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(57) Abrégé/Abstract:
The present invention concerns methods and compositions for identifying genes or genetic pathways modulated by miR-16, using miR-16 to modulate a gene or gene pathway, using this profile in assessing the condition of a patient and/or treating the patient with an appropriate miRNA.

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(54) Title: MIRNA REGULATED GENES AND PATHWAYS AS TARGETS FOR THERAPEUTIC INTERVENTION

(57) Abstract: The present invention concerns methods and compositions for identifying genes or genetic pathways modulated by miR-16, using miR-16 to modulate a gene or gene pathway, using this profile in assessing the condition of a patient and/or treating the patient with an appropriate miRNA.

DESCRIPTION

miRNA REGULATED GENES AND PATHWAYS AS TARGETS FOR THERAPEUTIC INTERVENTION

[0001] This application is related to U.S. Patent Applications serial number 11/141,707 filed May 31, 2005 and serial number 11/273,640 filed November 14, 2005, each of which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

I. FIELD OF THE INVENTION

[0002] The present invention relates to the fields of molecular biology and medicine. More specifically, the invention relates to methods and compositions for the treatment of diseases or conditions that are affected by miR-16 microRNAs, microRNA expression, and genes and cellular pathways directly and indirectly modulated by such.

II. BACKGROUND

[0003] In 2001, several groups used a cloning method to isolate and identify a large group of "microRNAs" (miRNAs) from *C. elegans*, *Drosophila*, and humans (Lagos-Quintana *et al.*, 2001; Lau *et al.*, 2001; Lee and Ambros, 2001). Several hundreds of miRNAs have been identified in plants and animals - including humans - which do not appear to have endogenous siRNAs. Thus, while similar to siRNAs, miRNAs are distinct.

[0004] miRNAs thus far observed have been approximately 21-22 nucleotides in length and they arise from longer precursors, which are transcribed from non-protein-encoding genes. See review of Carrington *et al.* (2003). The precursors form structures that fold back on themselves in self-complementary regions; they are then processed by the nuclease Dicer in animals or DCL1 in plants. miRNA molecules interrupt translation through precise or imprecise base-pairing with their targets.

[0005] Many miRNAs are conserved among diverse organisms, and this has led to the suggestion that miRNAs are involved in essential biological processes throughout the life span of an organism (Esquela-Kerscher and Slack, 2006). In particular, miRNAs have been implicated in regulating cell growth, and cell and tissue differentiation; cellular processes that are associated with the development of cancer. For instance, lin-4 and miR-16 both regulate

passage from one larval state to another during *C. elegans* development (Ambros, 2001). mir-14 and bantam are *Drosophila* miRNAs that regulate cell death, apparently by regulating the expression of genes involved in apoptosis (Brennecke *et al.*, 2003, Xu *et al.*, 2003).

[0006] Research on miRNAs is increasing as scientists are beginning to appreciate the broad role that these molecules play in the regulation of eukaryotic gene expression. In particular, several recent studies have shown that expression levels of numerous miRNAs are associated with various cancers (reviewed in Esquela-Kerscher and Slack, 2006). Reduced expression of two miRNAs correlates strongly with chronic lymphocytic leukemia in humans, providing a possible link between miRNAs and cancer (Calin *et al.*, 2002). Others have evaluated the expression patterns of large numbers of miRNAs in multiple human cancers and observed differential expression of almost all miRNAs across numerous cancer types (Lu *et al.*, 2005). Most studies link miRNAs to cancer only by indirect evidence. However, He *et al.* (2005) has provided more direct evidence that miRNAs may contribute directly to causing cancer by forcing the over-expression of six miRNAs in mice that resulted in a significant increase in B cell lymphomas.

[0007] Others have shown that miR-16 is down-regulated in B-cells from patients with chronic lymphocytic leukemia (Calin *et al.*, 2002). Reduced expression of these miRNAs in B cell lymphomas results in overexpression of a miR-16 target gene, BCL2, and subsequent inhibition of apoptosis by the BCL2 gene product. This results in uncontrolled cellular proliferation and B cell malignancy (reviewed in Calin and Croce, 2006). Together these data suggest that miR-16-1 appears to function as a tumor suppressor in human B cells.

[0008] The inventors previously demonstrated that hsa-miR-16 is involved with the regulation of numerous cell activities that represent intervention points for cancer therapy and for therapy of other diseases and disorders (U.S. Patent Applications serial number 11/141,707 filed May 31, 2005 and serial number 11/273,640 filed November 14, 2005). Expression of miR-16 was reduced in lung tumors from numerous lung cancer patients when compared to its expression in normal adjacent lung tissues from the same patients. The inventors observed increased expression of miR-16 in breast and prostate tumors as compared to expression in adjacent normal cells from the same cancer patients. In human foreskin fibroblasts, hsa-miR-16 activated the hTert gene that encodes the catalytic domain of telomerase. Over 90% of human cancer samples have active telomerase (reviewed in Dong *et al.*, 2005). Hsa-miR-16 also induces cells to enter the S phase of the cell cycle and

decreases the proliferation of lung cancer cells (A549 and HTB-57 lung carcinoma cells), prostate cancer cells (22Rv1), and human basal cell carcinomas (TE354T). Anti-miR inhibitors of hsa-miR-16 increased the proliferation of non-malignant human breast epithelial cells and basal cell carcinoma cells (TE354T). In addition, the inventors previously observed that hsa-miR-16 is up-regulated in patients with prion disease and Alzheimer's disease when compared to patients without those diseases. As is the case for cancer therapy, genes and pathways that are altered by expression of hsa-miR-16 represent targets for therapeutic intervention in the treatment of certain diseases like Alzheimer's Disease and prion diseases, in which hsa-miR-16 likely plays a role.

[0009] In animals, most miRNAs are thought to interact with target genes through imprecise base pairing within the 3' untranslated regions of their gene targets. Regulation of target genes by miRNAs is thought to occur primarily by translation inhibition, but mRNA instability may also be a mechanism (Reinhart *et al.*, 2000; Bagga *et al.*, 2005). Bioinformatics analyses suggest that any given miRNA may bind to and alter the expression of up to several hundred different genes. In addition, a single gene may be regulated by several miRNAs. Thus, each miRNA may regulate a complex interaction among genes, gene pathways, and gene networks. Mis-regulation or alteration of these regulatory pathways and networks, involving miRNAs, are likely to contribute to the development of disorders and diseases such as cancer. Although bioinformatics tools are helpful in predicting miRNA binding targets, all have limitations. Because of the imperfect complementarity with their target binding sites, it is difficult to accurately predict miRNA targets with bioinformatics tools alone. Furthermore, the complicated interactive regulatory networks among miRNAs and target genes make it difficult to accurately predict which genes will actually be mis-regulated in response to a given miRNA.

[0010] Correcting gene expression errors by manipulating miRNA expression or by repairing miRNA mis-regulation represent promising methods to repair genetic disorders and cure diseases like cancer. A current, disabling limitation of this approach is that, as mentioned above, the details of the regulatory pathways and networks that are affected by any given miRNA remain largely unknown. Besides BCL2, the genes, gene pathways, and gene networks that are regulated by miR-16 in cancerous cells remain largely unknown. Currently, this represents a significant limitation for treatment of cancers in which miR-16

may play a role. A need exists to identify the genes, genetic pathways, and genetic networks that are regulated by or that may regulate hsa-miR-16 expression.

SUMMARY OF THE INVENTION

[0011] The present invention provides additional compositions and methods to address problems in the art by identifying genes in cancer cells that are direct targets for hsa-miR-16 regulation or that are downstream targets of regulation following the hsa-miR-16-mediated modification of upstream gene expression. Furthermore, the invention describes gene, disease, and/or physiologic pathways and networks that are influenced by hsa-miR-16. Many of these genes and pathways are associated with various cancers and other diseases. The altered expression of miR-16 in cells would lead to changes in the expression of these key genes and contribute to the development of disease. Introducing miR-16 (for diseases where the miRNA is down-regulated) or a miR-16 inhibitor (for diseases where the miRNA is up-regulated) into disease cells or tissues would result in a therapeutic response. The identities of key genes that are regulated directly or indirectly by miR-16 and the disease with which they are associated are provided herein. In certain aspects a cell may be an epithelial, stromal, or mucosal cell. The cell can be, but is not limited to brain, a neuronal, a blood, an esophageal, a lung, a cardiovascular, a liver, a breast, a bone, a thyroid, a glandular, an adrenal, a pancreatic, a stomach, a intestinal, a kidney, a bladder, a prostate, a uterus, an ovarian, a testicular, a splenic, a skin, a smooth muscle, a cardiac muscle, or a striated muscle cell. In certain aspects, the cell, tissue, or target may not be defective in miRNA expression yet may still respond therapeutically to expression or over expression of a miRNA. miR-16 could be used as a therapeutic target for any of these diseases. In certain aspects, compositions of the invention are administered to a subject having, suspected of having, or at risk of developing a metabolic, an immunologic, an infectious, a cardiovascular, a digestive, an endocrine, an ocular, a genitourinary, a blood, a musculoskeletal, a nervous system, a congenital, a respiratory, a skin, or a cancerous disease or condition.

[0012] In particular aspects, a subject or patient may be selected for treatment based on expression and/or aberrant expression of one or more miRNA or mRNA. In a further aspect, a subject or patient may be selected for treatment based on aberrations in one or more biologic or physiologic pathway(s), including aberrant expression of one or more gene associated with a pathway, or the aberrant expression of one or more protein encoded by one or more gene associated with a pathway. In still a further aspect, a subject or patient may be

selected based on aberrations in miRNA expression, or biologic and/or physiologic pathway(s). A subject may be assessed for sensitivity, resistance, and/or efficacy of a therapy or treatment regime based on the evaluation and/or analysis of miRNA or mRNA expression or lack thereof. A subject may be evaluated for amenability to certain therapy prior to, during, or after administration of one or therapy to a subject or patient. Typically, evaluation or assessment may be done by analysis of miRNA and/or mRNA, as well as combination of other assessment methods that include but are not limited to histology, immunohistochemistry, blood work, etc.

[0013] In some embodiments, an infectious disease or condition includes a bacterial, viral, parasite, or fungal infection. Many of these genes and pathways are associated with various cancers and other diseases. Cancerous conditions include, but are not limited to anaplastic large cell lymphoma, B-cell lymphoma, chronic lymphoblastic leukemia, multiple myeloma, testicular tumor, astrocytoma, acute myelogenous leukemia, breast carcinoma, bladder carcinoma, cervical carcinoma, colorectal carcinoma, endometrial carcinoma, esophageal squamous cell carcinoma, glioma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, Hodgkin lymphoma, leukemia, lipoma, melanoma, mantle cell lymphoma, myxofibrosarcoma, multiple myeloma, neuroblastoma, non-Hodgkin lymphoma, lung carcinoma, non-small cell lung carcinoma, ovarian carcinoma, esophageal carcinoma, osteosarcoma, pancreatic carcinoma, prostate carcinoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, urothelial carcinoma wherein the modulation of one or more gene is sufficient for a therapeutic response. Typically a cancerous condition is an aberrant hyperproliferative condition associated with the uncontrolled growth or inability to undergo cell death, including apoptosis.

[0014] A cell, tissue, or subject may be a cancer cell, a cancerous tissue, harbor cancerous tissue, or be a subject or patient diagnosed or at risk of developing a disease or condition.. In certain aspects a cancer cell is a neuronal, glial, lung, liver, brain, breast, bladder, blood, leukemic, colon, endometrial, stomach, skin, ovarian, fat, bone, cervical, esophageal, pancreatic, prostate, kidney, testicular or thyroid cell. In still a further aspect cancer includes, but is not limited to anaplastic large cell lymphoma, B-cell lymphoma, chronic lymphoblastic leukemia, multiple myeloma, testicular tumor, astrocytoma, acute myelogenous leukemia, breast carcinoma, bladder carcinoma, cervical carcinoma, colorectal carcinoma, endometrial carcinoma, esophageal squamous cell carcinoma, glioma, glioblastoma, gastric carcinoma,

hepatocellular carcinoma, Hodgkin lymphoma, leukemia, lipoma, melanoma, mantle cell lymphoma, myxofibrosarcoma, multiple myeloma, neuroblastoma, non-Hodgkin lymphoma, lung carcinoma, non-small cell lung carcinoma, ovarian carcinoma, esophageal carcinoma, osteosarcoma, pancreatic carcinoma, prostate carcinoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, urothelial carcinoma.

[0015] In certain aspects, the gene or genes modulated comprises 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 25, 30, 35, 40, 45, 50, 100, 150, 200 or more genes or any combination of genes identified in Table 1, 2, 4 and 5. In certain aspects the expression of a gene is down-regulated or up-regulated. In a particular aspect the gene modulated comprises or is selected from (and may even exclude) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31 or all of genes identified in Table 1, 2, 4 and 5, in various combinations and permutations. In particular embodiments, the invention may exclude or choose not to include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 25, 30, 35, 40, 45, 50, 100, 150, 200 or more genes or any combination of genes identified in Table 1, 2, 4 and 5, *e.g.*, BCL2, RARS (arginyl-tRNA synthetase), BTG2, WT1, PPM1D, PAK7, and/or RAB9B. In one particular aspect the gene modulated or selected to modulate includes one or more genes of Table 1, 2, 4 and/or 5 provided that RARS (arginyl-tRNA synthetase), BTG2, WT1, PPM1D, PAK7, and/or RAB9B is not included.

[0016] Embodiments of the invention include methods of modulating gene expression, or biologic or physiologic pathways in a cell, a tissue, or a subject comprising administering to the cell, tissue, or subject an amount of an isolated nucleic acid or mimetic thereof comprising a miR-16 nucleic acid, mimetic, or inhibitor sequence in an amount sufficient to modulate the expression of a gene positively or negatively modulated by a miR-16 miRNA. A "miR-16 nucleic acid sequence" or "miR-16 inhibitor" includes the full length precursor of miR-16, or complement thereof or processed (*i.e.,* mature) sequence of miR-16 and related sequences set forth herein, as well as 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or more nucleotides of a precursor miRNA or its processed sequence, or complement thereof, including all ranges and integers there between. In certain embodiments, the miR-16 nucleic acid sequence or miR-16 inhibitor contains the full-length processed miRNA sequence or complement thereof and is referred to as the "miR-16 full-length processed nucleic acid sequence" or "miR-16 full-length processed inhibitor sequence." In still further aspects, the miR-16 nucleic acid comprises at least one 5, 6, 7, 8,

9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 50 nucleotide (including all ranges and integers there between) segment or complementary segment of a miR-16 that is at least 75, 80, 85, 90, 95, 98, 99 or 100% identical to SEQ ID NOs provided herein. The general term miR-16 includes all members of the miR-16 family that share at least part of a mature miR-16 sequence. In still further aspects, the miR-16 nucleic acid comprises at least one 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 232, 24, 25, 50 nucleotide (including all ranges and integers there between) segment of miR-16 that is at least 75, 80, 85, 90, 95, 98, 99 or 100% identical to SEQ ID NOs:1-3 (SEQ ID NO:1 uagcagcacguaaauauuggcg (accession - MIMAT0000069), SEQ ID NO:2 (hsa-mir-16-1, accession - MI0000070) gucagcagugccuuagcagcacguaaauauuggcguuaagauucuaaaauuau cuccaguauuaacugugcugcugaaguaaggguugac; SEQ ID NO:3 (hsa-mir-16-2, accession MI0000115) guuccacucuagcagcacguaaauauuggcguagugaaauauauauuaaacaccaauauuacug ugcugcuuuagugugac). In certain embodiments the gene modulated or selected to modulate is from Table 1. In further embodiments the gene modulated or selected to modulate is from Table 2. In still further embodiments the gene modulated or selected to modulate is from Table 4. In yet further embodiments the gene modulated or selected to modulate is from Table 5. Embodiments of the invention may also include obtaining or assessing a gene expression profile or miRNA profile of a target cell prior to selecting the mode of treatment, *e.g.*, administration of a miR-16 nucleic acid.

[0017] In certain aspects, a miR-16 nucleic acid, or a segment or a mimetic thereof, will comprise 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or more nucleotides of the precursor miRNA or its processed sequence, including all ranges and integers there between. In certain embodiments, the miR-16 nucleic acid sequence contains the full-length processed miRNA sequence and is referred to as the "miR-16 full-length processed nucleic acid sequence." In still further aspects, a miR-16 comprises at least one 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 50 nucleotide (including all ranges and integers there between) segment of miR-16 that is at least 75, 80, 85, 90, 95, 98, 99 or 100% identical to SEQ ID NOs provided herein.

[0018] In specific embodiments, a miR-16 or miR-16 inhibitor containing nucleic acid is a hsa-miR-16 or hsa-miR-16 inhibitor, or a variation thereof. In a further aspect, a miR-16 nucleic acid or miR-16 inhibitor can be administered with 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 or more miRNAs or miRNA inhibitors. miRNAs or their complements can be administered

concurrently, sequentially, or in an ordered progression. In certain aspects, a miR-16 or miR-16 inhibitor can be administered in combination with one or more of let-7, miR-15, miR-126, miR-20, miR-21, miR-26a, miR-34a, miR-143, miR-147, miR-188, miR-200, miR-215, miR-216, miR-292-3p, and/or miR-331. All or combinations of miRNAs or inhibitors thereof may be administered in a single formulation. Administration may be before, during or after a second therapy.

[0019] miR-16 nucleic acids or complement thereof may also include various heterologous nucleic acid sequences, *i.e.*, those sequences not typically found operatively coupled with miR-16 in nature, such as promoters, enhancers, and the like. The miR-16 nucleic acid is a recombinant nucleic acid, and can be a ribonucleic acid or a deoxyribonucleic acid. The recombinant nucleic acid may comprise a miR-16 or miR-16 inhibitor expression cassette, *i.e.*, a nucleic acid segment that expresses a nucleic acid when introduce into an environment containing components for nucleic acid synthesis. In a further aspect, the expression cassette is comprised in a viral vector, or plasmid DNA vector or other therapeutic nucleic acid vector or delivery vehicle, including liposomes and the like. In a particular aspect, the miR-16 nucleic acid is a synthetic nucleic acid. Moreover, nucleic acids of the invention may be fully or partially synthetic. In certain aspects, viral vectors can be administered at $1x10^2$, $1x10^3$, $1x10^4$ $1x10^5$, $1x10^6$, $1x10^7$, $1x10^8$, $1x10^9$, $1x10^{10}$, $1x10^{11}$, $1x10^{12}$, $1x10^{13}$, $1x10^{14}$ pfu or viral particle (vp).

[0020] In a particular aspect, the miR-16 nucleic acid or miR-16 inhibitor is a synthetic nucleic acid. Moreover, nucleic acids of the invention may be fully or partially synthetic. In still further aspects, a nucleic acid of the invention or a DNA encoding such a nucleic acid of the invention can be administered at 0.001, 0.01, 0.1, 1, 10, 20, 30, 40, 50, 100, 200, 400, 600, 800, 1000, 2000, to 4000 μg or mg, including all values and ranges there between. In yet a further aspect, nucleic acids of the invention, including synthetic nucleic acid, can be administered at 0.001, 0.01, 0.1, 1, 10, 20, 30, 40, 50, 100, to 200 μg or mg per kilogram (kg) of body weight. Each of the amounts described herein may be administered over a period of time, including 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, minutes, hours, days, weeks, months or years, including all values and ranges there between.

[0021] In certain embodiments, administration of the composition(s) can be enteral or parenteral. In certain aspects, enteral administration is oral. In further aspects, parenteral administration is intralesional, intravascular, intracranial, intrapleural, intratumoral,

intraperitoneal, intramuscular, intralymphatic, intraglandular, subcutaneous, topical, intrabronchial, intratracheal, intranasal, inhaled, or instilled. Compositions of the invention may be administered regionally or locally and not necessarily directly into a lesion.

[0022] A cell, tissue, or subject may be or suffer from an abnormal or pathologic condition, or in the case of a cell or tissue, the component of a pathological condition. In certain aspects, a cell, tissue, or subject is a cancer cell, a cancerous tissue or harbor cancerous tissue, or a cancer patient. In a particular aspect the cancer is neuronal, glial, lung, liver, brain, breast, bladder, blood, leukemic, colon, endometrial, stomach, skin, ovarian, esophageal, pancreatic, prostate, kidney, or thyroid cancer. The database content related to all nucleic acids and genes designated by an accession number or a database submission are incorporated herein by reference as of the filing date of this application.

[0023] A further embodiment of the invention is directed to methods of modulating a cellular pathway comprising administering to the cell an amount of an isolated nucleic acid comprising a miR-16 nucleic acid sequence in an amount sufficient to modulate the expression, function, status, or state of a cellular pathway, in particular those pathways described in Table 2 or the pathways known to include one or more genes from Table 1, 3, 4, and/or 5. Modulation of a cellular pathway includes, but is not limited to modulating the expression of one or more gene. Modulation of a gene can include inhibiting the function of an endogenous miRNA or providing a functional miRNA to a cell, tissue, or subject. Modulation refers to the expression levels or activities of a gene or its related gene product or protein, *e.g.*, the mRNA levels may be modulated or the translation of an mRNA may be modulated, *etc.* Modulation may increase or up regulate a gene or gene product or it may decrease or down regulate a gene or gene product.

[0024] Still a further embodiment includes methods of treating a patient with a pathological condition comprising one or more of step (a) administering to the patient an amount of an isolated nucleic acid comprising a miR-16 nucleic acid sequence in an amount sufficient to modulate the expression of a cellular pathway; and (b) administering a second therapy, wherein the modulation of the cellular pathway sensitizes the patient to the second therapy. A cellular pathway may include, but is not limited to one or more pathway described in Table 2 below or a pathway that is known to include one or more gene of Table 1, 3, 4, and/or 5. A second therapy can include a second miRNA or other nucleic acid

therapy or one or more standard therapies, such as chemotherapy, drug therapy, radiation therapy, immunotherapy, thermal therapy, and the like.

[0025] Embodiments of the invention include methods of treating a subject with a pathological condition comprising one or more of the steps of (a) determining an expression profile of one or more genes selected from Table 1, 3, 4, and/or 5; (b) assessing the sensitivity of the subject to therapy based on the expression profile; (c) selecting a therapy based on the assessed sensitivity; and (d) treating the subject using selected therapy. Typically, the pathological condition will have as a component, indicator, or result the mis-regulation of one or more gene of Table 1, 3, 4, and/or 5.

[0026] Further embodiments include the identification and assessment of an expression profile indicative of miR-16 status in a cell or tissue comprising expression assessment of one or more gene from Table 1, 3, 4, and/or 5, or any combination thereof.

[0027] The term "miRNA" is used according to its ordinary and plain meaning and refers to a microRNA molecule found in eukaryotes that is involved in RNA-based gene regulation. See, *e.g.*, Carrington *et al.*, 2003, which is hereby incorporated by reference. The term can be used to refer to the single-stranded RNA molecule processed from a precursor or in certain instances the precursor itself.

[0028] In some embodiments, it may be useful to know whether a cell expresses a particular miRNA endogenously or whether such expression is affected under particular conditions or when it is in a particular disease state. Thus, in some embodiments of the invention, methods include assaying a cell or a sample containing a cell for the presence of one or more marker gene or mRNA or other analyte indicative of the expression level of a gene of interest. Consequently, in some embodiments, methods include a step of generating an RNA profile for a sample. The term "RNA profile" or "gene expression profile" refers to a set of data regarding the expression pattern for one or more gene or genetic marker in the sample (*e.g.*, a plurality of nucleic acid probes that identify one or more markers from Table 1, 3, 4, and/or 5); it is contemplated that the nucleic acid profile can be obtained using a set of RNAs, using for example nucleic acid amplification or hybridization techniques well known to one of ordinary skill in the art. The difference in the expression profile in the sample from the patient and a reference expression profile, such as an expression profile from a normal or non-pathologic sample, is indicative of a pathologic, disease, or cancerous condition. A

nucleic acid or probe set comprising or identifying a segment of a corresponding mRNA can include all or part of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 ,13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 100, 200, 500, or more, including any integer or range derivable there between, of a gene or genetic marker, or a nucleic acid, mRNA or a probe representative thereof that is listed in Table 1, 3, 4, and/or 5, or identified by the methods described herein.

[0029] Certain embodiments of the invention are directed to compositions and methods for assessing, prognosing, or treating a pathological condition in a patient comprising measuring or determining an expression profile of one or more marker(s) in a sample from the patient, wherein a difference in the expression profile in the sample from the patient and an expression profile of a normal sample or reference expression profile is indicative of pathological condition and particularly cancer. In certain aspects of the invention, the cellular pathway, gene, or genetic marker is or is representative of one or more pathway or marker described in Table 1, 3, 4, and/or 5, including any combination thereof and excluding 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 or more genes.

[0030] Aspects of the invention include treating, diagnosing, or prognosing a pathologic condition or preventing a pathologic condition from manifesting. For example, the methods can be used to screen for a pathological condition; assess prognosis of a pathological condition; stage a pathological condition; assess response of a pathological condition to therapy; or to modulate the expression of a gene, genes, or related pathway as a first therapy or to render a subject sensitive or more responsive to a second therapy. In particular aspects, assessing the pathological condition of the patient can be assessing prognosis of the patient. Prognosis may include, but is not limited to an estimation of the time or expected time of survival, assessment of response to a therapy, and the like. In certain aspects, the altered expression of one or more gene or marker is prognostic for a patient having a pathologic condition, wherein the marker is one or more of Table 1, 3, 4, and/or 5, including any combination thereof.

[0031] Certain embodiments of the invention include determining expression of one or more marker, gene, or nucleic acid representative thereof, by using an amplification assay, a hybridization assay, or protein assay, a variety of which are well known to one of ordinary skill in the art. In certain aspects, an amplification assay can be a quantitative amplification

assay, such as quantitative RT-PCR or the like. In still further aspects, a hybridization assay can include array hybridization assays or solution hybridization assays. The nucleic acids from a sample may be labeled from the sample and/or hybridizing the labeled nucleic acid to one or more nucleic acid probes. Nucleic acids, mRNA, and/or nucleic acid probes may be coupled to a support. Such supports are well known to those of ordinary skill in the art and include, but are not limited to glass, plastic, metal, or latex. In particular aspects of the invention, the support can be planar or in the form of a bead or other geometric shapes or configurations known in the art. Proteins are typically assayed by immunoblotting, chromatography, mass spectrometry or other methods known to those of ordinary skill in the art.

[0032] A further embodiment of the invention is directed to methods of modulating a cellular pathway comprising administering to the cell an amount of an isolated nucleic acid comprising a miR-16 nucleic acid sequence or a miR-16 inhibitor. A cell, tissue, or subject may be a cancer cell, a cancerous tissue or harbor cancerous tissue, or a cancer patient. The database content related to all nucleic acids and genes designated by an accession number or a database submission are incorporated herein by reference as of the filing date of this application.

