



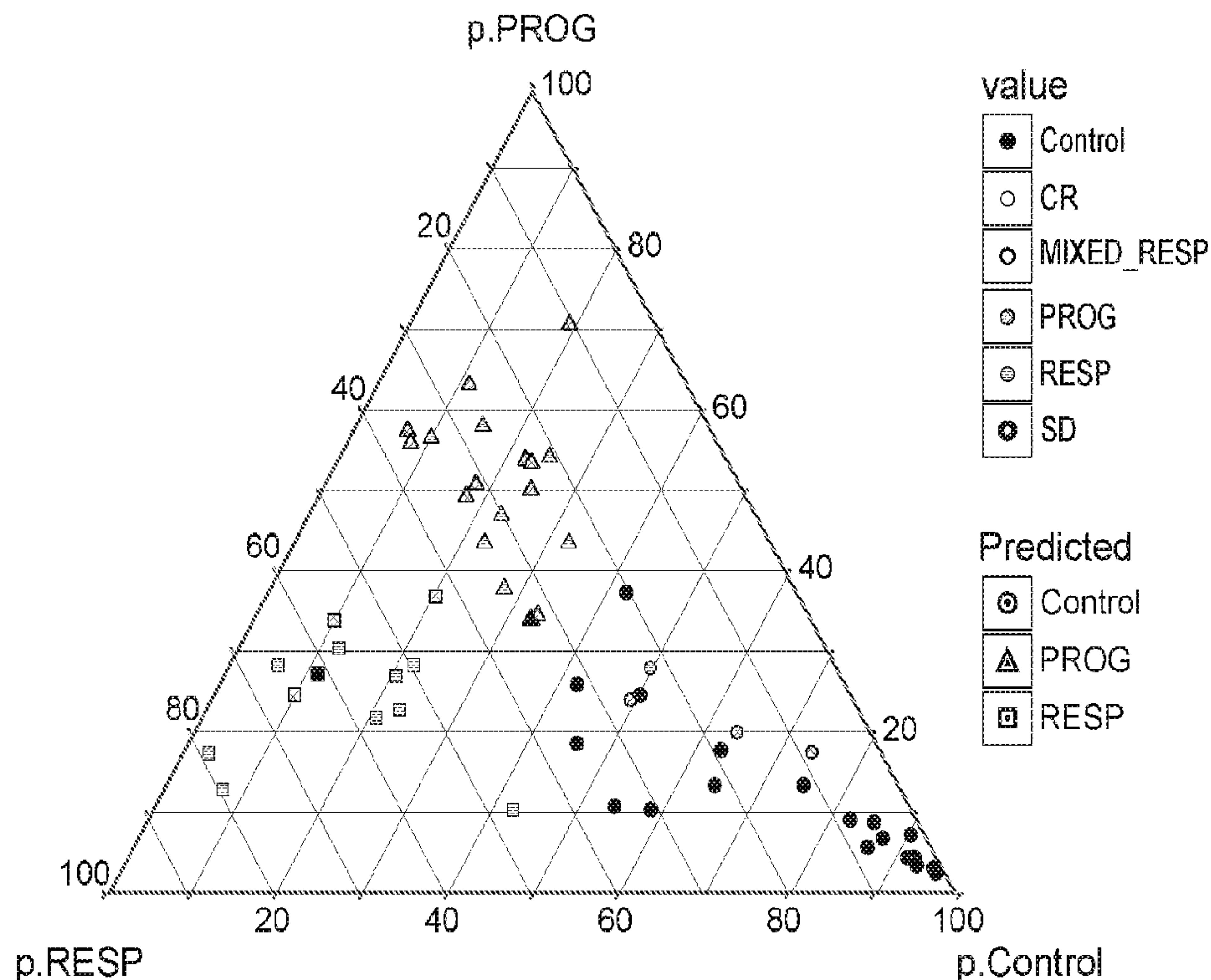
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(54) Title: METHODS FOR MELANOMA DETECTION



(57) **Abrégé/Abstract:**

The present invention is directed to methods for detecting a melanoma, methods for determining whether a melanoma is stable or progressive, methods for evaluating the extent of surgery resection in a subject having a melanoma, and methods for determining a response by a subject having a melanoma to a therapy.

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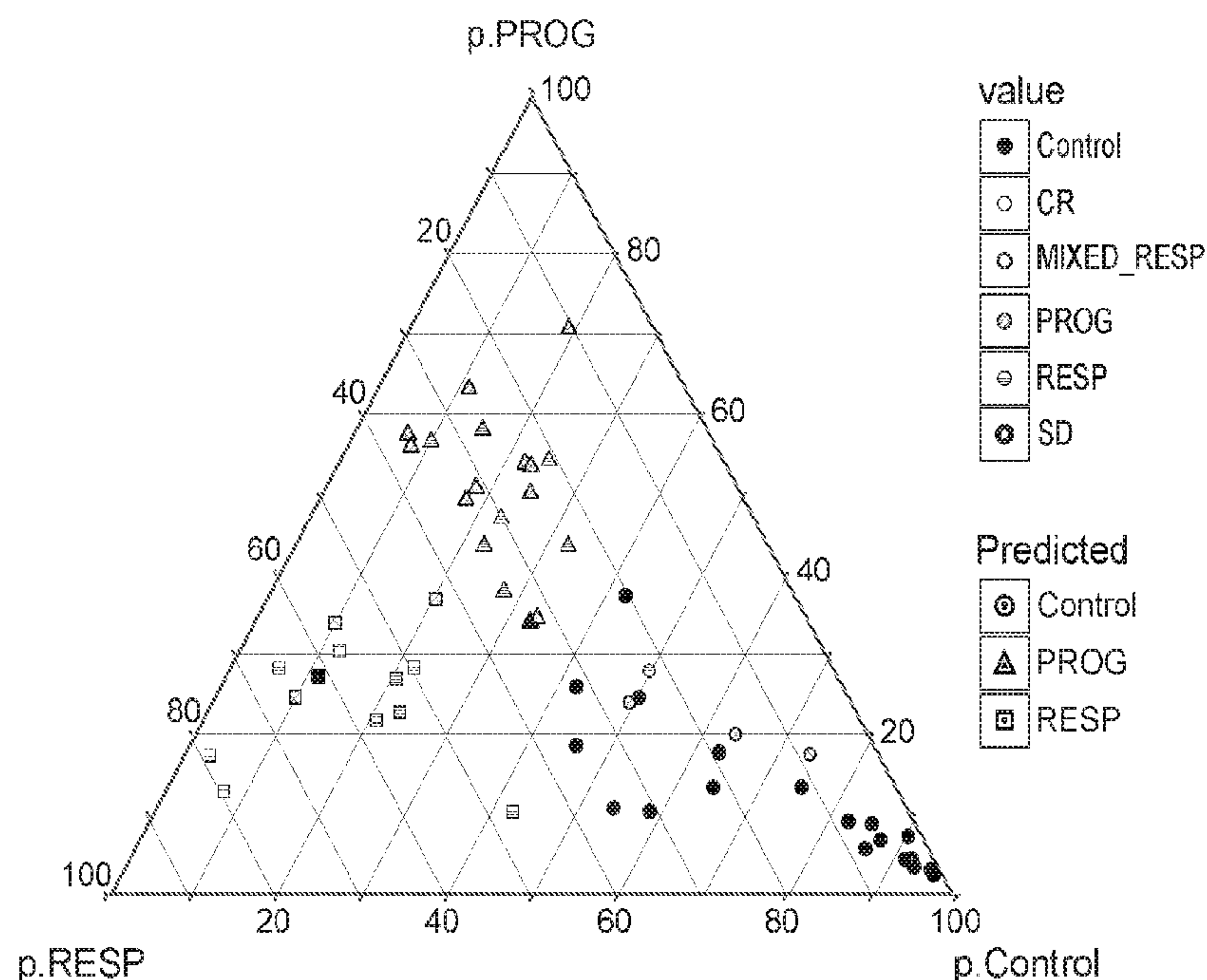
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(54) Title: METHODS FOR MELANOMA DETECTION



(57) Abstract: The present invention is directed to methods for detecting a melanoma, methods for determining whether a melanoma is stable or progressive, methods for evaluating the extent of surgery resection in a subject having a melanoma, and methods for determining a response by a subject having a melanoma to a therapy.

[Continued on next page]

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METHODS FOR MELANOMA DETECTION

Cross-Reference to Related Applications

[0001] This application claims the benefit of and priority to U.S. Provisional Application No. 62/511,058, filed on May 25, 2017, the contents of which are hereby incorporated by reference.

Incorporation by Reference of Sequence Listing

[0002] The contents of the text file named “LBIO-001_001WO SEQ LISTING.txt”, which was created on May 12, 2018 and is 265 kB in size, are hereby incorporated by reference in their entireties.

Field of the Invention

[0003] The present invention relates to melanoma detection.

Background of the Invention

[0004] Melanoma is a common (~24-35/100,000 incidence – US), highly aggressive, skin cancer with an incidence that continues to rise. The most common, cutaneous melanomas, are associated with UV exposure and immune dysregulation. As a group, melanoma is known to carry the highest mutational burden (>10mutations/Mb). Major mutations include BRAF (~50%), N-Ras (~20%) and NF-1 (~5%), which together, comprise 75% of all mutations. Melanomas are addicted to MAPK pathway activation, regardless of whether tumors exhibit mutations in genes coding for proteins in this pathway. This provides the rationale for targeted therapy e.g., BRAF v600E agents, in this tumor. Other gain-of-function and loss-of-function mutations e.g., in RASopathy genes and amplification of cyclin D1/cdk4 and/or mutation/loss of the tumor suppressor PTEN, also characterize the tumor. This makes melanoma one of the most aggressive and therapy-resistant cancers.

[0005] Five-year survival rates range from 95-100% for stage I, 65-93% for stage II, to 41-71% and 9-28% for stage III and IV, respectively. Surgery, immunotherapy and targeted therapies provide the basis for management, with chemotherapy and radiation as adjuncts. Surgery, however, has a critical role in melanoma care (diagnosis, cure and palliation). Sentinel lymph node biopsy has become widespread, as it provides prognostic information. Melanoma, however, lacks a clinically useful non-invasive e.g., blood-based biomarker of disease activity to help guide patient management by providing predictive or prognostic information.

[0006] Blood-based factors include lactate dehydrogenase (LDH), detecting mutations in circulating tumor (ct) DNA, measurements of circulating tumor cells (CTCs) and circulating mRNA. LDH is typically used to identify aggressive tumor behavior and predict recurrence but its metrics are very low e.g., 30-50% accurate. It is also non-specific for melanoma. Mutations in target genes, like BRAF, can be detected in the blood in ctDNA but its utility as an indicator of therapeutic efficacy is limited e.g., 45-70% accurate. CTCs do not appear to be an accurate marker in melanomas and there is no consensus as to their clinical utility. Circulating microRNAs (miRNA) have been detected but there is no evidence yet for clinical usefulness.

[0007] For melanomas, there are no multi-mRNA circulating biomarkers that function as a diagnostic or as a prognostic for disease recurrence. A biomarker that can be used to monitor the efficacy of surgery or drug therapy in melanomas is currently lacking.

Summary of the Invention

[0008] Among other things, disclosed herein is a 28-gene expression tool for melanoma. It has high sensitivity and specificity (>95%) for the detection of melanoma and can differentiate aggressive untreated disease from stable, treated disease.

[0009] One aspect of the present disclosure relates to a method for detecting a melanoma in a subject in need thereof, comprising: (1) determining the expression level of at least 29 biomarkers from a test sample from the subject by contacting the test sample with a plurality of agents specific to detect the expression of the at least 29 biomarkers, wherein the at least 29 biomarkers comprise ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1,

FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, YY2, and at least one housekeeping gene; (2) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of the at least one housekeeping gene, thereby obtaining a normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (3) inputting each normalized expression level into an algorithm to generate a score; (4) comparing the score with a first predetermined cutoff value; and (5) producing a report, wherein the report identifies the presence of a melanoma in the subject when the score is equal to or greater than the first predetermined cutoff value or identifies the absence of a melanoma in the subject when the score is below the first predetermined cutoff value, wherein the first predetermined cutoff value is 20 on a scale of 0 to 100.

[0010] In some embodiments, the method further comprises treating the subject identified as having a melanoma with surgery or drug therapy.

[0011] Another aspect of the present disclosure relates to a method for determining whether a melanoma in a subject is stable or progressive, comprising: (1) determining the expression level of at least 29 biomarkers from a test sample from the subject by contacting the test sample with a plurality of agents specific to detect the expression of the at least 29 biomarkers, wherein the at least 29 biomarkers comprise ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, YY2, and at least one housekeeping gene; (2) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5,

SPATS2L, TDRD7, TXK, and YY2 to the expression level of the at least one housekeeping gene, thereby obtaining a normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (3) inputting each normalized expression level into an algorithm to generate a score; (4) comparing the score with a second predetermined cutoff value; and (5) producing a report, wherein the report identifies that the melanoma is progressive when the normalized expression level is equal to or greater than the second predetermined cutoff value or identifies that the melanoma is stable when the normalized expression level is below the second predetermined cutoff value, wherein the second predetermined cutoff value is 50 on a scale of 0 to 100.

[0012] Another aspect of the present disclosure relates to a method for evaluating the extent of surgical resection in a subject having a melanoma, comprising: (1) determining the expression level of at least 29 biomarkers from a test sample from the subject after the surgical resection by contacting the test sample with a plurality of agents specific to detect the expression of the at least 29 biomarkers, wherein the at least 29 biomarkers comprise ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, YY2, and at least one housekeeping gene; (2) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of the at least one housekeeping gene, thereby obtaining a normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (3) inputting each normalized expression level into an algorithm to generate a score; (4) comparing the score with a third predetermined cutoff value; and (5) producing a report, wherein

the report identifies that the surgical resection does not remove the entire melanoma when the normalized expression level is equal to or greater than the third predetermined cutoff value or identifies that the surgical resection removes the entire melanoma when the normalized expression level is below the third predetermined cutoff value, wherein the third predetermined cutoff value is 20 on a scale of 0 to 100.

[0013] In some embodiments, the report further identifies that the risk of melanoma recurrence is high when the normalized expression level is equal to or greater than the third predetermined cutoff value or identifies that the risk of melanoma recurrence is low when the normalized expression level is below the third predetermined cutoff value.

[0014] Yet another aspect of the present disclosure relates to a method for determining a response by a subject having a melanoma to a therapy, comprising: (1) determining a first expression level of at least 28 biomarkers from a first test sample from the subject at a first time point by contacting the first test sample with a plurality of agents specific to detect the expression of the at least 28 biomarkers, wherein the 28 biomarkers comprise ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (2) determining a second expression level of the at least 28 biomarkers from a second test sample from the subject at a second time point by contacting the second test sample with a plurality of agents specific to detect the expression of the at least 28 biomarkers, wherein the second time point is after the first time point and after the administration of the therapy to the subject; (3) comparing the first expression level with the second expression level; and (4) producing a report, wherein the report identifies that the subject is responsive to the therapy when the second expression level is significantly decreased as compared to the first expression level.

[0015] In some embodiments, the first time point is prior to the administration of the therapy to the subject. In some embodiments, the first time point is after the administration of the therapy to the subject. In some embodiments, the therapy comprises an immunotherapy or a targeted therapy (e.g., a BRAF inhibitor).

[0016] In some embodiments, the at least one housekeeping gene is selected from the group consisting of ALG9, SEPN, YWHAQ, VPS37A, PRRC2B, DOPEY2, NDUFB11, ND4, MRPL19, PSMC4, SF3A1, PUM1, ACTB, GAPD, GUSB, RPLP0, TFRC, MORF4L1, 18S, PPIA, PGK1, RPL13A, B2M, YWHAZ, SDHA, HPRT1, TOX4, and TPT1.

[0017] In some embodiments, the at least one housekeeping gene comprises TOX4 and TPT1.

[0018] In some embodiments, the normalized expression level is obtained by: (1) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of TOX4, thereby obtaining a first normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (2) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of TPT1, thereby obtaining a second normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; and (3) averaging the first normalized expression level and the second normalized expression level to obtain the normalized expression level.

[0019] In some embodiments, the method can have a specificity, sensitivity, and/or accuracy of at least 75%, 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99%. In some embodiments, the method has a sensitivity of greater than 90%. In some embodiments, the method has a specificity of greater than 90%.

[0020] In some embodiments, the biomarker is RNA, cDNA, or protein. When the biomarker is RNA, the RNA can be reverse transcribed to produce cDNA, and the produced cDNA expression level is detected. In some embodiments, the expression level of the biomarker is detected by forming a complex between the biomarker and a labeled probe or primer. When the biomarker is RNA or cDNA, the RNA or cDNA can be detected by forming a complex between the RNA or cDNA and a labeled nucleic acid probe or primer. When the biomarker is protein, the protein can be detected by forming a complex between the protein and a labeled antibody. In some embodiments, the label is a fluorescent label.

[0021] In some embodiments, the test sample is blood, serum, plasma, or neoplastic tissue.

[0022] In some embodiments, the first predetermined cutoff value can be derived from a plurality of reference samples obtained from subjects free of a neoplastic disease. The second predetermined cutoff value can be derived from a plurality of reference samples obtained from subjects whose melanomas are being adequately controlled by therapies like immune therapy. The third predetermined cutoff value can be derived from a plurality of reference samples obtained from subjects whose melanomas have been completely removed by surgery and they are considered “disease free.” In some embodiments, each reference sample can be blood, serum, plasma, or non-neoplastic tissue.

[0023] In some embodiments, the subject in need thereof is a subject diagnosed with a melanoma, a subject having at least one melanoma symptom, or a subject having a predisposition or familial history for developing a melanoma. In some embodiments, the subject is a human.

[0024] In some embodiments, the algorithm is XGB, RF, glmnet, cforest, CART, treebag, knn, nnet, SVM-radial, SVM-linear, NB, NNET, or mlp.

Brief Description of the Drawings

[0025] FIG. 1 is a graph showing visualization of the melanoma score as a system of three contributors to the clinical picture - Control, Response, and Progression. Samples towards each of the corner represent pure representations of each clinical group. Samples in the middle are in the area of both algorithmic and clinical uncertainty.

[0026] FIG. 2 is a graph showing the metrics for the test in the test set ranged from 87-100%.

[0027] FIGs. 3A-3C are a set of graphs showing the evaluation of the circulating melanoma gene test (Melanomx) in test set 2. Values were significantly higher in melanoma samples than in controls (FIG. 3A). Patients who were responding to therapy had values similar to controls. Receiver operator curve analysis of test set 2 identifying the AUC for differentiating melanoma from controls was >0.95 (FIG. 3B). The metrics for the test ranged from 78-92% (FIG. 3C).

[0028] FIGs. 4A-4B are a set of graphs showing the effect of surgery on the Melanomx. Levels were significantly decreased by surgery ($p<0.0001$) (FIG. 4A). Values in the NED (no evidence of disease after surgery) group were significantly lower than in those with residual disease after surgery ($p=0.0007$) (FIG. 4B).

[0029] FIG. 5 is a graph showing the effect of therapy on the Melanomx score. Levels were significantly decreased by immunotherapy (ipilimumab) or a BRAF inhibitor (Vemurafenib).

[0030] FIGs. 6A-6B are a set of graphs showing Melanomx score in 3 different melanoma cell lines. FIG. 6A identifies the cell lines demonstrate elevated expression – Melanomx score ranging from 40 (A375) to 95 (Hs294). FIG. 6B identifies that spiking these cells into blood from a subject that does not have a melanoma, resulted in detectable gene expression and scores. A minimum of 1 cell/ml of blood could be consistently identified.

[0031] FIGs. 7A-7B are a set of graphs showing expression in tumor tissue and its correlation with blood samples collected at the same time. In FIG. 7A, the Melanomx score ranged 40-97 in melanoma tumor tissue. In contrast, normal epithelium exhibited values <20 . In FIG. 7B, gene expression in tumor tissue is compared to matched blood samples. This is highly concordant (correlation ~ 0.80).

Detailed Description of the Invention

[0032] The details of the invention are set forth in the accompanying description below. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, illustrative methods and materials are now

described. Other features, objects, and advantages of the invention will be apparent from the description and from the claims. In the specification and the appended claims, the singular forms also include the plural unless the context clearly dictates otherwise. Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. All patents and publications cited in this specification are incorporated herein by reference in their entireties.

[0033] Early signs of melanoma include changes to the shape or color of existing moles or, in the case of nodular melanoma, the appearance of a new lump anywhere on the skin. At later stages, the mole may itch, ulcerate or bleed. Visual inspection is the most common diagnostic technique. Melanoma can be divided into the following types: lentigo maligna, lentigo maligna melanoma, superficial spreading melanoma, acral lentiginous melanoma, mucosal melanoma, nodular melanoma, polypoid melanoma, and desmoplastic melanoma.

[0034] Measurements of circulating melanoma transcripts -- the Melanomx -- identify melanomas and decreases in the Melanomx score correlate with the efficacy of therapeutic interventions such as immunotherapy and targeted therapy. Targeted gene expression profile of RNA can be isolated from the peripheral blood of patients with melanoma. This expression profile is evaluated in an algorithm and converted to an output (prediction). It can identify active disease, provide an assessment of treatment responses, or predict risk of relapse, in conjunction with standard clinical assessment and imaging.

[0035] In one aspect, the present disclosure provides a method for detecting a melanoma in a subject in need thereof, including: (1) determining the expression level of at least 29 biomarkers from a test sample from the subject by contacting the test sample with a plurality of agents specific to detect the expression of the at least 29 biomarkers, wherein the at least 29 biomarkers comprise ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, YY2, and at least one housekeeping gene; (2) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1,

LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of the at least one housekeeping gene, thereby obtaining a normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (3) inputting each normalized expression level into an algorithm to generate a score; (4) comparing the score with a first predetermined cutoff value; and (5) producing a report, wherein the report identifies the presence of a melanoma in the subject when the score is equal to or greater than the first predetermined cutoff value or identifies the absence of a melanoma in the subject when the score is below the first predetermined cutoff value, wherein the first predetermined cutoff value is 20 on a scale of 0 to 100.

[0036] In some embodiments, the at least one housekeeping gene is selected from the group consisting of ALG9, SEPN, YWHAQ, VPS37A, PRRC2B, DOPEY2, NDUFB11, ND4, MRPL19, PSMC4, SF3A1, PUM1, ACTB, GAPD, GUSB, RPLP0, TFRC, MORF4L1, 18S, PPIA, PGK1, RPL13A, B2M, YWHAZ, SDHA, HPRT1, TOX4, and TPT1.

[0037] In some embodiments, the at least one housekeeping gene comprises TOX4 and TPT1. In some embodiments, the normalized expression level is obtained by: (1) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of TOX4, thereby obtaining a first normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (2) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2,

SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of TPT1, thereby obtaining a second normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; and (3) averaging the first normalized expression level and the second normalized expression level to obtain the normalized expression level.

[0038] Among the provided methods are those that are able to classify or detect a melanoma. In some embodiments, the provided methods can identify or classify a melanoma in a human blood sample. In some examples, the methods can provide such information with a specificity, sensitivity, and/or accuracy of at least 75%, 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99%.

[0039] The agents can be any agents for detection of the biomarkers, and typically are isolated polynucleotides or isolated polypeptides or proteins, such as antibodies, for example, those that specifically hybridize to or bind to the at least 29 biomarkers.

[0040] The biomarker can be RNA, cDNA, or protein. When the biomarker is RNA, the RNA can be reverse transcribed to produce cDNA (such as by RT-PCR), and the produced cDNA expression level is detected. The expression level of the biomarker can be detected by forming a complex between the biomarker and a labeled probe or primer. When the biomarker is RNA or cDNA, the RNA or cDNA detected by forming a complex between the RNA or cDNA and a labeled nucleic acid probe or primer. The complex between the RNA or cDNA and the labeled nucleic acid probe or primer can be a hybridization complex.

[0041] When the biomarker is protein, the protein can be detected by forming a complex between the protein and a labeled antibody. The label can be any label, for example a fluorescent label, chemiluminescence label, radioactive label, etc. The protein level can be measured by methods including, but not limited to, immunoprecipitation, ELISA, Western blot analysis, or immunohistochemistry using an agent, e.g., an antibody, that specifically detects the protein encoded by the gene.

[0042] In some embodiments, the methods are performed by contacting the test sample with one of the provided agents, more typically with a plurality of the provided agents, for example, a set of polynucleotides that specifically bind to the at least 29 biomarkers. In some embodiments, the set of polynucleotides includes DNA, RNA, cDNA, PNA, genomic DNA, or synthetic oligonucleotides. In some embodiments, the methods include the step of isolating RNA from the test sample prior to detection, such as by RT-PCR, e.g., QPCR. Thus, in some embodiments, detection of the melanoma biomarkers, such as expression levels thereof, includes detecting the presence, absence, or amount of RNA. In one example, the RNA is detected by PCR or by hybridization.

[0043] In some embodiments, the polynucleotides include sense and antisense primers, such as a pair of primers that is specific to each of the at least 29 biomarkers. In one aspect of this embodiment, the detection of the at least 29 biomarkers is carried out by PCR, typically quantitative or real-time PCR. For example, in one aspect, detection is carried out by producing cDNA from the test sample by reverse transcription; then amplifying the cDNA using the pairs of sense and antisense primers that specifically hybridize to the panel of at least 28 biomarkers, and detecting products of the amplification.

[0044] The test sample can be any biological fluid obtained from the subject. Preferably, the test sample is blood, serum, plasma or neoplastic tissue.

[0045] The first predetermined cutoff value can be derived from a plurality of reference samples obtained from subjects free of a neoplastic disease. Each reference sample can be any biological fluid obtained from a subject not having, showing symptoms of or diagnosed with a neoplastic disease. In some embodiments, the reference sample is blood, serum, plasma, or non-neoplastic tissue.

[0046] The subject in need thereof can be a subject diagnosed with a melanoma, a subject having at least one melanoma symptom or a subject having a predisposition or familial history for developing a melanoma. The subject can be any mammal. Preferably, the subject is human. The terms “subject” and “patient” are used interchangeably herein.

[0047] The score is the Melanomx score, which has a scale of 0 to 100. The Melanomx score is the product of a classifier built from predictive classification algorithms, e.g., XGB, RF, glmnet, cforest, CART, treebag, knn, nnet, SVM-radial, SVM-linear, NB, NNET, or mlp. The algorithm analyzes the data (i.e., expression levels) and then assigns a score.

[0048] The method can further include treating the subject identified as having a melanoma with surgery, drug therapy, radiation therapy, or a combination thereof. The drug therapy can be an immunotherapy, a targeted therapy, a chemotherapy, or a combination thereof. In some embodiments, the drug therapy includes an immunotherapy. Examples of immunotherapies for treating a melanoma include, but are not limited to, Imlygic (T-VEC), Yervoy in combination with Opdivo, Opdivo (nivolumab), Keytruda (pembrolizumab), Yervoy (ipilimumab), Interleukin-2 (IL-2), and Interferon alpha 2-b. In some embodiments, the drug therapy includes a targeted therapy such as a BRAF inhibitor. Examples of targeted therapies for treating a melanoma include, but are not limited to, Zelboraf in combination with Cotellic (cobimetinib), Tafinlar in combination with Mekinist, Tafinlar (dabrafenib), Mekinist (trametinib), and Zelboraf (vemurafenib). In some embodiments, the drug therapy includes a chemotherapy. In some embodiments, the chemotherapy includes dacarbazine.

[0049] The present disclosure also provides a method for determining whether a melanoma in a subject is stable or progressive, including: (1) determining the expression level of at least 29 biomarkers from a test sample from the subject by contacting the test sample with a plurality of agents specific to detect the expression of the at least 29 biomarkers, wherein the at least 29 biomarkers comprise ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, YY2, and at least one housekeeping gene; (2) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of the at least one housekeeping gene, thereby obtaining a normalized expression level of each of ATL1,

ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (3) inputting each normalized expression level into an algorithm to generate a score; (4) comparing the score with a second predetermined cutoff value; and (5) producing a report, wherein the report identifies that the melanoma is progressive when the normalized expression level is equal to or greater than the second predetermined cutoff value or identifies that the melanoma is stable when the normalized expression level is below the second predetermined cutoff value, wherein the second predetermined cutoff value is 50 on a scale of 0 to 100.

[0050] The second predetermined cutoff value can be derived from a plurality of reference samples obtained from subjects whose melanomas are being adequately controlled by therapies like immune therapy.

[0051] Surgical resection is a procedure that removes melanoma tissues from the subject in need thereof. The present disclosure also provides a method for evaluating the extent of surgical resection in a subject having a melanoma, including: (1) determining the expression level of at least 29 biomarkers from a test sample from the subject after the surgical resection by contacting the test sample with a plurality of agents specific to detect the expression of the at least 29 biomarkers, wherein the at least 29 biomarkers comprise ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, YY2, and at least one housekeeping gene; (2) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of the at least one housekeeping gene, thereby obtaining a normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L,

TDRD7, TXK, and YY2; (3) inputting each normalized expression level into an algorithm to generate a score; (4) comparing the score with a third predetermined cutoff value; and (5) producing a report, wherein the report identifies that the surgical resection does not remove the entire melanoma when the normalized expression level is equal to or greater than the third predetermined cutoff value or identifies that the surgical resection removes the entire melanoma when the normalized expression level is below the third predetermined cutoff value, wherein the third predetermined cutoff value is 20 on a scale of 0 to 100.

[0052] The third predetermined cutoff value can be derived from a plurality of reference samples obtained from subjects whose melanoma disease has been completely removed by surgery and they are considered “disease free.”

[0053] When it is determined that the surgical resection does not remove the entire melanoma, the subject is at risk of melanoma recurrence. Accordingly, in some embodiments, the report further identifies that the risk of melanoma recurrence is high when the normalized expression level is equal to or greater than the third predetermined cutoff value or identifies that the risk of melanoma recurrence is low when the normalized expression level is below the third predetermined cutoff value.

[0054] The present disclosure also provides a method for determining a response by a subject having a melanoma to a therapy, comprising: (1) determining a first expression level of at least 28 biomarkers from a first test sample from the subject at a first time point by contacting the first test sample with a plurality of agents specific to detect the expression of the at least 28 biomarkers, wherein the 28 biomarkers comprise ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (2) determining a second expression level of the at least 28 biomarkers from a second test sample from the subject at a second time point by contacting the second test sample with a plurality of agents specific to detect the expression of the at least 28 biomarkers, wherein the second time point is after the first time point and after the administration of the therapy to the subject; (3) comparing the first expression level with the second expression level; and (4) determining that the subject is

responsive to the therapy when the second expression level is significantly decreased as compared to the first expression level.

[0055] In some embodiments, the methods can predict treatment responsiveness to, or determine whether a patient has become clinically stable following, or is responsive or non-responsive to, a melanoma treatment, such as a surgical intervention or drug therapy (for example, an immunotherapy or targeted therapy). In some cases, the methods can do so with a specificity, sensitivity, and/or accuracy of at least 75%, 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99%. In some cases, it can differentiate between treated and untreated melanoma with a specificity, sensitivity, and/or accuracy of at least 75%, 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99%.

