use in hybridoma-producing fusion procedures preferably are non-antibody-producing and have high fusion efficiency and enzyme deficiencies that render then incapable of growing in certain selective media that support the growth of only the desired fused cells (hybridomas). Typically, the fusion partner includes a property that allows selection of the resulting hybridomas using specific media. For example, fusion partners can be hypoxanthine/aminopterin/thymidine (HAT)-sensitive. Methods for generating hybrids of antibody-producing spleen or lymph node cells and myeloma cells usually comprise mixing somatic cells with myeloma cells in the presence of an agent or agents (chemical or electrical) that promote the fusion of cell membranes. Next, selection of hybridomas can be performed by culturing the cells by single-

clone dilution in microtiter plates, followed by testing the individual clonal supernatants (after about two to three weeks) for the desired reactivity. Fusion procedures for making hybridomas, immunization protocols, and techniques for isolation of immunized splenocytes for fusion are known in the art.

[0163] Other techniques for producing monoclonal antibodies include the viral or oncogenic transformation of B-lymphocytes, a molecular cloning approach may be used to generate a nucleic acid or polypeptide, the selected lymphocyte antibody method (SLAM) (see, e.g., Babcook et al., Proc. Natl. Acad. Sci. USA 93:7843-7848 (1996), which is incorporated herein by reference in its entirety, the preparation of combinatorial immunoglobulin phagemid libraries from RNA isolated from the spleen of the immunized animal and selection of phagemids expressing appropriate antibodies, or producing a cell expressing an antibody from a genomic sequence of the cell comprising a modified immunoglobulin locus using Cre-mediated site-specific recombination (see, e.g., U.S. 6,091,001, which is incorporated herein by reference in its entirety).

[0164] Monoclonal antibodies may be further purified using filtration, centrifugation, and various chromatographic methods such as HPLC or affinity chromatography. Monoclonal antibodies may be further screened or optimized for properties relating to specificity, avidity, half-life, immunogenicity, binding association, binding disassociation, or overall functional properties relative to being a treatment for infection. Thus, monoclonal antibodies may have alterations in the amino acid sequence of CDRs, including insertions, deletions, or substitutions with a conserved or non-conserved amino acid.

[0165] The immunogenicity of a particular immunogen composition can be enhanced by the use of non-specific stimulators of the immune response, known as adjuvants. Adjuvants that may be used in accordance with embodiments include, but are not limited to, IL-1, IL-2, IL-4, IL-7, IL-12, -interferon, GMCSP, BCG, aluminum hydroxide, MDP compounds, such as thur-MDP and nor-MDP, CGP (MTP-PE), lipid A, and monophosphoryl lipid A (MPL). Exemplary adjuvants may include complete Freund's adjuvant (a non-specific stimulator of the immune response containing killed Mycobacterium tuberculosis), incomplete Freund's adjuvants, and/or aluminum hydroxide adjuvant. In addition to adjuvants, it may be desirable to co-administer biologic response modifiers (BRM), such as but not limited to, Cimetidine (CIM; 1200 mg/d) (Smith/Kline, PA); low-dose Cyclophosphamide (CYP; 300 mg/m2) (Johnson/ Mead, NJ), cytokines such as β-interferon, IL-2, or IL-12, or genes encoding proteins involved in immune helper functions, such as B-7.A phage-display system can be used to expand antibody molecule populations in vitro. Saiki, et al., Nature 324:163 (1986); Scharf et

al., Science 233:1076 (1986); U.S. Pat. Nos. 4,683,195 and 4,683,202; Yang et al., J Mol Biol. 254:392 (1995); Barbas, III et al., Methods: Comp. Meth Enzymol. (1995) 8:94; Barbas, III et al., Proc Natl Acad Sci USA 88:7978 (1991), which is incorporated herein by reference in its entirety.

B. Fully Human Antibody Production

[0166] Methods are available for making fully human antibodies. Using fully human antibodies can minimize the immunogenic and allergic responses that may be caused by administering non-human monoclonal antibodies to humans as therapeutic agents. In one embodiment, human antibodies may be produced in a non-human transgenic animal, e.g., a transgenic mouse capable of producing multiple isotypes of human antibodies to protein (e.g., IgG, IgA, and/or IgE) by undergoing V-D-J recombination and isotype switching. Accordingly, this aspect applies to antibodies, antibody fragments, and pharmaceutical compositions thereof, but also non-human transgenic animals, B-cells, host cells, and hybridomas that produce monoclonal antibodies. Applications of humanized antibodies include, but are not limited to, detect a cell expressing an anticipated protein, either in vivo or in vitro, pharmaceutical preparations containing the antibodies of the present invention, and methods of treating disorders by administering the antibodies.

[0167] Fully human antibodies can be produced by immunizing transgenic animals (usually mice) that are capable of producing a repertoire of human antibodies in the absence of endogenous immunoglobulin production. Antigens for this purpose typically have six or more contiguous amino acids, and optionally are conjugated to a carrier, such as a hapten. See, for example, Jakobovits et al., Proc. Natl. Acad. Sci. USA 90:2551-2555 (1993); Jakobovits et al., Nature 362:255-258 (1993); Bruggermann et al., Year in Immunol. 7:33 (1993), each of which are specifically incorporated herein by reference in their entirety. In one example, transgenic animals are produced by incapacitating the endogenous mouse immunoglobulin loci encoding the mouse heavy and light immunoglobulin chains therein, and inserting into the mouse genome large fragments of human genome DNA containing loci that encode human heavy and light chain proteins. Partially modified animals, which have less than the full complement of human immunoglobulin loci, are then crossbred to obtain an animal having all of the desired immune system modifications. When administered an immunogen, these transgenic animals produce antibodies that are immunospecific for the immunogen but have human rather than murine amino acid sequences, including the variable regions. For further details of such methods, see, for example, International Patent Application Publication Nos. WO 96/33735 and WO 94/02602, which are hereby incorporated by reference in their entirety. Additional

methods relating to transgenic mice for making human antibodies are described in U.S. Pat. Nos. 5,545,807; 6,713,610; 6,673,986; 6,162,963; 6,300,129; 6,255,458; 5,877,397; 5,874,299 and 5,545,806; in International Patent Application Publication Nos. WO 91/10741 and WO 90/04036; and in European Patent Nos. EP 546073B1 and EP 546073A1, all of which are hereby incorporated by reference in their entirety for all purposes.

[0168] The transgenic mice described above, referred to herein as "HuMAb" mice, contain a human immunoglobulin gene minilocus that encodes unrearranged human heavy (μ and γ) and κ light chain immunoglobulin sequences, together with targeted mutations that inactivate the endogenous μ and κ chain loci (Lonberg et al., Nature 368:856-859 (1994)). Accordingly, the mice exhibit reduced expression of mouse IgM or κ chains and in response to immunization, the introduced human heavy and light chain transgenes undergo class switching and somatic mutation to generate high affinity human IgG κ monoclonal antibodies (Lonberg et al., supra; Lonberg and Huszar, Intern. Ref. Immunol. 13:65-93 (1995); Harding and Lonberg, Ann. N.Y. Acad. Sci. 764:536-546 (1995)), each of which are specifically incorporated herein by reference in their entirety. The preparation of HuMAb mice is described in detail in Taylor et al., Nucl. Acids Res. 20:6287-6295 (1992); Chen et al., Int. Immunol. 5:647-656 (1993); Tuaillon et al., J. Immunol. 152:2912-2920 (1994); Lonberg et al., supra; Lonberg, Handbook of Exp. Pharmacol. 113:49-101 (1994); Taylor et al., Int. Immunol. 6:579-591 (1994); Lonberg and Huszar, Intern. Ref. Immunol. 13:65-93 (1995); Harding and Lonberg, Ann. N.Y. Acad. Sci. 764:536-546 (1995); Fishwild et al., Nat. Biotechnol. 14:845-851 (1996); the foregoing references are herein incorporated by reference in their entirety for all purposes. See further, U.S. Pat. Nos. 5,545,806; 5,569,825; 5,625,126; 5,633,425; 5,789,650; 5,877,397; 5,661,016; 5,814,318; 5,874,299; 5,770,429; and 5,545,807; as well as International Patent Application Publication Nos. WO 93/1227; WO 92/22646; and WO 92/03918, the disclosures of all of which are hereby incorporated by reference in their entirety for all purposes. Technologies utilized for producing human antibodies in these transgenic mice are disclosed also in WO 98/24893, and Mendez et al., Nat. Genetics 15:146-156 (1997), which are herein incorporated by reference. For example, the HCo7 and HCo12 transgenic mice strains can be used to generate human antibodies.

[0169] Using hybridoma technology, antigen-specific humanized monoclonal antibodies with the desired specificity can be produced and selected from the transgenic mice such as those described above. Such antibodies may be cloned and expressed using a suitable vector and host cell, or the antibodies can be harvested from cultured hybridoma cells. Fully human antibodies can also be derived from phage-display libraries (as disclosed in Hoogenboom et

al., J. Mol. Biol. 227:381 (1991); and Marks et al., J. Mol. Biol. 222:581 (1991)), each of which are specifically incorporated herein by reference in their entirety. One such technique is described in International Patent Application Publication No. WO 99/10494 (herein incorporated by reference), which describes the isolation of high affinity and functional agonistic antibodies for MPL- and msk-receptors using such an approach.

C. Antibody Fragments Production

[0170] Antibody fragments that retain the ability to recognize the antigen of interest will also find use herein. A number of antibody fragments are known in the art that comprise antigen-binding sites capable of exhibiting immunological binding properties of an intact antibody molecule and can be subsequently modified by methods known in the arts. Functional fragments, including only the variable regions of the heavy and light chains, can also be produced using standard techniques such as recombinant production or preferential proteolytic cleavage of immunoglobulin molecules. These fragments are known as Fv. See, e.g., Inbar et al., Proc. Nat. Acad. Sci. USA 69:2659-2662 (1972); Hochman et al., Biochem. 15:2706-2710 (1976); and Ehrlich et al., Biochem. 19:4091-4096 (1980), each of which are specifically incorporated herein by reference in their entirety.

[0171] Single-chain variable fragments (scFvs) may be prepared by fusing DNA encoding a peptide linker between DNAs encoding the two variable domain polypeptides (VL and VH). scFvs can form antigen-binding monomers, or they can form multimers (e.g., dimers, trimers, or tetramers), depending on the length of a flexible linker between the two variable domains (Kortt et al., Prot. Eng. 10:423 (1997); Kort et al., Biomol. Eng. 18:95-108 (2001), each of which are specifically incorporated herein by reference in their entirety). By combining different VL- and VH-comprising polypeptides, one can form multimeric scFvs that bind to different epitopes (Kriangkum et al., Biomol. Eng. 18:31-40 (2001), each of which are specifically incorporated herein by reference in their entirety). Antigen-binding fragments are typically produced by recombinant DNA methods known to those skilled in the art. Although the two domains of the Fv fragment, VL and VH, are coded for by separate genes, they can be joined using recombinant methods by a synthetic linker that enables them to be made as a single chain polypeptide (known as single chain Fv (sFv or scFv); see e.g., Bird et al., Science 242:423-426 (1988); and Huston et al., Proc. Natl. Acad. Sci. USA 85:5879-5883 (1988), each of which are specifically incorporated herein by reference in their entirety. Design criteria include determining the appropriate length to span the distance between the C-terminus of one chain and the N-terminus of the other, wherein the linker is generally formed from small hydrophilic amino acid residues that do not tend to coil or form secondary structures. Suitable

linkers generally comprise polypeptide chains of alternating sets of glycine and serine residues, and may include glutamic acid and lysine residues inserted to enhance solubility. Antigen-binding fragments are screened for utility in the same manner as intact antibodies. Such fragments include those obtained by amino-terminal and/or carboxy-terminal deletions, where the remaining amino acid sequence is substantially identical to the corresponding positions in the naturally occurring sequence deduced, for example, from a full-length cDNA sequence.

[0172] Antibodies may also be generated using peptide analogs of the epitopic determinants disclosed herein, which may consist of non-peptide compounds having properties analogous to those of the template peptide. These types of non-peptide compound are termed "peptide mimetics" or "peptidomimetics". Fauchere, J. Adv. Drug Res. 15:29 (1986); Veber and Freidinger TINS p. 392 (1985); and Evans et al., J. Med. Chem. 30:1229 (1987). Liu et al. (2003), each of which are specifically incorporated herein by reference in their entirety, also describe "antibody like binding peptidomimetics" (ABiPs), which are peptides that act as pared-down antibodies and have certain advantages of longer serum half-life as well as less cumbersome synthesis methods. These analogs can be peptides, non-peptides or combinations of peptide and non-peptide regions. Fauchere, Adv. Drug Res. 15:29 (1986); Veber and Freidiner, TINS p. 392 (1985); and Evans et al., J. Med. Chem. 30:1229 (1987), which are incorporated herein by reference in their entirety for any purpose. Peptide mimetics that are structurally similar to therapeutically useful peptides may be used to produce a similar therapeutic or prophylactic effect. Such compounds are often developed with the aid of computerized molecular modeling. Generally, peptidomimetics of the invention are proteins that are structurally similar to an antibody displaying a desired biological activity, such as the ability to bind a protein, but have one or more peptide linkages optionally replaced by a linkage selected from: —CH2NH—, —CH2S—, —CH2—CH2—, —CH=CH— (cis and trans), —COCH2—, —CH(OH)CH2—, and —CH2SO— by methods well known in the art. Systematic substitution of one or more amino acids of a consensus sequence with a D-amino acid of the same type (e.g., D-lysine in place of L-lysine) may be used in certain embodiments of the invention to generate more stable proteins. In addition, constrained peptides comprising a consensus sequence or a substantially identical consensus sequence variation may be generated by methods known in the art (Rizo and Gierasch, Ann. Rev. Biochem. 61:387 (1992), incorporated herein by reference), for example, by adding internal cysteine residues capable of forming intramolecular disulfide bridges which cyclize the peptide.

[0173] Once generated, a phage display library can be used to improve the immunological binding affinity of the Fab molecules using known techniques. The coding sequences for the

heavy and light chain portions of the Fab molecules selected from the phage display library can be isolated or synthesized and cloned into any suitable vector or replicon for expression. Any suitable expression system can be used.

VIII. Polypeptide Expression

[0174] In some aspects, there are nucleic acid molecule encoding polypeptides or peptides of the disclosure (e.g antibodies, TCR genes, and immunogenic peptides). These may be generated by methods known in the art, e.g., isolated from B cells of mice that have been immunized and isolated, phage display, expressed in any suitable recombinant expression system and allowed to assemble to form antibody molecules or by recombinant methods.

A. Expression

[0175] The nucleic acid molecules may be used to express large quantities of polypeptides. If the nucleic acid molecules are derived from a non-human, non-transgenic animal, the nucleic acid molecules may be used for humanization of the antibody or TCR genes.

1. Vectors

[0176] In some aspects, contemplated are expression vectors comprising a nucleic acid molecule encoding a polypeptide of the desired sequence or a portion thereof (e.g., a fragment containing one or more CDRs or one or more variable region domains). Expression vectors comprising the nucleic acid molecules may encode the heavy chain, light chain, or the antigen-binding portion thereof. In some aspects, expression vectors comprising nucleic acid molecules may encode fusion proteins, modified antibodies, antibody fragments, and probes thereof. In addition to control sequences that govern transcription and translation, vectors and expression vectors may contain nucleic acid sequences that serve other functions as well.

[0177] To express the polypeptides or peptides of the disclosure, DNAs encoding the polypeptides or peptides are inserted into expression vectors such that the gene area is operatively linked to transcriptional and translational control sequences. In some aspects, a vector that encodes a functionally complete human CH or CL immunoglobulin sequence with appropriate restriction sites engineered so that any VH or VL sequence can be easily inserted and expressed. In some aspects, a vector that encodes a functionally complete human TCR alpha or TCR beta sequence with appropriate restriction sites engineered so that any variable sequence or CDR1, CDR2, and/or CDR3 can be easily inserted and expressed. Typically, expression vectors used in any of the host cells contain sequences for plasmid or virus maintenance and for cloning and expression of exogenous nucleotide sequences. Such sequences, collectively referred to as "flanking sequences" typically include one or more of the following operatively linked nucleotide sequences: a promoter, one or more enhancer

sequences, an origin of replication, a transcriptional termination sequence, a complete intron sequence containing a donor and acceptor splice site, a sequence encoding a leader sequence for polypeptide secretion, a ribosome binding site, a polyadenylation sequence, a polylinker region for inserting the nucleic acid encoding the polypeptide to be expressed, and a selectable marker element. Such sequences and methods of using the same are well known in the art.

1. Expression Systems

[0178] Numerous expression systems exist that comprise at least a part or all of the expression vectors discussed above. Prokaryote- and/or eukaryote-based systems can be employed for use with an embodiment to produce nucleic acid sequences, or their cognate polypeptides, proteins and peptides. Commercially and widely available systems include in but are not limited to bacterial, mammalian, yeast, and insect cell systems. Different host cells have characteristic and specific mechanisms for the post-translational processing and modification of proteins. Appropriate cell lines or host systems can be chosen to ensure the correct modification and processing of the foreign protein expressed. Those skilled in the art are able to express a vector to produce a nucleic acid sequence or its cognate polypeptide, protein, or peptide using an appropriate expression system.

2. Methods of Gene Transfer

[0179] Suitable methods for nucleic acid delivery to effect expression of compositions are anticipated to include virtually any method by which a nucleic acid (e.g., DNA, including viral and nonviral vectors) can be introduced into a cell, a tissue or an organism, as described herein or as would be known to one of ordinary skill in the art. Such methods include, but are not limited to, direct delivery of DNA such as by injection (U.S. Patents 5,994,624,5,981,274, 5,945,100, 5,780,448, 5,736,524, 5,702,932, 5,656,610, 5,589,466 and 5,580,859, each incorporated herein by reference), including microinjection (Harland and Weintraub, 1985; U.S. Patent 5,789,215, incorporated herein by reference); by electroporation (U.S. Patent No. 5,384,253, incorporated herein by reference); by calcium phosphate precipitation (Graham and Van Der Eb, 1973; Chen and Okayama, 1987; Rippe et al., 1990, which is incorporated herein by reference in its entirety); by using DEAE dextran followed by polyethylene glycol (Gopal, 1985, which is incorporated herein by reference in its entirety); by direct sonic loading (Fechheimer et al., 1987, which is incorporated herein by reference in its entirety); by liposome mediated transfection (Nicolau and Sene, 1982; Fraley et al., 1979; Nicolau et al., 1987; Wong et al., 1980; Kaneda et al., 1989; Kato et al., 1991, each of which are specifically incorporated herein by reference in their entirety); by microprojectile bombardment (PCT Application Nos. WO 94/09699 and 95/06128; U.S. Patents 5,610,042; 5,322,783, 5,563,055, 5,550,318,

5,538,877 and 5,538,880, and each incorporated herein by reference); by agitation with silicon carbide fibers (Kaeppler et al., 1990; U.S. Patents 5,302,523 and 5,464,765, each incorporated herein by reference); by Agrobacterium mediated transformation (U.S. Patents 5,591,616 and 5,563,055, each incorporated herein by reference); or by PEG mediated transformation of protoplasts (Omirulleh et al., 1993; U.S. Patents 4,684,611 and 4,952,500, each incorporated herein by reference); by desiccation/inhibition mediated DNA uptake (Potrykus et al., 1985, which is incorporated herein by reference in its entirety). Other methods include viral transduction, such as gene transfer by lentiviral or retroviral transduction.

3. Host Cells

[0180] In another aspect, contemplated are the use of host cells into which a recombinant expression vector has been introduced. Antibodies can be expressed in a variety of cell types. An expression construct encoding an antibody can be transfected into cells according to a variety of methods known in the art. Vector DNA can be introduced into prokaryotic or eukaryotic cells via conventional transformation or transfection techniques. Some vectors may employ control sequences that allow it to be replicated and/or expressed in both prokaryotic and eukaryotic cells. In certain aspects, the antibody expression construct can be placed under control of a promoter that is linked to T-cell activation, such as one that is controlled by NFAT-1 or NF-κB, both of which are transcription factors that can be activated upon T-cell activation. Control of antibody expression allows T cells, such as tumor- targeting T cells, to sense their surroundings and perform real-time modulation of cytokine signaling, both in the T cells themselves and in surrounding endogenous immune cells. One of skill in the art would understand the conditions under which to incubate host cells to maintain them and to permit replication of a vector. Also understood and known are techniques and conditions that would allow large-scale production of vectors, as well as production of the nucleic acids encoded by vectors and their cognate polypeptides, proteins, or peptides.

[0181] For stable transfection of mammalian cells, it is known, depending upon the expression vector and transfection technique used, only a small fraction of cells may integrate the foreign DNA into their genome. In order to identify and select these integrants, a selectable marker (e.g., for resistance to antibiotics) is generally introduced into the host cells along with the gene of interest. Cells stably transfected with the introduced nucleic acid can be identified by drug selection (e.g., cells that have incorporated the selectable marker gene will survive, while the other cells die), among other methods known in the arts.

B. Isolation

[0182] The nucleic acid molecule encoding either or both of the entire heavy and light chains of an antibody or the variable regions thereof may be obtained from any source that produces antibodies. Methods of isolating mRNA encoding an antibody are well known in the art. See e.g., Sambrook et al., supra. The sequences of human heavy and light chain constant region genes are also known in the art. See, e.g., Kabat et al., 1991, supra. Nucleic acid molecules encoding the full-length heavy and/or light chains may then be expressed in a cell into which they have been introduced and the antibody isolated.

IX. Additional Therapies

A. Immunotherapy

[0183] In some embodiments, the methods comprise administration of an additional therapy. In some embodiments, the additional therapy comprises a cancer immunotherapy. Cancer immunotherapy (sometimes called immuno-oncology, abbreviated IO) is the use of the immune system to treat cancer. Immunotherapies can be categorized as active, passive or hybrid (active and passive). These approaches exploit the fact that cancer cells often have molecules on their surface that can be detected by the immune system, known as tumor-associated antigens (TAAs); they are often proteins or other macromolecules (e.g. carbohydrates). Active immunotherapy directs the immune system to attack tumor cells by targeting TAAs. Passive immunotherapies enhance existing anti-tumor responses and include the use of monoclonal antibodies, lymphocytes and cytokines. Immunotherapies are known in the art, and some are described below.

1. Checkpoint Inhibitors and Combination Treatment

[0184] Embodiments of the disclosure may include administration of immune checkpoint inhibitors, which are further described below.

a. PD-1, PDL1, and PDL2 inhibitors

[0185] PD-1 can act in the tumor microenvironment where T cells encounter an infection or tumor. Activated T cells upregulate PD-1 and continue to express it in the peripheral tissues. Cytokines such as IFN-gamma induce the expression of PDL1 on epithelial cells and tumor cells. PDL2 is expressed on macrophages and dendritic cells. The main role of PD-1 is to limit the activity of effector T cells in the periphery and prevent excessive damage to the tissues during an immune response. Inhibitors of the disclosure may block one or more functions of PD-1 and/or PDL1 activity.

[0186] Alternative names for "PD-1" include CD279 and SLEB2. Alternative names for "PDL1" include B7-H1, B7-4, CD274, and B7-H. Alternative names for "PDL2" include B7-

DC, Btdc, and CD273. In some embodiments, PD-1, PDL1, and PDL2 are human PD-1, PDL1 and PDL2.

[0187] In some embodiments, the PD-1 inhibitor is a molecule that inhibits the binding of PD-1 to its ligand binding partners. In a specific aspect, the PD-1 ligand binding partners are PDL1 and/or PDL2. In another embodiment, a PDL1 inhibitor is a molecule that inhibits the binding of PDL1 to its binding partners. In a specific aspect, PDL1 binding partners are PD-1 and/or B7-1. In another embodiment, the PDL2 inhibitor is a molecule that inhibits the binding of PDL2 to its binding partners. In a specific aspect, a PDL2 binding partner is PD-1. The inhibitor may be an antibody, an antigen binding fragment thereof, an immunoadhesin, a fusion protein, or oligopeptide. Exemplary antibodies are described in U.S. Patent Nos. 8,735,553, 8,354,509, and 8,008,449, all incorporated herein by reference. Other PD-1 inhibitors for use in the methods and compositions provided herein are known in the art such as described in U.S. Patent Application Nos. US2014/0294898, US2014/022021, and US2011/0008369, all incorporated herein by reference.

[0188] In some embodiments, the PD-1 inhibitor is an anti-PD-1 antibody (e.g., a human antibody, a humanized antibody, or a chimeric antibody). In some embodiments, the anti-PD-1 antibody is selected from the group consisting of nivolumab, pembrolizumab, and pidilizumab. In some embodiments, the PD-1 inhibitor is an immunoadhesin (e.g., an immunoadhesin comprising an extracellular or PD-1 binding portion of PDL1 or PDL2 fused to a constant region (e.g., an Fc region of an immunoglobulin sequence). In some embodiments, the PDL1 inhibitor comprises AMP- 224. Nivolumab, also known as MDX-1106-04, MDX-1106, ONO-4538, BMS-936558, and OPDIVO®, is an anti-PD-1 antibody described in WO2006/121168, incorporated herein by reference in its entirety. Pembrolizumab, also known as MK-3475, Merck 3475, lambrolizumab, KEYTRUDA®, and SCH-900475, is an anti-PD-1 antibody described in WO2009/114335, incorporated herein by reference in its entirety. Pidilizumab, also known as CT-011, hBAT, or hBAT-1, is an anti-PD-1 antibody described in WO2009/101611, incorporated herein by reference in its entirety. AMP-224, also known as B7-DCIg, is a PDL2-Fc fusion soluble receptor described in WO2010/027827 and WO2011/066342, each of which are specifically incorporated herein by reference in their entirety. Additional PD-1 inhibitors include MEDI0680, also known as AMP-514, and REGN2810.

[0189] In some embodiments, the immune checkpoint inhibitor is a PDL1 inhibitor such as Durvalumab, also known as MEDI4736, atezolizumab, also known as MPDL3280A, avelumab, also known as MSB00010118C, MDX-1105, BMS-936559, or combinations

thereof. In certain aspects, the immune checkpoint inhibitor is a PDL2 inhibitor such as rHIgM12B7.

[0190] In some embodiments, the inhibitor comprises the heavy and light chain CDRs or VRs of nivolumab, pembrolizumab, or pidilizumab. Accordingly, in one embodiment, the inhibitor comprises the CDR1, CDR2, and CDR3 domains of the VH region of nivolumab, pembrolizumab, or pidilizumab, and the CDR1, CDR2 and CDR3 domains of the VL region of nivolumab, pembrolizumab, or pidilizumab. In another embodiment, the antibody competes for binding with and/or binds to the same epitope on PD-1, PDL1, or PDL2 as the above-mentioned antibodies. In another embodiment, the antibody has at least about 70, 75, 80, 85, 90, 95, 97, or 99% (or any derivable range therein) variable region amino acid sequence identity with the above-mentioned antibodies.

a. **CTLA-4, B7-1, and B7-2**

[0191] Another immune checkpoint that can be targeted in the methods provided herein is the cytotoxic T-lymphocyte-associated protein 4 (CTLA-4), also known as CD152. The complete cDNA sequence of human CTLA-4 has the Genbank accession number L15006. CTLA-4 is found on the surface of T cells and acts as an "off" switch when bound to B7-1 (CD80) or B7-2 (CD86) on the surface of antigen-presenting cells. CTLA4 is a member of the immunoglobulin superfamily that is expressed on the surface of Helper T cells and transmits an inhibitory signal to T cells. CTLA4 is similar to the T-cell co-stimulatory protein, CD28, and both molecules bind to B7-1 and B7-2 on antigen-presenting cells. CTLA-4 transmits an inhibitory signal to T cells, whereas CD28 transmits a stimulatory signal. Intracellular CTLA-4 is also found in regulatory T cells and may be important to their function. T cell activation through the T cell receptor and CD28 leads to increased expression of CTLA-4, an inhibitory receptor for B7 molecules. Inhibitors of the disclosure may block one or more functions of CTLA-4, B7-1, and/or B7-2 activity. In some embodiments, the inhibitor blocks the CTLA-4 and B7-1 interaction. In some embodiments, the inhibitor blocks the CTLA-4 and B7-2 interaction.

[0192] In some embodiments, the immune checkpoint inhibitor is an anti-CTLA-4 antibody (e.g., a human antibody, a humanized antibody, or a chimeric antibody), an antigen binding fragment thereof, an immunoadhesin, a fusion protein, or oligopeptide.

[0193] Anti-human-CTLA-4 antibodies (or VH and/or VL domains derived therefrom) suitable for use in the present methods can be generated using methods well known in the art. Alternatively, art recognized anti-CTLA-4 antibodies can be used. For example, the anti-CTLA-4 antibodies disclosed in: US 8,119,129, WO 01/14424, WO 98/42752; WO 00/37504

(CP675,206, also known as tremelimumab; formerly ticilimumab), U.S. Patent No. 6,207,156; Hurwitz et al., 1998; can be used in the methods disclosed herein. The teachings of each of the aforementioned publications are hereby incorporated by reference. Antibodies that compete with any of these art-recognized antibodies for binding to CTLA-4 also can be used. For example, a humanized CTLA-4 antibody is described in International Patent Application No. WO2001/014424, WO2000/037504, and U.S. Patent No. 8,017,114; all incorporated herein by reference.

[0194] A further anti-CTLA-4 antibody useful as a checkpoint inhibitor in the methods and compositions of the disclosure is ipilimumab (also known as 10D1, MDX- 010, MDX- 101, and Yervoy®) or antigen binding fragments and variants thereof (see, e.g., WO0 1/14424, which is incorporated herein by reference in its entirety).

[0195] In some embodiments, the inhibitor comprises the heavy and light chain CDRs or VRs of tremelimumab or ipilimumab. Accordingly, in one embodiment, the inhibitor comprises the CDR1, CDR2, and CDR3 domains of the VH region of tremelimumab or ipilimumab, and the CDR1, CDR2 and CDR3 domains of the VL region of tremelimumab or ipilimumab. In another embodiment, the antibody competes for binding with and/or binds to the same epitope on PD-1, B7-1, or B7-2 as the above- mentioned antibodies. In another embodiment, the antibody has at least about 70, 75, 80, 85, 90, 95, 97, or 99% (or any derivable range therein) variable region amino acid sequence identity with the above-mentioned antibodies.

2. Activation of co-stimulatory molecules

[0196] In some embodiments, the immunotherapy comprises an activator of a co-stimulatory molecule. In some embodiments, the activator comprises an inhibitor of B7-1 (CD80), B7-2 (CD86), CD28, ICOS, OX40 (TNFRSF4), 4-1BB (CD137; TNFRSF9), CD40L (CD40LG), GITR (TNFRSF18), and combinations thereof. Activators include activating antibodies, polypeptides, compounds, and nucleic acids.

2. Dendritic cell therapy

[0197] Dendritic cell therapy provokes anti-tumor responses by causing dendritic cells to present tumor antigens to lymphocytes, which activates them, priming them to kill other cells that present the antigen. Dendritic cells are antigen presenting cells (APCs) in the mammalian immune system. In cancer treatment they aid cancer antigen targeting. One example of cellular cancer therapy based on dendritic cells is sipuleucel-T.

[0198] One method of inducing dendritic cells to present tumor antigens is by vaccination with autologous tumor lysates or short peptides (small parts of protein that correspond to the

protein antigens on cancer cells). These peptides are often given in combination with adjuvants (highly immunogenic substances) to increase the immune and anti-tumor responses. Other adjuvants include proteins or other chemicals that attract and/or activate dendritic cells, such as granulocyte macrophage colony-stimulating factor (GM-CSF).

[0199] Dendritic cells can also be activated in vivo by making tumor cells express GM-CSF. This can be achieved by either genetically engineering tumor cells to produce GM-CSF or by infecting tumor cells with an oncolytic virus that expresses GM-CSF.

[0200] Another strategy is to remove dendritic cells from the blood of a patient and activate them outside the body. The dendritic cells are activated in the presence of tumor antigens, which may be a single tumor-specific peptide/protein or a tumor cell lysate (a solution of broken down tumor cells). These cells (with optional adjuvants) are infused and provoke an immune response.

[0201] Dendritic cell therapies include the use of antibodies that bind to receptors on the surface of dendritic cells. Antigens can be added to the antibody and can induce the dendritic cells to mature and provide immunity to the tumor. Dendritic cell receptors such as TLR3, TLR7, TLR8 or CD40 have been used as antibody targets.

3. CAR-T cell therapy

[0202] Chimeric antigen receptors (CARs, also known as chimeric immunoreceptors, chimeric T cell receptors or artificial T cell receptors) are engineered receptors that combine a new specificity with an immune cell to target cancer cells. Typically, these receptors graft the specificity of a monoclonal antibody onto a T cell. The receptors are called chimeric because they are fused of parts from different sources. CAR-T cell therapy refers to a treatment that uses such transformed cells for cancer therapy.

[0203] The basic principle of CAR-T cell design involves recombinant receptors that combine antigen-binding and T-cell activating functions. The general premise of CAR-T cells is to artificially generate T-cells targeted to markers found on cancer cells. Scientists can remove T-cells from a person, genetically alter them, and put them back into the patient for them to attack the cancer cells. Once the T cell has been engineered to become a CAR-T cell, it acts as a "living drug". CAR-T cells create a link between an extracellular ligand recognition domain to an intracellular signalling molecule which in turn activates T cells. The extracellular ligand recognition domain is usually a single-chain variable fragment (scFv). An important aspect of the safety of CAR-T cell therapy is how to ensure that only cancerous tumor cells are targeted, and not normal cells. The specificity of CAR-T cells is determined by the choice of molecule that is targeted.

[0204] Exemplary CAR-T therapies include Tisagenlecleucel (Kymriah) and Axicabtagene ciloleucel (Yescarta). In some embodiments, the CAR-T therapy targets CD19.

4. Cytokine therapy

[0205] Cytokines are proteins produced by many types of cells present within a tumor. They can modulate immune responses. The tumor often employs them to allow it to grow and reduce the immune response. These immune-modulating effects allow them to be used as drugs to provoke an immune response. Two commonly used cytokines are interferons and interleukins.

[0206] Interferons are produced by the immune system. They are usually involved in anti-viral response, but also have use for cancer. They fall in three groups: type I (IFNα and IFNβ), type II (IFNγ) and type III (IFNλ).

[0207] Interleukins have an array of immune system effects. IL-2 is an exemplary interleukin cytokine therapy.

5. Adoptive T-cell therapy

[0208] Adoptive T cell therapy is a form of passive immunization by the transfusion of T-cells (adoptive cell transfer). They are found in blood and tissue and usually activate when they find foreign pathogens. Specifically they activate when the T-cell's surface receptors encounter cells that display parts of foreign proteins on their surface antigens. These can be either infected cells, or antigen presenting cells (APCs). They are found in normal tissue and in tumor tissue, where they are known as tumor infiltrating lymphocytes (TILs). They are activated by the presence of APCs such as dendritic cells that present tumor antigens. Although these cells can attack the tumor, the environment within the tumor is highly immunosuppressive, preventing immune-mediated tumour death.[60]

[0209] Multiple ways of producing and obtaining tumour targeted T-cells have been developed. T-cells specific to a tumor antigen can be removed from a tumor sample (TILs) or filtered from blood. Subsequent activation and culturing is performed ex vivo, with the results reinfused. Activation can take place through gene therapy, or by exposing the T cells to tumor antigens.

B. Chemotherapies

[0210] In some embodiments, the additional therapy comprises a chemotherapy. Suitable classes of chemotherapeutic agents include (a) Alkylating Agents, such as nitrogen mustards (e.g., mechlorethamine, cylophosphamide, ifosfamide, melphalan, chlorambucil), ethylenimines and methylmelamines (e.g., hexamethylmelamine, thiotepa), alkyl sulfonates (e.g., busulfan), nitrosoureas (e.g., carmustine, lomustine, chlorozoticin, streptozocin) and

triazines (e.g., dicarbazine), (b) Antimetabolites, such as folic acid analogs (e.g., methotrexate), pyrimidine analogs (e.g., 5-fluorouracil, floxuridine, cytarabine, azauridine) and purine analogs and related materials (e.g., 6-mercaptopurine, 6-thioguanine, pentostatin), (c) Natural Products, such as vinca alkaloids (e.g., vinblastine, vincristine), epipodophylotoxins (e.g., etoposide, teniposide), antibiotics (e.g., dactinomycin, daunorubicin, doxorubicin, bleomycin, plicamycin and mitoxanthrone), enzymes (e.g., L-asparaginase), and biological response modifiers (e.g., Interferon-α), and (d) Miscellaneous Agents, such as platinum coordination complexes (e.g., cisplatin, carboplatin), substituted ureas (e.g., hydroxyurea), methylhydiazine derivatives (e.g., procarbazine), and adreocortical suppressants (e.g., taxol and mitotane). In some embodiments, cisplatin is a particularly suitable chemotherapeutic agent.

[0211] Cisplatin has been widely used to treat cancers such as, for example, metastatic testicular or ovarian carcinoma, advanced bladder cancer, head or neck cancer, cervical cancer, lung cancer or other tumors. Cisplatin is not absorbed orally and must therefore be delivered via other routes such as, for example, intravenous, subcutaneous, intratumoral or intraperitoneal injection. Cisplatin can be used alone or in combination with other agents, with efficacious doses used in clinical applications including about 15 mg/m^2 to about 20 mg/m^2 for 5 days every three weeks for a total of three courses being contemplated in certain embodiments. In some embodiments, the amount of cisplatin delivered to the cell and/or subject in conjunction with the construct comprising an Egr-1 promoter operably linked to a polynucleotide encoding the therapeutic polypeptide is less than the amount that would be delivered when using cisplatin alone.

[0212] Other suitable chemotherapeutic agents include antimicrotubule agents, e.g., Paclitaxel ("Taxol") and doxorubicin hydrochloride ("doxorubicin"). The combination of an Egr-1 promoter/TNFα construct delivered via an adenoviral vector and doxorubicin was determined to be effective in overcoming resistance to chemotherapy and/or TNF-α, which suggests that combination treatment with the construct and doxorubicin overcomes resistance to both doxorubicin and TNF-α.

[0213] Doxorubicin is absorbed poorly and is preferably administered intravenously. In certain embodiments, appropriate intravenous doses for an adult include about 60 mg/m^2 to about 75 mg/m^2 at about 21-day intervals or about 25 mg/m^2 to about 30 mg/m^2 on each of 2 or 3 successive days repeated at about 3 week to about 4 week intervals or about 20 mg/m^2 once a week. The lowest dose should be used in elderly patients, when there is prior bone-marrow depression caused by prior chemotherapy or neoplastic marrow invasion, or when the drug is combined with other myelopoietic suppressant drugs.

[0214] Nitrogen mustards are another suitable chemotherapeutic agent useful in the methods of the disclosure. A nitrogen mustard may include, but is not limited to, mechlorethamine (HN_2), cyclophosphamide and/or ifosfamide, melphalan (L-sarcolysin), and chlorambucil. Cyclophosphamide (CYTOXAN®) is available from Mead Johnson and NEOSTAR® is available from Adria), is another suitable chemotherapeutic agent. Suitable oral doses for adults include, for example, about 1 mg/kg/day to about 5 mg/kg/day, intravenous doses include, for example, initially about 40 mg/kg to about 50 mg/kg in divided doses over a period of about 2 days to about 5 days or about 10 mg/kg to about 15 mg/kg about every 7 days to about 10 days or about 3 mg/kg to about 5 mg/kg twice a week or about 1.5 mg/kg/day to about 3 mg/kg/day. Because of adverse gastrointestinal effects, the intravenous route is preferred. The drug also sometimes is administered intramuscularly, by infiltration or into body cavities.

[0215] Additional suitable chemotherapeutic agents include pyrimidine analogs, such as cytarabine (cytosine arabinoside), 5-fluorouracil (fluouracil; 5-FU) and floxuridine (fluorodeoxyuridine; FudR). 5-FU may be administered to a subject in a dosage of anywhere between about 7.5 to about 1000 mg/m2. Further, 5-FU dosing schedules may be for a variety of time periods, for example up to six weeks, or as determined by one of ordinary skill in the art to which this disclosure pertains.

[0216] Gemcitabine diphosphate (GEMZAR®, Eli Lilly & Co., "gemcitabine"), another suitable chemotherapeutic agent, is recommended for treatment of advanced and metastatic pancreatic cancer, and will therefore be useful in the present disclosure for these cancers as well.

[0217] The amount of the chemotherapeutic agent delivered to the patient may be variable. In one suitable embodiment, the chemotherapeutic agent may be administered in an amount effective to cause arrest or regression of the cancer in a host, when the chemotherapy is administered with the construct. In other embodiments, the chemotherapeutic agent may be administered in an amount that is anywhere between 2 to 10,000 fold less than the chemotherapeutic effective dose of the chemotherapeutic agent. For example, the chemotherapeutic agent may be administered in an amount that is about 20 fold less, about 500 fold less or even about 5000 fold less than the chemotherapeutic effective dose of the chemotherapeutic agent. The chemotherapeutics of the disclosure can be tested in vivo for the desired therapeutic activity in combination with the construct, as well as for determination of effective dosages. For example, such compounds can be tested in suitable animal model systems prior to testing in humans, including, but not limited to, rats, mice, chicken, cows,

monkeys, rabbits, etc. In vitro testing may also be used to determine suitable combinations and dosages, as described in the examples.

C. Radiotherapy

[0218] In some embodiments, the additional therapy or prior therapy comprises radiation, such as ionizing radiation. As used herein, "ionizing radiation" means radiation comprising particles or photons that have sufficient energy or can produce sufficient energy via nuclear interactions to produce ionization (gain or loss of electrons). An exemplary and preferred ionizing radiation is an x-radiation. Means for delivering x-radiation to a target tissue or cell are well known in the art.

D. Surgery

[0219] In some embodiments, the additional therapy comprises surgery. Approximately 60% of persons with cancer will undergo surgery of some type, which includes preventative, diagnostic or staging, curative, and palliative surgery. Curative surgery includes resection in which all or part of cancerous tissue is physically removed, excised, and/or destroyed and may be used in conjunction with other therapies, such as the treatment of the present embodiments, chemotherapy, radiotherapy, hormonal therapy, gene therapy, immunotherapy, and/or alternative therapies. Tumor resection refers to physical removal of at least part of a tumor. In addition to tumor resection, treatment by surgery includes laser surgery, cryosurgery, electrosurgery, and microscopically-controlled surgery (Mohs' surgery).

[0220] Upon excision of part or all of cancerous cells, tissue, or tumor, a cavity may be formed in the body. Treatment may be accomplished by perfusion, direct injection, or local application of the area with an additional anti-cancer therapy. Such treatment may be repeated, for example, every 1, 2, 3, 4, 5, 6, or 7 days, or every 1, 2, 3, 4, and 5 weeks or every 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12 months (or any range derivable therein). These treatments may be of varying dosages as well.

X. Formulations and Culture of the Cells

[0221] In particular embodiments, the cells of the disclosure may be specifically formulated and/or they may be cultured in a particular medium. The cells may be formulated in such a manner as to be suitable for delivery to a recipient without deleterious effects.

[0222] The medium in certain aspects can be prepared using a medium used for culturing animal cells as their basal medium, such as any of AIM V, X-VIVO-15, NeuroBasal, EGM2, TeSR, BME, BGJb, CMRL 1066, Glasgow MEM, Improved MEM Zinc Option, IMDM, Medium 199, Eagle MEM, αMEM, DMEM, Ham, RPMI-1640, and Fischer's media, as well as any combinations thereof, but the medium may not be particularly limited thereto as far as

it can be used for culturing animal cells. Particularly, the medium may be xeno-free or chemically defined.

[0223] The medium can be a serum-containing or serum-free medium, or xeno-free medium. From the aspect of preventing contamination with heterogeneous animal-derived components, serum can be derived from the same animal as that of the stem cell(s). The serum-free medium refers to medium with no unprocessed or unpurified serum and accordingly, can include medium with purified blood-derived components or animal tissue-derived components (such as growth factors).

[0224] The medium may contain or may not contain any alternatives to serum. The alternatives to serum can include materials which appropriately contain albumin (such as lipid-rich albumin, bovine albumin, albumin substitutes such as recombinant albumin or a humanized albumin, plant starch, dextrans and protein hydrolysates), transferrin (or other iron transporters), fatty acids, insulin, collagen precursors, trace elements, 2-mercaptoethanol, 3'-thiolgiycerol, or equivalents thereto. The alternatives to serum can be prepared by the method disclosed in International Publication No. 98/30679, for example (incorporated herein in its entirety). Alternatively, any commercially available materials can be used for more convenience. The commercially available materials include knockout Serum Replacement (KSR), Chemically-defined Lipid concentrated (Gibco), and Glutamax (Gibco).

[0225] In certain embodiments, the medium may comprise one, two, three, four, five, six, seven, eight, nine, ten, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 or more of the following: Vitamins such as biotin; DL Alpha Tocopherol Acetate; DL Alpha-Tocopherol; Vitamin A (acetate); proteins such as BSA (bovine serum albumin) or human albumin, fatty acid free Fraction V; Catalase; Human Recombinant Insulin; Human Transferrin; Superoxide Dismutase; Other Components such as Corticosterone; D-Galactose; Ethanolamine HCl; Glutathione (reduced); L-Carnitine HCl; Linoleic Acid; Linolenic Acid; Progesterone; Putrescine 2HCl; Sodium Selenite; and/or T3 (triodo-I-thyronine). . In specific embodiments, one or more of these may be explicitly excluded.

[0226] In some embodiments, the medium further comprises vitamins. In some embodiments, the medium comprises 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, or 13 of the following (and any range derivable therein): biotin, DL alpha tocopherol acetate, DL alpha-tocopherol, vitamin A, choline chloride, calcium pantothenate, pantothenic acid, folic acid nicotinamide, pyridoxine, riboflavin, thiamine, inositol, vitamin B12, or the medium includes combinations thereof or salts thereof. In some embodiments, the medium comprises or consists essentially of biotin, DL alpha tocopherol acetate, DL alpha-tocopherol, vitamin A, choline chloride, calcium

pantothenate, pantothenic acid, folic acid nicotinamide, pyridoxine, riboflavin, thiamine, inositol, and vitamin B12. In some embodiments, the vitamins include or consist essentially of biotin, DL alpha tocopherol acetate, DL alpha-tocopherol, vitamin A, or combinations or salts thereof. In some embodiments, the medium further comprises proteins. In some embodiments, the proteins comprise albumin or bovine serum albumin, a fraction of BSA, catalase, insulin, transferrin, superoxide dismutase, or combinations thereof. In some embodiments, the medium further comprises one or more of the following: corticosterone, D-Galactose, ethanolamine, glutathione, L-carnitine, linoleic acid, linolenic acid, progesterone, putrescine, sodium selenite, or triodo-I-thyronine, or combinations thereof. In some embodiments, the medium comprises one or more of the following: a B-27® supplement, xeno-free B-27® supplement, GS21™ supplement, or combinations thereof. In some embodiments, the medium comprises or futher comprises amino acids, monosaccharides, inorganic ions. In some embodiments, the amino acids comprise arginine, cystine, isoleucine, leucine, lysine, methionine, glutamine, phenylalanine, threonine, tryptophan, histidine, tyrosine, or valine, or combinations thereof. In some embodiments, the inorganic ions comprise sodium, potassium, calcium, magnesium, nitrogen, or phosphorus, or combinations or salts thereof. In some embodiments, the medium further comprises one or more of the following: molybdenum, vanadium, iron, zinc, selenium, copper, or manganese, or combinations thereof. In certain embodiments, the medium comprises or consists essentially of one or more vitamins discussed herein and/or one or more proteins discussed herein, and/or one or more of the following: corticosterone, D-Galactose, ethanolamine, glutathione, L-carnitine, linoleic acid, linolenic acid, progesterone, putrescine, sodium selenite, or triodo-I-thyronine, a B-27® supplement, xeno-free B-27® supplement, GS21™ supplement, an amino acid (such as arginine, cystine, isoleucine, leucine, lysine, methionine, glutamine, phenylalanine, threonine, tryptophan, histidine, tyrosine, or valine), monosaccharide, inorganic ion (such as sodium, potassium, calcium, magnesium, nitrogen, and/or phosphorus) or salts thereof, and/or molybdenum, vanadium, iron, zinc, selenium, copper, or manganese. In specific embodiments, one or more of these may be explicitly excluded.

[0227] The medium can also contain one or more externally added fatty acids or lipids, amino acids (such as non-essential amino acids), vitamin(s), growth factors, cytokines, antioxidant substances, 2-mercaptoethanol, pyruvic acid, buffering agents, and/or inorganic salts. . In specific embodiments, one or more of these may be explicitly excluded.

[0228] One or more of the medium components may be added at a concentration of at least, at most, or about 0.1, 0.5, 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 150, 180, 200, 250 ng/L, ng/ml, μg/ml, mg/ml, or any range derivable therein.

[0229] In specific embodiments, the cells of the disclosure are specifically formulated. They may or may not be formulated as a cell suspension. In specific cases they are formulated in a single dose form. They may be formulated for systemic or local administration. In some cases the cells are formulated for storage prior to use, and the cell formulation may comprise one or more cryopreservation agents, such as DMSO (for example, in 5% DMSO). The cell formulation may comprise albumin, including human albumin, with a specific formulation comprising 2.5% human albumin. The cells may be formulated specifically for intravenous administration; for example, they are formulated for intravenous administration over less than one hour. In particular embodiments the cells are in a formulated cell suspension that is stable at room temperature for 1, 2, 3, or 4 hours or more from time of thawing.

[0230] In some embodiments, the method further comprises priming the T cells. In some embodiments, the T cells are primed with antigen presenting cells. In some embodiments, the antigen presenting cells present tumor antigens or peptides, such as those disclosed herein.

[0231] In particular embodiments, the cells of the disclosure comprise an exogenous TCR, which may be of a defined antigen specificity. In some embodiments, the TCR can be selected based on absent or reduced alloreactivity to the intended recipient (examples include certain virus-specific TCRs, xeno-specific TCRs, or cancer-testis antigen-specific TCRs). In the example where the exogenous TCR is non-alloreactive, during T cell differentiation the exogenous TCR suppresses rearrangement and/or expression of endogenous TCR loci through a developmental process called allelic exclusion, resulting in T cells that express only the non-alloreactive exogenous TCR and are thus non-alloreactive. In some embodiments, the choice of exogenous TCR may not necessarily be defined based on lack of alloreactivity. In some embodiments, the endogenous TCR genes have been modified by genome editing so that they do not express a protein. Methods of gene editing such as methods using the CRISPR/Cas9 system are known in the art and described herein.

[0232] In some embodiments, the cells of the disclosure further comprise one or more chimeric antigen receptors (CARs). Examples of tumor cell antigens to which a CAR may be directed include at least 5T4, 8H9, $\alpha_v\beta_6$ integrin, BCMA, B7-H3, B7-H6, CAIX, CA9, CD19, CD20, CD22, CD30, CD33, CD38, CD44, CD44v6, CD44v7/8, CD70, CD123, CD138, CD171, CEA, CSPG4, EGFR, EGFR family including ErbB2 (HER2), EGFRvIII, EGP2, EGP40, ERBB3, ERBB4, ErbB3/4, EPCAM, EphA2, EpCAM, folate receptor-a, FAP, FBP,

fetal AchR, FRα, GD2, G250/CAIX, GD3, Glypican-3 (GPC3), Her2, IL-13Rα2, Lambda, Lewis-Y, Kappa, KDR, MAGE, MCSP, Mesothelin, Muc1, Muc16, NCAM, NKG2D Ligands, NY-ESO-1, PRAME, PSC1, PSCA, PSMA, ROR1, SP17, Survivin, TAG72, TEMs, carcinoembryonic antigen, HMW-MAA, AFP, CA-125, ETA, Tyrosinase, MAGE, laminin receptor, HPV E6, E7, BING-4, Calcium-activated chloride channel 2, Cyclin-B1, 9D7, EphA3, Telomerase, SAP-1, BAGE family, CAGE family, GAGE family, MAGE family, SAGE family, XAGE family, NY-ESO-1/LAGE-1, PAME, SSX-2, Melan-A/MART-1, GP100/pmel17, TRP-1/-2, P. polypeptide, MC1R, Prostate-specific antigen, β-catenin, BRCA1/2, CML66, Fibronectin, MART-2, TGF-βRII, or VEGF receptors (*e.g.*, VEGFR2), for example. The CAR may be a first, second, third, or more generation CAR. The CAR may be bispecific for any two nonidentical antigens, or it may be specific for more than two nonidentical antigens.

XI. Administration of Therapeutic Compositions

[0233] The therapy provided herein may comprise administration of a combination of therapeutic agents, such as a first cancer therapy and a second cancer therapy. The therapies may be administered in any suitable manner known in the art. For example, the first and second cancer treatment may be administered sequentially (at different times) or concurrently (at the same time). In some embodiments, the first and second cancer treatments are administered in a separate composition. In some embodiments, the first and second cancer treatments are in the same composition.

[0234] Embodiments of the disclosure relate to compositions and methods comprising therapeutic compositions. The different therapies may be administered in one composition or in more than one composition, such as 2 compositions, 3 compositions, or 4 compositions. Various combinations of the agents may be employed.

[0235] The therapeutic agents of the disclosure may be administered by the same route of administration or by different routes of administration. In some embodiments, the cancer therapy is administered intravenously, intramuscularly, subcutaneously, topically, orally, transdermally, intraperitoneally, intraorbitally, by implantation, by inhalation, intrathecally, intraventricularly, or intranasally. In some embodiments, the antibiotic is administered intravenously, intramuscularly, subcutaneously, topically, orally, transdermally, intraperitoneally, intraorbitally, by implantation, by inhalation, intrathecally, intraventricularly, or intranasally. The appropriate dosage may be determined based on the type of disease to be treated, severity and course of the disease, the clinical condition of the

individual, the individual's clinical history and response to the treatment, and the discretion of the attending physician.

[0236] The treatments may include various "unit doses." Unit dose is defined as containing a predetermined-quantity of the therapeutic composition. The quantity to be administered, and the particular route and formulation, is within the skill of determination of those in the clinical arts. A unit dose need not be administered as a single injection but may comprise continuous infusion over a set period of time. In some embodiments, a unit dose comprises a single administrable dose.

[0237] The quantity to be administered, both according to number of treatments and unit dose, depends on the treatment effect desired. An effective dose is understood to refer to an amount necessary to achieve a particular effect. In the practice in certain embodiments, it is contemplated that doses in the range from 10 mg/kg to 200 mg/kg can affect the protective capability of these agents. Thus, it is contemplated that doses include doses of about 0.1, 0.5, 1, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 100, 105, 110, 115, 120, 125, 130, 135, 140, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195, and 200, 300, 400, 500, 1000 μg/kg, mg/kg, μg/day, or mg/day or any range derivable therein. Furthermore, such doses can be administered at multiple times during a day, and/or on multiple days, weeks, or months.

[0238] In certain embodiments, the effective dose of the pharmaceutical composition is one which can provide a blood level of about 1 μM to 150 μM. In another embodiment, the effective dose provides a blood level of about 4 μM to 100 μM.; or about 1 μM to 100 μM; or about 1 μM to 50 μM; or about 1 μM to 40 μM; or about 1 μM to 30 μM; or about 1 μM to 20 μM; or about 1 μM to 10 μM; or about 10 μM to 150 μM; or about 10 μM to 100 μM; or about 10 μM to 50 μM; or about 25 μM to 150 μM; or about 25 μM to 100 μM; or about 25 μM to 50 μM; or about 50 μM to 150 μM; or about 50 μM to 100 μM (or any range derivable therein). In other embodiments, the dose can provide the following blood level of the agent that results from a therapeutic agent being administered to a subject: about, at least about, or at most about 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, or 100 μM or any range derivable therein. In certain embodiments, the therapeutic agent that is administered to a subject is metabolized in the body to a metabolized therapeutic agent, in which case the blood levels may refer to the amount of that agent. Alternatively, to the extent the therapeutic

agent is not metabolized by a subject, the blood levels discussed herein may refer to the unmetabolized therapeutic agent.

[0239] Precise amounts of the therapeutic composition also depend on the judgment of the practitioner and are peculiar to each individual. Factors affecting dose include physical and clinical state of the patient, the route of administration, the intended goal of treatment (alleviation of symptoms versus cure) and the potency, stability and toxicity of the particular therapeutic substance or other therapies a subject may be undergoing.

[0240] It will be understood by those skilled in the art and made aware that dosage units of μg/kg or mg/kg of body weight can be converted and expressed in comparable concentration units of μg/ml or mM (blood levels), such as 4 μM to 100 μM. It is also understood that uptake is species and organ/tissue dependent. The applicable conversion factors and physiological assumptions to be made concerning uptake and concentration measurement are well-known and would permit those of skill in the art to convert one concentration measurement to another and make reasonable comparisons and conclusions regarding the doses, efficacies and results described herein.

[0241] "Tumor," as used herein, refers to all neoplastic cell growth and proliferation, whether malignant or benign, and all pre-cancerous and cancerous cells and tissues. The terms "cancer," "cancerous," "cell proliferative disorder," "proliferative disorder," and "tumor" are not mutually exclusive as referred to herein.

[0242] The cancers amenable for treatment include, but are not limited to, tumors of all types, locations, sizes, and characteristics. The methods and compositions of the disclosure are suitable for treating, for example, pancreatic cancer, colon cancer, acute myeloid leukemia, adrenocortical carcinoma, AIDS-related cancers, AIDS-related lymphoma, anal cancer, appendix cancer, astrocytoma, childhood cerebellar or cerebral basal cell carcinoma, bile duct cancer, extrahepatic bladder cancer, bone cancer, osteosarcoma/malignant fibrous histiocytoma, brainstem glioma, brain tumor, cerebellar astrocytoma brain tumor, cerebral astrocytoma/malignant glioma brain tumor, ependymoma brain tumor, medulloblastoma brain tumor, supratentorial primitive neuroectodermal tumors brain tumor, visual pathway and hypothalamic glioma, breast cancer, lymphoid cancer, bronchial adenomas/carcinoids, tracheal cancer, Burkitt lymphoma, carcinoid tumor, childhood carcinoid tumor, gastrointestinal carcinoma of unknown primary, central nervous system lymphoma, primary cerebellar astrocytoma, childhood cerebral astrocytoma/malignant glioma, childhood cervical cancer, childhood cancers, chronic lymphocytic leukemia, chronic myelogenous leukemia, chronic myeloproliferative disorders, cutaneous T-cell lymphoma, desmoplastic small round cell

tumor, endometrial cancer, ependymoma, esophageal cancer, Ewing's, childhood extragonadal Germ cell tumor, extrahepatic bile duct cancer, eye Cancer, intraocular melanoma eye Cancer, retinoblastoma, gallbladder cancer, gastric (stomach) cancer, gastrointestinal carcinoid tumor, gastrointestinal stromal tumor (GIST), germ cell tumor: extracranial, extragonadal, or ovarian, gestational trophoblastic tumor, glioma of the brain stem, glioma, childhood cerebral astrocytoma, childhood visual pathway and hypothalamic glioma, gastric carcinoid, hairy cell leukemia, head and neck cancer, heart cancer, hepatocellular (liver) cancer, Hodgkin lymphoma, hypopharyngeal cancer, hypothalamic and visual pathway glioma, childhood intraocular melanoma, islet cell carcinoma (endocrine pancreas), kaposi sarcoma, kidney cancer (renal cell cancer), laryngeal cancer , leukemia, acute lymphoblastic (also called acute lymphocytic leukemia) leukemia, acute myeloid (also called acute myelogenous leukemia) leukemia, chronic lymphocytic (also called chronic lymphocytic leukemia) leukemia, chronic myelogenous (also called chronic myeloid leukemia) leukemia, hairy cell lip and oral cavity cancer, liposarcoma, liver cancer (primary), lung cancer, non-small cell lung cancer, small cell lung cancer, lymphomas, AIDS-related lymphoma, brain cancer, glioblastoma, Burkitt lymphoma, cutaneous T-cell lymphoma, Hodgkin lymphoma, Non-Hodgkin (an old classification of all lymphomas except Hodgkin's) lymphoma, primary central nervous system lymphoma, Waldenstrom macroglobulinemia, malignant fibrous histiocytoma of bone/osteosarcoma, childhood medulloblastoma, melanoma, intraocular (eye) melanoma, merkel cell carcinoma, adult malignant mesothelioma, childhood mesothelioma, metastatic squamous neck cancer, mouth cancer, multiple endocrine neoplasia syndrome, multiple myeloma/plasma cell neoplasm, mycosis fungoides, myelodysplastic syndromes, myelodysplastic/myeloproliferative diseases, chronic myelogenous leukemia, adult acute myeloid leukemia, childhood acute myeloid leukemia, multiple myeloma, chronic myeloproliferative disorders, nasal cavity and paranasal sinus cancer, nasopharyngeal carcinoma, neuroblastoma, oral cancer, oropharyngeal cancer, osteosarcoma/malignant, fibrous histiocytoma of bone, ovarian cancer, ovarian epithelial cancer (surface epithelial-stromal tumor), ovarian germ cell tumor, ovarian low malignant potential tumor, pancreatic cancer, islet cell paranasal sinus and nasal cavity cancer, parathyroid cancer, penile cancer, pharyngeal cancer, pheochromocytoma, pineal astrocytoma, pineal germinoma, pineoblastoma and supratentorial primitive neuroectodermal tumors, childhood pituitary adenoma, plasma cell neoplasia/multiple myeloma, pleuropulmonary blastoma, primary central nervous system lymphoma, prostate cancer, rectal cancer, renal cell carcinoma (kidney cancer), renal pelvis and ureter transitional cell cancer, retinoblastoma, rhabdomyosarcoma, childhood Salivary

gland cancer Sarcoma, Ewing family of tumors, Kaposi sarcoma, soft tissue sarcoma, uterine sezary syndrome sarcoma, skin cancer (nonmelanoma), skin cancer (melanoma), skin carcinoma, Merkel cell small cell lung cancer, small intestine cancer, soft tissue sarcoma, squamous cell carcinoma. squamous neck cancer with occult primary, metastatic stomach cancer, supratentorial primitive neuroectodermal tumor, childhood T-cell lymphoma, testicular cancer, throat cancer, thymoma, childhood thymoma, thymic carcinoma, thyroid cancer, urethral cancer, uterine cancer, endometrial uterine sarcoma, vaginal cancer, visual pathway and hypothalamic glioma, childhood vulvar cancer, and wilms tumor (kidney cancer).

XII. Sample Preparation

[0243] In certain aspects, methods involve obtaining a sample from a subject. The methods of obtaining provided herein may include methods of biopsy such as fine needle aspiration, core needle biopsy, vacuum assisted biopsy, incisional biopsy, excisional biopsy, punch biopsy, shave biopsy or skin biopsy. In certain embodiments the sample is obtained from a biopsy from ovarian or endometrial tissue by any of the biopsy methods previously mentioned. In other embodiments the sample may be obtained from any of the tissues provided herein that include but are not limited to non-cancerous or cancerous tissue and non-cancerous or cancerous tissue from the ovarian epithelium, fallopian epithelium, ovaries, cervix, fallopian tube, or uterus. Alternatively, the sample may be obtained from any other source including but not limited to blood, serum, plasma, sweat, hair follicle, buccal tissue, tears, menses, feces, or saliva. In certain aspects of the current methods, any medical professional such as a doctor, nurse or medical technician may obtain a biological sample for testing. Yet further, the biological sample can be obtained without the assistance of a medical professional.

[0244] A sample may include but is not limited to, tissue, cells, or biological material from cells or derived from cells of a subject. The biological sample may be a heterogeneous or homogeneous population of cells or tissues. The biological sample may be obtained using any method known to the art that can provide a sample suitable for the analytical methods described herein. The sample may be obtained by non-invasive methods including but not limited to: scraping of the skin or cervix, swabbing of the cheek, saliva collection, urine collection, feces collection, collection of menses, tears, or semen.

[0245] The sample may be obtained by methods known in the art. In certain embodiments the samples are obtained by biopsy. In other embodiments the sample is obtained by swabbing, endoscopy, scraping, phlebotomy, or any other methods known in the art. In some cases, the

sample may be obtained, stored, or transported using components of a kit of the present methods. In some cases, multiple samples, such as multiple plasma or serum samples may be obtained for diagnosis by the methods described herein. In other cases, multiple samples, such as one or more samples from one tissue type (for example ovaries or related tissues) and one or more samples from another specimen (for example serum) may be obtained for diagnosis by the methods. Samples may be obtained at different times are stored and/or analyzed by different methods. For example, a sample may be obtained and analyzed by routine staining methods or any other cytological analysis methods.

[0246] In some embodiments the biological sample may be obtained by a physician, nurse, or other medical professional such as a medical technician, endocrinologist, cytologist, phlebotomist, radiologist, or a pulmonologist. The medical professional may indicate the appropriate test or assay to perform on the sample. In certain aspects a molecular profiling business may consult on which assays or tests are most appropriately indicated. In further aspects of the current methods, the patient or subject may obtain a biological sample for testing without the assistance of a medical professional, such as obtaining a whole blood sample, a urine sample, a fecal sample, a buccal sample, or a saliva sample.

[0247] In other cases, the sample is obtained by an invasive procedure including but not limited to: biopsy, needle aspiration, blood draw, endoscopy, or phlebotomy. The method of needle aspiration may further include fine needle aspiration, core needle biopsy, vacuum assisted biopsy, or large core biopsy. In some embodiments, multiple samples may be obtained by the methods herein to ensure a sufficient amount of biological material.

[0248] General methods for obtaining biological samples are also known in the art. Publications such as Ramzy, Ibrahim Clinical Cytopathology and Aspiration Biopsy 2001, which is herein incorporated by reference in its entirety, describes general methods for biopsy and cytological methods.

[0249] In some embodiments of the present methods, the molecular profiling business may obtain the biological sample from a subject directly, from a medical professional, from a third party, or from a kit provided by a molecular profiling business or a third party. In some cases, the biological sample may be obtained by the molecular profiling business after the subject, a medical professional, or a third party acquires and sends the biological sample to the molecular profiling business. In some cases, the molecular profiling business may provide suitable containers, and excipients for storage and transport of the biological sample to the molecular profiling business.

[0250] In some embodiments of the methods described herein, a medical professional need not be involved in the initial diagnosis or sample acquisition. An individual may alternatively obtain a sample through the use of an over the counter (OTC) kit. An OTC kit may contain a means for obtaining said sample as described herein, a means for storing said sample for inspection, and instructions for proper use of the kit. In some cases, molecular profiling services are included in the price for purchase of the kit. In other cases, the molecular profiling services are billed separately. A sample suitable for use by the molecular profiling business may be any material containing tissues, cells, nucleic acids, genes, gene fragments, expression products, gene expression products, or gene expression product fragments of an individual to be tested. Methods for determining sample suitability and/or adequacy are provided.

[0251] In some embodiments, the subject may be referred to a specialist such as an oncologist, surgeon, or endocrinologist. The specialist may likewise obtain a biological sample for testing or refer the individual to a testing center or laboratory for submission of the biological sample. In some cases the medical professional may refer the subject to a testing center or laboratory for submission of the biological sample. In other cases, the subject may provide the sample. In some cases, a molecular profiling business may obtain the sample.

XIII. Detection and Vaccination Kits

[0252] A peptide or antibody of the disclosure may be included in a kit. The peptide or antibody in the kit may be detectably labeled or immobilized on a surface of a support substrate also comprised in the kit. The peptide(s) or antibody may, for example, be provided in the kit in a suitable form, such as sterile, lyophilized, or both.

[0253] The support substrate comprised in a kit of the invention may be selected based on the method to be performed. By way of nonlimiting example, a support substrate may be a multi-well plate or microplate, a membrane, a filter, a paper, an emulsion, a bead, a microbead, a microsphere, a nanobead, a nanosphere, a nanoparticle, an ethosome, a liposome, a niosome, a transferosome, a dipstick, a card, a celluloid strip, a glass slide, a microslide, a biosensor, a lateral flow apparatus, a microchip, a comb, a silica particle, a magnetic particle, or a self-assembling monolayer.

[0254] As appropriate to the method being performed, a kit may further comprise one or more apparatuses for delivery of a composition to a subject or for otherwise handling a composition of the invention. By way of nonlimiting example, a kit may include an apparatus that is a syringe, an eye dropper, a ballistic particle applicator (e.g., applicators disclosed in

U.S. Patents 5,797,898, 5,770,219 and 5,783,208, and U.S. Patent Application 2005/0065463), a scoopula, a microslide cover, a test strip holder or cover, and such like.

[0255] A detection reagent for labeling a component of the kit may optionally be comprised in a kit for performing a method of the present invention. In particular embodiments, the labeling or detection reagent is selected from a group comprising reagents used commonly in the art and including, without limitation, radioactive elements, enzymes, molecules which absorb light in the UV range, and fluorophores such as fluorescein, rhodamine, auramine, Texas Red, AMCA blue and Lucifer Yellow. In other embodiments, a kit is provided comprising one or more container means and a BST protein agent already labeled with a detection reagent selected from a group comprising a radioactive element, an enzyme, a molecule which absorbs light in the UV range, and a fluorophore.

[0256] When reagents and/or components comprising a kit are provided in a lyophilized form (lyophilisate) or as a dry powder, the lyophilisate or powder can be reconstituted by the addition of a suitable solvent. In particular embodiments, the solvent may be a sterile, pharmaceutically acceptable buffer and/or other diluent. It is envisioned that such a solvent may also be provided as part of a kit.

[0257] When the components of a kit are provided in one and/or more liquid solutions, the liquid solution may be, by way of non-limiting example, a sterile, aqueous solution. The compositions may also be formulated into an administrative composition. In this case, the container means may itself be a syringe, pipette, topical applicator or the like, from which the formulation may be applied to an affected area of the body, injected into a subject, and/or applied to or mixed with the other components of the kit.

XIV. Examples

[0258] The following examples are included to demonstrate preferred embodiments of the invention. It should be appreciated by those of skill in the art that the techniques disclosed in the examples which follow represent techniques discovered by the inventor to function well in the practice of the invention, and thus can be considered to constitute preferred modes for its practice. However, those of skill in the art should, in light of the present disclosure, appreciate that many changes can be made in the specific embodiments which are disclosed and still obtain a like or similar result without departing from the spirit and scope of the invention.

Example 1: Pathway-guided analysis identifies Myc-dependent alternative pre-mRNA splicing in aggressive prostate cancers

[0259] Alternative pre-mRNA splicing is a regulated process that greatly diversifies gene products by changing the exons incorporated into mRNA. This process is dysregulated in

cancers. Here, the inventors studied exon usage in aggressive prostate cancers and linked exon incorporation decisions to cancer driver genes. Through computational and experimental studies, the inventors found that a strong cancer driver gene, Myc, was linked to exon changes in genes that themselves regulate alternative splicing. These exons often encoded premature stop codons that would decrease gene expression, suggestive of a Myc-driven auto-regulatory loop to help control levels of splicing regulatory proteins.