[0033] A further embodiment of the invention is directed to methods of modulating a cellular pathway comprising administering to the cell an amount of an isolated nucleic acid comprising a miR-16 nucleic acid sequence in an amount sufficient to modulate the expression, function, status, or state of a cellular pathway, in particular those pathways described or the pathways known to include one or more genes described herein. Modulation of a cellular pathway includes, but is not limited to modulating the expression of one or more gene(s). Modulation of a gene can include inhibiting the function of an endogenous miRNA or providing a functional miRNA to a cell, tissue, or subject. Modulation refers to the expression levels or activities of a gene or its related gene product (*e.g.*, mRNA) or protein, *e.g.*, the mRNA levels may be modulated or the translation of an mRNA may be modulated. Modulation may increase or up regulate a gene or gene product or it may decrease or down regulate a gene or gene product (*e.g.*, protein levels or activity).

[0034] Still a further embodiment includes methods of administering an miRNA or mimic thereof, and/or treating a subject or patient having, suspected of having, or at risk of developing a pathological condition comprising one or more of step (a) administering to a

patient or subject an amount of an isolated nucleic acid comprising a miR-16 nucleic acid sequence or a miR-16 inhibitor in an amount sufficient to modulate expression of a cellular pathway; and (b) administering a second therapy, wherein the modulation of the cellular pathway sensitizes the patient or subject, or increases the efficacy of a second therapy. An increase in efficacy can include a reduction in toxicity, a reduced dosage or duration of the second therapy, or an additive or synergistic effect. A cellular pathway may include, but is not limited to one or more pathway described herein or a pathway that is know to include one or more genes in the tables herein. The second therapy may be administered before, during, and/or after the isolated nucleic acid or miRNA or inhibitor is administered

[0035] A second therapy can include administration of a second miRNA or therapeutic nucleic acid such as a siRNA or antisense oligonucleotide, or may include various standard therapies, such as pharmaceuticals, chemotherapy, radiation therapy, drug therapy, immunotherapy, and the like. Embodiments of the invention may also include the determination or assessment of gene expression or gene expression profile for the selection of an appropriate therapy. In a particular aspect, a second therapy is chemotherapy. A chemotherapy can include, but is not limited to paclitaxel, cisplatin, carboplatin, doxorubicin, oxaliplatin, larotaxel, taxol, lapatinib, docetaxel, methotrexate, capecitabine, vinorelbine, cyclophosphamide, gemcitabine, amrubicin, cytarabine, etoposide, camptothecin, dexamethasone, dasatinib, tipifarnib, bevacizumab, sirolimus, temsirolimus, everolimus, lonafarnib, cetuximab, erlotinib, gefitinib, imatinib mesylate, rituximab, trastuzumab, nocodazole, sorafenib, sunitinib, bortezomib, alemtuzumab, gemtuzumab, tositumomab or ibritumomab.

[0036] Embodiments of the invention include methods of treating a subject with a disease or condition comprising one or more of the steps of (a) determining an expression profile of one or more genes selected from the tables; (b) assessing the sensitivity of the subject to therapy based on the expression profile; (c) selecting a therapy based on the assessed sensitivity; and (d) treating the subject using a selected therapy. Typically, the disease or condition will have as a component, indicator, or resulting mis-regulation of one or more gene described herein.

[0037] In certain aspects, 2, 3, 4, 5, 6, 7, 8, 9, 10, or more miRNA may be used in sequence or in combination. For instance, any combination of miR-16 or a miR-16 inhibitor with another miRNA. Further embodiments include the identification and assessment of an

expression profile indicative of miR-16 status in a cell or tissue comprising expression assessment of one or more gene from the tables, or any combination thereof.

[0038] The term "miRNA" is used according to its ordinary and plain meaning and refers to a microRNA molecule found in eukaryotes that is involved in RNA-based gene regulation. See, *e.g.*, Carrington *et al.*, 2003, which is hereby incorporated by reference. The term can be used to refer to the single-stranded RNA molecule processed from a precursor or in certain instances the precursor itself.

[0039] In some embodiments, it may be useful to know whether a cell expresses a particular miRNA endogenously or whether such expression is affected under particular conditions or when it is in a particular disease state. Thus, in some embodiments of the invention, methods include assaying a cell or a sample containing a cell for the presence of one or more marker gene or mRNA or other analyte indicative of the expression level of a gene of interest. Consequently, in some embodiments, methods include a step of generating an RNA profile for a sample. The term "RNA profile" or "gene expression profile" refers to a set of data regarding the expression pattern for one or more gene or genetic marker or miRNA in the sample (*e.g.*, a plurality of nucleic acid probes that identify one or more markers from the tables; it is contemplated that the nucleic acid profile can be obtained using a set of RNAs, using for example nucleic acid amplification or hybridization techniques well know to one of ordinary skill in the art. The difference in the expression profile in the sample from the patient and a reference expression profile, such as an expression profile of one or more genes or miRNAs, are indicative of which miRNAs to be administered.

[0040] In certain aspects, miR-16 or miR-16 inhibitor and let-7 or let-7 inhibitor are administered to patients with astrocytoma, breast carcinoma, bladder carcinoma, cervical carcinoma, chronic lymphoblastic leukemia, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, lung carcinoma, melanoma, medulloblastoma, myxofibrosarcoma, myeloid leukemia, multiple myeloma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, thyroid carcinoma.

[0041] Further aspects include administering miR-16 or miR-16 inhibitor and miR-10 or miR-10 inhibitor to patients with astrocytoma, breast carcinoma, bladder carcinoma, cervical

carcinoma, chronic lymphoblastic leukemia, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, lung carcinoma, melanoma, mantle cell lymphoma, multiple myeloma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, squamous cell carcinoma of the head and neck, thyroid carcinoma

[0042] In yet another aspect, miR-16 or miR-16 inhibitor and miR-15 or miR-15 inhibitor can be administered to patients with astrocytoma, breast carcinoma, B-cell lymphoma, bladder carcinoma, cervical carcinoma, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, lung carcinoma, laryngeal squamous cell carcinoma, melanoma, medulloblastoma, mantle cell lymphoma, myxofibrosarcoma, myeloid leukemia, multiple myeloma, neurofibroma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, pheochromocytoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, thyroid carcinoma.

[0043] In still further aspects, miR-16 or miR-16 inhibitor and miR-20 or miR-20 inhibitor are administered to patients with astrocytoma, breast carcinoma, bladder carcinoma, cervical carcinoma, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, Hodgkin lymphoma, melanoma, mantle cell lymphoma, myxofibrosarcoma, multiple myeloma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, squamous cell carcinoma of the head and neck, thyroid carcinoma.

[0044] In certain aspects, miR-16 or miR-16 inhibitor and miR-21 or miR-21 inhibitor are administered to patients with astrocytoma, breast carcinoma, bladder carcinoma, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, melanoma, mantle cell lymphoma, myeloid leukemia, neurofibroma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, pheochromocytoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck.

[0045] Aspects of the invention include methods where miR-16 or miR-16 inhibitor and miR-26 or miR-26 inhibitor are administered to patients with anaplastic large cell lymphoma, breast carcinoma, B-cell lymphoma, bladder carcinoma, cervical carcinoma, chronic lymphoblastic leukemia, colorectal carcinoma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, lung carcinoma, melanoma, multiple myeloma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, rhabdomyosarcoma, testicular tumor.

[0046] In still further aspects, miR-16 or miR-16 inhibitor and miR-34 or miR-34 inhibitor are administered to patients with astrocytoma, anaplastic large cell lymphoma, breast carcinoma, B-cell lymphoma, bladder carcinoma, cervical carcinoma, chronic lymphoblastic leukemia, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, lung carcinoma, laryngeal squamous cell carcinoma, melanoma, medulloblastoma, mantle cell lymphoma, myeloid leukemia, multiple myeloma, neurofibroma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, pheochromocytoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, testicular tumor.

[0047] In still a further aspect, miR-16 or miR-16 inhibitor and miR-124 or miR-124 inhibitor are administered to patients with astrocytoma, anaplastic large cell lymphoma, breast carcinoma, B-cell lymphoma, bladder carcinoma, cervical carcinoma, chronic lymphoblastic leukemia, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, lung carcinoma, laryngeal squamous cell carcinoma, melanoma, medulloblastoma, mantle cell lymphoma, myxofibrosarcoma, multiple myeloma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, testicular tumor.

[0048] In yet further aspects, miR-16 or miR-16 inhibitor and miR-126 or miR-126 inhibitor are administered to patients with astrocytoma, breast carcinoma, bladder carcinoma, cervical carcinoma, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, lung carcinoma, melanoma, mantle cell lymphoma, myeloid leukemia, neurofibroma, non-small cell lung

carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, pheochromocytoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, thyroid carcinoma.

[0049] In yet further aspects, miR-16 or miR-16 inhibitor and miR-143 or miR-143 inhibitor are administered to patients with astrocytoma, anaplastic large cell lymphoma, breast carcinoma, B-cell lymphoma, bladder carcinoma, cervical carcinoma, chronic lymphoblastic leukemia, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, Hodgkin lymphoma, lung carcinoma, melanoma, medulloblastoma, mantle cell lymphoma, multiple myeloma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, testicular tumor.

[0050] In a further aspect, miR-16 or miR-16 inhibitor and miR-147 or miR-147 inhibitor are administered to patients with astrocytoma, breast carcinoma, bladder carcinoma, cervical carcinoma, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, Hodgkin lymphoma, melanoma, mantle cell lymphoma, myxofibrosarcoma, multiple myeloma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, squamous cell carcinoma of the head and neck, thyroid carcinoma.

[0051] In still a further aspect, miR-16 or miR-16 inhibitor and miR-188 or miR-188 inhibitor are administered to patients with astrocytoma, anaplastic large cell lymphoma, breast carcinoma, B-cell lymphoma, bladder carcinoma, cervical carcinoma, chronic lymphoblastic leukemia, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, lung carcinoma, melanoma, multiple myeloma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, testicular tumor.

[0052] In a further aspect, miR-16 or miR-16 inhibitor and miR-200 or miR-200 inhibitor are administered to patients with anaplastic large cell lymphoma, breast carcinoma, B-cell lymphoma, cervical carcinoma, chronic lymphoblastic leukemia, colorectal carcinoma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, lung carcinoma, multiple

myeloma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, testicular tumor.

[0053] In yet another aspect, miR-16 or miR-16 inhibitor and miR-215 or miR-215 inhibitor are administered to patients with astrocytoma, anaplastic large cell lymphoma, breast carcinoma, B-cell lymphoma, bladder carcinoma, cervical carcinoma, chronic lymphoblastic leukemia, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, lung carcinoma, melanoma, mantle cell lymphoma, myxofibrosarcoma, myeloid leukemia, multiple myeloma, neurofibroma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, pheochromocytoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, testicular tumor.

[0054] In yet a further aspect, miR-16 or miR-16 inhibitor and miR-216 or miR-216 inhibitor are administered to patients with astrocytoma, breast carcinoma, cervical carcinoma, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, Hodgkin lymphoma, lung carcinoma, myeloid leukemia, neurofibroma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, prostate carcinoma, pheochromocytoma, squamous cell carcinoma of the head and neck, testicular tumor.

[0055] In other aspects, miR-16 or miR-16 inhibitor and miR-292-3p or miR-292-3p inhibitor are administered to patients with astrocytoma, anaplastic large cell lymphoma, breast carcinoma, B-cell lymphoma, bladder carcinoma, cervical carcinoma, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, lung carcinoma, laryngeal squamous cell carcinoma, melanoma, myxofibrosarcoma, multiple myeloma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, testicular tumor.

[0056] In certain aspects, miR-16 or miR-16 inhibitor and miR-331 or miR-331 inhibitor are administered to patients with astrocytoma, anaplastic large cell lymphoma, breast carcinoma, B-cell lymphoma, bladder carcinoma, cervical carcinoma, chronic lymphoblastic

leukemia, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, lung carcinoma, laryngeal squamous cell carcinoma, melanoma, myxofibrosarcoma, myeloid leukemia, multiple myeloma, neurofibroma, ovarian carcinoma, oesophageal carcinoma, pancreatic carcinoma, prostate carcinoma, pheochromocytoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, testicular tumor.

[0057] It is contemplated that when miR-16 or a miR-16 inhibitor is given in combination with one or more other miRNA molecules, the two different miRNAs or inhibitors may be given at the same time or sequentially. In some embodiments, therapy proceeds with one miRNA or inhibitor and that therapy is followed up with therapy with the other miRNA or inhibitor 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55 minutes, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24 hours, 1, 2, 3, 4, 5, 6, 7 days, 1, 2, 3, 4, 5 weeks, or 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12 months or any such combination later.

[0058] Further embodiments include the identification and assessment of an expression profile indicative of miR-16 status in a cell or tissue comprising expression assessment of one or more gene from the tables herein, or any combination thereof.

[0059] The term "miRNA" is used according to its ordinary and plain meaning and refers to a microRNA molecule found in eukaryotes that is involved in RNA-based gene regulation. See, *e.g.*, Carrington *et al.*, 2003, which is hereby incorporated by reference. The term can be used to refer to the single-stranded RNA molecule processed from a precursor or in certain instances the precursor itself or a mimetic thereof.

[0060] In some embodiments, it may be useful to know whether a cell expresses a particular miRNA endogenously or whether such expression is affected under particular conditions or when it is in a particular disease state. Thus, in some embodiments of the invention, methods include assaying a cell or a sample containing a cell for the presence of one or more miRNA marker gene or mRNA or other analyte indicative of the expression level of a gene of interest. Consequently, in some embodiments, methods include a step of generating an RNA profile for a sample. The term "RNA profile" or "gene expression profile" refers to a set of data regarding the expression pattern for one or more gene or genetic marker in the sample (*e.g.*, a plurality of nucleic acid probes that identify one or more

markers or genes from the tables); it is contemplated that the nucleic acid profile can be obtained using a set of RNAs, using for example nucleic acid amplification or hybridization techniques well know to one of ordinary skill in the art. The difference in the expression profile in the sample from a patient and a reference expression profile, such as an expression profile from a normal or non-pathologic sample, or a digitized reference, is indicative of a pathologic, disease, or cancerous condition. In certain aspects the expression profile is an indicator of a propensity to or probability of (*i.e.*, risk factor for a disease or condition) developing such a condition(s). Such a risk or propensity may indicate a treatment, increased monitoring, prophylactic measures, and the like. A nucleic acid or probe set may comprise or identify a segment of a corresponding mRNA and may include all or part of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 ,13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 100, 200, 500, or more segments, including any integer or range derivable there between, of a gene or genetic marker, or a nucleic acid, mRNA or a probe representative thereof that is listed in tables or identified by the methods described herein.

[0061] Certain embodiments of the invention are directed to compositions and methods for assessing, prognosing, or treating a pathological condition in a patient comprising measuring or determining an expression profile of one or more miRNA or marker(s) in a sample from the patient, wherein a difference in the expression profile in the sample from the patient and an expression profile of a normal sample or reference expression profile is indicative of pathological condition and particularly cancer (*e.g.*, In certain aspects of the invention, the miRNAs, cellular pathway, gene, or genetic marker is or is representative of one or more pathway or marker described in the tables, including any combination thereof.

[0062] Aspects of the invention include diagnosing, assessing, or treating a pathologic condition or preventing a pathologic condition from manifesting. For example, the methods can be used to screen for a pathological condition; assess prognosis of a pathological condition; stage a pathological condition; assess response of a pathological condition to therapy; or to modulate the expression of a gene, genes, or related pathway as a first therapy or to render a subject sensitive or more responsive to a second therapy. In particular aspects, assessing the pathological condition of the patient can be assessing prognosis of the patient. Prognosis may include, but is not limited to an estimation of the time or expected time of survival, assessment of response to a therapy, and the like. In certain aspects, the altered

expression of one or more gene or marker is prognostic for a patient having a pathologic condition, wherein the marker is one or more of the tables, including any combination thereof.

[0063] The present invention also concerns kits containing compositions of the invention or compositions to implement methods of the invention. In some embodiments, kits can be used to evaluate one or more marker molecules, and/or express one or more miRNA or miRNA inhibitor. In certain embodiments, a kit contains, contains at least or contains at most 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 100, 150, 200 or more probes, recombinant nucleic acid, or synthetic nucleic acid molecules related to the markers to be assessed or an miRNA or miRNA inhibitor to be expressed or modulated, and may include any range or combination derivable therein. Kits may comprise components, which may be individually packaged or placed in a container, such as a tube, bottle, vial, syringe, or other suitable container means. Individual components may also be provided in a kit in concentrated amounts; in some embodiments, a component is provided individually in the same concentration as it would be in a solution with other components. Concentrations of components may be provided as 1x, 2x, 5x, 10x, or 20x or more. Kits for using probes, synthetic nucleic acids, recombinant nucleic acids, or non-synthetic nucleic acids of the invention for therapeutic, prognostic, or diagnostic applications are included as part of the invention. Specifically contemplated are any such molecules corresponding to any miRNA reported to influence biological activity or expression of one or more marker gene or gene pathway described herein. In certain aspects, negative and/or positive controls are included in some kit embodiments. The control molecules can be used to verify transfection efficiency and/or control for transfection-induced changes in cells. .

[0064] Certain embodiments are directed to a kit for assessment of a pathological condition or the risk of developing a pathological condition in a patient by nucleic acid profiling of a sample comprising, in suitable container means, two or more nucleic acid hybridization or amplification reagents. The kit can comprise reagents for labeling nucleic acids in a sample and/or nucleic acid hybridization reagents. The hybridization reagents typically comprise hybridization probes. Amplification reagents include, but are not limited to amplification primers, reagents, and enzymes.

[0065] In some embodiments of the invention, an expression profile is generated by steps that include: (a) labeling nucleic acid in the sample; (b) hybridizing the nucleic acid to a number of probes, or amplifying a number of nucleic acids, and (c) determining and/or quantitating nucleic acid hybridization to the probes or detecting and quantitating amplification products, wherein an expression profile is generated. See U.S. Provisional Patent Application 60/575,743 and the U.S. Provisional Patent Application 60/649,584, and U.S. Patent Application Serial No. 11/141,707 and U.S. Patent Application Serial No. 11/273,640, all of which are hereby incorporated by reference.

[0066] Methods of the invention involve diagnosing and/or assessing the prognosis of a patient based on a miRNA and/or a marker nucleic acid expression profile. In certain embodiments, the elevation or reduction in the level of expression of a particular gene or genetic pathway or set of nucleic acids in a cell is correlated with a disease state or pathological condition compared to the expression level of the same in a normal or non-pathologic cell or tissue sample. This correlation allows for diagnostic and/or prognostic methods to be carried out when the expression level of one or more nucleic acid is measured in a biological sample being assessed and then compared to the expression level of a normal or non-pathologic cell or tissue sample. It is specifically contemplated that expression profiles for patients, particularly those suspected of having or having a propensity for a particular disease or condition such as cancer, can be generated by evaluating any of or sets of the miRNAs and/or nucleic acids discussed in this application. The expression profile that is generated from the patient will be one that provides information regarding the particular disease or condition. In many embodiments, the profile is generated using nucleic acid hybridization or amplification, (*e.g.*, array hybridization or RT-PCR). In certain aspects, an expression profile can be used in conjunction with other diagnostic and/or prognostic tests, such as histology, protein profiles in the serum and/or cytogenetic assessment.

[0067] The methods can further comprise one or more of the steps including: (a) obtaining a sample from the patient, (b) isolating nucleic acids from the sample, (c) labeling the nucleic acids isolated from the sample, and (d) hybridizing the labeled nucleic acids to one or more probes. Nucleic acids of the invention include one or more nucleic acid comprising at least one segment having a sequence or complementary sequence of to a nucleic acid representative of one or more of genes or markers in the tables.

[0068] It is contemplated that any method or composition described herein can be implemented with respect to any other method or composition described herein and that different embodiments may be combined. It is specifically contemplated that any methods and compositions discussed herein with respect to miRNA molecules, miRNA, genes and nucleic acids representative of genes may be implemented with respect to synthetic nucleic acids. In some embodiments the synthetic nucleic acid is exposed to the proper conditions to allow it to become a processed or mature nucleic acid, such as a miRNA under physiological circumstances. The claims originally filed are contemplated to cover claims that are multiply dependent on any filed claim or combination of filed claims.

[0069] Also, any embodiment of the invention involving specific genes (including representative fragments thereof), mRNA, or miRNAs by name is contemplated also to cover embodiments involving miRNAs whose sequences are at least 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99% identical to the sequence or mature sequence of the specified miRNA, mRNA, gene, or representative nucleic acid.

[0070] It will be further understood that shorthand notations are employed such that a generic description of a gene or marker thereof, or of a miRNA refers to any of its gene family members (distinguished by a number) or representative fragments thereof, unless otherwise indicated. It is understood by those of skill in the art that a "gene family" refers to a group of genes having the same or similar coding sequence or miRNA coding sequence. Typically, miRNA members of a gene family are identified by a number following the initial designation. For example, miR-16-1 and miR-16-2 are members of the miR-16 gene family and "mir-7" refers to miR-7-1, miR-7-2 and miR-7-3. Moreover, unless otherwise indicated, a shorthand notation refers to related miRNAs (distinguished by a letter). Thus, "let-7," for example, refers to let-7a, let-7b, let-7c, *etc.* Exceptions to this shorthand notation will be otherwise identified.

[0071] Other embodiments of the invention are discussed throughout this application. Any embodiment discussed with respect to one aspect of the invention applies to other aspects of the invention as well and *vice versa*. The embodiments in the Example and Detailed Description section are understood to be embodiments of the invention that are applicable to all aspects of the invention.

[0072] The terms "inhibiting," "reducing," or "prevention," or any variation of these terms, when used in the claims and/or the specification includes any measurable decrease or complete inhibition to achieve a desired result.

[0073] The use of the word "a" or "an" when used in conjunction with the term "comprising" in the claims and/or the specification may mean "one," but it is also consistent with the meaning of "one or more," "at least one," and "one or more than one."

[0074] Throughout this application, the term "about" is used to indicate that a value includes the standard deviation of error for the device or method being employed to determine the value.

[0075] The use of the term "or" in the claims is used to mean "and/or" unless explicitly indicated to refer to alternatives only or the alternatives are mutually exclusive, although the disclosure supports a definition that refers to only alternatives and "and/or."

[0076] As used in this specification and claim(s), the words "comprising" (and any form of comprising, such as "comprise" and "comprises"), "having" (and any form of having, such as "have" and "has"), "including" (and any form of including, such as "includes" and "include") or "containing" (and any form of containing, such as "contains" and "contain") are inclusive or open-ended and do not exclude additional, unrecited elements or method steps.

[0077] Other objects, features and advantages of the present invention will become apparent from the following detailed description. It should be understood, however, that the detailed description and the specific examples, while indicating specific embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

DETAILED DESCRIPTION OF THE INVENTION

[0078] The present invention is directed to compositions and methods relating to the identification and characterization of genes and biological pathways related to these genes as represented by the expression of the identified genes, as well as use of miRNAs related to such, for therapeutic, prognostic, and diagnostic applications. In particular, the present invention is directed to those methods and compositions related to assessing and/or identifying pathological conditions directly or indirectly related to miR-16 expression or the

aberrant expression thereof. The mature sequence of miR-16 is typically comprised of uagcagcacguaaauauuggcg SEQ ID NO:1 (MIMAT0000069).

[0079] In certain aspects, the invention is directed to methods for the assessment, analysis, and/or therapy of a cell or subject where certain genes have a reduced expression (relative to normal) as a result of an increased or decreased expression of miR-16 and/or genes with an increased expression (relative to normal) as a result of an increased or decreased expression of miR-16. The expression profile and/or response to miR-16 expression or lack of expression are indicative of an individual with a pathological condition, *e.g.*, cancer.

[0080] Prognostic assays featuring any one or combination of the miRNAs listed or the markers listed (including nucleic acids representative thereof) could be used to assess a patient to determine what if any treatment regimen is justified. As with the diagnostic assays mentioned above, the absolute values that define low expression will depend on the platform used to measure the miRNA(s). The same methods described for the diagnostic assays could be used for a prognostic assays.

I. THERAPEUTIC METHODS

[0081] Embodiments of the invention concern nucleic acids that perform the activities of or inhibit endogenous miRNAs when introduced into cells. In certain aspects, nucleic acids are synthetic or non-synthetic miRNA. Sequence-specific miRNA inhibitors can be used to inhibit sequentially or in combination the activities of one or more endogenous miRNAs in cells, as well those genes and associated pathways modulated by the endogenous miRNA.

[0082] The present invention concerns, in some embodiments, short nucleic acid molecules that function as miRNAs or as inhibitors of miRNA in a cell. The term "short" refers to a length of a single polynucleotide that is 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 50, 100, or 150 nucleotides or fewer, including all integers or ranges range derivable there between. The nucleic acid molecules are typically synthetic. The term "synthetic" refers to a nucleic acid molecule that is isolated and not produced naturally in a cell. In certain aspects the sequence (the entire sequence) and/or chemical structure deviates from a naturally-occurring nucleic acid molecule, such as an endogenous precursor miRNA or miRNA molecule or complement thereof. While in some embodiments, nucleic acids of the invention do not have an entire sequence that is identical or complementary to a sequence of a

naturally-occurring nucleic acid, such molecules may encompass all or part of a naturally-occurring sequence or a complement thereof.. It is contemplated, however, that a synthetic nucleic acid administered to a cell may subsequently be modified or altered in the cell such that its structure or sequence is the same as non-synthetic or naturally occurring nucleic acid, such as a mature miRNA sequence. For example, a synthetic nucleic acid may have a sequence that differs from the sequence of a precursor miRNA, but that sequence may be altered once in a cell to be the same as an endogenous, processed miRNA or an inhibitor thereof.. The term "isolated" means that the nucleic acid molecules of the invention are initially separated from different (in terms of sequence or structure) and unwanted nucleic acid molecules such that a population of isolated nucleic acids is at least about 90% homogenous, and may be at least about 95, 96, 97, 98, 99, or 100% homogenous with respect to other polynucleotide molecules. In many embodiments of the invention, a nucleic acid is isolated by virtue of it having been synthesized *in vitro* separate from endogenous nucleic acids in a cell. It will be understood, however, that isolated nucleic acids may be subsequently mixed or pooled together. In certain aspects, synthetic miRNA of the invention are RNA or RNA analogs. miRNA inhibitors may be DNA or RNA, or analogs thereof. miRNA and miRNA inhibitors of the invention are collectively referred to as "synthetic nucleic acids."

[0083] In some embodiments, there is a miRNA or a synthetic miRNA having a length of between 17 and 130 residues. The present invention concerns miRNA or synthetic miRNA molecules that are, are at least, or are at most 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 140, 145, 150, 160, 170, 180, 190, 200 or more residues in length, including any integer or any range there between.

[0084] In certain embodiments, synthetic miRNA have (a) a "miRNA region" whose sequence or binding region from 5' to 3' is identical or complementary to all or a segment of a mature miRNA sequence, and (b) a "complementary region" whose sequence from 5' to 3' is between 60% and 100% complementary to the miRNA sequence in (a). In certain embodiments, these synthetic miRNA are also isolated, as defined above. The term "miRNA

region" refers to a region on the synthetic miRNA that is at least 75, 80, 85, 90, 95, or 100% identical, including all integers there between, to the entire sequence of a mature, naturally occurring miRNA sequence or a complement thereof. In certain embodiments, the miRNA region is or is at least 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.1, 99.2, 99.3, 99.4, 99.5, 99.6, 99.7, 99.8, 99.9 or 100% identical to the sequence of a naturally-occurring miRNA or complement thereof.