[0056] In some embodiments, the first and second test samples can be of the same type. In some embodiments, the first and second test samples can be of different types.

[0057] In some embodiments, the therapy can be a drug therapy. The drug therapy can be an immunotherapy, a targeted therapy, a chemotherapy, or a combination thereof. In some embodiments, the therapy can be a radiation therapy.

[0058] In some embodiments, the first time point is prior to the administration of the therapy to the subject. In some embodiments, the first time point is after the administration of the therapy to the subject. The second time point can be a few days, a few weeks, or a few months after the first time point. For example, the second time point can be at least 1 day, at least 7 days, at least 14 days, at least 30 days, at least 60 days, or at least 90 days after the first time point.

[0059] In some embodiments, the second expression level is significantly decreased as compared to the first expression level when the second expression level is at least 10% less than the first expression level. In some embodiments, the second expression level is significantly decreased as compared to the first expression level when the second expression level is at least 20% less than the first expression level. In some embodiments, the second expression level is significantly decreased as compared to the first expression level when the second expression level is at least 30% less than the first expression level. In some embodiments, the second expression level is significantly decreased as compared to the first expression level when the

second expression level is at least 40% less than the first expression level. In some embodiments, the second expression level is significantly decreased as compared to the first expression level when the second expression level is at least 50% less than the first expression level. In some embodiments, the second expression level is significantly decreased as compared to the first expression level when the second expression level is at least 60% less than the first expression level. In some embodiments, the second expression level is significantly decreased as compared to the first expression level when the second expression level is at least 70% less than the first expression level. In some embodiments, the second expression level is significantly decreased as compared to the first expression level when the second expression level is at least 80% less than the first expression level. In some embodiments, the second expression level is significantly decreased as compared to the first expression level when the second expression level is at least 90% less than the first expression level.

[0060] In some embodiments, the method further comprises determining a third expression level of the at least 28 biomarkers from a third test sample from the subject at a third time point by contacting the third test sample with a plurality of agents specific to detect the expression of the at least 28 biomarkers, wherein the third time point is after the second time point. The method can further comprise creating a plot showing the trend of the expression level change.

[0061] The present disclosure also provides an assay comprising: (1) determining the expression level of biomarkers consisting essentially of the following 30 biomarkers from a test sample from a patient diagnosed of a melanoma or a subject suspected of having a melanoma: ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, YY2, TOX4, and TPT1, wherein the expression level is measured by contacting the test sample with a plurality of agents specific to detect the expression of the 30 biomarkers; (2) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of

TOX4, thereby obtaining a first normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (3) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of TPT1, thereby obtaining a second normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (4) averaging the first normalized expression level and the second normalized expression level to obtain a normalized expression level for each biomarker; (5) inputting each normalized expression level into an algorithm to generate a score; and (6) comparing the score with a first predetermined cutoff value.

[0062] The present disclosure also provides an assay comprising: (1) determining the expression level of biomarkers consisting of the following 30 biomarkers from a test sample from a patient diagnosed of a melanoma or a subject suspected of having a melanoma: ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, YY2, TOX4, and TPT1, wherein the expression level is measured by contacting the test sample with a plurality of agents specific to detect the expression of the 30 biomarkers; (2) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of TOX4, thereby obtaining a first normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR,

CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (3) normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of TPT1, thereby obtaining a second normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2; (4) averaging the first normalized expression level and the second normalized expression level to obtain a normalized expression level for each biomarker; (5) inputting each normalized expression level into an algorithm to generate a score; and (6) comparing the score with a first predetermined cutoff value.

[0063] The sequence information of the melanoma biomarkers and housekeepers is shown in Table 1.

[0064] Table 1. Melanoma Biomarker/Housekeeper Sequence Information

Gene Name	RefSeq Accession	Sequence	SEQ ID NO:
ATL1	NM_001127713.1	AGTTTGAGGC TGCAC TGCAC ACCTGCACAA CCTGCCTTCT ACTTAGTTCT TCTGAGACAT TTCTGAAAGT CTGAATTCCT AGGACTGCTC AATGACCTTT GTCCCTGTTG GGCACACGCA GTGTCTCATC GCTGGTATTG CACCTTTAAT GAGACCAGGA GTTCCGCAAA AGTAAAACAA AGGGGTCACA GACTGGTTCT GGTTCTACCA CTCCTCAGT ATGTGCTCTG GGACAAAACA GCATATTTGG CAACATCTCG GTGTCCTTAT CTGCAGCTTG AAGAGGCGCC ACAGCAACAT CCTCAGAGTC TGAGCGAACT GCGCCCAGCG CGGGCACGGA GCCTCCCACC GCCAGCAACC TGCGGCCCCG GAGAAGGCAG CGAGCGCAGT GACAGCGCCT CACCGCCACC AGCTCCTGGA CCACCATGGC CAAGAACCGC AGGGACAGAA ACAGTTGGGG TGGATTTTCG GAAAAGACAT	1

ATGAATGGAG CTCAGAAGAG GAGGAGCCAG TGAAAAAGGC
 AGGACCAGTC CAAGTCCTCA TTGTCAAAGA TGACCATTC
 TTTGAGTTAG ATGAAACTGC ATTAAATCGG ATCCTTCTCT
 CGGAGGCTGT CAGAGACAAG GAGGTTGTTG CTGTATCTGT
 TGCTGGAGCA TTTAGAAAAG GAAAATCATT CCTGATGGAC
 TTCATGTTGA GATACATGTA CAACCAGGAA TCAGTTGATT
 GGGTTGGAGA CTACAATGAA CCATTGACTG GTTTTTTCATG
 GAGAGGTGGA TCTGAGCGAG AGACCACAGG AATTCAGATA
 TGGAGTGAAA TCTTCCTTAT CAATAAACCT GATGGTAAAA
 AGGTTGCAGT GTTATTGATG GATACTCAGG GAACCTTTGA
 TAGTCAGTCA ACTTTGAGAG ATTCAGCCAC AGTATTTGCC
 CTTAGCACAA TGATCAGCTC AATACAGGTA TATACTTAT
 CCCAAAATGT CCAGGAGGAT GATCTTCAGC ACCTCCAGCT
 TTTCACTGAG TATGGCAGAC TGGCAATGGA GGAAACATTC
 CTGAAGCCAT TTCAGAGTCT GATATTTCTT GTTCGAGACT
 GGAGTTTCCC ATACGAATTT TCATATGGAG CCGATGGTGG
 TGCCAAATTC TTGGAAAAAC GCCTCAAGGT CTCAGGGAAC
 CAGCATGAAG AACTACAGAA CGTCAGAAAA CACATCCATT
 CCTGTTTCAC CAACATTTCC TGTTTTCTGC TACCTCATCC
 TGGCTTAAAA GTAGCTACCA ATCCAAACTT TGATGGAAAA
 TTGAAAGAAA TAGATGATGA ATTCATCAAA AACTTGAAAA
 TACTGATTCC TTGGCTACTT AGTCCCGAGA GCCTAGATAT
 TAAAGAGATC AATGGGAATA AAATCACCTG CCGGGGTCTG
 GTGGAGTACT TCAAGGCTTA TATAAAGATC TATCAAGGTG
 AAGAATTACC ACATCCCAAA TCCATGTTAC AGGCCACAGC
 AGAAGCTAAC AATTTAGCAG CCGTGGCAAC TGCCAAGGAC
 ACATACAACA AAAAAATGGA AGAGATTTGT GGTGGTGACA
 AACCATTTCT GGCCCCAAAT GACTTGCAGA CCAAACACCT
 GCAACTTAAG GAAGAATCTG TGAAGCTATT CCGAGGGGTG
 AAGAAGATGG GTGGGGAAGA ATTTAGCCGG CGTTACCTGC
 AGCAGTTGGA GAGTGAAATA GATGAACTTT ACATCCAATA
 TATCAAGCAC AATGATAGCA AAAATATCTT CCATGCAGCT
 CGTACCCCAG CCACACTGTT TGTAGTCATC TTTATCACAT
 ATGTGATTGC TGGTGTGACT GGATTCATTG GTTTGGACAT
 CATAGCTAGC CTATGCAATA TGATAATGGG ACTGACCCTT
 ATCACCCTGT GCACTTGGGC ATATATCCGG TACTCTGGAG
 AATACCGAGA GCTGGGAGCT GTAATAGACC AGGTGGCTGC
 AGCTCTGTGG GACCAGGCTT TGTACAAGCT TTACAGTGCA
 GCAGCAACCC ACAGACATCT GTATCATCAA GCTTTCCCTA
 CACCAAAGTC GGAATCTACT GAACAATCAG AAAAGAAAAA
 AATGTAATGC AAATTTTAAG AAATACAGGT GCATGACCAA
 TTGTCAATTA AATATTCAGT TTTATGTCTC CATGCAAACA

		TTCAAAGTGC TTCCATCAGA ACGGAGTAAA ATACTAAACA CCTCTGAAGA CTGCAAACCTG GATTAGTTCT TTTACTTCAG TGTTTAAATAA GCAGATGTAT GTATGCATGG TTATACTATT TTGTTAACAT GTACAATTTC CTGATTTTTTC TTCAAAAATG CTGTTATAAA GTATTTGTCT ATTTATGATA ACAGTACACG TGTTCTGCTT GAATTTACTA AATTCTACTA CTGGGTTATA ATTAAATCAT GTGATATTCC ACGTTTGGAT ATGCTCATTT AATTTCTACA GAAAAAATTT TAAATTATTT CACATTAGCC ATTTGTTAAA ACACAGCATC ATAACTCAGC AGGCTGGATT TAATCTGTAT CATCTTATAT ATATCACAAT CTTATTTTAA AGCACATTTT AGAGTTCCTT AGTTGCTTTA TCAAAAACCA GATATTGCTT TTACATGGTT TAATAGAATA TAAACCTCTT GATAAAAAAT GCACAAAAAA TCACTTTGTA TATGTGAGTT TCACTGCATT GTATATTTTT TCATTTGGTA CACAAAGAAT GTATTCTTCA TAGGTTTATT CTTTAAATAT GTGAACTATT ATTAAAGTTT ACTCTGGTTC CTAAGATTAA AAACAAATGC TTRACTGAATT TGAAAAAAA A	
ATP6V 0D	NM_0 04691. 4	ACTTGACAGC CCGCTGAGGA CGCAGCGTCA GCTGACCTGG GGAGTCGCGA TTCGTGCCGG CCGGTCCTGG TTCTCCGGTC CCGCCGCTCC CGCAGCAGCC ATGTCGTTCT TCCCGGAGCT TTACTTTAAC GTGGACAATG GCTACTTGGA GGGACTGGTG CGCGGCCTGA AGGCCGGGGT GCTCAGCCAG GCCGACTACC TCAACCTGGT GCAGTGCGAG ACGCTAGAGG ACTTGAAACT GCATCTGCAG AGCACTGATT ATGGTAACTT CCTGGCCAAC GAGGCATCAC CTCTGACGGT GTCAGTCATC GATGACCGGC TCAAGGAGAA GATGGTGGTG GAGTTCCGCC ACATGAGGAA CCATGCCTAT GAGCCACTCG CCAGCTTCCT AGACTTCATT ACTTACAGTT ACATGATCGA CAACGTGATC CTGCTCATCA CAGGCACGCT GCACCAGCGC TCCATCGCTG AGCTCGTGCC CAAGTGCCAC CCACTAGGCA GCTTCGAGCA GATGGAGGCC GTGAACATTG CTCAGACACC TGCTGAGCTC TACAATGCCA TTCTGGTGGA CACGCCTCTT GCGGCTTTTT TCCAGGACTG CATTTCAGAG CAGGACCTTG ACGAGATGAA CATCGAGATC ATCCGCAACA CCCTCTACAA GGCCTACCTG GAGTCCTTCT ACAAGTTCTG CACCCTACTG GGCGGGACTA CGGCTGATGC CATGTGCCCC ATCCTGGAGT TTGAAGCAGA CCGCCGCGCC TTCATCATCA CCATCAATTC TTTCGGCACA GAGCTGTCCA AAGAGGACCG TGCCAAGCTC TTCCACACT GTGGGCGGCT CTACCCTGAG GGCCTGGCGC AGCTGGCTCG GGCTGACGAC TATGAACAGG TCAAGAACGT GGCCGATTAC TACCCGGAGT ACAAGCTGCT CTTCGAGGGT GCAGGTAGCA ACCCTGGAGA CAAGACGCTG GAGGACCGAT TCTTTGAGCA CGAGGTAAAG CTGAACAAGT TGGCCTTCCT GAACCAGTTC CACTTTGGTG TCTTCTATGC CTTCGTGAAG CTCAAGGAGC AGGAGTGTCG CAACATCGTG TGGATCGCTG AATGTATCGC CCAGCGCCAC	2

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CIORE 21	NM_0 30806. 3	CCCTCCCTCG CTCGCTCCTC GCAAGCTCCC GCTCGCTCCC TGCCCACTCC CGGGGGGACG TTCCGTGCCG CGGCCGCCGC GGCCGCTGCT TCTTTCACAC TTTAGTTGGG AGCTGCGCGC CGCGCTCAGT TACTGGAGAG CTGGCCGCGC GCCGCCGCCT CCCGCACGCT TGCACGCGGG CCCGGCTTCG GGGTTTTGGG TTCTTACTCC AAGCGGCGGG GAGGAGGGGG AGCCCCGGAC AACTGTGGG GAGGAGGAGG AAGAAGAGGA GGAGGGAGGA AGAAAAAGA CGAGGAGGAC AGGGGCGGGG GGCGGGAGGC TTGCCACCTT CAGCCCCCCC GCGAACGCCC AAGGTGCACA CATCTTGACC AACTCAGCAG CAAGGTGGAT TTCTTTGTG TTTAAAGAAA AAAAATGTCC CTGTGTCTGT AGAGATGATT TGCAGTTCAG CCCGGCTGAA GCTGACCGAA TGAGACTATG GGCTGTGCCT CCGCCAAGCA TGTTGCCACT GTTCAAAATG AAGAGGAAGC CCAGAAAGGG AAAA ACTACC AGAACGGAGA TGTGTTTGGC GATGAGTATA GGATCAAACC AGTGGAAGAG GTCAAATACA TGAAAAATGG GGCAGAAGAA GAGCAGAAAA TAGCAGCCAG GAACCAAGAA AACTTGGAAG AAAGTGCCAG CTCAAATGTA AGACTTAAAA CTAATAAAGA GGTTCGGGA TTAGTTCATC AACCCAGAGC AACATGCAC ATCTCTGAAA GCCAACAAGA ATTCTTCAGA ATGCTGGATG AAAAAATTGA AAAGGGTCGG GATTACTGTT CGGAAGAAGA GGATATCACA TAGCACCAAT TTTACCACTC AAACCAGGAG CTACTACTGT GTAAATAGGT TACACCCAG TTGAAATCTT TGCAAAGGTC GGTTCATTG AGCGAACAGC ACTATAGCAA AAGAAGATCG TTCCATATTG TACGCCCCAT TAAATTACAG TGTTTCTTAA TGA ACTTGCA AAGGAATATT GCTAAAAACA AACAAAAAAA ACTGTTATCG AACTTTCTTT GTTGCTGCTA GTTAAACTT GTTGCAACTT TTCACTTCTC TTGTGTCCAG GTATGCAGCA AAATTCTGCA ATTTCACCTT AAAGATACTG TTGGTTTTAC	3

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CFLAR -ASI	NR_04 0030.1	CATGCATACA GCCCAGTCTA ACGTACAGGA TCAAAAAGAG ACCTTATTTT GGCTGGCAAT TACCTTACCC GCTTGTTTCAT TATCTGACTC CTGCACTCCT CCAAGTGTT CAATGTTAAC CAGATGGCAA AGTTAACCAG ACAGAGGAAA TCCACATAAT TACTCTAGAT GAAGCCCCCT AACTGCGGAT TAGAAGGAAA AGAGATGAAG GGTGCTGCAC TAATAATAAC AACCATTTTC	5

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DMD	NM_00109.3	CGTTAAATGC AAACGCTGCT CTGGCTCATG TGTTTGCTCC GAGGTATAGG TTTTGTTTGA CTGACGTATC AGATAGTCAG AGTGGTTACC ACACCGACGT TGTAGCAGCT GCATAATAAA TGA CTGAAAG AATCATGTTA GGCATGCCCA CCTAACCTAA CTTGAATCAT GCGAAAGGGG AGCTGTTGGA ATTCAAATAG ACTTTCTGGT TCCCAGCAGT CGGCAGTAAT AGAATGCTTT CAGGAAGATG ACAGAATCAG GAGAAAGATG CTGTTTTGCA CTATCTTGAT TTGTTACAGC AGCCAACCTTA TTGGCATGAT GGAGTGACAG GAAAAACAGC TGGCATGGAA GATGAAAGAG AAGATGTTCA AAAGAAAACA TTCACAAAAT GGGTAAATGC ACAATTTTCT AAGTTTGGGA AGCAGCATAT TGAGAACCTC TTCAGTGACC TACAGGATGG GAGGCGCCTC CTAGACCTCC TCGAAGGCCT GACAGGGCAA AAAC TGCCAA AAGAAAAAGG ATCCACAAGA GTTCATGCCC TGAACAATGT CAACAAGGCA CTGCGGGTTT TGCAGAACAA TAATGTTGAT TTAGTGAATA TTGGAAGTAC TGACATCGTA GATGGAAATC ATAAACTGAC TCTTGGTTTG ATTTGGAATA TAATCCTCCA CTGGCAGGTC AAAAATGTAA TGAAAAATAT CATGGCTGGA TTGCAACAAA CCAACAGTGA AAAGATTCTC CTGAGCTGGG TCCGACAATC AACTCGTAAT TATCCACAGG TTAATGTAAT CAACTTCACC ACCAGCTGGT CTGATGGCCT GGCTTTGAAT GCTCTCATCC ATAGTCATAG GCCAGACCTA TTTGACTGGA ATAGTGTGGT TTGCCAGCAG TCAGCCACAC AACGACTGGA ACATGCATTC AACATCGCCA GATATCAATT AGGCATAGAG AAAC TACTCG ATCCTGAAGA TGTTGATACC ACCTATCCAG ATAAGAAGTC CATCTTAATG TACATCACAT CACTCTTCCA AGTTTTGCCT CAACAAGTGA GCATTGAAGC CATCCAGGAA GTGGAAATGT TGCCAAGGCC ACCTAAAGTG ACTAAAGAAG AACATTTTCA GTTACATCAT CAAATGCACT ATTCTCAACA GATCACGGTC AGTCTAGCAC AGGGATATGA GAGAACTTCT TCCCCTAAGC CTCGATTCAA GAGCTATGCC TACACACAGG CTGCTTATGT CACCACCTCT GACCCTACAC GGAGCCCAT TCCCTTACAG CATTTGGAAG CTCCTGAAGA CAAGTCATTT GGCAGTTCAT TGATGGAGAG TGAAGTAAAC CTGGACCGTT ATCAAACAGC TTTAGAAGAA GTATTATCGT GGCTTCTTTC TGCTGAGGAC ACATTGCAAG CACAAGGAGA GATTCTAAT GATGTGGAAG TGGTGAAAGA CCAGTTTCAT ACTCATGAGG GGTACATGAT GGATTTGACA GCCCATCAGG GCCGGGTGG TAATATTCTA CAATTGGGAA GTAAGCTGAT TGGAACAGGA AAATTATCAG	8

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HLA- DOA	NM_0 02119. 3	CTTCTTCTTT ACCTCCGCCT TGTTCCGTGC CTCACCACAC GGACTGAGAC TGATTTGATT AAAGCACCAG AGTGTAATGG CCCTCAGAGC AGGGCTGGTC CTGGGGTTCC ACACCCTGAT GACCCTCCTG AGCCCGCAGG AGGCAGGGGC CACCAAGGCT GACCACATGG GCTCCTACGG ACCCGCCTTC TACCAGTCTT ACGGCGCCTC GGGCCAGTTC ACCCATGAAT TTGATGAGGA ACAGCTGTTT TCTGTGGACC TGAAGAAAAG CGAGGCCGTG TGGCGTCTGC CTGAGTTTGG TGACTTTGCC CGCTTTGACC CGCAGGGCGG GCTGGCCGGC ATCGCCGCAA TCAAAGCCCA TCTGGACATC CTGGTGGAGC GCTCCAACCG CAGCAGAGCC ATCAACGTGC CTCCACGGGT GACCGTGCTC CCAAGTCTC GGGTGGAGCT GGGCCAGCCC AACATCCTCA TCTGCATCGT GGACAACATC TTCCCCCCTG TGATCAATAT CACCTGGCTG CGCAACGGCC AAAGTGTAC TGAGGGAGTG GCCCAGACCA GCTTCTATTC CCAGCCTGAC CATTGTGTTCC GCAAGTTCCA CTACCTGCCC TTCGTGCCCT CAGCCGAGGA CGTCTATGAC TGCCAGGTGG AGCACTGGGG CCTGGATGCG CCACTCCTCA GGCATTGGGA GCTCCAGGTG CCTATTCCAC CACCAGATGC CATGGAGACC CTGGTCTGTG CCCTGGGCCT GGCCATCGGC CTGGTGGGCT TCCTCGTGGG CACCGTCCTC ATCATCATGG GCACATATGT GTCCAGTGTC CCCAGGTAAT GATCCTTCTG AGAGAAATGA CTTGTGGGAG ACACCCTGCA GATCCTCATG	13

	GGTTTGTGAC AGCCCCCTGCG TGCTCAGTGC CCTTTAAGTG CATCCCGCTG TGCTGACTTT GAGTGGGATC AACATCTGTC CTACGGGTCC CCTCTTTTTT GGCCCCAGTA TTCATGGCAG GGTTTGTGTTGG ACACCTACTA GCTTCCCTTC CCATTCAACA CACACACACA TTCTTGCTCT ACCCAAAGCT CTGGCTGGCA GCACTAAATG CTTTGGTGGT GTTTGCACTG TGTCCTTTCC AGGCCTTGGC CAGTTCTTCC AGGGGTGAGG CATGTGGTGC TGGGGATTGG CAGCCATCCT GGGGCCCACA CAGGTGTGTC TTGCTCCATT TGGCCCATG TGTGTTACTT TGTGAATGAG CCATTTCACA TGGACTTCAT GAAATTTGCC TCCTGAGTTC AGGTTTACCC TGAAAGGGAT GCAGATTATC CTGTTCCCTCA CGACCCCTC AGCTAACAAC AGTTCTGAAG GGTGCTGGGA CAGGACAGGC TCATGGGGAC TCCACTCCTG CCTGGGTTTA CTCTGTATGA AGAGGCCACT GGTATCCTGC CATGATGTTA TCTCCTTTTT CTACTTTTCC CTAGAGTCCC ATGCATGATA AAGAGAGGCC CAAGGCTTGG ATAAGGTGGC CACTTCCCTC AGTGGAGTCA GTCATGTTAG GTAGGAGGTG GTAGAGTCGG TCTGCGAGGT ATCTCGTAAG AGGGGAGGTC CACCTAGACA CACTCTAAAT ATGTGGCCTA GAAGATTTTG GTCTACTTTT CTGTGAACAG AATTAAAAC ATACAAAGAG ATAAATCACC ATACCACATA GTTTATGTCA GGACCAAAAT GAGCAATACA GATTACGGTT TTCAAACCAG AATGCACATA AGAACTGCTT GGGATCCTTT TAAAAGTACA GGCATTGGCC TGGTGCAGTG GCTCATTCCT GTAATCCCAG CACTTTGGGA GGCCAAGGGG ACAGGACTGC TTGAGGCCAA GAGGTGGAAA CCATCTTGGG CTACATAGAG AGACCCCATC TCTACAAAGA AAGATTTAAA AATTAACCAG GCATGGTGGC TCGCACCTGT ATTCCCAGCC ACTGGGGAGG CTGAGGCCGG AGGAGTGCTT GAGCCCAGGA GTTCAAGGCT GCAGTGAGCC AAGATTGCGC CACTGCACTC CAGCCTAGGT GACAGAGTGA GACCCTGTCT CTAAATAAAT AAATAAATAA AATATAAAAA TAACAGTCAT CACCCAGACC TACTGAATTA GAATCTCGGG AGTGCAGGGG GCAGCAACAG GGAGGCTGTC TTTTCTGAGA TGGGGTCTCA CTCTGTCACC AGGCTGGAGT GCCATGGCAT GATCTCAGCT CACTGCAACC TCCACCTCCT GAGTTCAAGC CATTCTCCTG CCTCAGCCTC CTGAGTAGCT GGGACTACAG GTGTGCGCCA CTACACTCAG CTAATTTTGT TATTTTAAGT AGAGACGGGG TTTCATCATG TTGGCCAGGA TGGCCTCCAT CTCTTGACCT CGTGATCCAC CCACCTTCCC TCCCAAAGTA CTGGAATTAC AGGCATTAGC CACTGTGCCC AGCCGAGGCT GTCATTTTAA ACCGGCTCTG GATGACTCTG ATGCAGCCAT CCTGGACCTT GGCTGTGGTC TGGTAACTGG AACCAGTGA CGTAATCAGG TGCCATCGGG	
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HLA-DRA	NM_019111.4	TTTTAATGGT CAGACTCTAT TACACCCAC ATTCTCTTTT CTTTTATTCT TGTCTGTTCT GCCTCACTCC CGAGCTCTAC TGACTCCCAA CAGAGCGCCC AAGAAGAAAA TGGCCATAAG TGGAGTCCCT GTGCTAGGAT TTTTCATCAT AGCTGTGCTG ATGAGCGCTC AGGAATCATG GGCTATCAAA GAAGAACATG TGATCATCCA GGCCGAGTTC TATCTGAATC CTGACCAATC AGGCGAGTTT ATGTTTGA CT TTGATGGTGA TGAGATTTTC CATGTGGATA TGGCAAAGAA GGAGACGGTC TGGCGGCTTG AAGAATTTGG ACGATTTGCC AGCTTTGAGG CTCAAGGTGC ATTGGCCAAC ATAGCTGTGG ACAAAGCCAA CCTGGAAATC ATGACAAAGC GCTCCA ACTA TACTCCGATC ACCAATGTAC CTCCAGAGGT AACTGTGCTC ACAAACAGCC CTGTGGA ACT GAGAGAGCCC AACGTCCTCA TCTGTTTCAT AGACAAGTTC ACCCAC CAG TGGTCAATGT CACGTGGCTT CGAAATGGAA AACCTGTCAC CACAGGAGTG TCAGAGACAG TCTTCCTGCC CAGGGAAGAC CACCTTTTCC GCAAGTTCCA CTATCTCCCC TTCCTGCCCT CAACTGAGGA CGTTTACGAC TGCAGGGTGG	14

		AGCACTGGGG CTTGGATGAG CCTCTTCTCA AGCACTGGGA GTTTGATGCT CCAAGCCCTC TCCCAGAGAC TACAGAGAAC GTGGTGTGTG CCCTGGGCCT GACTGTGGGT CTGGTGGGCA TCATTATTGG GACCATCTTC ATCATCAAGG GATTGCGCAA AAGCAATGCA GCAGAACGCA GGGGGCCTCT GTAAGGCACA TGGAGGTGAT GGTGTTTCTT AGAGAGAAGA TCACTGAAGA AACTTCTGCT TTAATGGCTT TACAAAGCTG GCAATATTAC AATCCTTGAC CTCAGTGAAA GCAGTCATCT TCAGCATTTT CCAGCCCTAT AGCCACCCCA AGTGTGGATA TGCCTCTTCG ATTGCTCCGT ACTCTAACAT CTAGCTGGCT TCCCTGTCTA TTGCCTTTTC CTGTATCTAT TTTCCTCTAT TTCCTATCAT TTTATTATCA CCATGCAATG CCTCTGGAAT AAAACATACA GGAGTCTGTC TCTGCTATGG AATGCCCCAT GGGGCATCTC TTGTGTACTT ATTGTTTAAG GTTTCCTCAA ACTGTGATTT TTCTGAACAC AATAAACTAT TTTGATGATC TTGGGTGGAA AAAAAAAAAA AAAAAAAAAA AAAAAAAAAA AA	
HNRNP A3P1	NR_00 2726.2	CGAGTTGGAA GAGGTGAGTC CTGTCTCAAA ATGGAGGTAA AACCGCCGCC TGGTTGCCCC CAGCCCGACT CCGGCAGTCG CCGTCGCCAC TGGGGGGAGG AGGGCCATGA TCCAAAGGAA CCAGAGCAGC TGAGAAAAC TTTTATTGGT GGTCTGAGCT TTGAAACTAC AGATGATAGT TTAAGAGAAC ATTTTGAGAA ATGGGGCACA CTCACAGATT GTCTGGTAAT GAGAGACCCC CAAACAAAAC GTTCCAGGGG CTTTGGTTTT GTGACTTATT CTTGTGTTAC AGAGGTGGAT GCAGCAATGC GTGCTCGACC ATTCAAGGTT GATGGGCGTG TAGTGGAACC AAAGAGAGCT GTTTCTAGAG AGGATTCTGT GAAGCCTGGT GCCCATCTAA CAGTGAAGAA AATTTTGTGTT GGCAGTATTA AAGAAGATAC AGAAGAATAT AATTGAGAG ACTACTTTGA AAAGTACGGC AAGATTGAAA CCATAGAAGT TATGGAAGAC AGGCAGAGTG GAAAAAAGAG AGGATTTGCT TCTGTAAC TTGATGATCA TGATACAGTT GATAAAATTG TTGTTCAGAA ATACCACACT ATTAATGGGC ATAACGTGA AGTGAAAAAG GCCCTTGCTA AACAAGTGAT GCAGCCGGCT GGATCACAGA GGGGTCGTGG AGGTGGATCT GGCAATTGTA TGGGTCACAG AGGAAACTTT GGAGGTGGTG GAGGTAATTT TGGCCGTGAT GGAAACTTTG GTGGAAGAGG AGGCTATGGT GGTGGAGGTG GTGGCAGCAG AGGTAGTTAT GGAGGAGGTG ATGTGGATAT AATGGATTAG GAGGTGATGG TGGCAACTAT GGCAGTGGTC CTGGTTATAG TAGTAGAGGC GGGTATGGTG GTGGTGGACC AGGATATGGA AACCAAGGTG GTGGATATGG TGGCGGTGTT GGAGGATATG ATGGTTACAA TGAAGGAGGA AATTTTGACG GTAGTAACTA	15