[0260] Alternative pre-mRNA splicing is a regulated process that governs exon choice and greatly diversifies the proteome. It is an essential process that contributes to development, tissue specification, and homeostasis and is often dysregulated in disease states (1). In cancer, this includes growth signaling, epithelial-to-mesenchymal transition, resistance to apoptosis, and treatment resistance (2). In prostate cancer, our area of interest, the most notable splicing change is the emergence of the ligand-independent androgen receptor ARV7 isoform in response to hormone deprivation (3). Other examples include pro-angiogenic splice variants of VEGFA (4), tumorigenic variants of the transcription factors ERG and KLF6 (5, 6), and anti-apoptotic splicing of BCL2L2 (7, 8). However, the intersection of upstream oncogenic signaling, pre- mRNA splicing, and the biological processes affected by those splicing events has not been defined at a global level.

[0261] Prostate cancers progress from hormone-responsive, localized disease to hormone-independent, metastatic disease accompanied by changes in gene expression and mutations that confer cell autonomous growth and therapeutic resistance (9). The study of disease progression from primary prostate adenocarcinoma (PrAd) to metastatic, castration-resistant prostate cancer (mCRPC) and treatment-related neuroendocrine prostate cancer (NEPC) has been aided by large- scale genomic and transcriptomic studies of patient samples representing each form of the disease (10-13). Examples of driver alterations found in precursor lesions and primary tumors include TMPRSS2-ERG translocations and PTEN loss (14). Metastatic tumors are characterized by Myc and AR amplification (15, 16). NEPC includes near-universal loss of TP53 signaling by inactivation mutation as well as chromosomal loss of RB1 (17). Sequencing efforts and subsequent functional experiments have identified prostate cancer driver alterations and defined the impact of gene expression networks on prostate cancer phenotypes. These studies have led to the successful development of new therapeutics targeting AR signaling and DNA repair in advanced disease (18, 19).

[0262] Prostate cancer progression is also associated with shifts in alternative pre-mRNA splicing patterns, but this process is not well-understood (20). Investigations of global changes in exon usage in prostate cancer have focused on stage- or race-specific comparisons (21-25).

Comparisons of tumor-adjacent benign material and PrAd identified intron retention and exon skipping events in the biomarkers KLK3 and AMACR, respectively (22). Others studying NEPC and PrAd have shown that a network of splicing events controlled by the Serine-Arginine RNA- binding protein SRRM4 contributes to the neuroendocrine phenotype (26-28). Comparisons of European American and African American (AA) PrAd samples identified an AA-specific splice variant of PIK3CD that enhanced AKT/mTOR signaling (23). How these splicing alterations connect to the driver alterations described above remains to be explored.

[0263] The accumulation of RNA-Seq data in large databases presents a unique opportunity to conduct an analysis of alternative splicing across the full range of prostate cancer disease states. For our study, the inventors prepared a unified dataset of large, publically-available RNA-Seq datasets representing normal tissue, tumor-adjacent benign tissue, primary adenocarcinoma, metastatic castration-resistant adenocarcinoma, and treatment-related metastatic NEPC. However, handling datasets of this size requires splicing analysis software with greater efficiency than what is currently available. To analyze these hundreds of datasets, the inventors created a new version of the rMATS software (dubbed rMATS-turbo) that can handle this volume of RNA-Seq data (29, 30).

[0264] The inventors identify a high-confidence set of exons whose incorporation varies across prostate cancer disease states. By combining expression-level and exon-level analyses, the inventors developed a pathway-guided strategy to examine the impact of oncogenic pathways on incorporation of these exons. This correlational analysis implicates Myc, mTOR, and E2F signaling in the control of exon choice in spliceosomal proteins. To further investigate the contributions of Myc signaling to exon choice, the inventors developed unique engineered human prostate cell lines with regulated Myc expression. Functional experiments in these cell lines identify Myc-dependent exons and experimentally confirm that cassette exon choice in many splicing regulatory proteins is responsive to Myc expression level. These exons often encode frameshifts or premature termination codons that would result in nonsense mediated decay. The inventors show that an ultra- conserved, nonsense-mediated decay determinant exon in the RNA-binding protein SRSF3 is particularly responsive to Myc signaling. These results implicate Myc signaling as a regulator of alternative splicing coupled nonsense-mediated decay (AS-NMD) as part of a program of growth control.

A. Results

1. Exon-level analysis defines the landscape of alternative pre-mRNA splicing across the prostate cancer disease spectrum

[0265] The inventors combined RNA-Seq data from disparate published datasets representing 876 samples of normal tissue, benign tumor-adjacent material, primary adenocarcinoma, metastatic castration- resistant adenocarcinoma (mCRPC), and treatment-related neuroendocrine prostate cancer (NEPC) (FIG. 1A) (10-13, 31, 32). Meta-analyses of RNA-Seq data with gene- or isoform- level counts are subject to confounding batch effects and rely on existing isoform annotation (33). Exon-level analysis, however, uses a ratio-based methodology to estimate exon incorporation, which may be more robust against batch effects and confounding factors in large- scale RNA-Seq datasets (34-37). In addition, exon-level analysis can detect novel exon-exon junctions and is thus independent of previous annotation.

[0266] To facilitate alternative splicing analysis in this and other large RNA-Seq datasets, the inventors developed rMATS-turbo (a.k.a. rMATS 4.0.2), a new computational pipeline that permits the efficient capture, storage, and analysis of splicing information from very large-scale raw RNA- Seq data. This improved pipeline refactors the original ratio-based rMATS software that the inventors developed for splicing analysis in RNA-Seq data to optimize it for very large-scale RNA-Seq datasets and is now available for public use (29, 30). It offers significant improvements in speed and data storage efficiency.

[0267] The inventors applied rMATS-turbo to the combined RNA-Seq dataset and identified over 330,000 different cassette exons across all prostate samples. Previous estimates of the diversity of splicing events in human cells vary, but are generally of the same order of magnitude (38). The inventors also identified tens of thousands of additional alternative splicing events (FIG. 1A), including alternative 5' and 3' splice sites, mutually exclusive exons, and retained introns. For this study, the inventors focused on cassette exons, as these are the most well-defined type of alternative splicing event. The inventors should note that although the rMATS-turbo software detected numerous mutually exclusive exons, most of these events were in fact part of more complex alternative splicing events, thus the inventors did not include these mutually exclusive exons in downstream analyses.

[0268] Filtering of these exons for coverage (≥10 splice junction reads per event), cross-sample variance (range of PSI >5%, mean skipping or inclusion >5%) and commonality (events detected in ≥1% of all samples) produced a set of 13,149 high-confidence exons with variable incorporation across samples (see Methods section). Principal component analysis (PCA) of this exon usage matrix grouped samples of the same disease phenotype regardless of dataset

(FIG. 1B). By comparison, a similar unsupervised analysis of isoform-level count-based metric from the same meta-dataset grouped samples more by dataset of origin than disease phenotype (FIGS. 7A-B). This result is consistent with prior observations that the exon-level splicing analysis is more robust against batch effects and other confounding factors in large-scale RNA-Seq datasets (35-37).

2. Combining gene pathway analysis and exon usage identifies exon correlates of oncogenic signaling

[0269] Genomic studies of prostate cancer have identified driver alterations associated with disease progression (39). The inventors sought to define how the variable cassette exons the inventors identified and the biological processes they participate in might relate to these oncogenic signals. Instead of selecting single oncogenes for study, the inventors developed PEGASAS (Pathway Enrichment-Guided Activity Study of Alternative Splicing), a pathway-guided analytic strategy that uses gene signatures to estimate the activities of signaling pathways and to discover potential downstream exon changes (FIG. 2A). Gene signature-based analyses use an ensemble of features (a set of genes collectively) to estimate pathway activity and outperform single gene measurements (40). To mitigate potential batch effects in the expression data, the inventors utilized a rank-based metric to calculate the signature score, providing a more robust measure of pathway activity as it is in essence normalized on a per sample basis (41).

[0270] The inventors employed the hallmark gene signature sets maintained by the Molecular Signatures Database (MSigDB) (42). These fifty sets represent a diverse and well-validated array of cellular functions and signaling pathways. To assess the performance of these signatures in the combined dataset, the inventors examined signature scores for the AR, Myc Targets V2, and MTOR gene sets across five different prostate phenotypes. Consistent with previously reported observations of pathway activation in prostate cancer progression, the androgen response gene signature scores the inventors measured were lowest in NEPC samples (FIG. 8A). Similarly, MTOR and Myc signature scores were higher in mCRPC samples than in normal tissues.

[0271] The inventors then scored each sample in the meta-dataset for all fifty pathways and correlated this score with the data matrix of over 13,000 variable cassette exons (Dataset S1). After filtering for correlation strength and false discovery rate, each pathway returned between 11 and 1,330 exon correlates (Dataset S1). The ten gene sets that returned the greatest number of exon correlates with a Pearson's correlation coefficient greater than 0.3 or less than -0.3 are

shown (FIG. 2B). Nine out of ten of these gene sets had exon correlates found in genes with strong functional enrichment by gene ontology (adjusted p-value < 0.05).

3. Cassette exons correlating with Myc, E2F, and MTOR signaling are enriched in splicing- related genes

[0272] The inventors next examined the biological processes specified by the genes containing the variant exons correlated with prostate cancer-relevant Hallmark signaling pathways (FIG. 2C). The inventors also added a signature that describes transcriptional activity due to TMPRSS signaling as this common prostate cancer alteration is not represented in the Hallmark set (43). Here the inventors represent the network of data as a hive plot to show how exons (left axis) correlate with signaling pathways (middle axis) and the functional enrichment of genes containing those correlated exons (right axis) (44). Gene ontology analysis indicated that the relatively small number of exons correlated with AR or Notch were modestly enriched in cell adhesion and chromatin remodeling processes. Surprisingly, the numerous exon correlates of Myc, E2F, and MTOR were strongly enriched in genes related to the spliceosome and alternative pre-mRNA splicing. In addition, the overlap in the exon sets correlated with Myc, E2F, and MTOR was striking, with 50-60% of exons held in common (FIG. 2D). These pathways play central roles in growth control and are frequently co-dysregulated in human cancers, so a shared set of exons might be expected from a correlation analysis.

4. Myc-correlated exons are found in the oncogenes SRSF3 and HRAS

[0273] Given the centrality of Myc signaling in tumorigenesis, tumor maintenance, and tumor progression in a multitude of tissue lineages (45, 46) including the prostate, this pathway was selected for further investigation (15, 47, 48). The validity of these correlational results critically depends on the integrity of the underlying gene signature used to produce them. The inventors therefore performed additional validation steps on the "MYC Targets V2" hallmark signature by examining its performance in The Cancer Genome Atlas prostate adenocarcinoma RNA-Seq dataset (TCGA-PRAD) that has accompanying patient outcomes data (32). The inventors noted that samples with genomic amplifications of Myc had higher signature scores on average, as did samples that overexpressed Myc at the mRNA level (FIG. 9A). To examine if these relatively small changes in signature score had clinical relevance, the inventors performed Kaplan-Meier survival analyses using the "MYC Targets V2" signature, Myc genomic amplification status, or Myc single gene overexpression status as strata. The Myc gene signature was equally predictive of overall survival as genomic amplification status and outperformed single gene expression stratification (FIG. 9B).

[0274] Convinced of the performance of the Myc signature by these additional tests, the inventors performed further analysis of the 1,039 Myc-correlated exons the inventors identified in the prostate meta- dataset (FIG. 3A and Tables 1a-1d). Unsupervised clustering of these 1,039 exons also grouped the samples by phenotype (FIG. 9C), identifying patterns in Myc-dependent exon incorporation that varied accordingly.

[0275] Two examples among the most strongly Myc-correlated cassette exons from this analysis are found in SRSF3 and HRAS (FIG. 3B). Incorporation of the identified alternate exon in SRSF3 is anti-correlated with the Myc signature score (FIG. 3B, left panel). When examined by cancer phenotype, incorporation of this exon decreases as prostate cancer progresses from normal tissue to primary tumor and is even lower in mCRPC samples (FIG. 3C, left panel). The Myc signature score increased between normal healthy donors (GTEx) and tumor-adjacent normal (TCGA-PRAD), consistent with field cancerization and tumor-stromal interaction effects on gene expression reported previously by others (49). Incorporation of this exon in NEPC is slightly higher, consistent with the Myc signature scores in these samples (FIG. 8A).

[0276] SRSF3 is a serine-arginine splicing factor that can act as a proto-oncogene and also participates in transcription termination and DNA repair (50-53). The exon in question is ultra-conserved throughout evolution and contains an in-frame stop codon. Also known as a poison exon, this sequence functions as a premature termination codon (PTC) (FIG. 9D, top panel). Incorporation of this PTC has been shown previously to reduce SRSF3 expression levels by inducing nonsense-mediated decay (NMD) of the transcript (54, 55). This data suggests increased Myc signaling leads to increased exon skipping, reduced NMD, and increased expression of SRSF3.

[0277] A cassette exon in HRAS was also anti-correlated with Myc activity (FIG. 3B, right panel). When examined by cancer phenotype, exon skipping increased with tumor progression (FIG. 3C, right panel). HRAS is a well-known oncogene that cooperates with Myc to induce carcinogenesis in multiple tissues (56, 57). Inclusion of the cassette exon and the stop codon it contains results in the truncated HRAS p19 product instead of the p21 form (58). HRASp19 lacks the cysteine residues in the carboxy-terminal domain of HRASp21 required for nuclear translocation and RAS-driven transformation and may function instead as a tumor suppressor (58, 59). This exon is conserved in mammals (FIG. 9D, bottom panel). Incorporation of this exon is anti-correlated with Myc activity, suggesting that Myc can drive increased expression of oncogenic HRAS by affecting its splicing.

5. Myc-correlated exons in prostate cancers are highly conserved in breast and lung adenocarcinomas

[0278] To determine if the observed effects of Myc activity on splicing were prostate-cancer specific, the inventors performed a similar correlation analysis on a second hormone-dependent malignancy, breast adenocarcinoma, and a third hormone-independent epithelial malignancy, lung adenocarcinoma. The normal tissue and cancer RNA-Seq datasets for this analysis were drawn from The Cancer Genome Atlas (TCGA-BRCA and TCGA-LUAD) datasets and the Genotype-Tissue Expression (GTEx) collection of normal tissue (31, 60, 61). The inventors performed a similar correlation between Myc signature score and exon usage as described above (FIG. 3D). The Myc signature scores in breast and lung tissues behaved similarly to those in the prostate tissues, with increases in score at each step when moving from normal to tumor-adjacent normal to carcinoma (FIG. 9E). The inventors identified 2,852 Myc-correlated cassette exons in breast samples and 2,465 in lung samples using the same filtering criteria for the prostate study (FIG. 9F). The exon list includes the same anti-correlated exon in SRSF3, as shown for lung samples (FIG. 3D, fourth panel). Intersecting this set with the inventors' previously-defined set of Myc-responsive prostate cancer exons (FIG. 3A), the inventors found extensive overlap and similar exon incorporation behavior in the three sets (FIG. 3E). The triple intersection was even more strongly enriched for RNA-binding proteins (FIG. 3F). This analysis suggests the exon incorporation response to Myc overexpression is conserved across these cancers.

6. Creation of an engineered model of advanced prostate cancer with regulated Myc expression from benign human prostate cells to define Myc-dependent exon events

[0279] Correlation analysis strongly implicates Myc, E2F, and MTOR signaling in the control of exons related to alternative pre-mRNA splicing but cannot define the individual contribution of each pathway to the observed phenotype. The inventors therefore sought to determine if the Myc-correlated splicing effects the inventors observed were indeed Myc-dependent.

[0280] Numerous studies of the effect of Myc overexpression have described large numbers of Myc target genes with significant tissue heterogeneity (62, 63). The presence of complex background genetics, undefined driver alterations, and tissue culture-specific phenomena further complicate the study of Myc biology (64). The inventors therefore constructed a model of advanced prostate cancer by the transformation of benign human prostate epithelial cells with defined oncogenes (FIG. 4A) (65). The inventors have previously

shown that the enforced expression of Myc and myristoylated (activated) AKT1 (myrAKT1) generates androgen receptor-independent adenocarcinoma (66, 67). MyrAKT1 is included to phenocopy the activation of AKT1 that follows deletion of the tumor suppressor PTEN, a common event in prostate cancer tumorigenesis. Here, the inventors cloned the Myc cDNA into a doxycycline-inducible promoter lentiviral construct whereas MyrAKT1 was constitutively expressed (FIG. 4B and Methods).

[0281] After lentiviral transduction of isolated human prostate basal cells (FIG. 10A), the inventors initiated the organoid culture and subsequent subcutaneous xenograft tumor outgrowth in immunocompromised mice in the constant presence of the drug (FIG. 10B-C). As previously reported, only doubly-transduced cells resulted in tumor outgrowth (FIG. 4C). The histologic appearance and marker expression patterns of the xenograft outgrowths were similar to those previously published with constitutive constructs (FIG. 4D and FIG. 10D). The xenograft outgrowths were dissociated, plated in tissue culture conditions with doxycycline to initiate autonomously growing cell lines (FIG. 4E). The inventors repeated the entire procedure to generate three independent cell lines from the prostate epithelium of three different human specimens.

7. Myc withdrawal leads to decreased expression of splicing-related genes

[0282] Withdrawal of doxycycline from the Myc/myrAKT1 cell lines resulted in the rapid, dose- dependent loss of Myc protein expression, consistent with its previously-reported short half-life (FIG. 5A and FIG. 11A) (68). The cells also rapidly slowed their growth with increased G0/G1 fraction at 24 hours (FIG. 11B-C). They adopted a senescent-like phenotype after prolonged Myc withdrawal with upregulation of P21 (FIG. 5A). A similar consequence of Myc withdrawal in oncogene-addicted transformed cells has been previously reported (69).

[0283] The inventors performed RNA-Seq on samples from Myc-high and Myc-low conditions to define Myc-dependent genes and exons in this model system. These samples were sequenced with high read depth (>100M reads) to enable accurate quantification of alternative splicing in downstream analysis. Primary analysis of the RNA expression data showed that thousands of genes were highly responsive to Myc withdrawal (CuffDiff q-value < 0.05) (FIG. 5B). Gene ontology analysis identified enrichment of several growth-related biological processes among the Myc- dependent genes (FIG. 5C). Of note, genes involved in RNA processing were among the most highly enriched in this subset. This is consistent with previous reports of Myc's broad control of the growth phenotype. The regulated Myc expression system

also allowed us to independently validate the Myc signature score the inventors used in the correlation analysis (FIG. 5D).

8. Experimentation confirms Myc-regulated exons are enriched in splicing-related proteins and often encode premature termination codons

[0284] The inventors applied rMATS-turbo to analyze Myc-regulated exon usage in the engineered cell lines. To accommodate the paired nature of the dataset (comparing Myc-high and Myc-low conditions for each), the inventors employed the PAIRADISE statistical test to the rMATS-turbo output (70). After filtering for coverage (≥10 splice junction reads per event), effect size ((|deltaPSI| > 5%), and false discovery rate (FDR < 5%), this analysis yielded 1,970 cassette exons that significantly changed incorporation in response to Myc withdrawal (FIGS. 6A-B, Tables 1a-1d). The inventors note that among the Myc-dependent exons the inventors again identified the alternative exons in SRSF3 and HRAS described above, experimentally demonstrating that their incorporation is dependent on Myc signaling (FIG. 6C). The relative incorporation of the poison exon in SRSF3 increased when Myc was withdrawn, which would act to decrease the amount of SRSF3 protein in response to oncogene loss. The inventors confirmed by immunoblotting that SRSF3 protein levels decreased relative to the housekeeping protein GAPDH in this experimental setting (FIG. 12A).

[0285] Similar to the correlational data from the patient specimens, the Myc-dependent exons were strikingly enriched in genes affecting RNA splicing-related processes (FIG. 6D). Intersecting this set of exons with the Myc-correlated exons in patient tissue identified 147 common exons (FIG. 6E), a highly-significant overlap ($p = 1.03 \times 10^{-90}$). The remaining exons may not be responsive to short-term withdrawal of Myc in the cell line model or may be correlated with other signaling derangements that often accompany Myc deregulation in patient cancers (e.g. E2F or MTOR).

[0286] To look for additional Myc-regulated exons in clinically-important genes beyond SRSF3 and HRAS, the inventors cross-referenced the 147-exon list with the MSKCC-IMPACT cancer driver panel (71). This search identified four additional exons in three genes: SMARCA4, PBRM1, and TBX3 (FIG. 12B). SMARCA4 and PBRM1 are both involved in chromatin remodeling, and TBX3 is a transcription factor that promotes tumor invasion (72, 73). However, the change in exon incorporation was relatively modest and correlation with protein level would be necessary before further study.

[0287] Alternative pre-mRNA splicing can regulate transcript levels through the incorporation or skipping of nonsense-mediated decay determinant exons (74). The inventors reasoned that Myc-driven exon choice in splicing proteins could contribute to the regulation of their expression levels. To examine the functional outcome of Myc-driven splicing changes on nonsense- mediated decay, the inventors annotated the 147 exons in the patient data-cell line intersection for premature termination codons (PTCs) and frameshifts (FIG. 6F, Tables 1a-1d). These 147 exons correspond to 124 genes, 30 of which were RNA-binding proteins by GO designation. The inventors annotated all these exons using the Ensembl database to identify those that contained verified PTCs. The inventors supplemented this annotation by parsing the remaining exons to identify those predicted to produce a frameshift within the coding sequence of the parent mRNA transcript. The inventors found that 36 of the 43 exons in RNA-binding genes encode a PTC, a frameshift, or both. These exons represent a set of Myc-responsive sequences that act to regulate transcript abundance of proteins involved in alternative pre-mRNA splicing.

B. Tables

Table 1a: Pathway AS Tissue

AS Events	AS Events	AS Events
SCAMP5_chr15_+_75308933_75309090_75305146_75310137	TMEM8B_chr9_+_35834457_35834647_35829952_35845971	SLC6A6_chr3_+_14509595_14509720_14509464_14513712
RAB27A_chr15_-_55529513_55529640_55527154_55562362	NASP_chr1_+_46066056_46066129_46056942_46067926	C14orf159_chr14_+_91690022_91690139_91681900_91691027
GAS6-AS1_chr13_+_114537550_114537737_114536552_114541049	ZFR_chr5_-_32380180_32380278_32379316_32385613	INPP5K_chr17_-_1416746_1416848_1413093_1417165
GALNS_chr16_-_88909113_88909237_88908379_88923165	TMEM184B_chr22_-_38642811_38642891_38642106_38643775	MICAL3_chr22_-_18355512_18355620_18354789_18368643
SPIN1_chr9_+_91033692_91033866_91003453_91041296	TM7SF2_chr11_+_64883246_64883294_64882866_64883364	RP11-231C18.3_chr4_+_54280781_54280889_54266006_54292038
NAA16_chr13_+_41936866_41937009_41936295_41941574	PPIP5K2_chr5_+_102518934_102519108_102515889_102520372	ALKBH3_chr11_+_43913590_43913679_43911378_43923065
RWDD2B_chr21_-_30380560_30380628_30380444_30380715	MARK3_chr14_+_103966492_103966537_103958371_103969218	MCCC1_chr3_-_182810196_182810333_182804576_182812346
ENOSF1_chr18_-_691067_691106_690631_693881	AKR7A3_chr1_-_19611511_19611608_19611279_19612381	FLNA_chrX_-_153585618_153585642_153583440_153585801
IFT122_chr3_+_129180070_129180147_129170841_129182402	SLC25A29_chr14_-_100761962_100762034_100759714_100765178	FAT1_chr4_-_187511521_187511557_187510374_187516842
BIN1_chr2_-_127825738_127825831_127821594_127826499	ECHDC2_chr1_-_53370705_53372283_53364896_53373539	SLC38A5_chrX_-_48324616_48324709_48321365_48325185
STIM1_chr11_+_4105902_4105995_4104728_4107706	IQCB1_chr3_-_121518042_121518221_121509062_121526190	ATG2A_chr11_-_64671061_64671132_64670836_64673034
ECHDC2_chr1_-_53379566_53379767_53377462_53387224	DNASE1_chr16_+_3705849_3705938_3705521_3706102	TSTD1_chr1_-_161008340_161008463_161007865_161008669
TINF2_chr14_-_24711095_24711127_24710982_24711346	TMEM175_chr4_+_942298_942403_941942_944208	USP9Y_chrY_+_14930354_14930545_14928279_14945613
MAGIX_chrX_+_49021245_49021428_49021127_49021527	ITGA7_chr12_-_56093653_56093773_56092701_56094045	CRAT_chr9_-_131871457_131871556_131870356_131872761
PRUNE2_chr9_-_79256887_79256896_79253204_79259654	GGCT_chr7_-_30540151_30540297_30538554_30544184	CDK10_chr16_+_89753996_89754223_89753205_89755659
SRSF11_chr1_+_70697541_70697658_70694238_70697950	DDX46_chr5_+_134125795_134125912_134124281_134126159	CALD1_chr7_+_134620438_134620516_134618141_134625842

AS Events	AS Events	AS Events
PRPF39_chr14_+_45579096_45579196_45578983_45579296	PRKRA_chr2_-_179310152_179310262_179309227_179312231	BZW2_chr7_+_16725548_16725665_16722470_16729421
NUDT2_chr9_+_34336226_34336339_34329597_34338710	PHLDB2_chr3_+_111667778_111667922_111664204_111672776	IFT22_chr7_-_100961404_100961494_100959823_100964951
INO80E_chr16_+_30013756_30014334_30012851_30016541	CARD19_chr9_+_95874160_95874220_95873003_95874499	ARFIP2_chr11_-_6499808_6499882_6499428_6499967
FLAD1_chr1_+_154960580_154961325_154956542_154965188	USP3_chr15_+_63821212_63821365_63797029_63824845	TP53BP1_chr15_-_43738963_43739108_43738788_43739563
BCAR1_chr16_-_75270779_75270896_75269884_75276367	KANK2_chr19_-_11306231_11306496_11305266_11308160	METTL26_chr16_-_685517_685774_685340_686093
RPS6KB1_chr17_+_58008160_58008413_58007535_58008982	BNIP2_chr15_-_59970974_59971033_59970286_59971790	BPTF_chr17_+_65871671_65871860_65871136_65882243
MPST_chr22_+_37419792_37419968_37415815_37420232	WDR77_chr1_-_111984120_111984226_111984011_111984646	UBE3A_chr15_-_25652213_25652409_25650649_25654234
MORF4L2_chrX_-_102939608_102939657_102933548_102940098	CCSER2_chr10_+_86259630_86259715_86185649_86273204	EVA1C_chr21_+_33873724_33873848_33867480_33887123
DDX39A_chr19_-_14521232_14521417_14521146_14521800	TMEM50B_chr21_-_34809189_34809299_34805109_34811520	RUFY1_chr5_+_179013331_179013476_179012866_179016546
ACSF3_chr16_+_89180746_89180895_89178654_89187208	PIGP_chr21_-_38444444_38444610_38439680_38444733	RBM10_chrX_+_47034417_47034491_47032596_47035898
TMPRSS2_chr21_-_42870045_42870116_42861520_42880007	SON_chr21_+_34944856_34944936_34941393_34945613	PRMT2_chr21_+_48056350_48056459_48055675_48056807
CCHCR1_chr6_-_31122272_31122576_31118899_31124507	ADA_chr20_-_43251228_43251293_43249788_43251469	EZH2_chr7_-_148516069_148516151_148515209_148516687
RBM5_chr3_+_50137964_50138038_50137484_50140515	ANXA2_chr15_-_60689456_60689537_60688626_60690141	LMF1_chr16_-_905106_906055_904706_918943
NMRAL1_chr16_-_4521314_4521450_4519466_4524093	SMTN_chr22_+_31496870_31497035_31495882_31500301	RCC1_chr1_+_28857034_28857127_28856451_28858314
ADD3_chr10_+_111892062_111892158_111890244_111893083	RSRC2_chr12_-_122998313_122998421_122995735_122999651	C17orf62_chr17_-_80407306_80407832_80407168_80408575
IFT22_chr7_-_100962236_100962344_100961494_100964951	RNASE1_chr14_-_21270407_21270490_21270252_21270955	BET1_chr7_-_93623663_93623697_93605412_93625576
CD151_chr11_+_834529_834745_833026_836062	TNS1_chr2_-_218695089_218695113_218694605_218696177	IGFLR1_chr19_-_36230610_36230987_36230527_36231924
ACY1_chr3_+_52019222_52019287_52018174_52019376	LMBR1L_chr12_-_49500436_49500529_49499740_49500743	CAMK2G_chr10_-_75577966_75578653_75577312_75581439
NOL3_chr16_+_67207764_67207949_67204477_67208064	DPH7_chr9_-_140472028_140472055_140470619_140473076	RHOC_chr1_-_113247721_113247823_113246428_113249699
IMMP1L_chr11_-_31477806_31477933_31455117_31531065	NEDD4L_chr18_+_56002709_56002769_56001124_56008269	LAS1L_chrX_-_64744443_64744494_64744142_64744844

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FMNL3_chr12_-_50040421_50040536_50039686_50040668	ABCC9_chr12_-_22017372_22017411_22015988_22025558	COL6A3_chr2_-_238303229_238303847_238296827_238305369
CRELD1_chr3_+_9979698_9979790_9976601_9982533	CDC14B_chr9_-_99277930_99278074_99266071_99284787	CHD3_chr17_+_7810918_7811020_7810806_7811211
TREX1_chr3_+_48508028_48508040_48507708_48508138	EEF1D_chr8_-_144674816_144675063_144672908_144679517	AUH_chr9_-_94122560_94122722_94118437_94123909
GGT1_chr22_+_25004956_25005198_25003990_25005931	PDGFA_chr7_-_540067_540136_538211_540752	TRIP6_chr7_+_100465532_100465610_100465228_100465729
GINS1_chr20_+_25394425_25394490_25388531_25405846	LGMN_chr14_-_93172827_93172998_93170706_93176016	NISCH_chr3_+_52514894_52515053_52514311_52518528
HPS1_chr10_-_100190887_100191048_100190427_100193696	SORBS1_chr10_-_97174250_97174412_97170534_97181717	PRR3_chr6_+_30529104_30529285_30525989_30529610
NIN_chr14_-_51223209_51225348_51221585_51226574	PRKAG1_chr12_-_49399525_49399664_49399326_49406844	SLC27A1_chr19_+_17599656_17599748_17598338_17599816
TMEM184A_chr7_-_1589182_1589240_1588324_1589489	METTL21B_chr12_+_58168411_58168550_58166911_58174037	NUDT22_chr11_+_63997321_63997542_63997043_63997654
SVIL_chr10_-_29797270_29797318_29788192_29801663	ST7_chr7_+_116830186_116830322_116829447_116830887	EIF4A2_chr3_+_186502750_186502890_186502485_186503671
NCOR2_chr12_-_124812092_124812179_124810916_124815390	LSM1_chr8_-_38027319_38027435_38021358_38029482	ATG16L1_chr2_+_234182366_234182423_234181698_234183321
CAPN3_chr15_+_42698123_42698141_42695975_42700408	TMEM175_chr4_+_941496_941680_926328_944208	ZNF605_chr12_-_133524733_133524856_133522383_133532828
CCDC130_chr19_+_13872304_13872382_13870086_13873112	RPL17_chr18_-_47018105_47018203_47017954_47018627	ARRB2_chr17_+_4618307_4618338_4614039_4619267
SEPT6_chrX_-_118759297_118759359_118754014_118763280	MCCC1_chr3_-_182746880_182746977_182743592_182751778	FAM160B2_chr8_+_21947271_21947365_21946809_21951950
PRUNE2_chr9_-_79239938_79239974_79229516_79244107	METTL26_chr16_-_684888_684956_684797_686093	IDH3A_chr15_+_78449249_78449504_78447617_78449889
CCND3_chr6_-_41908107_41908323_41905132_42016238	FASTKD3_chr5_-_7866758_7868309_7866096_7869091	TMED5_chr1_-_93624371_93624442_93622040_93625685
PIGB_chr15_+_55642896_55643001_55634000_55646995	DCUN1D5_chr11_-_102953476_102953568_102937296_102953984	EBF4_chr20_+_2730046_2730164_2729276_2730265
METTL26_chr16_-_684888_685063_684797_686093	ALG13_chrX_+_110964830_110964939_110963398_110966020	TMEM234_chr1_-_32683037_32683178_32682952_32686731
SEPT6_chrX_-_118759297_118759342_118754014_118763280	LIN7A_chr12_-_81241877_81241954_81239718_81242029	ADGRG1_chr16_+_57675498_57675620_57654048_57684164
SYNE2_chr14_+_64682003_64682072_64681188_64682965	ACTN2_chr1_+_236898934_236899020_236894614_236900421	RANBP17_chr5_+_170455875_170455993_170395381_170597133
RP11-793H13.8_chr12_+_53858543_53858636_53856351_53859715	HMGN1_chr21_-_40717755_40717884_40717200_40720217	LRRFIP2_chr3_-_37132957_37133029_37125297_37136282

AS Events	AS Events	AS Events
RHOC_chr1_-_113247721_113248874_113246428_113249699	UBE3A_chr15_-_25652213_25652375_25650649_25654234	SEC61A2_chr10_+_12197776_12197930_12191960_12198905
ARIH2_chr3_+_48962150_48962272_48960244_48982568	MEAF6_chr1_-_37962307_37962337_37962205_37967404	ILF3_chr19_+_10791021_10791119_10790603_10791694
BIRC5_chr17_+_76218908_76219073_76212862_76219545	LSM14B_chr20_+_60702640_60702757_60701495_60704840	PAM_chr5_+_102309819_102310140_102296933_102325975
PPRC1_chr10_+_103904776_103904847_103904064_103908128	AKAP8_chr19_-_15479877_15480035_15479133_15480956	MRPL55_chr1_-_228296137_228296175_228296019_228296961
TRIQK_chr8_-_93966633_93966792_93929238_93978234	DNAJB14_chr4_-_100845916_100845972_100844342_100851606	C17orf62_chr17_-_80407045_80407168_80404572_80408575
WDSUB1_chr2_-_160114455_160114496_160112886_160116320	ALDH2_chr12_+_112213408_112213524_112204900_112219721	TBL2_chr7_-_72990870_72991031_72988843_72992749
CSNK1G3_chr5_+_122941032_122941056_122940524_122950035	SETD5_chr3_+_9510202_9510259_9506356_9512142	MRPS18C_chr4_+_84379498_84379582_84378111_84380892
KDM6A_chrX_+_44921891_44921993_44920664_44922666	SRP9_chr1_+_225974563_225974687_225971070_225976941	MRPS33_chr7_-_140710218_140710460_140706335_140714710
MLPH_chr2_+_238443206_238443290_238434448_238448990	INO80E_chr16_+_30012734_30012851_30012361_30016541	SPIRE1_chr18_-_12459753_12459927_12454482_12463349
ARMC10_chr7_+_102732923_102733100_102727211_102737723	BIRC5_chr17_+_76212046_76212115_76210870_76219545	MGEA5_chr10_-_103553669_103553755_103552700_103557736
HAUS7_chrX_-_152720334_152720511_152719966_152720999	MYO18A_chr17_-_27412621_27412666_27409456_27413455	DCN_chr12_-_91573138_91573463_91572362_91576431
SNAPIN_chr1_+_153631613_153631660_153631362_153631923	DNM1L_chr12_+_32890798_32890876_32890095_32891197	NAGPA_chr16_-_5078297_5078366_5078186_5078880
KIF13A_chr6_-_17790102_17790141_17788106_17794479	GK5_chr3_-_141903552_141904635_141901891_141904770	HNRNPC_chr14_-_21731825_21731988_21702388_21737456
THTPA_chr14_+_24025951_24026243_24025552_24027903	FBXO31_chr16_-_87392016_87392103_87380856_87393900	HNRNPA1_chr12_+_54676862_54677018_54676658_546775995
SLC37A4_chr11_-_118897280_118897398_118896790_118897646	ZCCHC6_chr9_-_88933872_88933973_88932191_88934498	DNASE1_chr16_+_3705849_3705967_3705521_3706102
GPS1_chr17_+_80010253_80010335_80009840_80011149	FKRP_chr19_+_47251771_47251878_47251345_47258668	C2CD5_chr12_-_22611417_22611519_22610095_22622642
ADAM15_chr1_+_155034379_155034593_155033308_155034720	G3BP2_chr4_-_76649239_76649360_76587233_76649459	SLC2A8_chr9_+_130160183_130160390_130159565_130162185
MRPL55_chr1_-_228296137_228296722_228296022_228296961	PARP12_chr7_-_139737514_139737656_139734131_139741443	ZMIZ1_chr10_+_81070680_81070941_81067328_81072398
GUSB_chr7_-_65439905_65440058_65439691_65441001	POMT2_chr14_-_77767432_77767592_77765904_77769177	ATP6V0B_chr1_+_44441336_44441520_44440779_44441761
KANK2_chr19_-_11306297_11306496_11305266_11308160	NDUFAF5_chr20_+_13795063_13795161_13789548_13797108	MRPL1_chr4_+_78828099_78828364_78815404_78830419

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RPL17_chr18_-_47018105_47018203_47017954_47018644	THEM4_chr1_-_151862458_151862690_151861849_151867483	ADD1_chr4_+_2928368_2928402_2927839_2929897
COBL_chr7_-_51240152_51240227_51204028_51251798	FAM136A_chr2_-_70528539_70528735_70528112_70529056	IDE_chr10_-_94240549_94240673_94239178_94243011
AURKA_chr20_-_54963742_54963840_54963258_54966998	MRPL47_chr3_-_179320439_179320585_179319578_179322314	SPTAN1_chr9_+_131355261_131355321_131353904_131356453
ARHGEF10L_chr1_+_17975048_17975170_17966797_17981130	PILRB_chr7_+_99950995_99951106_99950746_99951517	DHX30_chr3_+_47857452_47857618_47852201_47859511
NT5C2_chr10_-_104871501_104871562_104866463_104899162	IGFLR1_chr19_-_36231280_36231465_36230527_36231924	SCRIB_chr8_-_144889721_144889784_144889183_144890778
POFUT2_chr21_-_46697147_46697688_46697057_46698017	NOL3_chr16_+_67205054_67205360_67204477_67208064	TMPO_chr12_+_98938007_98938127_98931350_98940136
LINC01881_chr2_+_243058333_243058383_243037178_243061115	LRRFIP1_chr2_+_238622901_238622919_238617273_238628165	DTX3_chr12_+_57999353_57999514_57998641_57999972
TATDN2_chr3_+_10320347_10320444_10320146_10320568	ZBTB7B_chr1_+_154986490_154986569_154975419_154987130	BIRC5_chr17_+_76218908_76219073_76210870_76219545
ABHD4_chr14_+_23074692_23074772_23072984_23075327	SLC20A2_chr8_-_42328584_42328719_42323435_42329619	MKNK2_chr19_-_2039629_2039855_2037828_2040132
C16orf58_chr16_-_31510813_31510846_31508271_31512006	PHPT1_chr9_+_139744954_139745012_139744589_139745206	MAP3K7_chr6_-_91254270_91254351_91246120_91256976
CWC25_chr17_-_36966528_36966653_36966018_36966720	CASK_chrX_-_41414852_41414888_41413168_41416284	PTK2B_chr8_+_27303310_27303436_27301788_27308265
ROGDI_chr16_-_4851267_4851322_4850579_4851503	ITGA7_chr12_-_56094045_56094177_56093773_56094682	RPL17_chr18_-_47018115_47018203_47017954_47018644
DIS3L2_chr2_+_233063236_233063486_233028342_233075035	INO80C_chr18_-_33067349_33067403_33060527_33077682	UPRT_chrX_+_74514397_74514455_74513349_74516176
ADAM15_chr1_+_155034051_155034122_155033965_155034720	KLHL29_chr2_+_23907268_23907407_23865720_23914543	RNF146_chr6_+_127606352_127606493_127601485_127607194
VRK3_chr19_-_50500760_50500827_50498532_50504046	NFIX_chr19_+_13198802_13198950_13189549_13201112	ZNF761_chr19_+_53948253_53948376_53935281_53949479
S100A13_chr1_-_153600596_153600713_153600074_153603486	S100A13_chr1_-_153602925_153603132_153600713_153603486	KLK2_chr19_+_51380959_51381012_51380264_51381659
LRRC75A-AS1_chr17_+_16342894_16343017_16342728_16343498	STARD4_chr5_-_110837659_110837786_110836814_110842027	MTSS1L_chr16_-_70699368_70699443_70698999_70708208
TANGO2_chr22_+_20040882_20041074_20040107_20043465	INO80E_chr16_+_30015875_30015978_30012361_30016541	NEB_chr2_-_152357904_152357997_152354232_152359306
CSGALNACT1_chr8_-_19315040_19315327_19297442_19315936	DENND1A_chr9_-_126150008_126150137_126146192_126165680	ACOT9_chrX_-_23752457_23752484_23751334_23761241
FBXW8_chr12_+_117387422_117387511_117383333_117402501	CXorf40B_chrX_-_149102594_149102786_149102355_149105650	PCBP4_chr3_-_51995956_51996104_51995320_51996825

AS Events	AS Events	AS Events
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COL4A5_chrX_+_107913457_107913466_107911734_107920729	RBM3_chrX_+_48434202_48434471_48434055_48434701	AP3S2_chr15_-_90420537_90420656_90414778_90431752
PDCD10_chr3_-_167443188_167443261_167438061_167452593	THAP9-AS1_chr4_-_83816844_83816927_83816000_83821229	FDPS_chr1_+_155279543_155279756_155278756_155279833
PLA2G15_chr16_+_68282471_68282595_68279456_68283192	METTL22_chr16_+_8738385_8738582_8736422_8739964	CNDP2_chr18_+_72164743_72164830_72163666_72167171
KCTD17_chr22_+_37456862_37456962_37455478_37457578	RNF19A_chr8_-_101312755_101312879_101300495_101322094	D2HGDH_chr2_+_242690660_242690803_242689709_242694459
DDR1_chr6_+_30853401_30853457_30850942_30856464	KLK2_chr19_+_51377976_51378136_51376775_51379727	NDUFV3_chr21_+_44323291_44324386_44317157_44328973
EIF4A2_chr3_+_186506098_186506209_186505671_186506913	EPS8L1_chr19_+_55595134_55596010_55595012_55597208	QDPR_chr4_-_17493854_17493963_17492368_17503341
TNK2_chr3_-_195609156_195609199_195606046_195610027	PCSK7_chr11_-_117077782_117077876_117077514_117078685	TRMT2B_chrX_-_100306239_100306722_100297301_100306805
ENOSF1_chr18_-_678695_678737_677872_683245	KIAA1217_chr10_+_24831811_24833410_24825822_24833909	ARHGEF11_chr1_-_156908209_156908305_156907288_156909339
CDIPT_chr16_-_29873906_29873956_29872580_29874135	SYTL2_chr11_-_85422155_85422275_85420543_85425455	CORO7_chr16_-_4411749_4411804_4411470_4411985
MPDZ_chr9_-_13186268_13186385_13183584_13188782	CAST_chr5_+_96062457_96062563_96058402_96063192	LTBP3_chr11_-_65307483_65307624_65307352_65307715
FEZ2_chr2_-_36785580_36785656_36782891_36805739	ANKRD10_chr13_-_111546631_111546740_111545610_111558379	RANBP3_chr19_-_5957928_5957984_5951607_5978071
BRD8_chr5_-_137502206_137502416_137501797_137503622	EZH1_chr17_-_40871122_40871225_40865407_40872290	COASY_chr17_+_40714373_40714505_40714237_40714629
ERMARD_chr6_+_170153133_170153277_170151759_170153959	FAM192A_chr16_-_57212621_57212764_57207781_57219732	ATRIP_chr3_+_48501185_48501315_48500853_48501508
ME3_chr11_-_86161342_86161440_86159297_86176132	RALGAPA1_chr14_-_36017713_36017744_36008896_36018315	TMEM94_chr17_+_73488319_73488418_73487981_73488554
MPRIP_chr17_+_17083920_17083983_17083402_17088136	IFT22_chr7_-_100961404_100962313_100959823_100964951	TNFSF10_chr3_-_172229406_172229449_172227111_172232650
TCF20_chr22_-_42564614_42564709_42557364_42565852	P2RX4_chr12_+_121660749_121660765_121659969_121666335	ABCD4_chr14_-_74759856_74760013_74759572_74761850
HM13_chr20_+_30155880_30156083_30149539_30156922	CTNND1_chr11_+_57558856_57559145_57529518_57561481	GEMIN8_chrX_-_14044170_14044340_14039630_14047895
BICD1_chr12_+_32491719_32491913_32490640_32520603	NR2C1_chr12_-_95434251_95434373_95425264_95442843	TSTD1_chr1_-_161008340_161008484_161007865_161008669
FAM192A_chr16_-_57212413_57212764_57207781_57219942	BNIP2_chr15_-_59970946_59971033_59970286_59971790	PTBP1_chr19_+_805512_805569_805187_806407

AS Events	AS Events	AS Events
TBX3_chr12_-_115117717_115117777_115117456_115118683	ASXL1_chr20_+_30959580_30959677_30956926_30959966	CARMIL1_chr6_+_25507706_25507718_25500463_25509883
OS9_chr12_+_58113881_58114046_58112965_58114188	EPOR_chr19_-_11493522_11493625_11492781_11493772	NASP_chr1_+_46082372_46082375_46082065_46083134
CACNA1D_chr3_+_53752708_53752768_53752415_53753781	FAAP20_chr1_-_2117442_2117688_2116952_2125077	ING4_chr12_-_6764803_6765079_6762216_6765892
METTL25_chr12_+_82832496_82832570_82828503_82850505	NUTF2_chr16_+_67881180_67881359_67880888_67899004	UPP1_chr7_+_48139266_48139384_48134424_48141420
TANGO2_chr22_+_20040959_20041074_20040107_20043465	MAZ_chr16_+_29820860_29821085_29820062_29821397	ZNF7_chr8_+_146054862_146054989_146052994_146062775
MAP2K7_chr19_+_7970692_7970740_7968953_7974639	NAGPA_chr16_-_5078297_5078399_5078186_5078880	COMTD1_chr10_-_76995373_76995501_76994936_76995592
SRRM1_chr1_+_24973569_24973699_24973280_24975349	DPF2_chr11_+_65112050_65112092_65111540_65113136	NOP58_chr2_+_203142934_203143052_203142725_203147073
HNRNPH1_chr5_-_179046269_179046408_179045324_179047892	CCNL2_chr1_-_1328169_1328183_1326245_1328775	MED24_chr17_-_38191168_38191225_38189709_38191369
ZNF384_chr12_-_6781515_6781698_6780004_6782381	TKFC_chr11_+_61103311_61103409_61102203_61105412	MARK3_chr14_+_103966492_103966537_103964865_103969218
RAD51C_chr17_+_56783238_56783383_56780690_56787219	PILRA_chr7_+_99987510_99987729_99972056_99995501	MED31_chr17_-_6553301_6553398_6547979_6553675
FOLH1_chr11_-_49228329_49228426_49227724_49229843	MAPK12_chr22_-_50686120_50686205_50685395_50686318	TAF1C_chr16_-_84219085_84219189_84218595_84220506
ANK3_chr10_-_61905725_61905779_61898845_61926348	RNF217_chr6_+_125292646_125292744_125284572_125366356	NAGLU_chr17_+_40692967_40693224_40690773_40695045
C12orf73_chr12_-_104347191_104347312_104345408_104350408	TRMT2B_chrX_-_100306632_100306722_100297301_100306805	BTF3L4_chr1_+_52525506_52525573_52522051_52530496
ABCD4_chr14_-_74764632_74764772_74763152_74766250	MCEE_chr2_-_71356846_71356947_71351673_71357309	UFD1L_chr22_-_19462590_19462623_19459331_19466605
LMAN2L_chr2_-_97403685_97403804_97400263_97405590	S100A13_chr1_-_153602925_153603132_153600074_153603486	PAAF1_chr11_+_73597973_73598144_73589864_73598398
GUSB_chr7_-_65444385_65444528_65441189_65445210	C12orf49_chr12_-_117158100_117158252_117155698_117175594	CAB39L_chr13_-_49975268_49975406_49957077_50007453
HNRNPH3_chr10_+_70097614_70097753_70097090_70098259	SREK1_chr5_+_65454636_65454760_65449424_65455046	SPOP_chr17_-_47714120_47714171_47700238_47723477
LYNX1_chr8_-_143856758_143856781_143846558_143857010	LIAS_chr4_+_39469738_39470047_39469266_39471638	ACTN1_chr14_-_69345705_69345786_69345240_69346678
BCLAF1_chr6_-_136590278_136590441_136589477_136590574	IFT81_chr12_+_110581186_110581350_110574665_110584757	EVI5L_chr19_+_7921977_7922010_7920954_7923076
HDAC6_chrX_+_48678512_48678662_48676516_48681029	BCS1L_chr2_+_219524759_219524941_219524466_219525661	OTUD6B_chr8_+_92088819_92088959_92086139_92090583

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INTS4_chr11_-_77622015_77622198_77618856_77629866	MACF1_chr1_+_39930766_39930784_39929358_39934286	GFM2_chr5_-_74026084_74026223_74021951_74028846
ARHGEF9_chrX_-_62947070_62947299_62944591_62974194	RNF167_chr17_+_4843781_4843937_4843525_4844167	TBC1D1_chr4_+_38053519_38053681_38051519_38055819
TMEM11_chr17_-_21114379_21114540_21102153_21117403	MSRB3_chr12_+_65702308_65702435_65672645_65720605	PDCD4_chr10_+_112636427_112636511_112635828_11264090
C2CD5_chr12_-_22611417_22611519_22610095_22612425	COQ4_chr9_+_131087421_131087518_131085426_131088057	MGST1_chr12_+_16507164_16507204_16500644_16510538
MDM1_chr12_-_68710360_68710390_68710033_68715126	MTFR1L_chr1_+_26149728_26149814_26149619_26150134	GARNL3_chr9_+_130111202_130111314_130107756_130116124
MSH5-SAPCD1_chr6_+_31713013_31713096_31712358_31715163	CROCCP2_chr1_-_16969261_16969345_16961663_16971140	EXD3_chr9_-_140269063_140269215_140268051_140277764
ABCD4_chr14_-_74756729_74756821_74756222_74756993	PRUNE1_chr1_+_150990942_150991145_150990380_150997086	FXR1_chr3_+_180688862_180688943_180688146_180693100
STX2_chr12_-_131280539_131280665_131276522_131283069	CUL7_chr6_-_43015684_43015727_43014845_43015885	DGKD_chr2_+_234377068_234377199_234375849_234378016
TMEM14B_chr6_+_10751365_10751467_10749931_10770309	MCF2L_chr13_+_113745434_113745509_113744042_113748827	PDLIM5_chr4_+_95506136_95506154_95497185_95506715
TTC38_chr22_+_46688099_46688225_46685796_46688687	VMP1_chr17_+_57911372_57911411_57895134_57915655	EED_chr11_+_85979497_85979603_85977258_85988021
PTGES2_chr9_-_130887057_130887150_130886829_130887522	KLHDC4_chr16_-_87790004_87790083_87788898_87795554	CSPP1_chr8_+_67999057_67999081_67998345_68005777
MFF_chr2_+_228217229_228217289_228212100_228220392	MBTD1_chr17_-_49286674_49286791_49284366_49294694	DGUOK_chr2_+_74184251_74184367_74154179_74185272
FNBP1_chr9_-_132686122_132686275_132671278_132687238	NUP50_chr22_+_45566868_45567058_45564127_45567480	RIPK2_chr8_+_90775056_90775210_90770461_90777568
PXN_chr12_-_120654075_120654919_120653464_120659425	DBN1_chr5_-_176886603_176886741_176886269_176887432	PAPD4_chr5_+_78952780_78952824_78945013_78964714
TRMU_chr22_+_46739158_46739265_46733841_46742318	DNAJC19_chr3_-_180704730_180704810_180703784_180705810	ACIN1_chr14_-_23559190_23559310_23551045_23559730
STK40_chr1_-_36833448_36833685_36821034_36851323	NBEA_chr13_+_36220005_36220068_36202385_36220395	DPH7_chr9_-_140470160_140470344_140469295_140470531
CBR4_chr4_-_169930102_169930205_169928907_169931098	MPND_chr19_+_4355093_4355170_4354417_4357249	FAM111A_chr11_+_58910969_58913329_58910777_58919222
SNRNP70_chr19_+_49605370_49605442_49604728_49607890	MRPL22_chr5_+_154330380_154330498_154320825_154335930	LINC00893_chrX_-_148619164_148619310_148615906_148619646
VCL_chr10_+_75871666_75871870_75868914_75873941	TAX1BP1_chr7_+_27855967_27856013_27839709_27867356	CENPO_chr2_+_25016720_25016834_25016389_25022543
GATA2_chr3_-_128210846_128211065_128205919_128211741	NFIX_chr19_+_13198802_13198950_13186485_13201112	SEMA4F_chr2_+_74884979_74885078_74884751_74889858

AS Events	AS Events	AS Events
ATAD3B_chr1_+_1425071_1425191_1424654_1425636	ABI1_chr10_-_27044583_27044670_27040712_27047990	SVIL_chr10_-_29820930_29821101_29820217_29821457
SSBP4_chr19_+_18542162_18542228_18541740_18542456	RBM38_chr20_+_55968334_55968389_55967833_55982598	PQLC1_chr18_-_77690227_77690311_77679400_77693968
GPS1_chr17_+_80010131_80010335_80009840_80011149	FDPS_chr1_+_155279579_155279756_155278756_155279833	CSAD_chr12_-_53554910_53554975_53554628_53555056
ZNF445_chr3_-_44499735_44499856_44497188_44519082	TM2D3_chr15_-_102191898_102191976_102190364_102192473	RFC5_chr12_+_118455494_118455858_118454697_118456876
PPP1R35_chr7_-_100033253_100033390_100033156_100033470	KTN1_chr14_+_56130672_56130759_56128330_56133958	TRIQK_chr8_-_93933730_93933888_93904302_93966633
IMPDH1_chr7_-_128033775_128033792_128033082_128034331	MAP4K4_chr2_+_102477286_102477448_102476326_102481391	TTLL3_chr3_+_9874787_9874957_9871079_9876364
SEC11A_chr15_-_85223162_85223200_85214013_85230855	DDX60L_chr4_-_169382849_169383191_169379159_169392897	CERS5_chr12_-_50535835_50535893_50532400_50536856
ZNF326_chr1_+_90472903_90473309_90470803_90475646	FNBP1_chr9_-_132686122_132686305_132671278_132687238	ZNF160_chr19_-_53594665_53594782_53589574_53594889
APBB3_chr5_-_139941428_139941434_139941286_139941684	KLK4_chr19_-_51411614_51411747_51410342_51411834	NPTN_chr15_-_73884306_73884410_73866136_73925465
INTS11_chr1_-_1258560_1258667_1257364_1259960	SF3B3_chr16_+_70584552_70584581_70582345_70588348	RNPS1_chr16_-_2314573_2314761_2314332_2318055
EIF3M_chr11_+_32610557_32610681_32605475_32611092	NKTR_chr3_+_42661507_42661535_42661200_42662920	LINC00963_chr9_+_132264675_132265418_132251578_132265601
SMARCA4_chr19_+_11144442_11144541_11144193_11144798	ST7L_chr1_-_113159434_113159517_113153625_113161530	SLC37A2_chr11_+_124956099_124956156_124955914_124958014
PDIA5_chr3_+_122849326_122849463_122843190_122864368	WSB1_chr17_+_25624212_25624334_25621461_25630392	ZNF644_chr1_-_91403828_91406866_91383711_91447866
ST3GAL3_chr1_+_44386453_44386600_44365399_44395803	CAD_chr2_+_27463434_27463485_27463229_27463778	USP54_chr10_-_75279554_75279750_75277505_75283340
NFYB_chr12_-_104525531_104525616_104522295_104529225	PXN_chr12_-_120653362_120653464_120653076_120659425	MMS19_chr10_-_99236591_99236720_99236501_99237103
KIF21A_chr12_-_39724043_39724064_39720126_39724547	HNRNPLL_chr2_-_38805061_38805144_38804674_38809054	IP6K2_chr3_-_48752747_48752960_48732854_48754589
TOMM34_chr20_-_43577370_43577518_43572220_43580473	VIL1_chr2_+_219299248_219299428_219297674_219300011	LRRFIP1_chr2_+_238647874_238647952_238629465_238657006
FAM76B_chr11_-_95512241_95512299_95512121_95512770	AP4M1_chr7_+_99699868_99700016_99699591_99700297	COL6A3_chr2_-_238287278_238287878_238285987_238289557
SLC12A7_chr5_-_1056696_1056711_1053597_1057585	MRPL55_chr1_-_228296655_228296722_228295570_228296961	ARIH2_chr3_+_48982568_48982614_48965246_48999044
CYTH1_chr17_-_76692088_76692091_76688575_76694350	TRNAU1AP_chr1_+_28887624_28887772_28887244_28887857	ARFGAP2_chr11_-_47194260_47194302_47193884_47196565

AS Events	AS Events	AS Events
KLHDC4_chr16_-_87790027_87790083_87788898_87795554	ZNF548_chr19_+_57904168_57904316_57901482_57905555	AAMDC_chr11_+_77552064_77552106_77532287_77553524
PNPLA8_chr7_-_108161919_108161965_108155891_108166472	HDAC7_chr12_-_48186320_48186452_48185787_48187151	PDE2A_chr11_-_72308553_72308663_72302400_72316181
RANBP3_chr19_-_5950727_5950886_5941846_5951403	GGT1_chr22_+_25004956_25005198_25003990_25006324	CHURC1_chr14_+_65392727_65392798_65390844_65398855
ZNF160_chr19_-_53594665_53594750_53589574_53594889	TBCK_chr4_-_107158647_107158695_107157965_107163626	ECHDC2_chr1_-_53370705_53370762_53370505_53373539
GIT2_chr12_-_110383064_110383154_110377052_110385060	RFC5_chr12_+_118455799_118455858_118454697_118456876	NDUFAF6_chr8_+_96056704_96056823_96053854_96057772
ATG12_chr5_-_115176193_115176309_115173461_115177086	SORBS2_chr4_-_186611715_186611765_186599976_186696380	GALNS_chr16_-_88909437_88909607_88909237_88923165
CHKA_chr11_-_67828959_67829297_67821514_67829419	OXNAD1_chr3_+_16313651_16313828_16313229_16327848	PLA2G5_chr1_+_20415317_20415394_20412720_20417060
KIAA0141_chr5_+_141318420_141318469_141318325_141319070	NAXD_chr13_+_111274562_111274713_111267994_111286891	TCF12_chr15_+_57544618_57544690_57543621_57545459
SETD3_chr14_-_99927528_99927677_99925522_99929822	DDX39A_chr19_-_14521359_14521417_14521146_14521800	GUF1_chr4_+_44690023_44690163_44688730_44691302
NDEL1_chr17_+_8366637_8366672_8363478_8370247	CARS_chr11_-_3068982_3069231_3063486_3078572	SF1_chr11_-_64540901_64540977_64537880_64543969
GOLGA4_chr3_+_37402733_37402796_37396678_37407570	SLK_chr10_+_105770573_105770666_105768114_105777917	NDUFB5_chr3_+_179333770_179333837_179322727_179334770
METTL13_chr1_+_171759591_171759756_171757070_171761156	NDUFA7_chr19_-_8384184_8384278_8381529_8386191	CAMK2G_chr10_-_75599296_75599359_75597269_75601926
DPY30_chr2_-_32248745_32248877_32248543_32254662	LCN10_chr9_-_139635703_139635813_139635395_139636332	UBE3A_chr15_-_25652213_25652284_25650649_25654234
PTDSS2_chr11_+_473894_473977_460288_479084	RPAIN_chr17_+_5331390_5331531_5329619_5335861	BCAT2_chr19_-_49310256_49310331_49303554_49314240
TIAL1_chr10_-_121339982_121340358_121339522_121341433	DENND5A_chr11_-_9164949_9165032_9164392_9165643	PHYKPL_chr5_-_177642276_177642431_177641886_177649355
NPEPL1_chr20_+_57280553_57280625_57276214_57282178	MRPL55_chr1_-_228296137_228296722_228296019_228296961	HERC4_chr10_-_69718869_69718893_69716733_69726439
NFASC_chr1_+_204960419_204960434_204957934_204978684	DNAJC2_chr7_-_102967778_102967825_102967131_102968102	PHKG2_chr16_+_30767675_30767841_30764878_30767910
ATG9A_chr2_-_220093155_220093204_220092775_220094256	FHOD3_chr18_+_34267090_34267141_34261533_34273171	CCDC90B_chr11_-_82989768_82989872_82985783_82991183
RAB4B-EGLN2_chr19_+_41289682_41289745_41286404_41289825	FAM193B_chr5_-_176963358_176963487_176959642_176964873	RABGAP1L_chr1_+_174927027_174927310_174926686_174938413
DPY30_chr2_-_32108454_32108531_32095021_32142994	ADAM15_chr1_+_155033893_155033965_155033308_155034720	MAPT_chr17_+_44060543_44061296_44055806_44064405

AS Events	AS Events	AS Events
DGUOK_chr2_+_74177727_74177859_74154179_74185272	KLHL24_chr3_+_183354008_183354099_183353581_183361267	ANKRD10_chr13_-_111552876_111553041_111545610_111558379
ARMCX2_chrX_-_100913446_100913555_100913128_100914742	D2HGDH_chr2_+_242688279_242689344_242684292_242689565	GEMIN4_chr17_-_653053_653149_651272_655372
DPY30_chr2_-_32117060_32117203_32095021_32142994	MYH11_chr16_-_15802659_15802698_15797980_15808765	PALM_chr19_+_740351_740483_736078_746284
NR1H3_chr11_+_47280730_47280810_47270550_47281341	GUSB_chr7_-_65444713_65444898_65441189_65445210	MTMR12_chr5_-_32233066_32233126_32230453_32233878
CLASP2_chr3_-_33638202_33638226_33633988_33644443	TRDN_chr6_-_123696749_123696776_123687327_123698860	PIGQ_chr16_+_631198_631341_630972_632247
RP11-43F13.1_chr5_-_1630523_1630681_1629745_1632959	AP1G2_chr14_-_24035770_24035895_24035628_24036319	PBRM1_chr3_-_52588739_52588895_52584833_52592264
ARF1_chr1_+_228284151_228284205_228270551_228284778	HERC2P9_chr15_+_28900640_28900837_28900566_28900941	PEX7_chr6_+_137167210_137167319_137147607_137187764
GABBR1_chr6_-_29577005_29577156_29576510_29578700	PHYKPL_chr5_-_177639973_177640104_177638971_177641796	HMOX2_chr16_+_4533637_4533739_4526488_4556895
PDDC1_chr11_-_773427_773629_772521_774007	ZC3H7A_chr16_-_11862886_11862951_11862357_11864638	ECHDC2_chr1_-_53372190_53372283_53370505_53373539
C1orf116_chr1_-_207198231_207198409_207196825_207205923	PYROXD2_chr10_-_100147621_100147841_100147064_100148110	PLPP1_chr5_-_54786787_54786942_54771278_54830399
MYL6_chr12_+_56553281_56553406_56552495_56553758	PRRC2C_chr1_+_171560290_171560339_171557644_171560725	UHRF2_chr9_+_6492302_6492401_6486925_6493825
BCAP29_chr7_+_107256705_107256834_107253877_107258772	SIRT2_chr19_-_39389018_39389065_39384611_39390145	GSTM4_chr1_+_110200211_110200293_110199901_110200393
LRRC27_chr10_+_134162466_134162561_134161860_134165110	TRAPPC2_chrX_-_13752162_13752304_13738101_13752643	TCF3_chr19_-_1632330_1632404_1627425_1646353
GNPTAB_chr12_-_102150197_102150344_102147317_102150989	DNM2_chr19_+_10919244_10919256_10916643_10922939	METTL6_chr3_-_15457004_15457090_15455669_15457278
PMF1_chr1_+_156195347_156195459_156182967_156203418	ALKBH1_chr14_-_78161080_78161243_78146313_78170711	INO80E_chr16_+_30012532_30014334_30012361_30016541
UVSSA_chr4_+_1374428_1374535_1374018_1374667	TMEM62_chr15_+_43470804_43470909_43461875_43473378	PLOD2_chr3_-_145795648_145795711_145794682_145796902
NEB_chr2_-_152371331_152371442_152370942_152372972	PLEKHA1_chr10_+_124187791_124187936_124186547_124189139	CSNK1A1_chr5_-_148897356_148897440_148892772_148899852
IRF6_chr1_-_209975316_209975388_209969897_209979291	PMPCB_chr7_+_102948042_102948155_102944937_102949398	COL16A1_chr1_-_32136202_32136247_32134456_32137215
PRR3_chr6_+_30529104_30529285_30525227_30529610	DPP9_chr19_-_4683201_4683336_4682850_4683488	CD27-AS1_chr12_-_6560058_6560146_6557903_6560634
TFDP1_chr13_+_114285937_114286220_114277601_114287434	B3GALNT2_chr1_-_235652472_235652573_235647831_235657990	CSAD_chr12_-_53565109_53565225_53564286_53565665

AS Events	AS Events	AS Events
CCDC50_chr3_+_191092850_191093378_191087825_191097947	NUMA1_chr11_-_71723446_71723488_71721900_71723940	POGK_chr1_+_166815848_166815975_166810325_166818174
BPTF_chr17_+_65959448_65959622_65955991_65960327	PPT2-EGFL8_chr6_+_32122806_32122960_32122554_32123464	SMYD2_chr1_+_214478529_214478593_214454770_214488104
ISOC2_chr19_-_55967002_55967212_55966697_55967715	SEC31A_chr4_-_83763292_83763634_83750211_83765538	MINDY3_chr10_-_15880226_15880278_15879317_15883424
GAS6_chr13_-_114550998_114551023_114542823_114566547	ABHD14B_chr3_-_52005475_52005908_52004200_52007980	SYNE4_chr19_-_36494514_36494573_36494422_36496234
APBB3_chr5_-_139941428_139941580_139941286_139941684	ZDHHC20_chr13_-_21999790_21999817_21987911_22033192	HEXA_chr15_-_72646031_72646078_72645519_72647899
GUK1_chr1_+_228328824_228329208_228328064_228333211	SPIDR_chr8_+_48641973_48642027_48626203_48647868	FAM192A_chr16_-_57208531_57208600_57207781_57219732
NDUFS8_chr11_+_67799618_67799676_67798200_67803719	CADPS_chr3_-_62516328_62516487_62503925_62518545	IGFLR1_chr19_-_36230610_36230670_36230527_36231924
CD44_chr11_+_35219667_35219793_35211612_35232792	UBE2B_chr5_+_133712359_133712385_133710154_133724015	GPS1_chr17_+_80010250_80010335_80009840_80011149
FAM126A_chr7_-_22986570_22986866_22985782_22999874	ASPH_chr8_-_62594997_62595042_62593595_62596597	GUSB_chr7_-_65444820_65444898_65441189_65445210
BIRC6_chr2_+_32815872_32816045_32800433_32818981	AGAP3_chr7_+_150817606_150817832_150817232_150820880	UTP6_chr17_-_30205720_30205800_30205346_30207591
SNRNP70_chr19_+_49605370_49605430_49604728_49607890	TP53I11_chr11_-_44958109_44958240_44957213_44958353	PTPMT1_chr11_+_47591251_47591443_47587538_47593022
BLOC1S6_chr15_+_45895301_45895385_45879723_45897625	SCAP_chr3_-_47467486_47467659_47464026_47476497	DNM1_chr9_+_131010202_131010214_131009765_131010861
LPIN2_chr18_-_2928588_2928658_2927809_2929062	TPM1_chr15_+_63356262_63356389_63354844_63358094	ERMARD_chr6_+_170153382_170153468_170151759_170153959
PDLIM7_chr5_-_176918404_176918421_176918147_176918807	RNASET2_chr6_-_167362053_167362113_167360227_167365975	TBRG4_chr7_-_45143697_45143855_45143042_45144136
MTERF4_chr2_-_242035807_242035853_242033847_242036657	ZC3H11A_chr1_+_203803064_203803230_203802981_203807093	ELMOD3_chr2_+_85614220_85614348_85604597_85616873
POLL_chr10_-_103345618_103345913_103344676_103347002	BIN1_chr2_-_127811480_127811588_127808819_127815048	RAN_chr12_+_131357128_131357162_131356671_131357380
RBM5_chr3_+_50147811_50147896_50147121_50148111	REPS1_chr6_-_139247537_139247618_139242261_139251113	BTBD1_chr15_-_83697367_83697480_83689514_83698887
AKR1A1_chr1_+_46034156_46034356_46033849_46034598	FOPNL_chr16_-_15976805_15976877_15973745_15977864	TSNAX_chr1_+_231699210_231699375_231697001_231700273
KANSL2_chr12_-_49056342_49056437_49054402_49061475	RHOC_chr1_-_113247721_113247745_113246428_113249699	GLT8D1_chr3_-_52738739_52738964_52731950_52739462
MICAL3_chr22_-_18310409_18310547_18305826_18314619	ZNF207_chr17_+_30693683_30693776_30692506_30694790	FKRP_chr19_+_47251771_47251974_47251345_47258668