[0085] The term "complementary region" or "complement" refers to a region of a nucleic acid or mimetic that is or is at least 60% complementary to the mature, naturally occurring miRNA sequence. The complementary region is or is at least 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.1, 99.2, 99.3, 99.4, 99.5, 99.6, 99.7, 99.8, 99.9 or 100% complementary, or any range derivable therein. With single polynucleotide sequences, there may be a hairpin loop structure as a result of chemical bonding between the miRNA region and the complementary region. In other embodiments, the complementary region is on a different nucleic acid molecule than the miRNA region, in which case the complementary region is on the complementary strand and the miRNA region is on the active strand.

[0086] In other embodiments of the invention, there are synthetic nucleic acids that are miRNA inhibitors. A miRNA inhibitor is between about 17 to 25 nucleotides in length and comprises a 5' to 3' sequence that is at least 90% complementary to the 5' to 3' sequence of a mature miRNA. In certain embodiments, a miRNA inhibitor molecule is 17, 18, 19, 20, 21, 22, 23, 24, or 25 nucleotides in length, or any range derivable therein. Moreover, an miRNA inhibitor may have a sequence (from 5' to 3') that is or is at least 70, 75, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.1, 99.2, 99.3, 99.4, 99.5, 99.6, 99.7, 99.8, 99.9 or 100% complementary, or any range derivable therein, to the 5' to 3' sequence of a mature miRNA, particularly a mature, naturally occurring miRNA. One of skill in the art could use a portion of the miRNA sequence that is complementary to the sequence of a mature miRNA as the sequence for a miRNA inhibitor. Moreover, that portion of the nucleic acid sequence can be altered so that it is still comprises the appropriate percentage of complementarity to the sequence of a mature miRNA.

[0087] In some embodiments, of the invention, a synthetic miRNA or inhibitor contains one or more design element(s). These design elements include, but are not limited to: (i) a replacement group for the phosphate or hydroxyl of the nucleotide at the 5' terminus of the

complementary region; (ii) one or more sugar modifications in the first or last 1 to 6 residues of the complementary region; or, (iii) noncomplementarity between one or more nucleotides in the last 1 to 5 residues at the 3' end of the complementary region and the corresponding nucleotides of the miRNA region. A variety of design modifications are known in the art, see below.

[0088] In certain embodiments, a synthetic miRNA has a nucleotide at its 5' end of the complementary region in which the phosphate and/or hydroxyl group has been replaced with another chemical group (referred to as the "replacement design"). In some cases, the phosphate group is replaced, while in others, the hydroxyl group has been replaced. In particular embodiments, the replacement group is biotin, an amine group, a lower alkylamine group, an acetyl group, 2'O-Me (2'oxygen-methyl), DMTO (4,4'-dimethoxytrityl with oxygen), fluoroscein, a thiol, or acridine, though other replacement groups are well known to those of skill in the art and can be used as well. This design element can also be used with a miRNA inhibitor.

[0089] Additional embodiments concern a synthetic miRNA having one or more sugar modifications in the first or last 1 to 6 residues of the complementary region (referred to as the "sugar replacement design"). In certain cases, there is one or more sugar modifications in the first 1, 2, 3, 4, 5, 6 or more residues of the complementary region, or any range derivable therein. In additional cases, there are one or more sugar modifications in the last 1, 2, 3, 4, 5, 6 or more residues of the complementary region, or any range derivable therein, have a sugar modification. It will be understood that the terms "first" and "last" are with respect to the order of residues from the 5' end to the 3' end of the region. In particular embodiments, the sugar modification is a 2'O-Me modification. In further embodiments, there are one or more sugar modifications in the first or last 2 to 4 residues of the complementary region or the first or last 4 to 6 residues of the complementary region. This design element can also be used with a miRNA inhibitor. Thus, a miRNA inhibitor can have this design element and/or a replacement group on the nucleotide at the 5' terminus, as discussed above.

[0090] In other embodiments of the invention, there is a synthetic miRNA or inhibitor in which one or more nucleotides in the last 1 to 5 residues at the 3' end of the complementary region are not complementary to the corresponding nucleotides of the miRNA region ("noncomplementarity") (referred to as the "noncomplementarity design"). The noncomplementarity may be in the last 1, 2, 3, 4, and/or 5 residues of the complementary

miRNA. In certain embodiments, there is noncomplementarity with at least 2 nucleotides in the complementary region.

[0091] It is contemplated that synthetic miRNA of the invention have one or more of the replacement, sugar modification, or noncomplementarity designs. In certain cases, synthetic RNA molecules have two of them, while in others these molecules have all three designs in place.

[0092] The miRNA region and the complementary region may be on the same or separate polynucleotides. In cases in which they are contained on or in the same polynucleotide, the miRNA molecule will be considered a single polynucleotide. In embodiments in which the different regions are on separate polynucleotides, the synthetic miRNA will be considered to be comprised of two polynucleotides.

[0093] When the RNA molecule is a single polynucleotide, there can be a linker region between the miRNA region and the complementary region. In some embodiments, the single polynucleotide is capable of forming a hairpin loop structure as a result of bonding between the miRNA region and the complementary region. The linker constitutes the hairpin loop. It is contemplated that in some embodiments, the linker region is, is at least, or is at most 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, or 40 residues in length, or any range derivable therein. In certain embodiments, the linker is between 3 and 30 residues (inclusive) in length.

[0094] In addition to having a miRNA or inhibitor region and a complementary region, there may be flanking sequences as well at either the 5' or 3' end of the region. In some embodiments, there is or is at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 nucleotides or more, or any range derivable therein, flanking one or both sides of these regions.

[0095] Methods of the invention include reducing or eliminating activity of one or more miRNAs in a cell comprising introducing into a cell a miRNA inhibitor (which may be described generally herein as an miRNA, so that a description of miRNA, where appropriate, also will refer to a miRNA inhibitor); or supplying or enhancing the activity of one or more miRNAs in a cell. The present invention also concerns inducing certain cellular characteristics by providing to a cell a particular nucleic acid, such as a specific synthetic miRNA molecule or a synthetic miRNA inhibitor molecule. However, in methods of the invention, the miRNA molecule or miRNA inhibitor need not be synthetic. They may have a

sequence that is identical to a naturally occurring miRNA or they may not have any design modifications. In certain embodiments, the miRNA molecule and/or the miRNA inhibitor are synthetic, as discussed above.

[0096] The particular nucleic acid molecule provided to the cell is understood to correspond to a particular miRNA in the cell, and thus, the miRNA in the cell is referred to as the "corresponding miRNA." In situations in which a named miRNA molecule is introduced into a cell, the corresponding miRNA will be understood to be the induced or inhibited miRNA or induced or inhibited miRNA function.. It is contemplated, however, that the miRNA molecule introduced into a cell is not a mature miRNA but is capable of becoming or functioning as a mature miRNA under the appropriate physiological conditions. In cases in which a particular corresponding miRNA is being inhibited by a miRNA inhibitor, the particular miRNA will be referred to as the "targeted miRNA." It is contemplated that multiple corresponding miRNAs may be involved. In particular embodiments, more than one miRNA molecule is introduced into a cell. Moreover, in other embodiments, more than one miRNA inhibitor is introduced into a cell. Furthermore, a combination of miRNA molecule(s) and miRNA inhibitor(s) may be introduced into a cell. The inventors contemplate that a combination of miRNA may act at one or more points in cellular pathways of cells with aberrant phenotypes and that such combination may have increased efficacy on the target cell while not adversely effecting normal cells. Thus, a combination of miRNA may have a minimal adverse effect on a subject or patient while supplying a sufficient therapeutic effect, such as amelioration of a condition, growth inhibition of a cell, death of a targeted cell, alteration of cell phenotype or physiology, slowing of cellular growth, sensitization to a second therapy, sensitization to a particular therapy, and the like.

[0097] Methods include identifying a cell or patient in need of inducing those cellular characteristics. Also, it will be understood that an amount of a synthetic nucleic acid that is provided to a cell or organism is an "effective amount," which refers to an amount needed (or a sufficient amount) to achieve a desired goal, such as inducing a particular cellular characteristic(s).

[0098] In certain embodiments of the methods include providing or introducing to a cell a nucleic acid molecule corresponding to a mature miRNA in the cell in an amount effective to achieve a desired physiological result.

[0099] Moreover, methods can involve providing synthetic or nonsynthetic miRNA molecules. It is contemplated that in these embodiments, that the methods may or may not be limited to providing only one or more synthetic miRNA molecules or only one or more nonsynthetic miRNA molecules. Thus, in certain embodiments, methods may involve providing both synthetic and nonsynthetic miRNA molecules. In this situation, a cell or cells are most likely provided a synthetic miRNA molecule corresponding to a particular miRNA and a nonsynthetic miRNA molecule corresponding to a different miRNA. Furthermore, any method articulated using a list of miRNAs using Markush group language may be articulated without the Markush group language and a disjunctive article (*i.e.*, or) instead, and vice versa.

[00100] In some embodiments, there is a method for reducing or inhibiting cell proliferation comprising introducing into or providing to the cell an effective amount of (i) a miRNA inhibitor molecule or (ii) a synthetic or nonsynthetic miRNA molecule that corresponds to a miRNA sequence. In certain embodiments the methods involves introducing into the cell an effective amount of (i) an miRNA inhibitor molecule having a 5' to 3' sequence that is at least 90% complementary to the 5' to 3' sequence of one or more mature miRNA.

[00101] Certain embodiments of the invention include methods of treating a pathologic condition, in particular cancer, *e.g.*, lung or liver cancer. In one aspect, the method comprises contacting a target cell with one or more nucleic acid, synthetic miRNA, or miRNA comprising at least one nucleic acid segment having all or a portion of a miRNA sequence. The segment may be 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 30 or more nucleotides or nucleotide analog, including all integers there between. An aspect of the invention includes the modulation of gene expression, miRNA expression or function or mRNA expression or function within a target cell, such as a cancer cell.

[00102] Typically, an endogenous gene, miRNA or mRNA is modulated in the cell. In particular embodiments, the nucleic acid sequence comprises at least one segment that is at least 70, 75, 80, 85, 90, 95, or 100% identical in nucleic acid sequence to one or more miRNA or gene sequence. Modulation of the expression or processing of an endogenous gene, miRNA, or mRNA can be through modulation of the processing of a mRNA, such processing including transcription, transportation and/or translation with in a cell. Modulation may also be effected by the inhibition or enhancement of miRNA activity with a cell, tissue, or organ. Such processing may affect the expression of an encoded product or the

stability of the mRNA. In still other embodiments, a nucleic acid sequence can comprise a modified nucleic acid sequence. In certain aspects, one or more miRNA sequence may include or comprise a modified nucleobase or nucleic acid sequence.

[00103] It will be understood in methods of the invention that a cell or other biological matter such as an organism (including patients) can be provided a miRNA or miRNA molecule corresponding to a particular miRNA by administering to the cell or organism a nucleic acid molecule that functions as the corresponding miRNA once inside the cell. The form of the molecule provided to the cell may not be the form that acts a miRNA once inside the cell. Thus, it is contemplated that in some embodiments, a synthetic miRNA or a nonsynthetic miRNA is provided a synthetic miRNA or a nonsynthetic miRNA, such as one that becomes processed into a mature and active miRNA once it has access to the cell's miRNA processing machinery. In certain embodiments, it is specifically contemplated that the miRNA molecule provided to the biological matter is not a mature miRNA molecule but a nucleic acid molecule that can be processed into the mature miRNA once it is accessible to miRNA processing machinery. The term "nonsynthetic" in the context of miRNA means that the miRNA is not "synthetic," as defined herein. Furthermore, it is contemplated that in embodiments of the invention that concern the use of synthetic miRNAs, the use of corresponding nonsynthetic miRNAs is also considered an aspect of the invention, and vice versa. It will be understand that the term "providing" an agent is used to include "administering" the agent to a patient.

[00104] In certain embodiments, methods also include targeting a miRNA to modulate in a cell or organism. The term "targeting a miRNA to modulate" means a nucleic acid of the invention will be employed so as to modulate the selected miRNA. In some embodiments the modulation is achieved with a synthetic or non-synthetic miRNA that corresponds to the targeted miRNA, which effectively provides the targeted miRNA to the cell or organism (positive modulation). In other embodiments, the modulation is achieved with a miRNA inhibitor, which effectively inhibits the targeted miRNA in the cell or organism (negative modulation).

[00105] In some embodiments, the miRNA targeted to be modulated is a miRNA that affects a disease, condition, or pathway. In certain embodiments, the miRNA is targeted because a treatment can be provided by negative modulation of the targeted miRNA. In other

embodiments, the miRNA is targeted because a treatment can be provided by positive modulation of the targeted miRNA or its targets.

[00106] In certain methods of the invention, there is a further step of administering the selected miRNA modulator to a cell, tissue, organ, or organism (collectively "biological matter") in need of treatment related to modulation of the targeted miRNA or in need of the physiological or biological results discussed herein (such as with respect to a particular cellular pathway or result like decrease in cell viability). Consequently, in some methods of the invention there is a step of identifying a patient in need of treatment that can be provided by the miRNA modulator(s). It is contemplated that an effective amount of a miRNA modulator can be administered in some embodiments. In particular embodiments, there is a therapeutic benefit conferred on the biological matter, where a "therapeutic benefit" refers to an improvement in the one or more conditions or symptoms associated with a disease or condition or an improvement in the prognosis, duration, or status with respect to the disease. It is contemplated that a therapeutic benefit includes, but is not limited to, a decrease in pain, a decrease in morbidity, a decrease in a symptom. For example, with respect to cancer, it is contemplated that a therapeutic benefit can be inhibition of tumor growth, prevention of metastasis, reduction in number of metastases, inhibition of cancer cell proliferation, induction of cell death in cancer cells, inhibition of angiogenesis near cancer cells, induction of apoptosis of cancer cells, reduction in pain, reduction in risk of recurrence, induction of chemo- or radiosensitivity in cancer cells, prolongation of life, and/or delay of death directly or indirectly related to cancer.

[00107] Furthermore, it is contemplated that the miRNA compositions may be provided as part of a therapy to a patient, in conjunction with traditional therapies or preventative agents. Moreover, it is contemplated that any method discussed in the context of therapy may be applied as preventatively, particularly in a patient identified to be potentially in need of the therapy or at risk of the condition or disease for which a therapy is needed.

[00108] In addition, methods of the invention concern employing one or more nucleic acids corresponding to a miRNA and a therapeutic drug. The nucleic acid can enhance the effect or efficacy of the drug, reduce any side effects or toxicity, modify its bioavailability, and/or decrease the dosage or frequency needed. In certain embodiments, the therapeutic drug is a cancer therapeutic. Consequently, in some embodiments, there is a method of treating cancer in a patient comprising administering to the patient the cancer therapeutic and

an effective amount of at least one miRNA molecule that improves the efficacy of the cancer therapeutic or protects non-cancer cells. Cancer therapies also include a variety of combination therapies with both chemical and radiation based treatments. Combination chemotherapies include but are not limited to, for example, 5-fluorouracil, alemtuzumab, amrubicin, bevacizumab, bleomycin, bortezomib, busulfan, camptothecin, capecitabine, cisplatin (CDDP), carboplatin, cetuximab, chlorambucil, cisplatin (CDDP), EGFR inhibitors (gefitinib and cetuximab), procarbazine, mechlorethamine, cyclophosphamide, camptothecin, COX-2 inhibitors (*e.g.*, celecoxib), cyclophosphamide, cytarabine,) ifosfamide, melphalan, chlorambucil, busulfan, nitrosurea, dactinomycin, dasatinib, daunorubicin, dexamethasone, docetaxel, doxorubicin (adriamycin), EGFR inhibitors (gefitinib and cetuximab), erlotinib, estrogen receptor binding agents, bleomycin, plicomycin, mitomycin, etoposide (VP16), everolimus, tamoxifen, raloxifene, estrogen receptor binding agents, taxol, taxotere, gemcitabien, navelbine, farnesyl-protein transferase inhibitors, gefitinib, gemcitabine, gemtuzumab, ibritumomab, ifosfamide, imatinib mesylate, larotaxel, lapatinib, lonafarnib, mechlorethamine, melphalan, transplatinum, 5-fluorouracil, vincristin, vinblastin and methotrexate, mitomycin, navelbine, nitrosurea, nocodazole, oxaliplatin, paclitaxel, plicomycin, procarbazine, raloxifene, rituximab, sirolimus, sorafenib, sunitinib, tamoxifen, taxol, taxotere, temsirolimus, tipifarnib, tositumomab, transplatinum, trastuzumab, vinblastin, vincristin, or vinorelbine or any analog or derivative variant of the foregoing.

[00109] Generally, inhibitors of miRNAs can be given to decrease the activity of an endogenous miRNA. For example, inhibitors of miRNA molecules that increase cell proliferation can be provided to cells to increase proliferation or inhibitors of such molecules can be provided to cells to decrease cell proliferation. The present invention contemplates these embodiments in the context of the different physiological effects observed with the different miRNA molecules and miRNA inhibitors disclosed herein. These include, but are not limited to, the following physiological effects: increase and decreasing cell proliferation, increasing or decreasing apoptosis, increasing transformation, increasing or decreasing cell viability, activating or inhibiting a kinase (*e.g.*, Erk)ERK, activating/inducing or inhibiting hTert, inhibit stimulation of growth promoting pathway (*e.g.*, Stat 3 signaling), reduce or increase viable cell number, and increase or decrease number of cells at a particular phase of the cell cycle. Methods of the invention are generally contemplated to include providing or introducing one or more different nucleic acid molecules corresponding to one or more different miRNA molecules. It is contemplated that the following, at least the following, or

at most the following number of different nucleic acid or miRNA molecules may be provided or introduced: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, or any range derivable therein. This also applies to the number of different miRNA molecules that can be provided or introduced into a cell.

II. PHARMACEUTICAL FORMULATIONS AND DELIVERY

[00110] Methods of the present invention include the delivery of an effective amount of a miRNA or an expression construct encoding the same. An "effective amount" of the pharmaceutical composition, generally, is defined as that amount sufficient to detectably and repeatedly to achieve the stated desired result, for example, to ameliorate, reduce, minimize or limit the extent of the disease or its symptoms. Other more rigorous definitions may apply, including elimination, eradication or cure of disease.

A. Administration

[00111] In certain embodiments, it is desired to kill cells, inhibit cell growth, inhibit metastasis, decrease tumor or tissue size, and/or reverse or reduce the malignant or disease phenotype of cells. The routes of administration will vary, naturally, with the location and nature of the lesion or site to be targeted, and include, *e.g.*, intradermal, subcutaneous, regional, parenteral, intravenous, intramuscular, intranasal, systemic, and oral administration and formulation. Direct injection, intratumoral injection, or injection into tumor vasculature is specifically contemplated for discrete, solid, accessible tumors, or other accessible target areas. Local, regional, or systemic administration also may be appropriate. For tumors of >4 cm, the volume to be administered will be about 4-10 ml (preferably 10 ml), while for tumors of <4 cm, a volume of about 1-3 ml will be used (preferably 3 ml).

[00112] Multiple injections delivered as a single dose comprise about 0.1 to about 0.5 ml volumes. Compositions of the invention may be administered in multiple injections to a tumor or a targeted site. In certain aspects, injections may be spaced at approximately 1 cm intervals.

[00113] In the case of surgical intervention, the present invention may be used preoperatively, to render an inoperable tumor subject to resection. Alternatively, the present

invention may be used at the time of surgery, and/or thereafter, to treat residual or metastatic disease. For example, a resected tumor bed may be injected or perfused with a formulation comprising a miRNA or combinations thereof. Administration may be continued post-resection, for example, by leaving a catheter implanted at the site of the surgery. Periodic post-surgical treatment also is envisioned. Continuous perfusion of an expression construct or a viral construct also is contemplated.

[00114] Continuous administration also may be applied where appropriate, for example, where a tumor or other undesired affected area is excised and the tumor bed or targeted site is treated to eliminate residual, microscopic disease. Delivery via syringe or catherization is contemplated. Such continuous perfusion may take place for a period from about 1-2 hours, to about 2-6 hours, to about 6-12 hours, to about 12-24 hours, to about 1-2 days, to about 1-2 wk or longer following the initiation of treatment. Generally, the dose of the therapeutic composition via continuous perfusion will be equivalent to that given by a single or multiple injections, adjusted over a period of time during which the perfusion occurs.

[00115] Treatment regimens may vary as well and often depend on tumor type, tumor location, immune condition, target site, disease progression, and health and age of the patient. Certain tumor types will require more aggressive treatment. The clinician will be best suited to make such decisions based on the known efficacy and toxicity (if any) of the therapeutic formulations.

[00116] In certain embodiments, the tumor or affected area being treated may not, at least initially, be resectable. Treatments with compositions of the invention may increase the resectability of the tumor due to shrinkage at the margins or by elimination of certain particularly invasive portions. Following treatments, resection may be possible. Additional treatments subsequent to resection may serve to eliminate microscopic residual disease at the tumor or targeted site.

[00117] Treatments may include various "unit doses." A unit dose is defined as containing a predetermined quantity of a therapeutic composition(s). The quantity to be administered, and the particular route and formulation, are within the skill of those in the clinical arts. A unit dose need not be administered as a single injection but may comprise continuous infusion over a set period of time. With respect to a viral component of the present invention, a unit dose may conveniently be described in terms of μg or mg of miRNA or miRNA

mimetic. Alternatively, the amount specified may be the amount administered as the average daily, average weekly, or average monthly dose.

[00118] miRNA can be administered to the patient in a dose or doses of about or of at least about 0.5, 1, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350, 360, 370, 380, 390, 400, 410, 420, 430, 440, 450, 460, 470, 480, 490, 500, 510, 520, 530, 540, 550, 560, 570, 580, 590, 600, 610, 620, 630, 640, 650, 660, 670, 680, 690, 700, 710, 720, 730, 740, 750, 760, 770, 780, 790, 800, 810, 820, 830, 840, 850, 860, 870, 880, 890, 900, 910, 920, 930, 940, 950, 960, 970, 980, 990, 1000 μg or mg, or more, or any range derivable therein. Alternatively, the amount specified may be the amount administered as the average daily, average weekly, or average monthly dose, or it may be expressed in terms of mg/kg, where kg refers to the weight of the patient and the mg is specified above. In other embodiments, the amount specified is any number discussed above but expressed as mg/m^2 (with respect to tumor size or patient surface area).

B. Injectable Compositions and Formulations

[00119] In some embodiments, the method for the delivery of a miRNA or an expression construct encoding such or combinations thereof is via systemic administration. However, the pharmaceutical compositions disclosed herein may also be administered parenterally, subcutaneously, directly, intratracheally, intravenously, intradermally, intramuscularly, or even intraperitoneally as described in U.S. Patents 5,543,158; 5,641,515 and 5,399,363 (each specifically incorporated herein by reference in its entirety).

[00120] Injection of nucleic acids may be delivered by syringe or any other method used for injection of a solution, as long as the nucleic acid and any associated components can pass through the particular gauge of needle required for injection. A syringe system has also been described for use in gene therapy that permits multiple injections of predetermined quantities of a solution precisely at any depth (U.S. Patent 5,846,225).

[00121] Solutions of the active compounds as free base or pharmacologically acceptable salts may be prepared in water suitably mixed with a surfactant, such as hydroxypropylcellulose. Dispersions may also be prepared in glycerol, liquid polyethylene glycols, mixtures thereof, and in oils. Under ordinary conditions of storage and use, these preparations contain a preservative to prevent the growth of microorganisms. The

pharmaceutical forms suitable for injectable use include sterile aqueous solutions or dispersions and sterile powders for the extemporaneous preparation of sterile injectable solutions or dispersions (U.S. Patent 5,466,468, specifically incorporated herein by reference in its entirety). In all cases the form must be sterile and must be fluid to the extent that easy syringability exists. It must be stable under the conditions of manufacture and storage and must be preserved against the contaminating action of microorganisms, such as bacteria and fungi. The carrier can be a solvent or dispersion medium containing, for example, water, ethanol, polyol (*e.g.*, glycerol, propylene glycol, and liquid polyethylene glycol, and the like), suitable mixtures thereof, and/or vegetable oils. Proper fluidity may be maintained, for example, by the use of a coating, such as lecithin, by the maintenance of the required particle size in the case of dispersion and by the use of surfactants. The prevention of the action of microorganisms can be brought about by various antibacterial and antifungal agents, for example, parabens, chlorobutanol, phenol, sorbic acid, thimerosal, and the like. In many cases, it will be preferable to include isotonic agents, for example, sugars or sodium chloride. Prolonged absorption of the injectable compositions can be brought about by the use in the compositions of agents delaying absorption, for example, aluminum monostearate and gelatin.

[00122] In certain formulations, a water-based formulation is employed while in others, it may be lipid-based. In particular embodiments of the invention, a composition comprising a tumor suppressor protein or a nucleic acid encoding the same is in a water-based formulation. In other embodiments, the formulation is lipid based.

[00123] For parenteral administration in an aqueous solution, for example, the solution should be suitably buffered if necessary and the liquid diluent first rendered isotonic with sufficient saline or glucose. These particular aqueous solutions are especially suitable for intravenous, intramuscular, subcutaneous, intratumoral, intralesional, and intraperitoneal administration. In this connection, sterile aqueous media which can be employed will be known to those of skill in the art in light of the present disclosure. For example, one dosage may be dissolved in 1 ml of isotonic NaCl solution and either added to 1000 ml of hypodermoclysis fluid or injected at the proposed site of infusion, (see for example, "Remington's Pharmaceutical Sciences" 15th Edition, pages 1035-1038 and 1570-1580). Some variation in dosage will necessarily occur depending on the condition of the subject being treated. The person responsible for administration will, in any event, determine the

appropriate dose for the individual subject. Moreover, for human administration, preparations should meet sterility, pyrogenicity, general safety, and purity standards as required by FDA Office of Biologics standards.

[00124] As used herein, a "carrier" includes any and all solvents, dispersion media, vehicles, coatings, diluents, antibacterial and antifungal agents, isotonic and absorption delaying agents, buffers, carrier solutions, suspensions, colloids, and the like. The use of such media and agents for pharmaceutical active substances is well known in the art. Except insofar as any conventional media or agent is incompatible with the active ingredient, its use in the therapeutic compositions is contemplated. Supplementary active ingredients can also be incorporated into the compositions.

[00125] The phrase "pharmaceutically acceptable" refers to molecular entities and compositions that do not produce an allergic or similar untoward reaction when administered to a human.

[00126] The nucleic acid(s) are administered in a manner compatible with the dosage formulation, and in such amount as will be therapeutically effective. The quantity to be administered depends on the subject to be treated, including, *e.g.*, the aggressiveness of the disease or cancer, the size of any tumor(s) or lesions, the previous or other courses of treatment. Precise amounts of active ingredient required to be administered depend on the judgment of the practitioner. Suitable regimes for initial administration and subsequent administration are also variable, but are typified by an initial administration followed by other administrations. Such administration may be systemic, as a single dose, continuous over a period of time spanning 10, 20, 30, 40, 50, 60 minutes, and/or 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24 or more hours, and/or 1, 2, 3, 4, 5, 6, 7, days or more. Moreover, administration may be through a time release or sustained release mechanism, implemented by formulation and/or mode of administration.