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LOC49 4127	NR_03 6691.1	GCAGTGCCCG ACTCCGCAGG AGCGCCAGGG CGGCTCCTGC TCTTCCTGGA CTCCCTGAAG AGGCGTTTGT CGAAATGTCC ACAGAAGGAG GATTTGGTGG TACTAGCCGC AGTGATGCCC AGCAAAGCCT AAAGTCCTTC TGGCTTCGGG TCATGGAAGA AATCTGGAAT TTAGCAGTGA AAGATTTCTG AATGCAGGAA CTCCCCTGG CTCGTATTAA GAAGATTATG AAACCTGGATG AAGATGTGAA GATGATCAGT GCAGAGGCCCT CTGTGCTCTT TGCCAGGGCA GCCCAGATTT TTTATCACAG AGTTGACTCT TCGAGCCTGG ATTCACACAG AGGATAACAA CTGCCGGACT TATGTCGCCA TGGCAATTAC GAAATTTGAT CAATTGGATT TTCTCATCGA TATTGTTCTA AGAGATGAAC TGAAACCTCC AAAGTGTCAG GAGGAGGTGC TGCAGTCTGT AACTCCTGCT GAGCCAGTCC AATACTATTT CACGCTGGCT CAGCAGCCCA CCGCCCCGTCC AAGTCCAGGG ACAGCAGCAA GGCCAGACCA CCGCCAGCTC CATGACCACC ATGCAGCCTG GGCAGATCAT CATCGCACAG CTTCAGCAGG GCCAGACCAC GCCCGTGACG ACGCAGGTTG GAGAAGGTCA GCAGGTGCAG ATTGTCCAGG CCCAGCCACA GGGTCAAGCC CAGTAGGCCC AGAGTGGTAC TGGATGGACC GTGCAGGTGA TGTAGCAGAT CCTCACTAAC ACAGGAGAGA TCCAGCAGAT CCCGGTGCAG CTGAAGGCTG GCCAGCTGCA GTGTATCCGC TTAGCCCAGT CTGTATCAGG CACCCACGTT CTGCAGGGAC AGATCCAGAC ACTTGCCACC AGCGCTCAAC CGATTACACA GACAGAGGTC CAGCAAAGAC AGCAGTAGTT CAGCCAGTTC ACAGATGGAC AGCAGCTCTA CCAGATCCAG CAAGTATCCA TACCTGCGGG CCAGGACCTG CCCAGCCCAT GTTTTTCCAG TCAGTCAACC AGCCCTCTGA TGGGCAGGCC CCCCAGGTGA CTGGCGGCTG AGGGCCGGAG CTGGCAAGGC CGAGGACACT CAACACAATT TTTGCCGTAC AGCCCCAGGT CATGAACACA GCCTTCTTCC CCAGAGGACC CGGCCGACCT CAGCTCCTCC TGCAGGCTAG GACAATGGCG CACTAGGCCT CATGCCTGGG GGCCGAGATT CTCCAACAGA AAGATGCAAT ATTTTTTGTT TCCTTTTTTC TCCAAGGAAT	18

		CAATATTTCA ATATGTTGAG CTGTGTGTCC AATGCTATGA AATTAAAATA TTAAATCACA AAAAAAAAAA AAAA	
LOC64 6471	NR_02 4498.1	AATGAATCCA ACTACTGTCC TTGTCCTCTC CTCTCTAGGT TTGTGGAGAC TGAATTCCAC AAACCTAGGG ACAGGGCACT CTCTAGGGGC AAGTCAACTC TCAATTATAG TGAGGGCAGG TTCCCCAGTT GCCAGCCTAC ACCCTGGCCA GCCACCCAAG GGAATACCTG CTGCTGCTAA GGCAGTCAAT GTTGGGAGGG TCAGGGAAGG GGAGAGGAAG TAGCTGAGTG TAGAGATTAT CCAGGCTTTC CTCCCCGTCC TCTGTACAGA AAGGCAGACA TACTACTGACT CCTGAAGTGC CCCAGGATCA TAGTTGGTTC TTCTTAGGGG GAGGGAGTGA AACGGTGGCC TTGCTCCAAT TCCAGGCCTC TGGAGAAAGG AGTGCTCAAC TGGAGAGTCT CAGAACCTTT TACAGTACTT CAGCAGGCCC AGCACCCAAC CTTCCCCACC ATACCCCTGC CCTGGGAATG CCCCTTACCA CAGTGGCTTC CATTCCTGAC ATTTGAACCA GCTCCTGCAC TTGAAGGACA AGGCAGCCAC TGGGCAGCTC CGGGAGGCGG GAGGCGTGAC TCCTTCATAT CAGGCCATCT GGAGGAGCAC CAGATTTCCC TCTTGTGAAA CAACCCCCCA CAGTGGGGAT TTAATGGTCA CCACACAAGC CCCAAAAAAC CAGGCCCTGC AGAGCCATGA CTTACAGGG GAGAAAACCA GCCCAAGAGG CTGCCCTCAC CCAACACTTA GCTCTAAGTC CAGACTCTTA AAGGTTCTGT TAAAGATCTG CGGCCAGGCG CAGTGGCTCA CATCTGTAAT CCCAGCACTT TGGGAGGCCG AGGTGGGCGG ATCACGAGGT CAGGAGAGCG AGACCATCCT GGCTAACACA GTGAAGCCCT GTCTCTACTA AAAATACAAA AAATTAGCCA GGTGTGGTGG CGGGCACCTG TAGTACCAGC TACTTGGGAG GCTGAGGCAG GAGAATGGCG TGAACCCAGG AGGCAGAGCT TGCAGTGAGC CGAGATCACG CCACTGCACT CCAACCTGGG TGACAGAGCG AGACTCCGTC TCAAAAAAAAA AAAAAAAAAA AAAAGATTTG CCTAGTGAGC TTGGCCAACC CAAGAGCCTT CCTGGGCTCT CAGGTTTCTT GAGGCAAAAC TTCTAAAGAT GCAAATAGAA TCCTTGGTAG CTACAAAGCT CATCTAGCCA AATTATAAGT ACTATCCAAG CCCAGGATTC ATTCTTGAAG ATGAGATGTA AAAGCACTGC TGGGCCCTTG CAAAGGGAGA GATCAGAGAA AATAGGAGAA CGAACACCAG CTCATGCCAA TCTCAGTCTC ATGAGCTACA GAGAAAAAGA GCCAAAAAAG TTTATCCTGG CTCAGCCACC TTCTGGCTTT GTAGCTACAG GCAAGTTATT TAACTTTTCT GAATGTTGGT TTTTCCATCT GGAAAAAGGA GACAGGAAAA GCTGCCACTG GAGGCTACCT TAAGGGTCAA TGAGTGAAAT GGGGTGAGT GCTTAATGAA CTGTTAAAC ATGACACAGA TGGGTGAGGT GACATCTGAC	19

	TGCTCTTCAC AGCAGTCCTT GCATGGTGAG CAGATGCAAT CAGTGTGCTC GTTCATTCAC TTGTTTCATCA AACACCAACA GTACCCACTT GTGCCAGGCC TTGTGCTGGG CACCGTAGGG GCTATGGAAG GAGTAAGACA CAGTCATGCT CTCAAGGAAC TCGCTGTCCA GCAGAGTGAT AGGACATGAA TACATACTTC TAGCAAAGGC TGAGTAGCAT TAGGCAGGTG GCCAGATGAG GTCAGAGCTC TGGCCCTAGT GCCCTGTAGT AAGTTGCGAG GGAGTAGGAA ATGAAGACAA AACAGCAAGA GCACAGGTCC AGCACAAGAA GGTGAAGGAC ATGGAAAGAG GAGCAGAGCA TGATAAAGCT ACAAAGTAG GGGGCAAGTC ATGAGGTCCG GGTCACTGGG GAGCCCTGGA CAGGCTCTGA ATGGGAGATA GACTAGACTG ACAAAGCAGC TCTTTCTGGA GACCTCCTGT GGAGGGTCCC CTCTTCTACC CTTGGGAGAC GAGGTGTCAT TCACTTCACG ATACACATGG GGAAAGGAAG TTGGACAGGG GAAGGCACTT GTCTAAGGTC ACTCAGTGGT CATGCCAGTG CAAAGCACCC AAAGCCTGGT CCAGGTCCTG CCACCTCCTG CGTGGGCTCC ATCTTCTCGG CTCAGTTCAA GCCTTTATTA TCAGAGTCCC TCTGTGTGCC AGGCTCTGTG CTGAATGTCC GTGTGCGCCA CAAATTGCAC TAACGGTGCT TACTGCCACT TCCTCTCCGA CCTTACCTCC AAAGACCCAG CCGGGCCTAA CCCTCACACA CAGCCAGAGG AATCCTTCCC AAACACAGTT AATCACATCG CTCATCCGTT TAAAACTGGC TTAGTAGAGC CAACACAGGA TAAAATCCAC AATCAGTCCC AAACCCATCT TTCTCTGCCG TCTCTAGACC ACATTCACTG AGCACCAAGG CCTGCACGCT TCGCAGCCAG CCCTCCTGCT CTCCCCCTTG CCCTCCAGCC ACACTGGGCC TCAACCCCCA ACACTGGGCC CACCTCTGAG CCCTGCATCA AACACCAGCA CCCCCTTCGC CGAGCTCATT CTTTCATCATT CCTCAGAGCT CAGCTTAAGC ATCACCTTCC TTCCCTGCGA CAGGGTCAGG TCCTTTCTTG TGCGCTCCGC AGCACCTGC CTGTCCCTCG GAGTCCTCGC GAGAGGAACT AGATAACTGT GATCCCCGCG CACAGCACGG TGTCTGCCTA GGACACAGTG AGCGCTTCAA CGCGCTGAAC TAAACGAATG AAGGGGAACA CCAACTCAGC TGTCACCCCC GCCCCCAAGT GTCACTGGCT AGAAGATCTT CCCCCGGTTC GCCGGCAGCA CCGGTGGGTC TTGTCACCTC TGCGCCCCGC AGCCCTCCGG AGGCTGCAGT TGCTGTCTGC TGACAGGCGT CCCCTCAGGA GAACGGGAGC TCCTCCAGCG CAGGGCCCTG CTCAGCACCC CTGGTCCCGG GGGCCCCCAC GGAGGCCGCC GCGCTCAGTG AAACTTTGCC GCGCGCAGCA GTGGCCGGAG ACCCGCGCGG ACCCTCTCCC CGCGGGGACC CGCCAGGGCG AGTCGCCCCT CCCCCGCGGC AGACGACCCG ACCTGGGCCA AGGTGCGCCA AGTGCTCGCC GCCTGCCCAG CGGCCCTTGG	
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LOH12 CR	NR_02 4061.1	GGCTACGCAA GACCTTCAGT TCCGGATTAG GAGGCCCCGC CCCCCGGCC GAGGGAGGGG CGGAGAGACC CGCTCCTGCG ACTTAGGGCG ATGCCACCTT AAAGGGCTTG ACCTCCTCGA AGCCAGAACT GCGGAAGAGG ATGGAGAAAG AAACGCTAGA TAGACCCAGG ATTCGAACCC ACAACAGCTT GGATGCAAAG CTCATTTTGA ATTCTGAAGA GCTGGGAGTT TAGCAGTGGA CGACCAAACA AAAAAATACC AGAAGACGGT GAAAGCAGCA GCTGGAAATG AGAGAAAAAT TAAGAAATAG AAAATGCTGT TTCATGTATT AGGGAGTGCA CATCTTTAAA GAGAAGTGAA GAACCTTTTT GGCTAGGCGC TTTCTGGGGA CCTTGGCAGT TATCAACAAG TCACTCTGAA ACTAACAGAA GGTGAGGAGG GAGTAATCCA GAAAGGAAAC TGCCATTTTT GCTAGGGCAA GAAAGTAGAC CTAGCAATGC AATGCCATCA AGGAGTTAGC TGGCTCTAGC GTTCTCCGAA CTTTGCAACT CATTTTATAT TACATTGTCT GCGTCAAGAA ATTTCAAGTA AATGCCTTGA GATTTTATAT GTATAAAATG TAGTCTCTGG CCAGGCGGGG TGGCTCACGC CTGTAATCCC AGCACTTTGG GAGGCTGAGG CGAGTAGATC ACGATGTCAG GAGATCAAGA CCATCCTGGC TAACATGGTG AAACCCCGTC TCTACTAAAA AATACAAAAA ATTAGCCGGG CATGATGGTG GGCGCCTGTA GTCCAGCTA CTCGGGAGGC TGAGACAGGA GAATGGTGTG AACCCGGGAG GCAGAGCTTG CAGTGAGCCG AGATCGCGCC ACTGCACTCC AGCCTGGGCG ACAGAGCGAG ACTCCGTCTC AAAAAAAAAA AAAAAAAAAA AAGTCTCAGA AGAAGTGTCA AGTTGACTAA ATGATTTTTA AGTCCCTTCC ACTCTACTAT ATCACAATAA TTTCCCCTAT TTTACCTTAT TTAATTTTCA CAACAACCCT GCAGCCTGTA AGTAGGTGAC TCCTCCATGG TCAGCAGGTG GTCAGTGGTC GAACTATTTA GGACTATCTG ATGCTCTTTC CTCTGCTCAC CATTGCAATA CAATGAGAAA AATGCAAATG AATCTAAGTA CAGTGTTCTC TGGGAATATG AAGATAGAAC	20

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SERTA D2	NM_0 14755. 2	CTCCTGCACG GCGAGTGCTG GAGCACGACG TACCGCTCGC TCGGTCAGGG CGCCCCCTCC GCCCGCCTCC TGCTTCCTCC TCCGCTGCCT GCCGCCGCCG CCTCCACCAT TGTATAATGC TCGGGGGCGCG CAGGCAGAGA ACGGCGGAGT CTTAGCTTCA GCCTCGCCTG CTGCCCCGCTC CCCGGCGCCA CCCTCGGGCC CCTGGAGCGG GGCACCTCCGC ATGGAGCGGG AGTAGCTGAG GAGTGGGCGG AAACCCCTCC TGATGCGTTA GTTCCCAGGT GGAGCTGCAT GTGATATATG TTGGGTAAAG GAGGAAAACG GAAGTTTGAT GAGCATGAAG ATGGGCTGGA AGGCAAAATC GTGTCTCCCT GTGACGGTCC ATCCAAGGTG TCTTACACCT TACAGCGCCA GACTATCTTC AACATTTCCC TTATGAAACT CTATAACCAC AGGCCCCCTGA CAGAGCCCAG CTTGCAAAAG ACCGTTTTAA TTAACAACAT GTTGAGGCGG ATCCAGGAGG AACTCAAACA GGAAGGCAGC CTGAGGCCCA TGTTCACCCC CTCCTCCCAG CCCACCACCG AGCCCAGCGA CAGCTACCGA GAGGCCCCCGC CGGCCTTCAG CCACCTGGCG TCCCCGTCCT CCCACCCCTG CGACCTCGGA AGCACTACGC CCCTGGAGGC CTGCCTCACC CCGGCCTCAC TGCTCGAGGA CGACGATGAC ACGTTTTGCA CCTCCCAGGC CATGCAGCCC ACGGCTCCCA CCAAACTGTC ACCTCCAGCC CTCTTGCCAG AAAAGGACAG TTTCTCCTCT GCCTTGGACG AGATCGAGGA GCTCTGTCCC ACATCTACCT CCACAGAGGC GGCCACGGCT GCGACTGACA GTGTGAAAGG GACCTCCAGC GAGGCTGGCA CCCAGAAACT CGACGGTCCT CAAGAGAGCC GCGCAGATGA CTCAAAACCTG ATGGACTCTC TGCCTGGGAA TTTTGAAATA ACGACGTCCA CGGGTTTCCT GACAGACTTG ACCCTGGATG ACATCCTGTT TGCTGACATT GATACGTCCA TGTATGATTT TGACCCCTGC ACTTCCTCAT CAGGGACAGC CTCAAAAATG GCCCCTGTGT CTGCCGACGA CCTCCTCAAA ACTCTGGCTC CTTACAGCAG TCAGCCTGTC ACCCCAAGTC AGCCTTTCAA AATGGACCTC ACAGAGCTGG ACCACATCAT GGAGGTGCTT GTTGGGTCCT AAGACCCAGG GACCCAGCGA CTATGCCAC CCAGACCCCA GAGCGTTCCC ATAACCCTGA CAGTTCTCCA CACTGTGCAT GCACCCTTGC TTGCCTTTTT CAGAGAAAAA GAAAATTTTA CAACAGGATC AACTAGTTT TTGCTTTGAG CAGAGTTGGA GTGCCTTCAT CCAAGTATGA CCACTTTTAA TACACTTTTT TGAGTGGTTC CTCAGAGACC TACTACCCTG GTATAGGAAA GAATCCATTT GAAGACAATG TTGCAATGTT GAATGACAAA AATAAACAGT TCAAGTGAAG CACAAGGATT AAGTTGGAAA AGCTGTAAAT TGCATGTGCA TATTTGTCTA TTTTTTCTAT AAGTTTTATT GCAAGAGGTA AAGAAGAAAA CTATATATAT ATATCTTATT TAGATAATCT CAGTACCTTT TCTGGCATT	23
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 CCTTGTTTCA ACCAAAGGGT GAGCAGTGGC CAGAGCCTCC
 TCTGCACCTC TCGAGTGTCT TTACCAATTG AGCTTTTTAT
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 AGGGCAGCCT TCTTAAATGA CAAATGTAAA AAAAAAAAAA
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 CTTTATACAT TTTCTGAAAA CAATGAAAAG AGTATATTTA

		ACCTTTTCTG GCTGTAAATG GTTACCTTCC TGTAAC TGCC CCGCACCTGG AGGCATGGAG TTGTGTGCAT CCTGCTTATG TACAATTGTT TTCAGTGTTT CTAAGAATGA GTCTGAATGG TTCTTGAAAA TTAGCCAGGA TCAAATGCTA TTGCAGACAA AGCCAATAAA AAGTTGGACT TCTTTTGGGG ATAACAAGTT TTGGAAGAGA AATGCAGGCC ATATGTGCGC ATGACCGAGA TTTTGAAAAA AGATGTACAT AGTGACATGT TTGGTGCATG GTTTTTGAGG AGGGCTTTTG TCAAAAAGGA GGTATAACCT TTCCCCACA GACCTGAGAG CTGTGCCTTT TCTATGCAAT ATTACAGACG TTACATCGGA ACCCAGATGG CTGTATTCAC ATGTAGGTTT GGGCTGTAAT CTAAACAATT GGACAGATTA AATGTACATG GAAATGAGCA GTCTTACTTT TGTAGTTTTA TATTATACAA TAAACAGTTA AAAGATGAAA AAAAAAAAAA AAAAA	
SLC35 G5	NM_0 54028. 1	TACCACCTCA GGAGAGTTCC AGGGAAGAAC CCCACCCGCA CTCCAATGAG GTCACAATGG CTGGAGCTCT GAGGGGCCCCA GGCTCCCTGA GCCAGGAGGA GAGGAGAAAG TCCAAGGAAA GATGGCTGGC AGTCACCCCT ACTTCAACCT GCCTGACTCC ACACACCCAT CGCCGCCCTC CGCTCCACCC AGCCTCCGCT GGCACCAGCG CTGCCAGCCC TCTGGTGCCA CCAATGGCCT GCTGGTGGCC CTGCTGGGTG GGGGCCTGCC TGCTGGCTTC GTGGGCCCCC TTCTCGTAT GGCTTACCAG GGTTCCAACC TGCCCTCGCT GGAGCTGCTC ATCTGTGCGAT GCCTCTTCCA CCTCCCTATT GCCCTGCTAC TTAAACTGCG TGGCGACCCC CTTCTGGGAC CTCCTGACAT CCGAGGCTGG GCCTGCTTCT GTGCCCTGCT CAACGTCCTC AGCATTGGAT GTGCCTACAG TGCAGTTCAG GTGGTGCCCG CTGGCAACGC TGCCACTGTT CGCAAAGGTT CTCCACCGT ATGCTCCGCT GTCCTCACCC TCTGCCTTGA GAGCCAGGGT CTCGGTGGCT ACGAGTGGTG TGGACTGTTG GGCAGCATCC TAGGACTAAT CATCATTCTG GGACCTGGAC TCTGGACACT ACAGGAGGGG ACCACAGGTG TCTACACCAC CCTGGGCTAT GTGCAGGCTT TCCTGGGAGG CCTGGCGCTG TCCCTGGGGC TTCTGGTCTA TCGTTCTCTG CACTTTCCCT CCTGCCTCCC AACAGTGGCC TTCCTATCTG GCTTGGTGGG GCTGCTGGGC TGTGTGCCAG GCCTCTTTGT GCTGCAGACC CCCGTGTTGC CCAGTGACCT CCTGAGTTGG AGTTGTGTGG GGGCAGAGGG GATCCTCGCC TTGGTCTCCT TCACATGTGT GGGCTATGCG GTCACCAAGG CCCACCCTGC CCTGGTGTGC GCTGTCCTGC ATTCCGAGGT GGTGTGGCC CTTATACTGC AGTATTATAT GCTCCATGAG ACTGTGGCAC TTTCTGACAT CATGGGGGCA GGGGTTGTGC TGGGCAGCAT	24

		TGCCATCATT ACAGCCCCGGA ACCTCAGCTG TGAGAGGACA GGGAAGGTGG AGGAGTGAGA TAGAACTTGG GAGCCCCGGG GTTGGGAGGG ACAGGGATAA ATAAAGACAA AGACTGAAGA C	
SPATS 2L	NM_0 011004 22.1	AGTGCTGAGG GAGCAAAGTT CATTTTCTCG GGTAGGAGAA GATGATTCTC TTGCAACACG TCGGATTGT GACAAAATCT TTCATTAACA AGGGGAGTTT CGGTGAAGTG GAGGTTTGGG GAAAGGCGAG GAAGTCGGTC TGGAGCAAGC AAGCAAAGTG CGGAAGCTGT ACTGGGATTC TTCTAGAAAG TGGGGTGGGA AAGGAGCTAG GGAGGGCGTG TGGAGGGACG AGATCTGTGT CAGAACGTGC GTGTGAGCGG ATACAAAACC CGAGAGAGGC GTGAGCAGCG CTGTGTTTGC GAGCGGGAGC GAGGGGCGCC GGCTGGGGTG TGTGCTCCTG AGCTCTTCAG AAACCAGGCT GCTTTCAGGA ACATTGCTGT GGATTCCCAG GGCCTATTCC ACTAGAAGCA AGATGGCTGA ACTCAATACT CATGTGAATG TCAAGGAAAA GATCTATGCA GTTAGATCAG TTGTTCCCAA CAAAAGCAAT AATGAAATAG TCCTGGTGCT CCAACAGTTT GATTTTAATG TGGATAAAGC CGTGCAAGCC TTTGTGGATG GCAGTGCAAT TCAAGTTCTA AAAGAATGGA ATATGACAGG AAAAAAGAAG AACAATAAAA GAAAAAGAAG CAAGTCCAAG CAGCATCAAG GCAACAAAGA TGCTAAAGAC AAGGTGGAGA GGCCTGAGGC AGGGCCCCCTG CAGCCGCAGC CACCACAGAT TCAAAACGGC CCCATGAATG GCTGCGAGAA GGACAGCTCG TCCACAGATT CTGCTAACGA AAAACCAGCC CTTATCCCTC GTGAGAAAAA GATCTCGATA CTTGAGGAAC CTTCAAAGGC ACTTCGTGGG GTCACAGAAG GCAACAGACT ACTGCAACAG AAACTATCCT TAGATGGGAA CCCCAAACCT ATACATGGAA CAACAGAGAG GTCAGATGGC CTACAGTGGT CAGCTGAGCA GCCTTGTAAC CCAAGCAAGC CTAAGGCAAA AACATCTCCT GTTAAGTCCA ATACCCCTGC AGCTCATCTT GAAATAAAGC CAGATGAGTT GGCAAAGAAA AGAGGCCCAA ATATTGAGAA ATCAGTGAAG GATTTGCAAC GCTGCACCGT TTCTCTAACT AGATATCGCG TCATGATTAA GGAAGAAGTG GATAGTTCCG TGAAGAAGAT CAAAGCTGCC TTTGCTGAAT TACACAAC TG CATCATTGAC AAAGAAGTTT CATTAAATGGC AGAAATGGAT AAAGTTAAAG AAGAAGCCAT GGAAATCCTG ACTGCTCGTC AGAAGAAAGC AGAAGAACTA AAGAGACTCA CTGACCTTGC CAGTCAGATG GCAGAGATGC AGCTGGCCGA ACTCAGGGCA GAAATTAAGC ACTTTGTCAG CGAGCGTAAA TATGACGAGG AGCTCGGGAA AGCTGCCCCG TTTTCCTGTG ACATCGAACA GCTGAAGGCC CAAATCATGC TCTGCGGAGA AATTACACAT CCAAAGAACA ACTATTCCTC AAGAACTCCC TGCAGCTCCC	25

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TDRD7	NM_001302884.1	AGAGCCGAGG CCAGGCTGCC CTCGAAGCGG GGCGGGGCGA AGCGGGGCGG GGCCGAGCAG GGCGGGGCGG GGGCTTGAGG TGATTCCCAA GCCGCGGGGC GGCTCCGGTG GTGCGGGGAA ACCGAAAGTG GGCGGCGGCC GCGGCGGGGC CCCTGGCGGA	26

	GACGGCGGCA GGAGCTGGGC CCAGAGACGC GGGGACGGGC CGTGGGCCCC CGGAACGAGA TTACCTGCTA TGCCATGGCC TGCACAGAAA CTGCAAGAAT TGCTCAGCTT GTGGCTCGTC AAAGGAGTTC TAAAAGGAAA ACCGGGCGTC AAGTTAATTG TCAGATGAGA GTGAAGAAAA CCATGCCATT TTTTCTAGAA GGAAAACCAA AAGCAACCCT CAGACAACCA GGATTTGCTT CAAATTTTTC TGTTGGCAA AAACCTAATC CAGCACCGTT AAGAGACAAA GGAAACTCTG TTGGAGTTAA GCCTGATGCT GAAATGTCTC CTTATATGCT ACACACAACCT CTTGGAAATG AAGCATTCAA AGACATTCCA GTGCAAAGGC ATGTGACCAT GTCCACCAAC AACAGGTTTA GCCCAAAGGC GTCCCTTCAA CCACCTTTGC AGATGCATCT CTCAAGAACC TCTACTAAGG AAATGAGTGA TAATTTAAAT CAGACTGTTG AAAAACCCTA TGTCAAGCCT CCTGCCTCTT ACACCTTATAA AATGGATGAG GTTCAAAATC GCATAAAGGA AATACTAAAC AAGCATAACA ATGGCATTG GATATCTAAG CTTCCACATT TTTACAAAGA GTTATATAAA GAAGACCTTA ATCAAGGAAT TTTACAACAG TTTGAACACT GGCCTCATAT TTGCACGGTG GAGAAACCTT GCAGTGGTGG CCAAGATTTA CTTCTTTATC CAGCTAAGAG AAAGCAGCTT TTGAGAAGTG AACTGGATAC TGAGAAAGTA CCTCTATCCC CACTACCTGG TCCCAAACAA ACACCACCGT TGAAAGGGTG TCCAACAGTT ATGGCAGGAG ACTTTAAAGA AAAAGTGGCA GACCTGCTGG TGAAATACAC AAGTGGCCTT TGGGCCAGTG CACTTCCGAA AGCATTTGAG GAAATGTACA AAGTGAAATT CCCTGAGGAT GCCTTAAAAA ATCTTGCCTC ACTTTCTGAT GTATGCAGCA TAGACTACAT TTCTGGAAAT CCCCAGAAGG CCATTCTCTA TGCTAAACTT CCATTGCCCA CTGACAAAAT CCAAAGGAT GCAGGGCAAG CACATGGTGA TAATGATATC AAGGCTATGG TTGAACAAGA GTATTTGCAG GTAGAAGAAA GCATTGCTGA AAGTGCTAAT ACCTTTATGG AGGACATAAC AGTTCCTCCT TTAATGATTC CAACTGAAGC ATCACCATCT GTATTGGTGG TTGAAGTGA CAACACAAAT GAAGTGGTTA TCAGGTATGT GGGCAAAGAC TATTCTGCTG CTCAGGAATT AATGGAAGAT GAGATGAAGG AATATTACAG TAAGAATCCT AAGATCACAC CAGTCCAGGC TGTGAATGTT GGGCAGTTGC TGGCCGTAAA TGCCGAGGAG GACGCCTGGT TACGGGCACA GGTCATCTCA ACAGAAGAGA ACAAATAAAA GGTATGCTAT GTTGACTATG GTTTTAGTGA AAATGTTGAA AAAAGCAAAG CATACAAATT AAACCCGAAG TTTTGTTTAC TCTCATTICA AGCTACAAAA TGTAAGCTTG CAGGCTTGGA AGTCCTAAGC GATGACCCTG ATCTAGTGAA GGTGGTTGAA TCTTTAACTT GTGGAAAGAT CTTTGCAGTG GAAATACTTG	
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		TATTAGAATA AAAATGTTTA TCAATATAAA AAAAAAAAAA AAAAAAAAAA AA	
TOX4 (housekeeping gene)	NM_001303523.1	AGCAGAGAGA ACACACGTCC TTGCGGAAGT GACGGCAGTT CCGAGTCCAG TGGGGGCGGT GGGAGCGATG AGGGTCTGAG ACGGTGGGAG CGGTTGTGTG AAGATGGAGA CATTCCATAC ACCAAGCTTG GGTGATGAGG AATTTGAAAT CCCACCTATC TCCTTGGAAT CTGATCCCTC ATTGGCTGTC TCAGATGTGG TTGGCCACTT TGATGACCTG GCAGACCCTT CCTCTTCACA GGATGGCAGT TTTTCAGCCC AGTATGGGGT CCAGACATTG GACATGCCTG TGGGCATGAC CCATGGCTTG ATGGAGCAGG GCGGGGGGCT CCTGAGTGGG GGCTTGACCA TGGACTTGGA CCACTCTATA GGAAGTCAGT ATAGTGCCAA CCCACCTGTT ACAATTGATG TACCAATGAC AGACATGACA TCTGGCTTGA TGGGGCATAG CCAGTTGACC ACCATTGATC AGTCAGAACT GAGTTCCCAG CTGGGTTTGA GCCTAGGGGG TGGCACCATC CTGCCACCTG CCCAGTCACC TGAAGATCGT CTTTCAACCA CCCCTTCACC TACTAGTTCA CTTACAGAGG ATGGTGTTGA GGATTTCCGG AGGCAACTTC CCAGCCAGAA GACAGTCGTG GTGGAAGCAG GGAAAAAGCA GAAGGCCCCA AAGAAGAGAA AAAAGAAAGA TCCTAATGAA CCTCAGAAAC CAGTTTCAGC ATATGCTTTA TTCTTTCGTG ATACACAGGC TGCCATCAAG GGACAGAATC CTAATGCCAC TTTTGGTGAG GTTTCAAAA TTGTGGCCTC CATGTGGGAT AGTCTTGGAG AGGAGCAAAA ACAGGTATAT AAGAGGAAAA CTGAGGCTGC CAAGAAAGAG TATCTGAAGG CACTGGCTGC TTACAAAGAC AACCAGGAGT GTCAGGCCAC TGTGGAAACA GTGGAATTGG ATCCAGCACC ACCATCACAA ACTCCTTCTC CACCTCCTAT GGCTACTGTT GACCCAGCAT CTCCAGCACC AGCTTCAATA GAGCCCCCTG CCCTGTCCCC ATCCATTGTT GTTAACTCCA CCCTTTCATC CTATGTGGCA AACCAGGCAT CTTCTGGAGC TGGGGGTCAG CCCAATATCA CCAAGTTGAT TATTACCAA CAAATGTTGC CCTCTTCTAT TACTATGTCT CAAGGAGGGA TGGTTACTGT TATCCCAGCC ACAGTGGTGA CCTCCCGGGG GCTCCAATA GGCCAAACCA GTACAGCTAC TATCCAGCCC AGTCAACAAG CCCAGATTGT CACTCGGTCA GTGTTGCAGG CAGCAGCAGC TGCTGCTGCT GCTGCTTCTA TGCAACTGCC TCCACCCCGA CTACAGCCCC CTCCATTACA ACAGATGCCA CAGCCCCCGA CTCAGCAGCA AGTTACCATT CTGCAGCAGC CTCCTCCACT CCAGGCCATG CAACAGCCTC CACCTCAGAA AGTTCGAATC AATTTACAGC AACAGCCTCC TCCTCTGCAG ATCAAGAGTG TGCCTCTACC CACTTTGAAA ATGCAGACTA CCTTAGTCCC	27