AS Events	AS Events	AS Events
SYTL1_chr1_+_27676462_27676623_27676256_27676879	SPAG9_chr17_-_49053223_49053262_49052308_49054468	EBPL_chr13_-_50243912_50243982_50237331_50265389
TAF1D_chr11_-_93466515_93466563_93463878_93467790	DMPK_chr19_-_46274228_46274314_46273898_46274825	SLC35B3_chr6_-_8422702_8422857_8421061_8428169
ACSF2_chr17_+_48541886_48541960_48541655_48548388	ACTN1_chr14_-_69345174_69345240_69343957_69345705	ZBTB1_chr14_+_64983317_64983469_64971664_64988204
AKAP8L_chr19_-_15509440_15509514_15508666_15510112	PPHLN1_chr12_+_42745686_42745851_42729776_42748962	GOLGB1_chr3_-_121387160_121387355_121387005_121388058
ZFAS1_chr20_+_47897439_47897501_47897107_47905581	METTL26_chr16_-_685611_685774_685340_686093	NADSYN1_chr11_+_71187078_71188484_71185572_711894 40
NUDT9_chr4_+_88366473_88366659_88363067_88370293	SPATA5L1_chr15_+_45699226_45699421_45697703_45702569	RMDN1_chr8_-_87497100_87497190_87492561_87498712
PVT1_chr8_+_129010445_129010605_129001537_129021835	HAUS2_chr15_+_42852979_42853068_42851606_42853467	RHOT1_chr17_+_30536368_30536464_30535328_30538134
BPTF_chr17_+_65871671_65871860_65871136_65887959	CYP4A11_chr1_-_47398654_47398719_47398509_47399617	NDRG2_chr14_-_21492134_21492255_21491480_21493187
U2SURP_chr3_+_142742816_142742860_142741906_142745990	IL18BP_chr11_+_71710273_71710708_71710065_71710972	NEK1_chr4_-_170476870_170477002_170459062_170477082
FAR2P2_chr2_-_131183738_131183836_131182731_131185276	RBM6_chr3_+_50036872_50036946_50012825_50085677	SPPL2A_chr15_-_51018269_51018323_51017520_51018517
PGAP3_chr17_-_37832866_37833008_37830932_37840849	SNRPA1_chr15_-_101833229_101833377_101827907_101835301	THRAP3_chr1_+_36724982_36725085_36690106_36748133
POLDIP3_chr22_-_42997975_42998113_42995799_42998775	MUC20_chr3_+_195449371_195449689_195447954_195451550	C17orf62_chr17_-_80407049_80407168_80404572_80408575
WDR73_chr15_-_85189203_85189316_85189067_85189414	NEB_chr2_-_152350288_152350381_152349008_152350674	RPS15_chr19_+_1439604_1439825_1438891_1440024
CTBP1_chr4_-_1235112_1235307_1232125_1242703	EIF2AK4_chr15_+_40324957_40325002_40322657_40326526	USMG5_chr10_-_105153955_105154151_105152223_105155502
MRNIP_chr5_-_179280196_179280276_179275066_179280377	NFE2L1_chr17_+_46134393_46134483_46133960_46134705	PRR34-AS1_chr22_+_46451478_46451613_46450833_46452726
ABI1_chr10_-_27044583_27044670_27040712_27054146	TRIP4_chr15_+_64706283_64706410_64702027_64710739	QTRT2_chr3_+_113786833_113786910_113785130_113789472
ZC3H14_chr14_+_89069171_89069389_89044484_89073586	MMS19_chr10_-_99228722_99228861_99228163_99229402	TIRAP_chr11_+_126159559_126159712_126153048_126160697
TMEM62_chr15_+_43430771_43430817_43427847_43438690	TBXAS1_chr7_+_139482464_139482528_139478270_139487136	NPRL3_chr16_-_174935_175072_169254_188148
FKRP_chr19_+_47251771_47252141_47251345_47258668	SS18_chr18_-_23615794_23615887_23615091_23618518	KIF21A_chr12_-_39711874_39712003_39705355_39713707
ATP8A2P1_chr10_+_37598024_37598108_37553565_37604623	MAN2B1_chr19_-_12769241_12769321_12769158_12772073	EZH1_chr17_-_40869993_40870085_40865407_40872290

AS Events	AS Events	AS Events
FAXDC2_chr5_-_154214184_154214288_154210482_154214402	TEP1_chr14_-_20840891_20841016_20839791_20841169	SERPINC1_chr1_-_173884155_173884324_173884057_173886356
VCAN_chr5_+_82815167_82818128_82808215_82841355	GALM_chr2_+_38925507_38925578_38917036_38956697	NUP35_chr2_+_184016235_184016377_183998351_184022171
ATXN2L_chr16_+_28847646_28847811_28847497_28848048	ADAM15_chr1_+_155034379_155034451_155033308_155034720	CCSER2_chr10_+_86259630_86259715_86237420_86273204
TRIM14_chr9_-_100872350_100872516_100872266_100881263	EIF2D_chr1_-_206772816_206772966_206772446_206773616	ABHD16A_chr6_-_31669850_31669907_31668805_31670926
CD44_chr11_+_35229651_35229753_35211612_35232792	PTRH2_chr17_-_57776231_57777550_57775339_57784731	ZNF761_chr19_+_53948253_53948376_53935281_53950448
TMEM8B_chr9_+_35835007_35835215_35829952_35841130	NSMF_chr9_-_140350080_140350086_140349759_140350862	SGSM3_chr22_+_40797596_40797679_40796817_40798142
AP2A2_chr11_+_1000431_1000598_994245_1003721	FAM131A_chr3_+_184056174_184056317_184053911_184059511	FAM219B_chr15_-_75197322_75197400_75197053_75197494
CD27-AS1_chr12_-_6559639_6559874_6557903_6560634	ZNF638_chr2_+_71649943_71651168_71645769_71651779	ZFYVE21_chr14_+_104196129_104196183_104195519_104198956
DGUOK_chr2_+_74166036_74166149_74154179_74185272	ADGRL2_chr1_+_82418670_82418709_82417826_82421560	FAM193B_chr5_-_176959156_176959201_176958522_176959443
TBC1D15_chr12_+_72288104_72288155_72287104_72288465	FAM193B_chr5_-_176974168_176974229_176966148_176981249	PRUNE2_chr9_-_79234255_79234303_79229516_79239938
SYNE1_chr6_-_152451854_152451913_152443811_152453256	TBP_chr6_+_170876313_170876593_170876097_170878699	PTCD3_chr2_+_86346666_86346737_86346167_86348601
NSUN5P2_chr7_-_72422690_72422834_72420735_72425163	AFMID_chr17_+_76201683_76201834_76200981_76202026	CSDE1_chr1_-_115284147_115284294_115282511_115300545
HSD17B6_chr12_+_57157001_57157198_57146102_57167617	WNK1_chr12_+_988738_989197_987527_989886	KLC1_chr14_+_104158695_104158762_104153548_104166991
HINFP_chr11_+_119002952_119003007_119002692_119003205	SYNE4_chr19_-_36497324_36497573_36496339_36498026	FAR2P3_chr2_+_131452809_131452907_131451369_131453914
DPP8_chr15_-_65748049_65748179_65746753_65748562	NUDT2_chr9_+_34336297_34336339_34329597_34338710	TNK2_chr3_-_195612283_195612414_195611904_195613847
AHSA2_chr2_+_61410681_61410797_61408540_61411846	SPTLC1_chr9_-_94841715_94841848_94830380_94842297	HEMK1_chr3_+_50615256_50615306_50615004_50617274
ARFIP1_chr4_+_153791904_153792000_153784866_153793603	PHYKPL_chr5_-_177650320_177650452_177649935_177651616	TEAD2_chr19_-_49859215_49859227_49858676_49860508
GSKIP_chr14_+_96846024_96846092_96829905_96848583	NFIB_chr9_-_14116206_14116345_14088325_14120438	SMPDL3A_chr6_+_123116821_123117035_123110603_123117968
FBLN2_chr3_+_13663274_13663415_13661331_13667944	TTC7A_chr2_+_47185633_47185691_47184146_47202111	SGCA_chr17_+_48244942_48245097_48244848_48245307
ARID4B_chr1_-_235377083_235377341_235359430_235383107	CPNE4_chr3_-_131753410_131753603_131624288_131756400	CAPN10_chr2_+_241535350_241535569_241534721_241535735

AS Events	AS Events	AS Events
RILP_chr17_-_1550199_1550283_1549913_1551128	AC005154.6_chr7_-_30590933_30591095_30590397_30603346	MRPS28_chr8_-_80915233_80915415_80831383_80942270
BRD2_chr6_+_32942797_32942889_32942542_32943160	RP4-539M6.19_chr22_+_30811936_30812076_30806668_30812222	CCAR1_chr10_+_70516029_70516240_70515293_70517050
CAST_chr5_+_96062497_96062563_96058402_96063192	PHYKPL_chr5_-_177658669_177658867_177658524_177659492	HEATR5B_chr2_-_37217790_37217942_37216002_37227728
EIF4A2_chr3_+_186506098_186506205_186505671_186506913	MICAL3_chr22_-_18295272_18295323_18293579_18299455	SRSF1_chr17_-_56082758_56082961_56082402_56083161
SLTM_chr15_-_59204761_59204809_59193486_59209133	CNDP2_chr18_+_72164743_72164830_72163666_72167116	PTBP1_chr19_+_806407_806556_799443_808359
RNH1_chr11_-_504823_504996_502181_507112	MBNL1_chr3_+_152174055_152174150_152165562_152177059	ARVCF_chr22_-_19958738_19958858_19958266_19959408
PCSK7_chr11_-_117078369_117078451_117077876_117078685	STYXL1_chr7_-_75643059_75643205_75634722_75651168	GOLGA8A_chr15_-_34727583_34727672_34699936_34729598
ECHDC2_chr1_-_53370705_53370762_53364896_53373539	FAR2P3_chr2_+_131453039_131453164_131451369_131453914	GAA_chr17_+_78075609_78075724_78075424_78078353
SFXN2_chr10_+_104487431_104487548_104486914_104488187	PDDC1_chr11_-_773521_773629_772521_774007	SBF1_chr22_-_50895462_50895540_50895102_50897683
ARIH2_chr3_+_48962150_48962404_48960244_48964894	FAM221A_chr7_+_23731801_23734532_23731215_23740404	WRNIP1_chr6_+_2770353_2770595_2766678_2779496
FAM206A_chr9_+_111698587_111698717_111697969_111712786	MAN2B1_chr19_-_12769241_12769324_12769158_12772073	MFSD11_chr17_+_74739479_74739538_74738355_74740403
APLP2_chr11_+_129993506_129993674_129992408_129996594	GOSR2_chr17_+_45012394_45012591_45009565_45015964	TXNDC16_chr14_-_52929529_52929688_52923892_52936754
CPNE4_chr3_-_131753410_131754286_131624288_131756400	C11orf49_chr11_+_47013093_47013198_46958402_47073938	NPHP3_chr3_-_132415574_132415657_132413809_132416103
DFFB_chr1_+_3782847_3782962_3782564_3784537	EPB41L2_chr6_-_131201283_131201346_131191266_131206235	RANBP3_chr19_-_5950727_5950883_5941846_5951403
PCBP4_chr3_-_51996825_51996908_51996104_52001341	EPB41_chr1_+_29386933_29386996_29385157_29391493	YPEL5_chr2_+_30371110_30371407_30369928_30379493
TAMM41_chr3_-_11868191_11868279_11858811_11871187	NT5C2_chr10_-_104860508_104860700_104859776_104860801	ARFGAP2_chr11_-_47194260_47194302_47193884_47197401
ATP2A2_chr12_+_110785197_110785258_110784126_110788096	PLXNB2_chr22_-_50733147_50733207_50729026_50745981	MORF4L2_chrX_-_102939608_102939657_102931979_102940098
IMMP1L_chr11_-_31484718_31484852_31455117_31531065	RCC1_chr1_+_28834639_28834672_28832596_28843236	KLK4_chr19_-_51411614_51411751_51410342_51411834
AFMID_chr17_+_76200736_76200822_76198832_76200908	CPSF7_chr11_-_61188663_61188729_61188045_61188861	RBM26_chr13_-_79927287_79927359_79918929_79928573
SLC4A7_chr3_-_27472788_27473160_27465643_27475406	TMEM62_chr15_+_43430771_43430817_43427847_43440952	TMEM214_chr2_+_27260657_27260760_27260570_27261013

AS Events	AS Events	AS Events
MCRIP2_chr16_+_696471_696608_692249_697416	OARD1_chr6_-_41036579_41036692_41035176_41038870	EXOC7_chr17_-_74086409_74086562_74085401_74090494
GUSB_chr7_-_65444820_65444898_65444528_65445210	ZC3H14_chr14_+_89069171_89069404_89044484_89073586	XPA_chr9_-_100444481_100444712_100437869_100447204
SRSF7_chr2_-_38976039_38976488_38975795_38976670	AMDHD2_chr16_+_2577573_2577616_2571124_2577773	NRDC_chr1_-_52302040_52302110_52301884_52305897
TOM1L2_chr17_-_17761082_17761169_17754266_17764789	SRSF1_chr17_-_56082774_56082961_56082402_56083161	TMEM5_chr12_+_64176320_64176484_64174954_64178749
HACL1_chr3_-_15628031_15628109_15624496_15631046	NSUN5P1_chr7_+_75043917_75044076_75042210_75044162	DCAF6_chr1_+_167988782_167988905_167974031_167992225
LRRFIP2_chr3_-_37146945_37147014_37138151_37162982	HMOX2_chr16_+_4533637_4533739_4526488_4555484	CEP70_chr3_-_138291700_138291774_138256189_138310695
RPS24_chr10_+_79799961_79799983_79797062_79800372	EZH2_chr7_-_148543561_148543690_148529842_148581255	SEC16A_chr9_-_139340096_139340171_139338352_139341306
AASDH_chr4_-_57211292_57211456_57204957_57215428	SUMF2_chr7_+_56141806_56141911_56140804_56142278	GGT5_chr22_-_24628018_24628176_24627498_24640520
FAM13B_chr5_-_137281916_137282000_137281686_137284643	RDH13_chr19_-_55559413_55559625_55558856_55559696	WBP1_chr2_+_74685958_74686244_74685798_74686769
LRRC23_chr12_+_7015008_7015118_7014923_701557 2	UIMC1_chr5_-_176396601_176396707_176385155_176402396	CBWD1_chr9_-_146101_146158_135030_154708
TOR1AIP2_chr1_-_179834570_179834989_179821946_179846373	MXI1_chr10_+_112004585_112004631_111988079_112038937	PARP6_chr15_-_72541585_72541655_72535040_72542360
TNC_chr9_-_117826925_117827198_117804620_117835881	MIF4GD_chr17_-_73265427_73265550_73264273_73266194	MPRIP_chr17_+_17078606_17078726_17077389_17079739
RPS6KB2_chr11_+_67199826_67199963_67198986_67200070	GSTM4_chr1_+_110200154_110200293_110199901_110200393	AGTRAP_chr1_+_11806183_11806280_11805894_11807496
PYROXD1_chr12_+_21605014_21605088_21602625_21608065	POLR2J3_chr7_-_102185152_102185223_102182109_102207028	OFD1_chrX_+_13771486_13771560_13769487_13774696
FAM192A_chr16_-_57208080_57208198_57207781_57219732	TCF25_chr16_+_89944868_89945035_89940267_89949758	NMRK1_chr9_-_77693241_77693498_77692496_77698002
THAP9-AS1_chr4_-_83819141_83819215_83816000_83821229	SAR1B_chr5_-_133967766_133967885_133959727_133968417	RANBP3_chr19_-_5957917_5957984_5933490_5978071
PARD3_chr10_-_34625126_34625171_34620272_34626202	FAM192A_chr16_-_57212413_57212764_57207781_57219732	NOC4L_chr12_+_132631825_132631933_132630210_132635525
GIT1_chr17_-_27905979_27906006_27905797_27908355	EPB41L2_chr6_-_131199243_131199390_131191266_131206235	HYAL2_chr3_-_50358796_50359204_50357966_50360083
PDE4DIP_chr1_-_144871695_144871881_144866723_144873876	ZNF273_chr7_+_64377407_64377496_64363797_64377958	NOSTRIN_chr2_+_169712395_169712720_169711970_169713199
DMD_chrX_-_31144758_31144790_31140047_31152218	NEB_chr2_-_152359306_152359399_152350767_152359862	C12orf73_chr12_-_104348652_104348746_104345408_104350408

AS Events	AS Events	AS Events
FAM219B_chr15_-_75197322_75197380_75197053_75197494	ABHD16A_chr6_-_31669050_31669117_31668805_31670926	HAPLN3_chr15_-_89422648_89422683_89422500_89424587
RBM6_chr3_+_50004902_50006181_50000118_50085677	BRD8_chr5_-_137502206_137502299_137501797_137503622	PKD1_chr16_-_2141423_2141598_2141175_2141781
PRPF39_chr14_+_45565626_45565961_45565431_45566089	JMJD6_chr17_-_74717344_74717433_74716580_74717879	MATR3_chr5_+_138642927_138644016_138629494_138650363
EPN3_chr17_+_48613389_48613560_48610205_48613781	DONSON_chr21_-_34954470_34954552_34954361_34956895	ARL4A_chr7_+_12727259_12727353_12726668_12727790
TBC1D23_chr3_+_100030676_100030721_100029386_100034942	THYN1_chr11_-_134118702_134118853_134118378_134119060	GSN_chr9_+_124062333_124062404_124043840_124064240
GORAB_chr1_+_170505450_170505562_170501425_170508350	NAPG_chr18_+_10530766_10530834_10526155_10539758	PLD3_chr19_+_40871459_40871492_40854675_40872325
FAM221A_chr7_+_23731801_23734532_23731215_23737810	KIAA0895L_chr16_-_67215508_67215600_67214569_67217164	SLTM_chr15_-_59182479_59182660_59181753_59185095
NT5C2_chr10_-_104871501_104871562_104866463_104934614	C12orf73_chr12_-_104348652_104348746_104347312_104350408	NDRG2_chr14_-_21492188_21492255_21491480_21493835
UHRF2_chr9_+_6495584_6497103_6493932_6497197	SUN1_chr7_+_889559_889670_889240_891586	RABGAP1L_chr1_+_174846529_174846743_174781098_174926593
TMEM50B_chr21_-_34819324_34819447_34811604_34821088	ING3_chr7_+_120604795_120604892_120595678_120606679	NPRL3_chr16_-_174935_175072_169254_180520
KIAA1191_chr5_-_175786483_175786570_175782752_175786813	MANBAL_chr20_+_35927165_35927282_35918089_35929610	PCBP2_chr12_+_53861588_53861627_53861077_53862563
MAP3K6_chr1_-_27691151_27691175_27690885_27691263	AP1B1_chr22_-_29725700_29725709_29724884_29726366	SORBS2_chr4_-_186605907_186605996_186599976_186611715
CD151_chr11_+_834457_834591_833026_836062	WDR27_chr6_-_170063658_170063745_170060862_170064261	PCBP2_chr12_+_53861588_53861627_53861077_53862560
RP11-532F12.5_chr15_-_41130740_41130884_41128480_41136376	SREK1_chr5_+_65451892_65454760_65449424_65455046	MXRA7_chr17_-_74679928_74680009_74676961_74681153
ING4_chr12_-_6764803_6765079_6762562_6765892	ATP5C1_chr10_+_7848936_7848973_7844817_7849621	EXOC7_chr17_-_74086409_74086478_74085401_74090494
C1orf159_chr1_-_1019294_1019391_1018367_1019732	GUSB_chr7_-_65444713_65444898_65444528_65445210	DMPK_chr19_-_46283580_46283639_46283127_46285450
TP53BP1_chr15_-_43738963_43739112_43738788_43739563	KIAA1191_chr5_-_175786464_175786570_175782752_175786813	STON1_chr2_+_48757851_48757968_48757355_48807725
RHOT2_chr16_+_719552_719606_718699_720122	ZNF271P_chr18_+_32870973_32871196_32870355_32885939	ERBIN_chr5_+_65370851_65371058_65350779_65372143
CTNND1_chr11_+_57558963_57559145_57529518_57561481	MAP3K4_chr6_+_161529982_161530073_161529891_161530786	SVIL_chr10_-_29815889_29815985_29813644_29818633
RUBCN_chr3_-_197417944_197418019_197411088_197420585	OSBPL9_chr1_+_52135105_52135184_52117713_52179674	ARFGEF2_chr20_+_47558400_47558524_47538547_47567859

AS Events	AS Events	AS Events
NRAP_chr10_-_115402692_115402797_115401231_115405583	ADGRG2_chrX_-_19055715_19055754_19054095_19058306	UIMC1_chr5_-_176396053_176396292_176385155_176396601
STX8_chr17_-_9460750_9460845_9408479_9471687	CCNDBP1_chr15_+_43482252_43482349_43481478_43482522	BCS1L_chr2_+_219524759_219524968_219524466_219525661
ERMP1_chr9_-_5791233_5791282_5787593_5797816	ZDHHC9_chrX_-_128977234_128977302_128963117_128977671	PEX2_chr8_-_77898422_77898532_77896431_77912225
C9orf3_chr9_+_97848211_97848401_97845001_97848963	CD151_chr11_+_834529_834591_833022_836062	RHBDD2_chr7_+_75510682_75510804_75508578_75511146
SVIL_chr10_-_29824917_29824998_29820217_29839525	C2CD5_chr12_-_22611417_22611489_22610095_22612425	SLAIN2_chr4_+_48396592_48396670_48385801_48422141
CXXC1_chr18_-_47813792_47813878_47813228_47813956	ORMDL1_chr2_-_190647739_190647849_190647328_190648994	KIAA1217_chr10_+_24831621_24831699_24825822_248339099
MMS19_chr10_-_99236591_99236676_99236501_99237103	FAN1_chr15_+_31202816_31203018_31200461_31206060	SCRIB_chr8_-_144886737_144886995_144886326_144887103
MARK3_chr14_+_103964838_103964865_103958371_103966492	C1orf116_chr1_-_207200838_207201024_207196825_207205923	NENF_chr1_+_212615887_212615967_212606462_212617680
UIMC1_chr5_-_176395555_176396292_176385155_176402396	PHLDB2_chr3_+_111671418_111671559_111664204_111672776	ACCS_chr11_+_44094893_44095067_44092865_44096161
MBD2_chr18_-_51714083_51714207_51692536_51715243	METTL26_chr16_-_685280_685340_684797_686093	TPM1_chr15_+_63356262_63356341_63354844_63358094
NAP1L4_chr11_-_2970456_2970494_2966876_2972488	TMEM120A_chr7_-_75616855_75616920_75616746_75617035	YBX3_chr12_-_10862506_10862713_10856747_10865809
EPOR_chr19_-_11493522_11493658_11492781_11493772	SLTM_chr15_-_59191667_59192082_59191051_59193458	C1orf52_chr1_-_85724617_85724744_85724405_85725040
FBXL6_chr8_-_145581098_145581162_145580781_145581287	SLC37A4_chr11_-_118897312_118897398_118896790_118897646	SEC31A_chr4_-_83752089_83752128_83750211_83765538
MBOAT2_chr2_-_9002400_9002452_9000894_9002719	TRPT1_chr11_-_63992266_63992442_63992189_63992970	SNHG16_chr17_+_74555026_74555125_74553939_74557369
POFUT2_chr21_-_46685936_46686142_46685550_46687504	CENPX_chr17_-_79977385_79977570_79977257_79977733	WNK2_chr9_+_96069058_96069103_96060349_96070609
LRRC75A-AS1_chr17_+_16342841_16343017_16342728_16343498	RBM4_chr11_+_66410920_66411611_66407594_66413497	DCAF8_chr1_-_160231074_160231148_160213824_160232238
AASS_chr7_-_121722841_121722945_121721649_121726065	KLK2_chr19_+_51380962_51381012_51380264_51381659	SLC2A8_chr9_+_130159654_130159817_130159565_130162185
ABI2_chr2_+_204260381_204260503_204259569_204267298	C17orf62_chr17_-_80407306_80407356_80407168_80408575	STAG2_chrX_+_123224703_123224814_123224614_123227867
SORBS1_chr10_-_97175225_97175942_97174619_97181717	HMGN1_chr21_-_40717755_40719218_40717200_40719304	ENOSF1_chr18_-_677742_677872_675402_678695
FKBP14_chr7_-_30059828_30059920_30058739_30062280	HNRNPC_chr14_-_21731469_21731741_21702388_21737456	COQ6_chr14_+_74422153_74422212_74420272_74422507

AS Events	AS Events	AS Events
CCNL2_chr1_-_1326676_1326955_1326245_1328058	CTNND1_chr11_+_57558965_57559145_57529518_57561481	SIRT1_chr10_+_69665919_69666044_69651312_69666546
CD151_chr11_+_834529_834803_833026_836062	CBY1_chr22_+_39052960_39053148_39052755_39064021	SSBP3_chr1_-_54723741_54723822_54722859_54747110
LIMS2_chr2_-_128411997_128412118_128400647_128432587	MXRA7_chr17_-_74679928_74680009_74676961_74684194	MYO18A_chr17_-_27443461_27443473_27442858_27445062
RGS14_chr5_+_176798475_176798590_176798397_176798873	KIAA1324_chr1_+_109716309_109716459_109716201_109727666	TNS1_chr2_-_218694566_218694605_218686661_218696177
C11orf80_chr11_+_66523823_66523976_66515988_66526513	NAGLU_chr17_+_40689415_40689563_40688673_40690356	FLOT2_chr17_-_27212874_27212965_27211333_27215962
DDR1_chr6_+_30853401_30853457_30850760_30856464	MAGOHB_chr12_-_10765238_10765577_10763279_10766037	ACBD4_chr17_+_43214385_43214506_43214143_43214734
SLC38A5_chrX_-_48324401_48324480_48321365_48325185	NDUFAF1_chr15_-_41686302_41686556_41680720_41687056	DHRS11_chr17_+_34956099_34956192_34955479_34956400
OSGEP_chr14_-_20919415_20919611_20917425_20920132	THOC5_chr22_-_29927066_29927099_29925228_29927819	AGTRAP_chr1_+_11806044_11806280_11805894_11807496
TIAL1_chr10_-_121336358_121336417_121336262_121336591	SNAP23_chr15_+_42820459_42820618_42807552_42837333	TMEM260_chr14_+_57088248_57088420_57085481_57092099
SNHG11_chr20_+_37076572_37076736_37076266_37077304	KMT2D_chr12_-_49417835_49417883_49416658_49418360	FRG1_chr4_+_190874222_190874280_190873442_190878552
PTGR2_chr14_+_74345798_74346008_74343871_74346757	SEC14L2_chr22_+_30795631_30795707_30793159_30802330	YTHDC2_chr5_+_112860677_112860874_112851059_112868575
SETD4_chr21_-_37429681_37429775_37429502_37431113	GEMIN7_chr19_+_45583164_45583287_45582635_45593364	RPL18A_chr19_+_17972101_17972116_17970783_17972902
FANCG_chr9_-_35078137_35078340_35077396_35078601	NT5C3B_chr17_-_39991839_39991894_39991524_39992110	ZSWIM7_chr17_-_15880892_15881014_15880406_15881357
EXOSC1_chr10_-_99198419_99198460_99197507_99200927	MBNL1_chr3_+_152173330_152173366_152165562_152174055	SMTN_chr22_+_31489769_31489862_31487468_31491288
RCOR3_chr1_+_211486061_211486303_211477482_211486765	IFT20_chr17_-_26659171_26659207_26659013_26662365	IGF1_chr12_-_102811732_102811781_102796344_102813286
CTTN_chr11_+_70268614_70268737_70266616_70269045	BSG_chr19_+_579523_579656_572701_580645	DCAF6_chr1_+_167992225_167992285_167974031_168007608
STAU2_chr8_-_74621266_74621397_74601048_74659017	SLC25A45_chr11_-_65144803_65144894_65144547_65146846	TMX2_chr11_+_57505257_57505498_57505140_57505825
MYL6_chr12_+_56556346_56556423_56556115_56556638	FANCL_chr2_-_58431264_58431361_58393009_58449076	EPB41L1_chr20_+_34783250_34783286_34782282_34785780
TPM1_chr15_+_63353396_63353472_63353138_63353911	NADSYN1_chr11_+_71191264_71191320_71189515_71191800	RNF7_chr3_+_141461485_141461749_141457358_141464000
IGFN1_chr1_+_201193806_201194002_201187786_201194951	DPH7_chr9_-_140470760_140470854_140470619_140471921	PLA2G6_chr22_-_38521645_38521698_38519265_38522377

AS Events	AS Events	AS Events
SRSF4_chr1_-_29492401_29492576_29487029_29508157	MADD_chr11_+_47310518_47310578_47308085_47310941	STIM2_chr4_+_27023115_27023234_27019606_27024140
PSMA3-AS1_chr14_-_58752308_58752474_58734111_58758352	NSMF_chr9_-_140350080_140350086_140348895_140350862	GUK1_chr1_+_228328824_228328989_228328064_228333211
CBWD1_chr9_-_151304_151427_146158_152033	TMX2_chr11_+_57505384_57505498_57505140_57505825	TRIM26_chr6_-_30172432_30172542_30166930_30181081
ACIN1_chr14_-_23536522_23537880_23535217_23538684	MAPKAP1_chr9_-_128268588_128268696_128246862_128305337	APP_chr21_-_27369674_27369731_27354790_27372329
BAZ2B_chr2_-_160253584_160253611_160252345_160253855	PLA2G6_chr22_-_38523413_38523465_38522456_38524275	TIMM17B_chrX_-_48752634_48752737_48752384_48754041
CLSTN1_chr1_-_9816538_9816568_9815367_9833329	TMEM69_chr1_+_46156645_46156782_46153947_46158875	TRIM16_chr17_-_15554404_15555260_15546130_15580489
NAPG_chr18_+_10534462_10534493_10526155_10539758	MAPK10_chr4_-_87010358_87010430_86989108_87022204	NUCB2_chr11_+_17308180_17308264_17298375_17316870
HOOK2_chr19_-_12876642_12876648_12876538_12876740	RP11-43F13.1_chr5_-_1626900_1627041_1602850_1632959	TBRG4_chr7_-_45143697_45143855_45143042_45145039
LMAN2L_chr2_-_97399255_97399338_97377762_97400145	DYSF_chr2_+_71776479_71776521_71766369_71778170	FAM45A_chr10_+_120864275_120864534_120863709_120867479
PRMT1_chr19_+_50183128_50183182_50180573_50183743	IL4R_chr16_+_27352390_27352634_27351594_27353441	LRRFIP2_chr3_-_37163125_37163182_37138151_37170553
ARIH2_chr3_+_48982414_48982614_48956431_48999044	XAF1_chr17_+_6662574_6662838_6661543_6662980	CD47_chr3_-_107768465_107768498_107766139_107769424
DCAF10_chr9_+_37857237_37857348_37854979_37860044	PQLC1_chr18_-_77690227_77690311_77679400_77703328	KLK15_chr19_-_51329876_51330013_51329204_51340370
ZNF263_chr16_+_3335058_3335239_3334205_3336022	GPBP1_chr5_+_56532939_56532999_56531859_56542126	LETMD1_chr12_+_51445874_51445990_51442261_51450132
FCGRT_chr19_+_50024951_50025070_50016730_50027763	RIMS2_chr8_+_105025669_105025849_105001649_105026733	PBRM1_chr3_-_52718871_52718930_52713742_52719764
TNS1_chr2_-_218695089_218695113_218686661_218696177	SMUG1_chr12_-_54582298_54582380_54577743_54582734	PPP4C_chr16_+_30092520_30092631_30087796_30093804
TMEM222_chr1_+_27657475_27657628_27657295_27658560	TMEM175_chr4_+_942198_942403_941942_944208	SIRT2_chr19_-_39389018_39389065_39380784_39390145
USP3_chr15_+_63826001_63826117_63824906_63829223	ADAM15_chr1_+_155033890_155033965_155033308_155034720	RP11-529K1.3_chr16_+_70346511_70346560_70333257_70348804
MBNL1_chr3_+_152164492_152164546_152163328_152165408	WDR19_chr4_+_39196163_39196279_39191401_39201097	RAB4A_chr1_+_229422232_229422313_229407117_229431594
ABCD4_chr14_-_74759856_74759951_74759572_74761850	CD99L2_chrX_-_149996778_149998077_149984551_149999703	SLC38A6_chr14_+_61519066_61519703_61518853_61545547
PIGB_chr15_+_55642896_55643110_55634000_55646995	ME3_chr11_-_86168407_86168801_86161440_86176132	SRSF7_chr2_-_38976039_38976315_38975795_38976670

AS Events	AS Events	AS Events
ALAS2_chrX_-_55054183_55054290_55052448_55057374	HNRNPH1_chr5_-_179042546_179042596_179041960_179043126	PLD3_chr19_+_40871459_40871492_40854631_40872325
DROSHA_chr5_-_31531556_31531632_31529212_31532096	CADM2_chr3_+_86028313_86028433_86010797_86114754	PPIL3_chr2_-_201742219_201742327_201741760_201746143
NADK_chr1_-_1688177_1688321_1688047_1688619	SMARCC2_chr12_-_56558086_56558152_56557549_56558431	LMAN2L_chr2_-_97402873_97402954_97400263_97403685
PIGT_chr20_+_44047411_44047619_44045334_44047934	MYO6_chr6_+_76604530_76604557_76602407_76617321	TIMM17B_chrX_-_48752634_48752784_48752384_48754041
NMRAL1_chr16_-_4521314_4521450_4519699_4524093	SORBS2_chr4_-_186605907_186606000_186599976_186696380	ADGRG1_chr16_+_57675502_57675620_57654048_57684164
INSR_chr19_-_7150507_7150543_7143101_7152736	MRPS33_chr7_-_140710218_140710417_140706335_140714710	YLPM1_chr14_+_75290958_75291010_75287840_75295915
METTL22_chr16_+_8738413_8738582_8736422_8739964	TUFT1_chr1_+_151534566_151534641_151512902_151536379	MARK3_chr14_+_103964838_103964865_103958371_103969218
BTBD3_chr20_+_11898425_11898659_11871602_11898981	HNRNPC_chr14_-_21731469_21731495_21702388_21737456	ERP29_chr12_+_112457559_112457698_112451413_112459953
LUC7L_chr16_-_258599_258663_258187_270647	AP2M1_chr3_+_183898432_183898529_183898039_183898636	SORBS2_chr4_-_186605907_186605996_186599976_186696380
FAM189B_chr1_-_155224190_155224247_155223523_155224443	RBM4B_chr11_-_66433742_66433964_66433049_66436085	CDC25B_chr20_+_3783376_3783455_3783023_3783556
ARMCX2_chrX_-_100914404_100914487_100913128_100914742	EMC8_chr16_-_85813984_85814079_85813473_85814816	NCOR2_chr12_-_124811954_124812179_124810916_124815390
CASP6_chr4_-_110617565_110617642_110615856_110618777	TMEM175_chr4_+_941496_941942_926328_944208	ARHGAP44_chr17_+_12890417_12890469_12888225_12893348
IQCB1_chr3_-_121507130_121507279_121500721_121508919	SVIL_chr10_-_29824917_29824998_29822387_29839525	RALGAPA2_chr20_-_20656879_20656932_20634231_20693017
COQ5_chr12_-_120964259_120964349_120960166_120966742	RIC8B_chr12_+_107273552_107273725_107254190_107279681	UBE2Q2_chr15_+_76182775_76182824_76175765_76191767
TRAK2_chr2_-_202265740_202265817_202264216_202272125	C6orf136_chr6_+_30615382_30615623_30615080_30617334	REXO4_chr9_-_136277897_136278041_136276193_136279784
TRA2A_chr7_-_23570799_23570889_23562051_23571407	DST_chr6_-_56329482_56329554_56328562_56330875	NGLY1_chr3_-_25761504_25761682_25761126_25770623
PI4KB_chr1_-_151298647_151298849_151297393_151299746	PKP4_chr2_+_159533250_159533379_159530512_159535092	HEXA_chr15_-_72646031_72646078_72643575_72647899
CAMK1_chr3_-_9802339_9802452_9801434_9803144	THTPA_chr14_+_24025951_24026248_24025552_24027903	NENF_chr1_+_212615906_212615967_212606462_212617680
BRE_chr2_+_28550140_28550314_28521358_28561316	NMRAL1_chr16_-_4516527_4516686_4516403_4519504	GARNL3_chr9_+_130126867_130127055_130119656_130127578
PRC1_chr15_-_91512308_91512350_91510432_91512676	TRPM2_chr21_+_45846892_45846994_45846619_45855013	TNFAIP2_chr14_+_103590711_103590843_103589820_103592646

AS Events	AS Events	AS Events
SVIL_chr10_-_29815889_29815985_29813644_29819535	FAM189B_chr1_-_155221523_155221699_155220955_155223415	GUK1_chr1_+_228329326_228329530_228328989_228333211
RRBP1_chr20_-_17660643_17660720_17641173_17662672	MYH11_chr16_-_15878554_15878575_15876334_15880486	CCNL2_chr1_-_1328058_1328183_1326245_1328775
SLC38A10_chr17_-_79223869_79223893_79220861_79225292	ANK2_chr4_+_114293688_114293781_114290961_114294245	LRRC23_chr12_+_7019053_7019190_7016609_7023054
ZNHIT3_chr17_+_34842778_34842810_34842629_34848656	SYNE4_chr19_-_36497324_36497573_36496339_36499455	TLE1_chr9_-_84248262_84248279_84235472_84267128
TM2D1_chr1_-_62152463_62152567_62149218_62160368	ZNF7_chr8_+_146054427_146054475_146052994_146062778	RAB11FIP3_chr16_+_541133_541268_539000_546823
GTPBP10_chr7_+_89984399_89984544_89983863_90001468	AP2B1_chr17_+_33997875_33997917_33984810_33998772	IDS_chrX_-_148583604_148583707_148582568_148585686
C11orf80_chr11_+_66590034_66590145_66583670_66595736	MGAT1_chr5_-_180222655_180222875_180220097_180229679	INO80E_chr16_+_30015888_30015978_30012361_30016541
NPEPPS_chr17_+_45654410_45654526_45646860_45656755	MVK_chr12_+_110016969_110017087_110013950_110017606	PPFIA1_chr11_+_70228193_70228264_70224301_70229108
TAMM41_chr3_-_11874476_11874625_11871338_11880695	ZNF7_chr8_+_146054427_146054475_146052994_146062775	SMARCA2_chr9_+_2170418_2170472_2161903_2181570
DNAJC25_chr9_+_114405136_114405374_114394023_114409386	RIOK3_chr18_+_21047362_21047490_21046240_21053392	SUOX_chr12_+_56395669_56395732_56391507_56395995
INO80E_chr16_+_30014756_30014847_30012851_30015888	JOSD2_chr19_-_51010830_51010956_51009829_51013542	CAMLG_chr5_+_134079676_134079742_134074482_134086448
TPT1-AS1_chr13_+_45964892_45965037_45963955_45965166	PLD3_chr19_+_40871459_40871492_40854675_40872290	MRPL33_chr2_+_27997290_27997397_27995559_28002299
LINC01006_chr7_-_156398351_156398458_156398074_156433229	GAS8_chr16_+_90102040_90102095_90099332_90102788	PFDN1_chr5_-_139680000_139680167_139661118_139682625
FAM45A_chr10_+_120864275_120864534_120863709_120867459	PAAF1_chr11_+_73598084_73598144_73589864_73598398	AARSD1_chr17_-_41105740_41105795_41103911_41106892
LUC7L2_chr7_+_139059146_139059217_139045068_139060807	PBRM1_chr3_-_52592264_52592429_52584833_52595782	PQLC1_chr18_-_77693968_77694022_77664183_77703328
PITPNM2_chr12_-_123474333_123474495_123473419_123475091	EPN3_chr17_+_48613389_48613560_48610346_48613781	UBAP2L_chr1_+_154241837_154241888_154241430_154243356
MMP19_chr12_-_56234889_56235020_56234666_56236136	TRA2A_chr7_-_23561750_23562051_23561459_23570799	FAM111A_chr11_+_58910969_58913329_58910777_58916308
STEAP4_chr7_-_87920230_87920329_87913586_87936106	P4HB_chr17_-_79813328_79813381_79805223_79817056	PPP4R3A_chr14_-_91932604_91932760_91931763_91937180
USP15_chr12_+_62768170_62768316_62749256_62775270	PHPT1_chr9_+_139744957_139745012_139744589_139745206	GLB1L3_chr11_+_134183289_134183368_134182781_134183834
ATP6V0B_chr1_+_44441471_44441520_44440779_44441761	LMBR1L_chr12_-_49500293_49500529_49499740_49500743	SORBS1_chr10_-_97174250_97174619_97170534_97181717

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EIF2D_chr1_-_206773086_206773190_206772446_206773616	CRAT_chr9_-_131870686_131870757_131870356_131872761	NDRG2_chr14_-_21492144_21492255_21491480_21493187
CPNE1_chr20_-_34246851_34246904_34220845_34252681	NAGK_chr2_+_71302691_71302772_71300724_71304687	SECISBP2_chr9_+_91954778_91954868_91953495_91956261
PCBP4_chr3_-_51996825_51996908_51995320_52001341	CD40_chr20_+_44750362_44750537_44747033_44750871	DCAF8_chr1_-_160231074_160231140_160213824_160232238
SEC31A_chr4_-_83763337_83763634_83750211_83765538	MGRN1_chr16_+_4730032_4730098_4727573_4731550	AASS_chr7_-_121741424_121741492_121738920_121741674
TARBP2_chr12_+_53898918_53899046_53898599_53899432	RAD52_chr12_-_1035961_1036112_1034691_1036310	PHKA2_chrX_-_18920909_18921028_18919721_18923875
WBP1_chr2_+_74685958_74686046_74685798_74686564	NEO1_chr15_+_73567032_73567065_73566346_73570471	WBP1_chr2_+_74686123_74686225_74685798_74686769
AK2_chr1_-_33497144_33497262_33490168_33502336	SELENOP_chr5_-_42810792_42810880_42801433_42811937	LIMCH1_chr4_+_41640948_41640984_41621457_41646516
ANO8_chr19_-_17444230_17444363_17444048_17444498	NPEPPS_chr17_+_45654446_45654526_45646860_45656755	SLC20A1_chr2_+_113410465_113410524_113410375_113414698
DNAJC14_chr12_-_56223272_56223420_56222498_56224479	SLC25A16_chr10_-_70276840_70277022_70276600_70287002	NOL8_chr9_-_95082224_95082661_95081638_95083949
TRMT11_chr6_+_126329802_126329891_126329618_126332398	PMS2P5_chr7_+_74312525_74312628_74312349_74313767	APTX_chr9_-_32988080_32988127_32987844_32989756
PIGX_chr3_+_196453525_196453642_196449427_196454793	RPS3A_chr4_+_152021636_152021740_152020866_152024022	RPAIN_chr17_+_5329290_5329619_5326149_5335861
VTI1B_chr14_-_68129745_68129907_68126639_68141091	XPNPEP3_chr22_+_41266051_41266143_41265119_41277773	CTNND1_chr11_+_57556508_57556627_57529518_57563048
PEX1_chr7_-_92138642_92138725_92136440_92140257	ACCS_chr11_+_44094996_44095085_44092865_44096161	MYO18A_chr17_-_27406744_27408018_27401932_27409333
DGUOK_chr2_+_74184251_74184367_74177859_74185272	SLC38A6_chr14_+_61514868_61515015_61512885_61517229	SYNGR2_chr17_+_76167590_76167730_76167135_76167819
MAN2C1_chr15_-_75655550_75655631_75655089_75656339	ABI1_chr10_-_27047990_27048167_27040712_27054146	PICALM_chr11_-_85689112_85689136_85685855_85692171
SRSF6_chr20_+_42087792_42088060_42087149_42088410	PRPF40A_chr2_-_153571063_153571143_153551136_153572508	FLNB_chr3_+_58127584_58127656_58124256_58128376
CYP20A1_chr2_+_204137368_204137471_204131404_204143295	DMTN_chr8_+_21924595_21924670_21924404_21925037	RPS3A_chr4_+_152022126_152022314_152020866_152024022
ZNF706_chr8_-_102214560_102214675_102213971_102217662	HNRNPAB_chr5_+_177637132_177637273_177636448_177637553	USP54_chr10_-_75280665_75280785_75277505_75283340
ZNF160_chr19_-_53594665_53594806_53589574_53594889	INO80E_chr16_+_30014970_30014991_30012851_30015888	WBP1_chr2_+_74686564_74686679_74685798_74686769
SYNE1_chr6_-_152466621_152466690_152464900_152469179	ITPA_chr20_+_3193964_3194072_3193872_3194630	ZNF263_chr16_+_3335680_3335754_3334205_3336022

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PLG_chr6_+_161135825_161135946_161134157_161137676	KIAA1524_chr3_-_108304512_108304596_108304059_108308120	PPOX_chr1_+_161137160_161137276_161137024_161140409
FAM126A_chr7_-_22986651_22986866_22985782_22999874	AP1G2_chr14_-_24035024_24035101_24034910_24035272	VEZT_chr12_+_95635939_95636040_95611662_95645715
MSI2_chr17_+_55754347_55754420_55752487_55756909	IFT172_chr2_-_27688612_27688749_27686048_27693794	COMTD1_chr10_-_76995024_76995130_76994936_76995592
PRUNE1_chr1_+_150991032_150991145_150981147_150997086	ACOT9_chrX_-_23731251_23731325_23726061_23739997	INTS11_chr1_-_1258271_1258667_1257364_1259960
TTC31_chr2_+_74717151_74717254_74710537_74717370	MBNL1_chr3_+_152173330_152173366_152165562_152177059	MRPL55_chr1_-_228296137_228296175_228296022_228296655
WBP5_chrX_+_102612010_102612089_102611534_102612542	CD47_chr3_-_107768465_107768498_107766139_107776323	DMWD_chr19_-_46287898_46287973_46287548_46288851
IFT88_chr13_+_21237401_21237525_21230569_21237636	ASRGL1_chr11_+_62123796_62123939_62105639_62124458	APLP2_chr11_+_130007150_130007186_130003623_130010292
PRPF39_chr14_+_45565798_45565961_45565431_45566089	DNAJC10_chr2_+_183604271_183604436_183601113_183605025	MPST_chr22_+_37419792_37419968_37415913_37420232
MYBPC1_chr12_+_102076381_102076440_102074307_102078159	BRD8_chr5_-_137495243_137495288_137492956_137495757	NGB_chr14_-_77735557_77735669_77734928_77737191
PWWP2A_chr5_-_159507657_159507777_159505175_159520107	CDC42SE1_chr1_-_151029131_151029262_151028469_151031954	NISCH_chr3_+_52514894_52515125_52514311_52518528
SDHC_chr1_+_161293403_161293460_161284215_161310383	IMMP2L_chr7_-_111172573_111172641_111161505_111201906	CAMK2G_chr10_-_75585036_75585105_75583842_75587846
IFI44_chr1_+_79126238_79126376_79125168_791283888	HMGN1_chr21_-_40719304_40719409_40717884_40720217	HEMK1_chr3_+_50616251_50616357_50615004_50617274
GOLGA2P7_chr15_-_84873982_84874071_84873727_84898603	OGDH_chr7_+_44695916_44695961_44687133_44706334	TMEM185A_chrX_-_148692969_148693146_148682143_148713225
RP11-407N17.3_chr14_+_39790131_39790260_39788495_39796067	IFT172_chr2_-_27688277_27688385_27686048_27693794	SEC31A_chr4_-_83752089_83752128_83750211_83763292
CDC42SE1_chr1_-_151029131_151029262_151027602_151031954	IFT88_chr13_+_21141808_21141924_21141395_21148518	CHID1_chr11_-_908541_908645_904859_910774
MYO9B_chr19_+_17321141_17321189_17320518_17321523	DIAPH2_chrX_+_95990756_95990789_95940189_95993584	TRMT2B_chrX_-_100306632_100306722_100290672_100306805
ENTPD6_chr20_+_25187714_25188033_25176503_25190484	FAM193B_chr5_-_176958953_176959132_176958522_176959443	HMGN1_chr21_-_40717755_40717884_40717200_40719304
CD27-AS1_chr12_-_6560035_6560146_6557903_6560634	PRDX5_chr11_+_64087205_64087340_64085858_64088336	FGFR1_chr8_-_38287199_38287466_38285953_38314873
FBXO38_chr5_+_147806775_147807510_147805264_147812986	ABHD14B_chr3_-_52005475_52005714_52004200_52007980	NSFL1C_chr20_-_1436358_1436364_1435777_1438844
PLEKHA1_chr10_+_124187791_124187832_124186547_124189139	NOL8_chr9_-_95082224_95082419_95081638_95083949	RCOR3_chr1_+_211486061_211486177_211477482_211486765

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MFSD3_chr8_+_145735742_145735890_145735398_145735980	FAM114A1_chr4_+_38870018_38870167_38869455_38879691	CYP2U1_chr4_+_108859193_108859332_108853289_108866125
HNRNPH1_chr5_-_179046269_179046361_179045324_179047892	SLC15A4_chr12_-_129294487_129294656_129294018_129299319	RBM3_chrX_+_48434309_48434471_48434055_48434701
UCKL1_chr20_-_62575005_62575022_62572561_62575749	DCUN1D4_chr4_+_52775085_52775141_52765544_52777235	ENOSF1_chr18_-_677344_677444_675402_678695
NTAN1_chr16_-_15141853_15141956_15141407_15149747	KANK2_chr19_-_11306725_11306903_11305266_11308160	WASHC3_chr12_-_102443966_102444069_102439897_102455025
MCAT_chr22_-_43533086_43533304_43529492_43537167	ARHGEF1_chr19_+_42402094_42402262_42400555_42402590	MMS19_chr10_-_99221252_99221379_99220764_99221584
S100A4_chr1_-_153517945_153517994_153517285_153518228	LZTR1_chr22_+_21349656_21349773_21349315_21350034	GMFB_chr14_-_54948839_54948920_54948176_54950388
SHROOM1_chr5_-_132161968_132162279_132161874_132166285	DECR2_chr16_+_456889_456952_456833_457424	ACOT9_chrX_-_23752457_23752484_23751334_23754035
PDCD2_chr6_-_170889089_170889193_170888058_170892144	SYNE4_chr19_-_36497503_36497573_36496339_36499455	QTRT2_chr3_+_113786833_113786910_113775711_113789472
CD47_chr3_-_107769424_107769449_107766139_107776323	RP11-452C8.1_chr4_+_80611141_80611230_80589281_80617566	DNAJC8_chr1_-_28556641_28556763_28555534_28559431
SPOUT1_chr9_-_131586025_131586173_131585112_131586350	INO80E_chr16_+_30012532_30015978_30012361_30016541	FOXRED1_chr11_+_126144825_126144916_126143349_126145221
ZDHHC17_chr12_+_77214837_77214947_77209799_77216185	SERPINA1_chr14_-_94854896_94855000_94849578_94856793	EHBP1_chr2_+_63215065_63215173_63206470_63217850
METTL22_chr16_+_8728895_8728936_8722967_8729024	RP11-597D13.9_chr4_+_159098063_159098198_159092632_159100812	TPM1_chr15_+_63353911_63353987_63353472_63354413
SDK1_chr7_+_4215406_4215466_4213989_4218116	MRPL55_chr1_-_228296655_228296722_228296019_228296961	COPS7A_chr12_+_6837091_6837167_6833984_6837388
KLK12_chr19_-_51537680_51537896_51537395_51538061	ARHGAP12_chr10_-_32128232_32128247_32120728_32128564	TRIP10_chr19_+_6746039_6746207_6745005_6746462
WASF3_chr13_+_27254171_27254338_27246126_27255190	GPS1_chr17_+_80010131_80010335_80009400_80011149	PSMC5_chr17_+_61905188_61905283_61904874_61905497
RNPEP_chr1_+_201958510_201958659_201958172_201965274	TCF3_chr19_-_1615283_1615484_1612432_1615684	ANKRD10_chr13_-_111546631_111546740_111546549_111558379
USP28_chr11_-_113702641_113702715_113700067_113704141	CXorf40B_chrX_-_149102594_149102791_149102355_149105650	ROGDI_chr16_-_4851050_4851322_4850579_4851503
TMTC4_chr13_-_101308634_101308722_101294565_101315217	MICAL3_chr22_-_18286576_18286627_18274067_18291609	C11orf80_chr11_+_66589113_66589235_66583670_66595736
FOLH1_chr11_-_49179503_49179595_49178359_49186256	IKBKAP_chr9_-_111681090_111681181_111679950_111685121	TPM1_chr15_+_63335904_63336030_63335142_63336225

AS Events	AS Events	AS Events
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AFMID_chr17_+_76201173_76201271_76200981_76202026	RPLP0_chr12_-_120636356_120636573_120635265_120636656	SNRPA1_chr15_-_101826418_101826498_101826006_101827112
VPS29_chr12_-_110937339_110937351_110931036_110939853	HNRNPK_chr9_-_86588816_86588888_86588314_86589431	HNRNPDL_chr4_-_83346715_83346820_83346036_83347189
CLTC_chr17_+_57764361_57764382_57763169_57767996	BCS1L_chr2_+_219524759_219524889_219524466_219526128	CPNE1_chr20_-_34218662_34218717_34218412_34218822
ANKS3_chr16_-_4776979_4777178_4776781_4779980	NT5C3A_chr7_-_33075545_33075600_33066527_33102179	FDPS_chr1_+_155279543_155279756_155278867_155279833
AC004381.6_chr16_+_20835760_20835849_20833224_20837154	LINC00963_chr9_+_132264675_132265418_132255874_132265601	PTPRF_chr1_+_44067741_44067768_44064584_44069086
IDS_chrX_-_148583604_148583707_148582568_148584841	NFU1_chr2_-_69650713_69650849_69646736_69659033	GALK2_chr15_+_49611168_49611313_49584734_49611800
GREB1_chr2_+_11778796_11778935_11778042_11780416	USF2_chr19_+_35760705_35760906_35760602_35761349	PPP4R1_chr18_-_9562919_9563044_9562073_9563375
ANKRD10_chr13_-_111546455_111546549_111545610_111558379	PANX2_chr22_+_50613860_50613911_50609385_50615367	ADAM15_chr1_+_155033890_155033965_155033308_155034379
RP11-793H13.8_chr12_+_53858543_53858636_53856351_53861004	TSPAN17_chr5_+_176078754_176078901_176074703_176079743	HDHD2_chr18_-_44663605_44663667_44662820_44676748
DOLPP1_chr9_+_131848417_131848546_131847895_131848987	HAPLN3_chr15_-_89422648_89423841_89422500_89424587	SRRT_chr7_+_100480385_100480711_100479862_100481690
SZRD1_chr1_+_16717869_16717919_16693803_16721532	FAM192A_chr16_-_57209450_57209612_57207781_57219732	ZNF326_chr1_+_90473170_90473309_90470803_90475646
APBB1_chr11_-_6423206_6423212_6422918_6423311	MTRF1L_chr6_-_153312319_153312551_153311230_153313991	NHLRC3_chr13_+_39618226_39618318_39613848_39621176
HCFC1R1_chr16_-_3073474_3073531_3073362_3073847	TMEM198_chr2_+_220412227_220412803_220409615_220413873	ABCA5_chr17_-_67281528_67281561_67280213_67282038
C20orf24_chr20_+_35236292_35236403_35236221_35240412	MTA1_chr14_+_105912003_105912189_105911848_105916394	RBM39_chr20_-_34328446_34328519_34326939_34328745
TCF3_chr19_-_1615283_1615514_1612432_1615684	TRIT1_chr1_-_40318402_40318548_40315933_40319641	SEMA4G_chr10_+_102729448_102729681_102729348_102732285
GPS1_chr17_+_80010134_80010335_80009840_80011149	TXNDC11_chr16_-_11794307_11794420_11792181_11815432	PMM2_chr16_+_8898623_8898700_8895767_8900172
MITD1_chr2_-_99789876_99789965_99788109_99790377	HNRNPA2B1_chr7_-_26230612_26230748_26230080_26232114	POLR1D_chr13_+_28195473_28195574_28195277_28222515
CTPS1_chr1_+_41473120_41473217_41471766_41474330	L1CAM_chrX_-_153128822_153128834_153128349_153128931	SLC9A8_chr20_+_48467298_48467381_48466217_48471974
LUC7L2_chr7_+_139060254_139060329_139045068_139060807	RHOC_chr1_-_113247674_113247790_113246428_113249699	MAGOHB_chr12_-_10761696_10761982_10760535_10762429

AS Events	AS Events	AS Events
IL17RC_chr3_+_9970263_9970314_9970170_9971535	WBP1_chr2_+_74686604_74686689_74685798_74686769	ACTR3B_chr7_+_152508781_152508818_152498816_152511634
CPNE1_chr20_-_34243123_34243266_34220845_34252681	C5orf38_chr5_+_2752735_2752868_2752578_2755142	IL32_chr16_+_3115621_3115688_3115495_3115784
HEXDC_chr17_+_80385905_80386003_80382379_80386433	SEC31A_chr4_-_83782783_83782861_83778917_83783686	DOCK7_chr1_-_63010617_63010710_63009416_63018402
C17orf49_chr17_+_6920268_6920333_6920004_6920575	KIF24_chr9_-_34271806_34271928_34263170_34286614	REPS1_chr6_-_139247537_139247615_139242261_139251113
TARBP1_chr1_-_234534127_234534299_234529583_234536926	ZFAND6_chr15_+_80390757_80390920_80364989_80412669	SPTAN1_chr9_+_131371929_131371944_131371563_131373992
CHTF8_chr16_-_69154955_69155073_69154552_69155338	CTNND1_chr11_+_57556508_57556627_57529518_57561481	TMEM14B_chr6_+_10751365_10751467_10749931_10755374
FIZ1_chr19_-_56106985_56107100_56105012_56108937	MKNK1_chr1_-_47051545_47051646_47049001_47059784	L3HYPDH_chr14_-_59941156_59941244_59939808_59942586
METTL26_chr16_-_684888_684956_684797_685611	LRRC27_chr10_+_134155716_134155775_134151199_134158001	PDLIM7_chr5_-_176918807_176918996_176918421_176919405
TPM1_chr15_+_63336225_63336351_63336030_63349183	UBE2D4_chr7_+_43982424_43982456_43978093_43988230	HEXDC_chr17_+_80398348_80398489_80397589_80398872
TEX264_chr3_+_51708286_51708578_51705304_51718428	LAS1L_chrX_-_64748139_64748249_64744930_64749091	ZDHHC8P1_chr22_-_23744223_23744342_23744140_23744547
FARS2_chr6_+_5404774_5404934_5369415_5431273	SH3D21_chr1_+_36773709_36773810_36773426_36773989	C20orf24_chr20_+_35236292_35236403_35236221_35238003
MID1_chrX_-_10588329_10588459_10535643_10851672	BTBD1_chr15_-_83718824_83718930_83710677_83725140	ST6GALNAC1_chr17_-_74633681_74633818_74625793_74639589
DMPK_chr19_-_46274607_46274654_46273898_46274825	SEC31A_chr4_-_83819141_83819215_83803093_83821229	WIPI2_chr7_+_5232748_5232802_5230124_5254165
SMPDL3A_chr6_+_123122454_123122551_123118113_123124808	WRNIP1_chr6_+_2770428_2770595_2766678_2779496	BRD8_chr5_-_137497484_137497553_137496757_137498818
EXOC1_chr4_+_56755053_56755098_56750094_56756388	RAB4B-EGLN2_chr19_+_41285923_41286004_41284296_41292569	BCLAF1_chr6_-_136595100_136595327_136594325_136596669
NAA25_chr12_-_112487286_112487415_112486247_112491361	OSR2_chr8_+_99960400_99960649_99957051_99961066	IP6K2_chr3_-_48732126_48732257_48731673_48732522
RCOR3_chr1_+_211485696_211485829_211477482_211486061	PLCB4_chr20_+_9353693_9353751_9353050_9360700	CHCHD4_chr3_-_14163416_14163586_14158024_14166154
NUP50_chr22_+_45566868_45567024_45564127_45567480	GMPR2_chr14_+_24703312_24703447_24702804_24704942	FAAH_chr1_+_46871709_46871750_46871466_46874130
GS1-124K5.12_chr7_-_66041741_66041916_66038537_66057243	FLNB_chr3_+_58127584_58127623_58124256_58128376	FOXRED1_chr11_+_126144821_126144916_126143349_126145221
SNHG6_chr8_-_67834848_67834960_67834627_67837671	HSH2D_chr19_+_16266451_16266573_16265301_16268019	PPP1R12A_chr12_-_80173100_80173131_80172380_80175594

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STYXL1_chr7_-_75630207_75630320_75625917_75633075	AKAP9_chr7_+_91671359_91671500_91670212_91671981	KIAA1468_chr18_+_59947006_59947089_59942706_59947592
GPATCH2_chr1_-_217668356_217668417_217665092_217671697	F3_chr1_-_95006127_95006622_95005924_95007092	TSC2_chr16_+_2127598_2127727_2126586_2129032
MINOS1_chr1_+_19927280_19927465_19923603_19949967	ALKBH6_chr19_-_36504229_36504324_36503991_36505076	SORBS1_chr10_-_97135729_97135813_97127456_97141441
MRPL55_chr1_-_228296137_228296722_228296019_228296849	SHC1_chr1_-_154945768_154945984_154941924_154946723	TTC38_chr22_+_46665038_46665186_46664488_46668231
PPP2R2D_chr10_+_133748397_133748510_133748059_133753534	CLASP2_chr3_-_33600616_33600667_33592887_33600798	THUMPD2_chr2_-_39984387_39984508_39983100_39988470
SLC22A17_chr14_-_23817099_23817205_23816940_23817369	ZNF213-AS1_chr16_-_3182850_3182946_3182104_3184630	FAM104A_chr17_-_71223303_71223321_71205907_71228224
HS1BP3_chr2_-_20840732_20840940_20838412_20845099	CC2D2A_chr4_+_15480842_15480952_15480430_15482327	POSTN_chr13_-_38145505_38145595_38143958_38151889
OCIAD1_chr4_+_48833243_48833513_48833069_48834636	DTNB_chr2_-_25606704_25606758_25602192_25610157	BCS1L_chr2_+_219524759_219524889_219524466_219525661
MAP4_chr3_-_47910703_47910817_47899002_47912302	ACAA1_chr3_-_38173086_38173129_38170879_38173416	METTL26_chr16_-_685611_685774_684797_686093
CERS5_chr12_-_50538551_50538752_50537840_50560883	STX3_chr11_+_59564755_59564869_59562955_59568327	LUC7L3_chr17_+_48814647_48814840_48814387_48817666
FAR2P2_chr2_-_131183486_131183611_131182731_131185276	EWSR1_chr22_+_29687550_29687588_29684775_29688125	MEMO1_chr2_-_32118310_32118390_32117203_32142994
METTL26_chr16_-_685517_685774_684797_686093	NUP88_chr17_-_5307418_5307566_5302970_5308376	RABGEF1_chr7_+_66233817_66234012_66205779_66236869
SRPK2_chr7_-_104909252_104909316_104844232_105029094	WBP1_chr2_+_74686604_74686689_74686225_74686769	TMEM144_chr4_+_159133212_159133372_159132726_159133759
POLG_chr15_-_89875448_89875605_89873507_89876326	TSFM_chr12_+_58186768_58186856_58180945_58189959	PFDN5_chr12_+_53690213_53690335_53689423_53691828
SREBF1_chr17_-_17720861_17720905_17720771_17721009	NT5C2_chr10_-_104860419_104860700_104859776_104860801	MTMR3_chr22_+_30419445_30419472_30418686_30421618
SUGP2_chr19_-_19102148_19102362_19101958_19105174	IFFO1_chr12_-_6660563_6660669_6660167_6664422	RNH1_chr11_-_504823_504996_502249_507112
MRPL55_chr1_-_228296137_228296209_228296019_228296655	DDX39B_chr6_-_31506923_31507051_31504460_31508098	SRRT_chr7_+_100478316_100478390_100473333_100478905
CAP2_chr6_+_17514079_17514185_17507543_17539499	DMPK_chr19_-_46274228_46274318_46273898_46274825	IFT88_chr13_+_21141808_21142136_21141395_21148518
DMKN_chr19_-_36000812_36000863_35996667_36001085	CRAT_chr9_-_131870686_131870757_131870356_131871457	SLC27A3_chr1_+_153750236_153750361_153749696_153750636
RHOT1_chr17_+_30536368_30536464_30535328_30551634	PML_chr15_+_74324912_74325056_74317268_74325496	TMEM183A_chr1_+_202986883_202987047_202985268_202987608

AS Events	AS Events	AS Events
CTNND1_chr11_+_57558856_57559145_57529591_57561481	APP_chr21_-_27369674_27369731_27354790_27394155	JMJD6_chr17_-_74717344_74717438_74716580_74717879
MLKL_chr16_-_74710198_74710323_74709662_74712796	CAMK2G_chr10_-_75577966_75578653_75577312_75579289	ILF3_chr19_+_10789288_10789380_10787986_10789772
HMOX2_chr16_+_4533637_4533755_4526488_4556895	SYNE4_chr19_-_36498026_36498170_36496339_36499455	ENOSF1_chr18_-_678695_678737_675402_683245
AFMID_chr17_+_76201683_76201819_76200981_76202026	ZFX_chrX_+_24169807_24169917_24167911_24190831	CANT1_chr17_-_76996181_76996352_76994045_77001453
RP11-20I23.3_chr16_+_2577561_2577616_2571124_2577773	TOP3B_chr22_-_22325351_22325433_22324778_22326248	TPCN2_chr11_+_68847301_68847351_68846488_68848867
CDK10_chr16_+_89755659_89755732_89753205_89756960	KLK2_chr19_+_51377976_51378222_51376775_51379727	NPRL3_chr16_-_167299_167374_162774_169124
SYNE4_chr19_-_36497503_36497573_36496339_36497651	BRD8_chr5_-_137499775_137499822_137499033_137500008	EPN3_chr17_+_48613409_48613560_48610205_48613781
WDR27_chr6_-_170063658_170063745_170062520_170064261	AGTRAP_chr1_+_11805986_11806280_11805894_11807496	TRA2B_chr3_-_185649364_185649640_185644522_185655612
IGFLR1_chr19_-_36230610_36230989_36230527_36231924	TSPAN17_chr5_+_176078616_176078667_176074703_176079743	TAPT1_chr4_-_16172275_16172352_16168416_16175826
SLC38A11_chr2_-_165801078_165801144_165796066_165811718	ZNF223_chr19_+_44567417_44567719_44564994_44570216	ELMOD3_chr2_+_85582677_85582907_85582293_85584089
MPHOSPH8_chr13_+_20244979_20245104_20244503_20245345	NUP88_chr17_-_5321334_5321461_5320002_5322673	MICAL3_chr22_-_18367040_18367124_18354789_18368643
BCAR1_chr16_-_75271080_75271242_75269884_75276367	CLSTN1_chr1_-_9797555_9797612_9796100_9801151	WDFY3_chr4_-_85648013_85648064_85645747_85654534
THNSL2_chr2_+_88485069_88485243_88478532_88485416	PARL_chr3_-_183560085_183560235_183558428_183562018	MRPL55_chr1_-_228296655_228296722_228295570_228296849
FBXO38_chr5_+_147806775_147807285_147805264_147812986	CTBS_chr1_-_85035613_85035822_85031695_85036264	DTNB_chr2_-_25678273_25678363_25674504_25705664
MAGI3_chr1_+_114224833_114224924_114223958_114225518	CBFA2T2_chr20_+_32211578_32211660_32211102_32212569	MTIF3_chr13_-_28015153_28015214_28014586_28019224
IFT43_chr14_+_76525669_76525716_76488737_76548637	POSTN_chr13_-_38148708_38148789_38143958_38151889	SFXN2_chr10_+_104489075_104489151_104488286_104489479
CRELD1_chr3_+_9985585_9985779_9985199_9986048	PSMC5_chr17_+_61905210_61905283_61904874_61905497	DCUN1D4_chr4_+_52753288_52753410_52752804_52757925
GATSL3_chr22_-_30684694_30684765_30683549_30685373	PSMC5_chr17_+_61905033_61905283_61904874_61905497	ARL16_chr17_-_79649472_79649705_79649179_79650042
COL16A1_chr1_-_32145404_32145452_32145286_32145642	CHURC1-FNTB_chr14_+_65392724_65392798_65390844_65398855	MRPL55_chr1_-_228296137_228296175_228296019_228296849
MRPL55_chr1_-_228296137_228296722_228296022_228296849	TEAD1_chr11_+_12900435_12900447_12886447_12901254	R3HDM2_chr12_-_57686354_57686450_57677839_57689181

AS Events	AS Events	AS Events
PLD3_chr19_+_40871459_40871492_40854675_40871624	AGA_chr4_-_178357429_178357505_178355643_178358558	KIF13A_chr6_-_17790102_17790141_17788106_17794802
SLC25A16_chr10_-_70276840_70276942_70276600_70287002	ZMYND8_chr20_-_45841286_45841370_45839542_45848908	FAM193B_chr5_-_176958953_176959201_176958522_176959443
SUN1_chr7_+_889559_889670_889240_891020	MBD1_chr18_-_47797838_47797910_47794033_47799046	BCS1L_chr2_+_219525661_219526030_219524466_219526128
PPP3CB_chr10_-_75199629_75199659_75198178_75204482	IFT43_chr14_+_76524984_76525017_76488737_76548637	SLC25A29_chr14_-_100761962_100762330_100759714_100765178
MEIS1_chr2_+_66796181_66796277_66795888_66798377	TM2D1_chr1_-_62189384_62189444_62175109_62190573	AHI1_chr6_-_135622545_135622677_135621696_135639656
ZNF213-AS1_chr16_-_3182850_3183195_3182104_3184630	ANKHD1_chr5_+_139851823_139851880_139844361_139862164	METTL26_chr16_-_684888_685063_684797_685611
HMGN1_chr21_-_40719172_40719218_40717200_40719304	CEP290_chr12_-_88448116_88448190_88447523_88449352	CRTC1_chr19_+_18854917_18854965_18853836_18856632
PBRM1_chr3_-_52588739_52588895_52584833_52595782	IGHMBP2_chr11_+_68697790_68697902_68696825_68700766	RTN2_chr19_-_45996417_45996636_45992811_45997423
TNPO2_chr19_-_12816823_12816923_12816582_12817009	UCHL5_chr1_-_192989436_192989511_192985525_192990226	GUSB_chr7_-_65435268_65435353_65432894_65439281
TAX1BP1_chr7_+_27855967_27856139_27839709_27867356	CD47_chr3_-_107768465_107768498_107766139_107770785	SUN1_chr7_+_872141_872238_856310_878434
CYP2J2_chr1_-_60370037_60370188_60366775_60370542	TIMM17B_chrX_-_48752634_48753255_48752384_48754041	NCOA5_chr20_-_44708025_44708092_44699175_44718455
ARMCX2_chrX_-_100913446_100913511_100913128_100914742	GDAP2_chr1_-_118429198_118429275_118426249_118439454	PCSK5_chr9_+_78749024_78749128_78722267_78771960
KPNA1_chr3_-_122176572_122176695_122172848_122180070	TBC1D1_chr4_+_38054726_38054846_38051519_38055819	VKORC1_chr16_-_31104632_31104803_31102663_31105877
ESYT2_chr7_-_158545471_158545534_158542414_158552176	TCF20_chr22_-_42564614_42564742_42557364_42565852	RP11-286N22.8_chr11_+_61205096_61205320_61197654_61213412
ARHGEF1_chr19_+_42410608_42410772_42410177_42410854	NPDC1_chr9_-_139935122_139935189_139934888_139935513	TERF1_chr8_+_73942570_73942630_73939287_73944276
RP4-800G7.2_chr7_+_148985521_148986548_148984867_148987028	PEX19_chr1_-_160253319_160253429_160252899_160254844	FLOT2_chr17_-_27211242_27211333_27210249_27215962
KCTD20_chr6_+_36411194_36411307_36410888_36437828	ADIRF_chr10_+_88729956_88730019_88728362_88730232	CEP95_chr17_+_62512840_62512946_62510476_62515438
TSEN15_chr1_+_184041290_184041328_184023997_184041960	AKAP8L_chr19_-_15509440_15509577_15508666_15510112	UQCRH_chr1_+_46775568_46775716_46769492_46775826
ZNF528-AS1_chr19_-_52900447_52900520_52899003_52900714	CCNH_chr5_-_86690221_86690301_86688721_86690860	COASY_chr17_+_40714313_40714505_40714237_40714629
ZNF691_chr1_+_43314961_43315084_43312328_43316620	SF3B1_chr2_-_198283619_198283675_198283312_198285151	ACAA1_chr3_-_38167652_38167832_38167372_38168000