C. Combination Treatments

[00127] In certain embodiments, the compositions and methods of the present invention involve a miRNA, or expression construct encoding such. These miRNA compositions can be used in combination with a second therapy to enhance the effect of the miRNA therapy, or increase the therapeutic effect of another therapy being employed. These compositions would be provided in a combined amount effective to achieve the desired effect, such as the

killing of a cancer cell and/or the inhibition of cellular hyperproliferation. This process may involve contacting the cells with the miRNA or second therapy at the same or different time. This may be achieved by contacting the cell with one or more compositions or pharmacological formulation that includes or more of the agents, or by contacting the cell with two or more distinct compositions or formulations, wherein one composition provides (1) miRNA; and/or (2) a second therapy. A second composition or method may be administered that includes a chemotherapy, radiotherapy, surgical therapy, immunotherapy, or gene therapy.

[00128] It is contemplated that one may provide a patient with the miRNA therapy and the second therapy within about 12-24 h of each other and, more preferably, within about 6-12 h of each other. In some situations, it may be desirable to extend the time period for treatment significantly, however, where several days (2, 3, 4, 5, 6 or 7) to several weeks (1, 2, 3, 4, 5, 6, 7 or 8) lapse between the respective administrations.

[00129] In certain embodiments, a course of treatment will last 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90 days or more. It is contemplated that one agent may be given on day 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, and/or 90, any combination thereof, and another agent is given on day 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, and/or 90, or any combination thereof. Within a single day (24-hour period), the patient may be given one or multiple administrations of the agent(s). Moreover, after a course of treatment, it is contemplated that there is a period of time at which no treatment is administered. This time period may last 1, 2, 3, 4, 5, 6, 7 days, and/or 1, 2, 3, 4, 5 weeks, and/or 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months or more, depending on the condition of the patient, such as their prognosis, strength, health, etc.

[00130] Various combinations may be employed, for example miRNA therapy is "A" and a second therapy is "B":

[00131] A/B/A B/A/B B/B/A A/A/B A/B/B B/A/A A/B/B/B B/A/B/B

[00132] B/B/B/A B/B/A/B A/A/B/B A/B/A/B A/B/B/A B/B/A/A

[00133] B/A/B/A B/A/A/B A/A/A/B B/A/A/A A/B/A/A A/A/B/A

[00134] Administration of any compound or therapy of the present invention to a patient will follow general protocols for the administration of such compounds, taking into account the toxicity, if any, of the vector or any protein or other agent. Therefore, in some embodiments there is a step of monitoring toxicity that is attributable to combination therapy. It is expected that the treatment cycles would be repeated as necessary. It also is contemplated that various standard therapies, as well as surgical intervention, may be applied in combination with the described therapy.

[00135] In specific aspects, it is contemplated that a second therapy, such as chemotherapy, radiotherapy, immunotherapy, surgical therapy or other gene therapy, is employed in combination with the miRNA therapy, as described herein.

1. Chemotherapy

[00136] A wide variety of chemotherapeutic agents may be used in accordance with the present invention. The term "chemotherapy" refers to the use of drugs to treat cancer. A "chemotherapeutic agent" is used to connote a compound or composition that is administered in the treatment of cancer. These agents or drugs are categorized by their mode of activity within a cell, for example, whether and at what stage they affect the cell cycle. Alternatively, an agent may be characterized based on its ability to directly cross-link DNA, to intercalate into DNA, or to induce chromosomal and mitotic aberrations by affecting nucleic acid synthesis. Most chemotherapeutic agents fall into the following categories: alkylating agents, antimetabolites, antitumor antibiotics, mitotic inhibitors, and nitrosoureas.

a. Alkylating agents

[00137] Alkylating agents are drugs that directly interact with genomic DNA to prevent the cancer cell from proliferating. This category of chemotherapeutic drugs represents agents that affect all phases of the cell cycle, that is, they are not phase-specific. Alkylating agents

can be implemented to treat chronic leukemia, non-Hodgkin's lymphoma, Hodgkin's disease, multiple myeloma, and particular cancers of the breast, lung, and ovary. They include: busulfan, chlorambucil, cisplatin, cyclophosphamide (cytoxan), dacarbazine, ifosfamide, mechlorethamine (mustargen), and melphalan. Troglitazaone can be used to treat cancer in combination with any one or more of these alkylating agents.

b. Antimetabolites

[00138] Antimetabolites disrupt DNA and RNA synthesis. Unlike alkylating agents, they specifically influence the cell cycle during S phase. They have been used to combat chronic leukemias in addition to tumors of breast, ovary and the gastrointestinal tract. Antimetabolites include 5-fluorouracil (5-FU), cytarabine (Ara-C), fludarabine, gemcitabine, and methotrexate.

[00139] 5-Fluorouracil (5-FU) has the chemical name of 5-fluoro-2,4(1H,3H)-pyrimidinedione. Its mechanism of action is thought to be by blocking the methylation reaction of deoxyuridylic acid to thymidylic acid. Thus, 5-FU interferes with the synthesis of deoxyribonucleic acid (DNA) and to a lesser extent inhibits the formation of ribonucleic acid (RNA). Since DNA and RNA are essential for cell division and proliferation, it is thought that the effect of 5-FU is to create a thymidine deficiency leading to cell death. Thus, the effect of 5-FU is found in cells that rapidly divide, a characteristic of metastatic cancers.

c. Antitumor Antibiotics

[00140] Antitumor antibiotics have both antimicrobial and cytotoxic activity. These drugs also interfere with DNA by chemically inhibiting enzymes and mitosis or altering cellular membranes. These agents are not phase specific so they work in all phases of the cell cycle. Thus, they are widely used for a variety of cancers. Examples of antitumor antibiotics include bleomycin, dactinomycin, daunorubicin, doxorubicin (Adriamycin), and idarubicin, some of which are discussed in more detail below. Widely used in clinical setting for the treatment of neoplasms, these compounds are administered through bolus injections intravenously at doses ranging from 25-75 mg/m^2 at 21 day intervals for adriamycin, to 35-100 mg/m^2 for etoposide intravenously or orally.

d. Mitotic Inhibitors

[00141] Mitotic inhibitors include plant alkaloids and other natural agents that can inhibit either protein synthesis required for cell division or mitosis. They operate during a specific phase during the cell cycle. Mitotic inhibitors comprise docetaxel, etoposide (VP16), paclitaxel, taxol, taxotere, vinblastine, vincristine, and vinorelbine.

e. Nitrosureas

[00142] Nitrosureas, like alkylating agents, inhibit DNA repair proteins. They are used to treat non-Hodgkin's lymphomas, multiple myeloma, malignant melanoma, in addition to brain tumors. Examples include carmustine and lomustine.

2. Radiotherapy

[00143] Radiotherapy, also called radiation therapy, is the treatment of cancer and other diseases with ionizing radiation. Ionizing radiation deposits energy that injures or destroys cells in the area being treated by damaging their genetic material, making it impossible for these cells to continue to grow. Although radiation damages both cancer cells and normal cells, the latter are able to repair themselves and function properly. Radiotherapy may be used to treat localized solid tumors, such as cancers of the skin, tongue, larynx, brain, breast, or cervix. It can also be used to treat leukemia and lymphoma (cancers of the blood-forming cells and lymphatic system, respectively).

[00144] Radiation therapy used according to the present invention may include, but is not limited to, the use of γ-rays, X-rays, and/or the directed delivery of radioisotopes to tumor cells. Other forms of DNA damaging factors are also contemplated such as microwaves, proton beam irradiation (U.S. Patents 5,760,395 and 4,870,287) and UV-irradiation. It is most likely that all of these factors affect a broad range of damage on DNA, on the precursors of DNA, on the replication and repair of DNA, and on the assembly and maintenance of chromosomes. Dosage ranges for X-rays range from daily doses of 50 to 200 roentgens for prolonged periods of time (3 to 4 wk), to single doses of 2000 to 6000 roentgens. Dosage ranges for radioisotopes vary widely, and depend on the half-life of the isotope, the strength and type of radiation emitted, and the uptake by the neoplastic cells. Radiotherapy may comprise the use of radiolabeled antibodies to deliver doses of radiation directly to the cancer site (radioimmunotherapy). Once injected into the body, the antibodies actively seek out the

cancer cells, which are destroyed by the cell-killing (cytotoxic) action of the radiation. This approach can minimize the risk of radiation damage to healthy cells.

[00145] Stereotactic radio-surgery (gamma knife) for brain and other tumors does not use a knife, but very precisely targeted beams of gamma radiotherapy from hundreds of different angles. Only one session of radiotherapy, taking about four to five hours, is needed. For this treatment a specially made metal frame is attached to the head. Then, several scans and x-rays are carried out to find the precise area where the treatment is needed. During the radiotherapy for brain tumors, the patient lies with their head in a large helmet, which has hundreds of holes in it to allow the radiotherapy beams through. Related approaches permit positioning for the treatment of tumors in other areas of the body.

3. Immunotherapy

[00146] In the context of cancer treatment, immunotherapeutics, generally, rely on the use of immune effector cells and molecules to target and destroy cancer cells. Trastuzumab (Herceptin™) is such an example. The immune effector may be, for example, an antibody specific for some marker on the surface of a tumor cell. The antibody alone may serve as an effector of therapy or it may recruit other cells to actually affect cell killing. The antibody also may be conjugated to a drug or toxin (chemotherapeutic, radionuclide, ricin A chain, cholera toxin, pertussis toxin, etc.) and serve merely as a targeting agent. Alternatively, the effector may be a lymphocyte carrying a surface molecule that interacts, either directly or indirectly, with a tumor cell target. Various effector cells include cytotoxic T cells and NK cells. The combination of therapeutic modalities, *i.e.*, direct cytotoxic activity and inhibition or reduction of ErbB2 would provide therapeutic benefit in the treatment of ErbB2 overexpressing cancers.

[00147] In one aspect of immunotherapy, the tumor or disease cell must bear some marker that is amenable to targeting, *i.e.*, is not present on the majority of other cells. Many tumor markers exist and any of these may be suitable for targeting in the context of the present invention. Common tumor markers include carcinoembryonic antigen, prostate specific antigen, urinary tumor associated antigen, fetal antigen, tyrosinase (p97), gp68, TAG-72, HMFG, Sialyl Lewis Antigen, MucA, MucB, PLAP, estrogen receptor, laminin receptor, erb B and p155. An alternative aspect of immunotherapy is to combine anticancer effects with immune stimulatory effects. Immune stimulating molecules also exist including: cytokines such as IL-2, IL-4, IL-12, GM-CSF, gamma-IFN, and chemokines such as MIP-1, MCP-1,

IL-8 and growth factors such as FLT3 ligand. Combining immune stimulating molecules, either as proteins or using gene delivery in combination with a tumor suppressor such as MDA-7 has been shown to enhance anti-tumor effects (Ju *et al.*, 2000). Moreover, antibodies against any of these compounds can be used to target the anti-cancer agents discussed herein.

[00148] Examples of immunotherapies currently under investigation or in use are immune adjuvants *e.g.*, *Mycobacterium bovis*, *Plasmodium falciparum*, dinitrochlorobenzene and aromatic compounds (U.S. Patents 5,801,005 and 5,739,169; Hui and Hashimoto, 1998; Christodoulides *et al.*, 1998), cytokine therapy *e.g.*, interferons α, β and γ; IL-1, GM-CSF and TNF (Bukowski *et al.*, 1998; Davidson *et al.*, 1998; Hellstrand *et al.*, 1998) gene therapy *e.g.*, TNF, IL-1, IL-2, p53 (Qin *et al.*, 1998; Austin-Ward and Villaseca, 1998; U.S. Patents 5,830,880 and 5,846,945) and monoclonal antibodies *e.g.*, anti-ganglioside GM2, anti-HER-2, anti-p185; Pietras *et al.*, 1998; Hanibuchi *et al.*, 1998; U.S. Patent 5,824,311). Herceptin (trastuzumab) is a chimeric (mouse-human) monoclonal antibody that blocks the HER2-neu receptor. It possesses anti-tumor activity and has been approved for use in the treatment of malignant tumors (Dillman, 1999). A non-limiting list of several known anti-cancer immunotherapeutic agents and their targets includes, but is not limted to (Generic Name (Target)) Cetuximab (EGFR), Panitumumab (EGFR), Trastuzumab (erbB2 receptor), Bevacizumab (VEGF), Alemtuzumab (CD52), Gemtuzumab ozogamicin (CD33), Rituximab (CD20), Tositumomab (CD20), Matuzumab (EGFR), Ibritumomab tiuxetan (CD20), Tositumomab (CD20), HuPAM4 (MUC1), MORAb-009 (Mesothelin), G250 (carbonic anhydrase IX), mAb 8H9 (8H9 antigen), M195 (CD33), Ipilimumab (CTLA4), HuLuc63 (CS1), Alemtuzumab (CD53), Epratuzumab (CD22), BC8 (CD45), HuJ591 (Prostate specific membrane antigen), hA20 (CD20), Lexatumumab (TRAIL receptor-2), Pertuzumab (HER-2 receptor), Mik-beta-1 (IL-2R), RAV12 (RAAG12), SGN-30 (CD30), AME-133v (CD20), HeFi-1 (CD30), BMS-663513 (CD137), Volociximab (anti-α5β1 integrin), GC1008 (TGFβ), HCD122 (CD40), Siplizumab (CD2), MORAb-003 (Folate receptor alpha), CNTO 328 (IL-6), MDX-060 (CD30), Ofatumumab (CD20), or SGN-33 (CD33). It is contemplated that one or more of these therapies may be employed with the miRNA therapies described herein.

[00149] A number of different approaches for passive immunotherapy of cancer exist. They may be broadly categorized into the following: injection of antibodies alone; injection of antibodies coupled to toxins or chemotherapeutic agents; injection of antibodies coupled to

radioactive isotopes; injection of anti-idiotype antibodies; and finally, purging of tumor cells in bone marrow.

4. Gene Therapy

[00150] In yet another embodiment, a combination treatment involves gene therapy in which a therapeutic polynucleotide is administered before, after, or at the same time as one or more therapeutic miRNA. Delivery of a therapeutic polypeptide or encoding nucleic acid in conjunction with a miRNA may have a combined therapeutic effect on target tissues. A variety of proteins are encompassed within the invention, some of which are described below. Various genes that may be targeted for gene therapy of some form in combination with the present invention include, but are not limited to inducers of cellular proliferation, inhibitors of cellular proliferation, regulators of programmed cell death, cytokines and other therapeutic nucleic acids or nucleic acid that encode therapeutic proteins.

[00151] The tumor suppressor oncogenes function to inhibit excessive cellular proliferation. The inactivation of these genes destroys their inhibitory activity, resulting in unregulated proliferation. The tumor suppressors (*e.g.*, therapeutic polypeptides) p53, FHIT, p16 and C-CAM can be employed.

[00152] In addition to p53, another inhibitor of cellular proliferation is p16. The major transitions of the eukaryotic cell cycle are triggered by cyclin-dependent kinases, or CDK's. One CDK, cyclin-dependent kinase 4 (CDK4), regulates progression through the G1. The activity of this enzyme may be to phosphorylate Rb at late G1. The activity of CDK4 is controlled by an activating subunit, D-type cyclin, and by an inhibitory subunit, the p16INK4 has been biochemically characterized as a protein that specifically binds to and inhibits CDK4, and thus may regulate Rb phosphorylation (Serrano *et al.*, 1993; Serrano *et al.*, 1995). Since the p16INK4 protein is a CDK4 inhibitor (Serrano, 1993), deletion of this gene may increase the activity of CDK4, resulting in hyperphosphorylation of the Rb protein. p16 also is known to regulate the function of CDK6.

[00153] p16INK4 belongs to a newly described class of CDK-inhibitory proteins that also includes p16B, p19, p21WAF1, and p27KIP1. The p16INK4 gene maps to 9p21, a chromosome region frequently deleted in many tumor types. Homozygous deletions and mutations of the p16INK4 gene are frequent in human tumor cell lines. This evidence suggests that the p16INK4 gene is a tumor suppressor gene. This interpretation has been

challenged, however, by the observation that the frequency of the p16INK4 gene alterations is much lower in primary uncultured tumors than in cultured cell lines (Caldas *et al.*, 1994; Cheng *et al.*, 1994; Hussussian *et al.*, 1994; Kamb *et al.*, 1994; Mori *et al.*, 1994; Okamoto *et al.*, 1994; Nobori *et al.*, 1995; Orlow *et al.*, 1994; Arap *et al.*, 1995). Restoration of wild-type p16INK4 function by transfection with a plasmid expression vector reduced colony formation by some human cancer cell lines (Okamoto, 1994; Arap, 1995).

[00154] Other genes that may be employed according to the present invention include Rb, APC, DCC, NF-1, NF-2, WT-1, MEN-I, MEN-II, zac1, p73, VHL, MMAC1 / PTEN, DBCCR-1, FCC, rsk-3, p27, p27/p16 fusions, p21/p27 fusions, anti-thrombotic genes (*e.g.*, COX-1, TFPI), PGS, Dp, E2F, ras, myc, neu, raf, erb, fms, trk, ret, gsp, hst, abl, E1A, p300, genes involved in angiogenesis (*e.g.*, VEGF, FGF, thrombospondin, BAI-1, GDAIF, or their receptors) and MCC.

5. Surgery

[00155] Approximately 60% of persons with cancer will undergo surgery of some type, which includes preventative, diagnostic or staging, curative and palliative surgery. Curative surgery is a cancer treatment that may be used in conjunction with other therapies, such as the treatment of the present invention, chemotherapy, radiotherapy, hormonal therapy, gene therapy, immunotherapy and/or alternative therapies.

[00156] Curative surgery includes resection in which all or part of cancerous tissue is physically removed, excised, and/or destroyed. Tumor resection refers to physical removal of at least part of a tumor. In addition to tumor resection, treatment by surgery includes laser surgery, cryosurgery, electrosurgery, and microscopically controlled surgery (Mohs' surgery). It is further contemplated that the present invention may be used in conjunction with removal of superficial cancers, precancers, or incidental amounts of normal tissue.

[00157] Upon excision of part of all of cancerous cells, tissue, or tumor, a cavity may be formed in the body. Treatment may be accomplished by perfusion, direct injection or local application of the area with an additional anti-cancer therapy. Such treatment may be repeated, for example, every 1, 2, 3, 4, 5, 6, or 7 days, or every 1, 2, 3, 4, and 5 weeks or every 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12 months. These treatments may be of varying dosages as well.

6. Other Agents

[00158] It is contemplated that other agents may be used in combination with the present invention to improve the therapeutic efficacy of treatment. These additional agents include immunomodulatory agents, agents that affect the upregulation of cell surface receptors and GAP junctions, cytostatic and differentiation agents, inhibitors of cell adhesion, agents that increase the sensitivity of the hyperproliferative cells to apoptotic inducers, or other biological agents. Immunomodulatory agents include tumor necrosis factor; interferon alpha, beta, and gamma; IL-2 and other cytokines; F42K and other cytokine analogs; or MIP-1, MIP-1beta, MCP-1, RANTES, and other chemokines. It is further contemplated that the upregulation of cell surface receptors or their ligands such as Fas / Fas ligand, DR4 or DR5 / TRAIL (Apo-2 ligand) would potentiate the apoptotic inducing abilities of the present invention by establishment of an autocrine or paracrine effect on hyperproliferative cells. Increases intercellular signaling by elevating the number of GAP junctions would increase the anti-hyperproliferative effects on the neighboring hyperproliferative cell population. In other embodiments, cytostatic or differentiation agents can be used in combination with the present invention to improve the anti-hyperproliferative efficacy of the treatments. Inhibitors of cell adhesion are contemplated to improve the efficacy of the present invention. Examples of cell adhesion inhibitors are focal adhesion kinase (FAKs) inhibitors and Lovastatin. It is further contemplated that other agents that increase the sensitivity of a hyperproliferative cell to apoptosis, such as the antibody c225, could be used in combination with the present invention to improve the treatment efficacy.

[00159] Apo2 ligand (Apo2L, also called TRAIL) is a member of the tumor necrosis factor (TNF) cytokine family. TRAIL activates rapid apoptosis in many types of cancer cells, yet is not toxic to normal cells. TRAIL mRNA occurs in a wide variety of tissues. Most normal cells appear to be resistant to TRAIL's cytotoxic action, suggesting the existence of mechanisms that can protect against apoptosis induction by TRAIL. The first receptor described for TRAIL, called death receptor 4 (DR4), contains a cytoplasmic "death domain"; DR4 transmits the apoptosis signal carried by TRAIL. Additional receptors have been identified that bind to TRAIL. One receptor, called DR5, contains a cytoplasmic death domain and signals apoptosis much like DR4. The DR4 and DR5 mRNAs are expressed in many normal tissues and tumor cell lines. Recently, decoy receptors such as DcR1 and DcR2 have been identified that prevent TRAIL from inducing apoptosis through DR4 and DR5. These decoy receptors thus represent a novel mechanism for regulating sensitivity to a pro-

apoptotic cytokine directly at the cell's surface. The preferential expression of these inhibitory receptors in normal tissues suggests that TRAIL may be useful as an anticancer agent that induces apoptosis in cancer cells while sparing normal cells. (Marsters *et al.*, 1999).

[00160] There have been many advances in the therapy of cancer following the introduction of cytotoxic chemotherapeutic drugs. However, one of the consequences of chemotherapy is the development/acquisition of drug-resistant phenotypes and the development of multiple drug resistance. The development of drug resistance remains a major obstacle in the treatment of such tumors and therefore, there is an obvious need for alternative approaches such as gene therapy.

[00161] Another form of therapy for use in conjunction with chemotherapy, radiation therapy or biological therapy includes hyperthermia, which is a procedure in which a patient's tissue is exposed to high temperatures (up to 106°F). External or internal heating devices may be involved in the application of local, regional, or whole-body hyperthermia. Local hyperthermia involves the application of heat to a small area, such as a tumor. Heat may be generated externally with high-frequency waves targeting a tumor from a device outside the body. Internal heat may involve a sterile probe , including thin, heated wires or hollow tubes filled with warm water, implanted microwave antennae, or radiofrequency electrodes.

[00162] A patient's organ or a limb is heated for regional therapy, which is accomplished using devices that produce high energy, such as magnets. Alternatively, some of the patient's blood may be removed and heated before being perfused into an area that will be internally heated. Whole-body heating may also be implemented in cases where cancer has spread throughout the body. Warm-water blankets, hot wax, inductive coils, and thermal chambers may be used for this purpose.

[00163] Hormonal therapy may also be used in conjunction with the present invention or in combination with any other cancer therapy previously described. The use of hormones may be employed in the treatment of certain cancers such as breast, prostate, ovarian, or cervical cancer to lower the level or block the effects of certain hormones such as testosterone or estrogen. This treatment is often used in combination with at least one other cancer therapy as a treatment option or to reduce the risk of metastases.

[00164] This application incorporates U.S. Application Serial No. 11/349,727 filed on February 8, 2006 claiming priority to U.S. Provisional Application Serial No. 60/650,807 filed February 8, 2005 herein by references in its entirety.

III. MIRNA MOLECULES

[00165] MicroRNA molecules ("miRNAs") are generally 21 to 22 nucleotides in length, though lengths of 19 and up to 23 nucleotides have been reported. The miRNAs are each processed from a longer precursor RNA molecule ("precursor miRNA"). Precursor miRNAs are transcribed from non-protein-encoding genes. The precursor miRNAs have two regions of complementarity that enables them to form a stem-loop- or fold-back-like structure, which is cleaved in animals by a ribonuclease III-like nuclease enzyme called Dicer. The processed miRNA is typically a portion of the stem.

[00166] The processed miRNA (also referred to as "mature miRNA") becomes part of a large complex to down-regulate a particular target gene or its gene product. Examples of animal miRNAs include those that imperfectly basepair with the target, which halts translation (Olsen *et al.*, 1999; Seggerson *et al.*, 2002). siRNA molecules also are processed by Dicer, but from a long, double-stranded RNA molecule. siRNAs are not naturally found in animal cells, but they can direct the sequence-specific cleavage of an mRNA target through a RNA-induced silencing complex (RISC) (Denli *et al.*, 2003).

A. Array Preparation

[00167] Certain embodiments of the present invention concerns the preparation and use of mRNA or nucleic acid arrays, miRNA or nucleic acid arrays, and/or miRNA or nucleic acid probe arrays, which are macroarrays or microarrays of nucleic acid molecules (probes) that are fully or nearly complementary (over the length of the prove) or identical (over the length of the prove) to a plurality of nucleic acid, mRNA or miRNA molecules, precursor miRNA molecules, or nucleic acids derived from the various genes and gene pathways modulated by miR-16 miRNAs and that are positioned on a support or support material in a spatially separated organization. Macroarrays are typically sheets of nitrocellulose or nylon upon which probes have been spotted. Microarrays position the nucleic acid probes more densely such that up to 10,000 nucleic acid molecules can be fit into a region typically 1 to 4 square centimeters. Microarrays can be fabricated by spotting nucleic acid molecules, *e.g.*, genes, oligonucleotides, *etc.*, onto substrates or fabricating oligonucleotide sequences *in situ* on a

substrate. Spotted or fabricated nucleic acid molecules can be applied in a high density matrix pattern of up to about 30 non-identical nucleic acid molecules per square centimeter or higher, *e.g.* up to about 100 or even 1000 per square centimeter. Microarrays typically use coated glass as the solid support, in contrast to the nitrocellulose-based material of filter arrays. By having an ordered array of marker RNA and/or miRNA-complementing nucleic acid samples, the position of each sample can be tracked and linked to the original sample.

[00168] A variety of different array devices in which a plurality of distinct nucleic acid probes are stably associated with the surface of a solid support are known to those of skill in the art. Useful substrates for arrays include nylon, glass, metal, plastic, latex, and silicon. Such arrays may vary in a number of different ways, including average probe length, sequence or types of probes, nature of bond between the probe and the array surface, *e.g.* covalent or non-covalent, and the like. The labeling and screening methods of the present invention and the arrays are not limited in its utility with respect to any parameter except that the probes detect miRNA, or genes or nucleic acid representative of genes; consequently, methods and compositions may be used with a variety of different types of nucleic acid arrays.