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TPT1 (housekeeping gene)	NM_001286272.1	CTTCGTGCCA CGTCACCGCC TGCCTCGCTT CCGGAGGCGC AGCGGGCGAT GACGTAGAGG GACGTGCCCT CTATATGAGG TTGGGGAGCG GCTGAGTCGG CCTTTTCCGC CCGCTCCCCC CTCCCCCGGA GCGCCGCTCC GGCTGCACCG CGCTCGCTCC GAGTTTCAGG CTCGTGCTAA GCTAGCGCCG TCGTCGTCTC CCTTCAGTCG CCATCATGAT TATCTACCGG GACCTCATCA GCCACGATGA GATGTTCTCC GACATCTACA AGATCCGGGA GATCGCGGAC GGGTTGTGCC TGGAGGTGGA GGGGAAGATG GTCAGTAGGA CAGAAGGTAA CATTGATGAC TCGCTCATTG GTGGAAATGC CTCCGCTGAA GGCCCCGAGG GCGAAGGTAC	28

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ALG9	NM_0 010776 90.1	GTCTTTTGTC CCTCGGCGGA CACCGTTTGC CAGCCAAAGC TATGTCTGCG CGCTCACCGA CTTCATAGGG TGCCGAATTC TTTTTTCCCC AGGCTTGCCA TGGCTAGTCG AGGGGCTCGG CAGCGCCTGA AGGGCAGCGG GGCCAGCAGT GGGGATACGG CCCCGGCTGC GGACAAGCTG CGGGAGCTGC TGGGCAGCCG AGAGGCGGGC GGCGCGGAGC ACCGGACCGA GTTATCTGGG AACAAAGCAG GACAAGTCTG GGCACCTGAA GGATCTACTG CTTTCAAGTG TCTGCTTTCA GCAAGGTTAT GTGCTGCTCT CCTGAGCAAC ATCTCTGACT GTGATGAAAC ATTCAACTAC TGGGAGCCAA CACACTACCT CATCTATGGG GAAGGGTTTC AGACTTGGGA ATATTCCCCA GCATATGCCA TTCGCTCCTA TGCTTACCTG TTGCTTCATG CCTGGCCAGC TGCATTTCAT GCAAGAATTC TACAAACTAA TAAGATTCTT GTGTTTTACT TTTTGCGATG TCTTCTGGCT TTGTGAGCT GTATTTGTGA ACTTTACTTT TACAAGGCTG TGTGCAAGAA GTTIGGGTTG CACGTGAGTC GAATGATGCT AGCCTTCTTG GTTCTCAGCA CTGGCATGTT TTGCTCATCA TCAGCATTCC TTCCTAGTAG CTTCTGTATG TACACTACGT TGATAGCCAT GACTGGATGG TATATGGACA AGACTTCCAT TGCTGTGCTG GGAGTAGCAG CTGGGGCTAT CTTAGGCTGG CCATTCAGTG CAGCTCTTGG TTTACCCATT GCCTTTGATT TGCTGGTCAT GAAACACAGG TGGAAGAGTT TCTTTCATTG GTCGCTGATG GCCCTCATA TATTTCTGGT GCCTGTGGTG GTCATTGACA GCTACTATTA TGGGAAGTTG GTGATTGCAC CACTCAACAT TGTTTTGTAT AATGTCTTTA CTCCTCATGG ACCTGATCTT TATGGTACAG AACCCTGGTA TTTCTATTTA ATTAATGGAT TTCTGAATTT CAATGTAGCC TTIGCTTTGG CTCTCCTAGT CCTACCACTG ACTTCTCTTA TGGAATACCT GCTGCAGAGA TTTCATGTTC AGAATTTAGG CCACCCGTAT TGGCTTACCT TGGCTCCAAT GTATATTTGG TTTATAATTT TCTTCATCCA GCCTCACAAA GAGGAGAGAT TTCTTTTCCC TGTGTATCCA CTTATATGTC TCTGTGGCGC TGTGGCTCTC TCTGCACTTC AGAAATGTTA CCACTTTGTG TTTCAACGAT ATCGCCTGGA GCACTATACT GTGACATCGA ATTGGCTGGC ATTAGGAACT GTCTTCCTGT TTGGGCTCTT GTCATTTTCT CGCTCTGTGG CACTGTTCAG AGGATATCAC GGGCCCCTTG ATTTGTATCC AGAATTTTAC CGAATTGCTA CAGACCCAAC CATCCACACT GTCCCAGAAG GCAGACCTGT GAATGTCTGT GTGGGAAAAG AGTGGTATCG ATTTCCCAGC AGCTTCCTTC TTCCTGACAA TTGGCAGCTT CAGTTCATT CACTCAGAGTT CAGAGGTCAG TTACCAAAC CTTTTGCAAG AGGACCTCTG GCCACCCGGA TTGTTCCCTAC TGACATGAAT GACCAGAATC TAGAAGAGCC ATCCAGATAT	31

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		AGTTCTAGGA AAGAACCTTG AAAACCTGAT ATGATTCTGC AGCATGAGGT CTACGGTGAC CATTGTTGGCA AAGCTCCAGT GGCAATCATT TATTGTGTTT TGCATTTCTT GGGATTTATT GAAATAAGAA TTCACTGTGA TTATGTAGTC TTCTGGCTAG TATCAGGCAG CTCTGCTTTT AATTGTTTCA ATTTTATTTT CTCTGAAGAG GGAGAAGAGG TACAATTTAA TCTTGGCCTC CACAAGCATA TTAAAGCTCA CGTGTTAATC AGTGCATTCT TATGCTCCTA CATTAAATGC CTGTTGGTAAA TGGATAAATG GACATGTGCC CAGCTTTAAT TTTTTTTGCA ACAGAAAGAT CAGACTTCCG TATGGCATCG TTGGATTTCA GAGGCTTTCT GGTGTATCTG TAAATCTGAA TGTTGCCTTC TGCCAGTCTG TATAACCAGG TGATTCATGC TGCAAATGAA ATCAGGAAGC AGTAAAGTGT TAAAGCAAGA GTATTGTCCA ATTCACTTGT CTTCCTGATC CTTGTACTTT ATTTACAGTG TCGGTGTTTA CATTACATAC TTATATTTCC TGTGAAAGAA AGAGTTAAAT AAATTGTAGC AGTTTGA	
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YWHAQ	NM_006826.3	TTGGGCGGTG GACCGCCCCCT CGGCCCCGGG GTAGGCTGAC ACGGGAGGGT CCTCAGCTAA AGCCAAAAGC AGATCAAAGT GGTGGGACTC GCGTCGCGGC CGCGGAGACG TGAAGCTCTC GAGGCTCCTC CCGCTGCGGG TCGGCGCTCG CCCTCGCTCT CCTCGCCCTC CGCCCCGGCC CCGGCCCCGC GCCCGCCATG GAGAAGACTG AGCTGATCCA GAAGGCCAAG CTGGCCGAGC AGGCCGAGCG CTACGACGAC ATGGCCACCT GCATGAAGGC AGTGACCGAG CAGGGCGCCG AGCTGTCCAA CGAGGAGCGC AACCTGCTCT CCGTGGCCTA CAAGAACGTG GTCGGGGGCC GCAGGTCCGC CTGGAGGGTC ATCTCTAGCA TCGAGCAGAA GACCGACACC TCCGACAAGA AGTTGCAGCT GATTAAGGAC TATCGGGAGA AAGTGGAGTC CGAGCTGAGA TCCATCTGCA CCACGGTGCT GGAATTGTTG GATAAATATT TAATAGCCAA TGCAACTAAT CCAGAGAGTA AGGTCTTCTA TCTGAAAATG AAGGGTGATT ACTTCCGGTA CCTTGCTGAA GTTGCGTGTG GTGATGATCG AAAACAAACG ATAGATAATT CCAAGGAGC TTACCAAGAG GCATTTGATA TAAGCAAGAA AGAGATGCAA CCCACACACC CAATCCGCCT GGGGCTTGCT CTTAACTTTT CTGTATTTTA CTATGAGATT CTTAATAACC CAGAGCTTGC CTGCACGCTG GCTAAAACGG CTTTIGATGA GGCCATTGCT GAACTTGATA CACTGAATGA AGACTCATAC AAAGACAGCA CCCTCATCAT GCAGTTGCTT AGAGACAACC TAACACTTTG GACATCAGAC AGTGCAGGAG AAGAATGTGA TGCGGCAGAA GGGGCTGAAA ACTAAATCCA TACAGGGTGT CATCCTTCTT TCCTTCAAGA AACCTTTTTTA CACATCTCCA TTCCTTATTC CACTTGGATT TCCTATAGCA AAGAAACCCA TTCATGTGTA TGGAATCAAC TGTTTATAGT CTTTTCACAC TGCAGCTTTG GGAAAACCTC ATTCCTTGAT TTGTGTTTGT CTTGGCCTTC CTGGTGTGCA GTACTGCTGT AGAAAAGTAT TAATAGCTTC ATTCATATA AACATAAGTA ACTCCCAAAC ACTTATGTAG AGGACTAAAA ATGTATCTGG TATTAAAGTA ATCTGAACCA GTTCTGCAAG TGACTGTGTT TTGTATTACT GTGAAAATAA GAAAATGTAG TTAATTACAA TTAAAGAGT ATTCCACATA ACTTCTTAAT TTCTACATTC CCTCCCTTAC TCTTCGGGGG TTTCCTTTCA GTAAGCAACT TTCCATGCT CTTAATGTAT TCCTTTTTAG TAGGAATCCG GAAGTATTAG ATTGAATGGA	33

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PRRC2 B	NM_0 13318. 3	GCAGATCGGG AGCGGTGCCG AGAAAAATTT CCTTACTAGA TGACATTTCA TCGCAATGTC CGATCGTTTG GGGCAAATTA CCAAGGGCAA GGATGGGAAA AGCAAGTACT CGACTCTCAG CCTGTTTGAT AAGTATAAAG GAAAATCAGT AGACGCGATT AGATCCTCAG TTATTCCTAG ACATGGCTTA CAGAGTCTTG GGAAAGTTGC TGCAGCCCGG CGCATGCCAC CGCCTGCAAA CCTGCCAAGC TTGAAGTCTG AAAACAAAGG AAACGACCCC AACATCGTGA TAGTACCCAA GGACGGGACG GGATGGGCAA ACAAGCAGGA TCAGCAAGAC CCAAAGAGTT CCAGTGCGAC	35

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DOPEY 2	NM_0 05128. 3	TCCCACAGTG CCTGGCCCAG AAGCCTTGCT AAATATTTGA ACAGGATTGC CCAATACTTT TCTGCTGTGA GAATGTAAGA TGGATCCAGA AGAGCAGGAG CTCTTAAATG ATTACAGATA CAGAAGCTAC TCTTCAGTGA TTGAAAAGGC TTTGAGAAAT TTTGAGTCCT CGAGTGAATG GGCGGATCTC ATATCTTCAC TTGGCAAACCT CAACAAGGCT CTTCAGAGTA ACCTGAGGTA CTCCTTGTG CCAAGACGGC TCCTCATCAG CAAAAGATTA GCTCAGTGTT TGCACCCTGC CCTGCCCAGT GGTGTCCACT TAAAAGCTCT GGAAACCTAC GAGATTATCT TTAATAATCGT GGGGACCAAA TGGCTGGCCA AGGACTTGTT TCTGTACAGC TGCGGGTTAT TTCCTCTCCT GGCACACGCG GCGGTGTGCG TGAGGCCGGT GCTGCTCACC CTGTACGAGA AGTACTTCCT CCCCTGCAG AAGCTGCTCC TGCCCAGTCT GCAGGCCTTC ATCGTGGGCC TGCTGCCCGG CCTTGAAGAG GGCTCCGAGA TCTCCGACAG AACGGATGCT CTGCTCCTGA GACTGTGCT GGTGGTTGGC AAAGAGGTGT TTTACACCGC CCTCTGGGGG AGCGTCCTGG CCAGCCCGTC CATCCGCCTC CCTGCCTCAG TCTTCGTGGT GGGCCACATC AACAGGGATG CCCCCGGCCG	36

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NDUFB 11	NM_0 19056. 6	GCTCTGGCCG GCCCCGGCGA TTGGTCACCG CCCGCTAGGG GACAGCCCTG GCCTCCTCTG ATTGGCAAGC GCTGGCCACC TCCCCACACC CCTTGCGAAC GCTCCCCTAG TGGAGAAAAG GAGTAGCTAT TAGCCAATTC GGCAGGGGCC GCTTTTTAGA AGCTTGATTT CCTTTGAAGA TGAAAGACTA GCGGAAGCTC TGCCTCTTTC CCCAGTGGGC GAGGGAATC GGGGCGATTG GCTGGGAACT GTATCCACCC AAATGTCACC GATTTCTTCC TATGCAGGAA ATGAGCAGAC CCATCAATAA GAAATTTCTC AGCCTGGCCG AAAATGGTTG GCCCCACGAA GCCACGACAA CTGGAGGCAA AGAGGGTTGC TCAACGCCCC GCCTCATTGG AAAACCAAAT CAGATCTGGG ACCTATATAG CGTGGCGGAG GCGGGGCGAT GATTGTCGCG CTCGCACCCA CTGCAGCTGC GCACAGTCGC ATTTCTTTCC CCGCCCCTGA GACCCTGCAG CACCATCTGT CATGGCGGCT GGGCTGTTT GTTTGAGCGC TCGCCGTCTT TTGGCGGCAG CGGCGACGCG AGGGCTCCCG	37

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MORF4 L1	NM_0 012656 03.1	CGGCGTGCCC TGGGGCGGCG CGGGCGCAGG GGCGCGTGCG CGGCGGGCTG TCGTTGGCTG GAGCAGCGGC TGCGCGGGTC GCGGTGCTGT GAGGTCTGCG GGCGCTGGCA AATCCGGCCC AGGATGTAGA GCTGGCAGTG CCTGACGGCG CGTCTGACGC GGAGTTGGGT GGGGTAGAGA GTAGGGGGCG GTAGTCGGGG GTGGTGGGAG AAGGAGGAGG CGGCGAATCA CTTATAAATG GCGCCGAAGC AGGACCCGAA GCCTAAATTC CAGGAGGTTG GGATGAATGG GTTCCGGAGA GCAGAGTACT CAAATACGTG GACACCAATT TGCAGAAACA GCGAGAACTT CAAAAAGCCA ATCAGGAGCA GTATGCAGAG GGGAAGATGA GAGGGGCTGC CCCAGGAAAG AAGACATCTG GTCTGCAACA GAAAAATGTT GAAGTGAAAA CGAAAAAGAA CAAACAGAAA ACACCTGGAA ATGGAGATGG TGGCAGTACC AGTGAGACCC CTCAGCCTCC TCGGAAGAAA AGGGCCCGGG TAGATCCTAC TGTTGAAAAT GAGGAAACAT TCATGAACAG AGTTGAAGTT AAAGTAAAGA TTCCTGAAGA GCTAAAACCG TGGCTTGTTG ATGACTGGGA CTTAATTACC AGGCAAAAAC AGCTCTTTTA TCTTCCTGCC AAGAAGAATG TGGATTCCAT TCTTGAGGAT TATGCAAATT ACAAGAAATC TCGTGGAAC ACAGATAATA AGGAGTATGC GGTTAATGAA GTTGTGGCAG GGATAAAAGA ATACTTCAAC GTAATGTTGG GTACCCAGCT ACTCTATAAA TTTGAGAGAC CACAGTATGC TGAAATTCTT GCAGATCATC CCGATGCACC CATGTCCCAG GTGTATGGAG CGCCACATCT CCTGAGATTA TTTGTACGAA TTGGAGCAAT GTTGGCTTAT ACACCTCTGG ATGAGAAGAG CCTTGCTTTA TTAACAATT ATCTTCACGA TTTCCTAAAG TACCTGGCAA AGAATTCTGC AACTTTGTTC AGTGCCAGCG ATTATGAAGT GGCTCCTCCT GAGTACCATC GGAAAGCTGT GTGAGAGGCA CTCTCACTCA CTTATGTTTG GATCTCCGTA AACACATTTT TGTTCCTAGT CTATCTCTTG TACAAACGAT GTGCTTTGAA GATGTTAGTG TATAACAATT GATGTTTGTT TTCTGTTTGA TTTTAAACAG AGAAAAAATA AAAGGGGGTA ATAGCTCCTT TTTTCTTCTT TCTTTTTTTT TTTCATTTCA AAATTGCTGC CAGTGTTTTT AATGATGGAC AACAGAGGGA TATGCTGTAG AGTGTTTTAT TGCCTAGTTG ACAAAGCTGC TTTTGAATGC TGGTGGTTCT ATTCCTTTGA CACTACGCAC TTTTATAATA CATGTTAATG CTATATGACA AAATGCTCTG ATTCCTAGTG CCAAAGGTTC AATTCAGTGT ATATAACTGA ACACACTCAT CCATTTGTGC TTTTGTTTTT TTTTATGGTG CTAAAGTAA AGAGCCCATC CTTTGCAAGT CATCCATGTT GTTACTTAGG CATTTTATCT TGGCTCAAAT TGTTGAAGAA TGGTGGCTTG TTTTATGGTT TTTGTATTTG TGTCTAATGC ACGTTTTAAC ATGATAGACG CAATGCATTG TGTAGCTAGT TTCTGGAAA AGTCAATCTT TTAGGAATTG TTTTTCAGAT CTTCAATAAA TTTTTCCTT AAATTTCAA GAACAAAAAA AAAAAAAAAA	39
MRPL1 9	NM_0 14763. 3	GTAGTCTTGA CGTGAGCTAG CTGGCATGGC GGCCTGCATT GCAGCGGGGC ACTGGGCTGC AATGGGCCTA GGCCGGAGTT TCCAAGCCGC CAGGACTCTG CTCCCCCGC CGGCCTCTAT	40

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PSMC4	NM_1 53001. 2	TGCGGGTACG GACAGCGCAT GAGCTTATGT TGAGGGCGGA GCCCAGACCA GCCCTTCGTC CTATCCTGCC CTTCCAGCAC CTCTCAGCCG TAACTTAAAC TACACTTCCC AGAAGCCTCC TCAGCCAGGG ACTTCCGTTG TCGTCAGCGG AAGCGGTGAC AGATCATCCC AGGCCACACA GAGGCCGGCT TGGTCACTAT GGAGGAGATA GGCATCTTGG TGGAGAAGGC TCAGGATGAG ATCCCAGCAC TGTCCGTGTC CCGGCCCCAG ACCGGCCTGT CCTTCCTGGG CCCTGAGCCT GAGGACCTGG AGGACCTGTA CAGCCGCTAC AAGGAGGAGG TGAAGCGAAT CCAAAGCATC CCGCTGGTCA TCGGACAATT TCTGGAGGCT GTGGATCAGA ATACAGCCAT CGTGGGCTCT ACCACAGGCT CCAACTATTA TGTGCGCATC CTGAGCACCA TCGATCGGGA GCTGCTCAAG CCCAACGCCT CAGTGGCCCT CCACAAGCAC AGCAATGCAC TGGTGGACGT GCTGCCCCC GAAGCCGACA GCAGCATCAT GATGCTCACC TCAGACCAGA AGCCAGATGT GATGTACGCG GACATCGGAG GCATGGACAT CCAGAAGCAG GAGGTGCGGG AGGCCGTGGA GCTCCCGCTC ACGCATTTCG AGCTCTACAA GCAGATCGGC ATCGATCCCC CCGAGGCGT CCTCATGTAT GGCCCACCTG GCTGTGGGAA GACCATGTTG GCAAAGGCGG TGGCACATCA CACAACAGCT GCATTCATCC GGGTCGTGGG CTCGGAGTTT GTACAGAAGT ATCTGGGTGA GGGCCCCCGC ATGGTCCGGG ATGTGTTCCG CCTGGCCAAG GAGAATGCAC CTGCCATCAT CTTCATAGAC GAGATTGATG CCATCGCCAC CAAGAGATTC GATGCTCAGA CAGGGGCCGA CAGGGAGGTT CAGAGGATCC TGCTGGAGCT GCTGAATCAG ATGGATGGAT TTGATCAGAA TGTCAATGTC AAGGTAATCA TGGCCACAAA CAGAGCAGAC ACCCTGGATC CGGCCCTGCT ACGGCCAGGA CGGCTGGACC GTAAAATTGA ATTTCCACTT CCTGACCGCC GCCAGAAGAG ATTGATTTTC TCCACTATCA CTAGCAAGAT GAACCTCTCT GAGGAGGTTG ACTTGGAAGA CTATGTGGCC CGGCCAGATA AGATTTTCAGG AGCTGATATT AACTCCATCT GTCAGGAGAG TGGAATGTTG GCTGTCCGTG AAAACCGCTA CATTGTCCTG GCCAAGGACT TCGAGAAAGC ATACAAGACT GTCATCAAGA AGGACGAGCA GGAGCATGAG TTTTACAAGT GACCCTTCCC TTCCCTCCAC CACACCACTC AGGGGCTGGG GCTTCTCTCG CACCCCCAGC ACCTCTGTCC CAAAACCTCA TTCCCTTTTT TCTTTACCCA GGATTGGTTT CTTCAATAAA TAGATAAGAT CGAATCCATT TAATTTCTTC TTAGAAGTTT AACTCCTTTG GAGAATGTGG GCCTTGAATA GGATCCTCTG GGTCCCTCTT AATCTGACAG ATGAGCAGAC GAGGTGCATG GCCTGGGTTG CAGCTTGAGA GAACCAAAAT ATTCAAACCA GATGACTTCC AAAATGTGGG GAAAGGGATG GAAAATGAAC CTGAGATGGA GTCCTTAATC ACGGGATAAA GCCCTGTGCA TCTCCCTCAT TTCCTACAGG TAAAAGACAG TAAAGAAATT CAGGTCACAG GCCTTGGGAG TTCATAGGAA GGAGATGTCC AGTGCTGTCC AGTAGAACTT T	41

SF3A1	NM_005877.5	GGTCCCGGAA GTGCGCCAGT CGTACCTTCG CGGCCGCAAC TCGCTCGGCC GCCGCCATCT TGCAGGCTCG TCGTACTGAC CGAGCGGGGA GGCTGTCTTG AGGCGGCACC GCTCACCGAC ACCGAGGCGG ACTGGCAGCC CTGAGCGTCG CAGTCATGCC GGCCGGACCC GTGCAGGCGG TGCCCCCGCC GCCGCCCGTG CCCACGGAGC CCAAACAGCC CACAGAAGAA GAAGCATCTT CAAAGGAGGA TTCTGCACCT TCTAAGCCAG TTGTGGGGAT TATTTACCCT CCTCCAGAGG TCAGAAATAT TGTTGACAAG ACTGCCAGCT TTGTGGCCAG AAACGGGGCCT GAATTIGAAG CTAGGATCCG ACAGAACGAG ATCAACAACC CCAAGTTCAA CTTTCTGAAC CCAATGACC CTTACCATGC CTACTACCGC CACAAGGTCA GCGAGTTCAA GGAAGGGAAG GCTCAGGAGC CGTCCGCCGC CATCCCCAAG GTCATGCAGC AGCAGCAGCA GACCACCCAG CAGCAGCTGC CCCAGAAGGT CCAAGCCCAA GTAATCCAAG AGACCATCGT GCCCAAAGAG CCTCCTCCTG AGTTTGAGTT CATTGCTGAT CCTCCCTCTA TCTCAGCCTT CGACTTGGAT GTGGTGAAGC TGACGGGCTCA GTTTGTGGCC AGGAATGGGC GCCAGTTTCT GACCCAGCTG ATGCAGAAAG AGCAGCGCAA CTACCAGTTT GACTTTCTCC GCCCACAGCA CAGCCTCTTC AACTACTTCA CGAAGCTAGT GGAACAGTAC ACCAAGATCT TGATTCCACC CAAAGGTTTA TTTTCAAAGC TCAAGAAAGA GGCTGAAAAC CCCCAGAGAAG TTTTGGATCA GGTGTGTTAC CGAGTGGAAT GGGCCAAATT CCAGGAACGT GAGAGGAAGA AGGAAGAAGA GGAGAAGGAG AAGGAGCGGG TGGCCTATGC TCAGATCGAC TGGCATGATT TTGTGGTGGT GGAAACAGTG GACTTCCAAC CCAATGAGCA AGGGAAC TTC CCTCCCCCA CCACGCCAGA GGAGCTGGGG GCCCGAATCC TCATTCAGGA GCGCTATGAA AAGTTTGGGG AGAGTGAGGA AGTTGAGATG GAGGTCGAGT CTGATGAGGA GGATGACAAA CAGGAGAAGG CGGAGGAGCC TCCTTCCCAG CTGGACCAGG ACACCCAAGT ACAAGATATG GATGAGGGTT CAGATGATGA AGAAGAAGGG CAGAAAGTGC CCCCACCCCC AGAGACACCC ATGCCTCCAC CTCTGCCCCC AACTCCAGAC CAAGTCATTG TCCGCAAGGA TTATGATCCC AAAGCCTCCA AGCCCTTGCC TCCAGCCCCT GCTCCAGATG AGTATCTTGT GTCCCCCATT ACTGGGGAGA AGATCCCCGC CAGCAAAATG CAGGAACACA TGCGCATTGG ACTTCTTGAC CCTCGCTGGC TGGAGCAGCG GGATCGCTCC ATCCGTGAGA AGCAGAGCGA TGATGAGGTG TACGCACCAG GTCTGGATAT TGAGAGCAGC TTGAAGCAGT TGGCTGAGCG GCGTACTGAC ATCTTCGGTG TAGAGGAAAC AGCCATTGGT AAGAAGATCG GTGAGGAGGA GATCCAGAAG CCAGAGGAAA AGGTGACCTG GGATGGCCAC TCAGGCAGCA TGGCCCGGAC CCAGCAGGCT GCCCAGGCCA ACATCACCTT CCAGGAGCAG ATTGAGGCCA TTCACAAGGC CAAAGGCCTG GTGCCAGAGG ATGACACTAA AGAGAAGATT GGCCCCAGCA AGCCCAATGA AATCCCTCAA CAGCCACCGC CACCATCTTC AGCCACCAAC ATCCCCAGCT CGGCTCCACC CATCACTTCA GTGCCCCGAC CACCACAAT GCCACCTCCA GTTCGTACTA	42
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CAGTTGTCTC CGCAGTACCC GTCATGCCCC GGCCCCCAAT GGCATCTGTG GTCCGGCTGC CCCCAGGCTC AGTGATCGCC CCCATGCCGC CCATCATCCA CGCGCCCAGA ATCAACGTGG TGCCCATGCC TCCCTCGGCC CCTCCTATTA TGGCCCCCG CCCACCCCCC ATGATTGTGC CAACAGCCTT TGTGCCTGCT CCACCTGTGG CACCTGTCCC AGCTCCAGCC CCAATGCCCC CTGTGCATCC CCCACCTCCC ATGGAAGATG AGCCCACCTC CAAAAACTG AAGACAGAGG ACAGCCTCAT GCCAGAGGAG GAGTTCCTGC GCAGAAACAA GGGTCCAGTG TCCATCAAAG TCCAGGTGCC CAACATGCAG GATAAGACGG AATGGAAACT GAATGGGCAG GTGCTGGTCT TCACCCTCCC ACTCACGGAC CAGGTCTCTG TCATTAAGGT GAAGATTCAT GAAGCCACAG GCATGCCTGC AGGGAAACAG AAGCTACAGT ATGAGGGTAT CTTCATCAA GATTCCAAC CACTGGCTTA CTACAACATG GCCAATGGCG CAGTCATCCA CCTGGCCCTC AAGGAGAGAG GCGGGAGGAA GAAGTAGACA AGAGGAACCT GCTGTCAAGT CCCTGCCATT TTGCCTCTCC TGTCTCCAC CCCCTGCCCC AGACCCAGGA GCCCCCTGA GGCTTTGCCT TGCCTGCATA TTTGTTTCGC TCTTACTCAG TTTGGGAATT CAAATTGTCC TGCAGAGGTT CATTCCCCTG ACCCTTTCCC CACATTGGTA AGAGTAGCTG GGTTTTCTAA GCCACTCTCT GGAATCTCTT TGTGTTAGGG TCTCGATTTG AGGACATTCA TTTCTTCAGC AGCCCATTAG CAACTGAGAG CCCAGGGATG TCCTACAGGA TAGTTTCATA GTGACAGGTG GCACCTGGCT AATAGAATAT GGCTGATATT GTCATTAATC ATTTTGTACC TTGACATGGG TTGTCTAATA AAACTCGGAC CCTTCTTGTG AAATCAGTTA AATAAGACTT GTCTCGGTCA CCTGTGCCCT GTCCAGACTC GAGGCAGTGG TAACACTGCA CAGTGCTATG TGGCTTCTCT TTGAGGATTT TTGGGTTTTG TAACTAAATT CTTGCTGCCC TCATACTTTT TATGTATTAG AATCATATTC GTATTGCCCT TTTAAAACAT TGGGATCCTC CAAAGGCCTG CCCCATGTAT TTAACAGTAA TACAGGAAGC ATGGCAGGCA CCATGCAAAC CAAGGATGGA TGGTGCAGTC CCTGTGTCAG TGGGCGGTGG TTTCCTGCTG GCCTGGAATC ACTCATCACC TGATTGATTG GCTCTGTGGT CCTGGGCAGG TGCCTCATAG GTGTGTGGAT ATGATGACGT TTCTTTAAAA TGTATGTATT TAACAAATAC TTAATTGTAT TAAGGTCATG TACCAAGGAT TTGATAAAGT TTAAATAATT TACTCTCTAC TTTTATCCAT TTTATCCATT TTAACTCATG TAATCCTCAT GTGAGTATTC CTGTTTAACA CTTGAGTAAA CTGAGGCACA GAGAACATAA GTTGCATGCC ATAGTCACAC ACTGTGAAAG TGAAAAGAGA ATGTGTGCAA AACACGTCAC AGTCCTGGTT TCTGAGTAAA GGCAGGCTGT TATCTTTAGA ATCAAGCTAT CACAGGGAGA TAGGCAATGC TGTGGGTGTT GGAGGAAGGT GAGAGCCTGT TGCTAACAAT TTCCTGGTTT TAAAGCTAAG GCTGATTTTA TTGGGAAGAT CTCACATGTG TGTGGCCCCT GAGAGTTCCC AGTGCCTTTT ATTTGCAGTC CTTCATTITG GACCTCCTAG CTGCCCCATC AGGTCATCTC CAGGGCTCAG AGGGGTGAGA CCATTTCCTA	
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		AGGTCACAGA ACCAGCTCTC TAGTCACCAC CCTGCCTCTC CCTCTCACCC AGAGTCAGTA CCAGTTTTAT GGCTTTATTA CAAAC TGCTG GGTCCCTCCC ATTTTCAACT TGATTGATGG GATGTCATCC CTTATCCTGT CTGACATTTG CCTCTGGCCT GGTTGCTAGA AGTTTGCCCC AGGGGCAAGA GTTGAAATTT GGCTTCCTGA GGTGGGCTTT GTGGTTTGCG TCCCTAAAGT GAGCCCATA CTGGTTGCTT GTCCATGGCC AACACCAGAA ATCCCCTGAG CACTACCTGG GTCTCATTC AAGAAGGAAG AGGGTCAGGA GACCTGGGGA GTCTCATATT CCAAGTTCTT CTTTCTTTCT GGGAGCAGTG GGCAGTTCAT GGTGTTAGGG CACTACCCC CACAGACTGG CAAACCCTGC AGGACTTCCG TGGCTGAGGC TGTGACCGGA GGCCAGGAAT GCCGTTGGGT GGATTGTGAG TGAATGGGCC CTTTGAGCTG CCCTCTAGAG AGCAAATCCA GTTTCCTGGA GCTCCTGAAT GAATATCTGT ACTGGCTCGC TCAGATGCAG AAGCTCCATT GACCATGAGG CCTTGTGAAC ATCAGTGGCC ACAGGCCCAG TGTGCTGCTT GGCACTGCAC TAGTTTAGGA CCTGCAGCAT GTAGGTAGCG TCCTAGTGTT TATAATACAA AGCTGCTCTG CACAGCTTTT CTGATTCTTC TTGCAATCTC CTGAGGATTA TCTGCCCCAT TTTTAAAACG AGGTGGAATA CCAAGGTCA TGTAGCCAGT GAGTGCTCTG GAAAGCCAAA GCAGCTCATC CCTTCCTGGG GACCACACTG CTCTGCTCCA CCAGACCACA CTATGAAATA GGAATAAGTG CTCCTGTTGC AGGACTGCTG GGAAAACAGG TGGTGTGGGA CTTAAGTCAC CATAATTTTG AAGACTTGCA TGCAGAGGGC TCCAGGAATT GTAGACATTA AGGAATTTCA CTTTCAGTTC TACCCACTAC TTAAGTACTT GTCATGTACT CTTAGAGGAG GCCAGTAATG ATCAGAACCA TTTTACTTTA AAATTAATAA TATTGTATTA GAGAATATAT TAAATGGTTA TATTGGGTTA TGTTAGGATA TATACTTGAA TGGAAATACA TGTACTATTA GCAATCATAT TTCATTTATC CCTGTAATTA GACAAGAAAG CATAATATAG CTCTACTCAT GGGTACACAT ACCAGTGTAT AAGATTTTTA GAAGTTTACT TTTTAAAAAT AAAAGCAAAA TGTAAGATCT TAAAAAAAAA AAAAAAAAAA	
PUMI	NM_0 010206 58.1	AGTGGGCCGC CATGTTGTCG GAGTGAAAGG TAAGGGGGAG CGAGAGCGCC AGAGAGAGAA GATCGGGGGG CTGAAATCCA TCTTCATCCT ACCGCTCCGC CCGTGTTGGT GGAATGAGCG TTGCATGTGT CTIGAAGAGA AAAGCAGTGC TTTGGCAGGA CTCTTTCAGC CCCCACCTGA AACATCACCC TCAAGAACCA GCTAATCCCA ACATGCCTGT TGTTTTGACA TCTGGAACAG GGTCGCAAGC GCAGCCACAA CCAGCTGCAA ATCAGGCTCT TGCAGCTGGG ACTCACTCCA GCCCTGTCCC AGGATCTATA GGAGTTGCAG GCCGTTCCCA GGACGACGCT ATGGTGGACT ACTTCTTTCA GAGGCAGCAT GGTGAGCAGC TTGGGGGAGG AGGAAGTGGA GGAGGCGGCT ATAATAATAG CAAACATCGA TGGCCTACTG GGGATAACAT TCATGCAGAA CATCAGGTGC GTTCCATGGA TGAAGTGAAT CATGATTTTC AAGCACTTGC TCTGGAGGGA AGAGCGATGG GAGAGCAGCT CTTGCCAGGT AAAAAGTTTT GGGAAACAGA TGAATCCAGC AAAGATGGAC	43