AS Events	AS Events	AS Events
ZNF83_chr19_-_53119970_53120128_53118050_53122188	COG4_chr16_-_70549770_70549943_70548412_70551528	ABHD2_chr15_+_89656955_89657055_89631794_89694907
MRPL55_chr1_-_228296137_228296175_228296019_228296655	NACA_chr12_-_57109654_57109990_57108471_57113320	TRIQK_chr8_-_93966633_93966792_93929235_93978234
EDRF1_chr10_+_127417571_127417673_127414407_127417926	TRA2A_chr7_-_23561739_23562051_23561459_23571407	HDHD2_chr18_-_44663605_44663709_44662820_44676748
RP11-606E8.2_chr11_+_93530700_93530885_93529706_93535000	IPO9_chr1_+_201804081_201804192_201798500_201816406	ZNF428_chr19_-_44112656_44112755_44112259_44118380
GUSBP11_chr22_-_23982494_23982610_23981129_24002051	LETMD1_chr12_+_51447594_51447643_51442968_51450132	AFMID_chr17_+_76201683_76201819_76198832_76202026
OARD1_chr6_-_41037814_41037873_41035176_41038870	KCTD6_chr3_+_58479879_58480135_58477896_58484439	GPATCH8_chr17_-_42544464_42544482_42541912_42552196
MAP3K4_chr6_+_161519309_161519459_161518208_161522923	ACAD10_chr12_+_112167609_112167760_112165947_112171726	GON4L_chr1_-_155802622_155802741_155796819_155823066
TARS2_chr1_+_150464073_150464138_150463987_150464886	STAU1_chr20_-_47795658_47795781_47770608_47804652	RNF115_chr1_+_145683574_145683647_145682094_145684584
ZBTB8OS_chr1_-_33100302_33100393_33093145_33116033	RP11-73M18.2_chr14_+_104040443_104040507_104029461_104053610	PPM1K_chr4_-_89199687_89199794_89198395_89205557
DONSON_chr21_-_34955793_34955972_34954361_34956895	PKIG_chr20_+_43211225_43211372_43160619_43218437	TBCE_chr1_+_235596260_235596413_235594119_235597518
DHODH_chr16_+_72055022_72055210_72051005_72057063	SNU13_chr22_-_42078359_42078591_42076368_42084797	NFASC_chr1_+_204971723_204971876_204957934_204978684
GGCX_chr2_-_85779538_85779690_85779104_85780061	MICAL3_chr22_-_18309219_18309282_18305826_18314619	HKR1_chr19_+_37835511_37835676_37826159_37838091
ABI1_chr10_-_27060003_27060018_27059274_27065993	AFMID_chr17_+_76200736_76200822_76198832_76202026	MAPK3_chr16_-_30126915_30126966_30126029_30127956
RNFT1_chr17_-_58037428_58037529_58035805_58039900	C12orf4_chr12_-_4627939_4628046_4614546_4634419	CSNK1D_chr17_-_80207573_80208055_80207478_80209254
TTC7B_chr14_-_91069596_91069647_91059970_91077085	AFMID_chr17_+_76201520_76201599_76200981_76202026	ERBIN_chr5_+_65364704_65364848_65350779_65372143
RHOQ_chr2_+_46803699_46803795_46770951_46808066	HNMT_chr2_+_138724666_138724956_138722198_138727734	CHD1L_chr1_+_146742592_146742666_146740537_146747016
NT5C3B_chr17_-_39991839_39991934_39991524_39992110	INF2_chr14_+_105181620_105181677_105181193_105185131	NEB_chr2_-_152349866_152349959_152349008_152361991
RBPMS_chr8_+_30402010_30402141_30361953_30404808	AP2M1_chr3_+_183898432_183898438_183898039_183898636	CTD-2006C1.2_chr19_+_12112588_12112637_12098638_12146368
GK_chrX_+_30745582_30745669_30742298_30746848	TAF1D_chr11_-_93464315_93464382_93463878_93467790	USO1_chr4_+_76716488_76716509_76715054_76720774

AS Events	AS Events	AS Events
DENND6B_chr22_-_50752828_50752923_50752701_50753033	LRRFIP1_chr2_+_238626404_238626452_238617273_238628165	FAM84A_chr2_+_14773709_14773952_14773061_14774067
SP140L_chr2_+_231265048_231265128_231264957_231265669	GOLIM4_chr3_-_167758573_167758657_167754782_167759179	PIGF_chr2_-_46815213_46815318_46808730_46819613
DHX58_chr17_-_40255625_40255816_40254330_40256783	PTBP2_chr1_+_97271974_97272008_97270495_97272421	IFI44_chr1_+_79126238_79126339_79125168_79128388
DLG1_chr3_-_196803456_196803556_196802741_196807921	SYNE4_chr19_-_36497503_36497573_36496339_36498026	ZNF83_chr19_-_53119970_53120094_53118050_53122188
FRG1_chr4_+_190876191_190876306_190873442_190878552	LIMS2_chr2_-_128431251_128431317_128415136_128432587	NUMB_chr14_-_73745988_73746132_73744001_73749066
TUSC3_chr8_+_15615299_15615364_15601121_15621711	SMC5_chr9_+_72961520_72961565_72959185_72961981	ENOSF1_chr18_-_691203_691276_690631_693881
WASH3P_chr15_+_102512798_102512897_102501844_102513103	PPP1R12A_chr12_-_80173118_80173131_80172380_80175594	PLA2G5_chr1_+_20416281_20416388_20412720_20417060
DGUOK_chr2_+_74173845_74174033_74154179_74185272	OSTC_chr4_+_109584388_109584462_109576813_109588402	FDPS_chr1_+_155279579_155279756_155278867_155279833
ARL16_chr17_-_79650042_79650156_79649179_79650565	ZC3H11A_chr1_+_203765420_203765729_203764922_203770702	ACOX1_chr17_-_73969705_73969866_73953647_73974614
NUP85_chr17_+_73225092_73225226_73222252_73227434	ETHE1_chr19_-_44030352_44030501_44015718_44030666	SLC35B1_chr17_-_47784704_47784806_47784430_47785437
TCOF1_chr5_+_149771106_149771358_149769586_149771519	BCS1L_chr2_+_219524759_219524889_219524466_219526481	PLSCR1_chr3_-_146246400_146246618_146243434_146251256
CYP4A11_chr1_-_47398654_47398719_47398509_47400124	MINK1_chr17_+_4762507_4762623_4736935_4781611	CMTM7_chr3_+_32490945_32491044_32483505_32493883
LETMD1_chr12_+_51445874_51445990_51442968_51450132	RHBDD1_chr2_+_227704124_227704343_227700803_227729319	RBM41_chrX_-_106356626_106356698_106332069_106358581
TDG_chr12_+_104376913_104376996_104376712_104377072	DAZAP1_chr19_+_1425876_1425959_1422395_1428840	EEF1D_chr8_-_144663455_144663876_144663324_144668388
CA11_chr19_-_49141496_49141550_49141401_49142144	PIP5K1A_chr1_+_151196846_151196882_151196755_151199795	CAPRIN2_chr12_-_30873744_30873849_30869610_30876192
PLEKHA7_chr11_-_16828690_16828771_16824842_16834659	PDCD5_chr19_+_33075860_33075917_33073138_33078158	VPS29_chr12_-_110937339_110937351_110934807_110939853
CD47_chr3_-_107770785_107770817_107766139_107776323	XIRP2_chr2_+_168099078_168108457_168098420_168110541	ADAM33_chr20_-_3652780_3652976_3652632_3653367
RPS24_chr10_+_79797722_79797740_79797062_79800372	ARL16_chr17_-_79649520_79649705_79649179_79650042	RP11-903H12.5_chr14_+_21161705_21161809_21152917_21167513
RASSF7_chr11_+_563395_563478_563317_563557	DOCK6_chr19_-_11339973_11340066_11339711_11342860	ENAH_chr1_-_225692692_225692755_225688772_225695652
SEC31A_chr4_-_83783686_83783725_83778917_83784470	PEX2_chr8_-_77900542_77900574_77896431_77912225	TXNL4A_chr18_-_77736717_77736787_77733856_77748239

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RBM6_chr3_+_50012755_50012825_50000118_50085677	RAB40B_chr17_-_80654264_80654729_80622432_80656330	DST_chr6_-_56333779_56333797_56330993_56334680
AMT_chr3_-_49455599_49455661_49455406_49456403	UPP1_chr7_+_48142893_48143008_48141579_48146469	ZNF83_chr19_-_53119970_53120068_53118050_53122188
IL32_chr16_+_3115642_3115688_3115495_3115784	MEF2D_chr1_-_156446285_156446306_156445029_156446803	C1D_chr2_-_68280192_68280418_68274451_68290076
LOXL3_chr2_-_74763835_74764055_74763598_74776495	TTC7B_chr14_-_91069596_91069647_91044652_91077085	MRPL22_chr5_+_154330362_154330498_154320825_154335930
NUPL2_chr7_+_23235457_23235534_23226765_23236298	GATAD2A_chr19_+_19612777_19612852_19612225_19613139	PPFIA1_chr11_+_70197099_70197129_70196145_70200406
C1orf43_chr1_-_154186368_154186422_154185100_154186932	DGUOK_chr2_+_74177727_74177859_74174033_74185272	MPRIP_chr17_+_17067422_17071229_17064670_17075031
RABGGTB_chr1_+_76255836_76255959_76255742_76256969	UQCRH_chr1_+_46775568_46775716_46774799_46775826	TUSC3_chr8_+_15615299_15615364_15605974_15615538
TTC13_chr1_-_231071903_231072010_231069607_231090078	TTLL7_chr1_-_84414310_84414378_84412965_84415547	MRPL48_chr11_+_73554291_73554412_73536841_73555851
SEC16A_chr9_-_139339503_139339563_139338352_139340096	MOGS_chr2_-_74691622_74691849_74690513_74692022	MTHFD2L_chr4_+_75025771_75025805_75023998_75040222
RMND5B_chr5_+_177558237_177558377_177558055_177565108	SLC2A11_chr22_+_24219907_24220056_24219358_24224645	TMEM70_chr8_+_74891313_74891406_74891096_74893389
SMTN_chr22_+_31496870_31496939_31495882_31500301	VIPAS39_chr14_-_77907408_77907516_77904224_77908902	RNF7_chr3_+_141461485_141461749_141457351_141462350
PRMT1_chr19_+_50183128_50183182_50180573_50185166	FAHD2A_chr2_+_96076611_96076774_96076334_96078181	GOLGA2P7_chr15_-_84872928_84873083_84871772_84873177
LAMP2_chrX_-_119572930_119573148_119565317_119575584	PPP3CC_chr8_+_22396981_22397011_22390531_22398127	EWSR1_chr22_+_29687553_29687588_29684775_29688125
RALY_chr20_+_32619327_32619410_32581937_32659871	IVNS1ABP_chr1_-_185275616_185275757_185274775_185276145	TTLL3_chr3_+_9859328_9860604_9855029_9867483
EPB41L1_chr20_+_34797409_34797820_34785963_34800193	FANCL_chr2_-_58390163_58390209_58388773_58390568	CBR3-AS1_chr21_-_37517276_37517374_37505372_37518553
HOOK3_chr8_+_42855413_42855419_42852780_42857249	SMAD4_chr18_+_48603676_48603789_48603146_48604625	AC005154.6_chr7_-_30618621_30618744_30617707_30618846
FRRS1_chr1_-_100176910_100177088_100176505_100177660	SHROOM1_chr5_-_132163152_132163299_132161874_132166285	ABHD11_chr7_-_73152205_73152402_73152065_73152657
SEC16A_chr9_-_139339503_139339563_139338352_139341306	ABLIM3_chr5_+_148622053_148622101_148619451_148624443	HMGN3_chr6_-_79911779_79911872_79911443_79911992
AFMID_chr17_+_76201683_76201834_76198832_76202026	USP53_chr4_+_120135224_120135377_120134028_120138704	MADD_chr11_+_47348288_47348358_47346128_47350208
PQLC1_chr18_-_77693968_77694022_77679400_77703328	TMEM267_chr5_-_43476215_43476360_43454145_43483923	DHX34_chr19_+_47880171_47880246_47879817_47880356

AS Events	AS Events	AS Events
MINOS1_chr1_+_19943751_19943830_19923603_19949967	LRRFIP1_chr2_+_238647874_238647952_238617273_238657006	STRN3_chr14_-_31398406_31398517_31381388_31404368
KIF13A_chr6_-_17771344_17771449_17765177_17772138	TJP1_chr15_-_30011980_30012220_30011342_30012561	FAM193B_chr5_-_176958953_176959201_176952206_176959443
TTLL3_chr3_+_9874787_9874929_9871079_9876364	SDCCAG3_chr9_-_139304541_139304691_139302390_139304779	MYL6_chr12_+_56553370_56553406_56552495_56553758
TMEM141_chr9_+_139686162_139686229_139685876_139686398	ECHDC2_chr1_-_53370705_53372283_53370505_53373539	ADAT1_chr16_-_75652483_75652596_75651170_75654163
DST_chr6_-_56327843_56327954_56325052_56328362	C11orf80_chr11_+_66523823_66523976_66512390_66526513	ZNF75D_chrX_-_134429693_134429965_134421778_134475692
AGBL5_chr2_+_27291915_27291962_27291612_27292440	ANXA2_chr15_-_60689456_60689537_60678285_60690069	MTA1_chr14_+_105934674_105934686_105933079_105935803
NTAN1_chr16_-_15141853_15141956_15141777_15149747	EPN3_chr17_+_48613389_48613639_48610346_48613781	GTPBP1_chr22_+_39104849_39104961_39102152_39111911
DLG1_chr3_-_196802707_196802741_196796131_196803456	SCAF8_chr6_+_155099134_155099179_155055064_155108994	D2HGDH_chr2_+_242694045_242694161_242690803_242694459
NME4_chr16_+_448207_448394_447313_448989	FLAD1_chr1_+_154962035_154962183_154961325_154962634	PTPN6_chr12_+_7060626_7060683_7055902_7060771
LUC7L_chr16_-_278331_278401_277335_279277	PXN_chr12_-_120653362_120653464_120653220_120659425	RP11-43F13.1_chr5_-_1632758_1632866_1629745_1632959
CELF1_chr11_-_47515882_47515995_47510576_47521004	SRRM2_chr16_+_2818505_2818600_2818262_2818997	RREB1_chr6_+_7240670_7240835_7232140_7246656
POLR3C_chr1_-_145597513_145597574_145597054_145598535	TPCN1_chr12_+_113726299_113726331_113726039_113726562	NR4A1_chr12_+_52446279_52446429_52437695_52448110
FUK_chr16_+_70503054_70503226_70502871_70504216	PAAF1_chr11_+_73598075_73598144_73589864_73598398	TSC2_chr16_+_2132436_2132505_2131799_2133695
DTX3_chr12_+_57999126_57999514_57998641_57999972	PSAP_chr10_-_73583644_73583653_73581764_73585593	HKR1_chr19_+_37815697_37815838_37815167_37838091
CRCP_chr7_+_65595113_65595235_65592727_65595730	LRRFIP1_chr2_+_238659842_238659914_238657967_238661951	SHMT2_chr12_+_57625263_57625343_57624783_57625495
MACF1_chr1_+_39946591_39946702_39945681_39950272	FLOT2_chr17_-_27211242_27211333_27210249_27212874	TMEM25_chr11_+_118404134_118404266_118403922_118404571
PREPL_chr2_-_44587757_44587815_44573529_44588518	TRAPPC2_chrX_-_13752168_13752304_13738101_13752643	CAPN7_chr3_+_15282959_15283095_15282360_15283684
SMPD4_chr2_-_130917085_130917207_130914969_130918758	SLTM_chr15_-_59191667_59192136_59191051_59193458	PTCD3_chr2_+_86352917_86353003_86352638_86354283
GIPC1_chr19_-_14603668_14603724_14591590_14606848	PDLIM7_chr5_-_176918807_176918977_176918421_176919405	SEPT6_chrX_-_118759297_118759342_118752749_118763280
CASK_chrX_-_41416284_41416353_41414888_41419031	CDK7_chr5_+_68551286_68551355_68548278_68553869	SBDSP1_chr7_+_72301271_72301393_72300362_72302181

AS Events	AS Events	AS Events
ITGA6_chr2_+_173366499_173366629_173362828_173368818	INO80E_chr16_+_30012785_30012851_30012361_30016541	TMEM185A_chrX_-_148685652_148685736_148682143_148713225
DTNA_chr18_+_32464691_32464740_32462165_32470263	NOD1_chr7_-_30477188_30477272_30469073_30485756	WIZ_chr19_-_15541822_15541993_15538344_15543244
CD74_chr5_-_149782683_149782875_149782188_149784242	LPAR2_chr19_-_19738562_19738778_19738093_19738900	MYEF2_chr15_-_48459545_48459598_48458325_48460827
CHORDC1_chr11_-_89939915_89939978_89939440_89943703	ZZEF1_chr17_-_3959509_3959639_3957489_3961287	CLK3_chr15_+_74914460_74914557_74912566_74914834
ATP2B4_chr1_+_203702350_203702528_203696699_203708673	BCAR1_chr16_-_75298248_75298499_75276988_75299722	SYNE1_chr6_-_152621775_152621916_152615262_152623003
CARS2_chr13_-_111296411_111296529_111294868_111296731	KXD1_chr19_+_18671229_18671360_18668724_18672845	ATP11C_chrX_-_138813809_138813914_138811121_138820074
GGA1_chr22_+_38021803_38021956_38019640_38025468	TM2D1_chr1_-_62152463_62152593_62149218_62160368	NADK_chr1_-_1688217_1688321_1688047_1688619
LRRC37B_chr17_+_30372718_30372837_30362658_30374779	TIAL1_chr10_-_121339982_121340050_121339522_121341433	RNF10_chr12_+_121008993_121009094_121004783_121013433
CENPX_chr17_-_79977516_79977570_79977257_79977733	ACLY_chr17_-_40052872_40052902_40049427_40054001	SRSF3_chr6_+_36567597_36568053_36566760_36568928
ZSCAN25_chr7_+_99216147_99216274_99214639_99217183	GLT8D1_chr3_-_52738739_52738968_52734512_52739462	MAPK10_chr4_-_87019676_87020438_86989108_87022204
CD151_chr11_+_834529_834745_833022_836062	SIRT2_chr19_-_39384458_39384507_39380784_39390145	NME6_chr3_-_48337608_48337726_48336725_48338216
NOL3_chr16_+_67207910_67207949_67204477_67208064	HGD_chr3_-_120365113_120365213_120360540_120365819	ST7_chr7_+_116774177_116774246_116772014_116776134
CD47_chr3_-_107769424_107769449_107766139_107770785	RP11-529K1.3_chr16_+_70346511_70346560_70333257_70349871	DCAF6_chr1_+_168007608_168007726_167974031_168012262
NEB_chr2_-_152359862_152359955_152349008_152361991	KHK_chr2_+_27317344_27317479_27315316_27317667	HRAS_chr11_-_533276_533358_532755_533452
RABGEF1_chr7_+_66204982_66205779_66177211_66236869	PLXDC1_chr17_-_37235754_37235781_37235417_37239711	RHBDF1_chr16_-_109296_109347_109091_109416
MTO1_chr6_+_74181182_74181280_74176329_74183087	R3HDM2_chr12_-_57682791_57682823_57677839_57689181	PDLIM7_chr5_-_176918807_176918926_176918421_176919405
ASL_chr7_+_65546789_65546984_65541080_65547354	BCLAF1_chr6_-_136588166_136588313_136582615_136589299	CNNM2_chr10_+_104831530_104831596_104828479_104835842
EAF2_chr3_+_121573533_121573670_121563394_121575857	NFYA_chr6_+_41048549_41048636_41046903_41051784	DPY19L3_chr19_+_32958379_32958532_32955690_32959636
PSMA4_chr15_+_78834917_78834987_78834561_78836531	SVIL_chr10_-_29820930_29821101_29820217_29839525	ABCA5_chr17_-_67247887_67248007_67246762_67249713
TBCE_chr1_+_235564817_235564902_235543464_235577747	TARSL2_chr15_-_102239533_102239638_102226265_102241288	DDR1_chr6_+_30852314_30852487_30850760_30856464

AS Events	AS Events	AS Events
COCH_chr14_+_31354115_31354247_31353862_31354599	TRMO_chr9_-_100673199_100675257_100672898_100675682	PDK1_chr2_+_173433468_173433545_173431661_173435453
SRSF2_chr17_-_74731853_74731957_74731240_74732235	SUPT20H_chr13_-_37599456_37599574_37598579_37600340	MGST2_chr4_+_140608813_140608894_140599796_140624608
C2CD5_chr12_-_22612425_22612476_22610095_22622642	GOLGA2_chr9_-_131035063_131035144_131030803_131036128	DHX9_chr1_+_182824711_182824848_182823313_182825666
CAMKK2_chr12_-_121682375_121682418_121678672_121682942	VRK3_chr19_-_50512492_50512546_50511083_50519280	GMIP_chr19_-_19745315_19745512_19744999_19745600
DGUOK_chr2_+_74177753_74177859_74174033_74185272	CLCC1_chr1_-_109504930_109505091_109493070_109505982	PILRB_chr7_+_99951517_99951635_99951106_99952765
TRA2B_chr3_-_185649364_185649640_185643414_185655612	SPIN1_chr9_+_91033764_91033866_91003453_91041296	TSPAN4_chr11_+_862549_862741_850367_864436
ZCCHC6_chr9_-_88941285_88941406_88940429_88943254	OAZ3_chr1_+_151740620_151740709_151739775_151742647	SLC12A4_chr16_-_67984556_67984614_67984396_67985042
PKD1_chr16_-_2163041_2163060_2162964_2163161	BYSL_chr6_+_41897869_41898008_41895274_41898372	EPB41_chr1_+_29386933_29386996_29379824_29391493
HNRNPM_chr19_+_8527412_8527465_8520458_8528380	RELL2_chr5_+_141018521_141018588_141018427_141019030	STAM_chr10_+_17726830_17726926_17702547_17730025
ATR_chr3_-_142169307_142169444_142168444_142171969	PKP4_chr2_+_159535092_159535166_159530512_159536940	ENTPD6_chr20_+_25187711_25188033_25176503_25190484
CYP20A1_chr2_+_204137392_204137471_204131404_204143295	NGLY1_chr3_-_25761620_25761682_25761126_25770623	EDEM1_chr3_+_5251859_5251933_5249948_5252804
FAM193B_chr5_-_176958953_176959132_176952206_176959443	TMX2_chr11_+_57505307_57505498_57505140_57505825	ATL1_chr14_+_51096712_51096727_51095180_51098946
GATSL3_chr22_-_30682251_30682365_30682087_30682813	TIA1_chr2_-_70455475_70455594_70454954_70456190	CD46_chr1_+_207963597_207963690_207959027_207966863
ENOSF1_chr18_-_697239_697355_694334_706469	NSUN5P1_chr7_+_75042066_75042210_75039743_75044162	PIGP_chr21_-_38444444_38444610_38441924_38444733
CENPS_chr1_+_10493898_10494022_10491458_10500403	FUS_chr16_+_31198122_31198157_31196500_31199645	FKRP_chr19_+_47251771_47251922_47251345_47258668
PMF1_chr1_+_156195347_156195459_156182967_156202110	CC2D2A_chr4_+_15480846_15480952_15480430_15482327	PTS_chr11_+_112100930_112100953_112099396_112101348
HACL1_chr3_-_15626754_15626849_15624496_15631046	SELENOP_chr5_-_42809861_42809890_42804875_42811937	C17orf62_chr17_-_80407049_80407168_80403836_80408575
CD27-AS1_chr12_-_6559506_6560146_6557903_6560634	ADAM33_chr20_-_3652780_3652976_3652632_3653183	FAM76B_chr11_-_95512241_95512299_95512118_95512770
TMEM136_chr11_+_120198149_120198349_120196077_120200685	GIGYF2_chr2_+_233565294_233565364_233562102_233599864	TMEM159_chr16_+_21172298_21172329_21170067_21172405
CHTOP_chr1_+_153614721_153614905_153610924_153617539	TBC1D17_chr19_+_50382579_50382761_50381829_50383535	INO80E_chr16_+_30015888_30015978_30012851_30016541

AS Events	AS Events	AS Events
SARAF_chr8_-_29931392_29931544_29927575_29940362	FIP1L1_chr4_+_54306748_54306775_54294350_54308819	FNBP1_chr9_-_132678244_132678259_132671278_132687238
SMTN_chr22_+_31492983_31493046_31491595_31493254	TMEM141_chr9_+_139686077_139686229_139685876_139686398	IFT20_chr17_-_26659171_26659408_26659013_26662365
CRAT_chr9_-_131871041_131871182_131870356_131871457	IQSEC1_chr3_-_12944272_12944322_12943022_12949848	MARK3_chr14_+_103966492_103966537_103946827_103969218
PLXNB2_chr22_-_50733154_50733207_50729026_50745981	WDR90_chr16_+_705028_705147_703803_705306	WNK2_chr9_+_96069058_96069103_96061543_96070609
ATG4B_chr2_+_242592721_242592784_242590750_242592926	SLC20A2_chr8_-_42390314_42390478_42330172_42396680	CCDC18-AS1_chr1_-_93804712_93804831_93791452_93804913
TCERG1_chr5_+_145889629_145889723_145888808_145890003	TINAGL1_chr1_+_32042734_32043059_32042196_32044804	RSRC2_chr12_-_123005050_123005128_123003598_123005931
MPP3_chr17_-_41894044_41894065_41893447_41895413	NSRP1_chr17_+_28483557_28483680_28445191_28499559	FXYD3_chr19_+_35610071_35610155_35607263_35611981
YPEL5_chr2_+_30371110_30371407_30369928_30381484	SRSF4_chr1_-_29486375_29486570_29485998_29486886	PRPSAP2_chr17_+_18770569_18770647_18769265_18775895
TMEM184B_chr22_-_38642790_38642891_38642106_38643775	PPP2R3C_chr14_-_35585815_35585943_35579835_35591107	ABCD4_chr14_-_74759856_74759982_74759572_74761850
CHD1L_chr1_+_146742592_146742666_146740537_146743831	LMBR1L_chr12_-_49500327_49500529_49499740_49500743	UBE2F_chr2_+_238925174_238925275_238903451_238933982
ARNT_chr1_-_150814899_150814944_150812130_150818738	POT1_chr7_-_124469307_124469396_124467359_124475332	TARBP1_chr1_-_234536598_234536694_234534299_234536926
INTS3_chr1_+_153733495_153733585_153733394_153734045	RAB40C_chr16_+_668199_668260_640433_675431	TRA2A_chr7_-_23561972_23562051_23561459_23571407
LIPF_chr10_+_90425235_90425316_90424248_90427043	FBXL6_chr8_-_145581116_145581162_145580781_145581287	ZNF790-AS1_chr19_+_37314632_37314723_37292835_37318551
RP11-216L13.19_chr9_+_139703706_139703881_139702778_139704139	TMEM8B_chr9_+_35834457_35834647_35829952_35841130	GCFC2_chr2_-_75907318_75907440_75900646_75914952
CCDC25_chr8_-_27606011_27606115_27605796_27610028	UBE2V1_chr20_-_48713019_48713357_48700791_48729643	MINK1_chr17_+_4795696_4795807_4795529_4795950
PI4KB_chr1_-_151282686_151282731_151280277_151288048	G6PC3_chr17_+_42152336_42152455_42152138_42152677	PXN_chr12_-_120654075_120654384_120653464_120659425
PDCD10_chr3_-_167443188_167443261_167438061_167452001	SCARB1_chr12_-_125267228_125267357_125263132_125270902	FXYD3_chr19_+_35610071_35610155_35607263_35610266
SLC37A4_chr11_-_118897215_118897398_118896790_118897646	RPARP-AS1_chr10_+_104211846_104211944_104210117_104215093	PLCB4_chr20_+_9353693_9353751_9351942_9360700
C2CD5_chr12_-_22611417_22611489_22610095_22622642	ANKRD49_chr11_+_94231067_94231130_94230117_94231236	ENOSF1_chr18_-_677742_677872_675402_683245

AS Events	AS Events	AS Events
IP6K2_chr3_-_48732134_48732257_48731673_48732522	PAK4_chr19_+_39658869_39658952_39616559_39660171	FAM114A2_chr5_-_153390800_153390880_153382529_153405958
FAM193B_chr5_-_176980168_176980351_176966148_176981249	CDK10_chr16_+_89755659_89755714_89753167_89756960	ZC3H11A_chr1_+_203765420_203765624_203764922_203770702
PTPRS_chr19_-_5216730_5216778_5215606_5218430	SVIL_chr10_-_29821457_29822387_29820217_29839525	ACOT8_chr20_-_44482561_44482618_44477314_44485826
ST7_chr7_+_116738666_116738869_116593745_116739815	RBPMS_chr8_+_30407016_30407102_30361953_30416403	SNRNP70_chr19_+_49605370_49606844_49604728_49607890
THTPA_chr14_+_24025951_24026513_24025552_24027903	PROC_chr2_+_128180609_128180747_128180517_128180849	MED17_chr11_+_93527415_93527605_93527201_93528073
PELO_chr5_+_52095718_52096954_52084248_52097242	ZNF506_chr19_-_19904642_19906469_19903293_19916839	CBY1_chr22_+_39052960_39053148_39052755_39061550
PRPF3_chr1_+_150300015_150300111_150298339_150300778	ADSL_chr22_+_40749076_40749121_40746039_40754867	CARS2_chr13_-_111302983_111303447_111299586_111315797
RPS24_chr10_+_79799958_79799983_79797062_79800372	ZNF585A_chr19_-_37656496_37656598_37647257_37660740	DDB2_chr11_+_47256307_47256485_47256223_47256820
ENOSF1_chr18_-_677344_677444_675402_683245	PASK_chr2_-_242047881_242048222_242047715_242051654	RFC2_chr7_-_73660991_73661093_73657576_73663341
MANBAL_chr20_+_35925698_35925937_35918089_35927165	TARBP1_chr1_-_234536598_234536694_234529583_234536926	LYPLAL1_chr1_+_219366471_219366593_219352588_219383873
CAMK2D_chr4_-_114424091_114424133_114421667_114430793	MAATS1_chr3_+_119452210_119452353_119451323_119456212	MRPL10_chr17_-_45906504_45906602_45906036_45908825
VPS54_chr2_-_64140958_64141059_64140444_64141315	DYRK4_chr12_+_4716492_4716553_4714252_4719320	ECHDC2_chr1_-_53363108_53363156_53362269_53364845
VEGFA_chr6_+_43748468_43748540_43746655_43749692	TRA2A_chr7_-_23561750_23562051_23561459_23571407	WNK2_chr9_+_96062332_96062431_96061543_96070609
UAP1_chr1_+_162562524_162562572_162560301_162567581	TRMT11_chr6_+_126327987_126328100_126320759_126329537	TCTN1_chr12_+_111072474_111072584_111070364_111074285
KCNMA1_chr10_-_78772276_78772315_78771801_78778770	PLEKHM2_chr1_+_16047823_16047883_16046415_16051811	SEPT6_chrX_-_118759297_118759342_118750705_118763280
ITGB3BP_chr1_-_63913235_63913285_63906774_63919588	MTRF1L_chr6_-_153312319_153312456_153311230_153313991	PNISR_chr6_-_99864224_99864304_99862566_99873090
IQCB1_chr3_-_121514303_121514413_121509062_121526190	GCFC2_chr2_-_75919102_75919226_75917845_75921366	AHI1_chr6_-_135623849_135623955_135621696_135639656
RAB40C_chr16_+_646316_646448_640433_667207	RHOU_chr1_+_228873419_228873478_228871751_228879031	FAM13A_chr4_-_89658622_89658706_89653349_89660180
MYO6_chr6_+_76608089_76608128_76602407_76617321	SYNE4_chr19_-_36497651_36497846_36496339_36499455	RAB25_chr1_+_156035701_156035897_156031234_156038060
SMARCD1_chr12_+_50481145_50481268_50480661_50482303	IP6K2_chr3_-_48752821_48752960_48732854_48754589	ZMYM4_chr1_+_35827219_35827390_35791006_35835629

AS Events	AS Events	AS Events
LSM14A_chr19_+_34717312_34717369_34712643_34718269	C9orf3_chr9_+_97848211_97848401_97843062_97848963	NDUFAF6_chr8_+_96048529_96048722_96047804_96053797
CCNB1IP1_chr14_-_20783643_20783777_20781960_20784385	ATP9B_chr18_+_76973961_76974038_76967012_77013380	ALOX15B_chr17_+_7950611_7950697_7950394_7951062
ARMC6_chr19_+_19144939_19145047_19144739_19153519	SENP5_chr3_+_196654666_196654750_196650422_196656503	TMCC1_chr3_-_129599151_129599402_129551669_129612336
APLP2_chr11_+_130007150_130007186_130005610_130010292	SARAF_chr8_-_29931392_29931567_29927575_29940362	ABHD11_chr7_-_73152205_73152472_73152065_73152657
NDUFAF6_chr8_+_96048598_96048722_96047804_96053797	PPT2-EGFL8_chr6_+_32132355_32132434_32130399_32134274	MBNL2_chr13_+_98018712_98018807_98009889_98043575
LINC01578_chr15_+_93426814_93426849_93426416_93428744	UIMC1_chr5_-_176395555_176396292_176385155_176396601	CTBP2_chr10_-_126799558_126799662_126692061_126848887
RPLP0_chr12_-_120636356_120636434_120635265_120636656	CANT1_chr17_-_77001453_77001563_76994045_77005745	ZRANB2_chr1_-_71531360_71531435_71530820_71532458
TCTN1_chr12_+_111082771_111082934_111078322_111085015	SYNE4_chr19_-_36497651_36497846_36496339_36498026	NFIX_chr19_+_13189426_13189549_13186485_13192493
DGUOK_chr2_+_74177711_74177859_74154179_74184251	ZNF707_chr8_+_144770831_144771471_144766712_144772226	R3HDM2_chr12_-_57699422_57699446_57697000_57704046
DYSF_chr2_+_71740369_71740462_71739051_71740845	CLK1_chr2_-_201724847_201724938_201724469_201725960	OSER1-AS1_chr20_+_42843527_42843643_42839996_42853460
UBE3A_chr15_-_25652213_25652359_25650649_25654234	NUP50_chr22_+_45566868_45567033_45564127_45567480	SMPDL3A_chr6_+_123122454_123122551_123118113_123126053
MIS12_chr17_+_5391515_5391909_5390004_5392142	TBC1D1_chr4_+_38054726_38054846_38053681_38055819	GOLGA2P7_chr15_-_84873982_84874071_84873727_84898653
PAOX_chr10_+_135197463_135197716_135195163_135202459	ANAPC15_chr11_-_71822487_71822542_71822332_71823695	COL16A1_chr1_-_32136156_32136247_32134456_32137215
ADCK1_chr14_+_78294196_78294314_78288861_78325418	ITGAE_chr17_-_3626581_3626677_3623696_3626981	SSFA2_chr2_+_182785323_182785389_182784173_182786674
XAF1_chr17_+_6665204_6665356_6663920_6665473	SEPT2_chr2_+_242256913_242257014_242255397_242265407	TRPM4_chr19_+_49684605_49684718_49675365_49685834
MAPT_chr17_+_44067243_44067441_44064461_44068825	ZNF239_chr10_-_44063346_44063469_44053619_44069987	TTC27_chr2_+_33036090_33036288_33012216_33042523
SPTAN1_chr9_+_131391403_131391466_131390221_131392599	HADHB_chr2_+_26477114_26477186_26467858_26486247	GLI4_chr8_+_144351529_144351690_144349654_144356873
HDAC6_chrX_+_48676626_48676819_48676516_48681029	ANKRD10_chr13_-_111552876_111553008_111545610_111558379	PRUNE2_chr9_-_79239938_79239974_79234303_79244107
SERHL2_chr22_+_42959394_42959487_42956271_42967126	SNHG5_chr6_-_86387512_86387593_86387210_86387671	FAM131A_chr3_+_184056174_184056317_184055159_184055511
SERPINA1_chr14_-_94854896_94854997_94849578_94856793	DMTN_chr8_+_21938315_21938381_21938136_21938623	MRRF_chr9_+_125048317_125048445_125047566_125054027

AS Events	AS Events	AS Events
BIRC5_chr17_+_76212744_76212862_76210870_76219545	ADCY6_chr12_-_49168739_49168837_49167881_49169085	RPS6KB2_chr11_+_67199823_67199963_67198986_67200070
VPS33B_chr15_-_91560192_91560254_91557663_91565383	TTN_chr2_-_179514280_179514358_179510757_179514543	ZNF431_chr19_+_21333881_21334001_21326446_21349137

Table 1b: Myc AS CL

AS Events	AS Events	AS Events
RP11-111H13.1_chr2_+_99938413_99938491_99937728_99938971	LRR1_chr14_+_50070269_50070336_50069186_50080973	KLHL8_chr4_-_88106402_88106951_88104541_88141569
CYP3A5_chr7_-_99269393_99269501_99264688_99270202	ANKRD18DP_chr3_-_197792623_197792677_197790659_197803666	ERMP1_chr9_-_5805610_5805785_5801328_5810010
SLC25A3_chr12_+_98989210_98989439_98987913_98991633	FBXL19_chr16_+_30939787_30939951_30939284_30941393	RNASEH1-AS1_chr2_+_3607037_3607319_3606588_3608906
WNK2_chr9_+_96061351_96061543_96060349_96070609	PRSS16_chr6_+_27219528_27219819_27219043_27220586	AKTIP_chr16_-_53536611_53536956_53534241_53537058
TP53INP1_chr8_-_95944297_95944335_95942956_95952087	VEZT_chr12_+_95692637_95692719_95690034_95693940	DAZAP1_chr19_+_1425876_1425959_1422395_1428840
FAM76B_chr11_-_95512241_95512299_95512121_95512770	SLC25A12_chr2_-_172644080_172644171_172641985_172644298	PPP1R7_chr2_+_242092890_242093019_242089123_242097221
SETD5_chr3_+_9471510_9471735_9470693_9475528	R3HDM2_chr12_-_57686354_57686432_57682823_57689181	COX20_chr1_+_245005245_245005360_244999058_245005496
CHD2_chr15_+_93541378_93541491_93540633_93541728	PLA2G12A_chr4_-_110639838_110639915_110638869_110650757	PEX2_chr8_-_77900542_77900574_77896431_77912225
TAF1D_chr11_-_93469306_93469470_93466563_93470229	EEF1D_chr8_-_144672777_144672908_144672251_144678257	RNF219_chr13_-_79218996_79219132_79216348_79233183
TAF1D_chr11_-_93467790_93467826_93466563_93468128	SLC27A5_chr19_-_59010151_59010282_59010058_59010489	NOP14-AS1_chr4_+_2940419_2940519_2939869_2948599
TAF1D_chr11_-_93466515_93466585_93463878_93467790	PNPLA8_chr7_-_108128388_108128397_108119823_108131853	TMEM39A_chr3_-_119176864_119176930_119171377_119180808
PPP4R3A_chr14_-_91932604_91932760_91931763_91937180	MPDU1_chr17_+_7489012_7489115_7487283_7489263	UPF3B_chrX_-_118974556_118974647_118972490_118975038
ZNF644_chr1_-_91403041_91403647_91383711_91447866	CEP135_chr4_+_56840911_56841135_56837574_56846308	AKT2_chr19_-_40788123_40788351_40771258_40788614
EFCAB11_chr14_-_90390856_90391021_90263668_90397884	MIR22HG_chr17_-_1617664_1617747_1617308_1619423	GRAMD1B_chr11_+_123465442_123465546_123464874_123466649

AS Events	AS Events	AS Events
KLHL17_chr1_+_898716_898884_898633_899299	PBRM1_chr3_-_52588739_52588895_52584833_52595782	APOPT1_chr14_+_104040443_104040507_104029716_104053610
ANKRD11_chr16_-_89358088_89358185_89357591_89371613	C21orf33_chr21_+_45560131_45560224_45557178_45563086	PTK2_chr8_-_141935759_141935848_141900868_142010978
HERC6_chr4_+_89304336_89304532_89300272_89306650	VTI1A_chr10_+_114208139_114208247_114207225_114208639	PLEKHG4B_chr5_+_179665_179869_174213_181628
HERC6_chr4_+_89304383_89304532_89300272_89306650	MTA1_chr14_+_105915695_105915746_105911848_105916394	TRPM2-AS_chr21_-_45843258_45843364_45834827_45845032
HERC6_chr4_+_89304372_89304532_89300272_89306650	ASXL1_chr20_+_31017703_31017856_31017234_31019123	SDCCAG8_chr1_+_243456392_243456521_243449699_243468014
ZNF778_chr16_+_89291126_89291210_89288591_89291962	CABIN1_chr22_+_24447286_24447436_24445682_24451335	CCDC90B_chr11_-_82989768_82989872_82985783_82991183
PMM2_chr16_+_8904935_8905035_8900264_8905494	HSCB_chr22_+_29139869_29139966_29138319_29147228	RUFY2_chr10_-_70164427_70164601_70161494_70166942
METTL22_chr16_+_8738413_8738582_8736422_8739964	ESYT2_chr7_-_158545471_158545534_158542414_158552176	DCUN1D2_chr13_-_114128438_114128569_114115451_114144981
MAPK10_chr4_-_87019676_87020438_86989108_87022204	IL6R_chr1_+_154408444_154408586_154407632_154417522	USP53_chr4_+_120135224_120135377_120134028_120138704
MTHFSD_chr16_-_86585578_86585752_86582183_86588250	TPP2_chr13_+_103320107_103320233_103317286_103326632	EVA1C_chr21_+_33825619_33825816_33785321_33840003
ME3_chr11_-_86168407_86168801_86161440_86176132	PLEKHG1_chr6_+_150959215_150959261_150921153_150971863	SNHG14_chr15_+_25301629_25301769_25299114_25304301
SH2D6_chr2_+_85663588_85663717_85662246_85663959	ZNF397_chr18_+_32825225_32825315_32823257_32834195	CEP162_chr6_-_84936054_84936170_84930889_84937297
SH2D6_chr2_+_85663588_85663717_85662947_85663959	NSUN5P1_chr7_+_75039888_75040009_75039743_75042066	TTPAL_chr20_+_43107263_43107287_43104631_43108624
ELMOD3_chr2_+_85614220_85614348_85604597_85616873	COL9A3_chr20_+_61467538_61467685_61467305_61467829	RP11-284E5.1_chr2_-_191491214_191491549_191481844_191512945
CEP162_chr6_-_84928820_84928932_84925640_84930774	MYCBP2_chr13_-_77700452_77700677_77699603_77713330	ZC3H11A_chr1_+_203765578_203765729_203764903_203786053
COQ2_chr4_-_84188242_84188361_84185516_84188738	TNKS_chr8_+_9588399_9588545_9584230_9592374	NOXRED1_chr14_-_77880276_77880470_77873988_77889077
NARF_chr17_+_80436446_80436543_80426772_80436675	MACC1_chr7_-_20238147_20238293_20204022_20256921	TLE4_chr9_+_82242288_82242363_82227633_82267507
HEXDC_chr17_+_80398348_80398489_80398210_80398872	PIAS1_chr15_+_68481540_68481608_68480569_68482830	TLE4_chr9_+_82242288_82242363_82227633_82267504
RPS24_chr10_+_79799961_79799983_79797062_79800372	EDRF1_chr10_+_127417571_127417673_127414407_127417926	ENKD1_chr16_-_67697559_67697723_67697459_67697839
SLC25A10_chr17_+_79680291_79680536_79679549_79681982	STAP2_chr19_-_4324451_4324664_4324194_4325212	FLOT2_chr17_-_27211242_27211333_27210249_27212874

AS Events	AS Events	AS Events
SGSH_chr17_-_78188413_78188564_78188127_78190830	STK39_chr2_-_168921828_168921891_168920080_168931491	DNAJC14_chr12_-_56223272_56223420_56222498_56224479
RABGGTB_chr1_+_76255636_76255959_76253289_76256969	ARPC4-TTLL3_chr3_+_9859328_9859443_9855029_9867483	SRRM2_chr16_+_2806334_2806607_2802847_2807472
SYNGR2_chr17_+_76167590_76167730_76167135_76167819	HCG18_chr6_-_30282045_30282259_30264014_30293785	VARS_chr6_-_31751990_31752085_31750963_31752170
JMJD6_chr17_-_74717344_74717433_74716580_74717879	MINDY1_chr1_-_150974640_150974799_150974258_150978787	TBL1X_chrX_+_9621584_9621729_9608400_9622254
JMJD6_chr17_-_74717344_74717438_74716580_74717879	ARTN_chr1_+_44401764_44401903_44401388_44401973	WASHC5_chr8_-_126095954_126096018_126095500_126103856
RECQL5_chr17_-_73646596_73646798_73627748_73647265	PLCB2_chr15_-_40583218_40583384_40583038_40583465	SH2D6_chr2_+_85659021_85659082_85658391_85660693
PMFBP1_chr16_-_72188109_72188358_72174481_72198662	TNFSF12-TNFSF13_chr17_+_7463162_7463210_7463019_7463365	UGT8_chr4_+_115540578_115540681_115520130_115544034
RNF121_chr11_+_71698049_71698157_71693961_71701642	ATP2A3_chr17_-_3831274_3831332_3828735_3831520	TANK_chr2_+_162080430_162080502_162061304_162081141
RNF121_chr11_+_71673197_71673335_71671937_71693806	RP5-1120P11.1_chr6_-_43968327_43968452_43967245_43968779	FAM92A_chr8_+_94736737_94736823_94722103_94738621
ZRANB2_chr1_-_71531360_71531435_71530820_71532458	HPS4_chr22_-_26862016_26862070_26861517_26862191	PAQR5_chr15_+_69677015_69677221_69672349_69689806
SRSF11_chr1_+_70697541_70697658_70694238_70697950	MTERF4_chr2_-_242033691_242033847_242029459_242036657	TM2D1_chr1_-_62152463_62152593_62149218_62160368
SLC25A16_chr10_-_70253205_70253327_70252955_70263388	GK_chrX_+_30745582_30745669_30742298_30746848	TIAL1_chr10_-_121339982_121340050_121339522_121341433
DNA2_chr10_-_70230245_70230369_70229920_70231547	TNS1_chr2_-_218677937_218678027_218677168_218678407	BIN1_chr2_-_127815048_127815177_127808488_127816586
MCRIP2_chr16_+_696471_696608_692249_697416	PAQR6_chr1_-_156215325_156215452_156215029_156215572	SCAMP4_chr19_+_1918887_1918989_1918282_1923068
NFATC3_chr16_+_68248231_68248335_68225678_68260252	TBC1D7_chr6_-_13325325_13325406_13321327_13327018	ABHD5_chr3_+_43759162_43759349_43756550_43759934
TSNAXIP1_chr16_+_67858485_67858682_67855128_67859039	LINC00630_chrX_+_102094728_102094791_102082072_102100784	DUOX1_chr15_+_45440101_45440195_45439856_45440469
ING4_chr12_-_6764803_6765079_6762216_6765892	IMPDH1_chr7_-_128045820_128045919_128043808_128049809	ADGRF1_chr6_-_46984352_46984504_46982580_46988466
FHOD1_chr16_-_67270313_67270337_67268375_67270459	LRIF1_chr1_-_111493909_111495437_111492745_111506242	SCART1_chr10_+_135304725_135304823_135280857_135311332
TMEM134_chr11_-_67232526_67232738_67232327_67234782	ARL16_chr17_-_79650042_79650156_79649179_79650565	CMTM7_chr3_+_32490945_32491044_32483505_32493883
HSF4_chr16_+_67201363_67201502_67201125_67201726	TCOF1_chr5_+_149771106_149771358_149769586_149771519	TMBIM6_chr12_+_50138195_50138325_50135898_50146246

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FAM20A_chr17_-_66586264_66586490_66551884_66596403	WASF1_chr6_-_110499800_110499945_110448832_110500641	SLC28A3_chr9_-_86928273_86928369_86924629_86955488
C17orf58_chr17_-_65989016_65989351_65988219_65989539	RHBDL3_chr17_+_30611677_30611836_30594944_30615810	KAT5_chr11_+_65480818_65480974_65480529_65481063
AGPAT5_chr8_+_6588231_6588347_6566408_6612571	KIF13A_chr6_-_17794479_17794626_17788106_17794802	DOCK9_chr13_-_99478125_99478194_99476758_99479083
SREK1_chr5_+_65454636_65454760_65449424_65455046	HTR3C_chr3_+_183773099_183773144_183770935_183774662	AC138969.4_chr16_+_16425710_16425837_16425620_16427503
SREK1_chr5_+_65451892_65454760_65449424_65455046	CD47_chr3_-_107770785_107770817_107766139_107776323	KIAA0895_chr7_-_36396510_36397199_36375906_36406524
CDH19_chr18_-_64176231_64176455_64172539_64178804	WDR11_chr10_+_122612035_122612147_122611039_122618154	TBCE_chr1_+_235582787_235582876_235577933_235590454
CDH19_chr18_-_64176231_64176483_64172539_64178804	UROS_chr10_-_127477851_127478097_127477574_127483448	TIA1_chr2_-_70455475_70455594_70454954_70456190
USP3_chr15_+_63826001_63826117_63824906_63845913	ATP13A3_chr3_-_194132927_194133017_194126845_194134487	KIAA1468_chr18_+_59931961_59932085_59931378_59933933
USP3_chr15_+_63826001_63826117_63824906_63829223	INTS11_chr1_-_1258560_1258667_1250998_1259960	ZNF83_chr19_-_53119970_53120068_53118050_53122188
USP3_chr15_+_63821212_63821365_63797029_63829223	MED15_chr22_+_20929399_20929519_20922918_20936897	PRPF38B_chr1_+_109236211_109236264_109235489_109238323
USP3_chr15_+_63821212_63821365_63797029_63824845	CELF6_chr15_-_72608185_72608268_72597135_72611953	UTAT33_chr2_-_105714656_105714720_105713856_105719293
SMURF2_chr17_-_62590108_62590222_62589691_62594499	PPM1K_chr4_-_89199295_89199794_89198395_89205557	MFSD6_chr2_+_191298052_191298118_191280139_191300702
IRF7_chr11_-_613950_614037_613865_614475	EPB41L1_chr20_+_34797409_34797820_34785963_34800193	FIP1L1_chr4_+_54306748_54306775_54294350_54308819
SLCO4A1_chr20_+_61299363_61299536_61299262_61299828	CCDC169_chr13_-_36869914_36869994_36857839_36871773	CPNE5_chr6_-_36720810_36720872_36716044_36724021
UBXN2B_chr8_+_59347416_59347507_59347063_59352191	FER1L5_chr2_+_97312800_97312892_97312190_97315359	LCMT1_chr16_+_25162874_25162936_25151568_25175918
VRK2_chr2_+_58381888_58381937_58373609_58386483	BLOC1S6_chr15_+_45890077_45890089_45879723_45895297	RAPGEF1_chr9_-_134525515_134525629_134518804_134526196
CTDSP2_chr12_-_58220778_58220906_58220185_58221334	ANKRD6_chr6_+_90331640_90331745_90315824_90333128	ETV4_chr17_-_41610041_41610307_41607549_41610554
TMX2_chr11_+_57505384_57505498_57505140_57505825	RERE_chr1_-_8674619_8674745_8617582_8684368	CANT1_chr17_-_77001453_77001563_76994368_77005745
MYL6_chr12_+_56554409_56554454_56554104_56555170	KIF13A_chr6_-_17771344_17771449_17765177_17772138	ZNF345_chr19_+_37367686_37367778_37342806_37383719
PSPH_chr7_-_56087292_56087501_56085072_56088765	ERMAP_chr1_+_43296114_43296204_43291409_43300708	KCNMB2-AS1_chr3_-_178577276_178577411_178559404_178578081

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RBM38_chr20_+_55967452_55967548_55966851_55967709	NTAN1_chr16_-_15141853_15141956_15141777_15149747	SLC50A1_chr1_+_155110036_155110198_155108852_155110454
USP24_chr1_-_55617584_55617648_55614243_55619542	TPRA1_chr3_-_127294591_127294652_127294348_127294782	RP11-977G19.10_chr12_-_56703749_56703813_56694004_56704741
EPB41L3_chr18_-_5394675_5394792_5393477_5395065	SYNE4_chr19_-_36499118_36499269_36498170_36499455	POU2AF1_chr11_-_111267575_111267768_111257017_111268304
HRAS_chr11_-_533276_533358_532755_533452	LUC7L_chr16_-_278331_278401_277335_279277	RABGAP1L_chr1_+_174957777_174957975_174952042_174958985
ST18_chr8_-_53122589_53122677_53119310_53124638	TEX9_chr15_+_56676149_56676229_56665702_56704499	RP11-164J13.1_chr15_+_42682150_42682294_42681294_42684836
TOM1L1_chr17_+_52981068_52981153_52978284_52990026	WARS_chr14_-_100841619_100841687_100835595_100842596	THAP5_chr7_-_108206273_108206466_108205549_108209933
DCUN1D4_chr4_+_52753288_52753410_52752804_52757925	MFF_chr2_+_228207460_228207535_228205096_228220392	CD44_chr11_+_35219667_35219793_35211612_35226058
VRK3_chr19_-_50512492_50512642_50511083_50519280	CCDC125_chr5_-_68590619_68590727_68588189_68595838	PMS2P5_chr7_+_74312525_74312628_74312349_74313767
ATP8B4_chr15_-_50214420_50214602_50212607_50215575	MAPK10_chr4_-_87019676_87019748_86989108_87022204	ANLN_chr7_+_36456688_36456799_36455493_36458852
LRR1_chr14_+_50074117_50074839_50069186_50080973	ZFP90_chr16_+_68573660_68573728_68567758_68591900	C19orf47_chr19_-_40840741_40840811_40839836_40842016
SNRNP70_chr19_+_49605370_49605442_49604728_49607890	ZUFSP_chr6_-_116987796_116988075_116982009_116989728	C15orf52_chr15_-_40631712_40631820_40631104_40632105
SNRNP70_chr19_+_49605370_49605430_49604728_49607890	PAOX_chr10_+_135203093_135203251_135202572_135204815	LCORL_chr4_-_17887690_17887784_17879836_17910716
SNRNP70_chr19_+_49605370_49606844_49604728_49607890	MINDY1_chr1_-_150974640_150974646_150974258_150978787	MMS19_chr10_-_99228722_99228861_99228163_99229402
BAX_chr19_+_49458943_49459090_49458856_49459454	HSD3B7_chr16_+_30996973_30997268_30996618_30997369	RPL18_chr19_-_49120572_49120672_49119459_49121047
LUC7L3_chr17_+_48826579_48826705_48825777_48827861	OPA1_chr3_+_193321288_193321346_193311198_193333462	MRPL22_chr5_+_154330362_154330498_154320825_154335930
LUC7L3_chr17_+_48815497_48815560_48814840_48817666	GIN1_chr5_-_102432244_102432530_102423876_102440244	WARS_chr14_-_100841619_100841743_100835595_100842596
IP6K2_chr3_-_48732134_48732257_48731673_48732522	DNM1L_chr12_+_32891197_32891230_32890876_32892997	TRA2A_chr7_-_23561750_23562051_23561459_23571407
IP6K2_chr3_-_48732126_48732257_48731673_48732522	DLG2_chr11_-_83641370_83641526_83585531_83673927	ARHGEF37_chr5_+_148996129_148996329_148989258_148997738
MYEF2_chr15_-_48435092_48435268_48434333_48441359	MIB2_chr1_+_1560370_1560565_1560281_1560665	PLEKHM2_chr1_+_16047823_16047883_16046415_16051811

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MGRN1_chr16_+_4736259_4736304_4733933_4738796	LINC00630_chrX_+_102100784_102100948_102094900_102119969	ZNF33B_chr10_-_43127742_43127887_43127472_43132367
ADGRF1_chr6_-_46984352_46988233_46982580_46988466	CBR3-AS1_chr21_-_37509391_37509474_37506059_37518553	RTFDC1_chr20_+_55045655_55045807_55043822_55046669
PHF21A_chr11_-_45956671_45956797_45955776_45957186	TBCE_chr1_+_235582731_235582876_235577933_235590454	GTF2H2C_chr5_+_68858499_68858597_68856230_68860926
DNAJA3_chr16_+_4504811_4504928_4498849_4505546	PRRG2_chr19_+_50087169_50087209_50084738_50091753	MGAM2_chr7_+_141887549_141887634_141885923_141889166
NME4_chr16_+_448207_448385_447079_448989	ADHFE1_chr8_+_67357452_67357649_67356983_67359498	RP1-27K12.2_chr6_-_53434220_53434403_53429687_53481683
SERINC4_chr15_-_44091507_44091684_44088425_44092082	ZNF566_chr19_-_36967450_36967518_36964360_36980387	EDC3_chr15_-_74979431_74979520_74948409_74988220
SERINC4_chr15_-_44088813_44088940_44088425_44092082	PUM1_chr1_-_31452908_31453025_31447649_31454158	STEAP3_chr2_+_119996938_119997006_119981464_120003064
SETMAR_chr3_+_4354581_4355445_4345210_4357895	ARMC10_chr7_+_102716223_102716328_102715858_102724128	TIA1_chr2_-_70455475_70455594_70454954_70456395
FMNL1_chr17_+_43322985_43323100_43322783_43323244	NOL3_chr16_+_67207910_67207949_67204477_67208064	RUFY3_chr4_+_71670064_71670133_71668700_716722 32
FMNL1_chr17_+_43322998_43323100_43322783_43323244	PATZ1_chr22_-_31724772_31724910_31723295_31731677	PRMT7_chr16_+_68381113_68381197_68380183_68381533
CENPM_chr22_-_42339613_42339705_42335200_42341228	APBB2_chr4_-_40937093_40937156_40936716_40946881	FAM227B_chr15_-_49860441_49860543_49834003_49867207
IKBKB_chr8_+_42147673_42147791_42129723_42162704	ASL_chr7_+_65546789_65546984_65541080_65547354	WASHC5_chr8_-_126096076_126096264_126095500_126103856
ECI2_chr6_-_4119419_4119509_4117685_4125483	CBY1_chr22_+_39061550_39061690_39052755_39064021	USH1C_chr11_-_17554801_17554869_17553089_17565818
HMGN1_chr21_-_40717755_40717884_40717200_40719304	ASAH2B_chr10_+_52504887_52505034_52502770_52509102	PCOLCE_chr7_+_100203298_100203435_100202838_100204038
HMGN1_chr21_-_40717755_40719218_40717200_40719304	RHOC_chr1_-_113247674_113247790_113246428_113249699	GGCT_chr7_-_30540151_30540297_30538554_30544184
MAP3K10_chr19_+_40711027_40711203_40704462_40715009	C19orf60_chr19_+_18700288_18700493_18699887_18702917	ESPN_chr1_+_6508952_6509151_6508862_6511662
NKIRAS2_chr17_+_40174587_40174658_40174490_40175671	NUP62_chr19_-_50430950_50431072_50413141_50432606	RP11-231C18.3_chr4_+_54280781_54280889_54266006_54292038
DNAJC7_chr17_-_40155376_40155575_40152588_40170455	ZNF197_chr3_+_44673596_44673688_44672713_44673964	SLC25A25-AS1_chr9_-_130879988_130880114_130877568_130880201
N4BP2_chr4_+_40101655_40101746_40099189_40103694	NPM2_chr8_+_21882726_21882817_21882341_21882946	HHAT_chr1_+_210591497_210591669_210578023_210637848
MOCS1_chr6_-_39894922_39895194_39893589_39902033	CCDC78_chr16_-_774910_774989_774509_775077	PILRB_chr7_+_99951517_99951635_99950893_99952765

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PGAP2_chr11_+_3844138_3844223_3832654_3845112	PLA2G4B_chr15_+_42130944_42131120_42130157_42132355	SLC38A5_chrX_-_48324616_48324709_48321365_48325185
FGFR1_chr8_-_38279314_38279459_38277253_38280542	INTS8_chr8_+_95862143_95862319_95861760_95863780	RPRD2_chr1_+_150414356_150414434_150413499_150415706
MEAF6_chr1_-_37962147_37962205_37961519_37967404	POLG_chr15_-_89865192_89865246_89862581_89865972	TPRKB_chr2_-_73959710_73959827_73959412_73964428
KCTD17_chr22_+_37457578_37457669_37455478_37458564	PHF21A_chr11_-_45956671_45956708_45955776_45957186	CLTA_chr9_+_36263194_36263439_36204176_36265417
MEIS2_chr15_-_37186917_37187013_37184660_37187351	DDHD1_chr14_-_53518561_53518645_53513667_53521155	CALD1_chr7_+_134620438_134620516_134618141_134625842
SRSF3_chr6_+_36567597_36568053_36566760_36568928	CDH24_chr14_-_23521178_23521292_23519152_23521681	TROVE2_chr1_+_193038163_193038311_193028906_193044949
SEPT7_chr7_+_35872407_35872503_35840880_35903161	YTHDC2_chr5_+_112862282_112862482_112851059_112868575	NUDT6_chr4_-_123833722_123833778_123818833_123838655
PSMA6_chr14_+_35778119_35778201_35761758_35782086	NFX1_chr9_+_33354083_33354185_33352717_33354848	PLEKHA6_chr1_-_204225929_204226016_204219742_204226480
SMIM11A_chr21_+_35757775_35757942_35751815_35772008	JMJD8_chr16_-_732952_733087_732874_733166	ZDHHC13_chr11_+_19164524_19164670_19138823_19167727
ACACA_chr17_-_35646319_35646430_35641871_35656204	C19orf48_chr19_-_51302528_51302614_51302215_51305473	METTL26_chr16_-_685517_685774_685340_686093
DONSON_chr21_-_34955793_34955972_34954552_34956895	CHTF18_chr16_+_845131_845356_844201_845684	POLR2J3_chr7_-_102183971_102184144_102182109_102185152
RBM39_chr20_-_34328446_34328519_34326939_34328745	IDE_chr10_-_94240549_94240673_94238546_94243011	DLG3_chrX_+_69717029_69717071_69713325_69718369
RBM39_chr20_-_34301623_34301779_34301018_34302106	HDAC2_chr6_-_114289797_114289860_114281182_114291643	HTR3E_chr3_+_183819272_183819317_183818439_183822574
ZNF195_chr11_-_3383762_3383832_3383119_3392204	ZSCAN20_chr1_+_33954714_33954791_33954251_33955117	GORASP1_chr3_-_39144168_39144372_39142593_39148969
ZNF195_chr11_-_3383775_3383832_3381795_3392204	TMTC4_chr13_-_101322613_101322823_101321048_101326997	STX16_chr20_+_57234678_57234690_57227143_57242545
ZNF195_chr11_-_3383775_3383832_3383119_3392204	FAM210A_chr18_-_13670869_13670967_13666712_13671860	PGAP3_chr17_-_37829303_37829508_37829119_37830245
EVA1C_chr21_+_33829904_33830028_33785321_33840003	RP11-252A24.2_chr16_-_74383639_74383757_74382913_74385937	INPP5J_chr22_+_31520127_31520249_31519105_31520830
NT5C3A_chr7_-_33075545_33075600_33066527_33102179	KIAA1456_chr8_+_12848342_12848540_12809867_12863710	RHOC_chr1_-_113247721_113247823_113246428_113249699
APTX_chr9_-_32988080_32988127_32987729_32989756	ZFX_chrX_+_24195800_24195983_24193560_24197299	NIPA2_chr15_-_23019799_23019856_23014528_23021197

AS Events	AS Events	AS Events
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BICD1_chr12_+_32520603_32520679_32490640_32530473	AC007040.11_chr2_-_71218959_71219113_71216946_71220825	MTIF2_chr2_-_55481176_55481337_55476670_55489451
BPHL_chr6_+_3119518_3119746_3119081_3123890	COMMD9_chr11_-_36297686_36297790_36296322_36298638	AKIP1_chr11_+_8933999_8934080_8933218_8936372
HSD3B7_chr16_+_30996780_30997145_30996618_30997369	GIGYF2_chr2_+_233587263_233587368_233568199_233589283	LCP2_chr5_-_169693811_169693895_169689996_169694012
ASXL1_chr20_+_30959580_30959677_30956926_30959966	EP400_chr12_+_132466033_132466141_132464338_132466637	SMARCC2_chr12_-_56566720_56566813_56566488_56567479
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C19orf12_chr19_-_30196180_30196301_30193884_30199160	CCDC18-AS1_chr1_-_93770944_93771027_93730329_93802933	CCDC78_chr16_-_774680_774806_774509_775077
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CLN3_chr16_-_28497667_28497845_28495439_28497898	SLC43A1_chr11_-_57265225_57265318_57261644_57268251	POLR2J3_chr7_-_102183971_102184108_102182109_102185152
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C5orf38_chr5_+_2752735_2752868_2752578_2755142	PARP11_chr12_-_3938075_3938196_3935399_3939055	PUF60_chr8_-_144906482_144906569_144904083_144911449
THOC1_chr18_-_260717_260759_260304_264025	MTMR12_chr5_-_32235067_32235235_32230453_32239106	ADCY5_chr3_-_123022913_123023030_123022066_123033081
PDPK1_chr16_+_2588619_2588772_2588137_2607703	RP9P_chr7_-_32973425_32973508_32969720_32982481	NCK2_chr2_+_106497783_106498505_106471745_106509437
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CENPJ_chr13_-_25460371_25460523_25459808_25463453	TTL_chr2_+_113277858_113278002_113260758_113286257	IVNS1ABP_chr1_-_185275616_185275757_185274775_185276145
CENPJ_chr13_-_25460372_25460523_25459808_25463453	CBR3-AS1_chr21_-_37517276_37517374_37509606_37518553	MGAM2_chr7_+_141831317_141831427_141830871_141831730
KCTD9_chr8_-_25303595_25303766_25298189_25315714	SEC24C_chr10_+_75526107_75526299_75525968_75526517	MBOAT7_chr19_-_54691042_54691169_54687563_54692070
SRRM1_chr1_+_24973569_24973699_24973280_24975349	PRKCD_chr3_+_53199119_53199231_53195444_53212419	ITGB6_chr2_-_161055689_161055769_161052931_161056513
ARHGAP17_chr16_-_24939004_24939053_24931581_24942104	AGTPBP1_chr9_-_88296182_88296250_88292497_88307603	IQCA1_chr2_-_237327791_237327914_237308131_237349682

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ATG4B_chr2_+_242591298_242591389_242590750_242593960	RAPGEF1_chr9_-_134479347_134479440_134477536_134497182	RGS21_chr1_+_192316442_192316519_192286235_192321176
SEPT2_chr2_+_242263823_242264077_242257014_242265407	RGL2_chr6_-_33262464_33262539_33261843_33262753	OGDHL_chr10_-_50947706_50947885_50946308_50950873
ASB1_chr2_+_239344351_239344654_239342336_239352982	ATF2_chr2_-_175986171_175986268_175983097_175994865	DNAJA4_chr15_+_78562838_78563019_78557237_78565436
SS18_chr18_-_23664015_23664139_23662492_23667464	PROM1_chr4_-_15981017_15981086_15972705_15981503	ISOC2_chr19_-_55967002_55967212_55966745_55967715
EIF4E2_chr2_+_233438972_233439051_233431924_233445613	DMTF1_chr7_+_86783543_86783594_86781871_86783705	FASTKD1_chr2_-_170425693_170425762_170419860_170427513
ZNF142_chr2_-_219516423_219517023_219515249_219520872	KIN_chr10_-_7825043_7825138_7822141_7829782	SH2D6_chr2_+_85657103_85657138_85656735_85658332
ZNF142_chr2_-_219516423_219516545_219515249_219520872	CANT1_chr17_-_76996181_76996352_76994368_77005745	UBXN11_chr1_-_26627416_26627544_26624553_26628184
ZMYM5_chr13_-_20411795_20411961_20409829_20425494	PPIP5K2_chr5_+_102518934_102519108_102515889_102520372	CRYBB2P1_chr22_+_25851678_25851807_25844251_25853225
CARF_chr2_+_203807462_203807690_203806703_203817281	UBL7_chr15_-_74753008_74753119_74751237_74753377	UBE2E3_chr2_+_181845668_181845700_181845273_181846744
CARF_chr2_+_203807485_203807690_203806703_203817281	MOCS1_chr6_-_39895067_39895194_39893589_39902033	HTRA2_chr2_+_74759745_74759841_74759052_747599446
PPP1R12B_chr1_+_202412214_202412255_202411700_202418116	GUSBP11_chr22_-_23982494_23982610_23981129_23994665	SFT2D2_chr1_+_168205826_168205862_168204420_168205949
TANGO2_chr22_+_20043465_20043536_20040107_20049052	SRRM1_chr1_+_24989673_24989715_24989295_24993305	ARHGAP22_chr10_-_49687678_49687807_49667934_49763507
MINOS1_chr1_+_19927280_19927465_19923603_199499967	DCTD_chr4_-_183837571_183837692_183836728_183838440	TEX30_chr13_-_103419622_103419828_103418930_103420609
PGAP1_chr2_-_197786826_197786910_197784874_197791193	RAD52_chr12_-_1023576_1023698_1023287_1025509	MYO3B_chr2_+_171071238_171071338_171070993_171073828
TNK2_chr3_-_195612283_195612414_195611904_195613847	B4GALT6_chr18_-_29237938_29238052_29225442_29246218	SETD9_chr5_+_56206868_56206938_56206221_56208837
NABP1_chr2_+_192547217_192547321_192546743_192548454	CSF2RB_chr22_+_37332590_37332694_37331729_37333418	GSTM1_chr1_+_110230738_110230867_110230531_110231294
EIF4A2_chr3_+_186506098_186506205_186505671_186506913	RP11-793H13.8_chr12_+_53858543_53858636_53856351_53861004	PCGF3_chr4_+_726232_726287_724899_727460
SNX25_chr4_+_186260532_186260664_186253913_186263129	TBPL1_chr6_+_134274322_134274563_134273868_134301219	TPCN1_chr12_+_113722522_113722576_113722442_113723693
TRA2B_chr3_-_185649364_185649640_185643414_185655612	JARID2_chr6_+_15410454_15410596_15374483_15452236	MTIF2_chr2_-_55493516_55493654_55491001_55494704