[00169] Representative methods and apparatus for preparing a microarray have been described, for example, in U.S. Patents 5,143,854; 5,202,231; 5,242,974; 5,288,644; 5,324,633; 5,384,261; 5,405,783; 5,412,087; 5,424,186; 5,429,807; 5,432,049; 5,436,327; 5,445,934; 5,468,613; 5,470,710; 5,472,672; 5,492,806; 5,525,464; 5,503,980; 5,510,270; 5,525,464; 5,527,681; 5,529,756; 5,532,128; 5,545,531; 5,547,839; 5,554,501; 5,556,752; 5,561,071; 5,571,639; 5,580,726; 5,580,732; 5,593,839; 5,599,695; 5,599,672; 5,610;287; 5,624,711; 5,631,134; 5,639,603; 5,654,413; 5,658,734; 5,661,028; 5,665,547; 5,667,972; 5,695,940; 5,700,637; 5,744,305; 5,800,992; 5,807,522; 5,830,645; 5,837,196; 5,871,928; 5,847,219; 5,876,932; 5,919,626; 6,004,755; 6,087,102; 6,368,799; 6,383,749; 6,617,112; 6,638,717; 6,720,138, as well as WO 93/17126; WO 95/11995; WO 95/21265; WO 95/21944; WO 95/35505; WO 96/31622; WO 97/10365; WO 97/27317; WO 99/35505; WO 09923256; WO 09936760; WO0138580; WO 0168255; WO 03020898; WO 03040410; WO 03053586; WO 03087297; WO 03091426; WO03100012; WO 04020085; WO 04027093; EP 373 203; EP 785 280; EP 799 897 and UK 8 803 000; the disclosures of which are all herein incorporated by reference.

[00170] It is contemplated that the arrays can be high density arrays, such that they contain 2, 20, 25, 50, 80, 100 or more different probes. It is contemplated that they may contain 1000, 16,000, 65,000, 250,000 or 1,000,000 or more different probes. The probes can be directed to mRNA and/or miRNA targets in one or more different organisms or cell types. The oligonucleotide probes range from 5 to 50, 5 to 45, 10 to 40, 9 to 34, or 15 to 40 nucleotides in length in some embodiments. In certain embodiments, the oligonucleotide probes are 5, 10, 15, 20 to 20, 25, 30, 35, 40 nucleotides in length including all integers and ranges there between.

[00171] The location and sequence of each different probe sequence in the array are generally known. Moreover, the large number of different probes can occupy a relatively small area providing a high density array having a probe density of generally greater than about 60, 100, 600, 1000, 5,000, 10,000, 40,000, 100,000, or 400,000 different oligonucleotide probes per cm^2. The surface area of the array can be about or less than about 1, 1.6, 2, 3, 4, 5, 6, 7, 8, 9, or 10 cm^2.

[00172] Moreover, a person of ordinary skill in the art could readily analyze data generated using an array. Such protocols are disclosed above, and include information found in WO 9743450; WO 03023058; WO 03022421; WO 03029485; WO 03067217; WO 03066906; WO 03076928; WO 03093810; WO 03100448A1, all of which are specifically incorporated by reference.

B. Sample Preparation

[00173] It is contemplated that the RNA and/or miRNA of a wide variety of samples can be analyzed using the arrays, index of probes, or array technology of the invention. While endogenous miRNA is contemplated for use with compositions and methods of the invention, recombinant miRNA - including nucleic acids that are complementary or identical to endogenous miRNA or precursor miRNA - can also be handled and analyzed as described herein. Samples may be biological samples, in which case, they can be from biopsy, fine needle aspirates, exfoliates, blood, tissue, organs, semen, saliva, tears, other bodily fluid, hair follicles, skin, or any sample containing or constituting biological cells, particularly cancer or hyperproliferative cells. In certain embodiments, samples may be, but are not limited to, biopsy, or cells purified or enriched to some extent from a biopsy or other bodily fluids or tissues. Alternatively, the sample may not be a biological sample, but be a chemical mixture, such as a cell-free reaction mixture (which may contain one or more biological enzymes).

C. Hybridization

[00174] After an array or a set of probes is prepared and/or the nucleic acid in the sample or probe is labeled, the population of target nucleic acids is contacted with the array or probes under hybridization conditions, where such conditions can be adjusted, as desired, to provide for an optimum level of specificity in view of the particular assay being performed. Suitable hybridization conditions are well known to those of skill in the art and reviewed in Sambrook *et al.* (2001) and WO 95/21944. Of particular interest in many embodiments is the use of stringent conditions during hybridization. Stringent conditions are known to those of skill in the art.

[00175] It is specifically contemplated that a single array or set of probes may be contacted with multiple samples. The samples may be labeled with different labels to distinguish the samples. For example, a single array can be contacted with a tumor tissue sample labeled with Cy3, and normal tissue sample labeled with Cy5. Differences between the samples for particular miRNAs corresponding to probes on the array can be readily ascertained and quantified.

[00176] The small surface area of the array permits uniform hybridization conditions, such as temperature regulation and salt content. Moreover, because of the small area occupied by the high density arrays, hybridization may be carried out in extremely small fluid volumes (*e.g.*, about 250 μl or less, including volumes of about or less than about 5, 10, 25, 50, 60, 70, 80, 90, 100 μl, or any range derivable therein). In small volumes, hybridization may proceed very rapidly.

D. Differential Expression Analyses

[00177] Arrays of the invention can be used to detect differences between two samples. Specifically contemplated applications include identifying and/or quantifying differences between miRNA or gene expression from a sample that is normal and from a sample that is not normal, between a disease or condition and a cell not exhibiting such a disease or condition, or between two differently treated samples. Also, miRNA or gene expression may be compared between a sample believed to be susceptible to a particular disease or condition and one believed to be not susceptible or resistant to that disease or condition. A sample that is not normal is one exhibiting phenotypic or genotypic trait(s) of a disease or condition, or one believed to be not normal with respect to that disease or condition. It may be compared

to a cell that is normal with respect to that disease or condition. Phenotypic traits include symptoms of, or susceptibility to, a disease or condition of which a component is or may or may not be genetic, or caused by a hyperproliferative or neoplastic cell or cells.

[00178] An array comprises a solid support with nucleic acid probes attached to the support. Arrays typically comprise a plurality of different nucleic acid probes that are coupled to a surface of a substrate in different, known locations. These arrays, also described as "microarrays" or colloquially "chips" have been generally described in the art, for example, U.S. Patents 5,143,854, 5,445,934, 5,744,305, 5,677,195, 6,040,193, 5,424,186 and Fodor *et al.*, (1991), each of which is incorporated by reference in its entirety for all purposes. Techniques for the synthesis of these arrays using mechanical synthesis methods are described in, *e.g.*, U.S. Patent 5,384,261, incorporated herein by reference in its entirety for all purposes. Although a planar array surface is used in certain aspects, the array may be fabricated on a surface of virtually any shape or even a multiplicity of surfaces. Arrays may be nucleic acids on beads, gels, polymeric surfaces, fibers such as fiber optics, glass or any other appropriate substrate, see U.S. Patents 5,770,358, 5,789,162, 5,708,153, 6,040,193 and 5,800,992, which are hereby incorporated in their entirety for all purposes. Arrays may be packaged in such a manner as to allow for diagnostics or other manipulation of an all inclusive device, see for example, U.S. Patents 5,856,174 and 5,922,591 incorporated in their entirety by reference for all purposes. See also U.S. patent application Ser. No. 09/545,207, filed April, 7, 2000 for additional information concerning arrays, their manufacture, and their characteristics, which is incorporated by reference in its entirety for all purposes.

[00179] Particularly, arrays can be used to evaluate samples with respect to pathological condition such as cancer and related conditions. It is specifically contemplated that the invention can be used to evaluate differences between stages or sub-classifications of disease, such as between benign, cancerous, and metastatic tissues or tumors.

[00180] Phenotypic traits to be assessed include characteristics such as longevity, morbidity, expected survival, susceptibility or receptivity to particular drugs or therapeutic treatments (drug efficacy), and risk of drug toxicity. Samples that differ in these phenotypic traits may also be evaluated using the compositions and methods described.

[00181] In certain embodiments, miRNA and/or expression profiles may be generated to evaluate and correlate those profiles with pharmacokinetics or therapies. For example, these

profiles may be created and evaluated for patient tumor and blood samples prior to the patient's being treated or during treatment to determine if there are miRNA or genes whose expression correlates with the outcome of the patient's treatment. Identification of differential miRNAs or genes can lead to a diagnostic assay for evaluation of tumor and/or blood samples to determine what drug regimen the patient should be provided. In addition, it can be used to identify or select patients suitable for a particular clinical trial. If an expression profile is determined to be correlated with drug efficacy or drug toxicity, that profile is relevant to whether that patient is an appropriate patient for receiving a drug, for receiving a combination of drugs, or for receiving a particular dosage of the drug.

[00182] In addition to the above prognostic assay, samples from patients with a variety of diseases can be evaluated to determine if different diseases can be identified based on miRNA and/or related gene expression levels. A diagnostic assay can be created based on the profiles that doctors can use to identify individuals with a disease or who are at risk to develop a disease. Alternatively, treatments can be designed based on miRNA profiling. Examples of such methods and compositions are described in the U.S. Provisional Patent Application entitled "Methods and Compositions Involving miRNA and miRNA Inhibitor Molecules" filed on May 23, 2005 in the names of David Brown, Lance Ford, Angie Cheng and Rich Jarvis, which is hereby incorporated by reference in its entirety.

E. Other Assays

[00183] In addition to the use of arrays and microarrays, it is contemplated that a number of different assays could be employed to analyze miRNAs or related genes, their activities, and their effects. Such assays include, but are not limited to, nucleic acid amplification, polymerase chain reaction, quantitative PCR, RT-PCR, *in situ* hybridization, Northern hybridization, hybridization protection assay (HPA)(GenProbe), branched DNA (bDNA) assay (Chiron), rolling circle amplification (RCA), single molecule hybridization detection (US Genomics), Invader assay (ThirdWave Technologies), and/or Bridge Litigation Assay (Genaco).

IV. NUCLEIC ACIDS

[00184] The present invention concerns nucleic acids, modified or mimetic nucleic acids, miRNAs, mRNAs, genes, and representative fragments thereof that can be labeled, used in array analysis, or employed in diagnostic, therapeutic, or prognostic applications, particularly

those related to pathological conditions such as cancer. The molecules may have been endogenously produced by a cell, or been synthesized or produced chemically or recombinantly. They may be isolated and/or purified. Each of the miRNAs described herein and includes the corresponding SEQ ID NO and accession numbers for these miRNA sequences. The name of a miRNA is often abbreviated and referred to without a "hsa-" prefix and will be understood as such, depending on the context. Unless otherwise indicated, miRNAs referred to in the application are human sequences identified as miR-X or let-X, where X is a number and/or letter.

[00185] In certain aspects, a miRNA probe designated by a suffix "5P" or "3P" can be used. "5P" indicates that the mature miRNA derives from the 5' end of the precursor and a corresponding "3P" indicates that it derives from the 3' end of the precursor, as described on the world wide web at sanger.ac.uk. Moreover, in some embodiments, a miRNA probe is used that does not correspond to a known human miRNA. It is contemplated that these non-human miRNA probes may be used in embodiments of the invention or that there may exist a human miRNA that is homologous to the non-human miRNA. In other embodiments, any mammalian cell, biological sample, or preparation thereof may be employed.

[00186] In some embodiments of the invention, methods and compositions involving miRNA may concern miRNA, markers (*e.g.*, mRNAs), and/or other nucleic acids. Nucleic acids may be, be at least, or be at most 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350, 360, 370, 380, 390, 400, 410, 420, 430, 440, 450, 460, 470, 480, 490, 500, 510, 520, 530, 540, 550, 560, 570, 580, 590, 600, 610, 620, 630, 640, 650, 660, 670, 680, 690, 700, 710, 720, 730, 740, 750, 760, 770, 780, 790, 800, 810, 820, 830, 840, 850, 860, 870, 880, 890, 900, 910, 920, 930, 940, 950, 960, 970, 980, 990, or 1000 nucleotides, or any range derivable therein, in length. Such lengths cover the lengths of processed miRNA, miRNA probes, precursor miRNA, miRNA containing vectors, mRNA, mRNA probes, control nucleic acids, and other probes and primers.

[00187] In many embodiments, miRNA are 19-24 nucleotides in length, while miRNA probes are 19-35 nucleotides in length, depending on the length of the processed miRNA and any flanking regions added. miRNA precursors are generally between 62 and 110 nucleotides in humans.

[00188] Nucleic acids of the invention may have regions of identity or complementarity to another nucleic acid. It is contemplated that the region of complementarity or identity can be at least 5 contiguous residues, though it is specifically contemplated that the region is, is at least, or is at most 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350, 360, 370, 380, 390, 400, 410, 420, 430, 440, 441, 450, 460, 470, 480, 490, 500, 510, 520, 530, 540, 550, 560, 570, 580, 590, 600, 610, 620, 630, 640, 650, 660, 670, 680, 690, 700, 710, 720, 730, 740, 750, 760, 770, 780, 790, 800, 810, 820, 830, 840, 850, 860, 870, 880, 890, 900, 910, 920, 930, 940, 950, 960, 970, 980, 990, or 1000 contiguous nucleotides. It is further understood that the length of complementarity within a precursor miRNA or other nucleic acid or between a miRNA probe and a miRNA or a miRNA gene are such lengths. Moreover, the complementarity may be expressed as a percentage, meaning that the complementarity between a probe and its target is 90% or greater over the length of the probe. In some embodiments, complementarity is or is at least 90%, 95% or 100%. In particular, such lengths may be applied to any nucleic acid comprising a nucleic acid sequence identified in any of SEQ ID NOs described herein, accession number, or any other sequence disclosed herein. Typically, the commonly used name of the miRNA is given (with its identifying source in the prefix, for example, "hsa" for human sequences) and the processed miRNA sequence. Unless otherwise indicated, a miRNA without a prefix will be understood to refer to a human miRNA. Moreover, a lowercase letter in a miRNA name may or may not be lowercase; for example, hsa-mir-130b can also be referred to as miR-130B. The term "miRNA probe" refers to a nucleic acid probe that can identify a particular miRNA or structurally related miRNAs.

[00189] It is understood that some nucleic acids are derived from genomic sequences or a gene. In this respect, the term "gene" is used for simplicity to refer to the genomic sequence

encoding the precursor nucleic acid or miRNA for a given miRNA or gene. However, embodiments of the invention may involve genomic sequences of a miRNA that are involved in its expression, such as a promoter or other regulatory sequences.

[00190] The term "recombinant" may be used and this generally refers to a molecule that has been manipulated *in vitro* or that is a replicated or expressed product of such a molecule.

[00191] The term "nucleic acid" is well known in the art. A "nucleic acid" as used herein will generally refer to a molecule (one or more strands) of DNA, RNA or a derivative or analog thereof, comprising a nucleobase. A nucleobase includes, for example, a naturally occurring purine or pyrimidine base found in DNA (*e.g.*, an adenine "A," a guanine "G," a thymine "T" or a cytosine "C") or RNA (*e.g.*, an A, a G, an uracil "U" or a C). The term "nucleic acid" encompasses the terms "oligonucleotide" and "polynucleotide," each as a subgenus of the term "nucleic acid."

[00192] The term "miRNA" generally refers to a single-stranded molecule, but in specific embodiments, molecules implemented in the invention will also encompass a region or an additional strand that is partially (between 10 and 50% complementary across length of strand), substantially (greater than 50% but less than 100% complementary across length of strand) or fully complementary to another region of the same single-stranded molecule or to another nucleic acid. Thus, miRNA nucleic acids may encompass a molecule that comprises one or more complementary or self-complementary strand(s) or "complement(s)" of a particular sequence. For example, precursor miRNA may have a self-complementary region, which is up to 100% complementary. miRNA probes or nucleic acids of the invention can include, can be or can be at least 60, 65, 70, 75, 80, 85, 90, 95, 96, 97, 98, 99 or 100% complementary to their target.

[00193] It is understood that a "synthetic nucleic acid" of the invention means that the nucleic acid does not have all or part of a chemical structure or sequence of a naturally occurring nucleic acid. Consequently, it will be understood that the term "synthetic miRNA" refers to a "synthetic nucleic acid" that functions in a cell or under physiological conditions as a naturally occurring miRNA.

[00194] While embodiments of the invention may involve synthetic miRNAs or synthetic nucleic acids, in some embodiments of the invention, the nucleic acid molecule(s) need not be "synthetic." In certain embodiments, a non-synthetic nucleic acid or miRNA employed in

methods and compositions of the invention may have the entire sequence and structure of a naturally occurring mRNA or miRNA precursor or the mature mRNA or miRNA. For example, non-synthetic miRNAs used in methods and compositions of the invention may not have one or more modified nucleotides or nucleotide analogs. In these embodiments, the non-synthetic miRNA may or may not be recombinantly produced. In particular embodiments, the nucleic acid in methods and/or compositions of the invention is specifically a synthetic miRNA and not a non-synthetic miRNA (that is, not a miRNA that qualifies as "synthetic"); though in other embodiments, the invention specifically involves a non-synthetic miRNA and not a synthetic miRNA. Any embodiments discussed with respect to the use of synthetic miRNAs can be applied with respect to non-synthetic miRNAs, and *vice versa*.

[00195] It will be understood that the term "naturally occurring" refers to something found in an organism without any intervention by a person; it could refer to a naturally-occurring wildtype or mutant molecule. In some embodiments a synthetic miRNA molecule does not have the sequence of a naturally occurring miRNA molecule. In other embodiments, a synthetic miRNA molecule may have the sequence of a naturally occurring miRNA molecule, but the chemical structure of the molecule, particularly in the part unrelated specifically to the precise sequence (non-sequence chemical structure) differs from chemical structure of the naturally occurring miRNA molecule with that sequence. In some cases, the synthetic miRNA has both a sequence and non-sequence chemical structure that are not found in a naturally-occurring miRNA. Moreover, the sequence of the synthetic molecules will identify which miRNA is effectively being provided or inhibited; the endogenous miRNA will be referred to as the "corresponding miRNA." Corresponding miRNA sequences that can be used in the context of the invention include, but are not limited to, all or a portion of those sequences in the SEQ IDs provided herein, as well as any other miRNA sequence, miRNA precursor sequence, or any sequence complementary thereof. In some embodiments, the sequence is or is derived from or contains all or part of a sequence identified herein to target a particular miRNA (or set of miRNAs) that can be used with that sequence. Any 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260 or any number or range of sequences there between may be selected to the exclusion of all non-selected sequences.

[00196] As used herein, "hybridization", "hybridizes" or "capable of hybridizing" is understood to mean the forming of a double or triple stranded molecule or a molecule with partial double or triple stranded nature. The term "anneal" as used herein is synonymous with "hybridize." The term "hybridization", "hybridize(s)" or "capable of hybridizing" encompasses the terms "stringent condition(s)" or "high stringency" and the terms "low stringency" or "low stringency condition(s)."

[00197] As used herein "stringent condition(s)" or "high stringency" are those conditions that allow hybridization between or within one or more nucleic acid strand(s) containing complementary sequence(s), but preclude hybridization of random sequences. Stringent conditions tolerate little, if any, mismatch between a nucleic acid and a target strand. Such conditions are well known to those of ordinary skill in the art, and are preferred for applications requiring high selectivity. Non-limiting applications include isolating a nucleic acid, such as a gene or a nucleic acid segment thereof, or detecting at least one specific mRNA transcript or a nucleic acid segment thereof, and the like.

[00198] Stringent conditions may comprise low salt and/or high temperature conditions, such as provided by about 0.02 M to about 0.5 M NaCl at temperatures of about 42°C to about 70°C. It is understood that the temperature and ionic strength of a desired stringency are determined in part by the length of the particular nucleic acid(s), the length and nucleobase content of the target sequence(s), the charge composition of the nucleic acid(s), and to the presence or concentration of formamide, tetramethylammonium chloride or other solvent(s) in a hybridization mixture.

[00199] It is also understood that these ranges, compositions and conditions for hybridization are mentioned by way of non-limiting examples only, and that the desired stringency for a particular hybridization reaction is often determined empirically by comparison to one or more positive or negative controls. Depending on the application envisioned it is preferred to employ varying conditions of hybridization to achieve varying degrees of selectivity of a nucleic acid towards a target sequence. In a non-limiting example, identification or isolation of a related target nucleic acid that does not hybridize to a nucleic acid under stringent conditions may be achieved by hybridization at low temperature and/or high ionic strength. Such conditions are termed "low stringency" or "low stringency conditions," and non-limiting examples of low stringency include hybridization performed at about 0.15 M to about 0.9 M NaCl at a temperature range of about 20°C to about 50°C. Of

course, it is within the skill of one in the art to further modify the low or high stringency conditions to suite a particular application.

A. Nucleobase, Nucleoside, Nucleotide, and Modified Nucleotides

[00200] As used herein a "nucleobase" refers to a heterocyclic base, such as for example a naturally occurring nucleobase (*i.e.*, an A, T, G, C or U) found in at least one naturally occurring nucleic acid (*i.e.*, DNA and RNA), and naturally or non-naturally occurring derivative(s) and analogs of such a nucleobase. A nucleobase generally can form one or more hydrogen bonds ("anneal" or "hybridize") with at least one naturally occurring nucleobase in a manner that may substitute for naturally occurring nucleobase pairing (*e.g.*, the hydrogen bonding between A and T, G and C, and A and U).

[00201] "Purine" and/or "pyrimidine" nucleobase(s) encompass naturally occurring purine and/or pyrimidine nucleobases and also derivative(s) and analog(s) thereof, including but not limited to, those a purine or pyrimidine substituted by one or more of an alkyl, caboxyalkyl, amino, hydroxyl, halogen (*i.e.*, fluoro, chloro, bromo, or iodo), thiol or alkylthiol moiety. Preferred alkyl (*e.g.*, alkyl, carboxyalkyl, *etc.*) moieties comprise of from about 1, about 2, about 3, about 4, about 5, to about 6 carbon atoms. Other non-limiting examples of a purine or pyrimidine include a deazapurine, a 2,6-diaminopurine, a 5-fluorouracil, a xanthine, a hypoxanthine, a 8-bromoguanine, a 8-chloroguanine, a bromothymine, a 8-aminoguanine, a 8-hydroxyguanine, a 8-methylguanine, a 8-thioguanine, an azaguanine, a 2-aminopurine, a 5-ethylcytosine, a 5-methylcyosine, a 5-bromouracil, a 5-ethyluracil, a 5-iodouracil, a 5-chlorouracil, a 5-propyluracil, a thiouracil, a 2-methyladenine, a methylthioadenine, a N,N-diemethyladenine, an azaadenines, a 8-bromoadenine, a 8-hydroxyadenine, a 6-hydroxyaminopurine, a 6-thiopurine, a 4-(6-aminohexyl/cytosine), and the like. Other examples are well known to those of skill in the art.

[00202] As used herein, a "nucleoside" refers to an individual chemical unit comprising a nucleobase covalently attached to a nucleobase linker moiety. A non-limiting example of a "nucleobase linker moiety" is a sugar comprising 5-carbon atoms (*i.e.*, a "5-carbon sugar"), including but not limited to a deoxyribose, a ribose, an arabinose, or a derivative or an analog of a 5-carbon sugar. Non-limiting examples of a derivative or an analog of a 5-carbon sugar include a 2'-fluoro-2'-deoxyribose or a carbocyclic sugar where a carbon is substituted for an oxygen atom in the sugar ring. Different types of covalent attachment(s) of a nucleobase to a nucleobase linker moiety are known in the art (Kornberg and Baker, 1992).

[00203] As used herein, a "nucleotide" refers to a nucleoside further comprising a "backbone moiety". A backbone moiety generally covalently attaches a nucleotide to another molecule comprising a nucleotide, or to another nucleotide to form a nucleic acid. The "backbone moiety" in naturally occurring nucleotides typically comprises a phosphorus moiety, which is covalently attached to a 5-carbon sugar. The attachment of the backbone moiety typically occurs at either the 3'- or 5'-position of the 5-carbon sugar. However, other types of attachments are known in the art, particularly when a nucleotide comprises derivatives or analogs of a naturally occurring 5-carbon sugar or phosphorus moiety.

[00204] A nucleic acid may comprise, or be composed entirely of, a derivative or analog of a nucleobase, a nucleobase linker moiety and/or backbone moiety that may be present in a naturally occurring nucleic acid. RNA with nucleic acid analogs may also be labeled according to methods of the invention. As used herein a "derivative" refers to a chemically modified or altered form of a naturally occurring molecule, while the terms "mimic" or "analog" refer to a molecule that may or may not structurally resemble a naturally occurring molecule or moiety, but possesses similar functions. As used herein, a "moiety" generally refers to a smaller chemical or molecular component of a larger chemical or molecular structure. Nucleobase, nucleoside and nucleotide analogs or derivatives are well known in the art, and have been described (see for example, Scheit, 1980, incorporated herein by reference).

[00205] Additional non-limiting examples of nucleosides, nucleotides or nucleic acids include those in: U.S. Patents 5,681,947, 5,652,099 and 5,763,167, 5,614,617, 5,670,663, 5,872,232, 5,859,221, 5,446,137, 5,886,165, 5,714,606, 5,672,697, 5,466,786, 5,792,847, 5,223,618, 5,470,967, 5,378,825, 5,777,092, 5,623,070, 5,610,289, 5,602,240, 5,858,988, 5,214,136, 5,700,922, 5,708,154, 5,728,525, 5,637,683, 6,251,666, 5,480,980, and 5,728,525, each of which is incorporated herein by reference in its entirety.

[00206] Labeling methods and kits of the invention specifically contemplate the use of nucleotides that are both modified for attachment of a label and can be incorporated into a miRNA molecule. Such nucleotides include those that can be labeled with a dye, including a fluorescent dye, or with a molecule such as biotin. Labeled nucleotides are readily available; they can be acquired commercially or they can be synthesized by reactions known to those of skill in the art.

[00207] Modified nucleotides for use in the invention are not naturally occurring nucleotides, but instead, refer to prepared nucleotides that have a reactive moiety on them. Specific reactive functionalities of interest include: amino, sulfhydryl, sulfoxyl, aminosulfhydryl, azido, epoxide, isothiocyanate, isocyanate, anhydride, monochlorotriazine, dichlorotriazine, mono-or dihalogen substituted pyridine, mono- or disubstituted diazine, maleimide, epoxide, aziridine, sulfonyl halide, acid halide, alkyl halide, aryl halide, alkylsulfonate, N-hydroxysuccinimide ester, imido ester, hydrazine, azidonitrophenyl, azide, 3-(2-pyridyl dithio)-propionamide, glyoxal, aldehyde, iodoacetyl, cyanomethyl ester, p-nitrophenyl ester, o-nitrophenyl ester, hydroxypyridine ester, carbonyl imidazole, and the other such chemical groups. In some embodiments, the reactive functionality may be bonded directly to a nucleotide, or it may be bonded to the nucleotide through a linking group. The functional moiety and any linker cannot substantially impair the ability of the nucleotide to be added to the miRNA or to be labeled. Representative linking groups include carbon containing linking groups, typically ranging from about 2 to 18, usually from about 2 to 8 carbon atoms, where the carbon containing linking groups may or may not include one or more heteroatoms, *e.g.* S, O, N etc., and may or may not include one or more sites of unsaturation. Of particular interest in many embodiments is alkyl linking groups, typically lower alkyl linking groups of 1 to 16, usually 1 to 4 carbon atoms, where the linking groups may include one or more sites of unsaturation. The functionalized nucleotides (or primers) used in the above methods of functionalized target generation may be fabricated using known protocols or purchased from commercial vendors, *e.g.*, Sigma, Roche, Ambion, Biosearch Technologies and NEN. Functional groups may be prepared according to ways known to those of skill in the art, including the representative information found in U.S. Patents 4,404,289; 4,405,711; 4,337,063 and 5,268,486, and U.K.. Patent 1,529,202, which are all incorporated by reference.