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		TGCTACGTCG CCCTGGACTT CGAGCAAGAG ATGGCCACGG CTGCTTCCAG CTCCTCCCTG GAGAAGAGCT ACGAGCTGCC TGACGGCCAG GTCATCACCA TTGGCAATGA GCGGTTCCGC TGCCCTGAGG CACTCTTCCA GCCTTCCTTC CTGGGCATGG AGTCCTGTGG CATCCACGAA ACTACCTTCA ACTCCATCAT GAAGTGTGAC GTGGACATCC GCAAAGACCT GTACGCCAAC ACAGTGCTGT CTGGCGGCAC CACCATGTAC CCTGGCATTG CCGACAGGAT GCAGAAGGAG ATCACTGCCC TGGCACCCAG CACAATGAAG ATCAAGATCA TTGCTCCTCC TGAGCGCAAG TACTCCGTGT GGATCGGCGG CTCCATCCTG GCCTCGCTGT CCACCTTCCA GCAGATGTGG ATCAGCAAGC AGGAGTATGA CGAGTCCGGC CCCTCCATCG TCCACCGCAA ATGCTTCTAG GCGGACTATG ACTTAGTTGC GTTACACCCT TTCTTGACAA AACCTAACTT GCGCAGAAAA CAAGATGAGA TTGGCATGGC TTTATTGTT TTTTITGTTT TGTTTGGTT TTTTTTTTTT TTTTGGCTTG ACTCAGGATT TAAAACTGG AACGGTGAAG GTGACAGCAG TCGGTTGGAG CGAGCATCCC CCAAAGTTCA CAATGTGGCC GAGGACTTTG ATTGCACATT GTTGTTTTTT TAATAGTCAT TCCAAATATG AGATGCGTTG TTACAGGAAG TCCCTTGCCA TCCTAAAAGC CACCCCACTT CTCTCTAAGG AGAATGGCCC AGTCCTCTCC CAAGTCCACA CAGGGGAGGT GATAGCATTG CTTTCGTGTA AATTATGTAA TGCAAAATTT TTTAATCTT CGCCTTAATA CTTTTTTATT TTGTTTTATT TTGAATGATG AGCCTTCGTG CCCCCCCTTC CCCCTTTTTT GTCCCCAAC TTGAGATGTA TGAAGGCTTT TGGTCTCCCT GGGAGTGGGT GGAGGCAGCC AGGGCTTACC TGTACACTGA CTTGAGACCA GTTGAATAAA AGTGCACACC TAAAAAATGA GGAAAAAAAA AAAAAAAAAA	
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		GGCTGTGGGC AAGGTCATCC CTGAGCTGAA CGGGAAGCTC ACTGGCATGG CCTTCCGTGT CCCCCTGCC AACGTGTCAG TGGTGGACCT GACCTGCCGT CTAGAAAAAC CTGCCAAATA TGATGACATC AAGAAGGTGG TGAAGCAGGC GTCGGAGGGC CCCCTCAAGG GCATCCTGGG CTACACTGAG CACCAGGTGG TCTCCTCTGA CTTCAACAGC GACACCCACT CCTCCACCTT TGACGCTGGG GCTGGCATTG CCCTCAACGA CCACTTTGTC AAGCTCATTT CCTGGTATGA CAACGAATTT GGCTACAGCA ACAGGGTGGT GGACCTCATG GCCCACATGG CCTCCAAGGA GTAAGACCCC TGGACCACCA GCCCCAGCAA GAGCACAAGA GGAAGAGAGA GACCCTCACT GCTGGGGAGT CCCTGCCACA CTCAGTCCCC CACCACACTG AATCTCCCCT CCTCACAGTT GCCATGTAGA CCCCTTGAAG AGGGGAGGGG CCTAGGGAGC CGCACCTTGT CATGTACCAT CAATAAAGTA CCCTGTGCTC AACCAGTTAA AAAAAAAAAA AAAAAAAAAA	
GUSB	NM_00181.3	GTCCTCAACC AAGATGGCGC GGATGGCTTC AGGCGCATCA CGACACCGGC GCGTCACGCG ACCCGCCCTA CGGGCACCTC CCGCGCTTTT CTTAGCGCCG CAGACGGTGG CCGAGCGGGG GACCGGGAAG CATGGCCCCG GGGTCGGCGG TTGCCTGGGC GGCGCTCGGG CCGTTGTTGT GGGGCTGCGC GCTGGGGCTG CAGGGCGGGA TGCTGTACCC CCAGGAGAGC CCGTCGCGGG AGTGCAAGGA GCTGGACGGC CTCTGGAGCT TCCGCGCCGA CTTCTCTGAC AACCGACGCC GGGGCTTCGA GGAGCAGTGG TACCGGCGGC CGCTGTGGGA GTCAGGCCCC ACCGTGGACA TGCCAGTTCC CTCCAGCTTC AATGACATCA GCCAGGACTG GCGTCTGCGG CATTTTGTCTG GCTGGGTGTG GTACGAACGG GAGGTGATCC TGCCGGAGCG ATGGACCCAG GACCTGCGCA CAAGAGTGGT GCTGAGGATT GGCAGTGCCC ATTCCTATGC CATCGTGTGG GTGAATGGGG TCGACACGCT AGAGCATGAG GGGGGCTACC TCCCCTTCGA GGCCGACATC AGCAACCTGG TCCAGGTGGG GCCCCTGCCC TCCCGGCTCC GAATCACTAT CGCCATCAAC AACACACTCA CCCCCACCAC CCTGCCACCA GGGACCATCC AATACCTGAC TGACACCTCC AAGTATCCCA AGGGTTACTT TGTCCAGAAC ACATATTTTG ACTTTTCAA CTACGCTGGA CTGCAGCGGT CTGTACTTCT GTACACGACA CCCACCACCT ACATCGATGA CATCACCGTC ACCACCAGCG TGGAGCAAGA CAGTGGGCTG GTGAATTACC AGATCTCTGT CAAGGGCAGT AACCTGTTCA AGTTGGAAGT GCGTCTTTTG GATGCAGAAA ACAAAGTCGT GGCGAATGGG ACTGGGACCC AGGGCCAACT TAAGGTGCCA GGTGTCAGCC TCTGGTGGCC GTACCTGATG CACGAACGCC CTGCCTATCT GTATTCAATTG GAGGTGCAGC TGA CTGCACA GACGTC ACTG GGGCCTGTGT CTGACTTCTA CACACTCCCT GTGGGGATCC GCACTGTGGC TGTCACCAAG AGCCAGTTCC TCATCAATGG GAAACCTTTC TATTCCACG GTGTCAACAA GCATGAGGAT GCGGACATCC GAGGGAAGGG CTTCGACTGG CCGCTGCTGG TGAAGGACTT CAACCTGCTT CGCTGGCTTG GTGCCAACGC TTTCCGTACC AGCCACTACC CCTATGCAGA GGAAGTGATG CAGATGTGTG	46

		ACCGCTATGG GATTGTGGTC ATCGATGAGT GTCCCGGCGT GGGCCTGGCG CTGCCGCAGT TCTTCAACAA CGTTTCTCTG CATCACCACA TGCAGGTGAT GGAAGAAGTG GTGCGTAGGG ACAAGAACCA CCCCgcGGTC GTGATGTGGT CTGTGGCCAA CGAGCCTGCG TCCCACCTAG AATCTGCTGG CTACTACTTG AAGATGGTGA TCGCTCACAC CAAATCCTTG GACCCCTCCC GGCCTGTGAC CTTTGTGAGC AACTCTAACT ATGCAGCAGA CAAGGGGGCT CCGTATGTGG ATGTGATCTG TTTGAACAGC TACTACTCTT GGTATCACGA CTACGGGCAC CTGGAGTTGA TTCAGCTGCA GCTGGCCACC CAGTTTGAGA ACTGGTATAA GAAGTATCAG AAGCCCATTA TTCAGAGCGA GTATGGAGCA GAAACGATTG CAGGGTTTCA CCAGGATCCA CCTCTGATGT TCACTGAAGA GTACCAGAAA AGTCTGCTAG AGCAGTACCA TCTGGGTCTG GATCAAAAAC GCAGAAAATA CGTGGTTGGA GAGCTCATTT GGAATTTTGC CGATTTCATG ACTGAACAGT CACCGACGAG AGTGCTGGGG AATAAAAAGG GGATCTTCAC TCGGCAGAGA CAACCAAAAA GTGCAGCGTT CCTTTTGCGA GAGAGATACT GGAAGATTGC CAATGAAACC AGGTATCCCC ACTCAGTAGC CAAGTCACAA TGTTTGGAAC ACAGCCTGTT TACTTGAGCA AGACTGATAC CACCTGCGTG TCCCTTCCTC CCCGAGTCAG GGCGACTTCC ACAGCAGCAG AACAAGTGCC TCCTGGACTG TTCACGGCAG ACCAGAACGT TTCTGGCCTG GGTTTTGTGG TCATCTATTC TAGCAGGGAA CACTAAAGGT GGAAATAAAA GATTTTCTAT TATGGAAATA AAGAGTTGGC ATGAAAGTGG CTACTGAAAA AAAAAAAAAA AAAAAAAAAA A	
RPLP0	NM_001002.3	GTCTGACGGG CGATGGCGCA GCCAATAGAC AGGAGCGCTA TCCGCGGTTT CTGATTGGCT ACTTTGTTTC CATTATAAAA GGCACGCGCG GGCGCGAGGC CCTTCTCTCG CCAGGCGTCC TCGTGGAAGT GACATCGTCT TTAAACCCTG CGTGGCAATC CCTGACGCAC CGCCGTGATG CCCAGGGAAG ACAGGGCGAC CTGGAAGTCC AACTACTTCC TTAAGATCAT CCAACTATTG GATGATTATC CGAAATGTTT CATTGTGGGA GCAGACAATG TGGGCTCCAA GCAGATGCAG CAGATCCGCA TGTCCTTCG CGGGAAGGCT GTGGTGCTGA TGGGCAAGAA CACCATGATG CGCAAGGCCA TCCGAGGGCA CCTGGAAAAC AACCCAGCTC TGGAGAAACT GCTGCCTCAT ATCCGGGGGA ATGTGGGCTT TGTGTTACAC AAGGAGGACC TCACTGAGAT CAGGGACATG TTGCTGGCCA ATAAGGTGCC AGCTGCTGCC CGTGCTGGTG CCATTGCCCC ATGTGAAGTC ACTGTGCCAG CCCAGAACAC TGGTCTCGGG CCCGAGAAGA CCTCCTTTTT CCAGGCTTTA GGTATCACCA CTAAAATCTC CAGGGGCACC ATTGAAATCC TGAGTGATGT GCAGCTGATC AAGACTGGAG ACAAAGTGGG AGCCAGCGAA GCCACGCTGC TGAACATGCT CAACATCTCC CCCTTCTCCT TTGGGCTGGT CATCCAGCAG GTGTTCGACA ATGGCAGCAT CTACAACCCT GAAGTGCTTG ATATCACAGA GGAAACTCTG CATTCTCGCT TCCTGGAGGG TGTCCGCAAT	47

		GTTGCCAGTG TCTGTCTGCA GATTGGCTAC CCAACTGTTG CATCAGTACC CCATTCTATC ATCAACGGGT ACAAACGAGT CCTGGCCTTG TCTGTGGAGA CGGATTACAC CTTCCCCTT GCTGAAAAGG TCAAGGCCTT CTTGGCTGAT CCATCTGCCT TTGTGGCTGC TGCCCCCTGTG GCTGCTGCCA CCACAGCTGC TCCTGCTGCT GCTGCAGCCC CAGCTAAGGT TGAAGCCAAG GAAGAGTCGG AGGAGTCGGA CGAGGATATG GGATTTGGTC TCTTTGACTA ATCACCAAAA AGCAACCAAC TTAGCCAGTT TTATTTGCAA AACAAGGAAA TAAAGGCTTA CTTCTTTAAA AAGTAAAAAA AAAAAAAAAA AAAAAAAAAA	
TFRC	NM_003234.3	AGAGCGTCGG GATATCGGGT GGCGGCTCGG GACGGAGGAC GCGCTAGTGT GAGTGCGGGC TTCTAGAACT ACACCGACCC TCGTGTCCTC CCTTCATCCT GCGGGGCTGG CTGGAGCGGC CGCTCCGGTG CTGTCCAGCA GCCATAGGGA GCCGCACGGG GAGCGGGAAA GCGGTGCGGG CCCCAGGCGG GGCGGCCGGG ATGGAGCGGG GCCGCGAGCC TGTGGGGAAG GGGCTGTGGC GGCGCCTCGA GCGGCTGCAG GTTCTTCTGT GTGGCAGTTC AGAATGATGG ATCAAGCTAG ATCAGCATTC TCTAACTTGT TTGGTGGAGA ACCATTGTCA TATACCCGGT TCAGCCTGGC TCGGCAAGTA GATGGCGATA ACAGTCATGT GGAGATGAAA CTTGCTGTAG ATGAAGAAGA AAATGCTGAC AATAACACAA AGGCCAATGT CACAAAACCA AAAAGGTGTA GTGGAAGTAT CTGCTATGGG ACTATTGCTG TGATCGTCTT TTTCTTGATT GGATTTATGA TTGGCTACTT GGGCTATTGT AAAGGGGTAG AACCAAAAAC TGAGTGTGAG AGACTGGCAG GAACCGAGTC TCCAGTGAGG GAGGAGCCAG GAGAGGACTT CCCTGCAGCA CGTCGCTTAT ATTGGGATGA CCTGAAGAGA AAGTTGTCGG AGAAACTGGA CAGCACAGAC TTCACCGGCA CCATCAAGCT GCTGAATGAA AATTCATATG TCCCTCGTGA GGCTGGATCT CAAAAAGATG AAAATCTTGC GTTGTATGTT GAAAATCAAT TTCGTGAATT TAAACTCAGC AAAGTCTGGC GTGATCAACA TTTTGTAAAG ATTCAGGTCA AAGACAGCGC TCAAACTCG GTGATCATAG TTGATAAGAA CGGTAGACTT GTTTACCTGG TGGAGAATCC TGGGGGTTAT GTGGCGTATA GTAAGGCTGC AACAGTTACT GGTAAACTGG TCCATGCTAA TTTTGGTACT AAAAAAGATT TTGAGGATTT ATACACTCCT GTGAATGGAT CTATAGTGAT TGTCAGAGCA GGGAAAATCA CCTTTGCAGA AAAGGTTGCA AATGCTGAAA GCTTAAATGC AATTGGTGTG TTGATATACA TGGACCAGAC TAAATTTCCC ATTGTTAACG CAGAACTTTC ATTCTTTGGA CATGCTCATC TGGGGACAGG TGACCCTTAC ACACCTGGAT TCCCTTCCTT CAATCACACT CAGTTTCCAC CATCTCGGTC ATCAGGATTG CCTAATATAC CTGTCCAGAC AATCTCCAGA GCTGCTGCAG AAAAGCTGTT TGGGAATATG GAAGGAGACT GTCCCTCTGA CTGGAAAACA GACTCTACAT GTAGGATGGT AACCTCAGAA AGCAAGAATG TGAAGCTCAC TGTGAGCAAT GTGCTGAAAG AGATAAAAAT	48

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18S	X0320 5.1	TACCTGGTTG ATCCTGCCAG TAGCATATGC TTGTCTCAAA GATTAAGCCA TGCATGTCTA AGTACGCACG GCCGGTACAG TGAAACTGCG AATGGCTCAT TAAATCAGTT ATGGTTCCTT TGGTCGCTCG CTCCTCTCCC ACTTGGATAA CTGTGGTAAT TCTAGAGCTA ATACATGCCG ACGGGCGCTG ACCCCCTTCG CGGGGGGGAT GCGTGCATTT ATCAGATCAA AACCAACCCG GTCAGCCCCT CTCCGGCCCC GGCCGGGGGG CGGGCGCCGG CGGCTTTGGT GACTCTAGAT AACCTCGGGC CGATCGCACG CCCCCGTGG CGGCGACGAC CCATTCGAAC GTCTGCCCTA TCAACTTTTCG ATGGTAGTCG CCGTGCCTAC CATGGTGACC ACGGGTGACG GGAATCAGG GTTCGATTCC GGAGAGGGAG CCTGAGAAAC GGCTACCACA TCCAAGGAAG GCAGCAGGCG CGCAAATTAC CCACTCCCGA CCCGGGGAGG TAGTGACGAA AAATAACAAT ACAGGACTCT TTCGAGGCCC TGTAATTGGA ATGAGTCCAC TTAAATCCT TTAACGAGGA TCCATTGGAG GGCAAGTCTG GTGCCAGCAG CCGCGGTAAT TCCAGCTCCA ATAGCGTATA TTAAAGTTGC TGCAGTTAAA AAGCTCGTAG TTGGATCTTG GGAGCGGGCG GCGGGTCCGC CGCGAGGCGA GCCACCGCCC GTCCCCGCCC CTTGCCTCTC GGCGCCCCCT CGATGCTCTT AGCTGAGTGT CCCGCGGGGC CCGAAGCGTT TACTTTGAAA AAATTAGAGT GTTCAAAGCA GGCCCGAGCC GCCTGGATAC CGCAGCTAGG AATAATGGAA TAGGACCGCG GTTCTATTTT GTTGGTTTTT GGAAGTGAAG CCATGATTAA GAGGGACGGC CGGGGGCATT CGTATTGCGC CGCTAGAGGT GAAATTCTTG GACCGGCGCA AGACGGACCA GAGCGAAAGC ATTTGCCAAG AATGTTTTCA TTAATCAAGA ACGAAAGTCG GAGGTTCGAA GACGATCAGA TACCGTCGTA GTTCCGACCA TAAACGATGC CGACCGGCGA TGCGGCGGCG TTATTCCCAT GACCCGCCGG GCAGCTTCCG GGAAACCAAA GTCTTTGGGT TCCGGGGGGA GTATGGTTGC AAAGCTGAAA CTTAAAGGAA TTGACGGAAG GGCACCACCA GGAGTGGAGC CTGCGGCTTA ATTTGACTCA ACACGGGAAA CCTCACCCGG CCCGGACACG GACAGGATTG ACAGATTGAT AGCTCTTTCT CGATTCCGTG GGTGGTGGTG CATGGCCGTT CTTAGTTGGT GGAGCGATTT GTCTGGTTAA TTCCGATAAC GAACGAGACT CTGGCATGCT AACTAGTTAC GCGACCCCCG AGCGGTCCGC GTCCCCCAAC TTCTTAGAGG GACAAGTGGC GTTCAGCCAC CCGAGATTGA GCAATAACAG GTCTGTGATG CCCTTAGATG TCCGGGGGCTG CACGCGCGCT AACTGACTG GCTCAGCGTG TGCCTACCCT ACGCCGGCAG GCGCGGGTAA CCCGTTGAAC CCCATTCGTG ATGGGGATCG GGGATTGCAA TTATTCCCCA TGAACGAGGA ATTCCCAGTA AGTGCGGGTC ATAAGCTTGC GTTGATTAA TCCCTGCCCT TTGTACACAC CGCCCGTCGC TACTACCGAT TGGATGGTTT AGTGAGGCCC TCGGATCGGC CCCGCCGGGG TCGGCCACG GCCCTGGCGG AGCGCTGAGA AGACGGTCGA ACTTGACTAT CTAGAGGAAG TAAAAGTCGT AACAAGGTTT CCGTAGGTGA ACCTGCGGAA GGATCATTA	49
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<i>PPIA</i>	NM_021130.4	GGGGCCGAAC GTGGTATAAA AGGGGCGGGA GGCCAGGCTC GTGCCGTTTT GCAGACGCCA CCGCCGAGGA AAACCGTGTA CTATTAGCCA TGGTCAACCC CACCGTGTTT TCGACATTG CCGTCGACGG CGAGCCCTTG GGCCGCGTCT CCTTTGAGCT GTTTGCAGAC AAGGTCCCAA AGACAGCAGA AAATTTTCGT GCTCTGAGCA CTGGAGAGAA AGGATTTGGT TATAAGGGTT CCTGCTTTCA CAGAATTATT CCAGGGTTTA TGTGTCAGGG TGGTGACTTC ACACGCCATA ATGGCACTGG TGGCAAGTCC ATCTATGGGG AGAAATTIGA AGATGAGAAC TTCATCCTAA AGCATACGGG TCCTGGCATC TTGTCCATGG CAAATGCTGG ACCCAACACA AATGGTTCCC AGTTTTTCAT CTGCACTGCC AAGACTGAGT GGTGATGG CAAGCATGTG GTGTTTGGCA AAGTGAAAGA AGGCATGAAT ATTGTGGAGG CCATGGAGCG CTTTGGGTCC AGGAATGGCA AGACCAGCAA GAAGATCACC ATTGCTGACT GTGGACAAC CGAATAAGTT TGACTTGTGT TTTATCTTAA CCACCAGATC ATTCCTTCTG TAGCTCAGGA GAGCACCCCT CCACCCCAT TGTCTGCAGT ATCCTAGAAT CTTTGTGCTC TCGCTGCAGT TCCCTTTGGG TTCCATGTTT TCCTTGTTCC CTCCCATGCC TAGCTGGATT GCAGAGTTAA GTTTATGATT ATGAAATAAA AACTAAATA CAATTGTCCT CGTTTGAGTT AAGAGTGTTG ATGTAGGCTT TATTTTAAGC AGTAATGGGT TACTTCTGAA ACATCACTTG TTTGCTTAAT TCTACACAGT ACTTAGATTT TTTTACTTT CCAGTCCCAG GAAGTGTCAG TGTGTTTGA GTGGAATATT GAAAATGTAG GCAGCAACTG GGCATGGTGG CTCCTGTCT GTAATGTATT ACCTGAGGCA GAAGACCACC TGAGGGTAGG AGTCAAGATC AGCCTGGGCA ACATAGTGAG ACGCTGTCT TACAAAAAAT AATTAGCCTG GCCTGGTGGT GCATGCCTAG TCCTAGCTGA TCTGGAGGCT GACGTGGGAG GATTGCTTGA GCCTAGAGTG AGCTATTATC ATGCCACTGT ACAGCCTGGG TGTTACAGA TCTTGTGTCT CAAAGGTAGG CAGAGGCAGG AAAAGCAAGG AGCCAGAATT AAGAGGTTGG GTCAGTCTGC AGTGAGTTCA TGCATTTAGA GGTGTTCTTC AAGATGACTA ATGTCAAAAA TTGAGACATC TGTTGCGGTT TTTTTTTTTT TTTTTTCCC TGGAATGCAG TGGCGTGATC TCAGCTCACT GCAGCCTCCG CCTCCTGGGT TCAAGTGATT CTAGTGCCTC AGCCTCCTGA GTAGCTGGGA TAATGGGCGT GTGCCACCAT GCCCAGCTAA TTTTTGATT TTTAGTATAG ATGGGGTTTC ATCATTTTGA CCAGGCTGGT CTCAAACCTCT TGACCTCAGC TGATGCGCCT GCCTTGGCCT CCCAACTGC TGAGATTACA GATGTGAGCC ACCGCACCT ACCTCATTTT CTGTAACAAA GCTAAGCTTG AACACTGTTG ATGTTCTTGA GGAAGCATA TTGGGCTTTA GGCTGTAGGT CAAGTTTATA CATCTTAATT ATGGTGGAAT TCCTATGTAG AGTCTAAAAA GCCAGGTACT TGGTGCTACA GTCAGTCTCC CTGCAGAGGG TTAAGGCGCA GACTACCTGC AGTGAGGAGG TACTGCTTGT AGCATATAGA GCCTCTCCCT AGCTTTGGTT ATGGAGGCTT TGAGGTTTTG CAAACCTGAC CAATTTAAGC CATAAGATCT GGTCAAAGGG ATACCCTTCC	50
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		CACTAAGGAC TTGGTTTCTC AGGAAATTAT ATGTACAGTG CTTGCTGGCA GTTAGATGTC AGGACAATCT AAGCTGAGAA AACCCCTTCT CTGCCCACCT TAACAGACCT CTAGGGTTCT TAACCCAGCA ATCAAGTTTG CCTATCCTAG AGGTGGCGGA TTTGATCATT TGGTGTGTTG GGCAATTTT GTTTTACTGT CTGGTTCCTT CTGCGTGAAT TACCACCACC ACCACTTGTG CATCTCAGTC TTGTGTGTTG TCTGGTTACG TATTCCCTGG GTGATACCAT TCAATGTCTT AATGTACTTG TGGCTCAGAC CTGAGTGCAA GGTGGAAATA AACATCAAAC ATCTTTTCAT TATCCCTA	
PGKI	NM_00291.3	GAGAGCAGCG GCCGGGAAGG GGCGGTGCGG GAGGCGGGGT GTGGGGCGGT AGTGTGGGCC CTGTTCCCTGC CCGCGCGGTG TTCCGCATTC TGCAAGCCTC CGGAGCGCAC GTCGGCAGTC GGCTCCCTCG TTGACCGAAT CACCGACCTC TCTCCCCAGC TGTATTTCCA AAATGTCGCT TTCTAACAAG CTGACGCTGG ACAAGCTGGA CGTTAAAGGG AAGCGGGTCG TTATGAGAGT CGACTTCAAT GTTCCTATGA AGAACAACCA GATAACAAAC AACCAGAGGA TTAAGGCTGC TGTCCCAAGC ATCAAATTCT GCTTGGACAA TGGAGCCAAG TCGGTAGTCC TTATGAGCCA CCTAGGCCGG CCTGATGGTG TGCCCATGCC TGACAAGTAC TCCTTAGAGC CAGTTGCTGT AGAACTCAA TCTCTGCTGG GCAAGGATGT TCTGTTCTTG AAGGACTGTG TAGGCCCAGA AGTGGAGAAA GCCTGTGCCA ACCCAGCTGC TGGGTCTGTC ATCCTGCTGG AGAACCTCCG CTTTCATGTG GAGGAAGAAG GGAAGGGAAA AGATGCTTCT GGGAACAAGG TTAAAGCCGA GCCAGCCAAA ATAGAAGCTT TCCGAGCTTC ACTTTCCAAG CTAGGGGATG TCTATGTCAA TGATGCTTTT GGCCTGCTC ACAGAGCCCA CAGCTCCATG GTAGGAGTCA ATCTGCCACA GAAGGCTGGT GGGTTTTTGA TGAAGAAGGA GCTGAACTAC TTTGCAAAGG CCTTGGAGAG CCCAGAGCGA CCCTTCCTGG CCATCCTGGG CGGAGCTAAA GTTGCAGACA AGATCCAGCT CATCAATAAT ATGCTGGACA AAGTCAATGA GATGATTATT GGTGGTGGAA TGGCTTTTAC CTTCTTAAG GTGCTCAACA ACATGGAGAT TGGCACTTCT CTGTTTGATG AAGAGGGAGC CAAGATTGTC AAAGACCTAA TGTCCAAAGC TGAGAAGAAT GGTGTGAAGA TTACCTTGCC TGTTGACTTT GTCCTGCTG ACAAGTTTGA TGAGAATGCC AAGACTGGCC AAGCCACTGT GGCTTCTGGC ATACCTGCTG GCTGGATGGG CTTGGACTGT GGTCCTGAAA GCAGCAAGAA GTATGCTGAG GCTGTCACTC GGGCTAAGCA GATTGTGTGG AATGGTCCTG TGGGGGTATT TGAATGGGAA GCTTTTGCCC GGGGAACCAA AGCTCTCATG GATGAGGTGG TGAAAGCCAC TTCTAGGGGC TGCATCACCA TCATAGGTGG TGGAGACACT GCCACTTGCT GTGCCAAATG GAACACGGAG GATAAAGTCA GCCATGTGAG CACTGGGGGT GGTGCCAGTT TGGAGCTCCT GGAAGGTAAA GTCCTTCCTG GGGTGGATGC TCTCAGCAAT ATTTAGTACT TTCCTGCCTT	51