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TRA2B_chr3_-_185649364_185649640_185644522_185655612	RP1-27K12.2_chr6_-_53437997_53438073_53434403_53481683	GPALPP1_chr13_+_45603373_45606242_45602138_45607370
NOP16_chr5_-_175813840_175813927_175812328_175815235	CBR3-AS1_chr21_-_37518553_37518653_37509474_37528514	AC092675.3_chr2_-_98949903_98949966_98949767_98950385
NOP16_chr5_-_175813840_175813944_175812328_175815235	PLEKHG7_chr12_+_93162758_93162856_93157970_93163863	NAXD_chr13_+_111277536_111277625_111276626_111279785
CEP44_chr4_+_175238485_175239816_175237718_175252632	FAM114A2_chr5_-_153417852_153417994_153414527_153418416	CABIN1_chr22_+_24558033_24558183_24552544_24560367
NPRL3_chr16_-_174935_175072_169254_180520	ADGRE5_chr19_+_14507153_14507285_14501891_14508469	RIMKLB_chr12_+_8852380_8853210_8850893_8866406
BABAM1_chr19_+_17384712_17384833_17382464_17387303	SLAMF7_chr1_+_160720093_160720213_160719883_160721975	RGL3_chr19_-_11515998_11516102_11515907_11517094
MPRIP_chr17_+_17083920_17083983_17083402_17088136	COQ6_chr14_+_74428439_74428606_74428273_74429672	LTBP3_chr11_-_65307483_65307624_65307352_65307715
EPS15L1_chr19_-_16472589_16472795_16466662_16495939	SYTL1_chr1_+_27676462_27676623_27676256_27676879	SFMBT1_chr3_-_53077151_53077270_53003274_53078961
OXNAD1_chr3_+_16313651_16313828_16313229_16327848	TEX9_chr15_+_56681515_56681598_56676229_56683440	ARNTL2_chr12_+_27529278_27529320_27521345_27533179
MAP3K4_chr6_+_161529982_161530073_161529891_161530786	LINC00174_chr7_-_65941245_65941314_65915223_65943995	CDS1_chr4_+_85564176_85564296_85562143_85569709
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NDE1_chr16_+_15793585_15793711_15790717_15818047	LINC00893_chrX_-_148617478_148617514_148615906_148617705	BCL11A_chr2_-_60695866_60695968_60689559_60773105
DNAJB6_chr7_+_157202488_157208223_157178305_157208709	RP3-449O17.1_chr22_-_38765990_38766050_38765384_38776374	PTBP1_chr19_+_805512_805569_805187_806407
CCNL1_chr3_-_156869517_156869719_156868170_156869965	SGSM1_chr22_+_25270381_25270546_25264822_25272543	FRMD8_chr11_+_65161043_65161145_65156999_65161511
MIB2_chr1_+_1564764_1564946_1564691_1565018	ZNF35_chr3_+_44694048_44694193_44692751_44700192	MED24_chr17_-_38191168_38191225_38189709_38191369
MIB2_chr1_+_1561746_1562134_1561033_1562216	TMEM176B_chr7_-_150491048_150491159_150490688_150493453	ATP13A2_chr1_-_17312957_17313127_17312853_17313299
INTS3_chr1_+_153733495_153733585_153733394_153734045	ARMC10_chr7_+_102737723_102737795_102733100_102738745	FOXM1_chr12_-_2974520_2974565_2973918_2975558
THEM4_chr1_-_151862458_151862690_151861849_151867483	WDSUB1_chr2_-_160116320_160116354_160112886_160132056	NDUFS1_chr2_-_207017142_207017234_207014649_207018341
PDXDC1_chr16_+_15095632_15095744_15092262_15098043	FAM228B_chr2_+_24360778_24360970_24358057_24362239	YIPF3_chr6_-_43480806_43480836_43480612_43481096
TSC22D2_chr3_+_150155984_150156141_150129095_150174862	VPS13A_chr9_+_79898270_79898387_79897190_79898462	STEAP3_chr2_+_119988195_119988610_119981464_120003064

AS Events	AS Events	AS Events
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REPIN1_chr7_+_150067848_150067973_150066957_15006 8316	KIF27_chr9_-_86474070_86474286_86468750_86482598	IFT172_chr2_-_27668611_27668710_27668316_27668795
REPIN1_chr7_+_150067848_150067973_150066030_15006 8319	MAX_chr14_-_65568263_65568290_65560533_65569021	THAP9-AS1_chr4_-_83819141_83819215_83816927_83821229
REPIN1_chr7_+_150067848_150067973_150066030_15006 8316	WASH3P_chr15_+_102506155_102506426_102501844_10 2512798	BRF1_chr14_-_105707601_105707751_105695250_105718843
REPIN1_chr7_+_150067802_150067973_150066957_15006 8316	MYEF2_chr15_-_48444430_48444481_48444139_48445988	HNRNPH1_chr5_-_179061065_179061158_179050165_179061449
TMEM185A_chrX_-_148685652_148685736_148682143_148713225	MIB2_chr1_+_1562029_1562134_1561033_1562216	WEE2-AS1_chr7_-_141437182_141437367_141427945_141437997
EZH2_chr7_-_148529725_148529842_148526940_148543561	MYO18A_chr17_-_27412621_27412666_27409456_27413455	LINC01607_chr8_+_80712795_80712925_80696001_8071 4721
SHPRH_chr6_-_146272926_146273059_146271618_146273484	LSP1_chr11_+_1902661_1902826_1901454_1904648	ST7_chr7_+_116738666_116738869_116655068_1167398 15
TCERG1_chr5_+_145889629_145889723_145888808_1458 90003	RP1-27K12.2_chr6_-_53434220_53434382_53429687_53481683	HSD3B7_chr16_+_30996973_30997145_30996618_30997 743
DDX39A_chr19_-_14521232_14521417_14521146_14521800	SPIDR_chr8_+_48639761_48639855_48626203_48647868	DNAH2_chr17_+_7708275_7708392_7707784_7708569
DDX39A_chr19_-_14521359_14521417_14521146_14521800	RP4-800G7.2_chr7_+_148987028_148987129_148984867_1489 89301	USMG5_chr10_-_105155502_105155789_105152223_105156165
GK5_chr3_-_141903552_141904635_141901891_141904770	SYNRG_chr17_-_35939227_35939530_35937711_35944755	PIK3IP1_chr22_-_31685300_31685379_31679274_31685484
GNPTG_chr16_+_1407700_1407833_1402307_1411743	AFMID_chr17_+_76201683_76201819_76201599_7620202 6	DGKD_chr2_+_234377068_234377199_234375849_23437 8016
SPOPL_chr2_+_139312008_139312105_139310251_13931 6591	NCK1_chr3_+_136586272_136586367_136581195_136646 825	JMJD8_chr16_-_732957_733087_732874_733166
NDUFAF5_chr20_+_13795063_13795161_13789548_1379 7108	PEAK1_chr15_-_77657504_77657567_77578846_77712347	SPTBN5_chr15_-_42180125_42180283_42179639_42182286
BRD8_chr5_-_137493330_137493583_137492956_137495243	CARM1_chr19_+_11032050_11032119_11031803_110322 90	TBC1D3K_chr17_+_36291898_36291964_36291514_3629 2427
BCLAF1_chr6_-_136590278_136590441_136589477_136590574	GPR107_chr9_+_132872648_132872705_132869818_1328 87193	OCRL_chrX_+_128691837_128691927_128691412_12869 2609
MUM1_chr19_+_1358586_1358699_1358463_1360134	PISD_chr22_-_32021748_32022002_32017871_32034351	ACIN1_chr14_-_23559190_23559310_23551045_23559730
MUM1_chr19_+_1358586_1358692_1358463_1360134	TMPRSS5_chr11_-_113560486_113560639_113558996_113565199	CHKA_chr11_-_67848870_67848924_67842297_67864485
PPP2R2D_chr10_+_133748397_133748510_133748059_13 3753534	FAIM_chr3_+_138329445_138329879_138327779_138340 248	SNHG1_chr11_-_62621023_62621062_62620587_62622359

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IRF1_chr5_-_131821942_131822065_131821408_131822248	CD44_chr11_+_35219667_35219793_35211612_35236398	CENPO_chr2_+_25016720_25016834_25016389_25022543
ARHGAP44_chr17_+_12890417_12890469_12888225_12893348	TCP11L1_chr11_+_33076138_33076271_33065482_33079464	IFT80_chr3_-_160109333_160109431_160095328_160116933
ZNF490_chr19_-_12720683_12720788_12720016_12721377	N6AMT1_chr21_-_30252191_30252275_30250655_30254481	PROX1-AS1_chr1_-_214016825_214016911_214005965_214068005
CHCHD6_chr3_+_126499182_126499273_126452065_126571489	ATM_chr11_+_108095510_108095598_108093913_108098321	SH3D19_chr4_-_152065371_152065440_152065202_152069073
METTL10_chr10_-_126450868_126451127_126449072_126453960	PGAP2_chr11_+_3832479_3832654_3829881_3844842	RFC5_chr12_+_118455494_118455858_118454697_118456876
C5orf63_chr5_-_126392088_126392198_126388361_126394573	CASD1_chr7_+_94164620_94164835_94163114_94166783	MUTYH_chr1_-_45804178_45804328_45800183_45805570
TRMT11_chr6_+_126327987_126328100_126320759_12629537	CTBP2_chr10_-_126811225_126811437_126799662_126848425	ABCB9_chr12_-_123425353_123425542_123424831_123428937
TATDN1_chr8_-_125531058_125531122_125528271_125535177	LINC00339_chr1_+_22353906_22354027_22352132_22356772	UBE3A_chr15_-_25652213_25652409_25650649_25654234
TATDN1_chr8_-_125530982_125531122_125528271_125535177	CHTF8_chr16_-_69154955_69155073_69154552_69155338	ADGRL1_chr19_-_14275432_14275517_14274218_14277827
MRRF_chr9_+_125048317_125048445_125047566_125054027	EFS_chr14_-_23829763_23830042_23829490_23834216	GLYATL1_chr11_+_58714518_58714541_58711139_58715330
PSTK_chr10_+_124746849_124747020_124746478_124749689	LEMD1_chr1_-_205353415_205353492_205350984_205389582	RLIM_chrX_-_73832416_73832478_73815835_73834256
ANAPC5_chr12_-_121756079_121756207_121746494_121756303	ALKBH3_chr11_+_43923065_43923275_43911378_43940587	POLL_chr10_-_103345072_103345235_103344676_103347002
EAF2_chr3_+_121555491_121555641_121554238_121563299	SEC24D_chr4_-_119679566_119679782_119679000_119681545	WASF1_chr6_-_110481837_110481935_110448832_110500641
TIAL1_chr10_-_121339982_121340358_121339522_121341433	ARID1B_chr6_+_157471858_157471987_157470085_157488173	SLC2A8_chr9_+_130167096_130167270_130159565_130169390
LAMP2_chrX_-_119572930_119573148_119565317_119575584	C19orf57_chr19_-_13994120_13994213_13993765_13996773	LRMP_chr12_+_25214525_25214587_25205890_252166513
TMEM39A_chr3_-_119176864_119177031_119171377_119180808	DUSP22_chr6_+_335113_335163_311962_345853	MYO15A_chr17_+_18062919_18062993_18062661_18063248
TAMM41_chr3_-_11874476_11874625_11871338_11880695	TXNL1_chr18_-_54314679_54314766_54305736_54318247	RBCK1_chr20_+_401514_401675_400375_402770
REV3L_chr6_-_111793215_111793343_111737675_111803952	PPP3CB-AS1_chr10_+_75258490_75258625_75256664_75259352	ZNF17_chr19_+_57929279_57929406_57925004_579310002
RBM15_chr1_+_110888160_110888271_110884890_110888929	ADAMTS13_chr9_+_136301948_136302075_136298824_136302868	KIAA1191_chr5_-_175786813_175786921_175775359_175788604

AS Events	AS Events	AS Events
DDO_chr6_-_110725976_110726153_110714545_110729536	NAXD_chr13_+_111279785_111279894_111276626_111286891	PCCA_chr13_+_101167680_101167821_101101559_101179928
C12orf76_chr12_-_110482224_110482338_110480264_110486167	CEP350_chr1_+_180021358_180021451_180017840_180022104	SLC44A3_chr1_+_95357836_95358073_95356823_95360373
MAGOHB_chr12_-_10761696_10761982_10760535_10762429	GPBP1L1_chr1_-_46151247_46151292_46126897_46152664	PHKB_chr16_+_47497809_47497904_47495337_475313309
TCP11L2_chr12_+_106706070_106706212_106705010_106708135	MAPKAPK5_chr12_+_112306556_112306665_112305473_112308074	GCNT2_chr6_+_10527706_10527893_10521827_106215823
ATXN7L1_chr7_-_105289853_105290007_105283568_105305512	SDR39U1_chr14_-_24910879_24911001_24910132_24911551	SUCO_chr1_+_172554997_172555088_172548407_172557899
NT5C2_chr10_-_104871501_104871562_104866463_104899162	GUCD1_chr22_-_24950916_24951104_24944969_24951582	SMUG1_chr12_-_54582298_54582380_54581689_54582734
KLC1_chr14_+_104151322_104151373_104145855_104153417	BTBD2_chr19_-_2028706_2028833_2017299_2034749	PGAP2_chr11_+_3832479_3832654_3829881_3845112
KLC1_chr14_+_104151322_104151373_104145882_104153417	MAD2L2_chr1_-_11741095_11741495_11740670_11751469	TCF12_chr15_+_57544618_57544690_57543621_575454559
APOPT1_chr14_+_104029551_104029716_104029461_104037959	PRPF3_chr1_+_150300015_150300111_150298339_150300778	GUF1_chr4_+_44690023_44690163_44688730_44691302
SRRT_chr7_+_100480385_100480711_100479862_100481690	FLCN_chr17_-_17124850_17124942_17122523_17129489	MAMDC4_chr9_+_139752637_139752728_139752549_139752851
SRRT_chr7_+_100478316_100478390_100473333_100478905	PODNL1_chr19_-_14046792_14046857_14044806_14047179	TDP1_chr14_+_90422921_90423144_90422314_90429451
RP4-714D9.5_chr1_+_100464816_100464971_100459297_100472589	FGGY_chr1_+_59811918_59812070_59787422_59844420	TOM1L1_chr17_+_52982849_52982928_52978284_52990026
DLG3_chrX_+_69675636_69675952_69675113_69698999	QSER1_chr11_+_32948702_32948815_32914880_329532888	NCOR1_chr17_-_15990485_15990659_15989756_15995176
NMU_chr4_-_56482504_56482552_56475346_56496568	MAPK8_chr10_+_49533939_49534008_49514864_496096544	UBE3A_chr15_-_25652213_25652284_25650649_25654234
MOB4_chr2_+_198388347_198388410_198380870_198400253	ARMCX5-GPRASP2_chrX_+_101856391_101856437_101854775_101860409	MEGF8_chr19_+_42862938_42863106_42862459_42863249
DHX33_chr17_-_5354126_5354254_5353726_5356899	TKFC_chr11_+_61103311_61103409_61102203_61105412	PPP1R7_chr2_+_242092897_242093019_242089962_24209721
TPX2_chr20_+_30330343_30330450_30327424_30345209	NEK11_chr3_+_130746773_130746846_130745850_130748456	PACRGL_chr4_+_20709425_20709493_20706437_20715054
ATG5_chr6_-_106756238_106756366_106740981_106763975	RCC1_chr1_+_28857034_28857085_28856451_28858314	KPNA5_chr6_+_117013217_117013319_117010616_117013455
GALNS_chr16_-_88909113_88909237_88908379_88923165	CHTF18_chr16_+_841850_841948_841370_842223	MCPH1-AS1_chr8_-_6527509_6527761_6492940_6565661

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AC005083.1_chr7_+_20257410_20257481_20257245_2025 7878	PROM1_chr4_-_15981503_15981527_15972705_15982044	PFAS_chr17_+_8168605_8168786_8168443_8168873
TTLL3_chr3_+_9876110_9876187_9874929_9876364	CCDC112_chr5_-_114605399_114605495_114604697_114606909	AC005154.6_chr7_-_30591715_30591795_30590397_30603346
ACSL4_chrX_-_108939372_108939425_108926601_108976367	TMEM161B_chr5_-_87493485_87493582_87492305_87494792	CANT1_chr17_-_76994229_76994368_76994045_77001453
HPS1_chr10_-_100190887_100191048_100190427_100193696	METTL4_chr18_-_2544193_2544285_2539144_2547353	BICDL1_chr12_+_120510314_120510533_120509605_120 518690
KIF1A_chr2_-_241696735_241697011_241689964_241697776	SENP1_chr12_-_48482945_48483076_48482743_48491776	ANKRD36_chr2_+_97830133_97830206_97830048_9783 3313
SKA1_chr18_+_47911585_47911723_47908596_47917493	CRTC1_chr19_+_18882251_18882356_18879603_1888570 9	NFRKB_chr11_-_129763191_129763280_129762765_129764253
CTSC_chr11_-_88061279_88061364_88059611_88068104	COQ4_chr9_+_131087421_131087518_131085426_131088 057	SNX5_chr20_-_17949017_17949100_17937681_17949342
PISD_chr22_-_32019669_32019835_32017871_32034351	SIGIRR_chr11_-_409867_410027_408206_417293	EBP_chrX_+_48380580_48380640_48380295_48382086
CTNND1_chr11_+_57561481_57561553_57529518_57563 048	EFCAB6_chr22_-_44030981_44031096_44028118_44062983	ARMC6_chr19_+_19144939_19145047_19144739_191535 19
ABHD5_chr3_+_43759257_43759349_43756550_43759934	YAF2_chr12_-_42604349_42604421_42555567_42631400	CEACAM19_chr19_+_45182124_45182208_45179693_45 185838
RBM27_chr5_+_145631273_145631438_145616995_14563 4505	STAMBP_chr2_+_74056531_74056637_74056123_740579 71	LPGAT1_chr1_-_212003524_212003672_212002661_212003914
ANKMY1_chr2_-_241465645_241465862_241465266_241468453	CCDC18-AS1_chr1_-_93790191_93790286_93771027_93802933	SYDE2_chr1_-_85643828_85643955_85634908_85647780
TMEM39B_chr1_+_32542764_32542919_32541423_32557 275	CAMTA2_chr17_-_4885383_4885522_4885126_4886051	PLOD2_chr3_-_145795648_145795711_145794682_145796902
LSM14B_chr20_+_60702640_60702757_60701495_607052 74	SNX22_chr15_+_64444441_64444525_64444049_6444483 6	SLTM_chr15_-_59191667_59192136_59191051_59193458
RP11-321G12.1_chr15_+_63723403_63723541_63690666_63724 350	R3HDM2_chr12_-_57686354_57686450_57682823_57689181	ARHGEF38_chr4_+_106604078_106604203_106603766_1 06616716
KAT6A_chr8_-_41907093_41907225_41906820_41909418	ARHGEF12_chr11_+_120300420_120300540_120300226_ 120302479	GMDS-AS1_chr6_+_2263834_2263918_2249160_2329516
KLK11_chr19_-_51528847_51528922_51526484_51529793	CSPP1_chr8_+_68062017_68062170_68049838_68066258	ADGRD1_chr12_+_131484927_131484987_131476937_1 31488730
DICER1_chr14_-_95600697_95600840_95599840_95623566	RIMKLB_chr12_+_8932630_8932708_8930398_8933170	ZNF410_chr14_+_74388768_74388909_74387808_743900 97
CCDC191_chr3_-_113737524_113737715_113729868_113750472	BTBD3_chr20_+_11899733_11899824_11899249_1190036 5	CRACR2A_chr12_-_3842107_3842376_3822483_3862180
ATG4D_chr19_+_10657514_10657747_10655806_1065786 4	SLC35B1_chr17_-_47784326_47784430_47783671_47785091	BLOC1S6_chr15_+_45884332_45884474_45879723_4589 0077

AS Events	AS Events	AS Events
L3MBTL3_chr6_+_130370900_130370975_130370538_130372393	ALOX12B_chr17_-_7979492_7979662_7976636_7979974	ARHGAP23_chr17_+_36633819_36633946_36628247_36634068
ZNF611_chr19_-_53217267_53217394_53210795_53219084	ACACA_chr17_-_35567380_35567404_35564714_35578644	ATXN7L1_chr7_-_105279933_105280016_105279056_105283284
RFXANK_chr19_+_19307994_19308060_19307855_19308329	MAPKBP1_chr15_+_42109811_42109933_42109656_42110206	ERP29_chr12_+_112457559_112457698_112451413_112459953
PPP2R2A_chr8_+_26197418_26197489_26196503_26211983	ABI1_chr10_-_27044583_27044670_27040712_27047990	DDX5_chr17_-_62497174_62497261_62496891_62497378
KAT6A_chr8_-_41907137_41907225_41906820_41909418	PLD3_chr19_+_40871624_40871837_40854675_40872325	ITGB1BP1_chr2_-_9547577_9547727_9547034_9548241
AP000275.65_chr21_-_33974581_33974677_33954725_33975470	MPDZ_chr9_-_13143464_13143563_13140148_13147546	TCIRG1_chr11_+_67812513_67812569_67811811_67814899
RP11-96H17.1_chr16_-_63094197_63094314_63092558_63124165	UBA6_chr4_-_68562362_68562425_68547931_68566766	NRSN2_chr20_+_330281_330476_330007_333853
IFT80_chr3_-_160109333_160109431_160102434_160116933	KTN1_chr14_+_56130672_56130759_56128330_56133958	ALCAM_chr3_+_105270987_105271026_105269103_105271311
SENP1_chr12_-_48482945_48483076_48482743_48490125	PIP4K2C_chr12_+_57993182_57993221_57992994_57994106	LRBA_chr4_-_151842349_151842445_151837890_151849667
TBC1D32_chr6_-_121576473_121576556_121563485_121600266	EPN2_chr17_+_19183170_19183293_19152839_19185267	TNKS_chr8_+_9590788_9590954_9584230_9592374
IL17RB_chr3_+_53889320_53889368_53886153_53890870	ASCC1_chr10_-_73975539_73975867_73973089_73975964	LINC01748_chr1_-_61009148_61009193_61008083_61053708
SLC38A9_chr5_-_54945034_54945142_54941723_54948356	DSTYK_chr1_-_205117332_205117467_205116873_205119807	MINDY1_chr1_-_150974640_150974876_150974258_150978787
SYNE2_chr14_+_64682003_64682072_64681188_64682965	CTU2_chr16_+_88776630_88776690_88773006_88778042	BHLHB9_chrX_+_102002744_102002839_101975955_102003626
KIF9_chr3_-_47323629_47323875_47318869_47323984	MTHFSD_chr16_-_86585638_86585752_86582183_86588250	RGP1_chr9_+_35751952_35752142_35751751_35752647
ANKRD20A8P_chr2_-_95504557_95504588_95501874_95511124	EZH2_chr7_-_148533913_148534092_148526940_148543561	ERCC1_chr19_-_45917220_45917292_45917003_45918118
DYRK3_chr1_+_206810994_206811106_206809125_206820732	P4HA2_chr5_-_131562389_131562914_131554337_131563482	SIGIRR_chr11_-_408694_408893_408206_417293
PAPLN_chr14_+_73735264_73735431_73732215_73739202	FOXM1_chr12_-_2974520_2974565_2973921_2975558	C16orf95_chr16_-_87343902_87343939_87339511_87348576
FAT3_chr11_+_92622354_92622414_92620279_92623656	ITPA_chr20_+_3193814_3193872_3190263_3194630	ZNF185_chrX_+_152090716_152090800_152089292_152097118
PCGF3_chr4_+_726188_726287_724899_727460	CEP44_chr4_+_175219116_175219213_175205291_175220222	MICAL1_chr6_-_109769077_109769166_109768925_109769405
SLC25A48_chr5_+_135209709_135209843_135207407_135215656	SMAD2_chr18_-_45456731_45456817_45423180_45457170	KLHL8_chr4_-_88106402_88106723_88104541_88116475

AS Events	AS Events	AS Events
PAX8-AS1_chr2_+_114012966_114013126_113995789_114020854	YARS_chr1_-_33263192_33263239_33252676_33263363	RHBG_chr1_+_156351596_156351734_156351304_156351858
PHF8_chrX_-_54020033_54020336_54019272_54022125	SLC29A2_chr11_-_66136530_66136602_66136142_66136839	HECTD1_chr14_-_31583082_31583265_31582690_31583491
ADGRL1_chr19_-_14271404_14271508_14271109_14272123	PALB2_chr16_-_23649779_23649913_23649450_23652430	ARHGAP27_chr17_-_43509581_43509715_43509118_43510117
ARMC10_chr7_+_102732923_102733100_102727211_102737723	EYA3_chr1_-_28354299_28354437_28343750_28362054	OTUD7B_chr1_-_149949360_149949511_149943179_149982396
STARD3NL_chr7_+_38256625_38256679_38254706_38256788	ASIC1_chr12_+_50470750_50470843_50453737_50470995	USMG5_chr10_-_105153955_105154151_105152223_105155502
LINC01572_chr16_-_72604333_72604414_72589225_72661433	CHD3_chr17_+_7813745_7813909_7812656_7814164	PTPN6_chr12_+_7060771_7060894_7055902_7061145
CEACAM19_chr19_+_45174575_45174708_45165665_45175017	PRPSAP2_chr17_+_18768781_18768877_18761574_18769114	CFAP69_chr7_+_89933282_89933420_89929373_89934057
SLC29A1_chr6_+_44193797_44193904_44191378_44194999	TROVE2_chr1_+_193038163_193038764_193028906_19304494 9	HEATR5A_chr14_-_31814292_31814482_31813271_31816953
RPL17_chr18_-_47018105_47018203_47017954_47018644	USP39_chr2_+_85872936_85873022_85872206_85875883	CANT1_chr17_-_76994229_76994368_76994045_77005745
TBL1XR1_chr3_-_176797614_176797733_176782810_176914908	SPIN1_chr9_+_91077410_91077664_91063904_91083286	LSM14B_chr20_+_60704840_60705008_60701495_60705274
ATXN7L1_chr7_-_105516257_105516326_105429154_105516823	GCNT1_chr9_+_79074975_79075093_79074221_79115831	SNHG17_chr20_-_37056322_37056409_37055146_37059683
IRF1_chr5_-_131825083_131825175_131822822_131826236	ZNF417_chr19_-_58426705_58426899_58423557_58427746	TMEM87B_chr2_+_112838911_112839095_112838695_112843581
ATP5SL_chr19_-_41939176_41939339_41938313_41939441	MCRS1_chr12_-_49961429_49961532_49959998_49961830	NQO2_chr6_+_3004728_3004885_3000319_3006701
NAA16_chr13_+_41936866_41937009_41936295_41941574	LRMP_chr12_+_25219298_25219446_25216750_25222283	CRYZ_chr1_-_75172786_75172888_75172678_75175781
MRI1_chr19_+_13876767_13876943_13875923_13879172	DNAJC2_chr7_-_102967778_102967825_102967131_102968102	SGSM3_chr22_+_40797596_40797679_40796817_40798142
GUSBP11_chr22_-_24042912_24043032_24026054_24047615	GAS5_chr1_-_173835898_173835934_173835344_173836128	GUCD1_chr22_-_24939809_24940051_24939068_24942881
DIS3L2_chr2_+_233063236_233063486_233028342_233075035	GORASP1_chr3_-_39144183_39144372_39142593_39148969	CCDC77_chr12_+_514676_514730_498652_520912
DNAH1_chr3_+_52409970_52410009_52409429_52412617	SYNE4_chr19_-_36498026_36498170_36497573_36499455	PGAP2_chr11_+_3844842_3844970_3832654_3845112
ENAH_chr1_-_225704897_225705692_225702602_225706899	KIAA0895_chr7_-_36396510_36397199_36375906_36406719	CRYZL1_chr21_-_34969585_34969707_34968142_34971455
NUTM2B-AS1_chr10_-_81568514_81568588_81565878_81574368	FAM204A_chr10_-_120101238_120101439_120095935_120101781	HSCB_chr22_+_29139869_29139911_29138319_29147228

AS Events	AS Events	AS Events
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EZH2_chr7_-_148533913_148534092_148529842_148543561	UBXN2B_chr8_+_59325857_59325930_59324028_59329408	MAMDC4_chr9_+_139751616_139751750_139751493_139751818
KIN_chr10_-_7822226_7822270_7822141_7829782	SLC50A1_chr1_+_155109303_155109427_155108852_155110454	ZNF81_chrX_+_47702048_47702167_47696406_47705503
KYAT1_chr9_-_131609711_131609922_131607690_131644175	SYNE4_chr19_-_36498026_36498170_36496339_36499455	ANKRD36C_chr2_-_96604576_96604649_96601392_96604734
RAD1_chr5_-_34915520_34915731_34915066_34918156	HOTAIRM1_chr7_+_27138692_27138985_27136007_27139397	SLCO4A1-AS1_chr20_-_61297211_61297362_61294839_61297736
TPGS2_chr18_-_34385336_34385360_34380274_34387809	ZDHHC16_chr10_+_99213555_99213603_99213420_99214470	ECHDC1_chr6_-_127637594_127637647_127636041_127648146
SLC44A3-AS1_chr1_-_95144980_95145163_95104114_95197813	NBEAL2_chr3_+_47033964_47034045_47033436_47035426	UBL7_chr15_-_74740818_74740899_74738568_74741526
ACSF3_chr16_+_89178499_89178654_89160404_89187208	MKI67_chr10_-_129913191_129914271_129911866_129914754	SELENON_chr1_+_26128506_26128608_26127651_26131632
SSBP3_chr1_-_54723741_54723822_54717533_54747110	SLC37A4_chr11_-_118900941_118901445_118900274_118901558	ZFAND6_chr15_+_80390757_80390920_80352151_80412669
SHC1_chr1_-_154945768_154945984_154942675_154946723	AMMECR1L_chr2_-_128628387_128628502_128624570_128631401	LACE1_chr6_+_108831414_108831555_108798495_108840899
NSUN5P1_chr7_+_75040937_75041042_75040009_75042066	N4BP2L2_chr13_-_33052364_33052412_33052185_33054726	MRPS28_chr8_-_80940929_80941031_80915415_80941995
EXD2_chr14_+_69670633_69670717_69658308_69695532	AKIP1_chr11_+_8938833_8938914_8936477_8940883	YPEL5_chr2_+_30371110_30371407_30369928_30379493
RP11-286N22.8_chr11_+_61205475_61205585_61197654_61213412	SIRT2_chr19_-_39389018_39389065_39384611_39390145	PROM1_chr4_-_15981017_15981086_15972705_15982044
PACSIN2_chr22_-_43272893_43273016_43272339_43275053	SDR39U1_chr14_-_24911383_24911466_24910132_24911551	KDM4A_chr1_+_44119333_44119470_44118984_44121261
TSPAN15_chr10_+_71243446_71243632_71211446_71255349	TYW3_chr1_+_75204373_75204472_75202306_75214434	CROT_chr7_+_87022263_87022383_87022139_87027839
GGA1_chr22_+_38009125_38009198_38005161_38010196	ZNF480_chr19_+_52817405_52817532_52803737_52819086	NAB1_chr2_+_191520702_191520879_191514086_191523883
MYEOV_chr11_+_69181806_69181880_69181634_69182062	PMPCB_chr7_+_102948042_102948155_102944937_102949398	BAIAP2L2_chr22_-_38485528_38485681_38483271_38493038
PEX5_chr12_+_7342617_7342812_7342346_7342957	DPP9_chr19_-_4683201_4683336_4682850_4683488	CTTN_chr11_+_70267575_70267686_70266616_70269045
PRRC2A_chr6_+_31590466_31590678_31588635_31592037	NUMA1_chr11_-_71723446_71723488_71721900_71723940	ANAPC1_chr2_-_112631189_112631241_112630985_112636386
KCTD9_chr8_-_25301807_25301851_25298189_25315714	LSAMP_chr3_-_115553408_115553444_115535493_115560691	IRF7_chr11_-_614173_614399_613865_614475

AS Events	AS Events	AS Events
ZNF195_chr11_-_3382972_3383119_3381795_3383775	VWDE_chr7_-_12406982_12407119_12401147_12409170	CDC42BPB_chr14_-_103420534_103420612_103418940_103420938
BLOC1S1_chr12_+_56110716_56110789_56110501_56112874	WDR45_chrX_-_48935301_48935406_48934412_48935495	TET2_chr4_+_106155053_106158508_106068136_106180775
EXD3_chr9_-_140246517_140246653_140245980_140247071	BCL3_chr19_+_45261502_45261730_45260980_45261980	LRRFIP2_chr3_-_37163125_37163182_37163027_37170553
TBX3_chr12_-_115117717_115117777_115117456_115118683	ARHGEF7_chr13_+_111862218_111862349_111857720_111870025	WNK1_chr12_+_980430_980514_971436_987377
TIA1_chr2_-_70456190_70456223_70454954_70456395	C19orf60_chr19_+_18700288_18700493_18699887_18701663	IL17RB_chr3_+_53889320_53889368_53887024_53890870
CHEK2_chr22_-_29133872_29134026_29130715_29137756	PREPL_chr2_-_44586635_44586889_44573529_44588662	TFAM_chr10_+_60150524_60150620_60148579_60154117
ZNF213-AS1_chr16_-_3182850_3182943_3182104_3184634	ATRX_chrX_-_76851181_76851255_76849319_76854879	ARL4A_chr7_+_12727259_12727353_12726668_12727790
IST1_chr16_+_71957190_71957283_71956583_71958671	SF1_chr11_-_64533422_64533627_64532990_64534371	ARL4A_chr7_+_12727259_12727353_12726668_12727793
ST18_chr8_-_53134199_53134353_53126817_53142591	KIAA1456_chr8_+_12848342_12848509_12809867_12863710	DQX1_chr2_-_74752135_74752329_74751434_74752619
BCORL1_chrX_+_129158964_129159354_129156952_129162609	RHOC_chr1_-_113247721_113247745_113246428_113249699	FNIP1_chr5_-_131046270_131046354_131044965_131052257
BIN1_chr2_-_127808729_127808819_127808488_127816586	PGAP3_chr17_-_37829766_37829903_37829119_37830245	NDRG2_chr14_-_21492188_21492255_21491480_21493835
GUSBP11_chr22_-_24032422_24032543_24026054_24036305	SHC1_chr1_-_154940679_154940733_154940507_154940970	RP1-234P15.4_chr6_+_75999969_76000054_75995025_76000664
HBP1_chr7_+_106814892_106815190_106810575_106820323	ZNF207_chr17_+_30693683_30693776_30692506_30694790	EZH2_chr7_-_148533913_148534092_148529842_148581255
DENND1A_chr9_-_126531792_126531842_126520101_126554865	LRP8_chr1_-_53742363_53742750_53741425_53755238	STAP2_chr19_-_4324451_4324661_4324194_4325212
HIVEP1_chr6_+_12136023_12136125_12126103_12161671	DNAI1_chr9_+_34489997_34490122_34489447_34490366	RBMXL1_chr1_-_89453934_89454034_89449749_89458267
C16orf59_chr16_+_2510283_2510382_2510171_2510623	PTPN4_chr2_+_120639361_120639406_120635118_120639672	TRPV1_chr17_-_3491511_3491661_3489220_3493100
TPD52L1_chr6_+_125578243_125578304_125569529_125583979	KCTD17_chr22_+_37456862_37456962_37455478_37458564	ALDOA_chr16_+_30077196_30077248_30075826_30078554
HNRNPH1_chr5_-_179046269_179046408_179045324_179047892	ATG4B_chr2_+_242594685_242594758_242594062_242606059	TMUB2_chr17_+_42264984_42265111_42264477_42266389
FRMD8_chr11_+_65156831_65156999_65154592_65161511	ZNF195_chr11_-_3394806_3394905_3392933_3400267	BCS1L_chr2_+_219524759_219524968_219524466_219525661
TCIRG1_chr11_+_67817953_67818131_67817721_67818207	METTL26_chr16_-_685611_685774_685340_686093	PEX2_chr8_-_77898422_77898532_77896431_77912225

AS Events	AS Events	AS Events
BDH1_chr3_-_197281432_197281584_197260432_197282651	PSAP_chr10_-_73583644_73583653_73581764_73585593	YIF1A_chr11_-_66052851_66053007_66052437_66053171
ITPA_chr20_+_3193964_3194029_3190263_3194630	SNRPA1_chr15_-_101833229_101833377_101827907_101835301	FAM49B_chr8_-_130916744_130916831_130915596_130951853
HNRNPH3_chr10_+_70097614_70097753_70097090_70098259	OXR1_chr8_+_107715133_107715318_107705105_107718609	SLAIN2_chr4_+_48396592_48396670_48385801_48422141
RPS6KL1_chr14_-_75385215_75385308_75378544_75386547	CASD1_chr7_+_94147514_94147635_94146968_94156473	PUF60_chr8_-_144906482_144906566_144904083_144911449
LINC01572_chr16_-_72651081_72651133_72604414_72698790	MYH10_chr17_-_8479960_8479990_8473130_8480553	ABHD14A_chr3_+_52014408_52014644_52012390_52014851
CRTC1_chr19_+_18885709_18885796_18879603_18886450	SDR39U1_chr14_-_24910879_24911001_24910132_24911303	PRRC2C_chr1_+_171556786_171556890_171556360_171557517
PPP1CB_chr2_+_29011523_29011675_29006844_29022064	GS1-124K5.12_chr7_-_66043515_66043714_66038537_66053498	TFAP2E_chr1_+_36039527_36040010_36039205_36040549
NME6_chr3_-_48342016_48342124_48340013_48342768	HPS1_chr10_-_100195028_100195171_100193848_100195391	CCDC92_chr12_-_124440830_124440991_124428911_124457075
HM13_chr20_+_30155880_30156027_30149539_30156922	CNTRL_chr9_+_123898083_123898260_123886362_123900822	C1orf52_chr1_-_85724617_85724744_85724405_85725040
TTC39C_chr18_+_21703797_21703907_21698196_21708849	NFE2L1_chr17_+_46134393_46134483_46133960_46134705	WNK2_chr9_+_96069058_96069103_96060349_96070609
ABCA7_chr19_+_1054568_1054693_1054340_1054778	C19orf60_chr19_+_18700222_18700493_18699887_18701663	DCAF8_chr1_-_160231074_160231148_160213824_160232238
SYNE2_chr14_+_64473760_64473940_64470048_64476683	SORBS2_chr4_-_186560030_186560189_186551752_186567821	BPTF_chr17_+_65925074_65925236_65924717_65925451
MFF_chr2_+_228217229_228217289_228212100_228220392	FANCL_chr2_-_58421363_58421408_58393009_58425728	HHAT_chr1_+_210522276_210522410_210502448_210536195
SH3BP2_chr4_+_2811505_2811556_2794865_2822340	SEC22C_chr3_-_42605256_42605472_42605178_42610356	RALY_chr20_+_32661624_32661672_32661441_32663679
NAXD_chr13_+_111277536_111277625_111276626_111286891	FER1L5_chr2_+_97313514_97313623_97312190_97315359	NDUFAF7_chr2_+_37469777_37469836_37468780_37471005
NSMF_chr9_-_140349690_140349759_140348895_140350862	ZNF211_chr19_+_58145390_58145429_58144804_58145996	ACBD4_chr17_+_43214385_43214506_43214143_43214734
CTD-2228K2.7_chr5_+_477358_477451_476678_477920	LAS1L_chrX_-_64753489_64753615_64752510_64754359	SOX13_chr1_+_204082042_204082262_204042839_204083448
KLHL8_chr4_-_88116475_88116842_88104541_88141569	MLLT10_chr10_+_21971153_21971186_21970305_22002700	INPP5K_chr17_-_1419181_1419412_1418879_1419749
NLGN2_chr17_+_7311330_7312031_7308929_7315475	HNRNPA2B1_chr7_-_26237450_26237486_26237352_26240191	NUMA1_chr11_-_71760464_71760585_71747021_71780887
HSD3B7_chr16_+_30996845_30997145_30996618_30997369	P4HA2_chr5_-_131562624_131562914_131554337_131563482	YTHDC2_chr5_+_112860677_112860874_112851059_112868575

AS Events	AS Events	AS Events
C20orf96_chr20_-_270199_270317_264722_270899	SNHG15_chr7_-_45025619_45025696_45023645_45026123	PAFAH2_chr1_-_26323938_26324112_26317354_26324515
PPP1R35_chr7_-_100033253_100033390_100033156_100033470	RALGPS1_chr9_+_129975246_129975328_129974998_129977029	PIF1_chr15_-_65113565_65113719_65113480_65114464
FAXDC2_chr5_-_154218122_154218499_154217738_154230042	CLSPN_chr1_-_36212366_36212593_36211163_36213507	SLC43A1_chr11_-_57265225_57265318_57263637_57268251
AC159540.1_chr2_-_98089381_98089511_98088865_98091456	IL17RB_chr3_+_53889320_53889368_53883822_53890870	MTMR3_chr22_+_30366964_30367051_30353077_30384468
ZNF326_chr1_+_90472903_90473309_90470803_90475646	LDLRAD4_chr18_+_13484035_13484118_13465110_13621115	CPTP_chr1_+_1262215_1262412_1260482_1262620
GRIK2_chr6_+_102372475_102372594_102337738_102376289	RP11-252A24.2_chr16_-_74383639_74383757_74382913_74384514	EPSTI1_chr13_-_43493435_43493468_43491760_43500471
SMARCA4_chr19_+_11144442_11144541_11144193_11144798	ITM2C_chr2_+_231738131_231738272_231729860_231740334	LINC00174_chr7_-_65920645_65920840_65915223_65943995
MIB2_chr1_+_1560344_1560565_1560281_1560665	TXNRD3_chr3_-_126334197_126334305_126329975_126340584	CCDC88A_chr2_-_55530204_55530288_55529208_55535944
NACA_chr12_-_57113509_57115243_57113380_57118235	NAF1_chr4_-_164054305_164054408_164050500_164058350	STIM2_chr4_+_27023115_27023234_27019606_27024140
UGGT1_chr2_+_128913965_128913989_128913161_128914825	ZNF337-AS1_chr20_+_25612793_25612924_25604771_25614684	C1orf228_chr1_+_45154780_45154896_45140545_45155347
RP11-252A24.2_chr16_-_74384514_74384636_74382913_74385937	IL17RB_chr3_+_53886025_53886153_53882715_53889320	AC005154.6_chr7_-_30601081_30601744_30591795_30608448
SYN3_chr22_-_32934021_32934096_32929881_32937556	FAM234A_chr16_+_298242_298396_284856_299547	RHOC_chr1_-_113247721_113248874_113246428_113249699
TSPAN14_chr10_+_82228302_82228443_82214127_82248972	STAP2_chr19_-_4328671_4328806_4327382_4329957	SH2D6_chr2_+_85662535_85662619_85662246_85663959
EPB41L2_chr6_-_131199243_131199390_131191266_131206235	POLR2J3_chr7_-_102183971_102184149_102182109_102185152	DNAH10_chr12_+_124284762_124284935_124283918_124288207
ARHGAP18_chr6_-_129905132_129905257_129901276_129920360	SLCO4A1_chr20_+_61299509_61299536_61299262_61299828	HACE1_chr6_-_105291097_105291173_105244900_105297016
WASHC5_chr8_-_126095954_126096264_126095500_126103856	ERCC2_chr19_-_45872327_45872405_45872250_45873390	MDC1_chr6_-_30675342_30676134_30675231_30679188
ANKRD35_chr1_+_145560074_145560259_145558941_145560888	AAMDC_chr11_+_77552064_77552106_77532287_77553524	TSR1_chr17_-_2239330_2239434_2239024_2239624
SSPO_chr7_+_149519600_149519768_149519286_149520440	MFSD14C_chr9_-_99696076_99696197_99681108_99711836	AIM1L_chr1_-_26657979_26658109_26655364_26662585
TBL1XR1_chr3_-_176816253_176816329_176782810_176849150	MON2_chr12_+_62959793_62959811_62959160_62960101	SDR39U1_chr14_-_24911314_24911466_24910132_24911551
SLC2A4RG_chr20_+_62373221_62373409_62372832_62373482	YPEL5_chr2_+_30371110_30371407_30370957_30379493	PTBP1_chr19_+_805491_805569_805187_806407

AS Events	AS Events	AS Events
CHD3_chr17_+_7813756_7813909_7812656_7814164	TMEM63B_chr6_+_44114583_44114664_44108835_44115113	RPL32P3_chr3_-_129115059_129115263_129112638_129115882
ESRRA_chr11_+_64082215_64082383_64081839_64083178	EEF1D_chr8_-_144672777_144672899_144672251_144679517	AKR1A1_chr1_+_46018107_46018235_46016827_46027460
SHARPIN_chr8_-_145153983_145154108_145153897_145154179	TCHP_chr12_+_110346390_110346503_110345504_110346675	PKP4_chr2_+_159535092_159535166_159530512_159536940
RP11-295P9.13_chr10_+_13655740_13655881_13653683_13656014	PPP6R3_chr11_+_68334466_68334634_68331900_68337215	CYLD_chr16_+_50778640_50778777_50776752_50783486
HTR3E_chr3_+_183819272_183819317_183818439_183823552	MINDY3_chr10_-_15863654_15863725_15838171_15902204	FAT3_chr11_+_92623021_92623057_92620279_92623656
FRMD8_chr11_+_65161043_65161145_65154592_65161511	PTP4A2_chr1_-_32381495_32381588_32377427_32384570	WAPL_chr10_-_88232368_88232521_88232101_88233634
ADAMTS6_chr5_-_64592934_64593071_64587297_64595811	TTLL3_chr3_+_9857757_9857886_9855029_9867483	RP11-235E17.2_chr17_-_3491481_3491661_3489220_3493100
DIAPH1_chr5_-_140967790_140967817_140966764_140998364	SPATA4_chr4_-_177114108_177114227_177113998_177114603	NSUN5P1_chr7_+_75042066_75042210_75039743_75044162
FGGY_chr1_+_59811918_59812070_59762822_59844420	SLAMF7_chr1_+_160720093_160720213_160719883_160721134	FUS_chr16_+_31200440_31200547_31199678_31201360
C1orf168_chr1_-_57233501_57233611_57221600_57252847	EBPL_chr13_-_50243912_50243982_50237331_50265389	DYRK2_chr12_+_68043576_68043725_68042962_68050885
C3orf67_chr3_-_59025282_59025355_58923488_59031954	NEURL1B_chr5_+_172110421_172111141_172068440_172113173	PQLC1_chr18_-_77679183_77679400_77664183_77703328
MGRN1_chr16_+_4730032_4730098_4727573_4731550	MTO1_chr6_+_74190015_74190090_74189849_74190397	C16orf87_chr16_-_46843514_46843697_46836982_46858297
MRPS28_chr8_-_80940929_80941031_80915415_80942288	IMPA1_chr8_-_82597997_82598198_82593819_82598486	MALT1_chr18_+_56378152_56378185_56377304_56381314
CCDC88B_chr11_+_64118631_64118727_64117140_64118947	PPP4R1L_chr20_-_56813266_56813367_56811330_56814296	NBPF10_chr1_+_145295422_145295471_145293580_145296356
DPP8_chr15_-_65746600_65746753_65744440_65748562	SPATS2_chr12_+_49780836_49780920_49761370_49854552	MTFMT_chr15_-_65316009_65316132_65312610_65319168
SPTBN5_chr15_-_42171931_42172062_42171697_42173231	WDR45_chrX_-_48935301_48935406_48934409_48935495	JPX_chrX_+_73219189_73220331_73218679_73224104
FER1L5_chr2_+_97312800_97312892_97312190_97313514	SH2D6_chr2_+_85661595_85661620_85661493_85662187	MRPL33_chr2_+_27997290_27997397_27995559_28002299
ZNF783_chr7_+_148985711_148985782_148984867_148987028	CNTNAP1_chr17_+_40840893_40841065_40840629_40841538	PFDN1_chr5_-_139680000_139680167_139661118_139682625
ACSS1_chr20_-_25002024_25002172_24995866_25011394	FAM208B_chr10_+_5777266_5777509_5773166_5781580	AARSD1_chr17_-_41105740_41105795_41103911_41106892
GRAMD1C_chr3_+_113594330_113594434_113588438_113601598	KCNQ1_chr11_+_2606441_2606537_2604775_2608799	PISD_chr22_-_32028168_32028277_32022002_32034351

AS Events	AS Events	AS Events
EIF2D_chr1_-_206772816_206772966_206772446_206773086	BID_chr22_-_18226568_18226779_18222254_18257146	NGLY1_chr3_-_25773809_25773974_25770809_25775362
SSPO_chr7_+_149484949_149485059_149484882_149485408	SLC50A1_chr1_+_155109303_155109427_155108852_155110036	MEF2A_chr15_+_100138634_100138716_100105874_100173182
PSMC5_chr17_+_61905033_61905283_61904874_61905497	ZNF592_chr15_+_85321413_85321543_85308046_85325887	SERPINB8_chr18_+_61645532_61645710_61637421_61647034
LYRM1_chr16_+_20913807_20914039_20912211_20926877	VIPAS39_chr14_-_77923437_77923708_77920445_77923837	SBF2_chr11_-_9849672_9849768_9838571_9850902
ALG1L_chr3_-_125651492_125651552_125650595_125652417	AADACL2_chr3_+_151458433_151458656_151451961_151461880	MKS1_chr17_-_56283825_56283908_56283741_56284445
LSM14B_chr20_+_60705274_60705352_60705008_60705585	HCG18_chr6_-_30262629_30262741_30260376_30263908	CCDC15_chr11_+_124861356_124861479_124858030_124862475
ISOC2_chr19_-_55967002_55967212_55966697_55967715	EEF1D_chr8_-_144674816_144675063_144672251_144679517	GPT2_chr16_+_46919378_46919489_46919243_46931559
NEURL1B_chr5_+_172096787_172097333_172068440_172113173	GOLGA2P5_chr12_-_100552575_100552651_100551855_100552735	DRC3_chr17_+_17877165_17877276_17876288_17880895
ARHGAP22_chr10_-_49687630_49687807_49667934_49763507	KIAA1191_chr5_-_175786464_175786570_175782752_175786813	DRC3_chr17_+_17876978_17877276_17876288_17880895
SAR1B_chr5_-_133967766_133967885_133959727_133968417	CLMN_chr14_-_95659655_95659752_95658065_95660185	GSTT1_chr22_-_24381699_24381787_24379511_24384119
SNHG15_chr7_-_45023955_45024025_45023645_45026123	GUCY1B2_chr13_-_51622355_51622450_51608295_51636956	PICALM_chr11_-_85689112_85689136_85685855_85692171
RAP2C_chrX_-_131352259_131352369_131351834_131353397	CCNDBP1_chr15_+_43482252_43482349_43481478_43482522	RP11-252A24.2_chr16_-_74378676_74378869_74376152_74382764
USP37_chr2_-_219344372_219344438_219341704_219346792	MTMR2_chr11_-_95620775_95620848_95598840_95621319	PER2_chr2_-_239169468_239169594_239168694_239170369
TMEM131_chr2_-_98460607_98460724_98458400_98475766	PLOD2_chr3_-_145795648_145795711_145791139_145796902	PDE4DIP_chr1_-_144955215_144955292_144952689_144994590
POLL_chr10_-_103345618_103345913_103344676_103347002	PUS1_chr12_+_132425836_132426528_132416857_132428083	ING4_chr12_-_6762395_6762562_6762216_6765892
STAU2_chr8_-_74439925_74440039_74334937_74464246	STRBP_chr9_-_125901807_125901966_125898794_125909133	GSN_chr9_+_124062333_124062404_124048463_124064240
MICAL3_chr22_-_18310409_18310547_18305826_18314619	MYO5A_chr15_-_52635313_52635394_52632591_52638557	MOCS1_chr6_-_39876830_39876878_39874893_39877578
TMTC4_chr13_-_101315217_101315434_101294565_101316474	ARIH2_chr3_+_48982568_48982614_48965246_48999044	LINC00571_chr13_-_38636285_38636371_38635590_38663709
SEC22C_chr3_-_42605256_42605372_42605178_42610356	SH2D6_chr2_+_85657486_85657557_85656735_85660693	PLA2G4C_chr19_-_48581027_48581081_48578131_48588315
RHPN1_chr8_+_144461998_144462155_144461678_144462758	DCTD_chr4_-_183837571_183837692_183836728_183838463	PEX26_chr22_+_18561061_18561372_18560813_18562639

AS Events	AS Events	AS Events
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UBE3A_chr15_-_25653718_25653831_25652409_25654234	WIPI2_chr7_+_5232748_5232802_5230124_5239206	PAM_chr5_+_102360834_102361038_102355547_102363888
GALNT14_chr2_-_31337608_31337693_31215873_31348019	XIAP_chrX_+_122994016_122994143_122993755_123019480	PAM_chr5_+_102360834_102361038_102355547_102363885
MTHFSD_chr16_-_86585784_86585898_86582183_86588250	SLTM_chr15_-_59191667_59192082_59191051_59193458	OFD1_chrX_+_13781863_13781974_13780563_13785245
CD44_chr11_+_35232792_35232996_35211612_35236398	CAMTA2_chr17_-_4885383_4885455_4885126_4886051	SLC25A3_chr12_+_98989210_98989335_98987913_98991633
DAG1_chr3_+_49514281_49514333_49507866_49524660	FAM208B_chr10_+_5754785_5754881_5727138_5759621	RP11-321G12.1_chr15_+_63723255_63723541_63690666_63724350
SYTL1_chr1_+_27677284_27677443_27676976_27677748	HNRNPC_chr14_-_21731469_21731741_21702388_21737456	CCDC57_chr17_-_80091948_80092070_80086473_80115623
CTBP1_chr4_-_1235112_1235307_1232125_1242703	WDPCP_chr2_-_63713675_63713720_63712121_63714580	GSTZ1_chr14_+_77793814_77793895_77787526_7779546 5
KB-1572G7.2_chr22_-_24032418_24032543_24026054_24036305	SH2D6_chr2_+_85662535_85662619_85662246_85663588	RP11-284E5.1_chr2_-_191505676_191506188_191493441_191512945
ABI1_chr10_-_27044583_27044670_27040712_27054146	HSD3B7_chr16_+_30996973_30997145_30996618_309973 69	WIPI2_chr7_+_5232748_5232976_5230124_5239206
XXbac-BPG32J3.22_chr6_+_31637095_31637285_31636949_31638932	NME9_chr3_-_138023714_138023869_138022485_138024845	POLB_chr8_+_42196529_42196587_42196203_42202470
HTR3E_chr3_+_183819272_183819317_183818439_183821969	ZNF639_chr3_+_179042829_179043110_179041079_179045348	MITD1_chr2_-_99787805_99787892_99787115_99787972
AC004076.9_chr19_-_57987027_57987154_57949460_57988001	COL4A3BP_chr5_-_74695134_74695212_74685512_74706835	HDAC11_chr3_+_13542212_13542289_13525064_135433 70
PEX5_chr12_+_7342617_7342812_7342127_7342957	MRPL47_chr3_-_179320439_179320525_179319578_179322314	CRCP_chr7_+_65592690_65592727_65579957_65617194
PTPN18_chr2_+_131116969_131117065_131116548_131117180	RPRD1A_chr18_-_33620769_33620828_33611060_33647216	ALOX12B_chr17_-_7979492_7979662_7979034_7979974
TTC13_chr1_-_231079551_231079644_231076302_231081134	GEMIN7_chr19_+_45583164_45583287_45582635_455933 64	FAM221B_chr9_-_35819193_35819391_35819006_35819886
MAP4_chr3_-_47960208_47960331_47958664_47963254	FRMD8_chr11_+_65156831_65156999_65154592_6516104 3	FAM47E-STBD1_chr4_+_77199221_77199377_77192921_7723029 6
UROS_chr10_-_127477851_127477932_127477574_127483448	SEMA6C_chr1_-_151114979_151115151_151112566_151116860	ITPA_chr20_+_3193903_3194029_3190263_3194630
EFCAB14_chr1_-_47154024_47154216_47152542_47155258	PABPC4_chr1_-_40029507_40029594_40029413_40030142	DST_chr6_-_56394245_56394572_56393723_56394771

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PCMTD1_chr8_-_52752006_52752198_52746249_52758220	NADSYN1_chr11_+_71191264_71191320_71189515_71191800	DGKH_chr13_+_42795399_42795530_42793930_42803234
SHMT1_chr17_-_18238872_18238989_18233985_18243356	RAD51C_chr17_+_56783238_56783383_56780690_56787219	PARPBP_chr12_+_102569260_102569444_102559661_102589728
MECP2_chrX_-_153357641_153357765_153298008_153363060	PLEKHJ1_chr19_-_2234148_2234239_2234060_2235760	SNRPA1_chr15_-_101826418_101826498_101826006_101827112
DNAH14_chr1_+_225394669_225394922_225393881_225418774	MAN2B1_chr19_-_12759949_12760030_12759216_12760726	HNRNPDL_chr4_-_83346715_83346820_83346036_83347189
FBXW11_chr5_-_171384600_171384702_171341409_171433461	VPS37A_chr8_+_17123415_17123490_17104878_17126364	POGZ_chr1_-_151384100_151384274_151381304_151384771
AC009120.6_chr16_-_74340152_74340319_74339478_74366464	ZMYND8_chr20_-_45984193_45984264_45976670_45985400	RIBC1_chrX_+_53455230_53455575_53455032_53456801
FBLN2_chr3_+_13663274_13663415_13661331_13667944	SEC31A_chr4_-_83782783_83782861_83778917_83784470	ELMO2_chr20_-_45015976_45016070_45014914_45017677
PKIB_chr6_+_122803043_122803101_122799084_122907065	PVT1_chr8_+_128808139_128808254_128806980_128867400	DDR1_chr6_+_30853401_30853457_30852487_30856464
STRADA_chr17_-_61784606_61784778_61784099_61787850	CAMTA2_chr17_-_4885383_4885470_4885126_4886051	CFAP70_chr10_-_75095187_75095282_75091034_75101156
SNAP47_chr1_+_227919285_227919413_227916487_227935392	NAXD_chr13_+_111289475_111289596_111287935_111290724	TMTC4_chr13_-_101308634_101308722_101294565_101316474
PARL_chr3_-_183551511_183551613_183551377_183558357	CEACAM19_chr19_+_45175161_45175258_45165665_45175867	RP11-216L13.19_chr9_+_139703706_139703881_139702778_139704139
TBL1XR1_chr3_-_176849150_176849237_176816329_176914908	GSN_chr9_+_124044716_124044828_124043840_124060043	COL6A6_chr3_+_130360495_130360558_130354605_130361675
HP1BP3_chr1_-_21106837_21107033_21106404_21113687	SERPINB8_chr18_+_61645532_61645710_61637404_61647034	TMPRSS13_chr11_-_117782482_117782575_117781465_117784491
DDR1_chr6_+_30852314_30852487_30851922_30856464	PYCR1_chr17_-_79892528_79892621_79892365_79892801	EPN3_chr17_+_48616244_48616325_48615558_48616547
SLTM_chr15_-_59205697_59205895_59204809_59209133	MACC1_chr7_-_20203878_20204022_20201493_20256921	PCGF5_chr10_+_93000240_93000337_92982740_93008261
ZNF852_chr3_-_44544456_44544548_44544160_44552044	CBR3-AS1_chr21_-_37509391_37509606_37506059_37518553	FAM228B_chr2_+_24384375_24384483_24369956_24387067
DFFB_chr1_+_3782847_3782962_3782564_3784537	MTFMT_chr15_-_65313851_65313954_65312610_65319168	SPTAN1_chr9_+_131371929_131371944_131371563_131373992
CEP164_chr11_+_117253511_117253658_117252584_117261492	LRP8_chr1_-_53715051_53715228_53712728_53716361	PRR5_chr22_+_45130906_45131042_45128271_45132651
METTL6_chr3_-_15457004_15457090_15456421_15457278	SORBS1_chr10_-_97082502_97082562_97081778_97098889	MYCBP2_chr13_-_77807290_77807398_77799689_77817193

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TAMM41_chr3_-_11868191_11868279_11858811_11871187	ELFN2_chr22_-_37813807_37813958_37772036_37822910	RPL17_chr18_-_47018105_47018203_47017954_47018627
PRKAR2A_chr3_-_48789608_48789750_48789151_48793811	TRIM2_chr4_+_154215456_154215637_154197282_15421 6464	CORO6_chr17_-_27948241_27948441_27943865_27949705
APH1B_chr15_+_63579622_63579745_63578827_6359454 3	CSGALNACT2_chr10_+_43659313_43659492_43656043_ 43671398	POMGNT1_chr1_-_46662450_46662521_46661749_46662641
YY1AP1_chr1_-_155657861_155657992_155650247_155658720	DENND3_chr8_+_142170730_142170886_142166069_142 173431	CARF_chr2_+_203789019_203789138_203782766_20379 9224
HPS5_chr11_-_18339297_18339454_18333571_18343492	PROM2_chr2_+_95942341_95942405_95942095_95942719	CRYZ_chr1_-_75196065_75196104_75190518_75198639
RNF185_chr22_+_31591454_31591567_31588688_315974 83	HNRNPC_chr14_-_21731469_21731495_21702388_21737456	GZF1_chr20_+_23350220_23350378_23349566_23350727
PI4KAP2_chr22_-_21842512_21842670_21841961_21846282	TNS1_chr2_-_218677937_218678030_218677168_218678407	IFT46_chr11_-_118428452_118428605_118427760_118430499
ZNF394_chr7_-_99096338_99096465_99092254_99097260	SS18L1_chr20_+_60729336_60729521_60718945_6073372 7	LRP8_chr1_-_53746258_53746387_53737018_53755238
KDM4C_chr9_+_7105401_7105500_7103870_7128065	MED23_chr6_-_131936463_131936481_131931386_131937046	FOXRED1_chr11_+_126144821_126144916_126143349_1 26145221
FLCN_chr17_-_17127235_17127457_17122523_17129489	TMPO_chr12_+_98938219_98938315_98931350_98938728	FGGY_chr1_+_59787207_59787422_59762822_59844420
ANKRD6_chr6_+_90321990_90322089_90315824_903331 28	MFF_chr2_+_228211941_228212100_228205096_2282203 92	LINC00511_chr17_-_70416840_70417105_70400957_70424376
CEACAM1_chr19_-_43015727_43015780_43015072_43016501	RP13-507P19.2_chr12_+_131833872_131834089_131832206_131 850500	KIAA1468_chr18_+_59947006_59947089_59942706_5994 7592
GMIP_chr19_-_19746452_19746530_19746378_19747515	SLC35B1_chr17_-_47784704_47784806_47783671_47785091	TSC2_chr16_+_2127598_2127727_2126586_2129032
SP100_chr2_+_23134886_23134970_23134425_231325 976	PDXDC1_chr16_+_15095632_15095713_15092262_150980 43	INTS11_chr1_-_1258526_1258667_1250998_1259960
RP11-696N14.1_chr4_+_100207951_100208190_100125588_100 209822	UBTF_chr17_-_42289711_42289822_42289374_42290186	PATZ1_chr22_-_31724772_31724845_31723295_31731677
CRTC1_chr19_+_18882251_18882356_18879603_1888645 0	CNTRL_chr9_+_123887993_123888214_123886362_12390 0822	MTMR2_chr11_-_95615537_95615660_95599650_95621319
MARK2_chr11_+_63671457_63671619_63670630_636722 57	AC005154.6_chr7_-_30591715_30591795_30590397_30601081	ELOC_chr8_-_74882813_74882869_74872053_74884104
PVT1_chr8_+_128867400_128867565_128808254_1289028 34	KMT2E_chr7_+_104678572_104678646_104654982_10468 1285	HAUS8_chr19_-_17173507_17173589_17170902_17179840
PPP3CB_chr10_-_75199629_75199659_75198178_75206249	HUWE1_chrX_-_53589791_53589890_53589205_53590706	LTB4R2_chr14_+_24779376_24779461_24775073_24779 860

AS Events	AS Events	AS Events
DAXX_chr6_-_33288512_33289344_33288368_33290638	JOSD2_chr19_-_51010830_51010956_51009829_51013542	RP11-110G21.1_chr8_+_52825616_52825740_52812406_52858995
LINC00511_chr17_-_70427268_70427365_70424439_70588341	SMCHD1_chr18_+_2722516_2722661_2718432_2724896	PCK2_chr14_+_24572368_24572464_24572099_24572718
CCDC159_chr19_+_11462732_11462809_11460875_11464126	TMC6_chr17_-_76117636_76117792_76117245_76118685	OASL_chr12_-_121465378_121465620_121461940_121469244
KIAA1191_chr5_-_175786483_175786570_175782752_175786813	CAMK2G_chr10_-_75579289_75579403_75577312_75581439	MFF_chr2_+_228217229_228217289_228205096_228220392
ABLIM1_chr10_-_116233637_116233715_116232891_116247716	PPIP5K2_chr5_+_102523014_102523077_102522140_102526542	MRI1_chr19_+_13876767_13876879_13875923_13879172
MB_chr22_-_36013209_36013312_36007153_36018524	PBRM1_chr3_-_52592064_52592429_52584833_52595782	CANT1_chr17_-_76996181_76996352_76994045_77001453
ZNF326_chr1_+_90473170_90473309_90470803_90475646	PHPT1_chr9_+_139744957_139745012_139744589_139745206	NRCAM_chr7_-_107866088_107866145_107864280_107866651
TCOF1_chr5_+_149771106_149771220_149769586_149771519	KIAA1468_chr18_+_59947592_59947675_59942706_59947878	ZMIZ2_chr7_+_44790570_44790690_44789579_44795786
NUCB2_chr11_+_17336932_17337022_17333667_17351673	ARIH2_chr3_+_48962150_48962404_48960244_48964894	SLC9B2_chr4_-_103978957_103979128_103971539_103987483
EML3_chr11_-_62373326_62373452_62373245_62373534	ZNF195_chr11_-_3394806_3394886_3392933_3400267	RTN3_chr11_+_63486173_63488504_63472379_63517462
GPER1_chr7_+_1127833_1127957_1126880_1131042	SFSWAP_chr12_+_132249000_132249231_132241189_132250662	CSNK1E_chr22_-_38691392_38691453_38690540_38694790
PKIB_chr6_+_122803043_122803101_122799084_122803291	CNOT10_chr3_+_32778901_32778982_32776468_32800949	NEK3_chr13_-_52715155_52715205_52711038_52718050
ATG4D_chr19_+_10657514_10657791_10655806_10657864	NEO1_chr15_+_73567032_73567065_73566346_73570471	ACSF3_chr16_+_89164998_89165171_89160404_89169011
C14orf80_chr14_+_105960171_105960270_105959071_105963693	ADGRL1_chr19_-_14275432_14275517_14274218_14281493	HDAC2_chr6_-_114283530_114283558_114281182_114291643
KIAA1958_chr9_+_115380150_115380234_115337531_115407929	CS_chr12_-_56692392_56692475_56680429_56693611	NAB1_chr2_+_191520702_191520879_191514086_191548463
PDPK1_chr16_+_2616356_2616454_2588137_2627425	NEURL1B_chr5_+_172110421_172111141_172097333_172113173	MORC4_chrX_-_106242906_106242979_106236592_106243097
ABL2_chr1_-_179102446_179102509_179100616_179112067	EPB41L1_chr20_+_34761685_34761876_34742818_34763472	ARHGAP22_chr10_-_49687678_49687807_49667934_49732097
DMTF1_chr7_+_86823999_86824144_86823418_86824346	ERBB4_chr2_-_212522674_212522719_212522553_212530047	CAMK2G_chr10_-_75579289_75579375_75577312_75581439
PAM16_chr16_-_4393207_4393292_4391673_4401232	RP11-233J9.4_chr9_+_100053652_100053769_100053184_100070017	EDC3_chr15_-_74969281_74969363_74967483_74979431

AS Events	AS Events	AS Events
BECN1_chr17_-_40965965_40966026_40962946_40966541	EHMT2_chr6_-_31856745_31856847_31856524_31857004	KIF13A_chr6_-_17790102_17790141_17788106_17794802
TNS2_chr12_+_53448053_53448225_53447798_53448969	FAM13B_chr5_-_137354643_137354835_137354203_137356719	FLOT1_chr6_-_30709568_30709644_30709110_30709923
ASCC1_chr10_-_73975539_73975612_73973089_73975964	P3H4_chr17_-_39959538_39959683_39959231_39963047	TFDP1_chr13_+_114292132_114292211_114291015_114294434
KYAT1_chr9_-_131608958_131609138_131607690_131644175	CFAP70_chr10_-_75036997_75037119_75035356_75037936	LINC00893_chrX_-_148619164_148619274_148617745_148619646
WNK2_chr9_+_96018580_96018736_96010116_96019229	POSTN_chr13_-_38148708_38148789_38145595_38151889	DIS3_chr13_-_73355426_73355494_73355141_73355742
OGT_chrX_+_70775039_70775235_70774442_70775803	ATRX_chrX_-_76949312_76949426_76944417_76952064	ZCCHC7_chr9_+_37121596_37121669_37120773_37126308
SLC44A3_chr1_+_95286504_95286612_95286034_95290048	ARHGEF10_chr8_+_1828213_1828330_1824900_1830800	RPL5_chr1_+_93298945_93299015_93297674_93301746
AC005154.6_chr7_-_30601081_30601744_30590397_30603346	UBR3_chr2_+_170734003_170734147_170732459_170735034	STAG3L5P-PVRIG2P-PILRB_chr7_+_99950995_99951635_99950893_99952765
EPS15L1_chr19_-_16487932_16488065_16466662_16495939	MBD1_chr18_-_47800555_47800723_47800233_47801346	NUP62_chr19_-_50430950_50431072_50413141_50432582
ACYP1_chr14_-_75530172_75530264_75520362_75535912	BRD8_chr5_-_137495243_137495288_137492956_137495757	TNRC6C_chr17_+_76093825_76093942_76089844_76094423
PLSCR3_chr17_-_7296919_7297155_7296828_7297422	ZNF195_chr11_-_3394806_3394886_3392933_3398846	CCDC18-AS1_chr1_-_93791325_93791452_93771027_93802933
RGS14_chr5_+_176798475_176798590_176798397_176798873	RP11-242J7.1_chr4_-_185544575_185544612_185540471_185545892	PLSCR1_chr3_-_146254326_146254352_146251337_146262253
ARHGAP44_chr17_+_12877405_12877627_12862214_12883374	SH2D6_chr2_+_85662187_85662246_85660754_85663959	AGA_chr4_-_178357451_178357505_178355635_178358558
RP11-958N24.1_chr16_+_15013101_15013285_15012983_15013719	RGS12_chr4_+_3430284_3430438_3429896_3432133	TERF1_chr8_+_73942570_73942630_73939287_73944276
ADNP_chr20_-_49545187_49545362_49520538_49547362	UAP1L1_chr9_+_139972501_139972706_139972273_139972953	GEMIN7_chr19_+_45583164_45583287_45582537_45593364
FBXL19_chr16_+_30939787_30939949_30939284_30941393	TTC31_chr2_+_74717151_74717254_74710537_74717370	SDR39U1_chr14_-_24911303_24911466_24910132_24911551
SLC38A5_chrX_-_48324401_48324480_48321365_48325185	PRDX5_chr11_+_64087205_64087340_64085858_64088336	DYSF_chr2_+_71895883_71895972_71894645_71896241
SNHG11_chr20_+_37076572_37076736_37076266_37077304	PPM1N_chr19_+_46003907_46003968_46003819_46005274	IRF1_chr5_-_131823617_131823717_131822822_131826236
SETD4_chr21_-_37429681_37429775_37429502_37431113	TMEM181_chr6_+_159028275_159028375_159026379_159029364	PPM1K_chr4_-_89199687_89199794_89198395_89205557
SLCO4A1_chr20_+_61299506_61299536_61299262_61299828	PRKDC_chr8_-_48694722_48694815_48691654_48694938	SEPT3_chr22_+_42377648_42377840_42373078_42381987