[00208] Amine-modified nucleotides are used in several embodiments of the invention. The amine-modified nucleotide is a nucleotide that has a reactive amine group for attachment of the label. It is contemplated that any ribonucleotide (G, A, U, or C) or deoxyribonucleotide (G, A, T, or C) can be modified for labeling. Examples include, but are not limited to, the following modified ribo- and deoxyribo-nucleotides: 5-(3-aminoallyl)-UTP; 8-[(4-amino)butyl]-amino-ATP and 8-[(6-amino)butyl]-amino-ATP; N6-(4-amino)butyl-ATP, N6-(6-amino)butyl-ATP, N4-[2,2-oxy-bis-(ethylamine)]-CTP; N6-(6-Amino)hexyl-ATP; 8-[(6-Amino)hexyl]-amino-ATP; 5-propargylamino-CTP, 5-

propargylamino-UTP; 5-(3-aminoallyl)-dUTP; 8-[(4-amino)butyl]-amino-dATP and 8-[(6-amino)butyl]-amino-dATP; N6-(4-amino)butyl-dATP, N6-(6-amino)butyl-dATP, N4-[2,2-oxy-bis-(ethylamine)]-dCTP; N6-(6-Amino)hexyl-dATP; 8-[(6-Amino)hexyl]-amino-dATP; 5-propargylamino-dCTP, and 5-propargylamino-dUTP. Such nucleotides can be prepared according to methods known to those of skill in the art. Moreover, a person of ordinary skill in the art could prepare other nucleotide entities with the same amine-modification, such as a 5-(3-aminoallyl)-CTP, GTP, ATP, dCTP, dGTP, dTTP, or dUTP in place of a 5-(3-aminoallyl)-UTP.

B. Preparation of Nucleic Acids

[00209] A nucleic acid may be made by any technique known to one of ordinary skill in the art, such as for example, chemical synthesis, enzymatic production, or biological production. It is specifically contemplated that miRNA probes of the invention are chemically synthesized.

[00210] In some embodiments of the invention, miRNAs are recovered or isolated from a biological sample. The miRNA may be recombinant or it may be natural or endogenous to the cell (produced from the cell's genome). It is contemplated that a biological sample may be treated in a way so as to enhance the recovery of small RNA molecules such as miRNA. U.S. Patent Application Serial No. 10/667,126 describes such methods and it is specifically incorporated by reference herein. Generally, methods involve lysing cells with a solution having guanidinium and a detergent.

[00211] Alternatively, nucleic acid synthesis is performed according to standard methods. See, for example, Itakura and Riggs (1980) and U.S. Patents 4,704,362, 5,221,619, and 5,583,013, each of which is incorporated herein by reference. Non-limiting examples of a synthetic nucleic acid (*e.g.*, a synthetic oligonucleotide), include a nucleic acid made by *in vitro* chemically synthesis using phosphotriester, phosphite, or phosphoramidite chemistry and solid phase techniques such as described in EP 266,032, incorporated herein by reference, or *via* deoxynucleoside H-phosphonate intermediates as described by Froehler *et al.*, 1986 and U.S. Patent 5,705,629, each incorporated herein by reference. Various different mechanisms of oligonucleotide synthesis have been disclosed in for example, U.S. Patents 4,659,774, 4,816,571, 5,141,813, 5,264,566, 4,959,463, 5,428,148, 5,554,744, 5,574,146, 5,602,244, each of which is incorporated herein by reference.

[00212] A non-limiting example of an enzymatically produced nucleic acid include one produced by enzymes in amplification reactions such as PCR™ (see for example, U.S. Patents 4,683,202 and 4,682,195, each incorporated herein by reference), or the synthesis of an oligonucleotide described in U.S. Patent 5,645,897, incorporated herein by reference. See also Sambrook *et al.*, 2001, incorporated herein by reference).

[00213] Oligonucleotide synthesis is well known to those of skill in the art. Various different mechanisms of oligonucleotide synthesis have been disclosed in for example, U.S. Patents 4,659,774, 4,816,571, 5,141,813, 5,264,566, 4,959,463, 5,428,148, 5,554,744, 5,574,146, 5,602,244, each of which is incorporated herein by reference.

[00214] Recombinant methods for producing nucleic acids in a cell are well known to those of skill in the art. These include the use of vectors (viral and non-viral), plasmids, cosmids, and other vehicles for delivering a nucleic acid to a cell, which may be the target cell (*e.g.*, a cancer cell) or simply a host cell (to produce large quantities of the desired RNA molecule). Alternatively, such vehicles can be used in the context of a cell free system so long as the reagents for generating the RNA molecule are present. Such methods include those described in Sambrook, 2003, Sambrook, 2001 and Sambrook, 1989, which are hereby incorporated by reference.

C. Isolation of Nucleic Acids

[00215] Nucleic acids may be isolated using techniques well known to those of skill in the art, though in particular embodiments, methods for isolating small nucleic acid molecules, and/or isolating RNA molecules can be employed. Chromatography is a process often used to separate or isolate nucleic acids from protein or from other nucleic acids. Such methods can involve electrophoresis with a gel matrix, filter columns, alcohol precipitation, and/or other chromatography. If miRNA from cells is to be used or evaluated, methods generally involve lysing the cells with a chaotropic (*e.g.*, guanidinium isothiocyanate) and/or detergent (*e.g.*, N-lauroyl sarcosine) prior to implementing processes for isolating particular populations of RNA.

[00216] In particular methods for separating miRNA from other nucleic acids, a gel matrix is prepared using polyacrylamide, though agarose can also be used. The gels may be graded by concentration or they may be uniform. Plates or tubing can be used to hold the gel matrix for electrophoresis. Usually one-dimensional electrophoresis is employed for the separation

of nucleic acids. Plates are used to prepare a slab gel, while the tubing (glass or rubber, typically) can be used to prepare a tube gel. The phrase "tube electrophoresis" refers to the use of a tube or tubing, instead of plates, to form the gel. Materials for implementing tube electrophoresis can be readily prepared by a person of skill in the art or purchased, such as from C.B.S. Scientific Co., Inc. or Scie-Plas.

[00217] Methods may involve the use of organic solvents and/or alcohol to isolate nucleic acids, particularly miRNA used in methods and compositions of the invention. Some embodiments are described in U.S. Patent Application Serial No. 10/667,126, which is hereby incorporated by reference. Generally, this disclosure provides methods for efficiently isolating small RNA molecules from cells comprising: adding an alcohol solution to a cell lysate and applying the alcohol/lysate mixture to a solid support before eluting the RNA molecules from the solid support. In some embodiments, the amount of alcohol added to a cell lysate achieves an alcohol concentration of about 55% to 60%. While different alcohols can be employed, ethanol works well. A solid support may be any structure, and it includes beads, filters, and columns, which may include a mineral or polymer support with electronegative groups. A glass fiber filter or column has worked particularly well for such isolation procedures.

[00218] In specific embodiments, miRNA isolation processes include: a) lysing cells in the sample with a lysing solution comprising guanidinium, wherein a lysate with a concentration of at least about 1 M guanidinium is produced; b) extracting miRNA molecules from the lysate with an extraction solution comprising phenol; c) adding to the lysate an alcohol solution for forming a lysate/alcohol mixture, wherein the concentration of alcohol in the mixture is between about 35% to about 70%; d) applying the lysate/alcohol mixture to a solid support; e) eluting the miRNA molecules from the solid support with an ionic solution; and, f) capturing the miRNA molecules. Typically the sample is dried and resuspended in a liquid and volume appropriate for subsequent manipulation.

V. LABELS AND LABELING TECHNIQUES

[00219] In some embodiments, the present invention concerns miRNA that are labeled. It is contemplated that miRNA may first be isolated and/or purified prior to labeling. This may achieve a reaction that more efficiently labels the miRNA, as opposed to other RNA in a sample in which the miRNA is not isolated or purified prior to labeling. In many embodiments of the invention, the label is non-radioactive. Generally, nucleic acids may be

labeled by adding labeled nucleotides (one-step process) or adding nucleotides and labeling the added nucleotides (two-step process).

A. Labeling Techniques

[00220] In some embodiments, nucleic acids are labeled by catalytically adding to the nucleic acid an already labeled nucleotide or nucleotides. One or more labeled nucleotides can be added to miRNA molecules. See U.S. Patent 6,723,509, which is hereby incorporated by reference.

[00221] In other embodiments, an unlabeled nucleotide or nucleotides is catalytically added to a miRNA, and the unlabeled nucleotide is modified with a chemical moiety that enables it to be subsequently labeled. In embodiments of the invention, the chemical moiety is a reactive amine such that the nucleotide is an amine-modified nucleotide. Examples of amine-modified nucleotides are well known to those of skill in the art, many being commercially available such as from Ambion, Sigma, Jena Bioscience, and TriLink.

[00222] In contrast to labeling of cDNA during its synthesis, the issue for labeling miRNA is how to label the already existing molecule. The present invention concerns the use of an enzyme capable of using a di- or tri-phosphate ribonucleotide or deoxyribonucleotide as a substrate for its addition to a miRNA. Moreover, in specific embodiments, it involves using a modified di- or tri-phosphate ribonucleotide, which is added to the 3' end of a miRNA. Enzymes capable of adding such nucleotides include, but are not limited to, poly(A) polymerase, terminal transferase, and polynucleotide phosphorylase. In specific embodiments of the invention, a ligase is contemplated as not being the enzyme used to add the label, and instead, a non-ligase enzyme is employed. Terminal transferase catalyzes the addition of nucleotides to the 3' terminus of a nucleic acid. Polynucleotide phosphorylase can polymerize nucleotide diphosphates without the need for a primer.

B. Labels

[00223] Labels on miRNA or miRNA probes may be colorimetric (includes visible and UV spectrum, including fluorescent), luminescent, enzymatic, or positron emitting (including radioactive). The label may be detected directly or indirectly. Radioactive labels include ^{125}I, ^{32}P, ^{33}P, and ^{35}S. Examples of enzymatic labels include alkaline phosphatase, luciferase, horseradish peroxidase, and β-galactosidase. Labels can also be proteins with luminescent properties, *e.g.*, green fluorescent protein and phycoerythrin.

[00224] The colorimetric and fluorescent labels contemplated for use as conjugates include, but are not limited to, Alexa Fluor dyes, BODIPY dyes, such as BODIPY FL; Cascade Blue; Cascade Yellow; coumarin and its derivatives, such as 7-amino-4-methylcoumarin, aminocoumarin and hydroxycoumarin; cyanine dyes, such as Cy3 and Cy5; eosins and erythrosins; fluorescein and its derivatives, such as fluorescein isothiocyanate; macrocyclic chelates of lanthanide ions, such as Quantum Dye™; Marina Blue; Oregon Green; rhodamine dyes, such as rhodamine red, tetramethylrhodamine and rhodamine 6G; Texas Red; , fluorescent energy transfer dyes, such as thiazole orange-ethidium heterodimer; and, TOTAB.

[00225] Specific examples of dyes include, but are not limited to, those identified above and the following: Alexa Fluor 350, Alexa Fluor 405, Alexa Fluor 430, Alexa Fluor 488, Alexa Fluor 500. Alexa Fluor 514, Alexa Fluor 532, Alexa Fluor 546, Alexa Fluor 555, Alexa Fluor 568, Alexa Fluor 594, Alexa Fluor 610, Alexa Fluor 633, Alexa Fluor 647, Alexa Fluor 660, Alexa Fluor 680, Alexa Fluor 700, and, Alexa Fluor 750; amine-reactive BODIPY dyes, such as BODIPY 493/503, BODIPY 530/550, BODIPY 558/568, BODIPY 564/570, BODIPY 576/589, BODIPY 581/591, BODIPY 630/650, BODIPY 650/655, BODIPY FL, BODIPY R6G, BODIPY TMR, and, BODIPY-TR; Cy3, Cy5, 6-FAM, Fluorescein Isothiocyanate, HEX, 6-JOE, Oregon Green 488, Oregon Green 500, Oregon Green 514, Pacific Blue, REG, Rhodamine Green, Rhodamine Red, Renographin, ROX, SYPRO, TAMRA, 2',4',5',7'-Tetrabromosulfonefluorescein, and TET.

[00226] Specific examples of fluorescently labeled ribonucleotides are available from Molecular Probes, and these include, Alexa Fluor 488-5-UTP, Fluorescein-12-UTP, BODIPY FL-14-UTP, BODIPY TMR-14-UTP, Tetramethylrhodamine-6-UTP, Alexa Fluor 546-14-UTP, Texas Red-5-UTP, and BODIPY TR-14-UTP. Other fluorescent ribonucleotides are available from Amersham Biosciences, such as Cy3-UTP and Cy5-UTP.

[00227] Examples of fluorescently labeled deoxyribonucleotides include Dinitrophenyl (DNP)-11-dUTP, Cascade Blue-7-dUTP, Alexa Fluor 488-5-dUTP, Fluorescein-12-dUTP, Oregon Green 488-5-dUTP, BODIPY FL-14-dUTP, Rhodamine Green-5-dUTP, Alexa Fluor 532-5-dUTP, BODIPY TMR-14-dUTP, Tetramethylrhodamine-6-dUTP, Alexa Fluor 546-14-dUTP, Alexa Fluor 568-5-dUTP, Texas Red-12-dUTP, Texas Red-5-dUTP, BODIPY TR-14-dUTP, Alexa Fluor 594-5-dUTP, BODIPY 630/650-14-dUTP, BODIPY 650/665-14-

dUTP; Alexa Fluor 488-7-OBEA-dCTP, Alexa Fluor 546-16-OBEA-dCTP, Alexa Fluor 594-7-OBEA-dCTP, Alexa Fluor 647-12-OBEA-dCTP.

[00228] It is contemplated that nucleic acids may be labeled with two different labels. Furthermore, fluorescence resonance energy transfer (FRET) may be employed in methods of the invention (*e.g.*, Klostermeier *et al.*, 2002; Emptage, 2001; Didenko, 2001, each incorporated by reference).

[00229] Alternatively, the label may not be detectable *per se*, but indirectly detectable or allowing for the isolation or separation of the targeted nucleic acid. For example, the label could be biotin, digoxigenin, polyvalent cations, chelator groups and the other ligands, include ligands for an antibody.

C. Visualization Techniques

[00230] A number of techniques for visualizing or detecting labeled nucleic acids are readily available. Such techniques include, microscopy, arrays, Fluorometry, Light cyclers or other real time PCR machines, FACS analysis, scintillation counters, Phosphoimagers, Geiger counters, MRI, CAT, antibody-based detection methods (Westerns, immunofluorescence, immunohistochemistry), histochemical techniques, HPLC (Griffey *et al.*, 1997), spectroscopy, capillary gel electrophoresis (Cummins *et al.*, 1996), spectroscopy; mass spectroscopy; radiological techniques; and mass balance techniques.

[00231] When two or more differentially colored labels are employed, fluorescent resonance energy transfer (FRET) techniques may be employed to characterize association of one or more nucleic acid. Furthermore, a person of ordinary skill in the art is well aware of ways of visualizing, identifying, and characterizing labeled nucleic acids, and accordingly, such protocols may be used as part of the invention. Examples of tools that may be used also include fluorescent microscopy, a BioAnalyzer, a plate reader, Storm (Molecular Dynamics), Array Scanner, FACS (fluorescent activated cell sorter), or any instrument that has the ability to excite and detect a fluorescent molecule.

VI. KITS

[00232] Any of the compositions described herein may be comprised in a kit. In a non-limiting example, reagents for isolating miRNA, labeling miRNA, and/or evaluating a miRNA population using an array, nucleic acid amplification, and/or hybridization can be

included in a kit, as well reagents for preparation of samples from blood samples. The kit may further include reagents for creating or synthesizing miRNA probes. The kits will thus comprise, in suitable container means, an enzyme for labeling the miRNA by incorporating labeled nucleotide or unlabeled nucleotides that are subsequently labeled. In certain aspects, the kit can include amplification reagents. In other aspects, the kit may include various supports, such as glass, nylon, polymeric beads, and the like, and/or reagents for coupling any probes and/or target nucleic acids. It may also include one or more buffers, such as reaction buffer, labeling buffer, washing buffer, or a hybridization buffer, compounds for preparing the miRNA probes, and components for isolating miRNA. Other kits of the invention may include components for making a nucleic acid array comprising miRNA, and thus, may include, for example, a solid support.

[00233] Kits for implementing methods of the invention described herein are specifically contemplated. In some embodiments, there are kits for preparing miRNA for multi-labeling and kits for preparing miRNA probes and/or miRNA arrays. In these embodiments, kit comprise, in suitable container means, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 or more of the following: (1) poly(A) polymerase; (2) unmodified nucleotides (G, A, T, C, and/or U); (3) a modified nucleotide (labeled or unlabeled); (4) poly(A) polymerase buffer; and, (5) at least one microfilter; (6) label that can be attached to a nucleotide; (7) at least one miRNA probe; (8) reaction buffer; (9) a miRNA array or components for making such an array; (10) acetic acid; (11) alcohol; (12) solutions for preparing, isolating, enriching, and purifying miRNAs or miRNA probes or arrays. Other reagents include those generally used for manipulating RNA, such as formamide, loading dye, ribonuclease inhibitors, and DNase.

[00234] In specific embodiments, kits of the invention include an array containing miRNA probes, as described in the application. An array may have probes corresponding to all known miRNAs of an organism or a particular tissue or organ in particular conditions, or to a subset of such probes. The subset of probes on arrays of the invention may be or include those identified as relevant to a particular diagnostic, therapeutic, or prognostic application. For example, the array may contain one or more probes that is indicative or suggestive of (1) a disease or condition (acute myeloid leukemia), (2) susceptibility or resistance to a particular drug or treatment; (3) susceptibility to toxicity from a drug or substance; (4) the stage of development or severity of a disease or condition (prognosis); and (5) genetic predisposition to a disease or condition.

[00235] For any kit embodiment, including an array, there can be nucleic acid molecules that contain or can be used to amplify a sequence that is a variant of, identical to or complementary to all or part of any of SEQ IDs described herein. In certain embodiments, a kit or array of the invention can contain one or more probes for the miRNAs identified by the SEQ IDs described herein. Any nucleic acid discussed above may be implemented as part of a kit.

[00236] The components of the kits may be packaged either in aqueous media or in lyophilized form. The container means of the kits will generally include at least one vial, test tube, flask, bottle, syringe or other container means, into which a component may be placed, and preferably, suitably aliquoted. Where there is more than one component in the kit (labeling reagent and label may be packaged together), the kit also will generally contain a second, third or other additional container into which the additional components may be separately placed. However, various combinations of components may be comprised in a vial. The kits of the present invention also will typically include a means for containing the nucleic acids, and any other reagent containers in close confinement for commercial sale. Such containers may include injection or blow molded plastic containers into which the desired vials are retained.

[00237] When the components of the kit are provided in one and/or more liquid solutions, the liquid solution is an aqueous solution, with a sterile aqueous solution being particularly preferred.

[00238] However, the components of the kit may be provided as dried powder(s). When reagents and/or components are provided as a dry powder, the powder can be reconstituted by the addition of a suitable solvent. It is envisioned that the solvent may also be provided in another container means. In some embodiments, labeling dyes are provided as a dried power. It is contemplated that 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 120, 120, 130, 140, 150, 160, 170, 180, 190, 200, 300, 400, 500, 600, 700, 800, 900, 1000 μg or at least or at most those amounts of dried dye are provided in kits of the invention. The dye may then be resuspended in any suitable solvent, such as DMSO.

[00239] Such kits may also include components that facilitate isolation of the labeled miRNA. It may also include components that preserve or maintain the miRNA or that protect against its degradation. Such components may be RNAse-free or protect against RNAses.

Such kits generally will comprise, in suitable means, distinct containers for each individual reagent or solution.

[00240] A kit will also include instructions for employing the kit components as well the use of any other reagent not included in the kit. Instructions may include variations that can be implemented.

[00241] Kits of the invention may also include one or more of the following: Control RNA; nuclease-free water; RNase-free containers, such as 1.5 ml tubes; RNase-free elution tubes; PEG or dextran; ethanol; acetic acid; sodium acetate; ammonium acetate; guanidinium; detergent; nucleic acid size marker; RNase-free tube tips; and RNase or DNase inhibitors.

[00242] It is contemplated that such reagents are embodiments of kits of the invention. Such kits, however, are not limited to the particular items identified above and may include any reagent used for the manipulation or characterization of miRNA.

VII. EXAMPLES

[00243] The following examples are given for the purpose of illustrating various embodiments of the invention and are not meant to limit the present invention in any fashion. One skilled in the art will appreciate readily that the present invention is well adapted to carry out the objects and obtain the ends and advantages mentioned, as well as those objects, ends and advantages inherent herein. The present examples, along with the methods described herein are presently representative of preferred embodiments, are exemplary, and are not intended as limitations on the scope of the invention. Changes therein and other uses which are encompassed within the spirit of the invention as defined by the scope of the claims will occur to those skilled in the art. Unless otherwise designated, catalog numbers refer to products available by that number from Ambion, Inc.®, The RNA Company.

EXAMPLE 1:

GENE EXPRESSION ANALYSIS FOLLOWING TRANSFECTION WITH HSA-MIR-16

[00244] miRNAs are believed to primarily influence gene expression at the level of translation. Translational regulation leading to an up or down change in protein expression may lead to changes in activity and expression of downstream gene products and genes that

are in turn regulated by those proteins. These regulatory effects would be revealed as changes in the global mRNA expression profile. Furthermore, it has recently been reported that, in some instances, miRNAs may reduce the mRNA levels of their direct targets (Bagga *et al.*, 2005; Lim *et al.*, 2005), and such changes can be observed upon microarray gene expression analysis. Microarray gene expression analyses were performed to identify genes that are mis-regulated by hsa-miR-16.

[00245] Synthetic Pre-miR-16 (Ambion) was reverse transfected into quadruplicate samples of A549 cells for each of three time points. Cells were transfected using siPORT NeoFX (Ambion) according to the manufacturer's recommendations using the following parameters: 200,000 cells per well in a 6 well plate, 5.0 μl of NeoFX, 30 nM final concentration of miRNA in 2.5 ml. Cells were harvested at 4 h, 24 h, and 72 h post transfection. Total RNA was extracted using RNAqueous-4PCR (Ambion) according to the manufacturer's recommended protocol.

[00246] mRNA array analyses were performed by Asuragen Services (Austin,TX), according to the company's standard operating procedures. Using the MessageAmp™ II-96 aRNA Amplification Kit (Ambion, cat #1819) 2 μg of total RNA were used for target preparation and labeling with biotin. cRNA yields were quantified using an Agilent Bioanalyzer 2100 capillary electrophoresis protocol. Labeled target was hybridized to Affymetrix mRNA arrays (Human HG-U133A 2.0 arrays) using the manufacturer's recommendations and the following parameters. Hybridizations were carried out at 45°C for 16 hr in an Affymetrix Model 640 hybridization oven. Arrays were washed and stained on an Affymetrix FS450 Fluidics station, running the wash script Midi_euk2v3_450. The arrays were scanned on a Affymetrix GeneChip Scanner 3000. Summaries of the image signal data, group mean values, p-values with significance flags, log ratios and gene annotations for every gene on the array were generated using the Affymetrix Statistical Algorithm MAS 5.0 (GCOS v1.3). Data were reported in a file (cabinet) containing the Affymetrix data and result files and in files (.cel) containing the primary image and processed cell intensities of the arrays. Data were normalized for the effect observed by the average of two negative control microRNA sequences and then were averaged together for presentation. A list of genes whose expression levels varied by at least 0.7 $\log_2$ from the average negative control was assembled. Results of the microarray gene expression analysis are shown in Table 1.

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Table 1. Genes with increased (positive values) or decreased (negative values) expression following transfection of human cancer cells with pre-miR hsa-miR-16.