		TTAGTTCCCTG TGCACAGCCC CTAAGTCAAC TTAGCATTIT CTGCATCTCC ACTTGGCATT AGCTAAAACC TTCCATGTCA AGATTCAGCT AGTGGCCAAG AGATGCAGTG CCAGGAACCC TTAAACAGTT GCACAGCATC TCAGCTCATC TTCACTGCAC CCTGGATTIG CATACTTCT TCAAGATCCC ATTTGAATTT TTTAGTGACT AAACCATTTGT GCATTCTAGA GTGCATATAT TTATATTTTG CCTGTAAAA AGAAAGTGAG CAGTGTTAGC TTAGTTCTCT TTTGATGTAG GTTATTATGA TTAGCTTTGT CACTGTTTCA CTACTCAGCA TGGAAACAAG ATGAAATTCC ATTTGTAGGT AGTGAGACAA AATTGATGAT CCATTAAGTA AACAATAAAA GTGTCCATTG AAACCGTGAT TTTTTTTTTT TTCCTGTCAT ACTTTGTTAG GAAGGGTGAG AATAGAATCT TGAGGAACGG ATCAGATGTC TATATTGCTG AATGCAAGAA GTGGGGCAGC AGCAGTGGAG AGATGGGACA ATTAGATAAA TGTCCTTCT TTATCAAGGG CCTACTTTAT GGCAGACATT GTGCTAGTGC TTTTATTCTA ACTTTTATTT TTATCAGTTA CACATGATCA TAATTTAAAA AGTCAAGGCT TATAACAAAA AAGCCCCAGC CCATTCCTCC CATTCAAGAT TCCCACTCCC CAGAGGTGAC CACTTTCAAC TCTTGAGTTT TTCAGGTATA TACCTCCATG TTCTAAGTA ATATGCTTAT ATTGTTCACT TCTTTTTTTT TTATTTTTTA AAGAAATCTA TTTCATACCA TGGAGGAAGG CTCTGTTCCA CATATATTTT CACTTCTTCA TTCTCTCGGT ATAGTTTTGT CACAATTATA GATTAGATCA AAAGTCTACA TAACTAATAC AGCTGAGCTA TGTAGTATGC TATGATTAAA TTTACTTATG TAAAAA AAAA	
RPL13A	NM_012423.3	CACTTCTGCC GCCCCTGTTT CAAGGGATAA GAAACCCTGC GACAAAACCT CCTCCTTTTC CAAGCGGCTG CCGAAGATGG CGGAGGTGCA GGTCTGGTG CTTGATGGTC GAGGCCATCT CCTGGGCCGC CTGGCGGCCA TCGTGGCTAA ACAGGTACTG CTGGGCCGGA AGGTGGTGGT CGTACGCTGT GAAGGCATCA ACATTCTGG CAATTCTAC AGAAACAAGT TGAAGTACCT GGCTTTCCTC CGCAAGCGGA TGAACACCAA CCCTTCCCGA GGCCCCTACC ACTTCCGGGC CCCCAGCCGC ATCTTCTGGC GGACCGTGCG AGGTATGCTG CCCCACAAAA CCAAGCGAGG CCAGGCCGCT CTGGACCGTC TCAAGGTGTT TGACGGCATC CCACCGCCCT ACGACAAGAA AAAGCGGATG GTGGTTCCTG CTGCCCTCAA GGTCGTGCGT CTGAAGCCTA CAAGAAAGTT TGCCTATCTG GGGCGCCTGG CTCACGAGGT TGGCTGGAAG TACCAGGCAG TGACAGCCAC CCTGGAGGAG AAGAGGAAAG AGAAAGCCAA GATCCACTAC CGGAAGAAGA AACAGCTCAT GAGGCTACGG AAACAGGCCG AGAAGAACGT GGAGAAGAAA ATTGACAAAT ACACAGAGGT CCTCAAGACC CACGGACTCC TGGTCTGAGC CCAATAAAGA CTGTTAATTC CTCATGCGTT GCCTGCCCTT CCTCCATTGT TGCCCTGGAA TGTACGGGAC CCAGGGGCAG CAGCAGTCCA GGTGCCACAG GCAGCCCTGG GACATAGGAA GCTGGGAGCA AGGAAAGGGT CTTAGTCACT	52

		GCCTCCCGAA GTTGCTTGAA AGCACTCGGA GAATTGTGCA GGTGTCATTT ATCTATGACC AATAGGAAGA GCAACCAGTT ACTATGAGTG AAAGGGAGCC AGAAGACTGA TTGGAGGGCC CTATCTTG TG AGTGGGGCAT CTGTTGGACT TTCCACCTGG TCATATACTC TGCAGCTGTT AGAATGTGCA AGCACTTGGG GACAGCATGA GCTTGCTGTT GTACACAGGG TATTTCTAGA AGCAGAAATA GACTGGGAAG ATGCACAACC AAGGGGTTAC AGGCATCGCC CATGCTCCTC ACCTGTATTT TGTAATCAGA AATAAATTGC TTTTAAAGAA AAAAAAAAAA AAAAAA	
B2M	NM_004048.2	AATATAAGTG GAGGCGTCGC GCTGGCGGGC ATTCCTGAAG CTGACAGCAT TCGGGCCGAG ATGTCTCGCT CCGTGGCCTT AGCTGTGCTC GCGCTACTCT CTCTTTCTGG CCTGGAGGCT ATCCAGCGTA CTCCAAAGAT TCAGGTTTAC TCACGTCATC CAGCAGAGAA TGGAAAGTCA AATTTCTGA ATTGCTATGT GTCTGGGTTT CATCCATCCG ACATTGAAGT TGACTTACTG AAGAATGGAG AGAGAATTGA AAAAGTGGAG CATTCACTG TGCTTTTCAG CAAGGACTGG TCTTTCTATC TCTTGACTA CACTGAATTC ACCCCCACTG AAAAAGATGA GTATGCCTGC CGTGTGAACC ATGTGACTTT GTCACAGCCC AAGATAGTTA AGTGGGATCG AGACATGTAA GCAGCATCAT GGAGGTTTGA AGATGCCGCA TTTGGATTGG ATGAATTCCA AATTCTGCTT GCTTGCTTTT TAATATTGAT ATGCTTATAC ACTTACACTT TATGCACAAA ATGTAGGGTT ATAATAATGT TAACATGGAC ATGATCTTCT TTATAATTCT ACTTTGAGTG CTGTCTCCAT GTTTGATGTA TCTGAGCAGG TTGCTCCACA GGTAGCTCTA GGAGGGCTGG CAACTTAGAG GTGGGGAGCA GAGAATTCTC TTATCCAACA TCAACATCTT GGTCAGATTT GAACTCTTCA ATCTCTTGCA CTCAAAGCTT GTTAAGATAG TTAAGCGTGC ATAAGTTAAC TTCCAATTTA CATACTCTGC TTAGAATTTG GGGGAAAATT TAGAAATATA ATTGACAGGA TTATTGGAAA TTTGTTATAA TGAATGAAAC ATTTTGTCAT ATAAGATTCA TATTIACCTT TTATACATTT GATAAAGTAA GGCATGGTTG TGGTTAATCT GGTTTATTTT TGTTCCACAA GTTAAATAAA TCATAAAACT TGATGTGTTA TCTCTTA	53
YWHAZ	NM_003406.3	CTTTCTCCTT CCCCTTCTTC CGGGCTCCCG TCCCGGCTCA TCACCCGGCC TGTGGCCAC TCCCACCGCC AGCTGGAACC CTGGGGACTA CGACGTCCCT CAAACCTTGC TTCTAGGAGA TAAAAAGAAC ATCCAGTCAT GGATAAAAAT GAGCTGGTTC AGAAGGCCAA ACTGGCCGAG CAGGCTGAGC GATATGATGA CATGGCAGCC TGCATGAAGT CTGTAACTGA GCAAGGAGCT GAATTATCCA ATGAGGAGAG GAATCTTCTC TCAGTTGCTT ATAAAAATGT TGTAGGAGCC CGTAGGTCAT CTTGGAGGGT CGTCTCAAGT ATTGAACAAA AGACGGAAGG TGCTGAGAAA AAACAGCAGA TGGCTCGAGA ATACAGAGAG AAAATTGAGA CGGAGCTAAG AGATATCTGC AATGATGTAC TGTCTCTTTT GGAAAAGTTC TTGATCCCCA ATGCTTCACA AGCAGAGAGC	54

AAAGTCTTCT ATTTGAAAAT GAAAGGAGAT TACTACCGTT
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 TGGGTCTGGC CCTTAACTTC TCTGTGTTCT ATTATGAGAT
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 GCAAAGAAAA CTGCCTACAT ACTGGTTTGT CCTGGCGGGG
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 TGTGGGTACT TTAAGGTTTG GAGCACTTAC AAGGCTGTGG
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 TAAAGTTACC TGCTGTTAGC TTTTATTATT TTTGCTACAC
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 AAGTTTTGTG CTTCCAAATC ACTTTTGGT TTTAAGAAT
 TTCTTGATAC TCTTATAGCC TGCCTTCAAT TTGATCCTT
 TATTCTTCT ATTTGTCAGG TGCACAAGAT TACCTTCCTG
 TTTTAGCCTT CTGTCTTGTC ACCAACCATT CTTACTTGGT

		GGCCATGTAC TTGGAAAAAG GCCGCATGAT CTTTCTGGCT CCTCAGTG TCTAAGGCAC CCTGCTTCCT TTGCTTGCAT CCCACAGACT ATTTCCCTCA TCCTATTTAC TGCAGCAAAT CTCTCCTTAG TTGATGAGAC TGTGTTTATC TCCCTTTAAA ACCCTACCTA TCCTGAATGG TCTGTCATTG TCTGCCTTTA AAATCCTTCC TCTTTCTTCC TCCTCTATTG TCTAAATAAT GATGGGGCTA AGTTATACCC AAAGCTCACT TTACAAAATA TTTCCTCAGT ACTTTGCAGA AAACACCAAA CAAAAATGCC ATTTTAAAAA AGGTGTATTT TTTCTTTTAG AATGTAAGCT CCTCAAGAGC AGGGACAATG TTTTCTGTAT GTTCTATTGT GCCTAGTACA CTGTAAATGC TCAATAAATA TTGATGATGG GAGGCAGTGA GTCTTGATGA TAAGGGTGAG AAAGTGAAT CCCAAACACT GTTTTGTTGC TTGTTTTATT ATGACCTCAG ATTAAATTGG GAAATATTGG CCCTTTTGAA TAATTGTCCC AAATATTACA TTCAAATAAA AGTGCAATGG AGAAAAAAAA AAA	
SDHA	NM_004168.3	ACTGCAGCCC CGCTCGACTC CGGCGTGGTG CGCAGGCGCG GTATCCCCC TCCCCCGCCA GCTCGACCCC GGTGTGGTGC GCAGGCGCAG TCTGCGCAGG GACTGGCGGG ACTGCGCGGC GGCAACAGCA GACATGTCGG GGGTCCGGGG CCTGTCGCGG CTGCTGAGCG CTCGGCGCCT GCGCTGGCC AAGGCGTGGC CAACAGTGTT GCAAACAGGA ACCCGAGGTT TTCACTTCAC TGTTGATGGG AACAAGAGGG CATCTGCTAA AGTTTCAGAT TCCATTTCTG CTCAGTATCC AGTAGTGGAT CATGAATTTG ATGCAGTGGT GGTAGGCGCT GGAGGGGCAG GCTTGCGAGC TGCATTTGGC CTTTCTGAGG CAGGGTTTAA TACAGCATGT GTTACCAAGC TGTTTCCTAC CAGGTCACAC ACTGTTGCAG CACAGGGAGG AATCAATGCT GCTCTGGGGA ACATGGAGGA GGACAACTGG AGGTGGCATT TCTACGACAC CGTGAAGGGC TCCGACTGGC TGGGGGACCA GGATGCCATC CACTACATGA CGGAGCAGGC CCCC GCCGCC GTGGTCGAGC TAGAAAATTA TGGCATGCCG TTAGCAGAA CTGAAGATGG GAAGATTTAT CAGCGTGCAT TTGGTGGACA GAGCCTCAAG TTTGGAAAGG GCGGGCAGGC CCATCGGTGC TGCTGTGTGG CTGATCGGAC TGGCCACTCG CTATTGCACA CCTTATATGG AAGGTCTCTG CGATATGATA CCAGCTATTT TGTGGAGTAT TTIGCCTTGG ATCTCCTGAT GGAGAATGGG GAGTGCCGTG GTGTCATCGC ACTGTGCATA GAGGACGGGT CCATCCATCG CATAAGAGCA AAGAACACTG TTGTTGCCAC AGGAGGCTAC GGGCGCACCT ACTTCAGCTG CACGTCTGCC CACACCAGCA CTGGCGACGG CACGGCCATG ATCACCAGGG CAGGCCTTCC TTGCCAGGAC CTAGAGTTTG TTCAGTTCCA CCTACAGGC ATATATGGTG CTGGTTGTCT CATTACGGAA GGATGTCGTG GAGAGGGAGG CATTCTCATT AACAGTCAAG GCGAAAGGTT TATGGAGCGA TACGCCCCCTG TCGCGAAGGA CCTGGCGTCT AGAGATGTGG TGTCTCGGTC CATGACTCTG GAGATCCGAG AAGGAAGAGG	55

		CTGTGGCCCT GAGAAAGATC ACGTCTACCT GCAGCTGCAC CACCTACCTC CAGAGCAGCT GGCCACGCGC CTGCCTGGCA TTTCAGAGAC AGCCATGATC TTCGCTGGCG TGGACGTCAC GAAGGAGCCG ATCCCTGTCC TCCCCACCGT GCATTATAAC ATGGGCGGCA TTCCACCAA CTACAAGGGG CAGGTCCTGA GGCACGTGAA TGGCCAGGAT CAGATTGTGC CCGGCCTGTA CGCCTGTGGG GAGGCCGCCT GTGCCTCGGT ACATGGTGCC AACCGCCTCG GGGCAAACCTC GCTCTTGGAC CTGGTTGTCT TTGGTCGGGC ATGTGCCCTG AGCATCGAAG AGTCATGCAG GCCTGGAGAT AAAGTCCCTC CAATTAAACC AAACGCTGGG GAAGAATCTG TCATGAATCT TGACAAATTG AGATTTGCTG ATGGAAGCAT AAGAACATCG GAACTGCGAC TCAGCATGCA GAAGTCAATG CAAAATCATG CTGCCGTGTT CCGTGTGGGA AGCGTGTTGC AAGAAGGTTG TGGGAAAATC AGCAAGCTCT ATGGAGACCT AAAGCACCTG AAGACGTTTC ACCGGGGAAT GGTCTGGAAC ACGGACCTGG TGGAGACCCT GGAGCTGCAG AACCTGATGC TGTGTGCGCT GCAGACCATC TACGGAGCAG AGGCACGGAA GGAGTCACGG GGC GCGCATG CCAGGGAAGA CTACAAGGTG CGGATTGATG AGTACGATTA CTCCAAGCCC ATCCAGGGGC AACAGAAGAA GCCCTTTGAG GAGCACTGGA GGAAGCACAC CCTGTCCTAT GTGGACGTTG GCACTGGGAA GGTCACTCTG GAATATAGAC CCGTGATCGA CAAAACTTTG AACGAGGCTG ACTGTGCCAC CGTCCCGCCA GCCATTCGCT CCTACTGATG AGACAAGATG TGGTGATGAC AGAATCAGCT TTTGTAATTA TGTATAATAG CTCATGCATG TGTCCATGTC ATAACTGTCT TCATACGCTT CTGCACTCTG GGAAGAAGG AGTACATTGA AGGGAGATTG GCACCTAGTG GCTGGGAGCT TGCCAGGAAC CCAGTGGCCA GGGAGCGTGG CACTTACCTT TGTCCCTTGC TTCATTCTTG TGAGATGATA AACTGGGCA CAGCTCTTAA ATAAAATATA AATGAACAAA CTTTCTTTTA TTTCCAAATC CATTGAAAT ATTTTACTGT TGTGACTTTA GTCATATTTG TTGACCTAAA AATCAAATGT AATCTTTGTA TTGTGTTACA TCAAAATCCA GATATTTTGT ATAGTTTCTT TTTTCTTTTT CTTTTCTTTT TTTTTTTTGA GACAGGATCG GTGCAGTAGT ACAATCACAG CTCACTGCAG CCTCAAACCTC CTGGGCAGCT CAGGTGATCT TCCTGACTCA GCCTTCTGAG TAGTTGGGGC TACAGGTGTG CACCACCATG CCCAGCTCAT TTATTTTGTA ATTGTAGGGA CAGGGTCTCA CTGTGTTGCC TAGGCTGGTC TCAAGTGATC CTCCTCCTT GGCCTCCCAA GGTGCTGGAA TTATAGGTGT GAACAAACCA AAAAAAAAAA AAA	
HPRT1	NM_00194.2	GGCGGGGCCT GCTTCTCCTC AGCTTCAGGC GGCTGCGACG AGCCCTCAGG CGAACCTCTC GGCTTTCCCG CGCGGCGCCG CCTCTTGCTG CGCCTCCGCC TCCTCCTCTG CTCCGCCACC GGCTTCCTCC TCCTGAGCAG TCAGCCCGCG CGCCGGCCGG CTCCGTTATG GCGACCCGCA GCCCTGGCGT CGTGATTAGT GATGATGAAC CAGGTTATGA CCTTGATTTA TTTGCATAC	56

		CTAATCATTATGCTGAGGATTTGGAAAGGGTGTTTATTCC TCATGGACTATTATGGACAGGACTGAACGTCTTGCTCGA GATGTGATGAGGAGATGGGAGGCCATCACATTGTAGCCC TCTGTGTGCTCAAGGGGGGGCTATAAATTCTTTGCTGACCT GCTGGATTACATCAAAGCACGGAATAGAAA TAGTGATAGA TCCATTCTATGACTGTAGATTTTATCAGACTGAAGAGCT ATTGTAATGACCAGTCAACA GGGGACATAA AAGTAATTGG TGGAGATGATCTCTCAACTTAACTGGAAA GAATGTCTTG ATTGTGGAAGATATAATTGACACTGGCAAAACAATGCAGA CTTTGCTTTCCTTGGTCAGGCAGTATAATC CAAAGATGGT CAAGGTCGCAAGCTTGCTGGTGAAAAGGACCCCACGAAGT GTTGGATATAAGCCAGACTTTGTTGGATTTGAAATTCCAG ACAAGTTTGTGTAGGATATGCCCTTGACTATAATGAATA CTTCAGGGATTTGAATCATGTTTGTGTCATTAGTGAAACT GGAAAAGCAA AATACAAAGCCTAAGATGAGAGTTCAAGTT GAGTTTGGAAACATCTGGAGTCCTATTGACATCGCCAGTA AAATTATCAATGTTCTAGTTCTGTGGCCATCTGCTTAGTA GAGCTTTTTCATGTATCTTCTAAGAATTTTATCTGTTTT GTACTTTAGAAATGTCAGTTGCTGCATTCC TAAACTGTTT ATTTGCACTATGAGCCTATAGACTATCAGTTCCCTTTGGG CGGATTGTTGTTTAACTTGTAAATGAAAAAATTCTCTTAA ACCACAGCACATTGAGTGAACATTGAACTCATATCTGT AAGAAATAAAGAGAAGATATATTAGTTTTTAAATTGGTAT TTTAAATTTTATATATGCAGGAAAGAATAGAGTGATTGA ATATTGTTAATATACCACC GTGTGTTAGA AAAGTAAGAA GCAGTCAATTTCACATCAAAGACAGCATCTAAGAAGTTT TGTTCTGTCC TGGAATTATTTAGTAGTGTTCAGTAATG TTGACTGTATTTTCCAACCTGTTCAAATTA TTACCAGTGA ATCTTTGTCA GCAGTTCCCTTTTAAATGCA AATCAATAAA TTCCCAAAAA TTAAAAAAA AAAAAAAAAA AAAAA	
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Definitions

[0065] The articles “a” and “an” are used in this disclosure to refer to one or more than one (i.e., to at least one) of the grammatical object of the article. By way of example, “an element” means one element or more than one element.

[0066] The term “and/or” is used in this disclosure to mean either “and” or “or” unless indicated otherwise.

[0067] As used herein, the terms “polynucleotide” and “nucleic acid molecule” are used interchangeably to mean a polymeric form of nucleotides of at least 10 bases or base pairs in length, either ribonucleotides or deoxynucleotides or a modified form of either type of

nucleotide, and is meant to include single and double stranded forms of DNA. As used herein, a nucleic acid molecule or nucleic acid sequence that serves as a probe in a microarray analysis preferably comprises a chain of nucleotides, more preferably DNA and/or RNA. In other embodiments, a nucleic acid molecule or nucleic acid sequence comprises other kinds of nucleic acid structures such as for instance a DNA/RNA helix, peptide nucleic acid (PNA), locked nucleic acid (LNA) and/or a ribozyme. Hence, as used herein the term “nucleic acid molecule” also encompasses a chain comprising non-natural nucleotides, modified nucleotides and/or non-nucleotide building blocks which exhibit the same function as natural nucleotides.

[0068] As used herein, the terms “hybridize,” “hybridizing,” “hybridizes,” and the like, used in the context of polynucleotides, are meant to refer to conventional hybridization conditions, such as hybridization in 50% formamide/6XSSC/0.1% SDS/100 µg/ml ssDNA, in which temperatures for hybridization are above 37 degrees and temperatures for washing in 0.1 XSSC/0.1% SDS are above 55 degrees C, and preferably to stringent hybridization conditions.

[0069] As used herein, the term “normalization” or “normalizer” refers to the expression of a differential value in terms of a standard value to adjust for effects which arise from technical variation due to sample handling, sample preparation, and measurement methods rather than biological variation of biomarker concentration in a sample. For example, when measuring the expression of a differentially expressed protein, the absolute value for the expression of the protein can be expressed in terms of an absolute value for the expression of a standard protein that is substantially constant in expression.

[0070] The terms “diagnosis” and “diagnostics” also encompass the terms “prognosis” and “prognostics”, respectively, as well as the applications of such procedures over two or more time points to monitor the diagnosis and/or prognosis over time, and statistical modeling based thereupon. Furthermore, the term diagnosis includes: a. prediction (determining if a patient will likely develop aggressive disease (hyperproliferative/invasive)), b. prognosis (predicting whether a patient will likely have a better or worse outcome at a pre-selected time in the future), c. therapy selection, d. therapeutic drug monitoring, and e. relapse monitoring.

[0071] The term “providing” as used herein with regard to a biological sample refers to directly or indirectly obtaining the biological sample from a subject. For example, “providing”

may refer to the act of directly obtaining the biological sample from a subject (e.g., by a blood draw, tissue biopsy, lavage and the like). Likewise, "providing" may refer to the act of indirectly obtaining the biological sample. For example, providing may refer to the act of a laboratory receiving the sample from the party that directly obtained the sample, or to the act of obtaining the sample from an archive.

[0072] "Accuracy" refers to the degree of conformity of a measured or calculated quantity (a test reported value) to its actual (or true) value. Clinical accuracy relates to the proportion of true outcomes (true positives (TP) or true negatives (TN) versus misclassified outcomes (false positives (FP) or false negatives (FN)), and may be stated as a sensitivity, specificity, positive predictive values (PPV) or negative predictive values (NPV), or as a likelihood, odds ratio, among other measures.

[0073] The term "biological sample" as used herein refers to any sample of biological origin potentially containing one or more biomarkers. Examples of biological samples include tissue, organs, or bodily fluids such as whole blood, plasma, serum, tissue, lavage or any other specimen used for detection of disease.

[0074] The term "subject" as used herein refers to a mammal, preferably a human.

[0075] "Treating" or "treatment" as used herein with regard to a condition may refer to preventing the condition, slowing the onset or rate of development of the condition, reducing the risk of developing the condition, preventing or delaying the development of symptoms associated with the condition, reducing or ending symptoms associated with the condition, generating a complete or partial regression of the condition, or some combination thereof.

[0076] Biomarker levels may change due to treatment of the disease. The changes in biomarker levels may be measured by the present disclosure. Changes in biomarker levels may be used to monitor the progression of disease or therapy.

[0077] "Altered", "changed" or "significantly different" refer to a detectable change or difference from a reasonably comparable state, profile, measurement, or the like. Such changes may be all or none. They may be incremental and need not be linear. They may be by orders of magnitude. A change may be an increase or decrease by 1%, 5%, 10%, 20%, 30%, 40%, 50%,

60%, 70%, 80%, 90%, 95%, 99%, 100%, or more, or any value in between 0% and 100%.

Alternatively, the change may be 1-fold, 1.5-fold, 2-fold, 3-fold, 4-fold, 5-fold or more, or any values in between 1-fold and five-fold. The change may be statistically significant with a p value of 0.1, 0.05, 0.001, or 0.0001.

[0078] The term “stable disease” refers to a diagnosis for the presence of a melanoma, however the melanoma has been treated and remains in a stable condition, i.e. one that is not progressive, as determined by imaging data and/or best clinical judgment.

[0079] The term “progressive disease” refers to a diagnosis for the presence of a highly active state of a melanoma, i.e. one has not been treated and is not stable or has been treated and has not responded to therapy, or has been treated and active disease remains, as determined by imaging data and/or best clinical judgment.

Examples

[0080] The disclosure is further illustrated by the following examples, which are not to be construed as limiting this disclosure in scope or spirit to the specific procedures herein described. It is to be understood that the examples are provided to illustrate certain embodiments and that no limitation to the scope of the disclosure is intended thereby. It is to be further understood that resort may be had to various other embodiments, modifications, and equivalents thereof which may suggest themselves to those skilled in the art without departing from the spirit of the present disclosure and/or scope of the appended claims.

EXAMPLE 1

[0081] Derivation of a 28-marker gene panel

[0082] Raw probe intensities ($n = 6,892,960$ features) from $n = 49$ whole blood samples were used to identify genes that best discriminated between different types of melanoma samples e.g., treated versus untreated, simultaneously. A total of 28 transcripts were identified in an unbiased manner as potential markers of melanoma behavior (Table 2).

[0083] An artificial intelligence model of melanoma disease dynamics was built using normalized gene expression of these 28 markers in whole blood from Controls ($n = 90$), Responders/Stable ($n = 68$), and Progressive ($n = 66$) samples. The dataset was randomly split into training ($n = 169$) and testing ($n = 55$) partitions for model creation and validation respectively. Five algorithms (XGB, RF, TreeBag, SVM, NNET) were identified that best predicted the training data. In the test set, each algorithm produced probability scores that predicted the sample. Each probability score reflects the “certainty” of an algorithm that an unknown sample belongs to Control, Responder/Stable or Progressive class. For example, an unknown sample S1 can have the following probability vector {Control = 20, Responder = 50, Progressive = 30}. This sample would be considered a responder, given a score of 50, but there may be potential of progression (probability of 30) (FIG. 1).

[0084] Table 2.