AS Events	AS Events	AS Events
ZC3H18_chr16_+_88694029_88694190_88691675_88695165	MTMR2_chr11_-_95615537_95615660_95598840_95621319	PROM2_chr2_+_95950716_95950863_95947974_95951386
ANKMY1_chr2_-_241496606_241496769_241494472_241500147	EIF2AK4_chr15_+_40308702_40308873_40303547_40309308	DIS3_chr13_-_73354983_73355141_73352518_73355426
PATL2_chr15_-_44967683_44967889_44966428_44968672	DCAF8_chr1_-_160190248_160190481_160188758_160192440	ALOX12B_chr17_-_7976974_7977075_7976636_7979974
NCAPG2_chr7_-_158494938_158495039_158494629_158496340	RNF38_chr9_-_36390463_36390613_36376124_36400093	SCNN1D_chr1_+_1220950_1221044_1219470_1221305
ATG13_chr11_+_46639874_46639925_46639440_46642609	SPTBN5_chr15_-_42172357_42172510_42171697_42173231	RICTOR_chr5_-_39074212_39074260_39021238_39074430
PTP4A2_chr1_-_32396533_32396743_32385259_32403355	ELP2_chr18_+_33719381_33719576_33718835_33721099	CCDC162P_chr6_+_109674041_109674117_109669750_109676050
HTR3C_chr3_+_183772508_183772675_183770935_183773099	C11orf1_chr11_+_111753859_111753926_111753322_111754494	USO1_chr4_+_76716488_76716509_76715054_76720774
DDO_chr6_-_110734493_110734669_110729645_110736669	PTPN6_chr12_+_7060667_7060894_7055902_7061145	CEACAM19_chr19_+_45182124_45182208_45179693_45183559
FAM208B_chr10_+_5751492_5751626_5727138_5754785	ATP6V0E2-AS1_chr7_-_149567330_149567440_149566947_149568730	MICAL2_chr11_+_12277189_12277297_12265659_12278331
CLTCL1_chr22_-_19175069_19175240_19171124_19175492	DPH7_chr9_-_140459344_140459410_140459058_140459536	SNRNP48_chr6_+_7599905_7599913_7595334_7601568
TSPAN14_chr10_+_82222843_82222883_82214127_82228302	CARD8_chr19_-_48753007_48753104_48752890_48759048	ZNF83_chr19_-_53119970_53120094_53118050_53122188
XPO1_chr2_-_61752404_61752468_61749818_61752626	SH2D6_chr2_+_85662788_85662947_85662246_85663959	RABGEF1_chr7_+_66240213_66240380_66205779_66260497
ATP13A2_chr1_-_17322880_17322973_17322795_17323514	MFSD14C_chr9_-_99704884_99705034_99696197_99711836	PLCB2_chr15_-_40582225_40582283_40581559_40582777
SMG7_chr1_+_183516237_183516387_183515472_183518342	ARIH2_chr3_+_48962150_48962272_48960244_48964894	FGGY_chr1_+_59805629_59805741_59762822_59811918
ACSF3_chr16_+_89167069_89167755_89160404_89169011	CHID1_chr11_-_893426_893519_884169_899339	TOP3B_chr22_-_22336810_22336846_22330559_22337126
RC3H2_chr9_-_125613601_125613715_125613508_125616230	KIF1C_chr17_+_4902307_4902341_4901451_4903144	PGAP2_chr11_+_3844842_3844970_3829545_3845112
CCDC189_chr16_-_30770974_30771045_30770779_30771604	TXNL4A_chr18_-_77737597_77737701_77733856_77748239	FIS1_chr7_-_100887287_100887420_100884187_100888240
DNM1L_chr12_+_32890798_32890876_32890095_32891197	ADGRV1_chr5_+_90445846_90446038_90398157_90449037	TBL1XR1_chr3_-_176878658_176878776_176782810_176914908
KCNH3_chr12_+_49934681_49934915_49933275_49935412	SEC31A_chr4_-_83783686_83783725_83782861_83784470	SYCP2_chr20_-_58452439_58452610_58450524_58453062
SLC12A9_chr7_+_100454489_100454798_100452000_100456456	SEC31A_chr4_-_83783686_83783725_83778917_83784470	PRDX5_chr11_+_64088132_64088264_64085858_64088336

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RFT1_chr3_-_53159924_53160010_53157856_53164353	FLAD1_chr1_+_154962814_154963004_154962733_154965188	PPIA_chr7_+_44838845_44838876_44836392_44840885
MTA1_chr14_+_105915695_105915746_105905076_105916394	BOD1L1_chr4_-_13574325_13574466_13571752_13578461	ARAP2_chr4_-_36020765_36020908_36014453_36047600
CCDC43_chr17_-_42757952_42758020_42756411_42759370	DHRS3_chr1_-_12638745_12638984_12632881_12640550	RASGEF1B_chr4_-_82378652_82378775_82377942_82380485
LRP8_chr1_-_53741302_53741425_53737018_53755238	GALNT14_chr2_-_31348019_31348119_31215873_31360823	L3MBTL3_chr6_+_130370795_130370975_130370538_130372393
FAM207A_chr21_+_46393111_46393180_46387096_46396594	EPB41L1_chr20_+_34802278_34802362_34800298_34806797	KMT2D_chr12_-_49417835_49417883_49416658_49418360
ZFAND5_chr9_-_74978385_74978522_74975703_74979611	KCNQ4_chr1_+_41289768_41289930_41288074_41296755	MAPK9_chr5_-_179713974_179714067_179707608_179718847
PTAR1_chr9_-_72365696_72365866_72356774_72374768	DNAI1_chr9_+_34517282_34517465_34514737_34520655	TNS2_chr12_+_53453950_53454042_53453755_53454188
MECR_chr1_-_29527885_29528030_29527101_29528454	RPRD1A_chr18_-_33620769_33620828_33613800_33647216	CRACR2B_chr11_+_830865_831032_830713_831223
SAMD11_chr1_+_876523_876686_874840_877515	LINC01572_chr16_-_72604349_72604414_72589225_72661433	SSBP2_chr5_-_80946085_80946158_80911376_81047486
GOLGA8N_chr15_+_32892899_32892968_32892644_32894213	ANKS6_chr9_-_101552385_101552888_101547158_101558414	AMPD2_chr1_+_110163535_110163888_110162900_110167924
DAG1_chr3_+_49530255_49530406_49507866_49547851	SP110_chr2_-_231036411_231036483_231035477_231036781	FAM189B_chr1_-_155220066_155220720_155218264_155220885
LUC7L_chr16_-_258599_258663_258187_270647	PHKB_chr16_+_47497792_47497904_47495337_47531309	RALGPS2_chr1_+_178861364_178861442_178858831_178863053
GSN_chr9_+_124045596_124045670_124043840_124060043	ARHGEF39_chr9_-_35664752_35664847_35664489_35673807	CCDC125_chr5_-_68588014_68588189_68581294_68595838
CASP6_chr4_-_110617565_110617642_110615856_110618777	SH2D6_chr2_+_85662788_85662939_85661493_85663959	NLRC5_chr16_+_57080463_57080553_57079404_57081456
TNRC18_chr7_-_5401224_5401353_5399200_5401527	SNX14_chr6_-_86248555_86248582_86246642_86251702	CSGALNACT2_chr10_+_43662451_43662546_43659492_43671398
LPIN2_chr18_-_2928588_2928658_2927809_2929062	ZNF76_chr6_+_35261527_35261692_35260821_35262232	PIK3C3_chr18_+_39637846_39638015_39629569_39644703
EVA1B_chr1_-_36788571_36788668_36788326_36789059	C1orf61_chr1_-_156376871_156376989_156374393_156389962	AC005154.6_chr7_-_30618621_30618744_30617707_30618846
BCAM_chr19_+_45317408_45317545_45316877_45317860	PAM_chr5_+_102360837_102361038_102355547_102363888	HMGN3_chr6_-_79911779_79911872_79911443_79911992
SMUG1_chr12_-_54580630_54580795_54577743_54582298	FLNB_chr3_+_58117653_58117746_58116635_58118534	TMPRSS5_chr11_-_113563792_113563971_113558996_113565199
FXR1_chr3_+_180693100_180693192_180688146_180693909	TPST1_chr7_+_65817491_65817542_65751696_65824881	PLA2G6_chr22_-_38524275_38524437_38522456_38525460

AS Events	AS Events	AS Events
PDCD10_chr3_-_167443188_167443261_167438061_167452246	NUP62_chr19_-_50430950_50431105_50413141_50432582	MYL6_chr12_+_56553370_56553406_56552495_56553758
TM2D1_chr1_-_62152463_62152567_62149218_62160368	FAM136A_chr2_-_70528539_70528735_70528112_70529056	EFHD2_chr1_+_15753645_15753780_15752514_15755088
MICAL2_chr11_+_12270730_12270793_12265659_12278331	USPL1_chr13_+_31195209_31195376_31192193_31195900	AKNA_chr9_-_117143339_117143726_117139812_117156636
GUCD1_chr22_-_24944884_24944969_24944041_24951582	PAQR5_chr15_+_69681992_69682119_69672349_69689806	UBXN11_chr1_-_26627416_26627515_26624553_26628184
PLSCR3_chr17_-_7296462_7296683_7296271_7296785	ASPH_chr8_-_62546241_62546286_62538839_62550505	SPTBN5_chr15_-_42162643_42162758_42162551_42163572
PLD3_chr19_+_40871459_40871837_40854675_40872325	ZKSCAN5_chr7_+_99117449_99117532_99110214_99123435	ATXN7L1_chr7_-_105258238_105258544_105255263_105260646
C17orf58_chr17_-_65989159_65989351_65988219_65989539	NMU_chr4_-_56471441_56471516_56466742_56473464	TMEM9B_chr11_-_8983638_8983730_8977845_8985755
FMR1_chrX_+_147019617_147019680_147019119_147022094	MEF2D_chr1_-_156446285_156446306_156445029_156446803	EEF1D_chr8_-_144672777_144672905_144672251_144679517
EMILIN1_chr2_+_27308027_27308165_27307876_27308545	PVT1_chr8_+_128867400_128867565_128806980_128902834	SOS1_chr2_-_39216410_39216455_39214732_39222263
ATG4D_chr19_+_10657514_10657758_10655806_10657864	NTRK1_chr1_+_156843424_156843751_156838439_156844362	HKR1_chr19_+_37815697_37815838_37815167_37838091
DNAH14_chr1_+_225533663_225534082_225528403_225534157	NOP14-AS1_chr4_+_2939701_2939869_2939571_2948599	LZTFL1_chr3_-_45868847_45868951_45867824_45869930
AMMECR1L_chr2_-_128628822_128628933_128624570_128631401	DCAF8_chr1_-_160190248_160190322_160188758_160192440	LL0XNC01-237H1.2_chrX_+_102155950_102156061_102155760_102156558
TMEM51_chr1_+_15541390_15541927_15480450_15545821	PAK4_chr19_+_39658869_39658952_39647490_39660171	MROH6_chr8_-_144649780_144649846_144649635_144649955
ATXN7L1_chr7_-_105260646_105260768_105255263_105264521	MYL6_chr12_+_56553406_56553514_56552495_56553758	ANO7_chr2_+_242135117_242135260_242130666_242138730
METTL8_chr2_-_172182551_172182658_172182416_172187068	APOBEC3C_chr22_+_39411599_39411756_39410384_39413770	YLPM1_chr14_+_75264282_75266400_75249028_75269258
YY1AP1_chr1_-_155657861_155657992_155650247_155658449	CRAMP1_chr16_+_1716073_1716178_1715139_1716422	GOLGA2P5_chr12_-_100552456_100552651_100551855_100552735
RNPEPL1_chr2_+_241513191_241513308_241512678_241513529	APP_chr21_-_27369674_27369731_27354790_27394155	SPTBN5_chr15_-_42166042_42166243_42165806_42166489
GNMT_chr6_+_42930809_42930952_42930616_42931065	ZNF83_chr19_-_53119970_53120128_53118050_53122188	PLA2G12A_chr4_-_110639844_110639915_110638869_110650757
PAX8-AS1_chr2_+_114016840_114017161_113995789_114020854	ASIC1_chr12_+_50470750_50470832_50453737_50470995	PAQR6_chr1_-_156216471_156216547_156216041_156217747

AS Events	AS Events	AS Events
MTCL1_chr18_+_8809445_8809559_8807058_8812976	CCDC125_chr5_-_68590619_68590727_68581294_68595838	ACIN1_chr14_-_23540333_23540395_23538826_23540635
DIAPH2_chrX_+_95990756_95990789_95940189_95993584	MLH1_chr3_+_37090007_37090100_37089174_37090394	MYNN_chr3_+_169491818_169491885_169491250_169492052
TPRA1_chr3_-_127295663_127295736_127295539_127295832	PALM3_chr19_-_14168162_14168243_14167616_14169926	RRP8_chr11_-_6622155_6622285_6622005_6622378
FES_chr15_+_91434211_91434421_91433714_91434783	PPP6R1_chr19_-_55752606_55752759_55752447_55752844	BCL3_chr19_+_45261502_45261670_45260980_45261980
MBD1_chr18_-_47800555_47800720_47800233_47801346	KIAA1191_chr5_-_175777615_175777740_175775359_175788604	ERBIN_chr5_+_65367996_65368119_65350779_65370851
USP21_chr1_+_161130155_161130296_161129468_161130409	KCNH3_chr12_+_49943862_49944112_49943423_49948119	ELOC_chr8_-_74876721_74876860_74872053_74884104
ALOX5_chr10_+_45939563_45939734_45939276_45940955	WARS_chr14_-_100841619_100841740_100835595_100842596	CCDC189_chr16_-_30770974_30771130_30770779_30771604
MAPKAPK5_chr12_+_112308074_112308164_112306665_112308888	ZDHHC3_chr3_-_44974398_44974482_44970928_44974609	PILRB_chr7_+_99951517_99951635_99951106_99952765
IFI44_chr1_+_79126238_79126376_79125168_79128388	SCOC_chr4_+_141300722_141300806_141300346_141302115	BAIAP2_chr17_+_79010662_79010761_79009108_79027467
EEF1D_chr8_-_144672777_144672908_144672251_144679517	CBLC_chr19_+_45287520_45287658_45285748_45293260	TRIP12_chr2_-_230725121_230725247_230724290_230744697
MYO9B_chr19_+_17321141_17321189_17320518_17321523	ATAD2B_chr2_-_24050667_24050730_24046439_24051718	ARVCF_chr22_-_19978107_19978335_19969614_19997977
TRAPPC12_chr2_+_3481462_3481566_3469466_3482616	BOLA3_chr2_-_74369398_74369487_74362785_74372315	PPP1R12B_chr1_+_202414173_202414356_202411700_202418116
R3HDM1_chr2_+_136374237_136374327_136289203_136379063	AGTPBP1_chr9_-_88293249_88293313_88292497_88307603	MIS18BP1_chr14_-_45719233_45719341_45716580_45722237
TTYH3_chr7_+_2687592_2687688_2687272_2689200	PRSS22_chr16_-_2905574_2905852_2904023_2906082	HNRNPA1_chr12_+_54676862_54677018_54676449_54677595
SLC29A2_chr11_-_66136530_66136670_66136142_66136839	EFCAB6_chr22_-_44204874_44205011_44178205_44208047	TSPAN14_chr10_+_82222843_82222883_82219263_82264483
TET2_chr4_+_106111516_106111662_106068136_106180775	ZNF271P_chr18_+_32870973_32871196_32870355_32885939	MTA1_chr14_+_105911754_105911848_105905076_105916394
ARPC4-TTLL3_chr3_+_9862229_9862425_9855029_9867483	CANT1_chr17_-_76994229_76994368_76994045_76996181	HPF1_chr4_-_170669894_170669993_170663258_170671686
TMUB2_chr17_+_42265274_42265377_42265111_42266302	ZNF300_chr5_-_150282702_150282744_150278116_150283425	CDC42BPA_chr1_-_227239581_227239686_227235711_227257477
HNRNPH1_chr5_-_179046269_179046361_179045324_179047892	C12orf49_chr12_-_117157567_117157681_117155698_117175594	OGDHL_chr10_-_50945831_50945904_50944566_50945992
FAM208B_chr10_+_5754356_5754502_5727138_5754785	MFF_chr2_+_228211941_228212100_228205096_228217229	DGKI_chr7_-_137178528_137178582_137154365_137206611

AS Events	AS Events	AS Events
ABCA1_chr9_-_107665894_107666052_107651476_107690215	PLD3_chr19_+_40871568_40871837_40854675_40872325	MFSD14C_chr9_-_99704884_99705034_99681108_99711836
ZNF706_chr8_-_102214560_102214675_102213971_102217662	TMPO_chr12_+_98938007_98938127_98931350_98938728	FNBP1_chr9_-_132678244_132678259_132671278_132687238
METTL4_chr18_-_2544651_2544758_2539144_2547353	INPP5J_chr22_+_31521818_31521996_31520892_31522361	ARRB1_chr11_-_74982744_74982768_74980003_74983938
OGDHL_chr10_-_50948755_50948883_50946308_50950873	STAMBP_chr2_+_74097269_74097479_74089431_74100478	TANGO2_chr22_+_20049052_20049206_20043536_20050860
FAM189B_chr1_-_155220885_155220955_155218264_155223415	NSUN5P2_chr7_-_72422690_72422834_72420735_72423864	RUSC1-AS1_chr1_-_155292033_155292228_155291486_155293868
KLHL12_chr1_-_202862366_202862553_202861787_202863311	LINC01993_chr17_-_76267332_76268048_76260303_76274524	CADPS2_chr7_-_122033249_122033369_122028792_122033494
SLC25A22_chr11_-_796042_796367_795169_798216	BPNT1_chr1_-_220246191_220246299_220242774_220247308	MTMR2_chr11_-_95620775_95620923_95598840_95621319
CHN1_chr2_-_175869621_175869808_175816930_175869933	ALOX12B_chr17_-_7982713_7982857_7980511_7983086	NASP_chr1_+_46072992_46074009_46072263_46078840
KLHL8_chr4_-_88106402_88106951_88104541_88116475	SLC43A1_chr11_-_57263503_57263637_57261644_57268251	SPTBN5_chr15_-_42172357_42172510_42172062_42173231
DYRK3_chr1_+_206810219_206810313_206809125_206810994	CD47_chr3_-_107768465_107768498_107766139_107776323	DNAH1_chr3_+_52386567_52386723_52386119_52387118
EPB41L1_chr20_+_34802281_34802362_34800298_34806797	U2SURP_chr3_+_142773784_142773961_142772636_142775153	TARBP1_chr1_-_234536598_234536694_234534299_234536926
PQLC1_chr18_-_77693968_77694022_77664183_77703328	MKNK1_chr1_-_47040618_47040692_47037839_47042246	SLC29A1_chr6_+_44193709_44193904_44191378_44194999
COPS7B_chr2_+_232656442_232656518_232646593_232658972	FGFR1OP_chr6_+_167416680_167416735_167413601_167424300	HM13_chr20_+_30154012_30154098_30149539_30156922
C1orf61_chr1_-_156384445_156384545_156374393_156391346	LRMP_chr12_+_25215753_25215834_25205890_25216653	C6orf52_chr6_-_10672779_10672869_10671831_10683419
MCCC2_chr5_+_70922466_70922580_70900295_70927947	TROVE2_chr1_+_193038163_193038764_193028906_193045630	MTMR2_chr11_-_95620775_95620848_95599650_95621319
BDH1_chr3_-_197281432_197281584_197273357_197282651	NACA_chr12_-_57109654_57109990_57108471_57113320	MPRIP_chr17_+_17046869_17046983_17046079_17049349
TBL1XR1_chr3_-_176816253_176816329_176782810_176914908	TRA2A_chr7_-_23561739_23562051_23561459_23571407	HUWE1_chrX_-_53713214_53713313_53707139_53713532
FAM3B_chr21_+_42694849_42694993_42688825_42710304	RAD52_chr12_-_1023596_1023698_1023287_1025509	FAM208B_chr10_+_5751492_5751626_5734881_5754356
SF1_chr11_-_64533422_64533627_64532990_64534663	JMJD1C_chr10_-_64979637_64979743_64977091_65024410	UBA2_chr19_+_34921480_34921564_34919475_34922765
SGO1_chr3_-_20215740_20216547_20212724_20218092	IQCE_chr7_+_2608587_2608633_2598851_2611159	TMEM144_chr4_+_159136342_159136465_159133928_159140461

AS Events	AS Events	AS Events
SSH1_chr12_-_109205035_109205104_109203534_109210813	ACAD10_chr12_+_112148076_112148169_112147488_112150301	CCDC159_chr19_+_11462581_11462649_11461679_11462732
CTPS1_chr1_+_41473120_41473217_41471766_41474330	HCG18_chr6_-_30262247_30262741_30260376_30263908	PPP2R3C_chr14_-_35565763_35565839_35564390_35568457
ATP6V1C2_chr2_+_10917710_10917848_10915197_10918697	PRPF4B_chr6_+_4061888_4061934_4061381_4062446	ANKRD19P_chr9_+_95591219_95591445_95588860_95599058
DNM1L_chr12_+_32890798_32890876_32890095_32892997	G3BP2_chr4_-_76579166_76579265_76573925_76580249	SCAF1_chr19_+_50148277_50148391_50145499_50149364
RAC1_chr7_+_6438292_6438349_6431672_6439756	WDR17_chr4_+_177036946_177037130_177032854_177041017	IFI44_chr1_+_79126238_79126339_79125168_79128388
FIZ1_chr19_-_56106985_56107100_56105012_56108937	MPP2_chr17_-_41981797_41981861_41975748_41984841	KDM5D_chrY_-_21901413_21901548_21897636_21903203
PPP1CB_chr2_+_29016728_29016863_29006844_29022064	SNU13_chr22_-_42078359_42078591_42076368_42084797	SSPO_chr7_+_149476116_149476196_149476028_149479269
HPS1_chr10_-_100189547_100189646_100189399_100190327	FOXJ3_chr1_-_42671432_42671534_42664901_42693553	MTO1_chr6_+_74190040_74190090_74189849_74190397
PIEZO1_chr16_-_88791416_88791488_88790379_88791823	KCTD9_chr8_-_25303644_25303766_25298189_25315714	KLHL8_chr4_-_88106402_88106723_88104541_88141569
NSD2_chr4_+_1895456_1895636_1873269_1902352	ENTPD4_chr8_-_23261466_23261586_23243558_23291829	DTNB_chr2_-_25818954_25819109_25803695_25851039
NAA25_chr12_-_112487286_112487415_112486247_112491361	ZNF789_chr7_+_99075896_99075979_99074103_99077283	CHCHD7_chr8_+_57125320_57125448_57124396_57127156
EHBP1L1_chr11_+_65349009_65349487_65348844_65351711	FBXW11_chr5_-_171341346_171341409_171337801_171384600	CNN2_chr19_+_1036065_1036245_1032695_1036414
EGFL7_chr9_+_139564057_139564173_139563125_139564365	KITLG_chr12_-_88909310_88909394_88900914_88910110	ARHGAP28_chr18_+_6876129_6876207_6873774_68821 35
ENTPD6_chr20_+_25201867_25201969_25198217_25203473	AP2M1_chr3_+_183898432_183898438_183898039_183898636	RAB25_chr1_+_156035701_156035897_156031234_156038060
HPGD_chr4_-_175414301_175414465_175413245_175416698	TAF1D_chr11_-_93464315_93464382_93463878_93467906	MAP2K5_chr15_+_68040568_68040595_67995746_68040906
PUM1_chr1_-_31452908_31453013_31447649_31454158	GTSE1_chr22_+_46704046_46704104_46693376_46704215	CFAP157_chr9_+_130472879_130473033_130471972_130473507
SULT1C3_chr2_+_108869800_108869898_108868949_108872027	FAM175A_chr4_-_84393374_84393441_84390304_84397795	TMEM62_chr15_+_43430771_43430817_43427847_43438690
EXTL3_chr8_+_28494818_28494946_28480327_28570973	ZNF654_chr3_+_88177958_88178161_88175419_88178836	ING4_chr12_-_6761436_6761475_6760551_6761827
TOGARAM1_chr14_+_45492112_45492176_45481278_45494985	SSPO_chr7_+_149490397_149490551_149489817_149490653	SH2D6_chr2_+_85662187_85662246_85661493_85663959
ITGB4_chr17_+_73735752_73735786_73733525_73735960	NETO2_chr16_-_47120136_47120250_47117712_47143393	SNRPN_chr15_+_25165619_25165694_25165271_25207260

AS Events	AS Events	AS Events
SYNE4_chr19_-_36499118_36499269_36497846_36499455	GOLIM4_chr3_-_167758573_167758657_167754782_167759179	RP13-794C1.1_chr3_+_48502759_48502844_48502198_48505143
PRKCZ_chr1_+_1990979_1991030_1987001_2066700	MFSD8_chr4_-_128851837_128851972_128843118_128854139	SSFA2_chr2_+_182785323_182785389_182784173_182786674
MRPS28_chr8_-_80940929_80941031_80915415_80942139	RP1-27K12.2_chr6_-_53434277_53434403_53429687_53481683	PREPL_chr2_-_44586635_44587177_44573529_44588518
LYRM1_chr16_+_20913807_20914039_20911857_20926877	SSPO_chr7_+_149479934_149480110_149479387_149480194	NBPF15_chr1_+_148566781_148566880_148561115_148568735
SUGP2_chr19_-_19102148_19102362_19101958_19105174	SMC5_chr9_+_72961520_72961565_72959185_72961981	PXN_chr12_-_120653362_120653464_120653220_120657009
ZNF185_chrX_+_152088871_152088955_152087625_152089253	DAG1_chr3_+_49524686_49524848_49514338_49547851	DCAF6_chr1_+_167992225_167992285_167974031_168007608
BBC3_chr19_-_47731414_47731703_47725175_47735771	PDDC1_chr11_-_770992_771104_767373_771332	CCDC57_chr17_-_80109435_80109649_80086473_80115623
PCBP1-AS1_chr2_-_70286774_70286812_70283042_70310669	IFT122_chr3_+_129183477_129183624_129182469_129188184	

Table 1c: Myc AS Tissue

AS Events	AS Events	AS Events
AARSD1_chr17_-_41105740_41105795_41103911_41106892	MAN2B1_chr19_-_12769241_12769324_12769158_12772073	TRMU_chr22_+_46739158_46739265_46733841_46742318
AASS_chr7_-_121741424_121741492_121738920_121741674	MANBAL_chr20_+_35925698_35925937_35918089_35927165	TRNAU1AP_chr1_+_28887624_28887772_28887244_28887857
ABCA5_chr17_-_67247887_67248007_67246762_67249713	MANBAL_chr20_+_35927165_35927282_35918089_35929610	TSC2_chr16_+_2132436_2132505_2131799_2133695
ABCD4_chr14_-_74756729_74756821_74756222_74756993	MAP2K7_chr19_+_7970692_7970740_7968953_7974639	TSFM_chr12_+_58186768_58186856_58180945_58189959
ABHD16A_chr6_-_31669050_31669117_31668805_31670926	MAP3K6_chr1_-_27691151_27691175_27690885_27691263	TSNAX_chr1_+_231699210_231699375_231697001_231700273
ABHD4_chr14_+_23074692_23074772_23072984_23075327	MAP3K7_chr6_-_91254270_91254351_91246120_91256976	TSPAN4_chr11_+_862549_862741_850367_864436
ABI1_chr10_-_27044583_27044670_27040712_27047990	MAP4_chr3_-_47910703_47910817_47899002_47912302	TTC27_chr2_+_33036090_33036288_33012216_33042523
ABI1_chr10_-_27044583_27044670_27040712_27054146	MAPK12_chr22_-_50686120_50686205_50685395_50686318	TTC31_chr2_+_74717151_74717254_74710537_74717370

AS Events	AS Events	AS Events
ABLIM3_chr5_+_148622053_148622101_148619451_148624443	MAPK3_chr16_-_30126915_30126966_30126029_30127956	TTC7A_chr2_+_47185633_47185691_47184146_47202111
AC005154.6_chr7_-_30590933_30591095_30590397_30603346	MAPT_chr17_+_44060543_44061296_44055806_44064405	TTC7B_chr14_-_91069596_91069647_91044652_91077085
AC005154.6_chr7_-_30618621_30618744_30617707_30618846	MARK3_chr14_+_103964838_103964865_103958371_103966492	TTC7B_chr14_-_91069596_91069647_91059970_91077085
ACAA1_chr3_-_38173086_38173129_38170879_38173416	MARK3_chr14_+_103964838_103964865_103958371_103969218	TTLL7_chr1_-_84414310_84414378_84412965_84415547
ACLY_chr17_-_40052872_40052902_40049427_40054001	MARK3_chr14_+_103966492_103966537_103946827_103969218	U2AF1_chr21_-_44521475_44521542_44520629_44524424
ACOT9_chrX_-_23752457_23752484_23751334_23754035	MARK3_chr14_+_103966492_103966537_103958371_103969218	U2SURP_chr3_+_142742816_142742860_142741906_142745990
ACSF3_chr16_+_89180746_89180895_89178654_89187208	MATR3_chr5_+_138642927_138644016_138629494_138650363	UBAP2L_chr1_+_154241837_154241888_154241430_154243356
ACTN1_chr14_-_69345174_69345240_69343957_69345705	MBNL1_chr3_+_152164492_152164546_152163328_152165408	UPP1_chr7_+_48139266_48139384_48134424_48141420
ACTN1_chr14_-_69345705_69345786_69345240_69346678	MBNL1_chr3_+_152173330_152173366_152165562_152177059	USP15_chr12_+_62768170_62768316_62749256_627752770
ACTR3B_chr7_+_152508781_152508818_152498816_152511634	MBNL1_chr3_+_152174055_152174150_152165562_152177059	USP28_chr11_-_113702641_113702715_113700067_113704141
ACY1_chr3_+_52019222_52019287_52018174_52019376	MCAT_chr22_-_43533086_43533304_43529492_43537167	USP54_chr10_-_75279554_75279750_75277505_75283340
ADA_chr20_-_43251228_43251293_43249788_43251469	MCCC1_chr3_-_182746880_182746977_182743592_182751778	USP54_chr10_-_75280665_75280785_75277505_75283340
ADAM15_chr1_+_155034051_155034122_155033965_155034720	MCCC1_chr3_-_182810196_182810333_182804576_182812346	UTP6_chr17_-_30205720_30205800_30205346_30207591
ADAM15_chr1_+_155034379_155034451_155033308_155034720	MCF2L_chr13_+_113745434_113745509_113744042_113748827	VMP1_chr17_+_57911372_57911411_57895134_57915655
ADAM33_chr20_-_3652780_3652976_3652632_3653183	ME3_chr11_-_86161342_86161440_86159297_86176132	VRK3_chr19_-_50500760_50500827_50498532_50504046
ADAM33_chr20_-_3652780_3652976_3652632_3653367	MEMO1_chr2_-_32118310_32118390_32117203_32142994	WBP1_chr2_+_74686604_74686689_74685798_74686769
ADSL_chr22_+_40749076_40749121_40746039_40754867	METTL6_chr3_-_15457004_15457090_15455669_15457278	WBP1_chr2_+_74686604_74686689_74686225_74686769
AFMID_chr17_+_76201173_76201271_76200981_76202026	MGEA5_chr10_-_103553669_103553755_103552700_103557736	WDFY3_chr4_-_85648013_85648064_85645747_85654534
AFMID_chr17_+_76201683_76201819_76198832_76202026	MICAL3_chr22_-_18286576_18286627_18274067_18291609	WDSUB1_chr2_-_160114455_160114496_160112886_160116320
AFMID_chr17_+_76201683_76201819_76200981_76202026	MICAL3_chr22_-_18295272_18295323_18293579_18299455	WNK1_chr12_+_988738_989197_987527_989886
AFMID_chr17_+_76201683_76201834_76198832_76202026	MICAL3_chr22_-_18309219_18309282_18305826_18314619	WNK2_chr9_+_96062332_96062431_96061543_96070609

AS Events	AS Events	AS Events
AFMID_chr17_+_76201683_76201834_76200981_76202026	MICAL3_chr22_-_18310409_18310547_18305826_18314619	WNK2_chr9_+_96069058_96069103_96060349_96070609
AGA_chr4_-_178357429_178357505_178355643_178358558	MICAL3_chr22_-_18355512_18355620_18354789_18368643	WNK2_chr9_+_96069058_96069103_96061543_96070609
AHI1_chr6_-_135622545_135622677_135621696_135639656	MINDY3_chr10_-_15880226_15880278_15879317_15883424	WRNIP1_chr6_+_2770353_2770595_2766678_2779496
AKAP8L_chr19_-_15509440_15509514_15508666_15510112	MINK1_chr17_+_4762507_4762623_4736935_4781611	WRNIP1_chr6_+_2770428_2770595_2766678_2779496
AKAP8L_chr19_-_15509440_15509577_15508666_15510112	MINK1_chr17_+_4795696_4795807_4795529_4795950	WSB1_chr17_+_25624212_25624334_25621461_25630392
AKAP9_chr7_+_91671359_91671500_91670212_91671981	MIS12_chr17_+_5391515_5391909_5390004_5392142	YBX3_chr12_-_10862506_10862713_10856747_10865809
ALKBH3_chr11_+_43913590_43913679_43911378_43923065	MMS19_chr10_-_99221252_99221379_99220764_99221584	YLPM1_chr14_+_75290958_75291010_75287840_75295915
AMDHD2_chr16_+_2577573_2577616_2571124_2577773	MMS19_chr10_-_99228722_99228861_99228163_99229402	YPEL5_chr2_+_30371110_30371407_30369928_30379493
ANK3_chr10_-_61905725_61905779_61898845_61926348	MPND_chr19_+_4355093_4355170_4354417_4357249	YTHDC2_chr5_+_112860677_112860874_112851059_112868575
ANKMY1_chr2_-_241468453_241468926_241465266_241492330	MPRIP_chr17_+_17078606_17078726_17077389_17079739	ZBTB1_chr14_+_64983317_64983469_64971664_649882044
ANO8_chr19_-_17444230_17444363_17444048_17444498	MRPL1_chr4_+_78828099_78828364_78815404_78830419	ZC3H7A_chr16_-_11862886_11862951_11862357_11864638
AP1B1_chr22_-_29725700_29725709_29724884_29726366	MRPL10_chr17_-_45906504_45906602_45906036_45908825	ZCCHC6_chr9_-_88933872_88933973_88932191_88934498
AP1G2_chr14_-_24035024_24035101_24034910_24035272	MRPL22_chr5_+_154330362_154330498_154320825_154335930	ZCCHC6_chr9_-_88941285_88941406_88940429_88943254
AP2A2_chr11_+_1000431_1000598_994245_1003721	MRPL22_chr5_+_154330380_154330498_154320825_154335930	ZCCHC8_chr12_-_122967825_122967891_122967242_122973932
APLP2_chr11_+_129993506_129993674_129992408_129996594	MRPL33_chr2_+_27997290_27997397_27995559_28002299	ZCCHC8_chr12_-_122967825_122968110_122967242_122973932
APLP2_chr11_+_130007150_130007186_130003623_130010292	MRPL47_chr3_-_179320439_179320585_179319578_179322314	ZFR_chr5_-_32380180_32380278_32379316_32385613
APP_chr21_-_27369674_27369731_27354790_27372329	MRPL48_chr11_+_73554291_73554412_73536841_73555851	ZMIZ1_chr10_+_81070680_81070941_81067328_810723938
ARF1_chr1_+_228284151_228284205_228270551_228284778	MRPL55_chr1_-_228296137_228296175_228296019_228296655	ZMYND8_chr20_-_45841286_45841370_45839542_45848908
ARFGAP2_chr11_-_47194260_47194302_47193884_47196565	MRPL55_chr1_-_228296137_228296175_228296019_228296849	ZNF160_chr19_-_53594665_53594750_53589574_53594889
ARHGEF11_chr1_-_156908209_156908305_156907288_156909339	MRPL55_chr1_-_228296137_228296175_228296019_228296961	ZNF160_chr19_-_53594665_53594782_53589574_53594889

AS Events	AS Events	AS Events
ARHGEF9_chrX_-_62947070_62947299_62944591_62974194	MRPL55_chr1_-_228296137_228296175_228296022_228296655	ZNF160_chr19_-_53594665_53594806_53589574_53594889
ARIH2_chr3_+_48982414_48982614_48956431_48999044	MRPL55_chr1_-_228296137_228296209_228296019_228296655	ZNF207_chr17_+_30693683_30693776_30692506_30694790
ARIH2_chr3_+_48982568_48982614_48965246_48999044	MRPS33_chr7_-_140710218_140710460_140706335_140714710	ZNF213-AS1_chr16_-_3182850_3182946_3182104_3184630
ARL4A_chr7_+_12727259_12727353_12726668_12727790	MTIF3_chr13_-_28015153_28015214_28014586_28019224	ZNF213-AS1_chr16_-_3182850_3183195_3182104_3184630
ARMCX2_chrX_-_100913446_100913511_100913128_100914742	MTMR10_chr15_-_31260122_31260213_31253276_31266516	ZNF263_chr16_+_3335058_3335239_3334205_3336022
ARMCX2_chrX_-_100913446_100913555_100913128_100914742	MTMR3_chr22_+_30419445_30419472_30418686_30421618	ZNF271P_chr18_+_32870973_32871196_32870355_32885939
ARMCX2_chrX_-_100914404_100914487_100913128_100914742	MVK_chr12_+_110016969_110017087_110013950_110017606	ZNF273_chr7_+_64377407_64377496_64363797_643779578
ARNT_chr1_-_150814899_150814944_150812130_150818738	MYEF2_chr15_-_48459545_48459598_48458325_48460827	ZNF326_chr1_+_90472903_90473309_90470803_904756446
ATAD3B_chr1_+_1425071_1425191_1424654_1425636	MYL6_chr12_+_56553370_56553406_56552495_56553758	ZNF326_chr1_+_90473170_90473309_90470803_904756446
ATG16L1_chr2_+_234182366_234182423_234181698_234183321	MYO18A_chr17_-_27412621_27412666_27409456_27413455	ZNF528-AS1_chr19_-_52900447_52900520_52899003_52900714
ATG2A_chr11_-_64671061_64671132_64670836_64673034	MYO18A_chr17_-_27443461_27443473_27442858_27445062	ZNF605_chr12_-_133524733_133524856_133522383_133532828
ATP6V0B_chr1_+_44441471_44441520_44440779_44441761	NAA16_chr13_+_41936866_41937009_41936295_419415744	ZNF638_chr2_+_71649943_71651168_71645769_716517779
ATP9B_chr18_+_76973961_76974038_76967012_770133801	NAA25_chr12_-_112487286_112487415_112486247_112491361	ZNF7_chr8_+_146054427_146054475_146052994_146062778
ATP9B_chr18_+_77108131_77108196_77107925_771193533	NACA_chr12_-_57109654_57109990_57108471_57113320	ZNF706_chr8_-_102214560_102214675_102213971_102217662
B3GALNT2_chr1_-_235652472_235652573_235647831_235657990	NADSYN1_chr11_+_71191264_71191320_71189515_711918800	ZNF761_chr19_+_53948253_53948376_53935281_53949479
BAZ2B_chr2_-_160253584_160253611_160252345_160253855	NAGLU_chr17_+_40689415_40689563_40688673_40690356	ZNF83_chr19_-_53119970_53120068_53118050_53122188
BCAR1_chr16_-_75270779_75270896_75269884_75276367	NAP1L1_chr12_-_76461150_76461253_76454059_76467982	ZNF83_chr19_-_53119970_53120094_53118050_53122188
BCAS3_chr17_+_59465978_59466069_59457932_594693377	NBEA_chr13_+_36220005_36220068_36202385_36220395	ZNF83_chr19_-_53119970_53120128_53118050_53122188
BET1_chr7_-_93623663_93623697_93605412_93625576	NCOA5_chr20_-_44708025_44708092_44699175_44718455	ZNHIT3_chr17_+_34842778_34842810_34842629_34848656
BIRC6_chr2_+_32815872_32816045_32800433_32818981	NCOR2_chr12_-_124811954_124812179_124810916_124815390	ZSWIM7_chr17_-_15880892_15881014_15880406_15881357

AS Events	AS Events	AS Events
BPTF_chr17_+_65871671_65871860_65871136_65882243	NCOR2_chr12_-_124812092_124812179_124810916_124815390	SRRT_chr7_+_100478316_100478390_100473333_100478905
BPTF_chr17_+_65871671_65871860_65871136_65887959	NDEL1_chr17_+_8366637_8366672_8363478_8370247	SRRT_chr7_+_100480385_100480711_100479862_100481690
BPTF_chr17_+_65959448_65959622_65955991_65960327	NDRG2_chr14_-_21492188_21492255_21491480_21493835	TARSL2_chr15_-_102239533_102239638_102226265_102241288
BRD8_chr5_-_137495243_137495288_137492956_137495757	NDUFAF7_chr2_+_37469777_37469836_37468780_37471005	WASHC3_chr12_-_102443966_102444069_102439897_102455025
BTBD1_chr15_-_83718824_83718930_83710677_83725140	NECAP1_chr12_+_8244435_8244446_8242895_8245271	RAD52_chr12_-_1035961_1036112_1034691_1036310
BYSL_chr6_+_41897869_41898008_41895274_41898372	NFIB_chr9_-_14116179_14116345_14088325_14120438	KLC1_chr14_+_104158695_104158762_104153548_104166991
C12orf4_chr12_-_4627939_4628046_4614546_4634419	NFIB_chr9_-_14116206_14116345_14088325_14120438	C12orf73_chr12_-_104347191_104347312_104345408_104350408
C17orf62_chr17_-_80407045_80407168_80404572_80408575	NFIX_chr19_+_13189426_13189549_13186485_13192493	C12orf73_chr12_-_104348652_104348746_104345408_104350408
C17orf62_chr17_-_80407049_80407168_80403836_80408575	NFU1_chr2_-_69650713_69650849_69646736_69659033	C12orf73_chr12_-_104348652_104348746_104347312_104350408
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C1orf43_chr1_-_154192311_154192413_154187050_154192817	NGLY1_chr3_-_25761504_25761682_25761126_25770623	NT5C2_chr10_-_104860508_104860700_104859776_104860801
C2CD5_chr12_-_22611417_22611489_22610095_22612425	NHLRC3_chr13_+_39618226_39618318_39613848_39621176	NT5C2_chr10_-_104871501_104871562_104866463_104899162
C2CD5_chr12_-_22611417_22611489_22610095_22622642	NIN_chr14_-_51223209_51225348_51221585_51226574	TBCK_chr4_-_107158647_107158695_107157965_107163626
C2CD5_chr12_-_22611417_22611519_22610095_22612425	NKTR_chr3_+_42661507_42661535_42661200_42662920	MAGOHB_chr12_-_10761696_10761982_10760535_10762429
C2CD5_chr12_-_22611417_22611519_22610095_22622642	NOC4L_chr12_+_132631825_132631933_132630210_132635525	MAGOHB_chr12_-_10765238_10765577_10763279_10766037
C9orf3_chr9_+_97848211_97848401_97843062_97848963	NOD1_chr7_-_30477188_30477272_30469073_30485756	TCTN1_chr12_+_111072474_111072584_111070364_111074285
CACNA1D_chr3_+_53752708_53752768_53752415_53753781	NPHP3_chr3_-_132415574_132415657_132413809_132416103	CARS2_chr13_-_111296411_111296529_111294868_111296731
CAD_chr2_+_27463434_27463485_27463229_27463778	NRDC_chr1_-_52302040_52302110_52301884_52305897	MAGI3_chr1_+_114224833_114224924_114223958_114225518
CALD1_chr7_+_134620438_134620516_134618141_134625842	NSFL1C_chr20_-_1436358_1436364_1435777_1438844	DNAJC25_chr9_+_114405136_114405374_114394023_114409386
CAMK2D_chr4_-_114424091_114424133_114421667_114430793	NSUN5P1_chr7_+_75043917_75044076_75042210_75044162	ATG12_chr5_-_115176193_115176309_115173461_115177086

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CAMK2G_chr10_-_75577966_75578653_75577312_75581439	NUDT2_chr9_+_34336226_34336339_34329597_34338710	TAMM41_chr3_-_11874476_11874625_11871338_11880695
CAMK2G_chr10_-_75599296_75599359_75597269_75601926	NUDT2_chr9_+_34336297_34336339_34329597_34338710	SEPT6_chrX_-_118759297_118759342_118750705_118763280
CAMKK2_chr12_-_121682375_121682418_121678672_121682942	NUDT9_chr4_+_88366473_88366659_88363067_88370293	SEPT6_chrX_-_118759297_118759342_118754014_118763280
CAPN3_chr15_+_42698123_42698141_42695975_4270040 8	NUMB_chr14_-_73745988_73746132_73744001_73749066	SEPT6_chrX_-_118759297_118759359_118754014_118763280
CAPN7_chr3_+_15282959_15283095_15282360_15283684	NUP35_chr2_+_184016235_184016377_183998351_18402 2171	LAMP2_chrX_-_119572930_119573148_119565317_119575584
CARD19_chr9_+_95874160_95874220_95873003_958744 99	NUP88_chr17_-_5307418_5307566_5302970_5308376	RPLP0_chr12_-_120636356_120636573_120635265_120636656
CASK_chrX_-_41414852_41414888_41413168_41416284	NUTF2_chr16_+_67881180_67881359_67880888_6789900 4	PXN_chr12_-_120654075_120654919_120653464_120659425
CASP6_chr4_-_110617565_110617642_110615856_110618777	OFD1_chrX_+_13771486_13771560_13769487_13774696	TIAL1_chr10_-_121339982_121340358_121339522_121341433
CAST_chr5_+_96062457_96062563_96058402_96063192	OGDH_chr7_+_44695916_44695961_44687133_44706334	AASS_chr7_-_121722841_121722945_121721649_121726065
CAST_chr5_+_96062497_96062563_96058402_96063192	ORMDL1_chr2_-_190647739_190647849_190647328_190648994	RSRC2_chr12_-_123005050_123005128_123003598_123005931
CBWD1_chr9_-_151304_151427_146158_152033	OSBPL9_chr1_+_52135105_52135184_52117713_5217967 4	PLEKHA1_chr10_+_124187791_124187936_124186547_1 24189139
CCDC130_chr19_+_13872304_13872382_13870086_13873 112	OSGEP_chr14_-_20919415_20919611_20917425_20920132	MRRF_chr9_+_125048317_125048445_125047566_12505 4027
CCDC25_chr8_-_27606011_27606115_27605796_27610028	OSR2_chr8_+_99960400_99960649_99957051_99961066	SCARB1_chr12_-_125267228_125267357_125263132_125270902
CCNDBP1_chr15_+_43482252_43482349_43481478_4348 2522	PAAF1_chr11_+_73597973_73598144_73589864_7359839	TRMT11_chr6_+_126327987_126328100_126320759_126 329537
CCSER2_chr10_+_86259630_86259715_86237420_862732 04	PAAF1_chr11_+_73598075_73598144_73589864_7359839 8	STX2_chr12_-_131280539_131280665_131276522_131283069
CD151_chr11_+_834457_834591_833026_836062	PAAF1_chr11_+_73598084_73598144_73589864_7359839 8	CRAT_chr9_-_131871457_131871556_131870356_131872761
CD151_chr11_+_834529_834591_833022_836062	PAOX_chr10_+_135197463_135197716_135195163_13520 2459	CCNL2_chr1_-_1326676_1326955_1326245_1328058
CDC25B_chr20_+_3783376_3783455_3783023_3783556	PARD3_chr10_-_34625126_34625171_34620272_34626202	PPP2R2D_chr10_+_133748397_133748510_133748059_13 3753534
CEP95_chr17_+_62512840_62512946_62510476_6251543 8	PASK_chr2_-_242047881_242048222_242047715_242051654	DDX46_chr5_+_134125795_134125912_134124281_13412 6159

AS Events	AS Events	AS Events
CHTOP_chr1_+_153614721_153614905_153610924_153617539	PBRM1_chr3_-_52588739_52588895_52584833_52595782	BCLAF1_chr6_-_136590278_136590441_136589477_136590574
CLASP2_chr3_-_33600616_33600667_33592887_33600798	PBRM1_chr3_-_52592264_52592429_52584833_52595782	BCLAF1_chr6_-_136595100_136595327_136594325_136596669
CLCC1_chr1_-_109504930_109505091_109493070_109505982	PCBP2_chr12_+_53861588_53861627_53861077_538625660	UVSSA_chr4_+_1374428_1374535_1374018_1374667
CLSTN1_chr1_-_9797555_9797612_9796100_9801151	PCBP2_chr12_+_53861588_53861627_53861077_538625663	NDUFAF5_chr20_+_13795063_13795161_13789548_13797108
CLSTN1_chr1_-_9816538_9816568_9815367_9833329	PCBP4_chr3_-_51995956_51996104_51995320_51996825	HNMT_chr2_+_138724666_138724956_138722198_138727734
CLTC_chr17_+_57764361_57764382_57763169_57767996	PCBP4_chr3_-_51996825_51996908_51995320_52001341	ATP11C_chrX_-_138813809_138813914_138811121_138820074
CMTM7_chr3_+_32490945_32491044_32483505_32493883	PCBP4_chr3_-_51996825_51996908_51996104_52001341	LUC7L2_chr7_+_139060254_139060329_139045068_13906060807
CNNM2_chr10_+_104831530_104831596_104828479_104835842	PCSK7_chr11_-_117078369_117078451_117077876_117078685	APBB3_chr5_-_139941428_139941580_139941286_139941684
COL16A1_chr1_-_32136156_32136247_32134456_32137215	PDCD2_chr6_-_170889089_170889193_170888058_170892144	GK5_chr3_-_141903552_141904635_141901891_141904770
COL16A1_chr1_-_32136202_32136247_32134456_32137215	PDCD4_chr10_+_112636427_112636511_112635828_11264040990	ATR_chr3_-_142169307_142169444_142168444_142171969
COPS7A_chr12_+_6837091_6837167_6833984_6837388	PDDC1_chr11_-_773521_773629_772521_774007	DDX39A_chr19_-_14521232_14521417_14521146_14521800
COQ5_chr12_-_120964259_120964349_120960166_120966742	PDIA5_chr3_+_122849326_122849463_122843190_122864368	DDX39A_chr19_-_14521359_14521417_14521146_14521800
CPNE1_chr20_-_34218662_34218717_34218412_34218822	PDK1_chr2_+_173433468_173433545_173431661_173435453	TCERG1_chr5_+_145889629_145889723_145888808_145890003
CPNE4_chr3_-_131753410_131753603_131624288_131756400	PDLIM7_chr5_-_176918404_176918421_176918147_176918807	EZH2_chr7_-_148516069_148516151_148515209_148516687
CPNE4_chr3_-_131753410_131754286_131624288_131756400	PELO_chr5_+_52095718_52096954_52084248_52097242	IDS_chrX_-_148583604_148583707_148582568_148584841
CRAT_chr9_-_131870686_131870757_131870356_131871457	PEX1_chr7_-_92138642_92138725_92136440_92140257	TARS2_chr1_+_150464073_150464138_150463987_150464886
CRAT_chr9_-_131870686_131870757_131870356_131872761	PEX19_chr1_-_160253319_160253429_160252899_160254844	AGAP3_chr7_+_150817606_150817832_150817232_150819811
CRELD1_chr3_+_9979698_9979790_9976601_9982533	PHLDB2_chr3_+_111667778_111667922_111664204_11167276	AGAP3_chr7_+_150817606_150817832_150817232_150820880
CROCCP2_chr1_-_16969261_16969345_16961663_16971140	PIGB_chr15_+_55642896_55643001_55634000_55646995	THEM4_chr1_-_151862458_151862690_151861849_151867483
CRTC1_chr19_+_18854917_18854965_18853836_18856632	PIGB_chr15_+_55642896_55643110_55634000_55646995	INTS3_chr1_+_153733495_153733585_153733394_153734045

AS Events	AS Events	AS Events
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CSNK1G3_chr5_+_122941032_122941056_122940524_122950035	PIGQ_chr16_+_631198_631341_630972_632247	CC2D2A_chr4_+_15480842_15480952_15480430_154823 27
CTBS_chr1_-_85035613_85035822_85031695_85036264	PILRB_chr7_+_99950995_99951106_99950746_99951517	CC2D2A_chr4_+_15480846_15480952_15480430_154823 27
CTNND1_chr11_+_57558856_57559145_57529518_57561 481	PKD1_chr16_-_2141423_2141598_2141175_2141781	HACL1_chr3_-_15628031_15628109_15624496_15631046
CTNND1_chr11_+_57558856_57559145_57529591_57561 481	PLA2G5_chr1_+_20415317_20415394_20412720_2041706 0	MYH11_chr16_-_15802659_15802698_15797980_15808765
CTNND1_chr11_+_57558963_57559145_57529518_57561 481	PLA2G5_chr1_+_20416281_20416388_20412720_2041706 0	MAP3K4_chr6_+_161529982_161530073_161529891_161 530786
CTNND1_chr11_+_57558965_57559145_57529518_57561 481	PLA2G6_chr22_-_38523413_38523465_38522456_38524275	TCF3_chr19_-_1615283_1615484_1612432_1615684
CTPS1_chr1_+_41473120_41473217_41471766_41474330	PLCB4_chr20_+_9353693_9353751_9353050_9360700	TCF3_chr19_-_1615283_1615514_1612432_1615684
CTTN_chr11_+_70268614_70268737_70266616_70269045	PLEKHA1_chr10_+_124187791_124187832_124186547_1 24189139	OXNAD1_chr3_+_16313651_16313828_16313229_163278 48
CXorf40B_chrX_-_149102594_149102791_149102355_149105650	PLEKHA7_chr11_-_16828690_16828771_16824842_16834659	BZW2_chr7_+_16725548_16725665_16722470_16729421
CXXC1_chr18_-_47813792_47813878_47813228_47813956	PLEKHM2_chr1_+_16047823_16047883_16046415_16051 811	DCAF6_chr1_+_167988782_167988905_167974031_16799 2225
CYP20A1_chr2_+_204137368_204137471_204131404_204 143295	PLPP1_chr5_-_54786787_54786942_54771278_54830399	NADK_chr1_-_1688177_1688321_1688047_1688619
CYP20A1_chr2_+_204137392_204137471_204131404_204 143295	PMF1_chr1_+_156195347_156195459_156182967_156202 110	NOSTRIN_chr2_+_169712395_169712720_169711970_16 9713199
CYP2J2_chr1_-_60370037_60370188_60366775_60370542	PML_chr15_+_74324912_74325056_74317268_74325496	CBR4_chr4_-_169930102_169930205_169928907_169931098
D2HGDH_chr2_+_242688279_242689344_242684292_242 689565	PMM2_chr16_+_8898623_8898700_8895767_8900172	RANBP17_chr5_+_170455875_170455993_170395381_17 0597133
DAZAP1_chr19_+_1425876_1425959_1422395_1428840	PMPCB_chr7_+_102948042_102948155_102944937_10294 9398	GORAB_chr1_+_170505450_170505562_170501425_1705 08350
DBN1_chr5_-_176886603_176886741_176886269_176887432	POFUT2_chr21_-_46697147_46697688_46697057_46698017	MPRIP_chr17_+_17083920_17083983_17083402_1708813 6
DCAF6_chr1_+_168007608_168007726_167974031_16801 2262	POLR3C_chr1_-_145597513_145597574_145597054_145598535	TBP_chr6_+_170876313_170876593_170876097_1708786 99
DCAF8_chr1_-_160231074_160231140_160213824_160232238	POT1_chr7_-_124469307_124469396_124467359_124475332	SLC27A1_chr19_+_17599656_17599748_17598338_17599 816
DCAF8_chr1_-_160231074_160231148_160213824_160232238	PPHLN1_chr12_+_42745686_42745851_42729776_427489 62	TSPAN17_chr5_+_176078754_176078901_176074703_176 079743

AS Events	AS Events	AS Events
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DCUN1D5_chr11_-_102953476_102953568_102937296_102953984	PPP1R12A_chr12_-_80173100_80173131_80172380_80175594	FAM193B_chr5_-_176958953_176959132_176952206_176959443
DDR1_chr6_+_30853401_30853457_30850942_30856464	PPP1R12A_chr12_-_80173118_80173131_80172380_80175594	FAM193B_chr5_-_176958953_176959132_176958522_176959443
DECR2_chr16_+_456889_456952_456833_457424	PPP3CB_chr10_-_75199629_75199659_75198178_75204482	FAM193B_chr5_-_176958953_176959201_176952206_176959443
DENND1A_chr9_-_126150008_126150137_126146192_126165680	PPP4R1_chr18_-_9562919_9563044_9562073_9563375	FAM193B_chr5_-_176958953_176959201_176958522_176959443
DFFB_chr1_+_3782847_3782962_3782564_3784537	PPT2-EGFL8_chr6_+_32132355_32132434_32130399_32134274	FAM193B_chr5_-_176963358_176963487_176959642_176964873
DGUOK_chr2_+_74184251_74184367_74177859_74185272	PQLC1_chr18_-_77693968_77694022_77679400_77703328	SREBF1_chr17_-_17720861_17720905_17720771_17721009
DHODH_chr16_+_72055022_72055210_72051005_72057063	PRKAG1_chr12_-_49399525_49399664_49399326_49406844	PHYKPL_chr5_-_177658669_177658867_177658524_177659492
DHX9_chr1_+_182824711_182824848_182823313_182825666	PRMT1_chr19_+_50183128_50183182_50180573_50185166	HNRNPH1_chr5_-_179042546_179042596_179041960_179043126
DIAPH2_chrX_+_95990756_95990789_95940189_95993584	PRMT2_chr21_+_48056350_48056459_48055675_48056807	PRKRA_chr2_-_179310152_179310262_179309227_179312231
DMPK_chr19_-_46274228_46274314_46273898_46274825	PRUNE2_chr9_-_79239938_79239974_79229516_79244107	DNAJC10_chr2_+_183604271_183604436_183601113_183605025
DMPK_chr19_-_46274607_46274654_46273898_46274825	PRUNE2_chr9_-_79239938_79239974_79234303_79244107	TRA2B_chr3_-_185649364_185649640_185643414_185655612
DMTN_chr8_+_21924595_21924670_21924404_21925037	PSAP_chr10_-_73583644_73583653_73581764_73585593	TRA2B_chr3_-_185649364_185649640_185644522_185655612
DMWD_chr19_-_46287898_46287973_46287548_46288851	PSMC5_chr17_+_61905033_61905283_61904874_61905497	PIGX_chr3_+_196453525_196453642_196449427_196454793
DNAJC14_chr12_-_56223272_56223420_56222498_56224479	PSMC5_chr17_+_61905188_61905283_61904874_61905497	MINOS1_chr1_+_19927280_19927465_19923603_19949967
DNAJC19_chr3_-_180704730_180704810_180703784_180705810	PSMC5_chr17_+_61905210_61905283_61904874_61905497	ARVCF_chr22_-_19958738_19958858_19958266_19959408
DNAJC2_chr7_-_102967778_102967825_102967131_102968102	PTCD3_chr2_+_86352917_86353003_86352638_86354283	NOP58_chr2_+_203142934_203143052_203142725_203147073
DNAJC8_chr1_-_28556641_28556763_28555534_28559431	PTDSS2_chr11_+_473894_473977_460288_479084	CD46_chr1_+_207963597_207963690_207959027_207966863
DNM1L_chr12_+_32890798_32890876_32890095_32891197	PTGES2_chr9_-_130887057_130887150_130886829_130887522	HS1BP3_chr2_-_20840732_20840940_20838412_20845099
DNM2_chr19_+_10919244_10919256_10916643_10922939	PTPA_chr9_+_131890242_131890347_131885417_131891263	RCOR3_chr1_+_211485696_211485829_211477482_211486061

AS Events	AS Events	AS Events
DPH7_chr9_-_140470160_140470344_140469295_140470531	PTPRS_chr19_-_5216730_5216778_5215606_5218430	STK36_chr2_+_219553113_219553216_219549951_219553419
DPP9_chr19_-_4683201_4683336_4682850_4683488	PTRH2_chr17_-_57776231_57777550_57775339_57784731	ACIN1_chr14_-_23536522_23537880_23535217_23538684
DPY30_chr2_-_32117060_32117203_32095021_32142994	PTS_chr11_+_112100930_112100953_112099396_112101348	ATG4B_chr2_+_242592721_242592784_242590750_242592926
DPY30_chr2_-_32248745_32248877_32248543_32254662	PVT1_chr8_+_129010445_129010605_129001537_129021835	SRRM1_chr1_+_24973569_24973699_24973280_249753449
DST_chr6_-_56333779_56333797_56330993_56334680	PXN_chr12_-_120653362_120653464_120653076_120659425	TMEM214_chr2_+_27260657_27260760_27260570_27261013
DYRK4_chr12_+_4716492_4716553_4714252_4719320	PXN_chr12_-_120653362_120653464_120653220_120659425	TMEM214_chr2_+_27260657_27260760_27260570_27261569
EBPL_chr13_-_50243912_50243982_50237331_50265389	PXN_chr12_-_120654075_120654384_120653464_120659425	IL4R_chr16_+_27352390_27352634_27351594_27353441
ECHDC2_chr1_-_53370705_53372283_53364896_53373539	PYROXD1_chr12_+_21605014_21605088_21602625_21608065	TMEM222_chr1_+_27657475_27657628_27657295_27658560
EDRF1_chr10_+_127417571_127417673_127414407_127417926	QTRT2_chr3_+_113786833_113786910_113785130_113789472	SRRM2_chr16_+_2818505_2818600_2818262_2818997
EED_chr11_+_85979497_85979603_85977258_85988021	RAB11FIP3_chr16_+_541133_541268_539000_546823	NSRP1_chr17_+_28483557_28483680_28445191_284995599
EHBP1_chr2_+_63215065_63215173_63206470_63217850	RABGEF1_chr7_+_66204982_66205779_66177211_66236869	BRE_chr2_+_28550140_28550314_28521358_28561316
EIF2D_chr1_-_206773086_206773190_206772446_206773616	RABGGTB_chr1_+_76255836_76255959_76255742_76256969	SRSF4_chr1_-_29486375_29486570_29485998_29486886
ELK1_chrX_-_47509319_47509425_47500874_47509821	RBM10_chrX_+_47034417_47034491_47032596_470358998	NAP1L4_chr11_-_2970456_2970494_2966876_2972488
EMC8_chr16_-_85813984_85814079_85813473_85814816	RBM26_chr13_-_79927287_79927359_79918929_79928573	MAZ_chr16_+_29820860_29821085_29820062_29821397
ENAH_chr1_-_225692692_225692755_225688772_225695652	RBM3_chrX_+_48434202_48434471_48434055_48434701	GATSL3_chr22_-_30684694_30684765_30683549_30685373
ENOSF1_chr18_-_678695_678737_677872_683245	RBM3_chrX_+_48434309_48434471_48434055_48434701	ASXL1_chr20_+_30959580_30959677_30956926_309599966
ENTPD6_chr20_+_25187711_25188033_25176503_25190484	RBM41_chrX_-_106356626_106356698_106332069_106358581	SMTN_chr22_+_31496870_31497035_31495882_315003001
ENTPD6_chr20_+_25187714_25188033_25176503_25190484	RBM4B_chr11_-_66433742_66433964_66433049_66436085	DTNA_chr18_+_32464691_32464740_32462165_324702623
EP400NL_chr12_+_132588541_132588715_132575488_132593116	RBM5_chr3_+_50137964_50138038_50137484_50140515	NT5C3A_chr7_-_33075545_33075600_33066527_33102179
EPB41L1_chr20_+_34783250_34783286_34782282_34785780	RBM5_chr3_+_50147811_50147896_50147121_50148111	ZNF263_chr16_+_3335680_3335754_3334205_3336022

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EPB41L1_chr20_+_34797409_34797820_34785963_34800193	RBM6_chr3_+_50012755_50012825_50000118_50085677	AK2_chr1_-_33497144_33497262_33490168_33502336
EPB41L2_chr6_-_131201283_131201346_131191266_131206235	RCC1_chr1_+_28834639_28834672_28832596_28843236	EVA1C_chr21_+_33873724_33873848_33867480_33887123
ERBIN_chr5_+_65370851_65371058_65350779_65372143	REPS1_chr6_-_139247537_139247618_139242261_139251113	CPNE1_chr20_-_34243123_34243266_34220845_34252681
ESYT2_chr7_-_158545471_158545534_158542414_158552176	RFC5_chr12_+_118455494_118455858_118454697_118456876	RBM39_chr20_-_34328446_34328519_34326939_34328745
ETHE1_chr19_-_44030352_44030501_44015718_44030666	RFC5_chr12_+_118455799_118455858_118454697_118456876	DONSON_chr21_-_34954470_34954552_34954361_34956895
EVI5L_chr19_+_7921977_7922010_7920954_7923076	RHBDF1_chr16_-_109296_109347_109091_109416	DONSON_chr21_-_34955793_34955972_34954361_34956895
EWSR1_chr22_+_29687550_29687588_29684775_29688125	RHOC_chr1_-_113247721_113247823_113246428_113249699	C20orf24_chr20_+_35236292_35236403_35236221_35238003
EWSR1_chr22_+_29687553_29687588_29684775_29688125	RHOC_chr1_-_113247721_113248874_113246428_113249699	SRSF3_chr6_+_36567597_36568053_36566760_36568928
EXD3_chr9_-_140269063_140269215_140268051_140277764	RHOT1_chr17_+_30536368_30536464_30535328_30551634	CWC25_chr17_-_36966528_36966653_36966018_36966720
EXOC1_chr4_+_56755053_56755098_56750094_56756388	RIC8B_chr12_+_107273552_107273725_107254190_107279681	GOLGA4_chr3_+_37402733_37402796_37396678_37407570
EXOC7_chr17_-_74086409_74086478_74085401_74090494	RILP_chr17_-_1550199_1550283_1549913_1551128	PLA2G6_chr22_-_38521645_38521698_38519265_38522377
EXOSC1_chr10_-_99198419_99198460_99197507_99200927	RIOK3_chr18_+_21047362_21047490_21046240_21053392	TMEM184B_chr22_-_38642790_38642891_38642106_38643775
EZH1_chr17_-_40871122_40871225_40865407_40872290	RNF146_chr6_+_127606352_127606493_127601485_127607194	TMEM184B_chr22_-_38642811_38642891_38642106_38643775
F3_chr1_-_95006127_95006622_95005924_95007092	RNF19A_chr8_-_101312755_101312879_101300495_101322094	HNRNPLL_chr2_-_38805061_38805144_38804674_38809054
FAAH_chr1_+_46871709_46871750_46871466_46874130	RNFT1_chr17_-_58037428_58037529_58035805_58039900	SRSF7_chr2_-_38976039_38976315_38975795_38976670
FAM111A_chr11_+_59910969_59913329_59910777_59919222	RNPEP_chr1_+_201958510_201958659_201958172_201965274	SRSF7_chr2_-_38976039_38976488_38975795_38976670
FAM114A2_chr5_-_153390800_153390880_153382529_153405958	ROGDI_chr16_-_4851267_4851322_4850579_4851503	THUMPD2_chr2_-_39984387_39984508_39983100_39988470
FAM136A_chr2_-_70528539_70528735_70528112_70529056	RP11-20I23.3_chr16_+_2577561_2577616_2571124_2577773	NT5C3B_chr17_-_39991839_39991894_39991524_39992110
FAM13A_chr4_-_89658622_89658706_89653349_89660180	RP11-216L13.19_chr9_+_139703706_139703881_139702778_139704139	NT5C3B_chr17_-_39991839_39991934_39991524_39992110

AS Events	AS Events	AS Events
FAM189B_chr1_-_155221523_155221699_155220955_155223415	RP11-529K1.3_chr16_+_70346511_70346560_70333257_70348804	HMGN1_chr21_-_40717755_40717884_40717200_40719304
FAM192A_chr16_-_57208080_57208198_57207781_57219732	RP11-848P1.9_chr17_+_29360312_29360383_29359524_29360941	HMGN1_chr21_-_40717755_40717884_40717200_40720217
FAM192A_chr16_-_57208531_57208600_57207781_57219732	RP4-800G7.2_chr7_+_148985521_148986548_148984867_148987028	HMGN1_chr21_-_40717755_40719218_40717200_40719304
FAM192A_chr16_-_57209450_57209612_57207781_57219732	RPL17_chr18_-_47018115_47018203_47017954_47018644	XPNPEP3_chr22_+_41266051_41266143_41265119_41277773
FAM192A_chr16_-_57212413_57212764_57207781_57219732	RPLP0_chr12_-_120636356_120636434_120635265_120636656	NDUFAF1_chr15_-_41686302_41686556_41680720_41687056
FAM192A_chr16_-_57212413_57212764_57207781_57219942	RPS24_chr10_+_79797722_79797740_79797062_79800372	SRSF6_chr20_+_42087792_42088060_42087149_42088410
FAM192A_chr16_-_57212621_57212764_57207781_57219732	RPS3A_chr4_+_152022126_152022314_152020866_152024022	GPATCH8_chr17_-_42544464_42544482_42541912_42552196
FAM193B_chr5_-_176959156_176959201_176958522_176959443	RSRC2_chr12_-_122998313_122998421_122995735_122999651	TCF20_chr22_-_42564614_42564742_42557364_42565852
FAM193B_chr5_-_176974168_176974229_176966148_176981249	RUBCN_chr3_-_197417944_197418019_197411088_197420585	HAUS2_chr15_+_42852979_42853068_42851606_42853467
FAM193B_chr5_-_176980168_176980351_176966148_176981249	RUFY1_chr5_+_179013331_179013476_179012866_179016546	TMEM62_chr15_+_43438690_43438832_43427847_43440952
FAM206A_chr9_+_111698587_111698717_111697969_111712786	S100A13_chr1_-_153600596_153600713_153600074_153603486	TP53BP1_chr15_-_43738963_43739108_43738788_43739563
FAM221A_chr7_+_23731801_23734532_23731215_23737810	S100A4_chr1_-_153517945_153517994_153517285_153518228	TP53BP1_chr15_-_43738963_43739112_43738788_43739563
FAM221A_chr7_+_23731801_23734532_23731215_23740404	SBDSP1_chr7_+_72301271_72301393_72300362_72302181	CORO7_chr16_-_4411749_4411804_4411470_4411985
FANCG_chr9_-_35078137_35078340_35077396_35078601	SBF1_chr22_-_50895462_50895540_50895102_50897683	ST3GAL3_chr1_+_44386453_44386600_44365399_44395803
FANCL_chr2_-_58390163_58390209_58388773_58390568	SCRIB_chr8_-_144886737_144886995_144886326_144887103	ATP6V0B_chr1_+_44441336_44441520_44440779_44441761
FAR2P2_chr2_-_131183738_131183836_131182731_131185276	SCRIB_chr8_-_144889721_144889784_144889183_144890778	ZNF223_chr19_+_44567417_44567719_44564994_44570216
FAT1_chr4_-_187511521_187511557_187510374_187516842	SEC11A_chr15_-_85223162_85223200_85214013_85230855	NMRAL1_chr16_-_4521314_4521450_4519466_4524093
FBXL6_chr8_-_145581098_145581162_145580781_145581287	SEC16A_chr9_-_139339503_139339563_139338352_139340096	PRPF39_chr14_+_45565626_45565961_45565431_45566089
FBXL6_chr8_-_145581116_145581162_145580781_145581287	SEC16A_chr9_-_139339503_139339563_139338352_139341306	PRPF39_chr14_+_45565798_45565961_45565431_45566089