Gene Symbol	RefSeq Transcript ID	Δ log_2
ABCB6 /// ATG9A	NM_005689 /// NM_024085	-0.774183
ACOX2	NM_003500	-0.747677
ACTR2	NM_001005386 /// NM_005722	0.706621
ADARB1	NM_001033049 /// NM_001112 /// NM_015833 /// NM_015834	1.12042
ADRB2	NM_000024	0.822471
ANKRD12	NM_015208	0.920296
AOX1	NM_001159	0.71218
ARHGDIA	NM_004309	-1.31009
ARHGDIB	NM_001175	0.974886
ARL2	NM_001667	-1.26863
ARL2BP	NM_012106	1.35222
ATP6V0E	NM_003945	1.25179
AXL	NM_001699 /// NM_021913	1.17272
BAMBI	NM_012342	-0.890685
C4BPB	NM_000716 /// NM_001017364 /// NM_001017365 /// NM_001017366 /// NM_001017367	1.48739
CA12	NM_001218 /// NM_206925	-1.09634
CCND1	NM_053056	-0.747979
CCNG2	NM_004354	0.94188
CDC37L1	NM_017913	-0.851037
CDH1	NM_004360	-0.735543
CDH17	NM_004063	-0.805907
CDKN2C	NM_001262 /// NM_078626	-0.77508
CDS2	NM_003818	-0.948554
CFH /// CFHL1	NM_000186 /// NM_001014975 /// NM_002113	-0.917773
CGI-48	NM_016001	1.48424
CHAF1A	NM_005483	-0.704031
CHUK	NM_001278	-1.05995
COL11A1	NM_001854 /// NM_080629 /// NM_080630	0.7736
COL1A1	NM_000088	-0.705029
CPS1	NM_001875	-0.713235
CTGF	NM_001901	1.22906
CYP4F11	NM_021187	-0.829511
CYP4F3	NM_000896	-1.12563
DDAH1	NM_012137	0.822493
DIO2	NM_000793 /// NM_001007023 /// NM_013989	0.814143
DSU	NM_018000	0.74556
DUSP1	NM_004417	0.773277
E2F8	NM_024680	-0.773773
EEF1D	NM_001960 /// NM_032378	0.95742
EFEMP1	NM_004105 /// NM_018894	0.882177
ENO1	NM_001428	1.00751
FBXO11	NM_012167 /// NM_018693 /// NM_025133	0.924295
FGF2	NM_002006	-1.19115
FGFR4	NM_002011 /// NM_022963 /// NM_213647	-0.872234
FGG	NM_000509 /// NM_021870	-0.813252
FLJ13910	NM_022780	0.846746
FNBP1	NM_015033	0.743257

GALNT7	NM_017423	-1.01457
GBP1	NM_002053	0.807432
HAS2	NM_005328	-0.861488
HEG	XM_087386	0.738182
IFI16	NM_005531	0.829221
INHBC	NM_005538	0.797435
INSL4	NM_002195	-0.916801
KCNJ2	NM_000891	0.857436
KIAA0485	---	0.743897
KLF4	NM_004235	-0.992125
KRT7	NM_005556	1.17333
LCN2	NM_005564	-0.811381
LRP12	NM_013437	-0.882349
MAP7	NM_003980	-0.940371
MCL1	NM_021960 /// NM_182763	1.11653
MYL9	NM_006097 /// NM_181526	1.15849
NAB1	NM_005966	-0.724633
NALP1	NM_001033053 /// NM_014922 /// NM_033004 /// NM_033006 /// NM_033007	0.914964
NF1	NM_000267	-1.03572
NNMT	NM_006169	0.997492
NPC1	NM_000271	0.911858
NUCKS	NM_022731	2.31221
NUPL1	NM_001008564 /// NM_001008565 /// NM_014089	-0.908999
PGK1	NM_000291	1.70175
PHACTR2	NM_014721	-1.1275
PLA2G4A	NM_024420	-0.878708
PLSCR4	NM_020353	-1.92309
PMCH	NM_002674	1.09088
PODXL	NM_001018111 /// NM_005397	0.927375
PPAP2C	NM_003712 /// NM_177526 /// NM_177543	-0.792886
PRO1843	---	1.14274
PTENP1	---	0.952354
PTGS2	NM_000963	-1.72596
PTK9	NM_002822 /// NM_198974	0.970336
PTPN12	NM_002835	0.711122
QKI	NM_006775 /// NM_206853 /// NM_206854 /// NM_206855	0.795792
RAB2	NM_002865	1.24122
RAFTLIN	NM_015150	1.16163
RBL1	NM_002895 /// NM_183404	-0.766312
RDX	NM_002906	0.704751
RHEB	NM_005614	1.07577
RIP	NM_001033002 /// NM_032308	1.34286
RPL14	NM_001034996 /// NM_003973	0.934016
RPL38	NM_000999	1.3638
RPS11	NM_001015	1.22134
RPS6KA3	NM_004586	-0.875649
RPS6KA5	NM_004755 /// NM_182398	0.806899
S100P	NM_005980	-0.840949
SCARB2	NM_005506	0.857602

SEPT6 /// N-PAC	NM_015129 /// NM_032569 /// NM_145799 /// NM_145800 /// NM_145802	0.703914
SKP2	NM_005983 /// NM_032637	0.728768
SLC11A2	NM_000617	-1.01869
SLC4A7	NM_003615	-0.80415
SMARCA2	NM_003070 /// NM_139045	0.967136
SPARC	NM_003118	1.07583
STC1	NM_003155	0.787502
SULT1C1	NM_001056 /// NM_176825	1.12689
SUMO2	NM_001005849 /// NM_006937	0.792739
SYNE1	NM_015293 /// NM_033071 /// NM_133650 /// NM_182961	0.852103
TACC1	NM_006283	-1.02015
TAGLN	NM_001001522 /// NM_003186	1.8698
TFG	NM_001007565 /// NM_006070	0.981989
THBD	NM_000361	0.840966
THBS1	NM_003246	-0.872199
THUMPD1	NM_017736	-0.721243
TMEM45A	NM_018004	-0.874868
TNFSF9	NM_003811	-1.13877
TOX	NM_014729	1.16189
TPM1	NM_000366 /// NM_001018004 /// NM_001018005 /// NM_001018006 /// NM_001018007 //	0.792231
TRA1	NM_003299	2.10346
TRIM22	NM_006074	1.24509
TXN	NM_003329	1.37224
UBE2I	NM_003345 /// NM_194259 /// NM_194260 /// NM_194261	0.882609
UBE2L6	NM_004223 /// NM_198183	0.709343
USP34	NM_014709	0.818893
VDAC3	NM_005662	1.14436
VIL2	NM_003379	0.899532
WISP2	NM_003881	0.703121
XTP2	NM_015172	1.05499
ZBED2	NM_024508	0.770913

[00247] Manipulation of the expression levels of the genes listed in Table 1 represents a potentially useful therapy for cancer and other diseases in which increased or reduced expression of hsa-miR-16 has a role in the disease.

EXAMPLE 2:

CELLULAR PATHWAYS AFFECTED BY HSA-MIR-16

[00248] The mis-regulation of gene expression by hsa-miR-16 (Table 1) affects many cellular pathways that represent potential therapeutic targets for the control of cancer and other diseases and disorders. The inventors determined the identity and nature of the cellular genetic pathways affected by the regulatory cascade induced by hsa-miR-16 expression.

Cellular pathway analyses were performed using Ingenuity Pathways Analysis (Ingenuity® Systems, Redwood City, CA). The most significantly affected pathways following over-expression of hsa-miR-16 in A549 cells are shown in Table 2.

Table 2. Significantly affected functional cellular pathways following hsa-miR-16 over-expression in human cancer cells.

Number of Genes	Pathway Functions
15	Drug Metabolism, Lipid Metabolism, Small Molecule Biochemistry
14	Cancer, Cell Morphology, Cell Cycle
13	Cellular Growth and Proliferation, Cancer, Cellular Development
1	Molecular Transport, Protein Trafficking, Cell-To-Cell Signaling and Interaction
1	Cellular Assembly and Organization, Cell Morphology, Molecular Transport

[00249] These data demonstrate that hsa-miR-16 directly or indirectly affects the expression of numerous metabolic-, cellular proliferation-, cellular development-, and cell cycle-related genes and thus primarily affects functional pathways related to cellular growth, development, and proliferation. Those cellular processes all have integral roles in the development and progression of various cancers. Manipulation of the expression levels of genes in the cellular pathways shown in Table 2 represents a potentially useful therapy for cancer and other diseases in which increased or reduced expression of hsa-miR-16 has a role in the disease.

EXAMPLE 3:

PREDICTED GENE TARGETS OF HSA-MIR-16

[00250] Gene targets for binding of and regulation by hsa-miR-16-1 were predicted using the proprietary algorithm miRNATarget™ (Asuragen) and are shown in Table 3.

Table 3. Predicted target genes of hsa-miR-16.

Gene Symbol	RefSeq Transcript ID	Description
AAA1	NM_207285	AAA1 protein isoform III
AACS	NM_023928	acetoacetyl-CoA synthetase
AADAT	NM_016228	alpha-aminoadipate aminotransferase
AASDHPPT	NM_015423	aminoadipate-semialdehyde
AATF	NM_012138	apoptosis antagonizing transcription factor
ABAT	NM_000663	4-aminobutyrate aminotransferase precursor
ABCA1	NM_005502	ATP-binding cassette, sub-family A member 1
ABCA3	NM_001089	ATP-binding cassette, sub-family A member 3
ABCB8	NM_007188	ATP-binding cassette, sub-family B, member 8
ABCB9	NM_203445	ATP-binding cassette, sub-family B (MDR/TAP),
ABCC10	NM_033450	ATP-binding cassette, sub-family C, member 10
ABCC13	NM_138726	ATP-binding cassette protein C13 isoform a
ABCC3	NM_020038	ATP-binding cassette, sub-family C, member 3
ABCC5	NM_005688	ATP-binding cassette, sub-family C, member 5
ABCF1	NM_001025091	ATP-binding cassette, sub-family F, member 1
ABCF2	NM_005692	ATP-binding cassette, sub-family F, member 2
ABCF3	NM_018358	ATP-binding cassette, sub-family F (GCN20),
ABCG4	NM_022169	ATP-binding cassette, subfamily G, member 4
ABHD11	NM_031295	abhydrolase domain containing 11 isoform 4
ABHD13	NM_032859	hypothetical protein LOC84945
ABHD2	NM_007011	alpha/beta hydrolase domain containing protein
ABI3	NM_016428	NESH protein
ABL1	NM_005157	v-abl Abelson murine leukemia viral oncogene
ABLIM1	NM_001003407	actin-binding LIM protein 1 isoform b
ABTB2	NM_145804	ankyrin repeat and BTB (POZ) domain containing
ACAA1	NM_001607	acetyl-Coenzyme A acyltransferase 1
ACACA	NM_198834	acetyl-Coenzyme A carboxylase alpha isoform 1
ACACB	NM_001093	acetyl-Coenzyme A carboxylase beta
ACAD9	NM_014049	acyl-Coenzyme A dehydrogenase family, member 9
ACCN4	NM_018674	amiloride-sensitive cation channel 4 isoform 1
ACE	NM_152831	angiotensin I converting enzyme isoform 3
ACOT11	NM_147161	thioesterase, adipose associated isoform BFIT2
ACOT7	NM_007274	acyl-CoA thioesterase 7 isoform hBACHa
ACOT8	NM_183385	peroxisomal acyl-CoA thioesterase 1 isoform b
ACOX1	NM_004035	acyl-Coenzyme A oxidase isoform a
ACOX3	NM_003501	acyl-Coenzyme A oxidase 3, pristanoyl
ACP2	NM_001610	lysosomal acid phosphatase 2 precursor
ACPT	NM_080789	testicular acid phosphatase isoform b precursor
ACSBG1	NM_015162	lipidosin
ACSBG2	NM_030924	bubblegum related protein
ACSL1	NM_001995	acyl-CoA synthetase long-chain family member 1
ACSL4	NM_004458	acyl-CoA synthetase long-chain family member 4
ACSL5	NM_016234	acyl-CoA synthetase long-chain family member 5
ACSS2	NM_018677	acyl-CoA synthetase short-chain family member 2
ACTR1A	NM_005736	ARP1 actin-related protein 1 homolog A,
ACTR2	NM_001005386	actin-related protein 2 isoform a
ACTR3B	NM_020445	actin-related protein 3-beta isoform 1
ACTR8	NM_022899	actin-related protein 8

ACVR2A	NM_001616	activin A receptor, type IIA precursor
ADAM10	NM_001110	ADAM metallopeptidase domain 10
ADAM11	NM_002390	ADAM metallopeptidase domain 11 preproprotein
ADAM12	NM_021641	ADAM metallopeptidase domain 12 isoform 2
ADAMTS1	NM_006988	ADAM metallopeptidase with thrombospondin type 1
ADAMTS13	NM_139028	ADAM metallopeptidase with thrombospondin type 1
ADAMTS18	NM_199355	ADAM metallopeptidase with thrombospondin type 1
ADAMTS3	NM_014243	ADAM metallopeptidase with thrombospondin type 1
ADAMTS4	NM_005099	ADAM metallopeptidase with thrombospondin type 1
ADAMTS5	NM_007038	ADAM metallopeptidase with thrombospondin type 1
ADAMTS6	NM_197941	ADAM metallopeptidase with thrombospondin type 1
ADAMTSL1	NM_139238	ADAMTS-like 1 isoform 1
ADAMTSL2	NM_014694	ADAMTS-like 2
ADAMTSL3	NM_207517	ADAMTS-like 3
ADAR	NM_001025107	adenosine deaminase, RNA-specific isoform d
ADARB1	NM_001033049	RNA-specific adenosine deaminase B1 isoform 4
ADARB2	NM_018702	adenosine deaminase, RNA-specific, B2
ADCY1	NM_021116	brain adenylate cyclase 1
ADCY7	NM_001114	adenylate cyclase 7
ADCY9	NM_001116	adenylate cyclase 9
ADD1	NM_001119	adducin 1 (alpha) isoform a
ADD2	NM_017482	adducin 2 isoform b
ADM2	NM_024866	adrenomedullin 2 precusor
ADORA1	NM_000674	adenosine A1 receptor
ADORA2A	NM_000675	adenosine A2a receptor
ADPRH	NM_001125	ADP-ribosylarginine hydrolase
ADRA1B	NM_000679	alpha-1B-adrenergic receptor
ADRA2A	NM_000681	alpha-2A-adrenergic receptor
ADRA2B	NM_000682	alpha-2B-adrenergic receptor
ADRB2	NM_000024	adrenergic, beta-2-, receptor, surface
ADRBK1	NM_001619	beta adrenergic receptor kinase 1
ADSS	NM_001126	adenylosuccinate synthase
AEBP2	NM_153207	AE binding protein 2
AFAP	NM_021638	actin filament associated protein
AFF2	NM_002025	fragile X mental retardation 2
AFF4	NM_014423	ALL1 fused gene from 5q31
AFM	NM_001133	afamin precursor
AGA	NM_000027	aspartylglucosaminidase precursor
AGPAT2	NM_001012727	1-acylglycerol-3-phosphate O-acyltransferase 2
AGPAT4	NM_001012733	1-acylglycerol-3-phosphate O-acyltransferase 4
AGPAT5	NM_018361	1-acylglycerol-3-phosphate O-acyltransferase 5
AGPAT6	NM_178819	lysophosphatidic acid acyltransferase zeta
AGPAT7	NM_153613	PLSC domain containing protein
AGRN	NM_198576	agrin
AGTR2	NM_000686	angiotensin II receptor, type 2
AHCYL1	NM_006621	S-adenosylhomocysteine hydrolase-like 1
AHNAK	NM_024060	AHNAK nucleoprotein isoform 2
AHSA1	NM_012111	AHA1, activator of heat shock 90kDa protein
AIM1	NM_001624	absent in melanoma 1
AK3L1	NM_001005353	adenylate kinase 3-like 1
AKAP1	NM_003488	A-kinase anchor protein 1 isoform 1 precursor
AKAP11	NM_016248	A-kinase anchor protein 11 isoform 1

AKAP12	NM_005100	A-kinase anchor protein 12 isoform 1
AKAP13	NM_006738	A-kinase anchor protein 13 isoform 1
AKNA	NM_030767	AT-hook transcription factor
AKR1CL1	NM_001007536	aldo-keto reductase family 1, member C-like 1
AKR1D1	NM_005989	aldo-keto reductase family 1, member D1
AKT3	NM_005465	v-akt murine thymoma viral oncogene homolog 3
ALAD	NM_000031	delta-aminolevulinic acid dehydratase isoform b
ALDH1A3	NM_000693	aldehyde dehydrogenase 1A3
ALDH3A2	NM_000382	aldehyde dehydrogenase 3A2 isoform 2
ALDH3B1	NM_000694	aldehyde dehydrogenase 3B1 isoform a
ALDH5A1	NM_001080	aldehyde dehydrogenase 5A1 precursor, isoform 2
ALKBH3	NM_139178	alkB, alkylation repair homolog 3
ALKBH5	NM_017758	hypothetical protein LOC54890
ALKBH6	NM_032878	hypothetical protein LOC84964 isoform 2
ALOX12	NM_000697	arachidonate 12-lipoxygenase
ALPK3	NM_020778	alpha-kinase 3
ALPPL2	NM_031313	placental-like alkaline phosphatase
ALS2	NM_020919	alsin
ALS2CL	NM_147129	ALS2 C-terminal like isoform 1
ALS2CR16	NM_205543	amyotrophic lateral sclerosis 2 (juvenile)
ALS2CR2	NM_018571	amyotrophic lateral sclerosis 2 (juvenile)
AMIGO3	NM_198722	amphoterin-induced gene and ORF 3
AMMECR1	NM_001025580	AMMECR1 protein isoform 2
AMOT	NM_133265	angiomotin
AMOTL1	NM_130847	angiomotin like 1
AMOTL2	NM_016201	angiomotin like 2
AMPD2	NM_004037	adenosine monophosphate deaminase 2 (isoform L)
AMPD3	NM_000480	erythrocyte adenosine monophosphate deaminase
AMT	NM_000481	aminomethyltransferase (glycine cleavage system
ANAPC11	NM_001002244	APC11 anaphase promoting complex subunit 11
ANAPC13	NM_015391	anaphase promoting complex subunit 13
ANGEL1	NM_015305	angel homolog 1
ANK1	NM_000037	ankyrin 1 isoform 3
ANK2	NM_001148	ankyrin 2 isoform 1
ANK3	NM_001149	ankyrin 3 isoform 2
ANKRD11	NM_013275	ankyrin repeat domain 11
ANKRD12	NM_015208	ankyrin repeat domain 12
ANKRD13B	NM_152345	hypothetical protein LOC124930
ANKRD13D	NM_207354	ankyrin repeat domain 13 family, member D
ANKRD15	NM_015158	ankyrin repeat domain protein 15 isoform a
ANKRD17	NM_032217	ankyrin repeat domain protein 17 isoform a
ANKRD19	NM_001010925	ankyrin repeat domain 19
ANKRD29	NM_173505	ankyrin repeat domain 29
ANKRD39	NM_016466	ankyrin repeat domain 39
ANKRD46	NM_198401	ankyrin repeat domain 46
ANKRD53	NM_024933	hypothetical protein LOC79998
ANKS1A	NM_015245	ankyrin repeat and sterile alpha motif domain
ANKS4B	NM_145865	harmonin-interacting ankyrin-repeat containing
ANKZF1	NM_018089	ankyrin repeat and zinc finger domain containing
ANLN	NM_018685	anillin, actin binding protein (scraps homolog,
ANP32E	NM_030920	acidic (leucine-rich) nuclear phosphoprotein 32
ANXA11	NM_001157	annexin A11

AP1G1	NM_001030007	adaptor-related protein complex 1, gamma 1
AP1GBP1	NM_007247	AP1 gamma subunit binding protein 1 isoform 1
AP1S1	NM_001283	adaptor-related protein complex 1, sigma 1
AP1S2	NM_003916	adaptor-related protein complex 1 sigma 2
AP2A1	NM_014203	adaptor-related protein complex 2, alpha 1
AP2A2	NM_012305	adaptor-related protein complex 2, alpha 2
AP2B1	NM_001030006	adaptor-related protein complex 2, beta 1
AP3B1	NM_003664	adaptor-related protein complex 3, beta 1
AP3M1	NM_012095	adaptor-related protein complex 3, mu 1 subunit
AP3S2	NM_005829	adaptor-related protein complex 3, sigma 2
APBA1	NM_001163	amyloid beta A4 precursor protein-binding,
APBB3	NM_133175	amyloid beta precursor protein-binding, family
APC2	NM_005883	adenomatosis polyposis coli 2
APLN	NM_017413	apelin preproprotein
APLP2	NM_001642	amyloid beta (A4) precursor-like protein 2
APOA4	NM_000482	apolipoprotein A-IV precursor
APOA5	NM_052968	apolipoprotein AV
APOBEC2	NM_006789	apolipoprotein B mRNA editing enzyme, catalytic
APOC3	NM_000040	apolipoprotein C-III precursor
APP	NM_000484	amyloid beta A4 protein precursor, isoform a
APPBP1	NM_001018159	amyloid beta precursor protein-binding protein 1
APPBP2	NM_006380	amyloid beta precursor protein-binding protein
APTX	NM_017692	aprataxin isoform d
AQP1	NM_198098	aquaporin 1
AQP11	NM_173039	aquaporin 11
AQP2	NM_000486	aquaporin 2
AQP4	NM_001650	aquaporin 4 isoform a
AQP8	NM_001169	aquaporin 8
ARC	NM_015193	activity-regulated cytoskeleton-associated
ARCN1	NM_001655	archain
ARF3	NM_001659	ADP-ribosylation factor 3
ARFGAP1	NM_018209	ADP-ribosylation factor GTPase activating
ARFRP1	NM_003224	ADP-ribosylation factor related protein 1
ARHGAP1	NM_004308	Rho GTPase activating protein 1
ARHGAP10	NM_024605	Rho GTPase activating protein 10
ARHGAP12	NM_018287	Rho GTPase activating protein 12
ARHGAP18	NM_033515	Rho GTPase activating protein 18
ARHGAP19	NM_032900	Rho GTPase activating protein 19
ARHGAP20	NM_020809	Rho GTPase activating protein 20
ARHGAP22	NM_021226	Rho GTPase activating protein 2
ARHGAP26	NM_015071	GTPase regulator associated with the focal
ARHGAP27	NM_199282	Rho GTPase activating protein 27
ARHGAP28	NM_001010000	Rho GTPase activating protein 28 isoform a
ARHGAP4	NM_001666	Rho GTPase activating protein 4
ARHGAP5	NM_001030055	Rho GTPase activating protein 5 isoform a
ARHGDIA	NM_004309	Rho GDP dissociation inhibitor (GDI) alpha
ARHGDIG	NM_001176	Rho GDP dissociation inhibitor (GDI) gamma
ARHGEF10	NM_014629	Rho guanine nucleotide exchange factor 10
ARHGEF12	NM_015313	Rho guanine nucleotide exchange factor (GEF) 12
ARHGEF4	NM_015320	Rho guanine nucleotide exchange factor 4 isoform
ARHGEF5	NM_001002861	rho guanine nucleotide exchange factor 5 isoform
ARHGEF7	NM_145735	Rho guanine nucleotide exchange factor 7 isoform

ARHGEF9	NM_015185	Cdc42 guanine exchange factor 9
ARID5A	NM_006673	AT rich interactive domain 5A isoform 2
ARL1	NM_001177	ADP-ribosylation factor-like 1
ARL10	NM_173664	ADP-ribosylation factor-like 10
ARL11	NM_138450	ADP-ribosylation factor-like 11
ARL2	NM_001667	ADP-ribosylation factor-like 2
ARL3	NM_004311	ADP-ribosylation factor-like 3
ARL5B	NM_178815	ADP-ribosylation factor-like 8
ARL6IP5	NM_006407	ADP-ribosylation-like factor 6 interacting
ARL8B	NM_018184	ADP-ribosylation factor-like 10C
ARMC1	NM_018120	armadillo repeat-containing protein
ARMC5	NM_024742	armadillo repeat containing 5
ARMC6	NM_033415	armadillo repeat containing 6
ARMCX1	NM_016608	armadillo repeat containing, X-linked 1
ARMCX2	NM_014782	ALEX2 protein
ARNT	NM_001668	aryl hydrocarbon receptor nuclear translocator
ARNT2	NM_014862	aryl hydrocarbon receptor nuclear translocator
ARPC1B	NM_005720	actin related protein 2/3 complex subunit 1B
ARPP-19	NM_006628	cyclic AMP phosphoprotein, 19 kD
ARPP-21	NM_001025068	cyclic AMP-regulated phosphoprotein, 21 kD
ARRDC4	NM_183376	arrestin domain containing 4
ARSD	NM_001669	arylsulfatase D isoform a precursor
ARTS-1	NM_016442	type 1 tumor necrosis factor receptor shedding
ARVCF	NM_001670	armadillo repeat protein
AS3MT	NM_020682	arsenic (+3 oxidation state) methyltransferase
ASB1	NM_016114	ankyrin repeat and SOCS box-containing protein
ASB13	NM_024701	ankyrin repeat and SOCS box-containing protein
ASB15	NM_080928	ankyrin repeat and SOCS box-containing 15
ASB6	NM_017873	ankyrin repeat and SOCS box-containing 6 isoform
ASCC3	NM_022091	activating signal cointegrator 1 complex subunit
ASCL2	NM_005170	achaete-scute complex homolog-like 2
ASNSD1	NM_019048	asparagine synthetase domain containing 1
ASPH	NM_032466	aspartate beta-hydroxylase isoform c
ASTN	NM_004319	astrotactin isoform 1
ASXL1	NM_015338	additional sex combs like 1
ASXL2	NM_018263	additional sex combs like 2
ATAD4	NM_024320	ATPase family, AAA domain containing 4
ATF3	NM_004024	activating transcription factor 3 isoform 2
ATF6	NM_007348	activating transcription factor 6
ATF7IP2	NM_024997	activating transcription factor 7 interacting
ATG4B	NM_013325	APG4 autophagy 4 homolog B isoform a
ATG4D	NM_032885	APG4 autophagy 4 homolog D
ATG9A	NM_024085	APG9 autophagy 9-like 1
ATG9B	NM_173681	nitric oxide synthase 3 antisense
ATHL1	NM_025092	hypothetical protein LOC80162
ATN1	NM_001007026	atrophin-1
ATOH8	NM_032827	atonal homolog 8
ATP11A	NM_015205	ATPase, Class VI, type 11A isoform a
ATP11C	NM_001010986	ATPase, Class VI, type 11C isoform b
ATP13A2	NM_022089	ATPase type 13A2
ATP1B2	NM_001678	Na+/K+ -ATPase beta 2 subunit
ATP1B4	NM_012069	ATPase, (Na+)/K+ transporting, beta 4

ATP2A1	NM_004320	ATPase, Ca++ transporting, fast twitch 1 isoform
ATP2A3	NM_005173	sarco/endoplasmic reticulum Ca2+ -ATPase isoform
ATP2B2	NM_001001331	plasma membrane calcium ATPase 2 isoform a
ATP2B3	NM_001001344	plasma membrane calcium ATPase 3 isoform 3b
ATP2B4	NM_001001396	plasma membrane calcium ATPase 4 isoform 4a
ATP4B	NM_000705	ATPase, H+/K+ exchanging, beta polypeptide
ATP6V0B	NM_004047	ATPase, H+ transporting, lysosomal 21kDa, V0
ATP6V0E2L	NM_145230	ATPase, H+ transporting, V0 subunit
ATP6V1B2	NM_001693	vacuolar H+ATPase B2
ATP6V1C1	NM_001007254	ATPase, H+ transporting, lysosomal 42kDa, V1
ATP6V1C2	NM_144583	vacuolar H+ ATPase C2 isoform b
ATP6V1G1	NM_004888	vacuolar H+ ATPase G1
ATP7A	NM_000052	ATPase, Cu++ transporting, alpha polypeptide
ATP7B	NM_000053	ATPase, Cu++ transporting, beta polypeptide
ATP8B3	NM_138813	ATPase, Class I, type 8B, member 3
ATPBD1C	NM_016301	ATP binding domain 1 family, member C
ATRNL1	NM_207303	attractin-like 1
ATXN2	NM_002973	ataxin 2
ATXN7L2	NM_153340	ataxin 7-like 2
AURKAIP1	NM_017900	aurora-A kinase interacting protein
AVEN	NM_020371	cell death regulator aven
AXIN2	NM_004655	axin 2
AXUD1	NM_033027	AXIN1 up-regulated 1
B3GALNT1	NM_003781	UDP-Gal:betaGlcNAc beta
B3GALT5	NM_006057	UDP-Gal:betaGlcNAc beta
B3GALT6	NM_080605	UDP-Gal:betaGal beta 1,3-galactosyltransferase
B3GAT1	NM_018644	beta-1,3-glucuronyltransferase 1
B3GAT3	NM_012200	beta-1,3-glucuronyltransferase 3
B3GNT2	NM_006577	UDP-GlcNAc:betaGal
B3GNT3	NM_014256	UDP-GlcNAc:betaGal
B3GNT4	NM_030765	UDP-GlcNAc:betaGal
B4GALT1	NM_001497	UDP-Gal:betaGlcNAc beta 1,4-
B4GALT2	NM_001005417	UDP-Gal:betaGlcNAc beta 1,4-
B4GALT4	NM_003778	UDP-Gal:betaGlcNAc beta 1,4-
B4GALT5	NM_004776	UDP-Gal:betaGlcNAc beta 1,4-
bA16L21.2.1	NM_001015882	hypothetical protein LOC548645
BAAT	NM_001701	bile acid Coenzyme A: amino acid
BACE1	NM_012104	beta-site APP-cleaving enzyme 1 isoform A
BACE2	NM_138992	beta-site APP-cleaving enzyme 2 isoform B
BACH1	NM_001011545	BTB and CNC homology 1 isoform b
BACH2	NM_021813	BTB and CNC homology 1, basic leucine zipper
BAG3	NM_004281	BCL2-associated athanogene 3
BAG4	NM_004874	BCL2-associated athanogene 4
BAG5	NM_001015048	BCL2-associated athanogene 5 isoform b
BAHD1	NM_014952	bromo adjacent homology domain containing 1
BAI1	NM_001702	brain-specific angiogenesis inhibitor 1
BAIAP2	NM_006340	BAI1-associated protein 2 isoform 3
BAP1	NM_004656	BRCA1 associated protein-1
BAT2D1	NM_015172	HBxAg transactivated protein 2
BAT4	NM_033177	HLA-B associated transcript 4
BAZ1B	NM_032408	bromodomain adjacent to zinc finger domain, 1B
BAZ2A	NM_013449	bromodomain adjacent to zinc finger domain, 2A