Melanoma Biomarker or Housekeeping Gene		Chromosome location [Cytogenetic band]	Uni Gen e ID	RefSeq	Am plic on pro duc ed usin g for war d and reve rse pri mer s	Assay Locat ion	Exon Boun dary
Symbol	Name				Len gth (bp)		
ATL1	atlastin GTPase 1	Chr.14: 50533082 - 50633068 [14q22.1]	Hs.5 849 05	NM_0 01127 713.1	65	1544	12 - 13

ATP6V0D	ATPase H ⁺ transporting VO subunit d1	Chr.16: 67438014 - 67481186 [16q22.1]	Hs.1 068 76	NM_0 04691. 4	72	224	1 - 2
C1ORF21	chromosome 1 open reading frame 21	Chr.1: 184387016 - 184629021 [1q25.3]	Hs.4 971 59	NM_0 30806. 3	84	805	5-6
CFLAR	CASP8 and FADD like apoptosis regulator	Chr.2: 201116015 - 201172688 [2q33.1]	Hs.3 907 36	NM_0 01127 183.2	59	874	3-4
CFLAR-AS1	CFLAR antisense RNA 1	Chr.2: 201140289 - 201157792 [2q33.1]	Hs.6 646 13	NR_04 0030.1	103	883	6-7
CHP1	calcineurin like EF-hand protein 1	Chr.15: 41231149 - 41281887 [15q15.1]	Hs.4 062 34	NM_0 07236. 4	120	212	1-2
DDX55	DEAD-box helicase 55	Chr.12: 123602077 - 123620943 [12q24.31]	Hs.2 861 73	NM_0 20936. 2	74	183	1-2
DMD	dystrophin	Chr.X: 31119219 - 33339609 [Xp21.1]	Hs.4 959 12	NM_0 00109. 3	76	9607	63-64
DNAJC9	DnaJ heat shock protein family (Hsp40) member C9	Chr.10: 73241954 - 73247331 [10q22.2]	Hs.4 085 77	NM_0 15190. 4	102	198	1-1
ENOSF1	enolase superfamily member 1	Chr.18: 670012 - 712664 [18p11.32]	Hs.6 585 50	NM_0 01126 123.3	110	X	13-14
FANCL	Fanconi anemia complementation group L	Chr.2: 58159243 - 58241380 [2p16.1]	Hs.6 318 90	NM_0 01114 636.1	138	540	6-7
HJURP	Holliday junction recognition protein	Chr.2: 233836701 - 233854566 [2q37.1]	Hs.5 329 68	NM_0 18410. 4	52	399	4-5
HLA-DOA	major histocompatibility complex, class II, DO alpha	Chr.6: 33004182 - 33009612 [6p21.32]	Hs.6 319 91	NM_0 02119. 3	124	160	1-2

HLA-DRA	major histocompatibility complex, class II, DR alpha	Chr.6: 32439842 - 32445046 [6p21.32]	Hs.5 200 48	NM_019111.4	129	884	4-5
HNRNPA3P1	heterogeneous nuclear ribonucleoprotein A3 pseudogene 1	Chr.10: 43787412 - 43790417 [10q11.21]	Hs.6 329 56	NR_002726.2	99	2455	1-1
IL23A	interleukin 23 subunit alpha	Chr.12: 56334159 - 56340410 [12q13.3]	Hs.3 822 12	NM_016584.2	107	323	1-2
IQGAP1	IQ motif containing GTPase activating protein 1	Chr.15: 90388241 - 90502243 [15q26.1]	Hs.4 305 51	NM_003870.3	69	4562	34-35
LOC494127	NFYC pseudogene	Chr.9: 87083886 - 87085225 [9q21.33]	Hs.6 263 16	NR_036691.1	86	150	1-1
LOC646471	uncharacterized LOC646471	Chr.1: 25819954 - 25823606 [1p36.11]	Hs.7 272 71	NR_024498.1	80	2858	1-1
LOH12CR	loss of heterozygosity, 12, chromosomal region 2 (non-protein coding)	Chr.12: 12355408 - 12357067 [12p13.2]	Hs.6 755 3	NR_024061.1	69	140	1-2
MTRNR2L2_MTO1	CUSTOM PRIMER						
PBXIP1	PBX homeobox interacting protein 1	Chr.1: 154944080 - 154956163 [1q21.3]	Hs.5 058 06	NM_020524.3	60	189	2-3
RNF5	ring finger protein 5	Chr.6: 32178385 - 32180793 [6p21.32]	Hs.7 317 74	NM_006913.3	67	273	1-2
SERTAD2	SERTA domain containing 2	Chr.2: 64631621 - 64751091 [2p14]	Hs.5 915 69	NM_014755.2	91	288	1-2
SLC35G5	solute carrier family 35 member G5	Chr.8: 11330986 - 11332186 [8p23.1]	Hs.4 583 97	NM_054028.1	144	541	1-1
SPATS2L	spermatogenesis associated serine rich 2 like	Chr.2: 200305881 - 200482263 [2q33.1]	Hs.1 203 23	NM_001100422.1	89	1364	10-11

TDRD7	tudor domain containing 7	Chr.9: 97412020 - 97496125 [9q22.33]	Hs.1 938 42	NM_0 01302 884.1	59	3084	15-16
TOX4 (housekeeping gene)	TOX high mobility group box family member 4	Chr.14: 21477176 - 21499177 [14q11.2]	Hs.5 559 10	NM_0 01303 523.1	145	447	3-3
TPT1 (housekeeping gene)	tumor protein, translationally-controlled 1	Chr.13: 45333471 - 45341284 [13q14.13]	Hs.3 745 96	NM_0 01286 272.1	131	377	3-3
TXK	TXK tyrosine kinase	Chr.4: 48066393 - 48135322 [4p12]	Hs.4 796 69	NM_0 03328. 2	113	1265	11-12
YY2	YY2 transcription factor	Chr.X: 21855987 - 21858727 [Xp22.12]	Hs.6 736 01	NM_2 06923. 3	110	552	1-1

[0085] Diagnosis: Identification of samples as melanoma

[0086] In the test set 1, the data for the utility of the test to differentiate melanoma from controls are included in **Table 3**. The metrics are included in **FIG. 2**. These are: sensitivity >90%, specificity 100%, PPV 100%, NPV 87%. The overall accuracy is 94%. The tool can therefore differentiate between controls and aggressive and stable melanoma disease.

[0087] Table 3. Confusion matrix showing classification accuracy of the 5-model algorithm that determines whether a sample is a melanoma or a control in blood samples

Predicted/Reference	Melanoma	Control
Control	3	20
Melanoma	30	0
Sensitivity	91%	
Specificity	100%	
Positive Predictive Value	100%	
Negative Predictive Value	87%	
Accuracy	94%	

[0088] The test was evaluated in a second test set (test set 2) that included 74 controls and 92 melanoma patients. The mean Melanomx score in the melanoma group was 73 ± 31 versus 10 ± 8 in the control group (FIG. 3A). The receiver operator curve analysis demonstrated the score exhibited an area under the curve (AUC) of 0.96 (FIG. 3B) and the metrics were 88-100% (FIG. 3C).

[0089] Correlation with surgical removal of melanoma.

[0090] In the surgical series ($n = 46$), removal of melanoma decreased the score from 74 ± 16 to 20 ± 12 (FIG. 4A). Evaluation of the post-surgical group identified the score was significantly different between patients with no evidence of disease 13 ± 6 (not different to the control group) and those with residual disease (33 ± 9) (FIG. 4B). The Melanomx score can therefore define the extent of surgery and identify those who are surgical cures.

[0091] Evaluation of immune-therapy and targeted (BRAF inhibitor) therapy.

[0092] In the therapy series ($n = 30$), treatment with ipilimumab (immune therapy targeting CTLA-4), nivolumab (immune therapy targeting PD-1) or a BRAF inhibitor (vemurafenib) for 5 months significantly decreased the Melanomx scores from 88 ± 12 to 15 ± 5 ($p < 0.0001$), 35 ± 14 ($p < 0.001$) and 38 ± 21 ($p < 0.0001$), respectively (FIG. 5). All patients in the treated groups were stable. This indicates that the Melanomx score can therefore be used to measure the efficacy of both immune and targeted-therapy in melanoma and that a decrease in score correlated with response to therapeutic intervention.

[0093] Confirmation that gene expression is melanoma derived.

[0094] We confirmed that melanoma was the source for the blood-based gene expression assay by evaluating expression in different melanoma cell lines, in tumor tissue and by comparing expression in blood with tumor tissue collected at the same time-point during surgery.

[0095] All 28 genes were highly expressed in all 3 melanoma cell lines. Scores ranged from 94 ± 6 (Hs294T) to 82 ± 5 (CHL) to 42 ± 9 (A375) (FIG. 6A).

[0096] Spike-in experiments using these 3 cell lines and normal whole blood demonstrated that gene expression scores were detected when as few as 1 cell was spiked into 1 ml of blood. One single melanoma cell was detectable. Scores ranged from 21 ± 4 (A375) to 30 ± 5 (CHL) to

34±2 (H2294) (**FIG. 6B**). Scores were significantly elevated compared to control blood (no spike-in; $p<0.0001$).

[0097] We then evaluated gene expression in tumor tissue. All 28 genes were highly expressed in melanoma compared to matched normal tissue and scores were significantly elevated 70±20 versus 4±3 ($p<0.0001$) (**FIG. 7A**).

[0098] We also compared gene expression in tumor tissue and blood collected at the same time point. Gene expression was highly concordant (Pearson r : 0.74 – 0.83, median: 0.819) identifying gene expression in tumor tissue and blood was concordant (**FIG. 7B**).

[0099] References:

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Equivalents

[00100] While the present invention has been described in conjunction with the specific embodiments set forth above, many alternatives, modifications and other variations thereof will be apparent to those of ordinary skill in the art. All such alternatives, modifications and variations are intended to fall within the spirit and scope of the present invention.

Claims:

1. A method for detecting a melanoma in a subject in need thereof, comprising:
 - determining the expression level of at least 29 biomarkers from a test sample from the subject by contacting the test sample with a plurality of agents specific to detect the expression of the at least 29 biomarkers, wherein the at least 29 biomarkers comprise ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, YY2, and at least one housekeeping gene;
 - normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of the at least one housekeeping gene, thereby obtaining a normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2;
 - inputting each normalized expression level into an algorithm to generate a score;
 - comparing the score with a first predetermined cutoff value; and
 - producing a report, wherein the report identifies the presence of a melanoma in the subject when the score is equal to or greater than the first predetermined cutoff value or identifies the absence of a melanoma in the subject when the score is below the first predetermined cutoff value, wherein the first predetermined cutoff value is 20 on a scale of 0 to 100.
2. The method of claim 1, wherein the at least one housekeeping gene is selected from the group consisting of ALG9, SEPN, YWHAQ, VPS37A, PRRC2B, DOPEY2, NDUFB11, ND4, MRPL19, PSMC4, SF3A1, PUM1, ACTB, GAPD, GUSB, RPLP0, TFRC, MORF4L1, 18S, PPIA, PGK1, RPL13A, B2M, YWHAZ, SDHA, HPRT1, TOX4, and TPT1.

3. The method of claim 2, wherein the at least one housekeeping gene comprises TOX4 and TPT1.

4. The method of claim 3, wherein the normalized expression level is obtained by:

normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of TOX4, thereby obtaining a first normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2;

normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of TPT1, thereby obtaining a second normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2;

averaging the first normalized expression level and the second normalized expression level to obtain the normalized expression level.

5. The method of any one of claims 1-4, having a sensitivity of greater than 90%.

6. The method of any one of claims 1-5, having a specificity of greater than 90%.

7. The method of any one of claims 1-6, wherein the melanoma is progressive.

8. The method of any one of claims 1-7, wherein at least one of the at least 29 biomarkers is RNA, cDNA, or protein.

9. The method of claim 8, wherein when the biomarker is RNA, the RNA is reverse transcribed to produce cDNA, and the produced cDNA expression level is detected.
10. The method of any one of claims 1-9, wherein the expression level of the biomarker is detected by forming a complex between the biomarker and a labeled probe or primer.
11. The method of claim 10, wherein when the biomarker is protein, the protein is detected by forming a complex between the protein and a labeled antibody.
12. The method of claim 11, wherein the label is a fluorescent label.
13. The method of claim 8, wherein when the biomarker is RNA or cDNA, the RNA or cDNA is detected by forming a complex between the RNA or cDNA and a labeled nucleic acid probe or primer.
14. The method of claim 13, wherein the label is a fluorescent label.
15. The method of claim 13, wherein the complex between the RNA or cDNA and the labeled nucleic acid probe or primer is a hybridization complex.
16. The method of any one of claims 1-15, wherein the test sample is blood, serum, plasma, or neoplastic tissue.
17. The method of any one of claims 1-16, wherein the first predetermined cutoff value is derived from a plurality of reference samples obtained from subjects free of a neoplastic disease.
18. The method of claim 17, wherein each reference sample is blood, serum, plasma, or non-neoplastic tissue.
19. The method of any one of claims 1-18, further comprising treating the subject identified as having a melanoma with surgery or drug therapy.
20. The method of any one of claims 1-19, wherein the subject in need thereof is a subject diagnosed with a melanoma, a subject having at least one melanoma symptom, or a subject having a predisposition or familial history for developing a melanoma.
21. The method of any one of claims 1-20, wherein a subject is human.
22. The method of any one of claims 1-21, wherein the algorithm is XGB, RF, glmnet, cforest, CART, treebag, knn, nnet, SVM-radial, SVM-linear, NB, NNET, or mlp.

23. A method for determining whether a melanoma in a subject is stable or progressive, comprising:

determining the expression level of at least 29 biomarkers from a test sample from the subject by contacting the test sample with a plurality of agents specific to detect the expression of the at least 29 biomarkers, wherein the at least 29 biomarkers comprise ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, YY2, and at least one housekeeping gene;

normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of the at least one housekeeping gene, thereby obtaining a normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2;

inputting each normalized expression level into an algorithm to generate a score;

comparing the score with a second predetermined cutoff value; and

producing a report, wherein the report identifies that the melanoma is progressive when the normalized expression level is equal to or greater than the second predetermined cutoff value or identifies that the melanoma is stable when the normalized expression level is below the second predetermined cutoff value, wherein the second predetermined cutoff value is 50 on a scale of 0 to 100.

24. The method of claim 23, wherein the at least one housekeeping gene is selected from the group consisting of ALG9, SEPN, YWHAQ, VPS37A, PRRC2B, DOPEY2, NDUFB11, ND4,

MRPL19, PSMC4, SF3A1, PUM1, ACTB, GAPD, GUSB, RPLP0, TFRC, MORF4L1, 18S, PPIA, PGK1, RPL13A, B2M, YWHAZ, SDHA, HPRT1, TOX4, and TPT1.

25. The method of claim 24, wherein the at least one housekeeping gene comprises TOX4 and TPT1.

26. A method for evaluating the extent of surgical resection in a subject having a melanoma, comprising:

determining the expression level of at least 29 biomarkers from a test sample from the subject after the surgical resection by contacting the test sample with a plurality of agents specific to detect the expression of the at least 29 biomarkers, wherein the at least 29 biomarkers comprise ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, YY2, and at least one housekeeping gene;

normalizing the expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2 to the expression level of the at least one housekeeping gene, thereby obtaining a normalized expression level of each of ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2;

inputting each normalized expression level into an algorithm to generate a score;

comparing the score with a third predetermined cutoff value; and

producing a report, wherein the report identifies that the surgical resection does not remove the entire melanoma when the normalized expression level is equal to or greater than the third predetermined cutoff value or identifies that the surgical resection removes the entire

melanoma when the normalized expression level is below the third predetermined cutoff value, wherein the third predetermined cutoff value is 20 on a scale of 0 to 100.

27. The method of claim 26, wherein the report further identifies that the risk of melanoma recurrence is high when the normalized expression level is equal to or greater than the third predetermined cutoff value or identifies that the risk of melanoma recurrence is low when the normalized expression level is below the third predetermined cutoff value.

28. The method of claim 26, wherein the at least one housekeeping gene is selected from the group consisting of ALG9, SEPN, YWHAQ, VPS37A, PRRC2B, DOPEY2, NDUFB11, ND4, MRPL19, PSMC4, SF3A1, PUM1, ACTB, GAPD, GUSB, RPLP0, TFRC, MORF4L1, 18S, PPIA, PGK1, RPL13A, B2M, YWHAZ, SDHA, HPRT1, TOX4, and TPT1.

29. The method of claim 28, wherein the at least one housekeeping gene comprises TOX4 and TPT1.

30. A method for determining a response by a subject having a melanoma to a therapy, comprising:

determining a first expression level of at least 28 biomarkers from a first test sample from the subject at a first time point by contacting the first test sample with a plurality of agents specific to detect the expression of the at least 28 biomarkers, wherein the 28 biomarkers comprise ATL1, ATP6V0D, C1ORF21, CFLAR, CFLAR-AS1, CHP1, DDX55, DMD, DNAJC9, ENOSF1, FANCL, HJURP, HLA-DOA, HLA-DRA, HNRNPA3P1, IL23A, IQGAP1, LOC494127, LOC646471, LOH12CR, PBXIP1, RNF5, SERTAD2, SLC35G5, SPATS2L, TDRD7, TXK, and YY2;

determining a second expression level of the at least 28 biomarkers from a second test sample from the subject at a second time point by contacting the second test sample with a plurality of agents specific to detect the expression of the at least 28 biomarkers, wherein the second time point is after the first time point and after the administration of the therapy to the subject;

comparing the first expression level with the second expression level; and

producing a report, wherein the report identifies that the subject is responsive to the therapy when the second expression level is significantly decreased as compared to the first expression level.