AS Events	AS Events	AS Events
FBXO31_chr16_-_87392016_87392103_87380856_87393900	SEC16A_chr9_-_139340096_139340171_139338352_139341306	SPATA5L1_chr15_+_45699226_45699421_45697703_45702569
FCGRT_chr19_+_50024951_50025070_50016730_50027763	SEC31A_chr4_-_83763292_83763634_83750211_83765538	TTC38_chr22_+_46665038_46665186_46664488_46668231
FLAD1_chr1_+_154962035_154962183_154961325_154962634	SEC31A_chr4_-_83763337_83763634_83750211_83765538	POFUT2_chr21_-_46685936_46686142_46685550_46687504
FLOT2_chr17_-_27211242_27211333_27210249_27212874	SEC31A_chr4_-_83782783_83782861_83778917_83784470	TTC38_chr22_+_46688099_46688225_46685796_46688687
FLOT2_chr17_-_27211242_27211333_27210249_27215962	SEC61A2_chr10_+_12197776_12197930_12191960_12198905	MKNK1_chr1_-_47051545_47051646_47049001_47059784
FLOT2_chr17_-_27212874_27212965_27211333_27215962	SERHL2_chr22_+_42959394_42959487_42956271_42967126	DHX34_chr19_+_47880171_47880246_47879817_47880356
FNIP1_chr5_-_131046270_131046354_131044965_131052257	SETD3_chr14_-_99927528_99927677_99925522_99929822	HDAC7_chr12_-_48186320_48186452_48185787_48187151
FOLH1_chr11_-_49179503_49179595_49178359_49186256	SETD4_chr21_-_37429681_37429775_37429502_37431113	ROGDI_chr16_-_4851050_4851322_4850579_4851503
FOLH1_chr11_-_49228329_49228426_49227724_49229843	SF1_chr11_-_64540901_64540977_64537880_64543969	SMAD4_chr18_+_48603676_48603789_48603146_48604625
FOPNL_chr16_-_15976805_15976877_15973745_15977864	SHMT2_chr12_+_57625263_57625343_57624783_57625495	UBE2V1_chr20_-_48713019_48713357_48700791_48729643
FOXRED1_chr11_+_126144821_126144916_126143349_126145221	SHROOM1_chr5_-_132161968_132162279_132161874_132166285	KANSL2_chr12_-_49056342_49056437_49054402_49061475
FOXRED1_chr11_+_126144825_126144916_126143349_126145221	SLC12A7_chr5_-_1056696_1056711_1053597_1057585	LMBR1L_chr12_-_49500293_49500529_49499740_49500743
FRG1_chr4_+_190874222_190874280_190873442_190878552	SLC20A1_chr2_+_113410465_113410524_113410375_113414698	LMBR1L_chr12_-_49500327_49500529_49499740_49500743
FRRS1_chr1_-_100176910_100177088_100176505_100177660	SLC25A13_chr7_-_95864113_95864229_95838289_95906507	LMBR1L_chr12_-_49500436_49500529_49499740_49500743
FUS_chr16_+_31198122_31198157_31196500_31199645	SLC25A45_chr11_-_65144803_65144894_65144547_65146846	SNRNP70_chr19_+_49605370_49605430_49604728_49607890
FXR1_chr3_+_180688862_180688943_180688146_180693100	SLC27A3_chr1_+_153750236_153750361_153749696_153750636	SNRNP70_chr19_+_49605370_49605442_49604728_49607890
FXYD3_chr19_+_35610071_35610155_35607263_35610266	SLC29A2_chr11_-_66133901_66134035_66133702_66134934	SNRNP70_chr19_+_49605370_49606844_49604728_49607890
G6PC3_chr17_+_42152336_42152455_42152138_42152677	SLC38A10_chr17_-_79223869_79223893_79220861_79225292	TBC1D17_chr19_+_50382579_50382761_50381829_50383535
GALK2_chr15_+_49611168_49611313_49584734_49611800	SLC38A5_chrX_-_48324401_48324480_48321365_48325185	CERS5_chr12_-_50538551_50538752_50537840_50560883
GATAD2A_chr19_+_19612777_19612852_19612225_19613139	SLC4A7_chr3_-_27472788_27473160_27465643_27475406	LETMD1_chr12_+_51445874_51445990_51442968_51450132

AS Events	AS Events	AS Events
GBP3_chr1_-_89476586_89476799_89475177_89478867	SLK_chr10_+_105770573_105770666_105768114_105777917	MBD2_chr18_-_51714083_51714207_51692536_51715243
GCFC2_chr2_-_75919102_75919226_75917845_75921366	SLTM_chr15_-_59182479_59182660_59181753_59185095	DCUN1D4_chr4_+_52753288_52753410_52752804_52757925
GEMIN4_chr17_-_653053_653149_651272_655372	SLTM_chr15_-_59191667_59192082_59191051_59193458	NUP88_chr17_-_5321334_5321461_5320002_5322673
GFM2_chr5_-_74026084_74026223_74021951_74028846	SLTM_chr15_-_59191667_59192136_59191051_59193458	HRAS_chr11_-_533276_533358_532755_533452
GGT1_chr22_+_25004956_25005198_25003990_25005931	SMARCA2_chr9_+_2170418_2170472_2161903_2181570	RDH13_chr19_-_55559413_55559625_55558856_55559696
GGT1_chr22_+_25004956_25005198_25003990_25006324	SMARCA4_chr19_+_11144442_11144541_11144193_11144798	NPEPL1_chr20_+_57280553_57280625_57276214_57282178
GGT5_chr22_-_24628018_24628176_24627498_24640520	SMARCC2_chr12_-_56558086_56558152_56557549_56558431	TMX2_chr11_+_57505307_57505498_57505140_57505825
GIT2_chr12_-_110383064_110383154_110377052_110385060	SMIM7_chr19_-_16764845_16764936_16758072_16770205	CTNND1_chr11_+_57556508_57556627_57529518_57558963
GLT8D1_chr3_-_52738739_52738968_52734512_52739462	SMPD4_chr2_-_130917085_130917207_130914969_130918758	CTNND1_chr11_+_57556508_57556627_57529518_57561481
GMFB_chr14_-_54948839_54948920_54948176_54950388	SMPDL3A_chr6_+_123116821_123117035_123110603_123117968	CTNND1_chr11_+_57556508_57556627_57529518_57563048
GOLGA2_chr9_-_131035063_131035144_131030803_131036128	SMPDL3A_chr6_+_123122454_123122551_123118113_123124808	SLMAP_chr3_+_57911571_57911661_57908750_57913022
GOLGA2P7_chr15_-_84873982_84874071_84873727_84898653	SMPDL3A_chr6_+_123122454_123122551_123118113_123126053	FLNB_chr3_+_58138434_58138581_58135729_58139101
GOLGA8A_chr15_-_34727583_34727672_34699936_34729598	SMTN_chr22_+_31489769_31489862_31487468_31491288	STX3_chr11_+_59564755_59564869_59562955_59568327
GPATCH2_chr1_-_217668356_217668417_217665092_217671697	SMTN_chr22_+_31496870_31496939_31495882_31500301	AHSA2_chr2_+_61410681_61410797_61408540_61411846
GTPBP1_chr22_+_39104849_39104961_39102152_39111911	SNHG16_chr17_+_74555026_74555125_74553939_74557369	SLC38A6_chr14_+_61514868_61515015_61512885_61517229
GUF1_chr4_+_44690023_44690163_44688730_44691302	SNHG5_chr6_-_86387508_86387593_86387210_86387671	TPM1_chr15_+_63353396_63353472_63353138_63353911
GUK1_chr1_+_228329326_228329530_228328989_228333211	SNHG5_chr6_-_86387512_86387593_86387210_86387671	TPM1_chr15_+_63353911_63353987_63353472_63354413
GUSB_chr7_-_65435268_65435353_65432894_65439281	SNRPA1_chr15_-_101826418_101826498_101826006_101827112	TPM1_chr15_+_63356262_63356389_63354844_63358094
GUSB_chr7_-_65444713_65444898_65441189_65445210	SNRPA1_chr15_-_101833229_101833377_101827907_101835301	USP3_chr15_+_63821212_63821365_63797029_63824845
GUSB_chr7_-_65444713_65444898_65444528_65445210	SNRPG_chr2_-_70516481_70516504_70515324_70520749	USP3_chr15_+_63826001_63826117_63824906_63829223
GUSB_chr7_-_65444820_65444898_65441189_65445210	SON_chr21_+_34944856_34944936_34941393_34945613	NUDT22_chr11_+_63997321_63997542_63997043_63997654

AS Events	AS Events	AS Events
GUSB_chr7_-_65444820_65444898_65444528_65445210	SORBS2_chr4_-_186605907_186605996_186599976_186696380	VPS54_chr2_-_64140958_64141059_64140444_64141315
HACL1_chr3_-_15626754_15626849_15624496_15631046	SORBS2_chr4_-_186605907_186606000_186599976_186696380	TMEM5_chr12_+_64176320_64176484_64174954_64178749
HAPLN3_chr15_-_89422648_89422683_89422500_89424587	SPAG9_chr17_-_49053223_49053262_49052308_49054468	RAB40C_chr16_+_646316_646448_640433_667207
HDAC6_chrX_+_48676626_48676819_48676516_48681029	SPIN1_chr9_+_91033692_91033866_91003453_91041296	TM7SF2_chr11_+_64883246_64883294_64882866_64883364
HDAC6_chrX_+_48678512_48678662_48676516_48681029	SPIN1_chr9_+_91033764_91033866_91003453_91041296	UHRF2_chr9_+_6492302_6492401_6486925_6493825
HDDC2_chr6_-_125619859_125619962_125614055_125621683	SPOP_chr17_-_47714120_47714171_47700238_47723477	ARFIP2_chr11_-_6499808_6499882_6499428_6499967
HDHD2_chr18_-_44663605_44663667_44662820_44676748	SPTAN1_chr9_+_131355261_131355321_131353904_131356453	GUSB_chr7_-_65444385_65444528_65441189_65445210
HDHD2_chr18_-_44663605_44663709_44662820_44676748	SPTAN1_chr9_+_131391403_131391466_131390221_131392599	SREK1_chr5_+_65451892_65454760_65449424_65455046
HEATR5B_chr2_-_37217790_37217942_37216002_37227728	SRPK2_chr7_-_104909252_104909316_104844232_105029094	SREK1_chr5_+_65454636_65454760_65449424_65455046
HEXA_chr15_-_72646031_72646078_72643575_72647899	SRSF2_chr17_-_74731853_74731957_74731240_74732235	CRCP_chr7_+_65595113_65595235_65592727_65595730
HEXA_chr15_-_72646031_72646078_72645519_72647899	SSBP3_chr1_-_54723741_54723822_54722859_54747110	DPP8_chr15_-_65748049_65748179_65746753_65748562
HINFP_chr11_+_119002952_119003007_119002692_119003205	ST7_chr7_+_116738666_116738869_116593745_116739815	XAF1_chr17_+_6662574_6662838_6661543_6662980
HMGN1_chr21_-_40719172_40719218_40717200_40719304	ST7_chr7_+_116774177_116774246_116772014_116776134	RPS6KB2_chr11_+_67199823_67199963_67198986_67200070
HMGN3_chr6_-_79911779_79911872_79911443_79911992	ST7_chr7_+_116830186_116830322_116829447_116830887	RPS6KB2_chr11_+_67199826_67199963_67198986_67200070
HNRNPA1_chr12_+_54676862_54677018_54676658_54677595	ST7L_chr1_-_113159434_113159517_113153625_113161530	CHKA_chr11_-_67828959_67829297_67821514_67829419
HNRNPA2B1_chr7_-_26230612_26230748_26230080_26232114	STAU1_chr20_-_47795658_47795781_47770608_47804652	MCRIP2_chr16_+_696471_696608_692249_697416
HNRNPAB_chr5_+_177637132_177637273_177636448_177637553	STIM1_chr11_+_4105902_4105995_4104728_4107706	PPFIA1_chr11_+_70228193_70228264_70224301_70229108
HNRNPH1_chr5_-_179046269_179046361_179045324_179047892	STRN3_chr14_-_31398406_31398517_31381388_31404368	SLC25A16_chr10_-_70276840_70276942_70276600_70287002
HNRNPH1_chr5_-_179046269_179046408_179045324_179047892	STX8_chr17_-_9460750_9460845_9408479_9471687	SLC25A16_chr10_-_70276840_70277022_70276600_70287002
HNRNPH3_chr10_+_70097614_70097753_70097090_70098259	STYXL1_chr7_-_75643059_75643205_75634722_75651168	COG4_chr16_-_70549770_70549943_70548412_70551528

AS Events	AS Events	AS Events
HNRNPK_chr9_-_86588816_86588888_86588314_86589431	SUPT20H_chr13_-_37599456_37599574_37598579_37600340	SF3B3_chr16_+_70584552_70584581_70582345_70588348
HNRNPM_chr19_+_8527412_8527465_8520458_8528380	SVIL_chr10_-_29797270_29797318_29788192_29801663	SRSF11_chr1_+_70697541_70697658_70694238_706979500
IDE_chr10_-_94240549_94240673_94239178_94243011	SVIL_chr10_-_29820930_29821101_29820217_29839525	NADSYN1_chr11_+_71187078_71188484_71185572_711894400
IFI44_chr1_+_79126238_79126339_79125168_79128388	SVIL_chr10_-_29821457_29822387_29820217_29839525	NAGK_chr2_+_71302691_71302772_71300724_71304687
IFI44_chr1_+_79126238_79126376_79125168_79128388	SVIL_chr10_-_29824917_29824998_29820217_29839525	ZRANB2_chr1_-_71531360_71531435_71530820_71532458
IFT172_chr2_-_27688277_27688385_27686048_27693794	SYNE2_chr14_+_64682003_64682072_64681188_646829665	TBL2_chr7_-_72990870_72991031_72988843_72992749
IFT172_chr2_-_27688612_27688749_27686048_27693794	SYNE4_chr19_-_36497503_36497573_36496339_36497651	ABHD11_chr7_-_73152205_73152402_73152065_73152657
IFT43_chr14_+_76524984_76525017_76488737_76548637	SYNE4_chr19_-_36497503_36497573_36496339_36499455	ABHD11_chr7_-_73152205_73152472_73152065_73152657
IFT81_chr12_+_110581186_110581350_110574665_110584757	SYNE4_chr19_-_36498026_36498170_36496339_36499455	NUP85_chr17_+_73225092_73225226_73222252_732274344
IFT88_chr13_+_21237401_21237525_21230569_21237636	SZRD1_chr1_+_16717869_16717919_16693803_16721532	TMEM94_chr17_+_73488319_73488418_73487981_73488554
IGHMBP2_chr11_+_68697790_68697902_68696825_68700766	TAMM41_chr3_-_11868191_11868279_11858811_11871187	MTO1_chr6_+_74181182_74181280_74176329_74183087
ILF3_chr19_+_10791021_10791119_10790603_10791694	TARBP1_chr1_-_234536598_234536694_234534299_234536926	COQ6_chr14_+_74422153_74422212_74420272_74422507
IMMP1L_chr11_-_31477806_31477933_31455117_31531065	TAX1BP1_chr7_+_27856508_27856657_27839709_27867356	JMJD6_chr17_-_74717344_74717433_74716580_74717879
IMMP1L_chr11_-_31484718_31484852_31455117_31531065	TBC1D1_chr4_+_38054726_38054846_38051519_380558119	JMJD6_chr17_-_74717344_74717438_74716580_74717879
IMMP2L_chr7_-_111172573_111172641_111161505_111201906	TBC1D22B_chr6_+_37259018_37259133_37254848_37280693	ABCD4_chr14_-_74764632_74764772_74763152_74766250
ING3_chr7_+_120604795_120604892_120595678_120606679	TBC1D23_chr3_+_100030676_100030721_100029386_100034942	TMEM70_chr8_+_74891313_74891406_74891096_74893389
INO80C_chr18_-_33067349_33067403_33060527_33077682	TBCE_chr1_+_235564817_235564902_235543464_235577747	FAM219B_chr15_-_75197322_75197380_75197053_75197494
INO80E_chr16_+_30012734_30012851_30012361_30016541	TBCE_chr1_+_235596260_235596413_235594119_235597518	FAM219B_chr15_-_75197322_75197400_75197053_75197494
INO80E_chr16_+_30012785_30012851_30012361_30016541	TBRG4_chr7_-_45143697_45143855_45143042_45144136	RHBDD2_chr7_+_75510682_75510804_75508578_75511146
INO80E_chr16_+_30014756_30014847_30012851_30015888	TBRG4_chr7_-_45144136_45144308_45143042_45145039	AFMID_chr17_+_76201520_76201599_76200981_76202026

AS Events	AS Events	AS Events
INO80E_chr16_+_30014970_30014991_30012851_30015888	TBX3_chr12_-_115117717_115117777_115117456_115118683	BIRC5_chr17_+_76218908_76219073_76210870_76219545
INO80E_chr16_+_30015875_30015978_30012361_30016541	TCOF1_chr5_+_149771106_149771358_149769586_149771519	BIRC5_chr17_+_76218908_76219073_76212862_76219545
INO80E_chr16_+_30015888_30015978_30012851_30016541	TDG_chr12_+_104376913_104376996_104376712_104377072	PDDC1_chr11_-_773427_773629_772521_774007
INTS4_chr11_-_77622015_77622198_77618856_77629866	TEAD1_chr11_+_12900435_12900447_12886447_12901254	PQLC1_chr18_-_77690227_77690311_77679400_77693968
IPO9_chr1_+_201804081_201804192_201798500_201816406	TEP1_chr14_-_20840891_20841016_20839791_20841169	PQLC1_chr18_-_77690227_77690311_77679400_77703328
IQCB1_chr3_-_121507130_121507279_121500721_121508919	TEX264_chr3_+_51708286_51708578_51705304_51718428	TXNL4A_chr18_-_77736717_77736787_77733856_77748239
IQSEC1_chr3_-_12944272_12944322_12943022_12949848	THAP9-AS1_chr4_-_83816844_83816927_83816000_83821229	IDH3A_chr15_+_78449249_78449504_78447617_78449889
KCTD6_chr3_+_58479879_58480135_58477896_58484439	THOC5_chr22_-_29927066_29927099_29925228_29927819	ATP5C1_chr10_+_7848936_7848973_7844817_7849621
KDM6A_chrX_+_44921891_44921993_44920664_44922666	TIAL1_chr10_-_121336358_121336417_121336262_121336591	BAIAP2_chr17_+_79084713_79084759_79082309_79089569
KIAA1191_chr5_-_175786464_175786570_175782752_175786813	TIAL1_chr10_-_121339982_121340050_121339522_121341433	RPS24_chr10_+_79799958_79799983_79797062_798003 72
KIAA1468_chr18_+_59947006_59947089_59942706_59947592	TKFC_chr11_+_61103311_61103409_61102203_61105412	RPS24_chr10_+_79799961_79799983_79797062_798003 72
KIF13A_chr6_-_17771344_17771449_17765177_17772138	TMED5_chr1_-_93624371_93624442_93622040_93625685	HEXDC_chr17_+_80398348_80398489_80397589_80398872
KIF21A_chr12_-_39724043_39724064_39720126_39724547	TMEM136_chr11_+_120198149_120198349_120196077_120200685	WDR73_chr15_-_85189203_85189316_85189067_85189414
KLHL29_chr2_+_23907268_23907407_23865720_23914543	TMEM14B_chr6_+_10751365_10751467_10749931_10770309	ME3_chr11_-_86168407_86168801_86161440_86176132
KLK2_chr19_+_51380959_51381012_51380264_51381659	TMEM168_chr7_-_112424909_112425008_112415373_112430214	METTL22_chr16_+_8738385_8738582_8736422_8739964
KLK2_chr19_+_51380962_51381012_51380264_51381659	TMEM183A_chr1_+_202986883_202987047_202985268_202987608	METTL22_chr16_+_8738413_8738582_8736422_8739964
KTN1_chr14_+_56130672_56130759_56128330_56133958	TMEM184A_chr7_-_1589182_1589240_1588324_1589489	C12orf29_chr12_+_88433924_88434042_88429515_88436601
KXD1_chr19_+_18671229_18671360_18668724_18672845	TMEM260_chr14_+_57088248_57088420_57085481_57092099	THNSL2_chr2_+_88485069_88485243_88478532_88485416
LAS1L_chrX_-_64744443_64744494_64744142_64744844	TMEM62_chr15_+_43430771_43430817_43427847_43440952	GALNS_chr16_-_88909437_88909607_88909237_88923165
LAS1L_chrX_-_64748139_64748249_64744930_64749091	TMEM62_chr15_+_43470804_43470909_43461875_43473378	HAPLN3_chr15_-_89422648_89423841_89422500_89424587

AS Events	AS Events	AS Events
LIMCH1_chr4_+_41640948_41640984_41621457_41646516	TNFAIP2_chr14_+_103590711_103590843_103589820_103592646	POLG_chr15_-_89875448_89875605_89873507_89876326
LMAN2L_chr2_-_97403685_97403804_97400263_97405590	TNFSF10_chr3_-_172229406_172229449_172227111_172232650	TCF25_chr16_+_89944868_89945035_89940267_89949758
LPAR2_chr19_-_19738562_19738778_19738093_19738900	TOM1L2_chr17_-_17761082_17761169_17754266_17764789	MBOAT2_chr2_-_9002400_9002452_9000894_9002719
LRRC23_chr12_+_7015008_7015118_7014923_7015572	TOMM34_chr20_-_43577370_43577518_43572220_43580473	C14orf159_chr14_+_91690022_91690139_91681900_91691027
LRRC27_chr10_+_134155716_134155775_134151199_134158001	TPCN2_chr11_+_68847301_68847351_68846488_68848867	PPP4R3A_chr14_-_91932604_91932760_91931763_91937180
LRRC37B_chr17_+_30372718_30372837_30362658_30374779	TPM1_chr15_+_63335904_63336030_63335142_63336225	MED17_chr11_+_93527415_93527605_93527201_93528073
LRRC75A-AS1_chr17_+_16342841_16343017_16342728_16343498	TPTEP1_chr22_+_17092547_17092783_17083105_17119468	TMEM175_chr4_+_942198_942403_941942_944208
LRRC75A-AS1_chr17_+_16342973_16343017_16342728_16343424	TRA2A_chr7_-_23561739_23562051_23561459_23571407	ANKRD49_chr11_+_94231067_94231130_94230117_94231236
LRRFIP1_chr2_+_238626404_238626452_238617273_238628165	TRA2A_chr7_-_23561750_23562051_23561459_23570799	TMEM175_chr4_+_942298_942403_941942_944208
LRRFIP1_chr2_+_238647874_238647952_238617273_238657006	TRA2A_chr7_-_23561750_23562051_23561459_23571407	NOL8_chr9_-_95082224_95082419_95081638_95083949
LRRFIP1_chr2_+_238647874_238647952_238629465_238657006	TRA2A_chr7_-_23561972_23562051_23561459_23571407	NOL8_chr9_-_95082224_95082661_95081638_95083949
LRRFIP1_chr2_+_238659842_238659914_238657967_238661951	TRAK2_chr2_-_202265740_202265817_202264216_202272125	FAM76B_chr11_-_95512241_95512299_95512118_95512770
LRRFIP2_chr3_-_37132957_37133029_37125297_37136282	TRDN_chr6_-_123696749_123696776_123687327_123698860	FAM76B_chr11_-_95512241_95512299_95512121_95512770
LRRFIP2_chr3_-_37146945_37147014_37138151_37162982	TRIM14_chr9_-_100872350_100872516_100872266_100881263	LMAN2L_chr2_-_97399255_97399338_97377762_97400145
LTBP3_chr11_-_65307483_65307624_65307352_65307715	TRIP10_chr19_+_6746039_6746207_6745005_6746462	MMS19_chr10_-_99236591_99236676_99236501_99237103
LUC7L_chr16_-_258599_258663_258187_270647	TRIP4_chr15_+_64706283_64706410_64702027_64710739	MMS19_chr10_-_99236591_99236720_99236501_99237103
LUC7L_chr16_-_278331_278401_277335_279277	TRIT1_chr1_-_40318402_40318548_40315933_40319641	AP4M1_chr7_+_99699868_99700016_99699591_99700297
MADD_chr11_+_47310518_47310578_47308085_47310941	TRMT2B_chrX_-_100306239_100306722_100297301_100306805	
MAN2B1_chr19_-_12769241_12769321_12769158_12772073	TRMT2B_chrX_-_100306632_100306722_100297301_100306805	

Table 1d: Oversap AS CL&Myc

AS Events	AS Events	AS Events
SRSF3_chr6_+_36567597_36568053_36566760_36568928	OXNAD1_chr3_+_16313651_16313828_16313229_16327848	ABI1_chr10_-_27044583_27044670_27040712_27054146
FAM76B_chr11_-_95512241_95512299_95512121_95512770	TRA2A_chr7_-_23561739_23562051_23561459_23571407	SETD4_chr21_-_37429681_37429775_37429502_37431113
PPP4R3A_chr14_-_91932604_91932760_91931763_91937180	TRA2A_chr7_-_23561750_23562051_23561459_23571407	PMPCB_chr7_+_102948042_102948155_102944937_102949398
METTL22_chr16_+_8738413_8738582_8736422_8739964	SLTM_chr15_-_59191667_59192136_59191051_59193458	MYL6_chr12_+_56553370_56553406_56552495_56553758
ME3_chr11_-_86168407_86168801_86161440_86176132	SLTM_chr15_-_59191667_59192082_59191051_59193458	TTC31_chr2_+_74717151_74717254_74710537_74717370
RPS24_chr10_+_79799961_79799983_79797062_79800372	MYO18A_chr17_-_27412621_27412666_27409456_27413455	DNAJC2_chr7_-_102967778_102967825_102967131_102968102
JMJD6_chr17_-_74717344_74717433_74716580_74717879	HNRNPH1_chr5_-_179046269_179046408_179045324_179047892	TBX3_chr12_-_115117717_115117777_115117456_115118683
JMJD6_chr17_-_74717344_74717438_74716580_74717879	ZNF706_chr8_-_102214560_102214675_102213971_102217662	TAMM41_chr3_-_11868191_11868279_11858811_11871187
ZRANB2_chr1_-_71531360_71531435_71530820_71532458	DAZAP1_chr19_+_1425876_1425959_1422395_1428840	ABI1_chr10_-_27044583_27044670_27040712_27047990
SRSF11_chr1_+_70697541_70697658_70694238_70697950	DPP9_chr19_-_4683201_4683336_4682850_4683488	NAA16_chr13_+_41936866_41937009_41936295_41941574
MCRIP2_chr16_+_696471_696608_692249_697416	SNRPA1_chr15_-_101826418_101826498_101826006_101827112	SNRPA1_chr15_-_101833229_101833377_101827907_101835301
SREK1_chr5_+_65454636_65454760_65449424_65455046	HNRNPH1_chr5_-_179046269_179046361_179045324_179047892	ARIH2_chr3_+_48982568_48982614_48965246_48999044
SREK1_chr5_+_65451892_65454760_65449424_65455046	NADSYN1_chr11_+_71191264_71191320_71189515_71191800	HMGN3_chr6_-_79911779_79911872_79911443_79911992
USP3_chr15_+_63826001_63826117_63824906_63829223	SYNE2_chr14_+_64682003_64682072_64681188_64682965	MRPL22_chr5_+_154330362_154330498_154320825_154335930
USP3_chr15_+_63821212_63821365_63797029_63824845	AC005154.6_chr7_-_30618621_30618744_30617707_30618846	ZNF207_chr17_+_30693683_30693776_30692506_30694790
HRAS_chr11_-_533276_533358_532755_533452	FAM136A_chr2_-_70528539_70528735_70528112_70529056	MMS19_chr10_-_99228722_99228861_99228163_99229402
DCUN1D4_chr4_+_52753288_52753410_52752804_52757925	PSMC5_chr17_+_61905033_61905283_61904874_61905497	RHOC_chr1_-_113247721_113248874_113246428_113249699
SNRNP70_chr19_+_49605370_49605430_49604728_49607890	PLEKHM2_chr1_+_16047823_16047883_16046415_16051811	KIAA1191_chr5_-_175786464_175786570_175782752_175786813
SNRNP70_chr19_+_49605370_49606844_49604728_49607890	NACA_chr12_-_57109654_57109990_57108471_57113320	GUF1_chr4_+_44690023_44690163_44688730_44691302

AS Events	AS Events	AS Events
SNRNP70_chr19_+_49605370_49605442_49604728_49607890	MRPL33_chr2_+_27997290_27997397_27995559_28002299	SEC31A_chr4_-_83782783_83782861_83778917_83784470
HMGN1_chr21_-_40717755_40719218_40717200_40719304	KIAA1468_chr18_+_59947006_59947089_59942706_59947592	NDRG2_chr14_-_21492188_21492255_21491480_21493835
HMGN1_chr21_-_40717755_40717884_40717200_40719304	MAP2K7_chr19_+_7970692_7970740_7968953_7974639	RHOC_chr1_-_113247721_113247823_113246428_113249699
RBM39_chr20_-_34328446_34328519_34326939_34328745	PBRM1_chr3_-_52588739_52588895_52584833_52595782	DNAJC14_chr12_-_56223272_56223420_56222498_56224479
NT5C3A_chr7_-_33075545_33075600_33066527_33102179	LUC7L_chr16_-_258599_258663_258187_270647	RFC5_chr12_+_118455494_118455858_118454697_118456876
ASXL1_chr20_+_30959580_30959677_30956926_30959966	ZNF83_chr19_-_53119970_53120128_53118050_53122188	YTHDC2_chr5_+_112860677_112860874_112851059_112868575
SRRM1_chr1_+_24973569_24973699_24973280_24975349	ZNF83_chr19_-_53119970_53120068_53118050_53122188	ZNF271P_chr18_+_32870973_32871196_32870355_32885939
MINOS1_chr1_+_19927280_19927465_19923603_19949967	KIF13A_chr6_-_17771344_17771449_17765177_17772138	ZNF326_chr1_+_90472903_90473309_90470803_90475646
TRA2B_chr3_-_185649364_185649640_185644522_185655612	D2HGDH_chr2_+_242688279_242689344_242684292_242689565	EDRF1_chr10_+_127417571_127417673_127414407_127417926
TRA2B_chr3_-_185649364_185649640_185643414_185655612	ZNF83_chr19_-_53119970_53120094_53118050_53122188	LTBP3_chr11_-_65307483_65307624_65307352_65307715
MPRIP_chr17_+_17083920_17083983_17083402_17088136	IFI44_chr1_+_79126238_79126339_79125168_79128388	DFFB_chr1_+_3782847_3782962_3782564_3784537
OXNAD1_chr3_+_16313651_16313828_16313229_16327848	WNK2_chr9_+_96069058_96069103_96060349_96070609	DNM1L_chr12_+_32890798_32890876_32890095_32891197
MAP3K4_chr6_+_161529982_161530073_161529891_161530786	HNRNPH3_chr10_+_70097614_70097753_70097090_70098259	AARSD1_chr17_-_41105740_41105795_41103911_41106892
INTS3_chr1_+_153733495_153733585_153733394_153734045	ESYT2_chr7_-_158545471_158545534_158542414_158552176	MICAL3_chr22_-_18310409_18310547_18305826_18314619
THEM4_chr1_-_151862458_151862690_151861849_151867483	PBRM1_chr3_-_52592264_52592429_52584833_52595782	CALD1_chr7_+_134620438_134620516_134618141_134625842
TCERG1_chr5_+_145889629_145889723_145888808_145890003	SMARCA4_chr19_+_11144442_11144541_11144193_11144798	SLC38A5_chrX_-_48324401_48324480_48321365_48325185
DDX39A_chr19_-_14521232_14521417_14521146_14521800	PAOX_chr10_+_135197463_135197716_135195163_135202459	EBPL_chr13_-_50243912_50243982_50237331_50265389
DDX39A_chr19_-_14521359_14521417_14521146_14521800	CASP6_chr4_-_110617565_110617642_110615856_110618777	YPEL5_chr2_+_30371110_30371407_30369928_30379493
GK5_chr3_-_141903552_141904635_141901891_141904770	DCAF8_chr1_-_160231074_160231148_160213824_160232238	DIAPH2_chrX_+_95990756_95990789_95940189_95993584
NDUFAF5_chr20_+_13795063_13795161_13789548_13797108	FOXRED1_chr11_+_126144821_126144916_126143349_126145221	KTN1_chr14_+_56130672_56130759_56128330_56133958

AS Events	AS Events	AS Events
BCLAF1_chr6_-_136590278_136590441_136589477_136590574	EPB41L1_chr20_+_34797409_34797820_34785963_348001 93	BRD8_chr5_-_137495243_137495288_137492956_137495757
PPP2R2D_chr10_+_133748397_133748510_133748059_13 3753534	TKFC_chr11_+_61103311_61103409_61102203_61105412	RP11-216L13.19_chr9_+_139703706_139703881_139702778_13 9704139
TRMT11_chr6_+_126327987_126328100_126320759_126 329537	LUC7L_chr16_-_278331_278401_277335_279277	NDUFAF7_chr2_+_37469777_37469836_37468780_37471 005
MRRF_chr9_+_125048317_125048445_125047566_12505 4027	IFI44_chr1_+_79126238_79126376_79125168_79128388	FNIP1_chr5_-_131046270_131046354_131044965_131052257
TIAL1_chr10_-_121339982_121340358_121339522_121341433	PSAP_chr10_-_73583644_73583653_73581764_73585593	SYNE4_chr19_-_36498026_36498170_36496339_36499455
LAMP2_chrX_-_119572930_119573148_119565317_119575584	NAA25_chr12_-_112487286_112487415_112486247_112491361	CCNDBP1_chr15_+_43482252_43482349_43481478_4348 2522
TAMM41_chr3_-_11874476_11874625_11871338_11880695	TIAL1_chr10_-_121339982_121340050_121339522_121341433	TCOF1_chr5_+_149771106_149771358_149769586_1497 71519
MAGOHB_chr12_-_10761696_10761982_10760535_10762429	ARL4A_chr7_+_12727259_12727353_12726668_12727790	ZNF326_chr1_+_90473170_90473309_90470803_9047564 6
NT5C2_chr10_-_104871501_104871562_104866463_104899162	TARBP1_chr1_-_234536598_234536694_234534299_234536926	CMTM7_chr3_+_32490945_32491044_32483505_324938 83
SRRT_chr7_+_100480385_100480711_100479862_100481 690	CTPS1_chr1_+_41473120_41473217_41471766_41474330	FLOT2_chr17_-_27211242_27211333_27210249_27212874

C. Methods

1. RNA-Seq data processing framework

[0288] A comprehensive RNA-Seq dataset was compiled from published prostate cancer and normal prostate datasets that reflect the full progression of prostate cancer. In total, 876 samples were downloaded from different sources. RNA-Seq Fastq files of normal prostate samples (GTEx consortium (31)) and prostate cancer samples (Beltran study (10), Robinson study (11) and Stand-Up-To-Cancer study (12)) were downloaded from dbGAP (85, 86) via *fastq-dump* in SRA toolkit. RNA-Seq Fastq files from TCGA primary prostate cancer and adjacent benign samples were downloaded from GDC via gdc-client (87).

[0289] A unified RNA-Seq processing framework was constructed to perform read mapping as well as gene and isoform quantification on the collected multi-phenotypic prostate RNA-Seq samples. Specifically, read mapping was done by STAR 2.5.3a (88) with a STAR 2-pass function enabled to improve the detection of splicing junctions. The STAR genome index was built with --sjdbOverhang 100 as a generic parameter to handle differences in read length of RNA-Seq samples from various sources. The genome annotation file was downloaded from GENCODE V26 (89) under human genome version hg19 (GRCh37). The subsequent gene/isoform expression quantification is performed by Cufflinks (90) with default parameters.

[0290] RNA-Seq alternative splicing quantification is conducted uniformly with a newly engineered version (v4.0.2) of the rMATS-turbo software package (29, 30). An exon-based ratio metric, commonly defined as Percent-Spliced-In (PSI) ratio, was employed to measure the alternative splicing events. The PSI ratio is calculated as follows:

$$\Psi = \frac{I/l_I}{S/l_S + I/l_I}$$

where S and I are the number of read mapped to the junction supporting skipping and inclusion form. Effective length l is used for normalization.

[0291] Customized scripts were applied to calculate PSI value for each individual alternative splicing event from the rMATS-turbo junction count output. To build a confident set of exon events, the splice junction of each event was required to be covered by no less than 10 splice junction reads. Additionally, each event was required to have a PSI range greater than 5% across the entire dataset (|maxPSI – minPSI| > 5%), with a mean skipping or inclusion value over 5%. Events with missing values in the majority (over 99%) of samples were removed.

2. Analysis and evaluation of alternative splicing profile of prostate cancer meta-dataset

[0292] Principal component analysis (PCA) was applied to inspect the RNA-Seq derived gene expression/alternative splicing profiles of the multi-phenotypic prostate cancer dataset. First, the matrix of sample vs. FPKM/PSI value was produced by customized scripts. Then, the matrix was completed and imputed by KNN method (*knnImputation* in *DMwR* package) (91) for missing values. Lastly, the matrix was mean centered and scaled (PSI matrix is not scaled). PCA was conducted via *prcomp* function in R. The top five PCs were inspected but only the first two that describe the highest percentage of the variance are shown.

[0293] In addition, silhouette width was applied to assess the fitness of the PCA clustering results derived from either alternative splicing or gene/isoform expression measurements (92). Specifically, disease conditions were used as sample labels to compute the silhouette width of each cluster. Average silhouette widths were compared between different metrics based PCA clustering results (93). The R package *cluster* (94) was used for Silhouette calculation based on PCA results and disease phenotype labels.

3. Gene Ontology (GO) analysis with background correction for expressed genes

[0294] The GO annotation was queried via the EnrichR (95) API in R. A customized background gene list is required for the proper calculation of over- and under-representation of a GO term (96). For the alternative splicing analysis in this study, the background genes were selected from a set with sufficient sequence coverage at splice junctions to pass the filtering criteria described above. With the customized background list, a corrected p-value can be computed using the hypergeometric test. The Benjamini-Hochberg procedure was used to control for false discovery rate (FDR) at 5%. To reduce complexity, the resulting GO terms were required to contain at least 10 genes. For GO terms displayed in FIG. 2B, the inventors increased the minimum GO term size to 100 to display the most representative GO terms.

[0295] To visualize the GO result, the REVIGO (97) web server was employed with customizations in the R plotting scripts for FIGS. 3 and 6. For the REVIGO web settings, default settings were kept except that 'Homo sapiens' was selected for the 'database with GO term size'. In the R script for plotting, log transformed p-value was used for the y-axis, and the 'semantic distance X' was used for the x-axis, which was computed based on Multidimensional scaling (MDS) according to the original publication (97). Only Molecular Function (MF) terms are displayed. The displayed terms were selected based on the following rules: first, find the

term with dispensibility <0.15 (calculated by REVIGO), then from these terms choose the term for the largest term size in the same cluster.

4. Pathway Enrichment-Guided Activity Study of Alternative Splicing (PEGASAS)

[0296] In order to identify exon incorporation shifts that could correspond to oncogenic pathway alternations during tumor progression, a correlation-based analysis was developed to define signaling pathway correlated alternative splicing events. It involves two major steps:

[0297] The first step is to define signaling pathway activity and alternative splicing levels. The quantification of gene expression and alternative splicing is detailed in the RNA-Seq data processing section. Signaling pathway activity can be characterized by assessing the expression level of its target genes as a set relative to other genes (42). The Molecular Signatures Database (MSigDB) (98) has compiled gene sets (42) for the use with gene set enrichment analysis (GSEA) (99) software or similar applications. Here, a group of well-defined gene sets, known as Hallmarks (42), was selected to assess a wide range of pathways in prostate cancers. To measure the activity of a given signaling pathway gene set, all genes (both genes within the gene set as well as those not in the gene set) were ranked according to their gene expression values, then a weight is assigned to each gene based on the number of genes in the set (pathway or non- pathway) they belonged to. This was used to construct empirical distributions for both sets, and a two-sample Kolmogorov–Smirnov (K-S) test statistic, which is the supremum of the differences between the two distributions, was computed as a measure of the activity of the signaling pathway, i.e. an "activity score". Given the same pathway gene set and gene annotation file, the higher the score, the higher the collective activity of a signaling pathway in a sample. Note that the score should not be used to compare across signaling pathways as each gene set has distinct number of genes, which influences the score.

[0298] The second step is to identify pathway activity-correlated alternatively spliced exons. For each pathway, the pathway activity score defined above was correlated with all the AS events identified by rMATS-turbo. The Pearson correlation coefficient was computed for each pathway- exon pair across samples in the tables. A Pearson's correlation coefficient with an absolute value >0.3 was considered as correlated. Data points for each pathway-exon pair were permutated 5,000 times locally to produce empirical p-values to filter out faulty correlations caused by data structure or missing data points. A stringent empirical p-value < 2×10^{-4} was required for this analysis. The analytical framework performs streamlined analysis

of multiple gene sets (e.g. 50 Hallmark sets). Customized scripts were implemented to generate the summary plot.

5. Overlap enrichment assessment

[0299] Hypergeometric test p-value is used to measure the significance of the overlap between two groups of AS events. The triple intersection p-value is calculated by R package 'SuperExactTest' based on hypergeometric test (100).

6. Breast cancer and lung cancer Myc-correlated alternative splicing analysis

[0300] The same RNA-Seq processing framework described in 'RNA-Seq data processing' section was applied to quantify gene expression and alternative splicing of GTEx normal breast and lung samples, and TCGA BRCA and LUAD tumor-adjacent normal samples and tumor samples that are matched to tumor-adjacent normal samples. The Myc pathway-dependent alternative splicing analysis is performed as described in the above section.

7. Lentiviral constructs

[0301] The myrAKT1 lentiviral vector has been described previously (101). The inducible Myc lentiviral vector was cloned by inserting MYC into the BamHI site of the PSTV lentiviral backbone. Lentiviruses were prepared and titered as described (101).

8. Organotypic human prostate transformation assay

[0302] This assay was conducted as previously described (65, 102). Briefly, benign portions of de-identified, IRB-exempt, human prostatectomy specimens were procured by the UCLA Translational Pathology Core Laboratory. Tissue processing and isolation of the $Trop2^{+}/CD49f^{hi}$ basal cells were as described previously. These cells were subjected to lentiviral transformation and placed into 3D organoid culture in a growth factor-reduced Matrigel droplet (Corning, 356230) for 10-14 days. Doxycycline (1 ug/mL, Calbiochem 324385) was added to all culture media and renewed every 3 days.

9. Xenograft outgrowth of transformed cells

[0303] The xenograft protocol has been previously described (65, 102). 10-14 day old prostate organoids were harvested by centrifugation after Dispase II (Life Technologies 17105041) dissociation of the growth factor-reduced Matrigel (Corning 356231), washed in PBS, placed in standard Matrigel (Corning 356234), and implanted subcutaneously in NSG mice (Jackson Laboratories 005557). Mice were fed sterile doxycycline chow (Bio-Serv S3888) continuously starting three days prior to implantation. Animals were sacrificed and the tumors harvested after 6-8 weeks of outgrowth.

10. Cell line derivation

[0304] Cell line initiation was performed as previously described (102) with the addition of 1 ug/mL doxycycline to all tissue culture media. Harvested tumors were digested to single cell suspension by mincing followed by trypsin and placed on ultra-low attachment plates (Corning 3262) in stem cell media. Stem cell media is composed of advanced DMEM/F12K (Gibco 12634028) base media with addition of B27 (Gibco 17504044), EGF (10 ng/mL, Peprotech 100- 47), and FGF2 (10 ng/mL, Peprotech 100-18B) as well as Glutamax (Gibco 35050061). Normocin antibiotic (1:500, InvivoGen ANT-NR-1) was added to the culture for the first two weeks to prevent contamination from the non-sterile preparation and then withdrawn. After two weeks in ultra-low attachment plates, cells were transferred to standard tissue culture plates and remained suspended.

11. Myc withdrawal experiments

[0305] Cells were collected by centrifugation and washed with media three times to remove doxycycline. 1 million cells were plated for each condition. Doxycycline was added back to the appropriate wells and then harvested at the appropriate time point (0-24h).

12. Histology

[0306] Portions of xenograft outgrowths were fixed in formalin overnight and transferred to 70% ethanol solution before submission for further processing by the Tissue Procurement Core Laboratory at UCLA (TPCL). Organoids were collected by dispase dissociation from matrigel, washed three times with PBS, and then formalin-fixed for 30 minutes at room temperature. The fixed organoids were again collected by centrifugation and resuspended in Histogel and submitted to TPCL. All samples were paraffin-embedded, sectioned at 4 μm, and mounted on glass slides. Hematoxylin and eosin staining was conducted according to standard protocols.

13. Immunohistochemistry

[0307] Immunohistochemical studies were conducted as previously described. Briefly, unstained slides were subjected to deparaffinization, rehydration, and heat-activated citric acid antigen retrieval. Rehydrated slides were blocked with 1% horse serum in PBS before overnight incubation with primary antibodies also diluted in 1% horse serum/PBS. Primary and secondary antibodies and their dilutions are listed below. Antibody binding was detected using an HRP- conjugated secondary antibody and a chromogenic substrate.

14. Immunoblotting

[0308] Portions of tumor xenografts or 10 million cultured cells were placed in 8M urea lysis buffer with protease inhibitors (Sigma-Aldrich 4693159001) and homogenized with a Dounce apparatus. The lysate was cleared by ultracentrifugation at 30,000 x g for 30 minutes. Samples were denatured by boiling in SDS loading buffer under reducing conditions for one minute and subjected by polyacrylamide gel electrophoresis. Wet transfer to nitrocellulose membrane was followed by blocking in 1% milk/0.1% Tween/PBS and overnight primary antibody incubation at 5C in the same buffer. HRP-conjugated secondary antibodies were applied after washing and the blot visualized with a pro-luminescent substrate. Semi-quantitative blots of SRSF3 protein levels used PVDF membrane. Fluorescence levels were measured by Typhoon scanner and normalized to GAPDH levels. Antibody sources and dilutions are described below.

15. Antibodies for flow cytometry, immunohistochemistry and immunoblotting

[0309] Antibodies used for flow cytometry were the fluorochrome conjugates CD49f-PE (12- 0495-82; eBiosciences) and Trop2-APC (FAB650A; R&D Systems). Primary antibodies used for immunohistochemistry include CK8 (1:1,000, Covance MMS-162P), AR (1:250, Santa Cruz sc-816), PSA (KLK3) (1:2000, Dako A0562), CK5 (1:1000, Covance PRB-160P), and p63 (1:250, Santa Cruz sc-8431). Secondary antibodies used were ImmPRESS Anti-Rabbit Ig Peroxidase and Anti-Mouse Ig Peroxidase (Vector Labs). Liquid DAB+ substrate reagent (Dako) was used to perform direct chromogenic visualization. Primary antibodies used for immunoblotting include the following, all used at 1:1000 dilution unless otherwise noted: Myc (Abcam ab32072), pan-AKT (Cell Signaling 4691), p53 (Cell Signaling Technology 2527), PARP1 (AbCam ab32138), Cleaved PARP1 antibody (AbCam, ab32064), Anti-Cdk2 (AbCam ab32147), Anti-Cdk2 (phospho Y15) (AbCam ab76146), p21 Anti-p21 antibody [EPR3993] (ab109199), GAPDH (1:5,000, GeneTex GT239). Secondary antibodies used were Goat Anti-Rabbit-HRP Conjugate and Goat Anti-Mouse-HRP Conjugate (BioRad)

for luminescent detection. Semi-quantitative Western blots used goat anti- mouse-cy5 (1:5000, Sigma-Aldrich GEPA45009).

16. Cell cycle analysis

[0310] One million cells were withdrawn from doxycycline as described above and harvested by centrifugation at the appropriate timepoint. Cell pellets were washed three times with PBS and then singly dissociated with trypsin prior to fixation in 10% cold ethanol. After overnight fixation at 5° C, cells were pelleted and rehydrated in PBS. RNAse was added and the suspension incubated at RT for 4h before staining with 20 ng/mL 7AAD and analysis by flow cytometry.

17. Cell growth assay

[0311] Cells were washed with PBS and withdrawn from doxycycline then plated at a density of 100,000 cells per well. Cells were lysed with CellTiterGlo luciferase reagent at the appropriate time and submitted for luminometry.

18. Whole transcriptome sequencing analysis

[0312] Total RNA was isolated by guanidinium thiocyanate-phenol-chloroform extraction followed by column clean-up. Isolated RNA was submitted for RNA integrity number (RIN) analysis and only samples with RIN > 9 were carried forward. cDNA libraries were prepared from isolated RNA after poly-A selection using the TruSeq RNA Sample Prep Kit v2 (Illumina). High-throughput sequencing with 150 bp paired-end reads was performed using an Illumina HiSeq 2500. At least 100M reads were collected for each sample.

19. Cell line gene expression and alternative splicing differential analysis

[0313] The same RNA-Seq processing framework described above was applied to quantify gene expression and alternative splicing of Myc cell line samples. Differentially expressed (DE) genes were identified and visualized by the Cuffdiff and cummeRbund pipeline with a threshold of q- value < 0.05 Skipped exon (SE) events quantified by rMATS-turbo were analyzed by the PAIRADISE statistical model for conducting paired tests of between Myc +/- conditions (90). PAIRADISE with equal.variance = TRUE was used to perform the test (70). The resulting events were first filtered by the coverage and deltaPSI requirements (≥10 splice junction reads per event, |deltaPSI| > 0.05). Then, an FDR 5% cutoff was applied to identify significant differential alternative splicing events between the on and off states of the engineered Myc cell line.

20. Cell line exon annotations

[0314] Exon annotations of known stop codons and the middle exon length were generated based on the same GENCODE gene annotation file used for alignment. Potential frameshift annotation is determined if the middle exon length cannot be divided by three. Potential RNA binding proteins were labeled according to the GO annotation term 'RNA binding'.

D. Supplementary Methods

1. Gene Ontology (GO) analysis with background correction for expressed genes

[0315] The GO annotation was queried via the EnrichR API in R (M. V. Kuleshov *et al.*, *Nucleic Acids Res* **44**, W90-97 (2016)). A customized background gene list is required for the proper calculation of over- and under-representation of a GO term (P. Khatri, S. Draghici, Ontological analysis of gene expression data: current tools, limitations, and open problems. *Bioinformatics* **21**, 3587-3595 (2005)). For the alternative splicing analysis in this study, the background genes were selected by having sufficient coverage at splice junctions to meet the filtering criteria described above. With this customized background list, a corrected p-value can be computed using the hypergeometric test. The Benjamini-Hochberg procedure was used to control for the false discovery rate (FDR) at 5%. To reduce complexity, the resulting GO terms were required to contain at least 10 genes, with an exception for FIG. 2B, where the minimum term size was increased to 100 to display the most representative terms. To visualize GO results, the REVIGO web server was employed with customized R plotting scripts for FIGS. 3 and 6 (F. Supek, et al., *PLoS One* **6**, e21800 (2011)).

2. Overlap enrichment assessment

[0316] Hypergeometric test p-value is used to measure the significance of the overlap between two groups of alternative splicing events. The triple intersection p-value is calculated by R package "SuperExactTest" based on hypergeometric test (M. Wang, et al., *Sci Rep* **5**, 16923 (2015)).

3. Breast cancer and lung cancer Myc-correlated alternative splicing analysis

[0317] The RNA-Seq processing framework described above was applied to quantify gene expression and alternative splicing of GTEx normal breast and lung samples, and TCGA BRCA and LUAD tumor-adjacent normal samples and tumor samples that are matched to tumor-adjacent normal samples. These datasets are de-identified. The Myc pathway-dependent splicing analysis was performed as described above.

4. Lentiviral constructs

[0318] The myrAKT1 lentiviral vector has been described previously (L. Xin, et al., *Proc Natl Acad Sci U S A* **102**, 6942-6947 (2005)). The inducible Myc lentiviral vector was cloned by inserting MYC into the BamHI site of the PSTV lentiviral backbone. Lentiviruses were prepared and titered as described (L. Xin, et al., *Proc Natl Acad Sci U S A* **102**, 6942-6947 (2005)).

5. Organotypic human prostate transformation assay

[0319] This assay was conducted as previously described (J. W. Park *et al.*, *Proc Natl Acad Sci U S A* **113**, 4482-4487 (2016); J. W. Park *et al.*, *Science* **362**, 91-95 (2018)) with de-identified human prostate samples. Doxycycline (1 ug/mL, Calbiochem 324385) was added to all culture media and renewed every 3 days.

6. Xenograft outgrowth of transformed cells and cell line derivation

[0320] The xenograft and cell line derivation protocols have been previously described and were modified only to accommodate the doxycyline-inducible vector (J. W. Park *et al.*, *Proc Natl Acad Sci U S A* **113**, 4482-4487 (2016); J. W. Park *et al.*, *Science* **362**, 91-95 (2018)). Mice were fed sterile doxycycline chow (Bio-Serv S3888) continuously starting 3 days before xenograft implantation. Cell line initiation was performed on harvested tumors with the addition of 1 ug/mL doxycycline to all media.

7. Cell line exon annotations

[0321] Exon annotations of known stop codons and the middle exon length were generated based on the same GENCODE gene annotation file used for alignment. Potential frameshift annotation is determined if the middle exon length cannot be divided by three. Potential RNA binding proteins were labeled according to the GO annotation term 'RNA binding'.

8. Cell line propagation

[0322] The engineered cell lines were grown in stem cell media, composed of advanced DMEM/F12K (Gibco 12634028) base media with addition of B27 (Gibco 17504044), EGF (10 ng/mL, Peprotech 100-47), and FGF2 (10 ng/mL, Peprotech 100-18B) as well as Glutamax (Gibco 35050061). Doxycycline (1 ug/mL) was added to cultures to maintain MYC expression. Media was renewed every 3 days.

9. Myc withdrawal experiments

[0323] Cells were collected by centrifugation and washed with media three times to remove doxycycline. 1 million cells were plated for each condition. Doxycycline was added back to the appropriate wells and then harvested at the appropriate time point (0-24 h).

10. Histology

[0324] Portions of xenograft outgrowths were fixed in formalin overnight and transferred to 70% ethanol solution before submission for further processing by the Tissue Procurement Core Laboratory at UCLA (TPCL). Organoids were collected by dispase dissociation from Matrigel, washed three times with PBS, and then formalin-fixed for 30 min at room temperature. The fixed organoids were again collected by centrifugation and resuspended in HistoGel and submitted to TPCL. All samples were paraffin-embedded, sectioned at 4 μm, and mounted on glass slides. Hematoxylin and eosin staining was conducted according to standard protocols.

11. Immunohistochemistry

[0325] Immunohistochemical studies were conducted as previously described (J. W. Park *et al.*, *Science* **362**, 91-95 (2018)). Briefly, unstained slides were subjected to deparaffinization, rehydration, and heat-activated citric acid antigen retrieval. Rehydrated slides were blocked with 1% horse serum in PBS before overnight incubation with primary antibodies also diluted in 1% horse serum/PBS. Primary and secondary antibodies and their dilutions are listed below. Antibody binding was detected using an HRP-conjugated secondary antibody and a chromogenic substrate.

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[0326] Portions of tumor xenografts or 10 million cultured cells were placed in 8M urea lysis buffer with protease inhibitors (Sigma-Aldrich 4693159001) and homogenized with a Dounce apparatus. The lysate was cleared by ultracentrifugation at 30,000 x g for 30 min. Samples were denatured by boiling in SDS loading buffer under reducing conditions for 1 min and subjected to polyacrylamide gel electrophoresis. Wet transfer to nitrocellulose membrane was followed by blocking in 1% milk/0.1% Tween/PBS and overnight primary antibody incubation at 5 °C in the same buffer. HRP-conjugated secondary antibodies were applied after washing and the blot visualized with a pro-luminescent substrate. Semi-quantitative blots of SRSF3 protein levels used PVDF membrane. Fluorescence levels were measured by Typhoon scanner and normalized to GAPDH levels. Antibody sources and dilutions are described below.

13. Antibodies for flow cytometry, immunohistochemistry and immunoblotting

[0327] Antibodies used for flow cytometry were the fluorochrome conjugates CD49f-PE (12-0495-82; eBiosciences) and Trop2-APC (FAB650A; R&D Systems). Primary antibodies used for immunohistochemistry included CK8 (1:1,000, Covance MMS-162P), AR (1:250, Santa Cruz sc-816), PSA (KLK3) (1:2000, Dako A0562), CK5 (1:1000, Covance PRB-160P),

and p63 (1:250, Santa Cruz sc-8431). Secondary antibodies used were ImmPRESS anti-rabbit Ig peroxidase and anti-mouse Ig peroxidase (Vector Labs). Liquid DAB+ substrate reagent (Dako) was used to perform direct chromogenic visualization. The following primary antibodies were used for immunoblotting (all at 1:1000 dilution, unless otherwise noted): Myc (Abcam ab32072), pan-AKT (Cell Signaling 4691), p53 (Cell Signaling Technology 2527), PARP1 (AbCam ab32138), cleaved PARP1 (AbCam, ab32064), anti-Cdk2 (AbCam ab32147), anti-Cdk2 (phospho Y15) (AbCam ab76146), p21 anti-p21 [EPR3993] (ab109199), and GAPDH (1:5,000, GeneTex GT239). HRP-conjugated goat anti-rabbit and goat-anti-mouse secondary antibodies (BioRad) were used for luminescent detection. For semi-quantitative Western blots, goat anti-mouse-cy5 (1:5000, Sigma-Aldrich GEPA45009) was used.

14. Cell cycle analysis

[0328] One million cells were withdrawn from doxycycline as described above and harvested by centrifugation at the appropriate time-point. Cell pellets were washed three times with PBS and then singly dissociated with trypsin prior to fixation in 10% cold ethanol. After overnight fixation at 5° C, cells were pelleted and rehydrated in PBS. RNAse was added and the suspension incubated at room temperature for 4 h before staining with 20 ng/mL 7AAD and analysis by flow cytometry.

15. Cell growth assay

[0329] Cells were washed with PBS, withdrawn from doxycycline, and plated at a density of 100,000 cells per well. Cells were lysed with CellTiterGlo luciferase reagent at the appropriate time and submitted for luminometry.

16. Whole transcriptome sequencing analysis

[0330] Total RNA was isolated by guanidinium thiocyanate-phenol-chloroform extraction, followed by column clean-up. Isolated RNA was submitted for RNA integrity number (RIN) analysis. Only samples with RIN > 9 were carried forward. cDNA libraries were prepared from isolated RNA after poly-A selection using the TruSeq RNA Sample Prep Kit v2 (Illumina). High-throughput sequencing with 150 bp paired-end reads was performed using an Illumina HiSeq 2500. At least 100 million reads were collected for each sample.

17. Cell line exon annotations

[0331] Exon annotations of known stop codons and the middle exon length were generated based on the same GENCODE gene annotation file used for alignment. Potential frameshift annotation is determined if the middle exon length cannot be divided by three. Potential RNA binding proteins were labeled according to the GO annotation term 'RNA binding'.

* * *

[0332] All of the methods disclosed and claimed herein can be made and executed without undue experimentation in light of the present disclosure. While the compositions and methods of this invention have been described in terms of preferred embodiments, it will be apparent to those of skill in the art that variations may be applied to the methods and in the steps or in the sequence of steps of the method described herein without departing from the concept, spirit and scope of the invention. More specifically, it will be apparent that certain agents which are both chemically and physiologically related may be substituted for the agents described herein while the same or similar results would be achieved. All such similar substitutes and modifications apparent to those skilled in the art are deemed to be within the spirit, scope and concept of the invention as defined by the appended claims.

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The following references and the references cited throughout the disclosure of the application, to the extent that they provide exemplary procedural or other details supplementary to those set forth herein, are specifically incorporated herein by reference in their entirety.

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WHAT IS CLAIMED IS:

1. A peptide comprising at least 70% sequence identity to a peptide of SEQ ID NO:1-19.

2. The peptide of claim 1, wherein the peptide comprises one of SEQ ID NOS:1-19.

3. The peptide of claim 1 or 2, wherein the peptide comprises at least 6 contiguous amino acids of one of SEQ ID NOS:1-19.

4. The peptide of claim 1 or 3, wherein the peptide is 13 amino acids or fewer in length.

5. The peptide of claim 4, wherein the peptide consists of 9 amino acids.

6. The peptide of any one of claims 1-5, wherein the peptide is immunogenic.

7. The peptide of any one of claims 1-6, wherein the peptide is modified.

8. The peptide of claim 7, wherein the modification comprises conjugation to a molecule.

9. The peptide of claim 7 or 8, wherein the molecule comprises an antibody, a lipid, an adjuvant, or a detection moiety.

10. The peptide of any of claims 1-9, wherein the peptide has 1, 2 or 3 substitutions relative to a peptide of one of SEQ ID NOS:1-19.

11. A peptide comprising at least 6 contiguous amino acids from an alternatively spliced polypeptide,

wherein the at least 6 contiguous amino acids comprises an alternative splice site junction of the polypeptide or wherein the peptide comprises at least 6 contiguous amino acids from an alternatively spliced exon; and

wherein the alternatively spliced peptide, exon, or junction is one that is derived from an alternative splice event (AS event) identified in Table 1a, 1b, 1c, or 1d.

12. The peptide of claim 11, wherein the AS event is selected from an AS event in Table 1a.

13. The peptide of claim 11, wherein the AS event is selected from an AS event in Table 1b.

14. The peptide of claim 11, wherein the AS event is selected from an AS event in Table 1c.

15. The peptide of claim 11, wherein the AS event is selected from an AS event in Table 1d.

16. The peptide of any one of claims 11-15, wherein the peptide comprises at least 10 amino acids.

17. The peptide of any one of claims 11-15, wherein the peptide consists of 10 amino acids.

18. The peptide of any one of claims 11-16, wherein the peptide is less than 20 amino acids in length.

19. The peptide of any one of claims 11-18, wherein the peptide is modified.

20. The peptide of claim 19, wherein the modification comprises conjugation to a molecule.

21. The peptide of claim 19 or 20, wherein the molecule comprises an antibody, a lipid, an adjuvant, or a detection moiety.

22. A molecular complex comprising the peptide of any one of claims 1-21 and a MHC polypeptide.

23. A composition comprising the peptide of any one of claims 1-22.

24. The composition of claim 23, wherein the composition is formulated as a vaccine.

25. The composition of claim 23 or 24, wherein the composition further comprises an adjuvant.

26. The composition of any one of claims 23-25, wherein the composition is formulated for parenteral administration, intravenous injection, intramuscular injection, inhalation, or subcutaneous injection.

27. A nucleic acid encoding for the peptide of any one of claims 1-21.

28. An expression vector comprising the nucleic acid of claim 27.

29. A host cell comprising the nucleic acid of claim 27 or the expression vector of claim 28.

30. An in vitro isolated dendritic cell comprising the peptide of any one of claims 1-21, the nucleic acid of claim 27, or the expression vector of claim 28.

31. The dendritic cell of claim 30, wherein the dendritic cell comprises a mature dendritic cell.

32. The dendritic cell of claim 30 or 31, wherein the cell is a cell with an HLA type selected from HLA-A, HLA-B, or HLA-C.

33. A peptide-specific binding molecule, wherein the molecule specifically binds to a peptide of any one of claim 1-21 or the molecular complex of claim 22.

34. The binding molecule of claim 33, wherein the binding molecule is an antibody, a T cell receptor (TCR), TCR mimc antibody, scFV, camellid, aptamer, or DARPIN.

35. A method of making a cell comprising transferring the nucleic acid of claim 27 or the expression vector of claim 28 into the cell.

36. The method of claim 35, wherein the method further comprises isolating the expressed peptide or polypeptide.

37. An *in vitro* method for making a dendritic cell vaccine comprising contacting a mature dendritic cell *in vitro* with a peptide of any one of claims 1-21.

38. The method of claim 37, wherein the method further comprises screening the dendritic cell for one or more cellular properties.

39. The method of claim 37 or 38, wherein the method further comprises contacting the cell with one or more cytokines or growth factors.

40. The method of claim 39, wherein the one or more cytokines or growth factors comprises GM-CSF.

41. The method of claim 38, wherein the cellular property comprises cell surface expression of one or more of CD86, HLA, and CD14.

42. The method of any one of claims 37-41, wherein the dendritic cell is derived from a CD34+ hematopoietic stem or progenitor cell.

43. The method of any one of claims 37-41, wherein the dendritic cell is derived from a peripheral blood monocyte (PBMC).

44. The method of any one of claims 37-41, wherein the dendritic cells are cells in which the DCs are derived are isolated by leukaphereses.

45. An *in vitro* composition comprising a dendritic cell and the peptide of any one of claims 1-21.

46. The composition of claim 45, wherein the composition further comprises one or more cytokines, growth factors, or adjuvants.

47. The composition of claim 46, wherein the composition comprises GM-CSF.

48. The composition of claim 47, wherein the peptide and GM-CSF are linked.

49. The composition of claim any one of claims 45-49, wherein the composition is determined to be serum-free, mycoplasma-free, endotoxin-free, and sterile.

50. The composition of any one of claims 45-49, wherein the peptide is on the surface of the dendritic cell.

51. The composition of claim 50, wherein the peptide is bound to a MHC molecule on the surface of the dendritic cell.

52. The composition of any one of claims 45-51, wherein the composition is enriched for dendritic cells expressing CD86 on the surface of the cell.

53. The composition of any one of claims 45-52, wherein the dendritic cell comprises a monocyte-derived dendritic cell.

54. The composition of any one of claims 45-52, wherein the dendritic cell is derived from a CD34+ hematopoietic stem or progenitor cell.

55. The composition of any one of claims 45-52, wherein the dendritic cell is derived from a peripheral blood monocyte (PBMC).

56. The composition of any one of claims 45-55, wherein the dendritic cells or the cells in which the DCs are derived from are isolated by leukaphereses.

57. An engineered T-cell Receptor (TCR) or chimeric antigen receptor (CAR) that specifically recognizes the peptide of any one of claims 1-21.

58. A cell comprising the TCR or CAR of claim 57.

59. The cell of claim 58, wherein the cell comprises at least one TCR and at least one CAR and wherein the TCR and CAR each recognize a different peptide.

60. The cell of claim 58 or 59, wherein the cell comprises a stem cell, a progenitor cell, or a T cell.

61. The cell of claim 60, wherein the cell comprises a hematopoietic stem or progenitor cell, a T cell, or an induced pluripotent stem cell (iPSC).

62. An antibody or antigen binding fragment thereof that specifically recognizes the peptide of any one of claims 1-21 or the molecular complex of claim 22.

63. A method of producing cancer-specific immune effector cells comprising:

(a) obtaining a starting population of immune effector cells; and

(b) contacting the starting population of immune effector cells with a peptide of any one of claims 1-21 or the molecular complex of claim 22, thereby generating peptide-specific immune effector cells.

64. The method of claim 63, wherein contacting is further defined as co-culturing the starting population of immune effector cells with antigen presenting cells (APCs), artificial antigen presenting cells (aAPCs), or an artificial antigen presenting surface (aAPSs); wherein the APCs, aAPCs, or the aAPSs present the peptide on their surface.

65. The method of claim 64, wherein the APCs are dendritic cells.

66. The method of any one of claims 63-65, wherein the immune effector cells are T cells, peripheral blood lymphocytes, NK cells, invariant NK cells, NKT cells.

67. The method of any one of claims 63-66, wherein the immune effector cells have been differentiated from mesenchymal stem cell (MSC) or induced pluripotent stem (iPS) cells.

68. The method of claim 66, wherein the T cells are $CD8^+$ T cells, $CD4^+$ T cells, or $\gamma\delta$ T cells.

69. The method of claim 66, wherein the T cells are cytotoxic T lymphocytes (CTLs).

70. The method of any one of claims 63-69, wherein obtaining comprises isolating the starting population of immune effector cells from peripheral blood mononuclear cells (PBMCs).

71. The method of any one of claims 63-70, wherein the starting population of immune effector cells is obtained from a subject.

72. The method of claim 71, wherein the subject is a human.

73. The method of claim 71 or 72, wherein the subject has a cancer.

74. The method of claim 73, wherein the cancer comprises tumor cells that are positive for expression of the peptide.

75. The method of any one of claims 63-74, wherein the cancer comprises prostate, lung, or breast cancer.

76. The method of any one of claims 65-75, wherein the method further comprises introducing the peptide or a nucleic acid encoding the peptide into the dendritic cells prior to the co-culturing.

77. The method of claim 76, where the peptide or nucleic acids encoding the peptide are introduced by electroporation.

78. The method of claim 76, wherein the peptide or nucleic acids encoding the peptide are introduced by adding the peptide or nucleic acid encoding the peptide to the dendritic cell culture media.

79. The method of any one of claims 76-78, wherein the immune effector cells are co-cultured with a second population of dendritic cells into which the peptide or the nucleic acid encoding the peptide has been introduced.

80. The method of one of claims 76-79, wherein a population of CD8 or CD4-positive and peptide MHC tetramer-positive T cells are purified from the immune effector cells following the co-culturing.

81. The method of claim 80, wherein a clonal population of peptide-specific immune effector cells are generated by limiting or serial dilution followed by expansion of individual clones by a rapid expansion protocol.

82. The method of claim 81, wherein the method further comprises cloning of a T cell receptor (TCR) from the clonal population of peptide-specific immune effector cells.

83. The method of claim 82, wherein cloning of the TCR is cloning of a TCR alpha and a beta chain.

84. The method of claim 82 or claim 83, wherein the TCR is cloned using a 5'-Rapid amplification of cDNA ends (RACE) method.

85. The method of claim 84, wherein the cloned TCR is subcloned into an expression vector.

86. The method of claim 85, wherein the expression vector is a retroviral or lentiviral vector.

87. The method of claim 86, where a host cell is transduced with the expression vector to generate an engineered cell that expresses the TCR.

88. The method of claim 87, wherein the host cell is an immune cell.

89. The method of any one of claims 65-88, wherein the immune cell is a T cell and the engineered cell is an engineered T cell.

90. The method of claim 89, wherein the T cell is a $CD8^+$ T cell, CD4+ T cell, or γδ T cell and the engineered cell is an engineered T cell.

91. The method of claim 90, wherein the starting population of immune effector cells is obtained from a subject with cancer and the host cell is allogeneic or autologous to the subject.

92. The method of claim 91, wherein the cancer is positive for expression of the peptide.

93. The method of claim 89 or 90, wherein a population of CD8 or CD4-positive and peptide MHC tetramer-positive engineered T cells are purified from the transduced host cells.

94. The method of any one of claims 80-93, wherein a clonal population of peptide-specific engineered T cells are generated by limiting or serial dilution followed by expansion of individual clones by a rapid expansion protocol.

95. An immune effector cell produced according to any one of the methods of claims 63-94.

96. A method of treating or preventing cancer in a subject, the method comprising administering an effective amount of the peptide of any one of claims 1-21, the molecular complex of claim 22, the composition of any one of claims 23-26 or 45-56, the nucleic acid or expression vector of any one of claims 27-28, the cell of any one of claims 29-32, 58-61, or 95, the peptide-specific binding molecule of claim 33 or 34, the antibody or antigen binding fragment of claim 62, or the TCR of claim 57.

97. A method of stimulating an immune response in a subject, the method comprising administering an effective amount of the peptide of any one of claims 1-21, the molecular complex of claim 22, the composition of any one of claims 23-26 or 45-56, the nucleic acid or expression vector of any one of claims 27-28, the cell of any one of claims 29-32, 58-61, or 95, the peptide-specific binding molecule of claim 33 or 34, the antibody or antigen binding fragment of claim 62, or the TCR of claim 57.

98. The method of claim 96 or 97, wherein the method comprises administering a cell or a composition comprising a cell and wherein the cell comprises an autologous or allogeneic cell.

99. The method of any one of claims 96-98, wherein the cancer comprises prostate, lung, or breast cancer.

100. The method of any one of claims 96-99, wherein the cancer comprises a cancer that is positive for expression of the peptide.

101. The method of any one of claims 96-100, wherein the subject has been determined to have a cancer that is positive for expression of the peptide.

102. The method of any one of claims 96-101, wherein the subject has previously been treated for the cancer.

103. The method of claim 102, wherein the subject has been determined to be resistant to the previous treatment.

104. The method of any one of claims 96-103, wherein the method further comprises the administration of an additional therapy.

105. The method of any one of claims 96-104, wherein the cancer comprises stage I, II, III, or IV cancer.

106. The method of any one of claims 96-105, wherein the cancer comprises metastatic and/or recurrent cancer.

107. The method of any one of claims 96-106, wherein treating comprises one or more of reducing tumor size; increasing the overall survival rate; reducing the risk of recurrence of the cancer; reducing the risk of progression; and/or increasing the chance of progression-free survival, relapse-free survival, and/or recurrence-free survival.

108. A method for prognosing a patient or for detecting T cell responses in a patient, the method comprising: contacting a biological sample from the patient with the peptide of any one of claims 1-21 or the molecular complex of claim 22.

109. The method of claim 108, wherein the biological sample comprises a blood sample, a fraction of a blood sample, a tissue sample, a biopsy, or a tumor sample.

110. The method of claim 109, wherein the biological sample comprises lymphocytes.

111. The method of claim 110, wherein the biological sample comprises a fractionated sample comprising lymphocytes.

112. The method of any one of claims 108-111, wherein the peptide is linked to a solid support.

113. The method of claim 112, wherein the peptide is conjugated to the solid support or is bound to an antibody that is conjugated to the solid support.

114. The method of claim 112, wherein the solid support comprises a microplate, a bead, a glass surface, a slide, or a cell culture dish.

115. The method of any one of claims 108-114, wherein detecting T cell responses comprises detecting the binding of the peptide to the T cell or TCR.

116. The method of any one of claims 108-115, wherein detecting T cell responses comprises an ELISA, ELISPOT, or a tetramer assay.

117. A composition comprising at least one MHC polypeptide and the peptide of any one of claims 1-21.

118. The composition of claims 117, wherein the MHC polypeptide is and/or peptide is conjugated to a detection tag.

119. The composition of claim 117 or 118, wherein the MHC polypeptide and peptide are operatively linked to form a peptide-MHC complex.

120. The composition of claim 119, wherein the MHC polypeptide and peptide are operatively linked through a peptide bond.

121. The composition of claim 119, wherein the MHC polypeptide and peptide are operatively linked through van der Waals forces.

122. The composition of any one of claims 119-121, wherein at least two peptide-MHC complexes are operatively linked to each other.

123. The composition of claim 122, wherein at least 3 or 4 peptide-MHC complexes are operatively linked to each other.

124. The composition of any one of claims 117-123, wherein the average ratio of MHC polypeptides to peptides is 1:1 to 4:1.

125. A method comprising contacting the composition of any one of claims 118-124 with a composition comprising T cells and detecting T cells with bound peptide and/or MHC polypeptide by detecting a detection tag.

126. The method of claim 125, wherein the method further comprises counting the number of T cells bound with peptide and/or MHC.

127. The method of claim 125 or 126, wherein the composition comprising T cells is isolated from a patient having or suspected of having a cancer.

128. The method of claim 127, wherein the cancer comprises a peptide-specific cancer.

129. The method of claim 127 or 128, wherein the cancer comprises prostate, breast, or lung cancer.

130. The method of any one of claims 125-129, wherein the peptide is selected from a peptide of one of SEQ ID NOS:1-19.

131. The method of any one of claims 125-130, wherein the method further comprises sorting the number of T cells bound with peptide and/or MHC.

132. The method of claim 131, wherein the method further comprises sequencing one or more TCR genes from T cells bound with peptide and/or MHC.

133. The method of claim 132, wherein the method further comprises grouping of lymphocyte interactions by paratope hotspots (GLIPH) analysis.

134. A kit comprising the peptide of any one of claims 1-21 in a container.

135. The kit of claim 134, wherein the peptide is comprised in a pharmaceutical preparation.

136. The kit of claim 135, wherein the pharmaceutical preparation is formulated for parenteral administration or inhalation.

137. The kit of claim 134, wherein the peptide is comprised in a cell culture media.

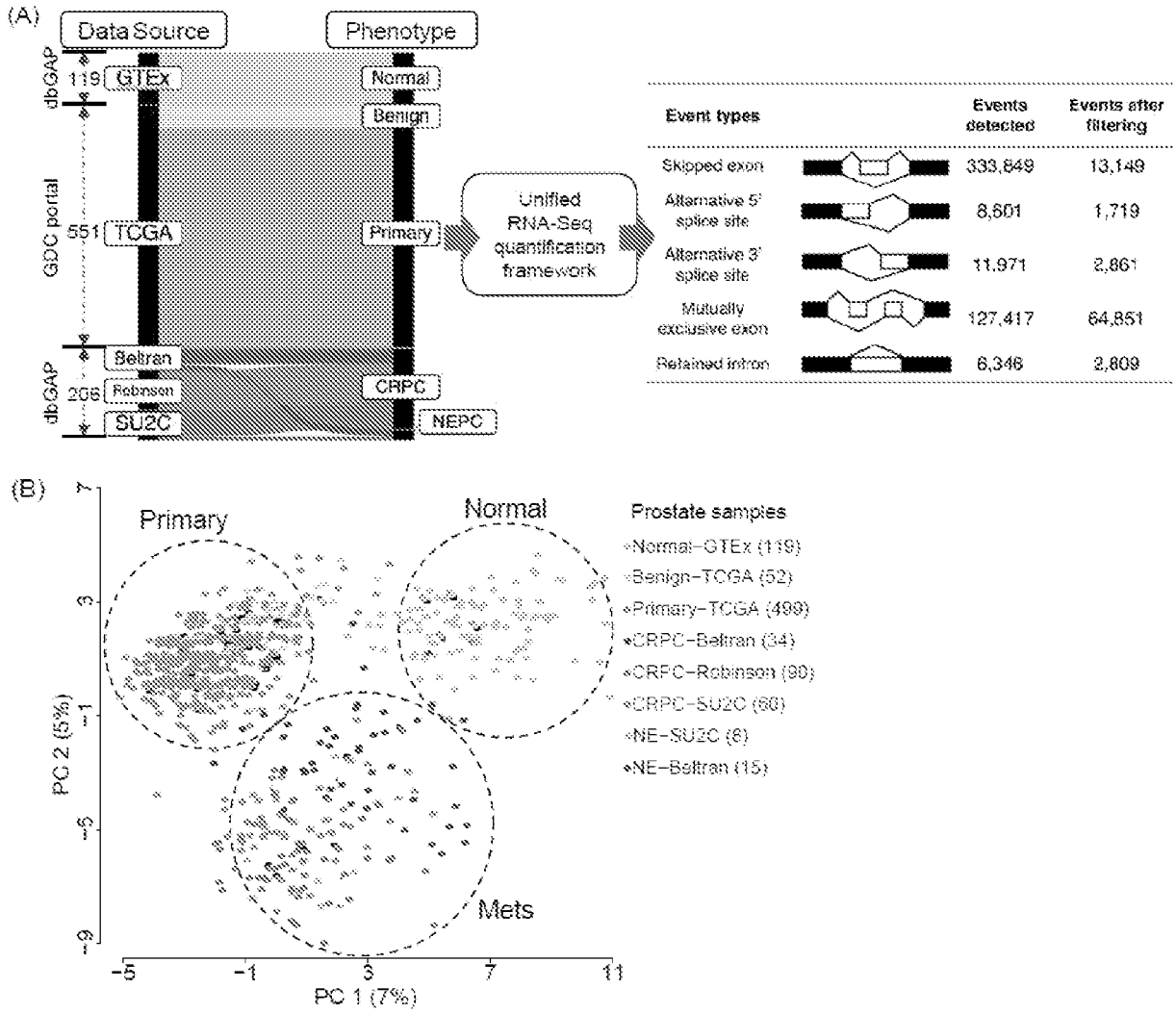

(A)
Data Source
Phenotype
dbGAP
119
GTEx
Normal
Benign
GDC portal
551
TCGA
Primary
Beltran
dbGAP
206
Robinson
SU2C
CRPC
NEPC
Unified RNA-Seq quantification framework
Event types
Events detected
Events after filtering
Skipped exon
333,849
13,149
Alternative 5' splice site
8,601
1,719
Alternative 3' splice site
11,971
2,861
Mutually exclusive exon
127,417
64,851
Retained intron
6,346
2,809
(B)
Primary
Normal
Mets
Prostate samples
Normal–GTEx (119)
Benign–TCGA (52)
Primary–TCGA (499)
CRPC–Beltran (34)
CRPC–Robinson (90)
CRPC–SU2C (60)
NE–SU2C (6)
NE–Beltran (15)
PC 2 (5%)
PC 1 (7%)
7
3
-1
-5
-9
-5
-1
3
7
11

FIG. 1A-B

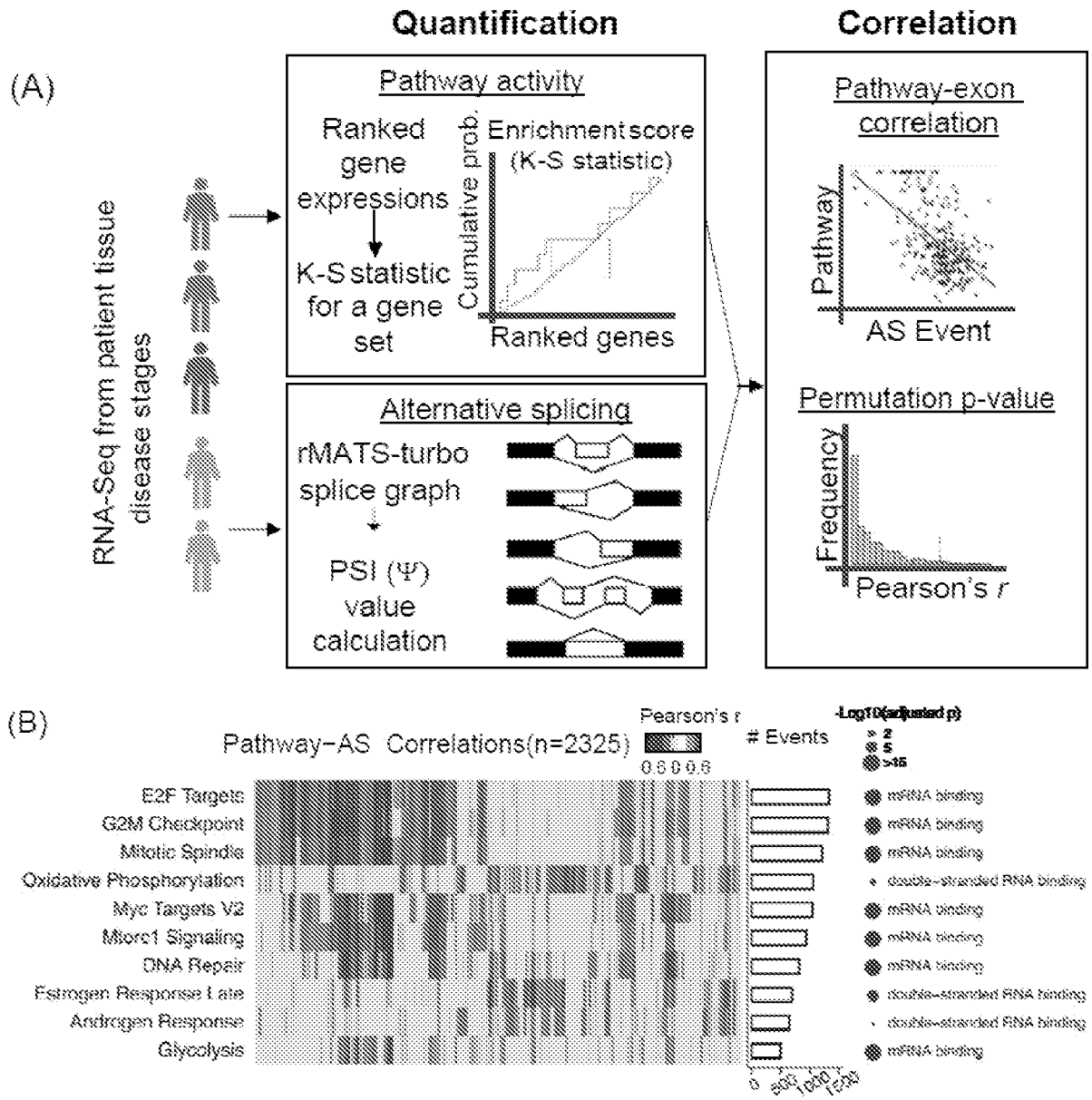
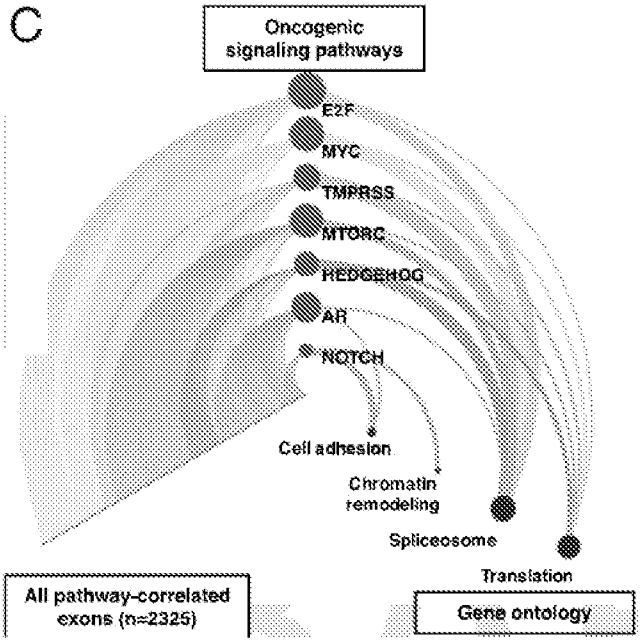

(A)
Quantification
Correlation
RNA-Seq from patient tissue
disease stages
Pathway activity
Ranked gene expressions
K-S statistic for a gene set
Cumulative prob.
Enrichment score (K-S statistic)
Ranked genes
Alternative splicing
rMATS-turbo splice graph
PSI (Ψ) value calculation
Pathway-exon correlation
Pathway
AS Event
Permutation p-value
Frequency
Pearson's r
(B)
Pathway−AS Correlations(n=2325)
Pearson's r
Events
E2F Targets
G2M Checkpoint
Mitotic Spindle
Oxidative Phosphorylation
Myc Targets V2
Mtorc1 Signaling
DNA Repair
Estrogen Response Late
Androgen Response
Glycolysis
mRNA binding
double−stranded RNA binding

FIG. 2A-B


C
Oncogenic signaling pathways
E2F
MYC
TMPRSS
MTORC
HEDGEHOG
AR
NOTCH
Cell adhesion
Chromatin remodeling
Spliceosome
Translation
All pathway-correlated exons (n=2325)
Gene ontology

(D)

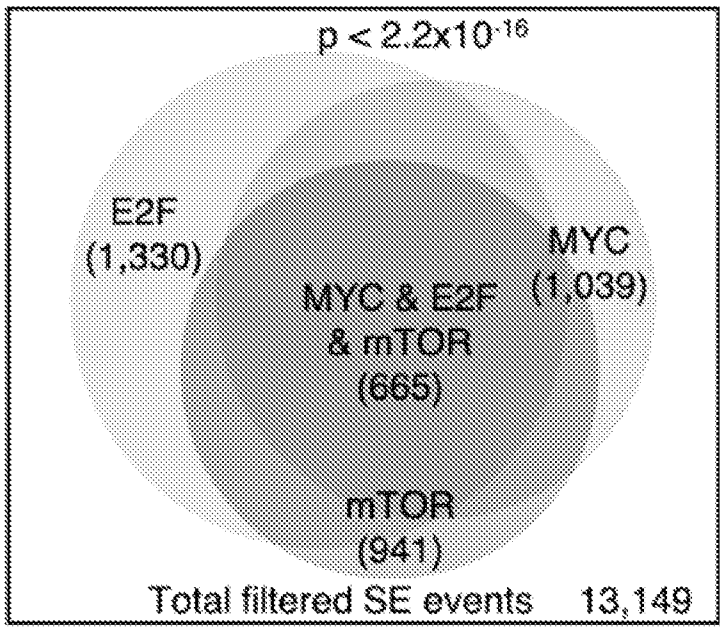

p < 2.2x10-16
E2F
(1,330)
MYC
(1,039)
MYC & E2F
& mTOR
(665)
mTOR
(941)
Total filtered SE events 13,149

FIG. 2C-D

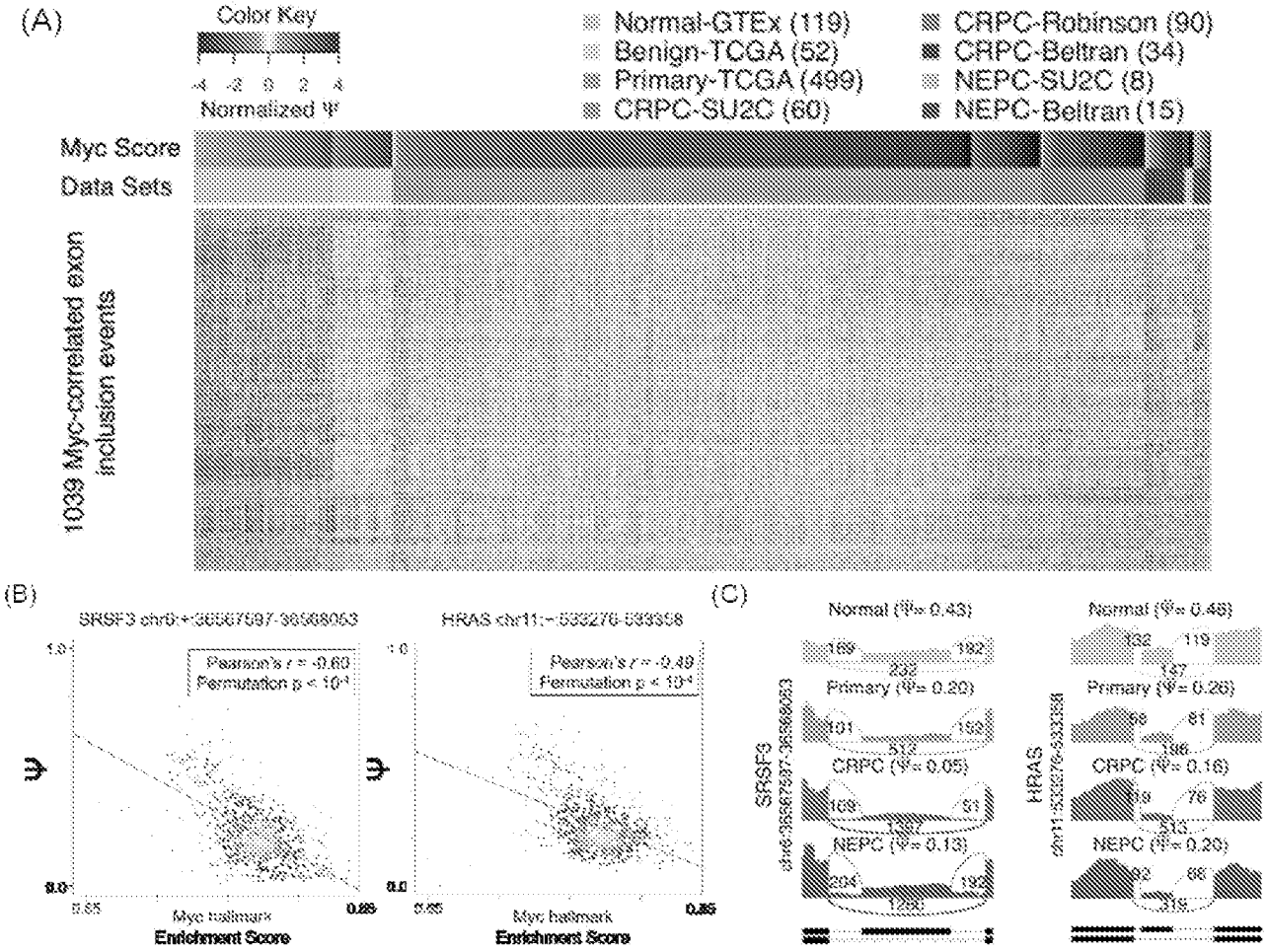

(A)
Color Key
-4 -2 0 2 4
Normalized Ψ
Normal-GTEx (119)
Benign-TCGA (52)
Primary-TCGA (499)
CRPC-SU2C (60)
CRPC-Robinson (90)
CRPC-Beltran (34)
NEPC-SU2C (8)
NEPC-Beltran (15)
Myc Score
Data Sets
1039 Myc-correlated exon inclusion events
(B)
Pearson's r = -0.60
Permutation p < 10^-4
Myc hallmark
Enrichment Score
Pearson's r = -0.49
Permutation p < 10^-4
Myc hallmark
Enrichment Score
(C)
Normal (Ψ= 0.43)
Primary (Ψ= 0.20)
CRPC (Ψ= 0.05)
NEPC (Ψ= 0.13)
Normal (Ψ= 0.48)
Primary (Ψ= 0.26)
CRPC (Ψ= 0.16)
NEPC (Ψ= 0.20)

FIG. 3A-C

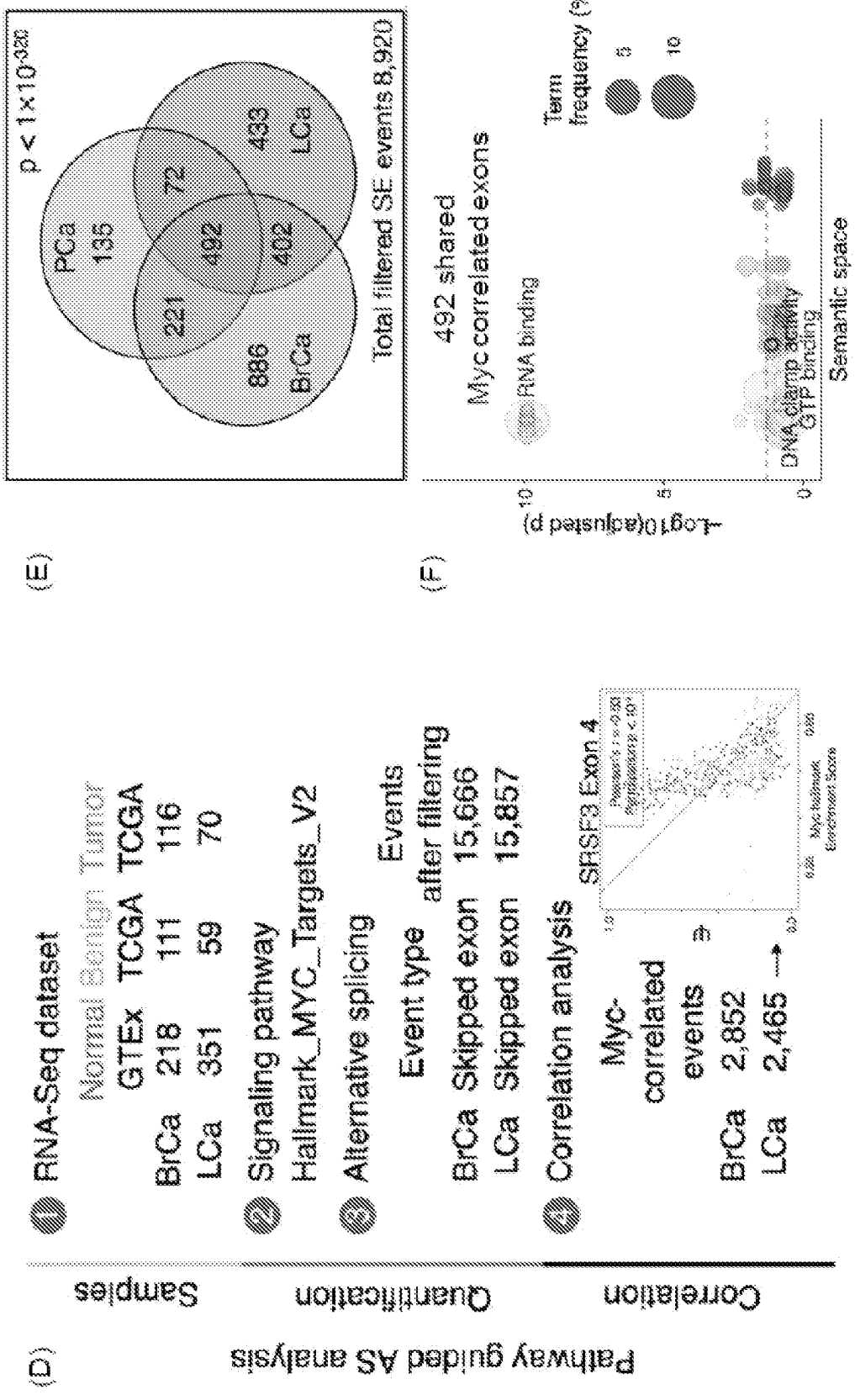

(D)
Pathway guided AS analysis
Samples
Quantification
Correlation
1 RNA-Seq dataset
Normal Benign Tumor
GTEx TCGA TCGA
BrCa 218 111 116
LCa 351 59 70
2 Signaling pathway
Hallmark_MYC_Targets_V2
3 Alternative splicing
Events
Event type after filtering
BrCa Skipped exon 15,666
LCa Skipped exon 15,857
4 Correlation analysis
Myc-correlated events
BrCa 2,852
LCa 2,465
SRSF3 Exon 4
(E)
p < 1x10-320
PCa
135
72
433
LCa
221
492
402
886
BrCa
Total filtered SE events 8,920
(F)
492 shared
Myc correlated exons
RNA binding
Term frequency (%)
5
10
DNA clamp activity
GTP binding
Semantic space
-log10(adjusted p)
10
5
0

FIG. 3D-F

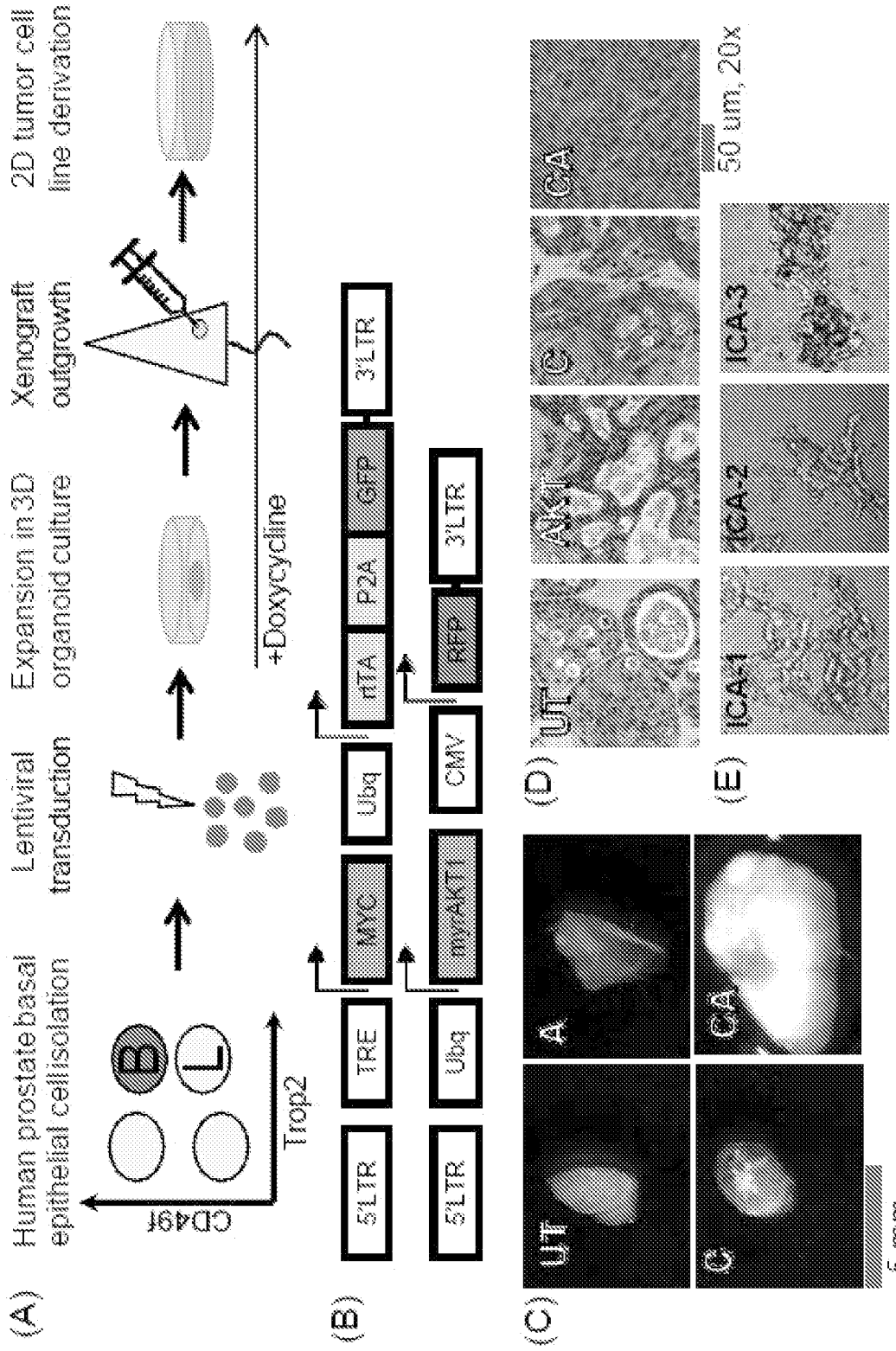

(A)
Human prostate basal epithelial cell isolation
Lentiviral transduction
Expansion in 3D organoid culture
Xenograft outgrowth
2D tumor cell line derivation
CD49f
Trop2
B
L
+Doxycycline
(B)
5'LTR
TRE
MYC
Ubq
rtTA
P2A
GFP
3'LTR
5'LTR
Ubq
myAKT1
CMV
RFP
3'LTR
(C)
UT
A
CA
C
5 mm
(D)
UT
AKT1
C
CA
50 um, 20x
(E)
ICA-1
ICA-2
ICA-3

FIG. 4A-E

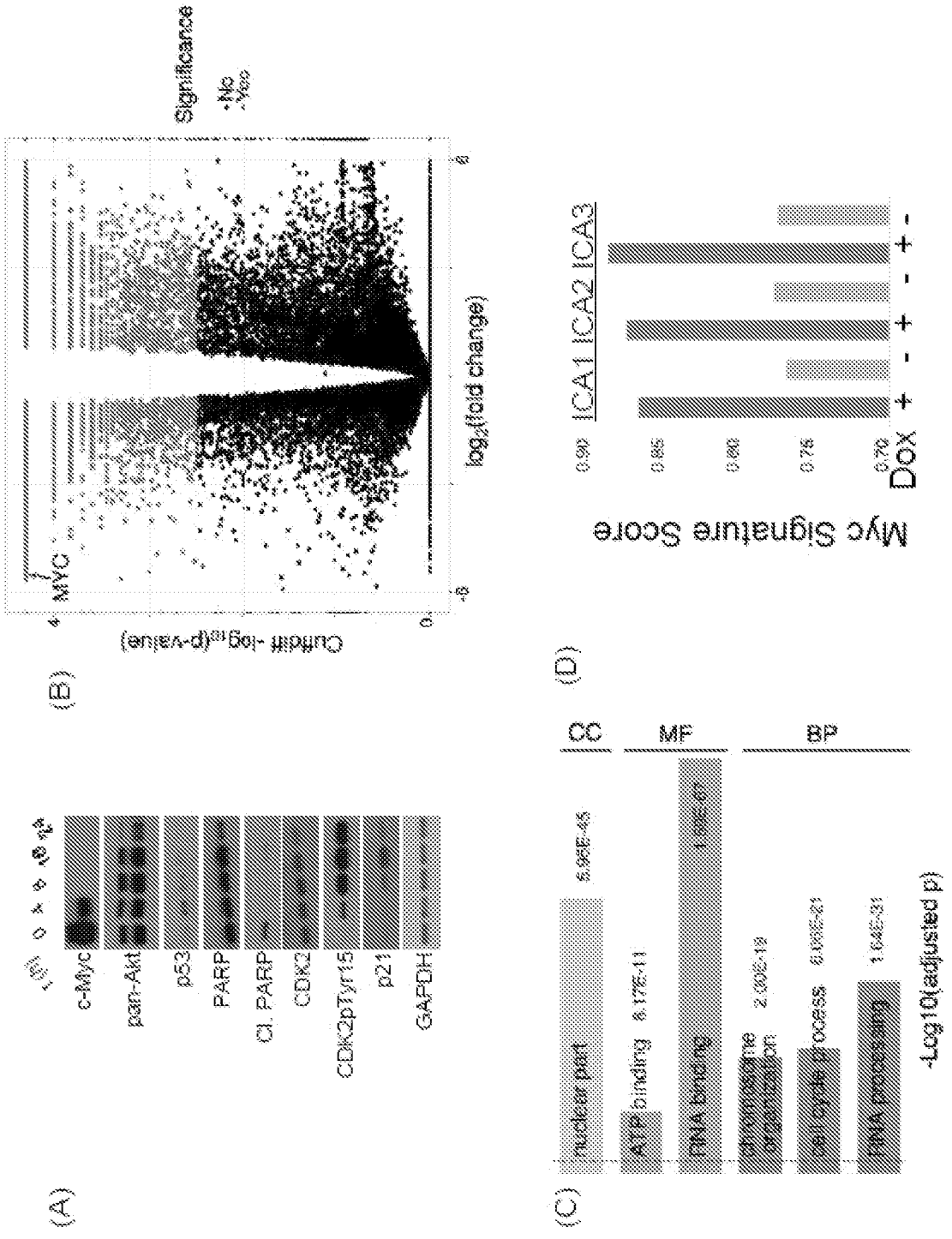

(A)
c-Myc
pan-Akt
p53
PARP
Cl. PARP
CDK2
CDK2pTyr15
p21
GAPDH
(B)
MYC
Significance
No
Yes
Cutoff -log10(p-value)
log2(fold change)
(C)
CC
MF
BP
nuclear part
ATP binding
RNA binding
chromosome organization
cell cycle process
RNA processing
-Log10(adjusted p)
(D)
ICA1 ICA2 ICA3
Myc Signature Score
Dox

FIG. 5A-D

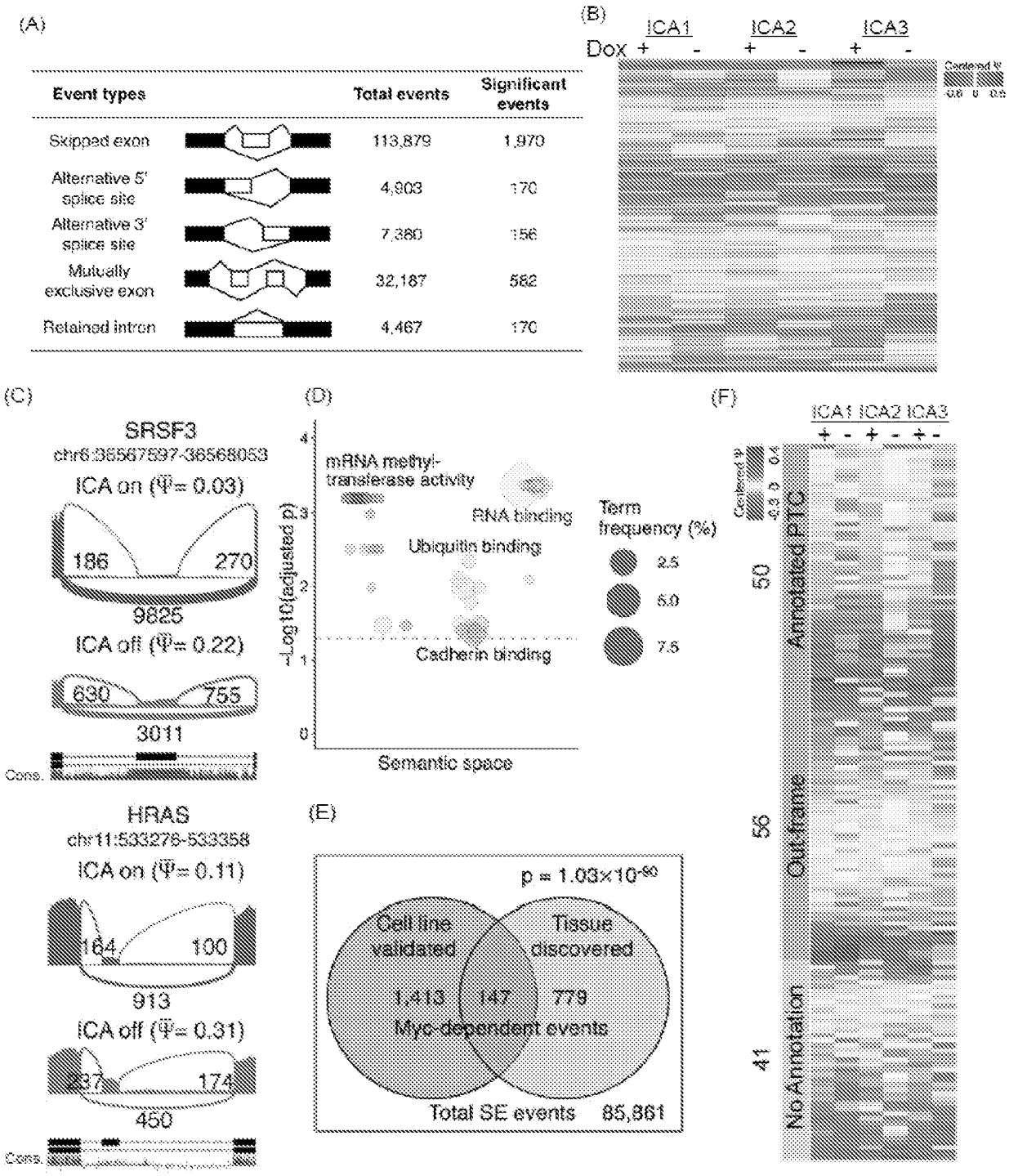

(A)
Event types
Total events
Significant events
Skipped exon
113,879
1,970
Alternative 5' splice site
4,903
170
Alternative 3' splice site
7,380
156
Mutually exclusive exon
32,187
582
Retained intron
4,467
170
(B)
ICA1
ICA2
ICA3
Dox + - + - + -
(C)
SRSF3
chr6:36567597-36568053
ICA on (Ψ= 0.03)
186
270
9825
ICA off (Ψ= 0.22)
630
755
3011
Cons.
HRAS
chr11:533276-533358
ICA on (Ψ= 0.11)
164
100
913
ICA off (Ψ= 0.31)
337
174
450
Cons.
(D)
mRNA methyltransferase activity
RNA binding
Ubiquitin binding
Cadherin binding
-Log10(adjusted p)
Semantic space
Term frequency (%)
2.5
5.0
7.5
(E)
p = 1.03×10-60
Cell line validated
Tissue discovered
1,413
147
779
Myc-dependent events
Total SE events
85,861
(F)
ICA1 ICA2 ICA3
+ - + - + -
Centered Ψ
Annotated PTC
Out-frame
No Annotation
50
56
41

FIG. 6A-F

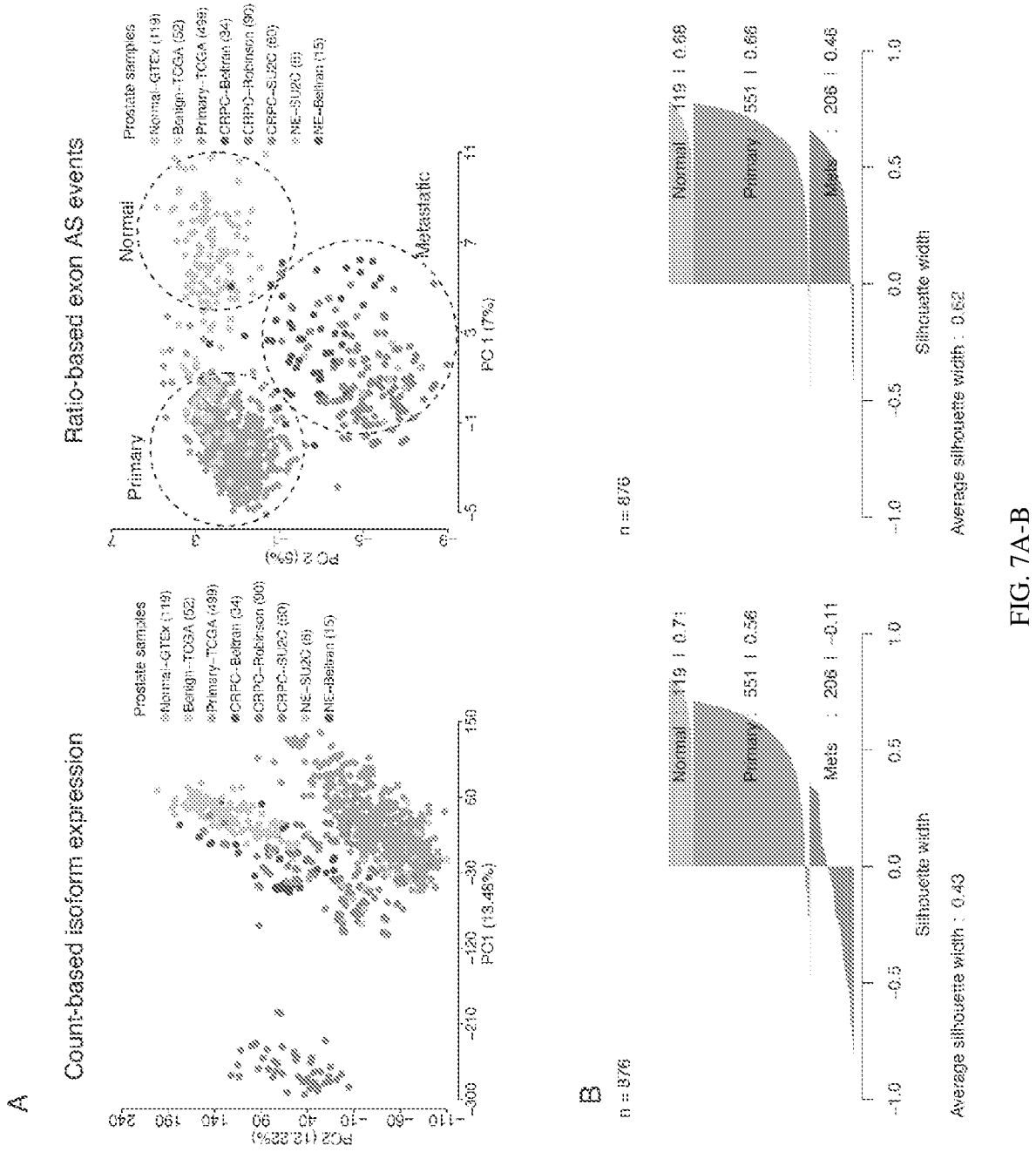

A
Count-based isoform expression
Ratio-based exon AS events
Prostate samples
Normal–GTEx (119)
Benign–TCGA (52)
Primary–TCGA (498)
CRPC–Beltran (34)
CRPC–Robinson (99)
CRPC–SU2C (80)
NE–SU2C (6)
NE–Beltran (15)
Normal
Primary
Metastatic
PC1 (13.46%)
PC2 (12.28%)
PC 1 (7%)
PC 2 (6%)
B
n = 876
Normal : 119 | 0.71
Primary : 551 | 0.56
Mets : 206 | -0.11
Normal : 119 | 0.69
Primary : 551 | 0.66
Mets : 206 | 0.46
Silhouette width
Average silhouette width : 0.43
Average silhouette width : 0.62

FIG. 7A-B

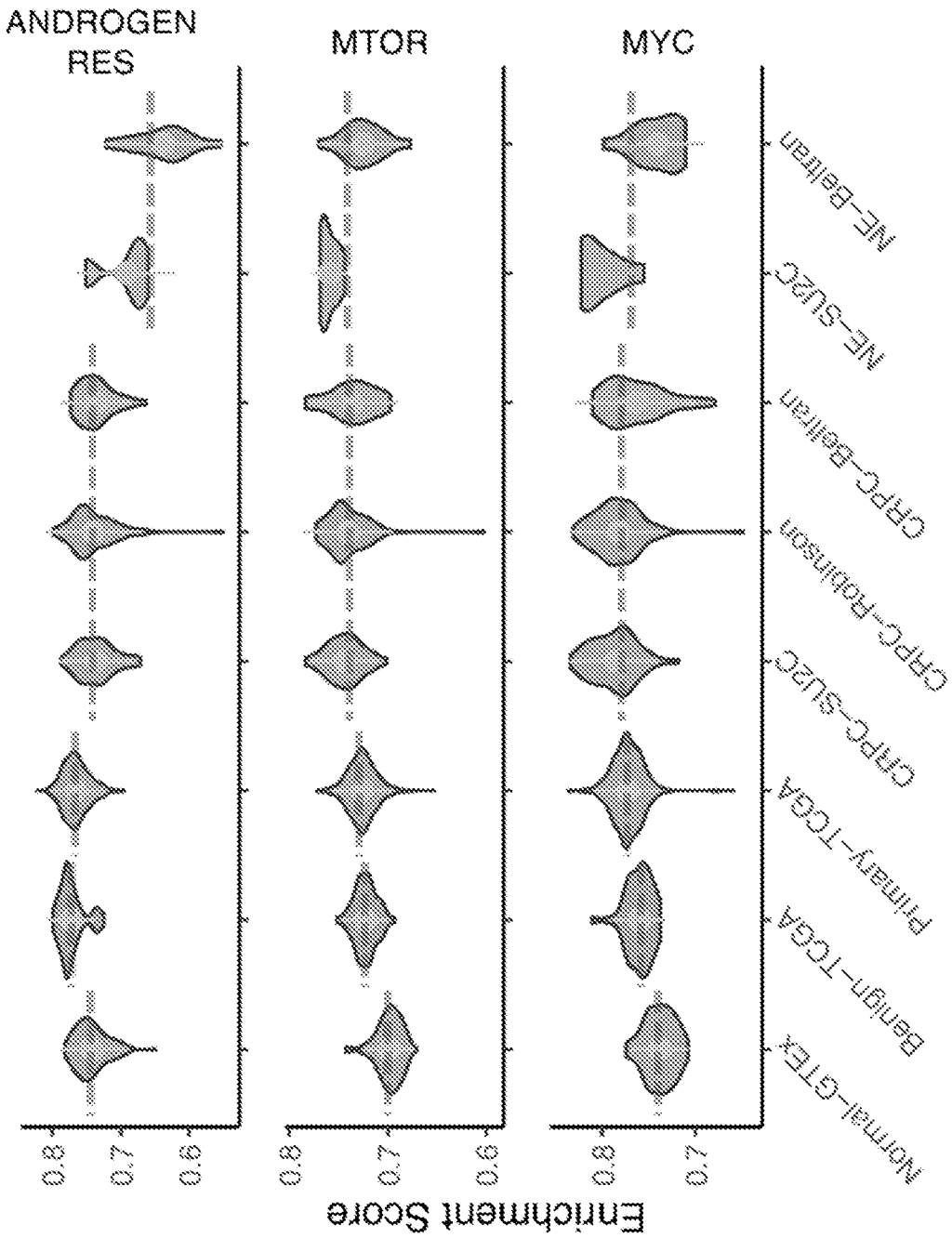

ANDROGEN RES
MTOR
MYC
Enrichment Score
0.8
0.7
0.6
0.8
0.7
0.6
0.8
0.7
Normal-GTEx
Benign-TCGA
Primary-TCGA
CRPC-SU2C
CRPC-Robinson
CRPC-Beltran
NE-SU2C
NE-Beltran

FIG. 8

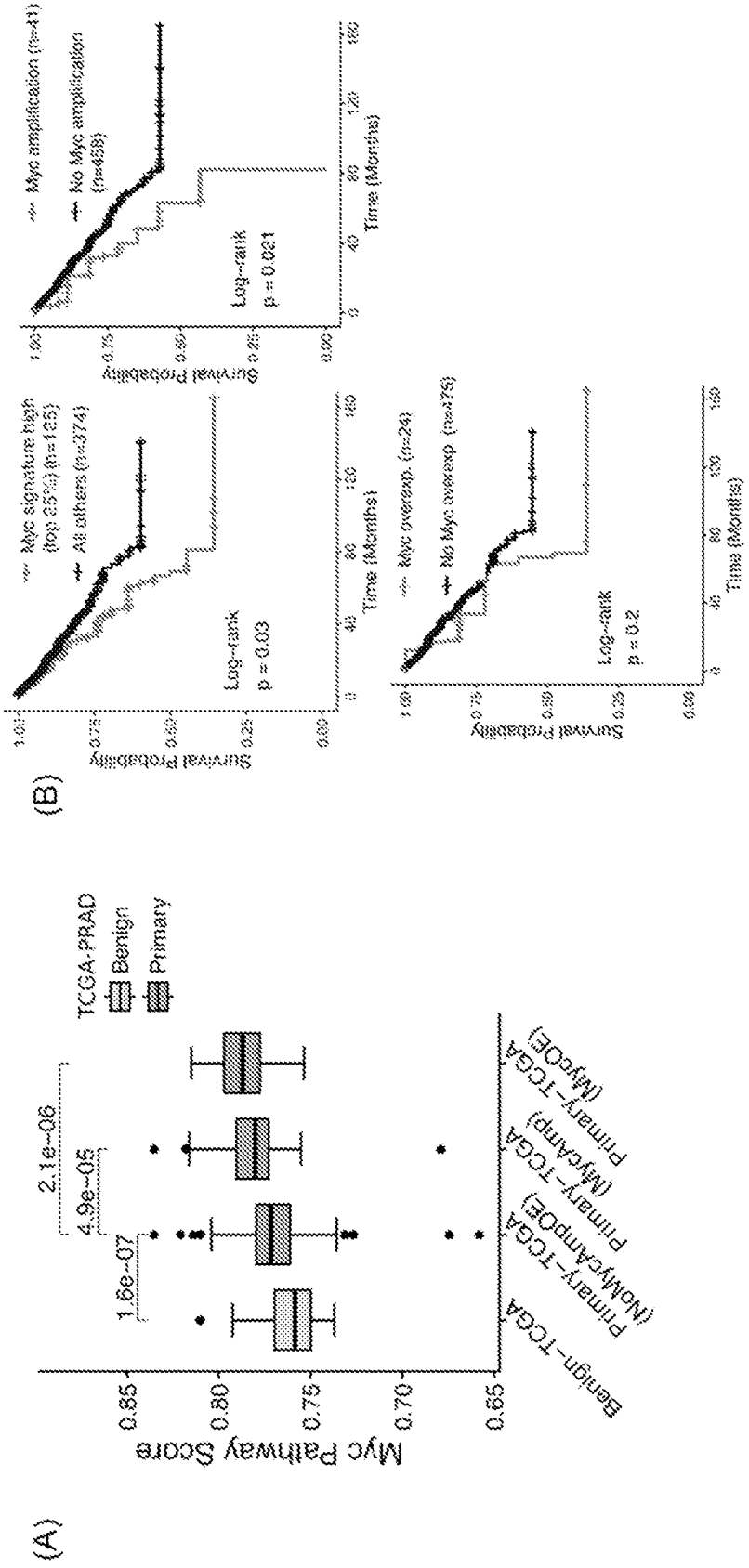

(A)
Myc Pathway Score
0.85
0.80
0.75
0.70
0.65
TCGA-PRAD
Benign
Primary
2.1e−06
4.9e−05
1.6e−07
Benign−TCGA
Primary−TCGA (NoMycCampOE)
Primary−TCGA (MycCamp)
Primary−TCGA (MycOE)
(B)
Myc amplification (n=41)
No Myc amplification (n=458)
Survival Probability
Log−rank p = 0.021
Time (Months)
Myc signature high (top 25%) (n=165)
All others (n=374)
Log−rank p = 0.03
Myc overexp. (n=24)
No Myc overexp. (n=475)
Log−rank p = 0.2

FIG. 9A-B

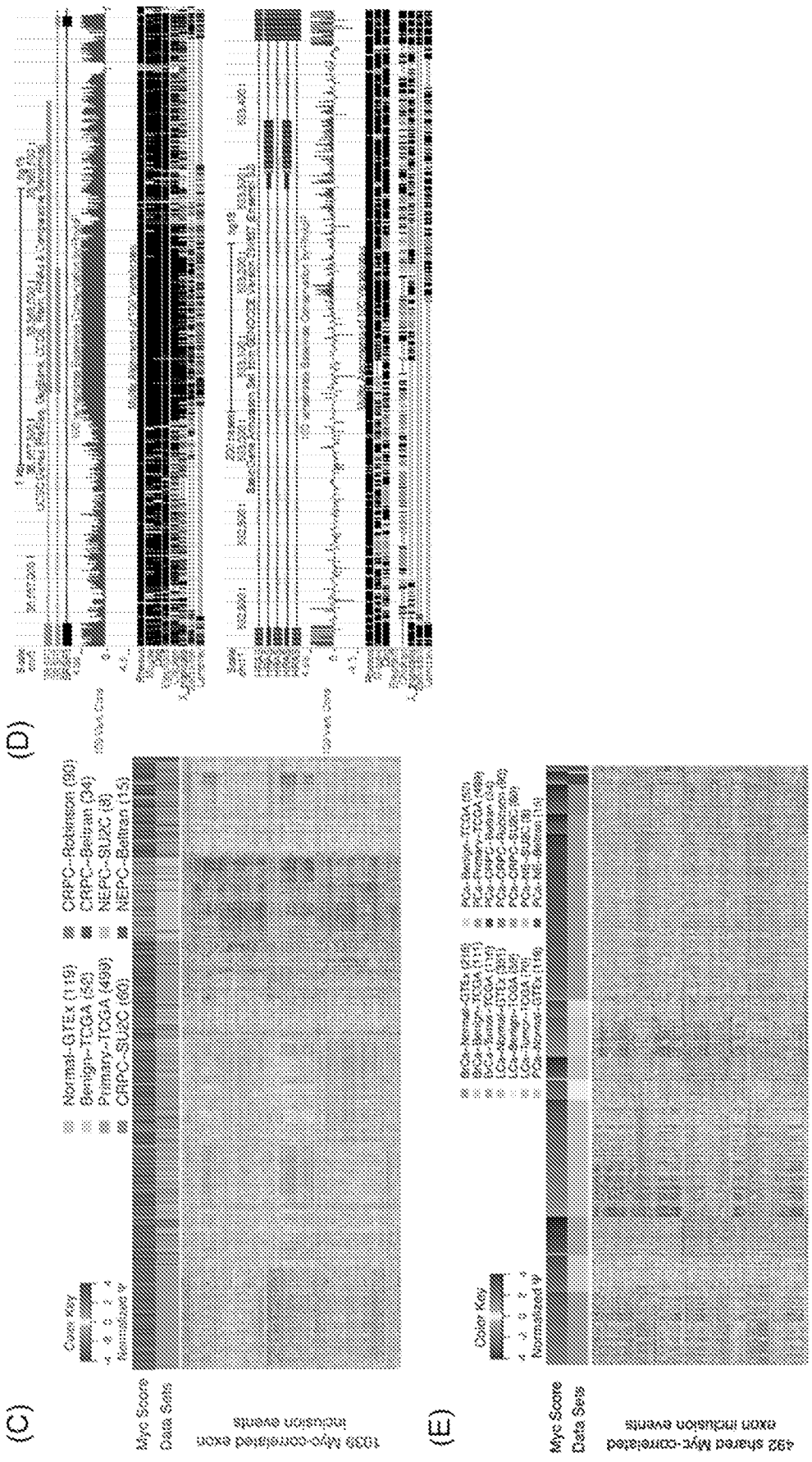

(C)
Color Key
Normalized Y
Myc Score
Data Sets
1039 Myc-correlated exon inclusion events
Normal-GTEx (119)
Benign-TCGA (52)
Primary-TCGA (499)
CRPC-SU2C (60)
CRPC-Robinson (99)
CRPC-Beltran (34)
NEPC-SU2C (8)
NEPC-Beltran (15)
(D)
(E)
Color Key
Normalized Y
Myc Score
Data Sets
492 shared Myc-correlated exon inclusion events

FIG. 9C-E

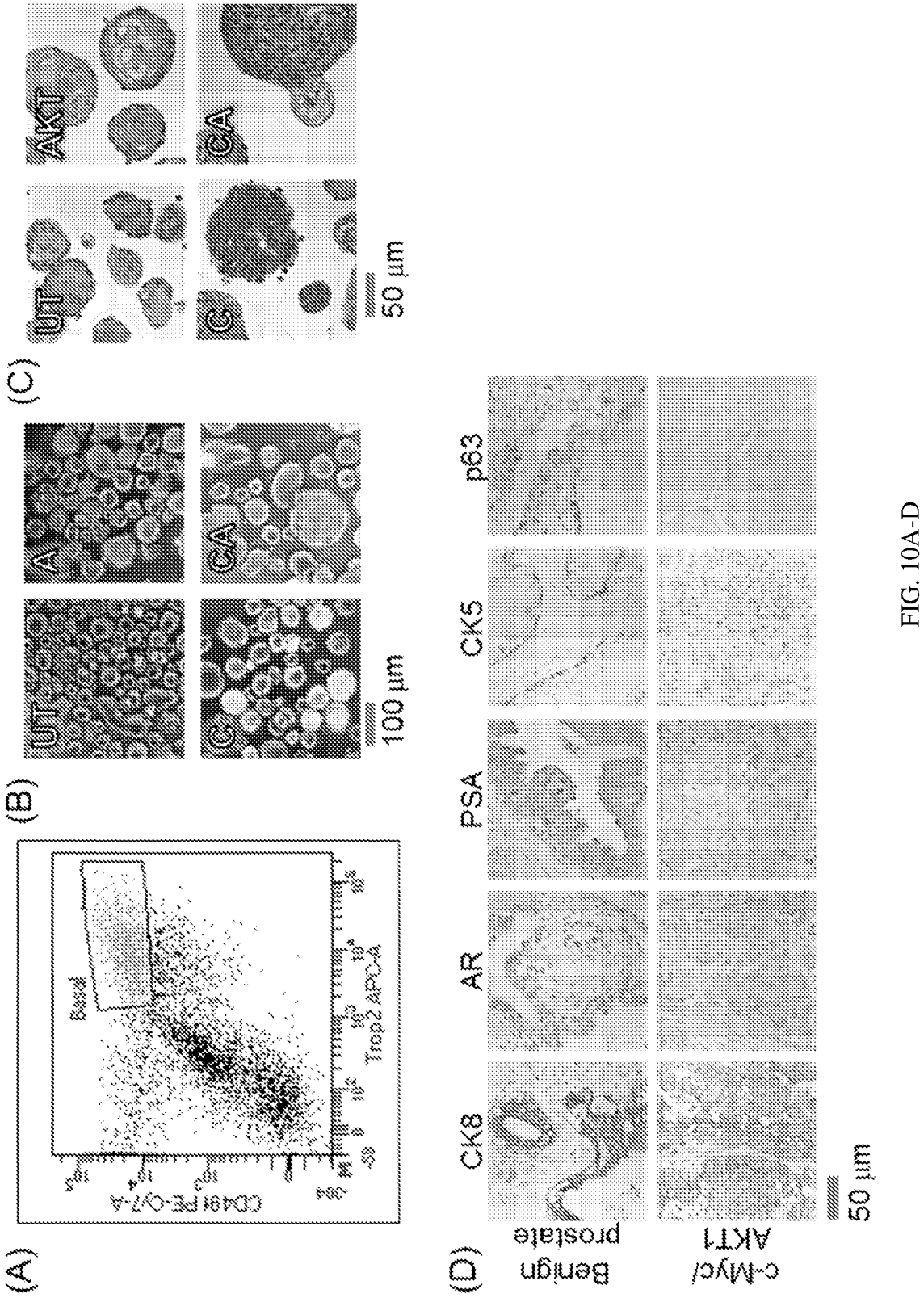

(A)
Basal
CD49f PE-Cy7-A
Trop2 APC-A
(B)
UT
AKT
CA
100 µm
(C)
UT
AKT
CA
50 µm
(D)
CK8
AR
PSA
CK5
p63
Benign prostate
c-Myc/ AKT1
50 µm

FIG. 10A-D

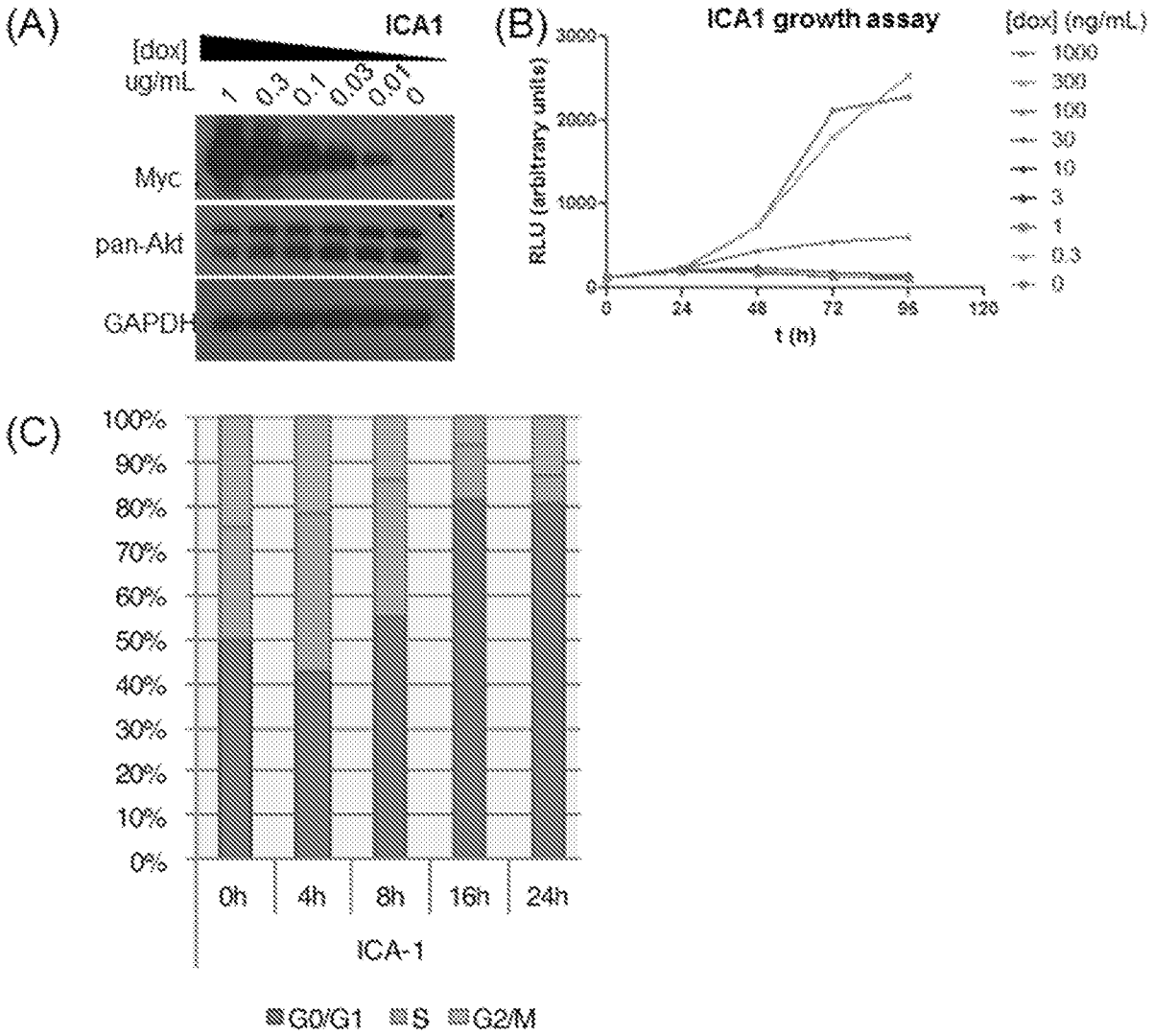

(A)
ICA1
[dox] ug/mL
1
0.3
0.1
0.03
0.01
0
Myc
pan-Akt
GAPDH
(B)
ICA1 growth assay
[dox] (ng/mL)
1000
300
100
30
10
3
1
0.3
0
RLU (arbitrary units)
3000
2000
1000
0
0
24
48
72
96
120
t (h)
(C)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0h
4h
8h
16h
24h
ICA-1
G0/G1
S
G2/M

FIG. 11A-C

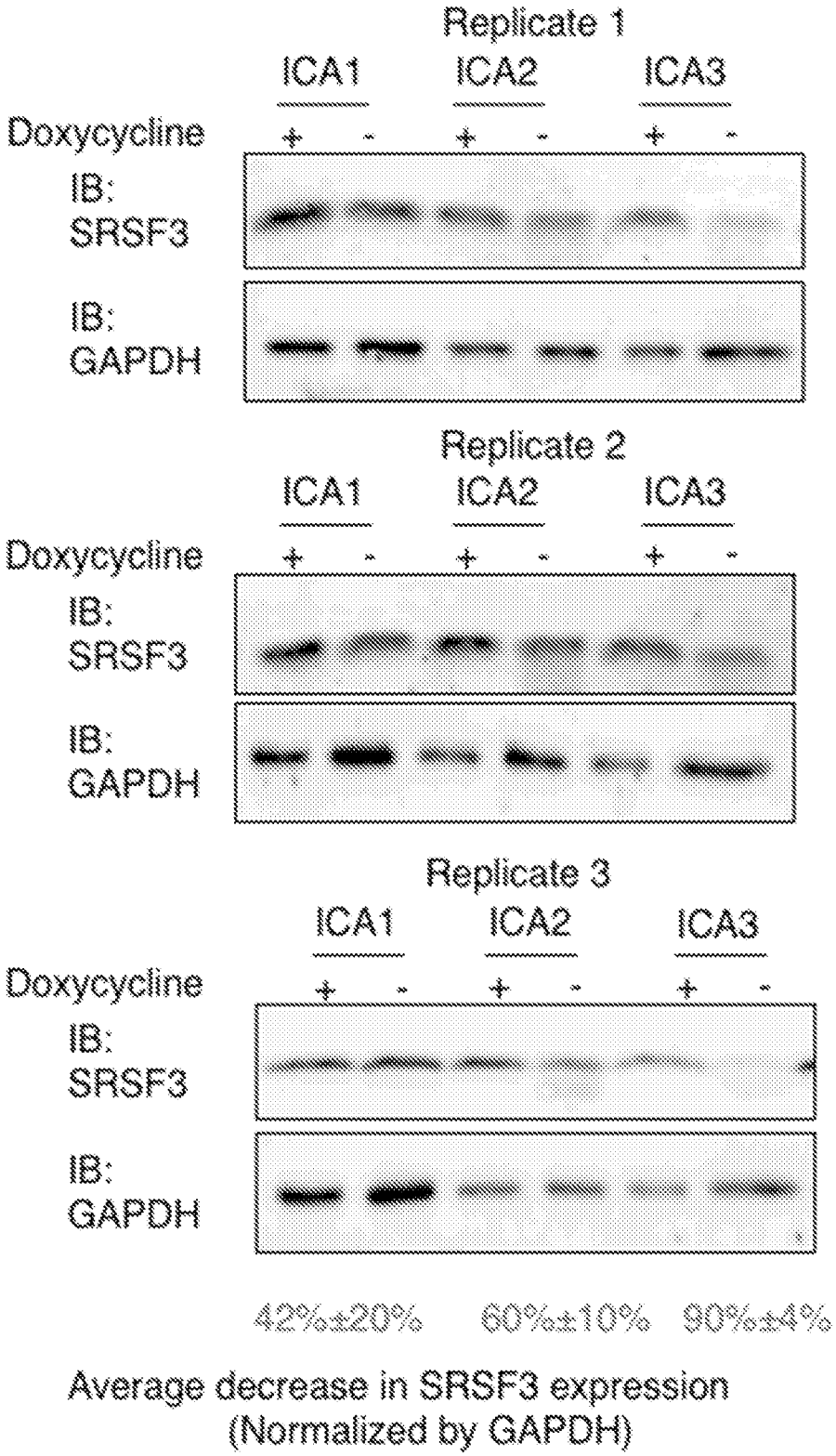

Replicate 1
ICA1
ICA2
ICA3
Doxycycline
+ - + - + -
IB:
SRSF3
IB:
GAPDH
Replicate 2
ICA1
ICA2
ICA3
Doxycycline
+ - + - + -
IB:
SRSF3
IB:
GAPDH
Replicate 3
ICA1
ICA2
ICA3
Doxycycline
+ - + - + -
IB:
SRSF3
IB:
GAPDH
42%±20%
60%±10%
90%±4%
Average decrease in SRSF3 expression
(Normalized by GAPDH)

FIG. 12