31. The method of claim 30, wherein the first time point is prior to the administration of the therapy to the subject.

32. The method of claim 30, wherein the first time point is after the administration of the therapy to the subject.

33. The method of any one of claims 30-32, wherein the therapy comprises an immunotherapy.

34. The method of any one of claims 30-32, wherein the therapy comprises a targeted therapy.

35. The method of claim 34, wherein the targeted therapy comprises a BRAF inhibitor.

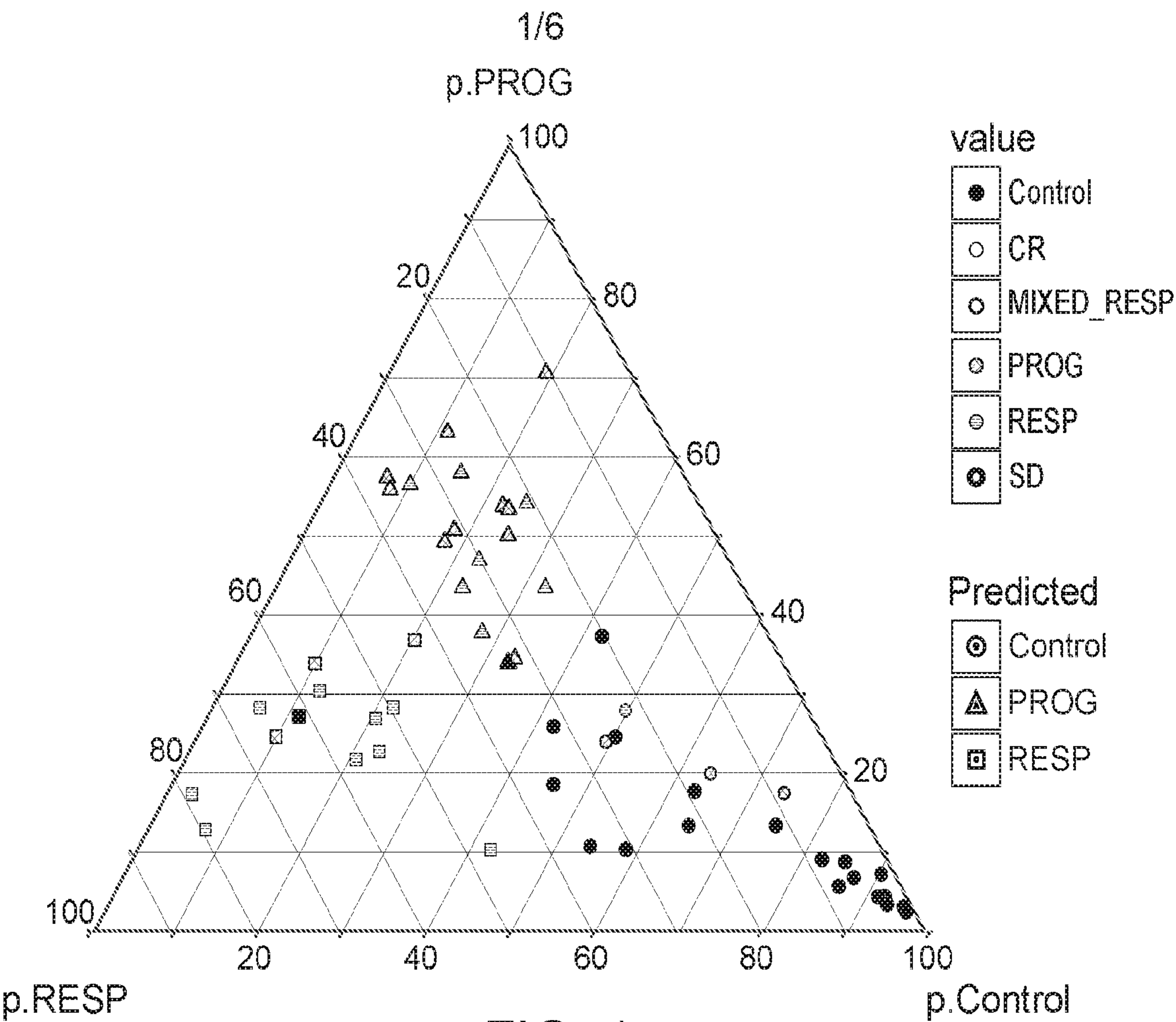


FIG. 1

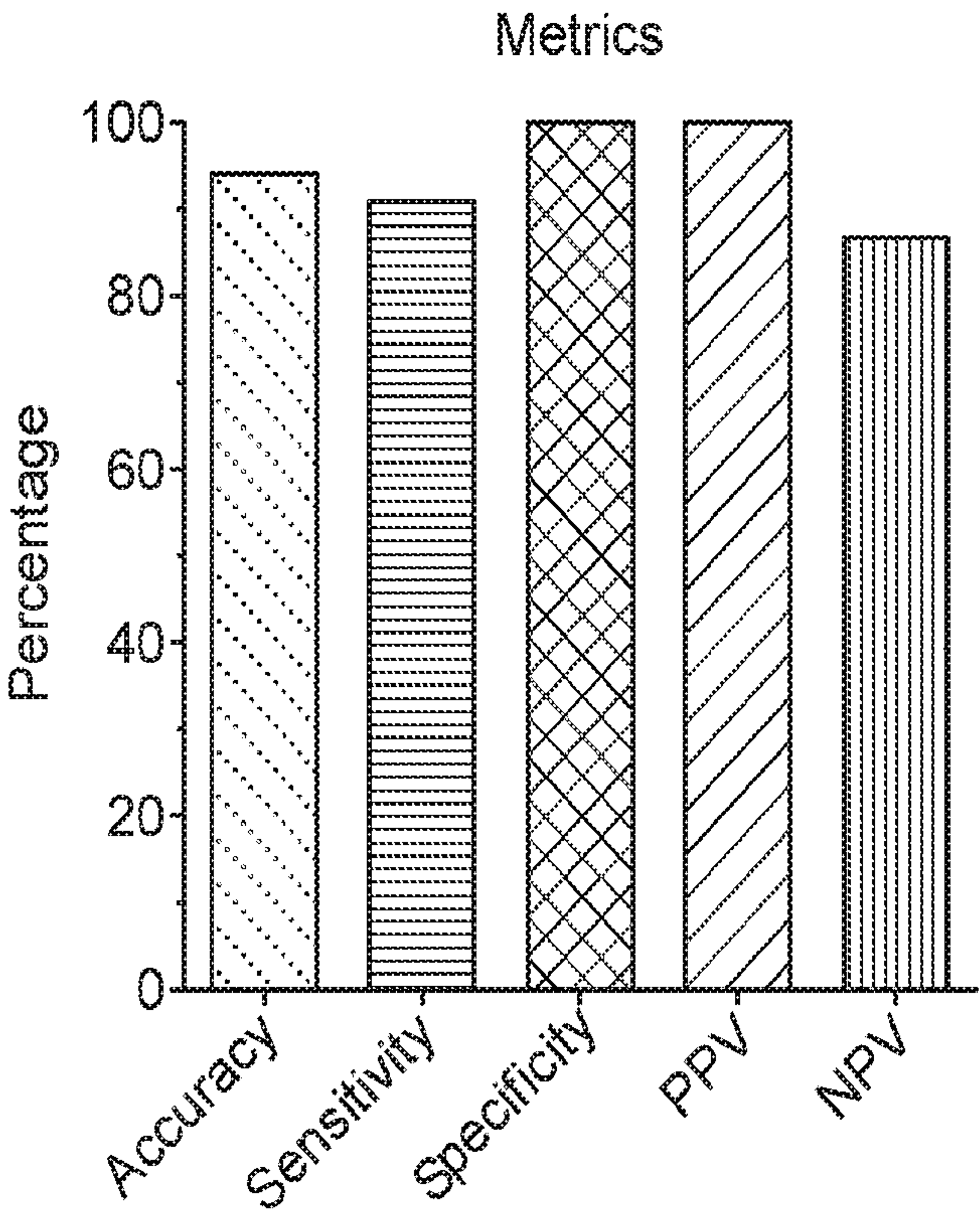


FIG. 2

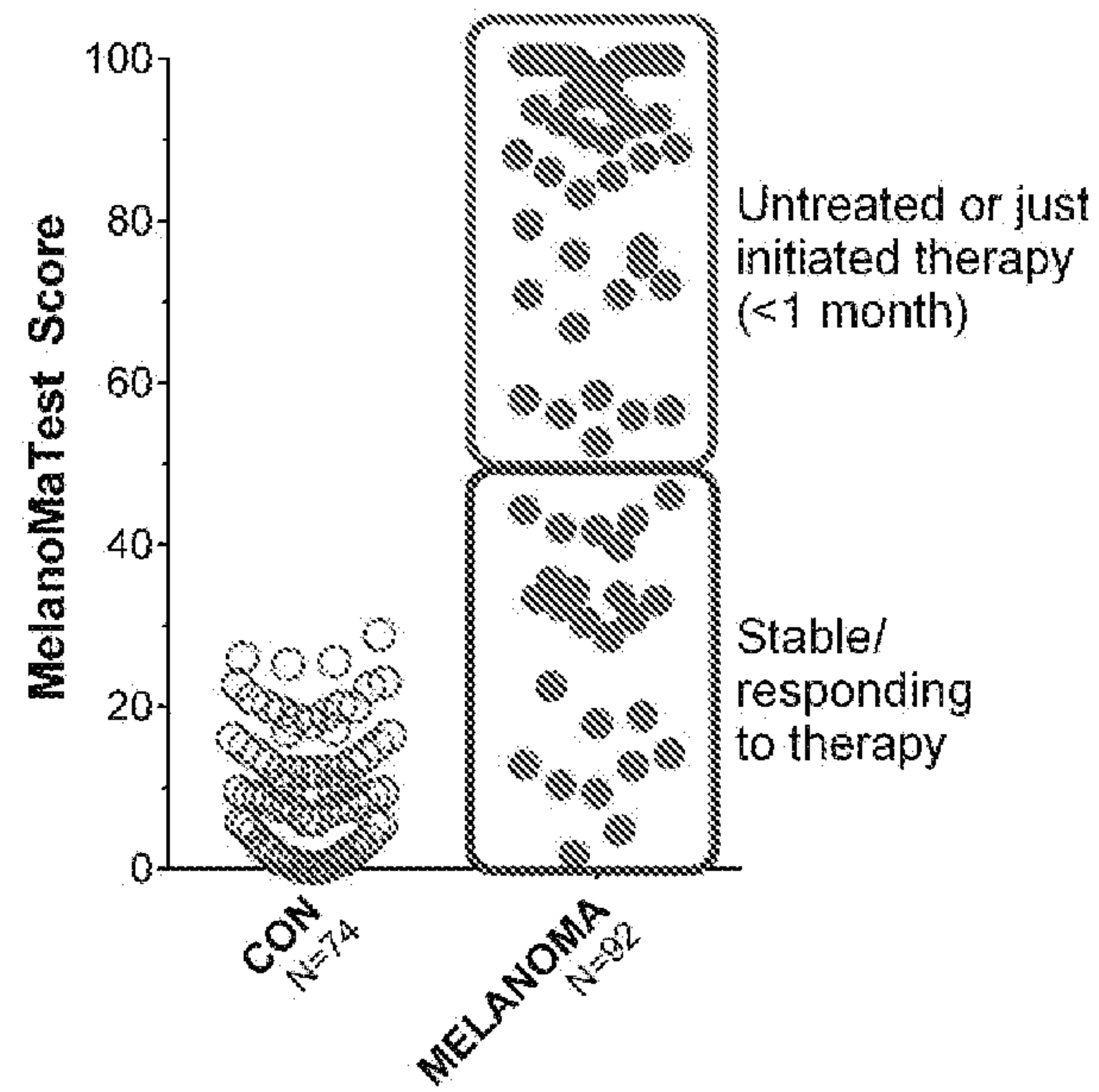


FIG. 3A

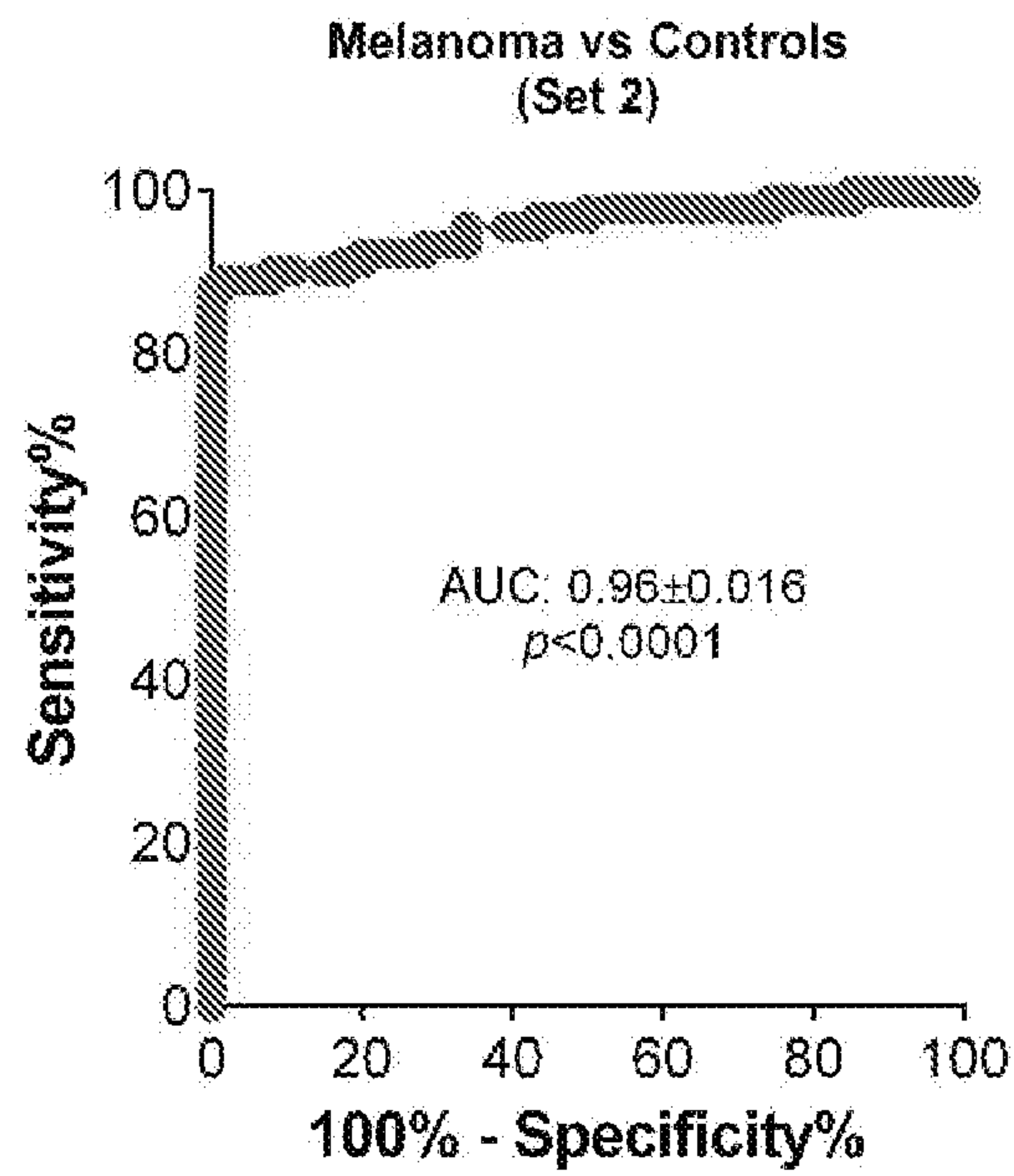


FIG. 3B

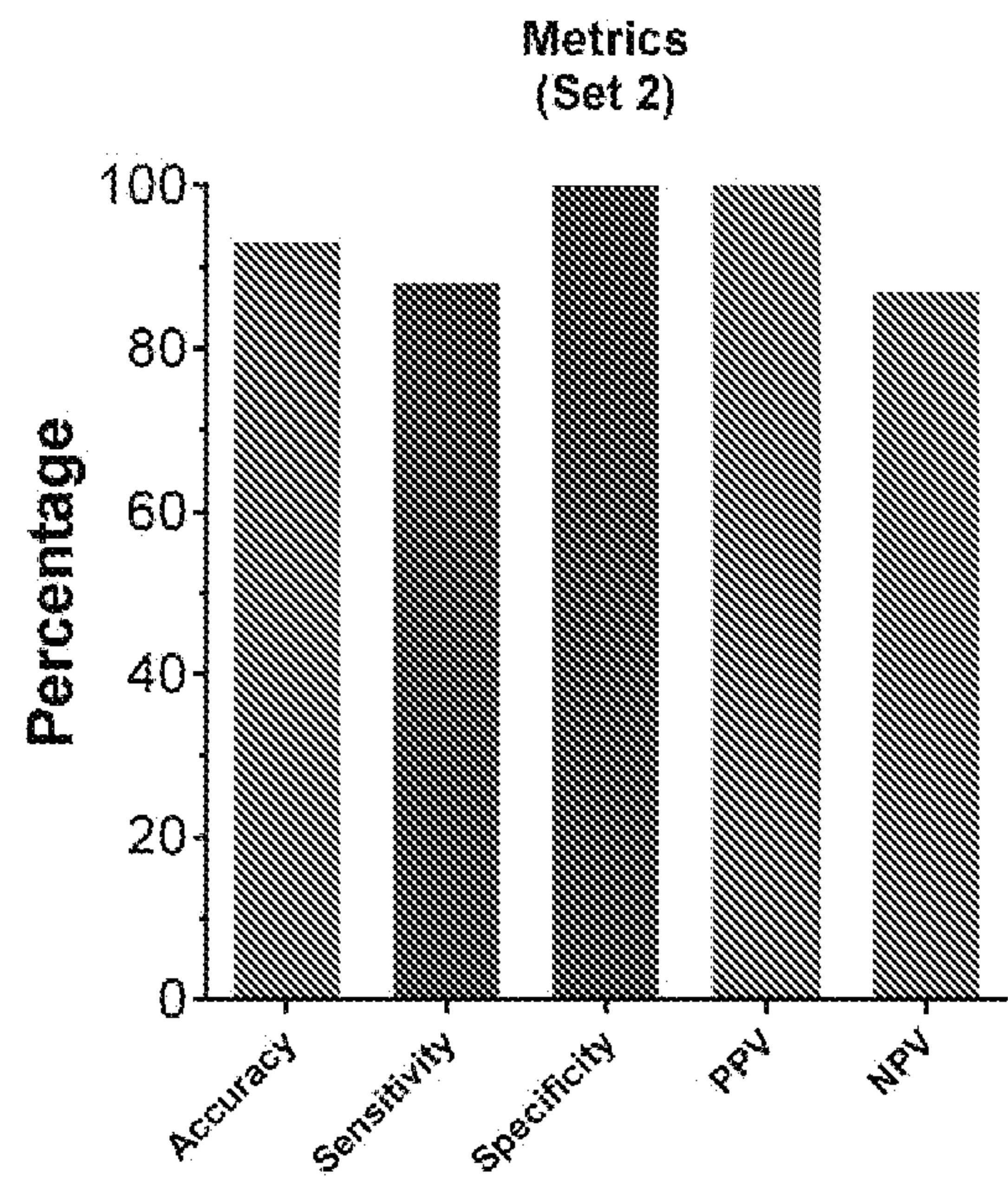


FIG. 3C

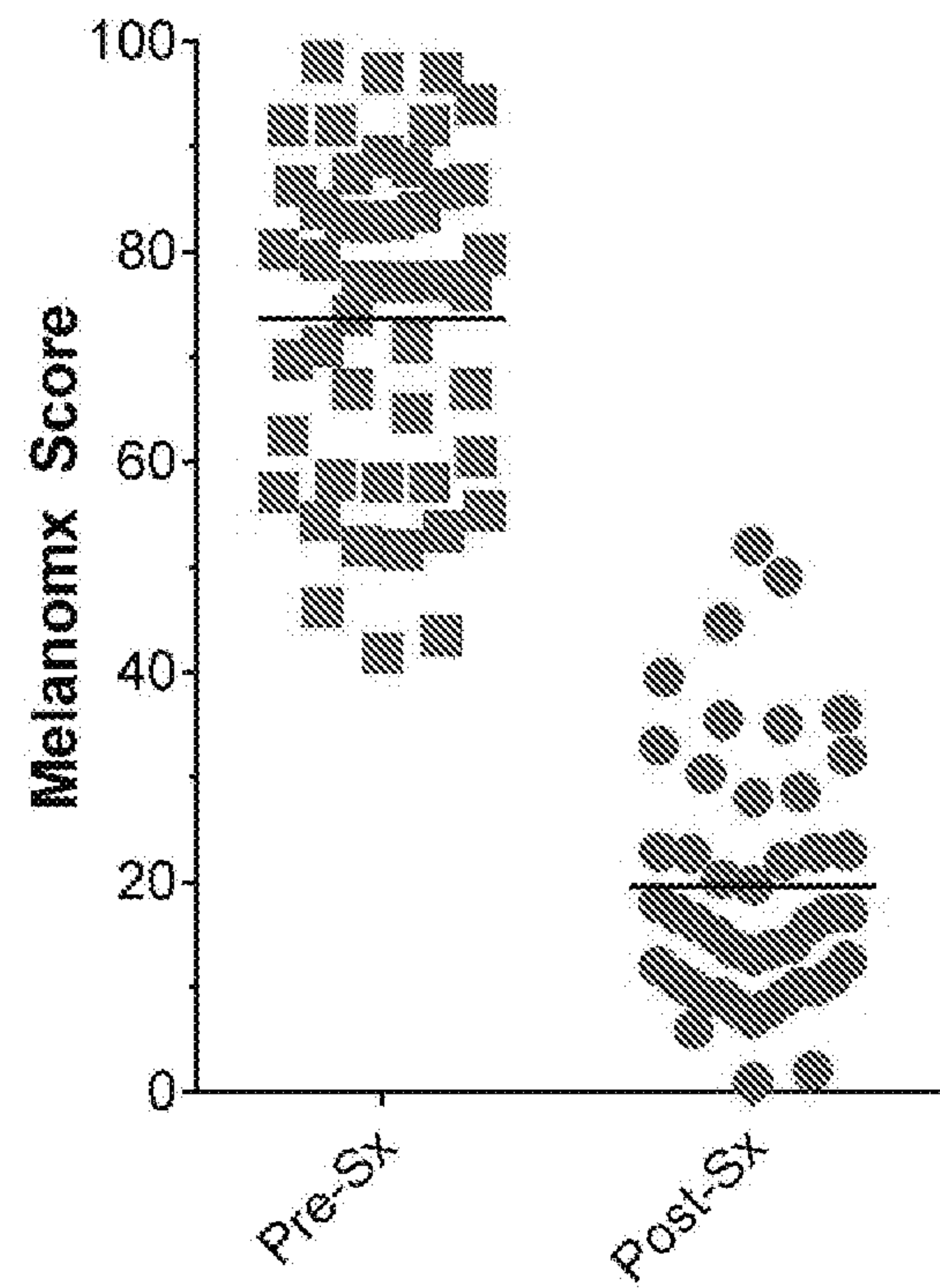


FIG. 4A

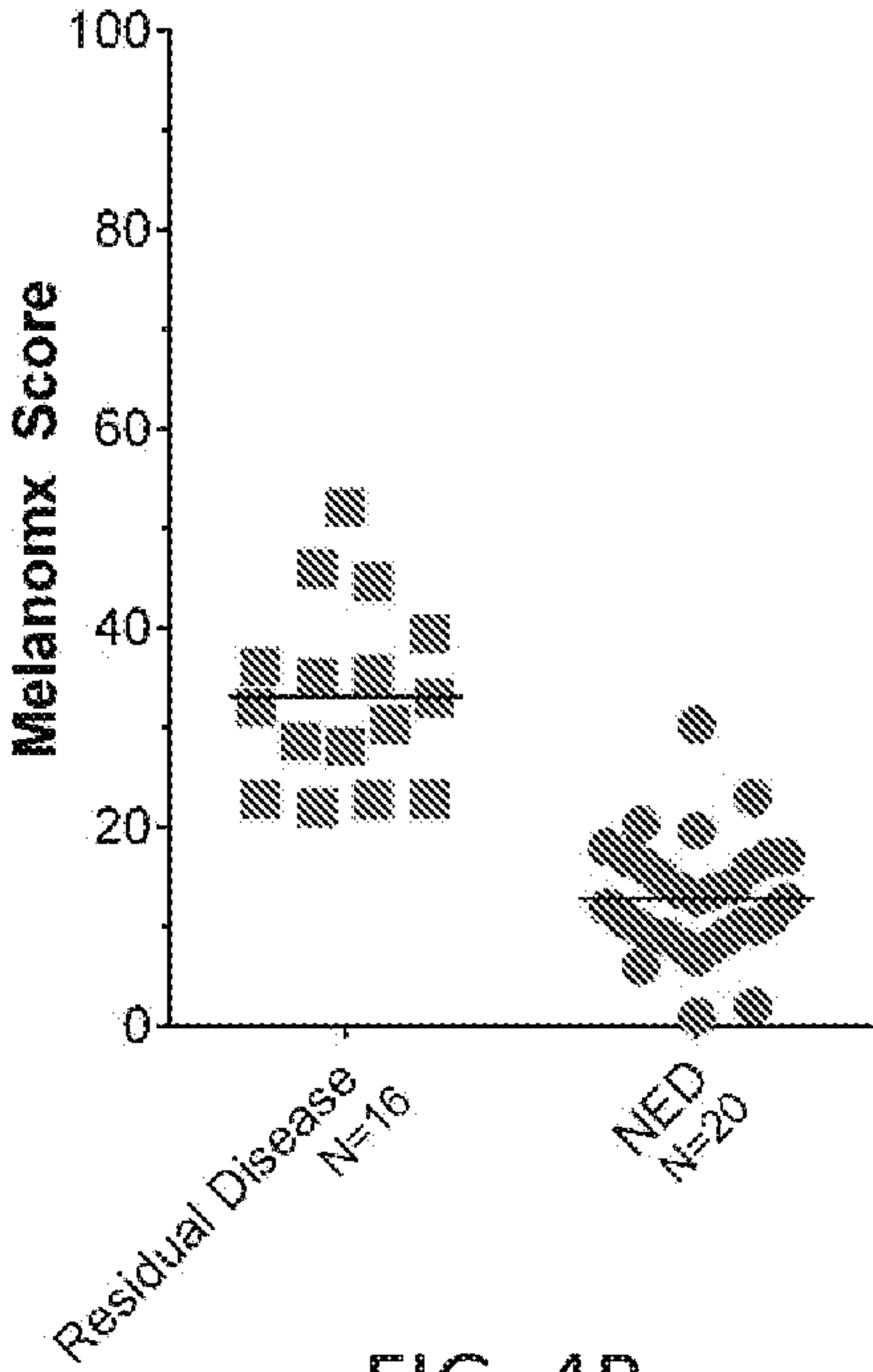


FIG. 4B

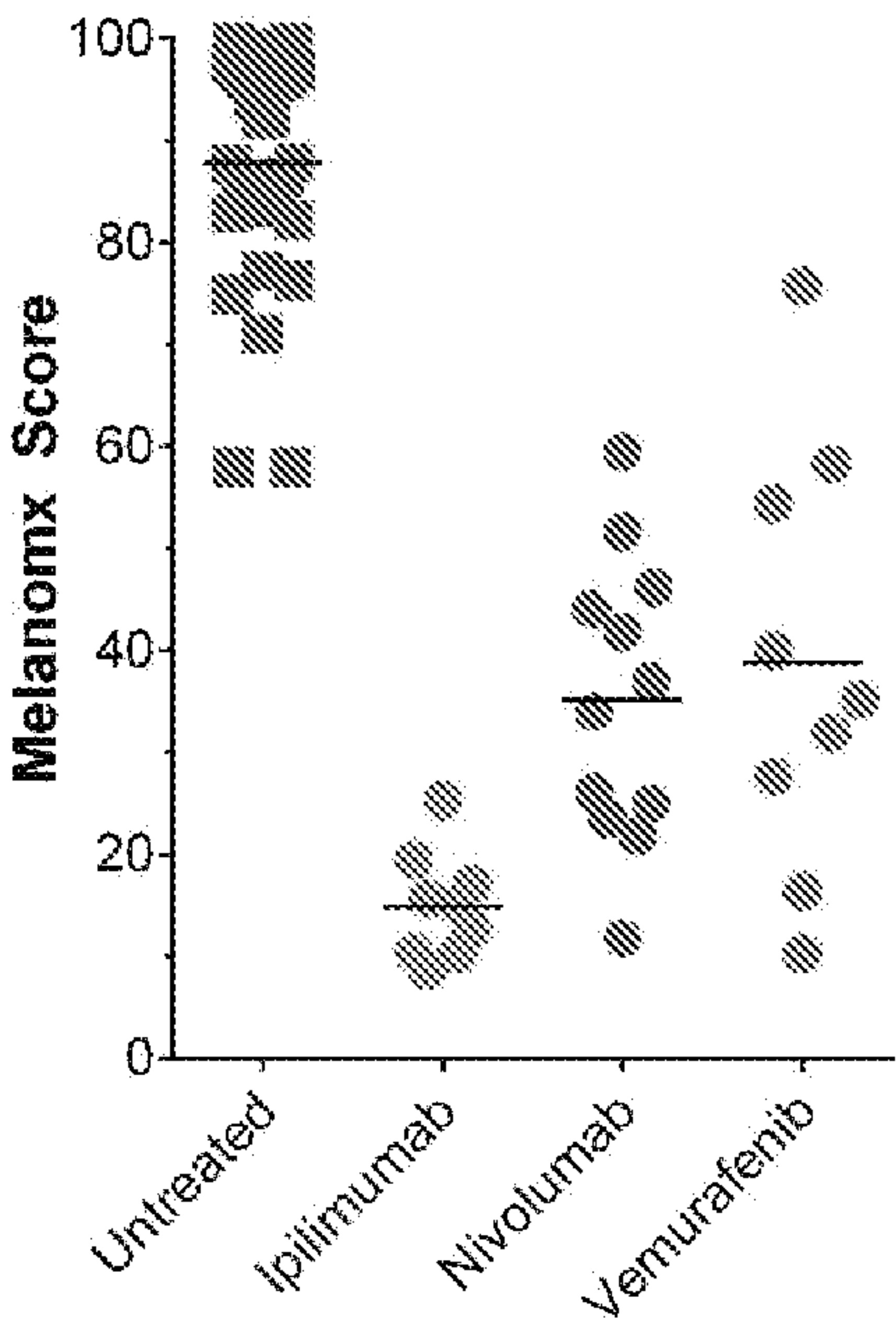


FIG. 5

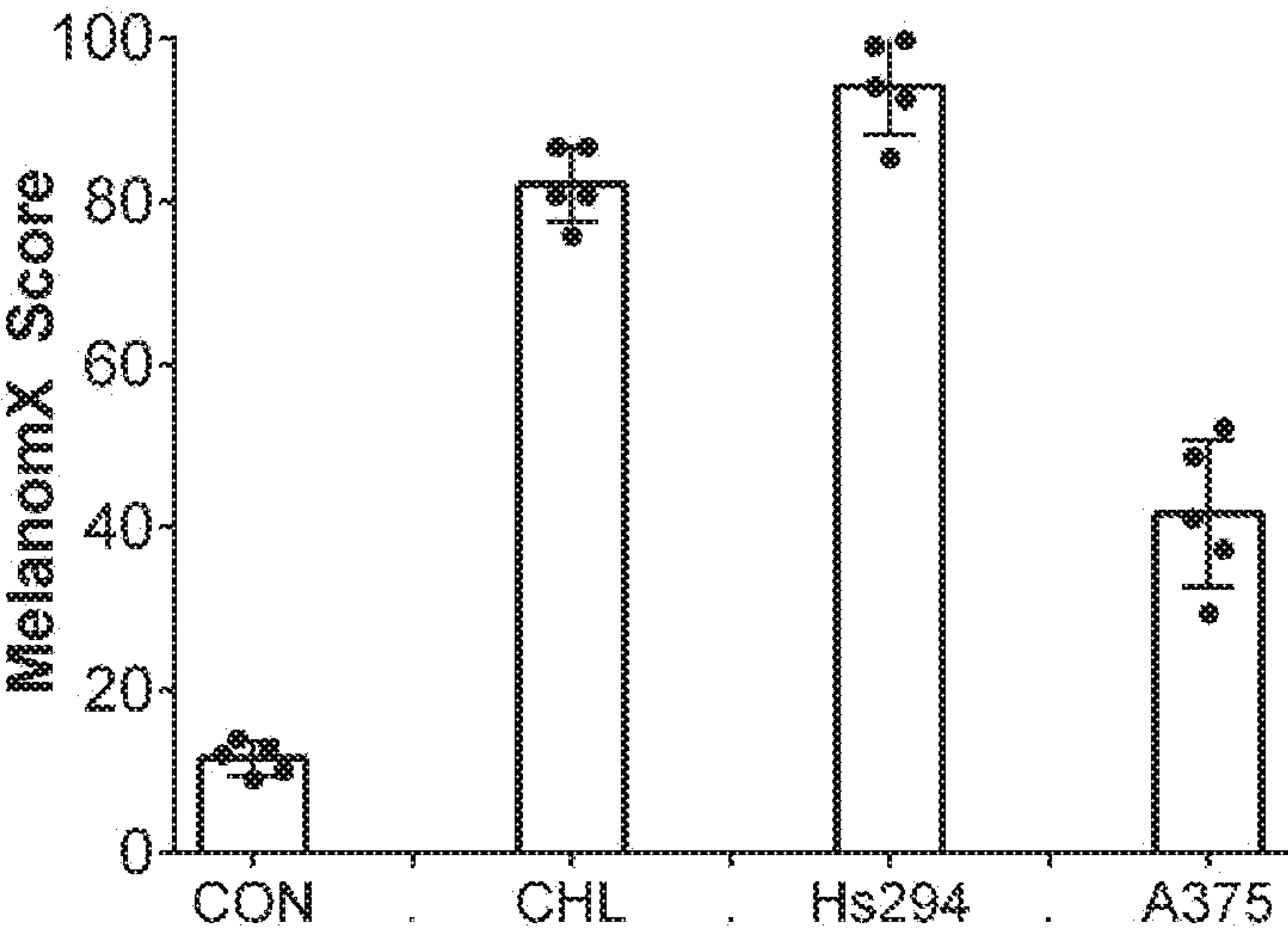


FIG. 6A

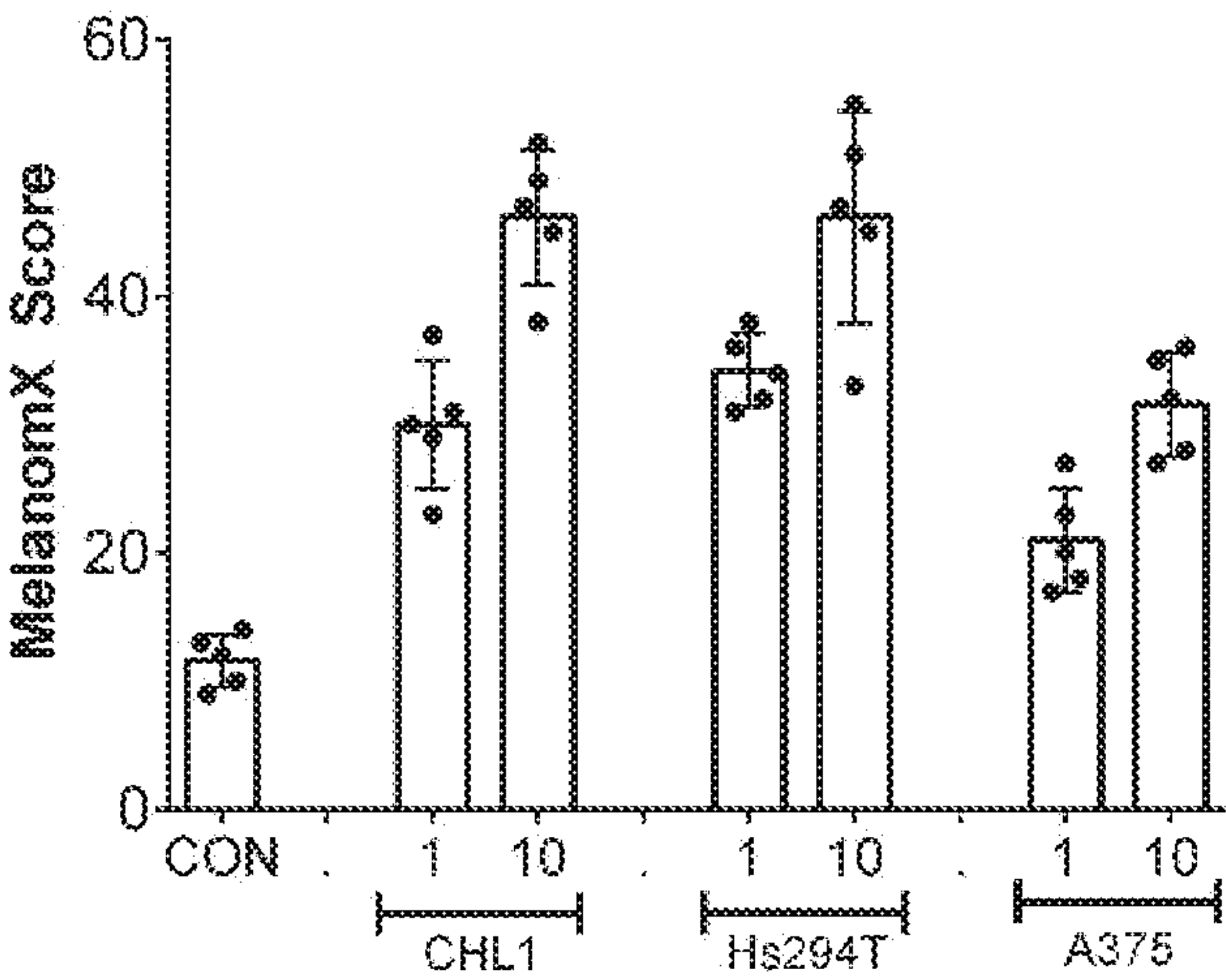


FIG. 6B

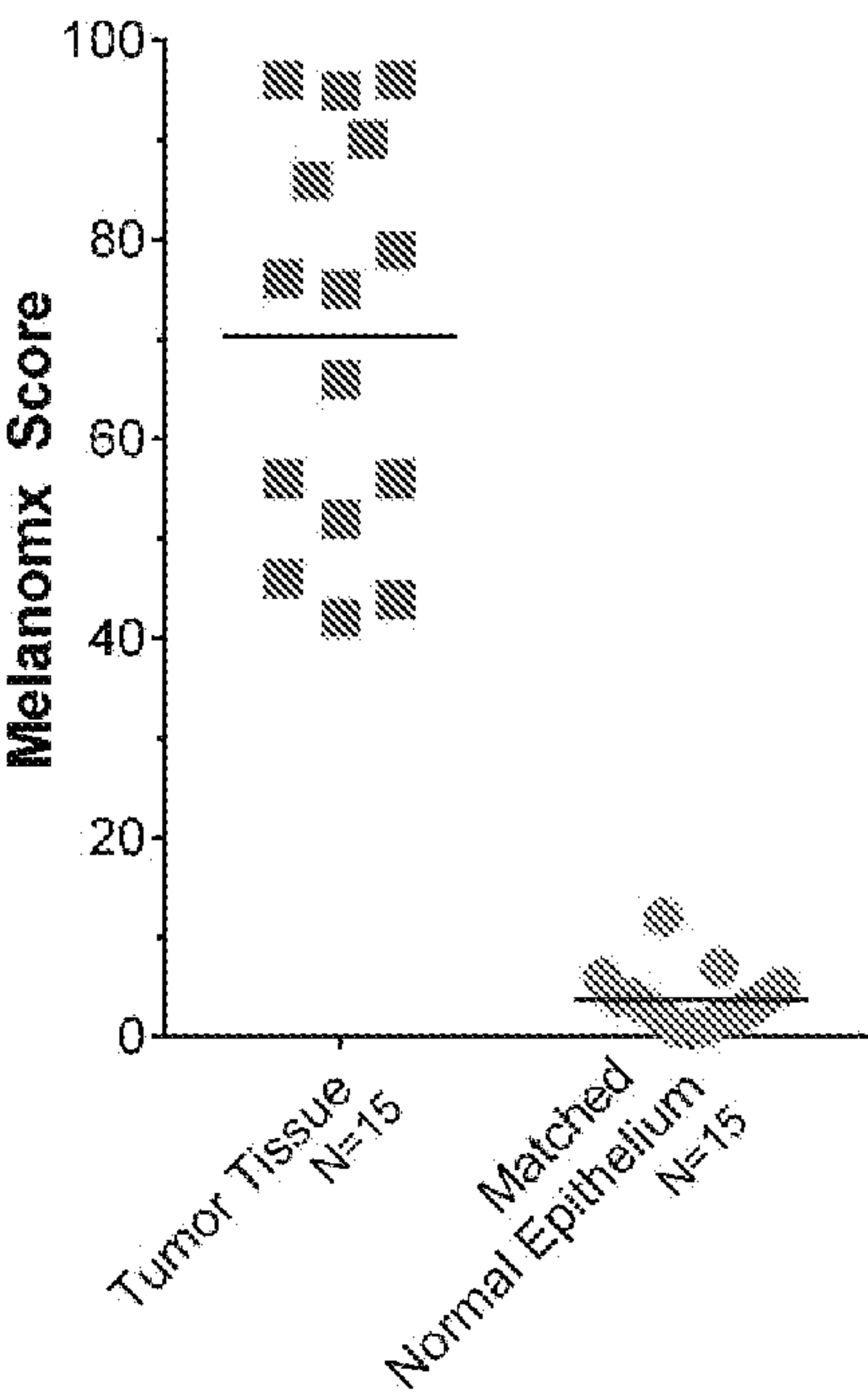


FIG. 7A

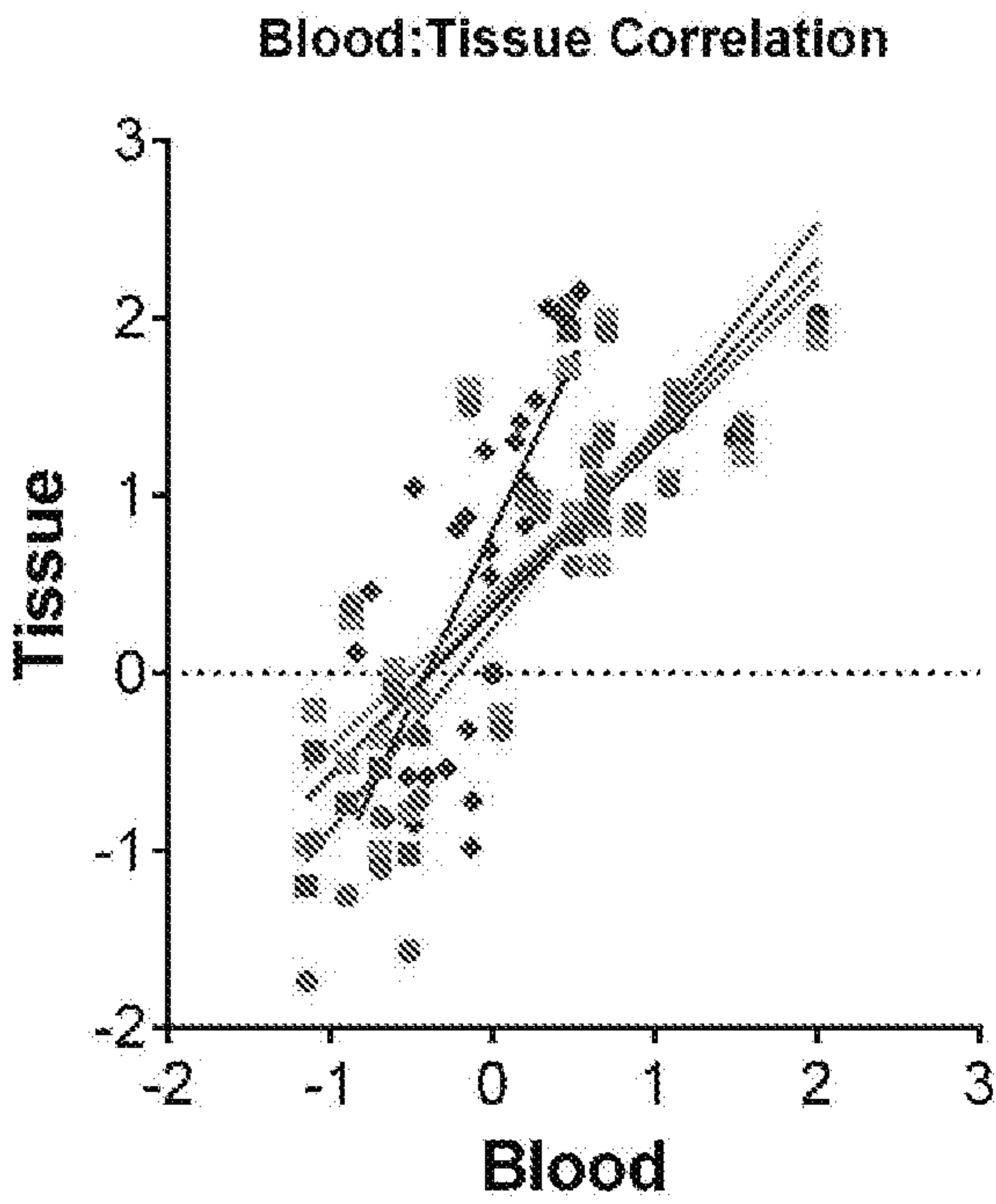


FIG. 7B