BBC3	NM_014417	BCL2 binding component 3
BCAP29	NM_001008406	B-cell receptor-associated protein BAP29 isoform
BCAP31	NM_005745	B-cell receptor-associated protein 31
BCAS1	NM_003657	breast carcinoma amplified sequence 1
BCAS4	NM_001010974	breast carcinoma amplified sequence 4 isoform c
BCL11B	NM_022898	B-cell CLL/lymphoma 11B isoform 2
BCL2	NM_000633	B-cell lymphoma protein 2 alpha isoform
BCL2L1	NM_001191	BCL2-like 1 isoform 2
BCL2L11	NM_006538	BCL2-like 11 isoform 6
BCL2L12	NM_052842	BCL2-like 12 isoform 2
BCL2L14	NM_030766	BCL2-like 14 isoform 2
BCL2L2	NM_004050	BCL2-like 2 protein
BCL7A	NM_001024808	B-cell CLL/lymphoma 7A isoform b
BCL7B	NM_001707	B-cell CLL/lymphoma 7B isoform 1
BCL9	NM_004326	B-cell CLL/lymphoma 9
BCL9L	NM_182557	B-cell CLL/lymphoma 9-like
BCOR	NM_020926	BCL-6 interacting corepressor isoform 2
BCORL1	NM_021946	BCL6 co-repressor-like 1
BCR	NM_004327	breakpoint cluster region isoform 1
BDH2	NM_020139	3-hydroxybutyrate dehydrogenase, type 2
BDKRB2	NM_000623	bradykinin receptor B2
BDNF	NM_001709	brain-derived neurotrophic factor isoform a
BET1L	NM_016526	blocked early in transport 1 homolog (S.
BHLHB2	NM_003670	basic helix-loop-helix domain containing, class
BHLHB3	NM_030762	basic helix-loop-helix domain containing, class
BHMT2	NM_017614	betaine-homocysteine methyltransferase 2
BICD2	NM_001003800	bicaudal D homolog 2 isoform 1
BIK	NM_001197	BCL2-interacting killer
BIN1	NM_004305	bridging integrator 1 isoform 8
BIRC5	NM_001012270	baculoviral IAP repeat-containing protein 5
BLCAP	NM_006698	bladder cancer associated protein
BLMH	NM_000386	bleomycin hydrolase
BLR1	NM_001716	Burkitt lymphoma receptor 1 isoform 1
BMF	NM_001003940	Bcl2 modifying factor isoform bmf-1
BMPER	NM_133468	BMP-binding endothelial regulator precursor
BMPR1A	NM_004329	bone morphogenetic protein receptor, type IA
BMPR2	NM_001204	bone morphogenetic protein receptor type II
BMS1L	NM_014753	BMS1-like, ribosome assembly protein
BMX	NM_001721	BMX non-receptor tyrosine kinase
BNIP1	NM_001205	BCL2/adenovirus E1B 19kD interacting protein 1
BOLA2	NM_001031833	BolA-like protein 2 isoform b
BOLA3	NM_212552	bolA-like 3 isoform 1
BRCA1	NM_007306	breast cancer 1, early onset isoform
BRD1	NM_014577	bromodomain containing protein 1
BRD8	NM_139199	bromodomain containing 8 isoform 2
BRF2	NM_018310	RNA polymerase III transcription initiation
BRI3	NM_015379	brain protein I3
BRMS1	NM_015399	breast cancer metastasis suppressor 1 isoform 1
BRP44L	NM_016098	brain protein 44-like
BRPF3	NM_015695	bromodomain and PHD finger containing, 3
BRS3	NM_001727	bombesin-like receptor 3
BRWD1	NM_001007246	bromodomain and WD repeat domain containing 1

BSDC1	NM_018045	BSD domain containing 1
BSN	NM_003458	bassoon protein
BSND	NM_057176	barttin
BSPRY	NM_017688	B-box and SPRY domain containing
BTAF1	NM_003972	BTAF1 RNA polymerase II, B-TFIID transcription
BTBD14B	NM_052876	transcriptional repressor NAC1
BTBD15	NM_014155	BTB (POZ) domain containing 15
BTBD2	NM_017797	BTB (POZ) domain containing 2
BTBD3	NM_014962	BTB/POZ domain containing protein 3 isoform a
BTBD4	NM_025224	BTB (POZ) domain containing 4
BTBD7	NM_001002860	BTB (POZ) domain containing 7 isoform 1
BTF3	NM_001207	basic transcription factor 3 isoform B
BTG2	NM_006763	B-cell translocation gene 2
BTN1A1	NM_001732	butyrophilin, subfamily 1, member A1
BTRC	NM_003939	beta-transducin repeat containing protein
BUB3	NM_004725	BUB3 budding uninhibited by benzimidazoles 3
BVES	NM_007073	blood vessel epicardial substance
BZW1	NM_014670	basic leucine zipper and W2 domains 1
C10orf108	NM_001012714	hypothetical protein LOC414235
C10orf26	NM_017787	hypothetical protein LOC54838
C10orf39	NM_194303	hypothetical protein LOC282973
C10orf4	NM_145246	FRA10AC1 protein isoform FRA10AC1-1
C10orf42	NM_138357	hypothetical protein LOC90550
C10orf46	NM_153810	hypothetical protein LOC143384
C10orf53	NM_182554	hypothetical protein LOC282966
C10orf54	NM_022153	hypothetical protein LOC64115
C10orf56	NM_153367	hypothetical protein LOC219654
C10orf6	NM_018121	hypothetical protein LOC55719
C10orf63	NM_145010	enkurin
C10orf67	NM_153714	hypothetical protein LOC256815
C10orf7	NM_006023	D123 gene product
C10orf72	NM_144984	hypothetical protein LOC196740 isoform 2
C10orf76	NM_024541	hypothetical protein LOC79591
C10orf77	NM_024789	hypothetical protein LOC79847
C10orf81	NM_024889	hypothetical protein LOC79949
C10orf83	NM_178832	hypothetical protein LOC118812
C10orf9	NM_145012	cyclin fold protein 1 isoform 1
C10orf95	NM_024886	hypothetical protein LOC79946
C11orf10	NM_014206	hypothetical protein LOC746
C11orf11	NM_006133	neural stem cell-derived dendrite regulator
C11orf17	NM_182901	chromosome 11 open reading frame 17
C11orf24	NM_022338	hypothetical protein LOC53838
C11orf42	NM_173525	hypothetical protein LOC160298
C11orf45	NM_145013	hypothetical protein LOC219833
C11orf46	NM_152316	hypothetical protein LOC120534
C11orf49	NM_001003676	hypothetical protein LOC79096 isoform 1
C11orf53	NM_198498	hypothetical protein LOC341032
C11orf55	NM_207428	hypothetical protein LOC399879
C11orf68	NM_031450	basophilic leukemia expressed protein BLES03
C12orf22	NM_030809	TGF-beta induced apoptosis protein 12
C12orf30	NM_024953	hypothetical protein LOC80018
C12orf34	NM_032829	hypothetical protein LOC84915

C12orf38	NM_024809	TECT2
C12orf4	NM_020374	hypothetical protein LOC57102
C12orf47	NM_016534	apoptosis-related protein PNAS-1
C12orf53	NM_153685	hypothetical protein LOC196500
C13orf1	NM_020456	hypothetical protein LOC57213
C13orf18	NM_025113	hypothetical protein LOC80183
C14orf1	NM_007176	hypothetical protein LOC11161
C14orf111	NM_015962	hypothetical protein LOC51077
C14orf129	NM_016472	hypothetical protein LOC51527
C14orf132	NM_020215	hypothetical protein LOC56967
C14orf139	NM_024633	hypothetical protein LOC79686
C14orf143	NM_145231	hypothetical protein LOC90141
C14orf150	NM_001008726	hypothetical protein LOC112840
C14orf32	NM_144578	MAPK-interacting and spindle-stabilizing
C14orf37	NM_001001872	hypothetical protein LOC145407
C14orf4	NM_024496	chromosome 14 open reading frame 4
C14orf43	NM_194278	hypothetical protein LOC91748
C14orf45	NM_025057	hypothetical protein LOC80127
C14orf68	NM_207117	chromosome 14 open reading frame 68
C14orf79	NM_174891	hypothetical protein LOC122616
C15orf37	NM_175898	hypothetical protein LOC283687
C15orf39	NM_015492	hypothetical protein LOC56905
C15orf40	NM_144597	hypothetical protein LOC123207
C15orf41	NM_032499	hypothetical protein LOC84529
C15orf42	NM_152259	leucine-rich repeat kinase 1
C16orf14	NM_138418	hypothetical protein LOC84331
C16orf34	NM_144570	chromosome 16 open reading frame 34
C16orf55	NM_153025	hypothetical protein LOC124045
C16orf56	NM_025082	hypothetical protein LOC80152
C16orf57	NM_024598	hypothetical protein LOC79650
C16orf58	NM_022744	hypothetical protein LOC64755
C16orf63	NM_144600	hypothetical protein LOC123811
C16orf7	NM_004913	chromosome 16 open reading frame 7
C16orf70	NM_025187	lin-10
C17orf27	NM_020914	chromosome 17 open reading frame 27
C17orf32	NM_152464	hypothetical protein LOC147007
C17orf39	NM_024052	hypothetical protein LOC79018
C17orf41	NM_024857	chromosome fragility associated gene 1
C17orf49	NM_174893	hypothetical protein LOC124944
C17orf54	NM_182564	hypothetical protein LOC283982
C17orf56	NM_144679	hypothetical protein LOC146705
C17orf59	NM_017622	hypothetical protein LOC54785
C17orf62	NM_001033046	hypothetical protein LOC79415
C17orf81	NM_203413	S-phase 2 protein isoform 2
C17orf82	NM_203425	hypothetical protein LOC388407
C18orf1	NM_001003674	hypothetical protein LOC753 isoform gamma 1
C18orf25	NM_001008239	chromosome 18 open reading frame 25 isoform b
C18orf34	NM_198995	hypothetical protein LOC374864
C18orf4	NM_032160	hypothetical protein LOC92126
C18orf43	NM_006553	chromosome 18 open reading frame 43
C18orf45	NM_032933	hypothetical protein LOC85019
C18orf54	NM_173529	hypothetical protein LOC162681

C18orf58	NM_173817	hypothetical protein LOC284222
C19orf12	NM_001031726	hypothetical protein LOC83636 isoform 1
C19orf23	NM_152480	hypothetical protein LOC148046
C19orf25	NM_152482	hypothetical protein LOC148223
C19orf26	NM_152769	hypothetical protein LOC255057
C19orf36	NM_001031735	hypothetical protein LOC113177 isoform 1
C19orf6	NM_033420	membralin isoform 2
C1orf101	NM_173807	hypothetical protein LOC257044
C1orf102	NM_145047	oxidored-nitro domain-containing protein isoform
C1orf103	NM_001006945	receptor-interacting factor 1 isoform 2
C1orf107	NM_014388	hypothetical protein LOC27042
C1orf113	NM_024676	hypothetical protein LOC79729
C1orf114	NM_021179	hypothetical protein LOC57821
C1orf115	NM_024709	hypothetical protein LOC79762
C1orf116	NM_023938	specifically androgen-regulated protein
C1orf119	NM_020141	hypothetical protein LOC56900
C1orf126	NM_182534	hypothetical protein LOC200197
C1orf130	NM_001010980	hypothetical protein LOC400746
C1orf142	NM_053052	hypothetical protein LOC116841
C1orf151	NM_001032363	chromosome 1 open reading frame 151 protein
C1orf173	NM_001002912	hypothetical protein LOC127254
C1orf187	NM_198545	chromosome 1 open reading frame 187
C1orf188	NM_173795	hypothetical protein LOC148646
C1orf19	NM_052965	hypothetical protein LOC116461
C1orf190	NM_001013615	hypothetical protein LOC541468
C1orf2	NM_006589	hypothetical protein LOC10712 isoform a
C1orf21	NM_030806	chromosome 1 open reading frame 21
C1orf36	NM_183059	chromosome 1 open reading frame 36
C1orf38	NM_004848	basement membrane-induced gene isoform 1
C1orf54	NM_024579	hypothetical protein LOC79630
C1orf62	NM_152763	hypothetical protein LOC254268
C1orf69	NM_001010867	hypothetical protein LOC200205
C1orf84	NM_001012960	RP11-506B15.1 protein isoform 1
C1orf9	NM_014283	chromosome 1 open reading frame 9 protein
C1orf95	NM_001003665	hypothetical protein LOC375057
C1QA	NM_015991	complement component 1, q subcomponent, A chain
C1QB	NM_000491	complement component 1, q subcomponent, B chain
C1QL3	NM_001010908	complement component 1, q subcomponent-like 3
C1QL4	NM_001008223	hypothetical protein LOC338761
C1QTNF3	NM_030945	C1q and tumor necrosis factor related protein 3
C1QTNF5	NM_015645	C1q and tumor necrosis factor related protein 5
C1QTNF6	NM_031910	C1q and tumor necrosis factor related protein 6
C1QTNF8	NM_207419	hypothetical protein LOC390664
C20orf11	NM_017896	chromosome 20 open reading frame 11
C20orf117	NM_080627	hypothetical protein LOC140710 isoform 1
C20orf121	NM_024331	hypothetical protein LOC79183
C20orf160	NM_080625	hypothetical protein LOC140706
C20orf161	NM_033421	sorting nexin 21 isoform a
C20orf166	NM_178463	hypothetical protein LOC128826
C20orf186	NM_182519	antimicrobial peptide RY2G5
C20orf23	NM_024704	kinesin-like motor protein C20orf23
C20orf29	NM_018347	hypothetical protein LOC55317

C20orf3	NM_020531	chromosome 20 open reading frame 3
C20orf39	NM_024893	hypothetical protein LOC79953
C20orf42	NM_017671	chromosome 20 open reading frame 42
C20orf43	NM_016407	hypothetical protein LOC51507
C20orf44	NM_018244	basic FGF-repressed Zic binding protein isoform
C20orf45	NM_016045	hypothetical protein LOC51012
C20orf46	NM_018354	hypothetical protein LOC55321
C20orf58	NM_152864	hypothetical protein LOC128414
C20orf71	NM_178466	hypothetical protein LOC128861 isoform b
C20orf77	NM_021215	hypothetical protein LOC58490
C20orf96	NM_153269	hypothetical protein LOC140680
C21orf123	NM_199175	hypothetical protein LOC378832
C21orf125	NM_194309	hypothetical protein LOC284836
C21orf129	NM_152506	hypothetical protein LOC150135
C21orf24	NM_001001789	hypothetical protein LOC400866
C21orf25	NM_199050	hypothetical protein LOC25966
C21orf33	NM_004649	es1 protein isoform Ia precursor
C21orf57	NM_001006114	hypothetical protein LOC54059 isoform 2
C21orf58	NM_199071	hypothetical protein LOC54058 isoform 2
C21orf6	NM_016940	hypothetical protein LOC10069
C21orf62	NM_019596	hypothetical protein LOC56245
C21orf69	NM_058189	chromosome 21 open reading frame 69
C21orf84	NM_153752	hypothetical protein LOC114038
C21orf93	NM_145179	hypothetical protein LOC246704
C22orf13	NM_031444	chromosome 22 open reading frame 13
C22orf5	NM_012264	chromosome 22 open reading frame 5
C22orf9	NM_001009880	hypothetical protein LOC23313 isoform b
C2orf17	NM_024293	hypothetical protein LOC79137
C2orf19	NM_001024676	chromosome 2 open reading frame 19
C2orf26	NM_023016	hypothetical protein LOC65124
C3orf10	NM_018462	chromosome 3 open reading frame 10
C3orf18	NM_016210	hypothetical protein LOC51161
C3orf19	NM_016474	hypothetical protein LOC51244
C3orf23	NM_001029839	hypothetical protein LOC285343 isoform 2
C3orf27	NM_007354	putative GR6 protein
C3orf37	NM_001006109	hypothetical protein LOC56941
C3orf56	NM_001007534	hypothetical protein LOC285311
C3orf58	NM_173552	hypothetical protein LOC205428
C4orf15	NM_024511	hypothetical protein LOC79441
C4orf19	NM_018302	hypothetical protein LOC55286
C5orf21	NM_032042	hypothetical protein LOC83989
C5orf24	NM_152409	hypothetical protein LOC134553
C6orf106	NM_022758	chromosome 6 open reading frame 106 isoform b
C6orf128	NM_145316	hypothetical protein LOC221468
C6orf142	NM_138569	hypothetical protein LOC90523
C6orf145	NM_183373	hypothetical protein LOC221749
C6orf151	NM_152551	U11/U12 snRNP 48K
C6orf152	NM_181714	hypothetical protein LOC167691
C6orf155	NM_024882	hypothetical protein LOC79940
C6orf168	NM_032511	hypothetical protein LOC84553
C6orf199	NM_145025	hypothetical protein LOC221264
C6orf35	NM_018452	hypothetical protein LOC55836

C6orf47	NM_021184	G4 protein
C6orf49	NM_013397	over-expressed breast tumor protein
C6orf51	NM_138408	hypothetical protein LOC112495
C6orf55	NM_016485	hypothetical protein LOC51534
C6orf57	NM_145267	hypothetical protein LOC135154
C6orf59	NM_024929	hypothetical protein LOC79992
C6orf64	NM_018322	hypothetical protein LOC55776
C6orf71	NM_203395	chromosome 6 open reading frame 71
C6orf85	NM_021945	ion transporter protein
C7orf16	NM_006658	G-substrate
C7orf19	NM_032831	hypothetical protein LOC80228
C7orf20	NM_015949	hypothetical protein LOC51608
C7orf21	NM_031434	hypothetical protein LOC83590
C7orf29	NM_138434	hypothetical protein LOC113763
C8orf30A	NM_016458	brain protein 16
C8orf38	NM_152416	hypothetical protein LOC137682
C8orf4	NM_020130	chromosome 8 open reading frame 4
C8orf42	NM_175075	hypothetical protein LOC157695
C8orf49	NM_001031839	hypothetical protein LOC606553
C8orf58	NM_001013842	hypothetical protein LOC541565
C8orf70	NM_016010	hypothetical protein LOC51101
C9orf100	NM_032818	hypothetical protein LOC84904
C9orf106	NM_001012715	hypothetical protein LOC414318
C9orf10OS	NM_198841	hypothetical protein LOC158293
C9orf114	NM_016390	hypothetical protein LOC51490
C9orf121	NM_145283	nucleoredoxin
C9orf123	NM_033428	hypothetical protein LOC90871
C9orf128	NM_001012446	hypothetical protein LOC392307
C9orf150	NM_203403	hypothetical protein LOC286343
C9orf163	NM_152571	hypothetical protein LOC158055
C9orf164	NM_182635	hypothetical protein LOC349236
C9orf19	NM_022343	chromosome 9 open reading frame 19
C9orf25	NM_147202	hypothetical protein LOC203259
C9orf26	NM_033439	interleukin 33
C9orf28	NM_001011703	hypothetical protein LOC89853 isoform 2
C9orf3	NM_032823	aminopeptidase O
C9orf42	NM_138333	hypothetical protein LOC116224
C9orf48	NM_194313	hypothetical protein LOC347240
C9orf5	NM_032012	hypothetical protein LOC23731
C9orf61	NM_004816	chromosome 9 open reading frame 61
C9orf66	NM_152569	hypothetical protein LOC157983
C9orf7	NM_017586	hypothetical protein LOC11094
C9orf74	NM_030914	hypothetical protein LOC81605
C9orf82	NM_024828	hypothetical protein LOC79886
C9orf88	NM_022833	hypothetical protein LOC64855
C9orf89	NM_032310	chromosome 9 open reading frame 89
C9orf91	NM_153045	hypothetical protein LOC203197
CA12	NM_001218	carbonic anhydrase XII isoform 1 precursor
CA2	NM_000067	carbonic anhydrase II
CA8	NM_004056	carbonic anhydrase VIII
CAB39	NM_016289	calcium binding protein 39
CAB39L	NM_030925	calcium binding protein 39-like isoform 2

CABC1	NM_020247	chaperone, ABC1 activity of bc1 complex like
CABLES2	NM_031215	Cdk5 and Abl enzyme substrate 2
CABP1	NM_001033677	calcium binding protein 1 isoform 3
CABP7	NM_182527	calcium binding protein 7
CACNA1E	NM_000721	calcium channel, voltage-dependent, alpha 1E
CACNA1I	NM_001003406	voltage-dependent T-type calcium channel
CACNA2D4	NM_001005737	voltage-gated calcium channel alpha(2)delta-4
CACNB1	NM_000723	calcium channel, voltage-dependent, beta 1
CACNB4	NM_000726	calcium channel, voltage-dependent, beta 4
CAD	NM_004341	carbamoylphosphate synthetase 2/aspartate
CALB2	NM_001740	calbindin 2 full length protein isoform
CALM1	NM_006888	calmodulin 1
CALML4	NM_033429	calmodulin-like 4 isoform 2
CALML5	NM_017422	calmodulin-like skin protein
CALML6	NM_138705	calmodulin-like 6
CALN1	NM_001017440	calneuron 1
CALU	NM_001219	calumenin precursor
CAMK2A	NM_015981	calcium/calmodulin-dependent protein kinase IIA
CAMK2G	NM_001222	calcium/calmodulin-dependent protein kinase II
CAMKK2	NM_006549	calcium/calmodulin-dependent protein kinase
CAMKV	NM_024046	CaM kinase-like vesicle-associated
CAMSAP1	NM_015447	calmodulin regulated spectrin-associated protein
CAMSAP1L1	NM_203459	calmodulin regulated spectrin-associated protein
CANX	NM_001024649	calnexin precursor
CAP1	NM_006367	adenylyl cyclase-associated protein
CAP2	NM_006366	adenylyl cyclase-associated protein 2
CAPN12	NM_144691	calpain 12
CAPN3	NM_212464	calpain 3 isoform g
CAPN5	NM_004055	calpain 5
CAPN6	NM_014289	calpain 6
CAPS	NM_004058	calcyphosine isoform a
CAPZA2	NM_006136	capping protein (actin filament) muscle Z-line,
CARD10	NM_014550	caspase recruitment domain protein 10
CARD14	NM_052819	caspase recruitment domain protein 14 isoform 2
CARD4	NM_006092	caspase recruitment domain family, member 4
CARM1	NM_199141	coactivator-associated arginine
CARS	NM_001014437	cysteinyl-tRNA synthetase isoform c
CASKIN1	NM_020764	CASK interacting protein 1
CASP10	NM_001230	caspase 10 isoform a preproprotein
CASP4	NM_033307	caspase 4 isoform delta
CASQ2	NM_001232	cardiac calsequestrin 2
CASR	NM_000388	calcium-sensing receptor
CAST	NM_173060	calpastatin isoform b
CAST1	NM_015576	cytomatrix protein p110
CASZ1	NM_017766	castor homolog 1, zinc finger
CBARA1	NM_006077	calcium binding atopy-related autoantigen 1
CBFA2T2	NM_001032999	core-binding factor, runt domain, alpha subunit
CBFA2T3	NM_005187	myeloid translocation gene-related protein 2
CBFB	NM_001755	core-binding factor, beta subunit isoform 2
CBL	NM_005188	Cas-Br-M (murine) ecotropic retroviral
CBLC	NM_012116	Cas-Br-M (murine) ecotropic retroviral
CBR3	NM_001236	carbonyl reductase 3

CBX2	NM_005189	chromobox homolog 2 isoform 1
CBX4	NM_003655	chromobox homolog 4
CC2D1B	NM_032449	coiled-coil and C2 domain containing 1B
CCDC18	NM_206886	sarcoma antigen NY-SAR-41
CCDC19	NM_012337	nasopharyngeal epithelium specific protein 1
CCDC21	NM_022778	coiled-coil domain containing 21
CCDC25	NM_001031708	coiled-coil domain containing 25 isoform 1
CCDC28A	NM_015439	hypothetical protein LOC25901
CCDC3	NM_031455	coiled-coil domain containing 3
CCDC32	NM_052849	coiled-coil domain containing 32
CCDC4	NM_207406	hypothetical protein LOC389206
CCDC44	NM_016360	clone HQ0477 PRO0477p
CCDC47	NM_020198	hypothetical protein LOC57003
CCDC52	NM_144718	coiled-coil domain containing 52
CCDC55	NM_001033563	hypothetical protein LOC84081 isoform 2
CCDC6	NM_005436	coiled-coil domain containing 6
CCDC68	NM_025214	CTCL tumor antigen se57-1
CCDC80	NM_199511	steroid-sensitive protein 1
CCDC81	NM_021827	hypothetical protein LOC60494
CCDC83	NM_173556	hypothetical protein LOC220047
CCDC88	NM_032251	hypothetical protein LOC283234
CCDC94	NM_018074	hypothetical protein LOC55702
CCDC95	NM_173618	coiled-coil domain containing 95
CCDC97	NM_052848	hypothetical protein LOC90324
CCL15	NM_004167	chemokine (C-C motif) ligand 15 precursor
CCL22	NM_002990	small inducible cytokine A22 precursor
CCND1	NM_053056	cyclin D1
CCND2	NM_001759	cyclin D2
CCND3	NM_001760	cyclin D3
CCNE1	NM_001238	cyclin E1 isoform 1
CCNE2	NM_057735	cyclin E2 isoform 2
CCNF	NM_001761	cyclin F
CCNJ	NM_019084	cyclin J
CCNT2	NM_001241	cyclin T2 isoform a
CCR7	NM_001838	chemokine (C-C motif) receptor 7 precursor
CCR9	NM_006641	chemokine (C-C motif) receptor 9 isoform B
CCRK	NM_012119	cell cycle related kinase isoform 2
CCS	NM_005125	copper chaperone for superoxide dismutase
CD151	NM_004357	CD151 antigen
CD163	NM_004244	CD163 antigen isoform a
CD164	NM_006016	CD164 antigen, sialomucin
CD180	NM_005582	CD180 antigen
CD200R1	NM_138806	CD200 receptor 1 isoform a
CD209	NM_021155	CD209 antigen
CD22	NM_001771	CD22 antigen
CD274	NM_014143	CD274 antigen
CD276	NM_001024736	CD276 antigen isoform a
CD28	NM_006139	CD28 antigen
CD300C	NM_006678	CD300C antigen
CD300LG	NM_145273	triggering receptor expressed on myeloid cells
CD302	NM_014880	CD302 antigen
CD37	NM_001774	CD37 antigen isoform A

CD3E	NM_000733	CD3E antigen, epsilon polypeptide (TiT3
CD4	NM_000616	CD4 antigen precursor
CD40	NM_001250	CD40 antigen isoform 1 precursor
CD47	NM_001025079	CD47 molecule isoform 3 precursor
CD48	NM_001778	CD48 antigen (B-cell membrane protein)
CD5	NM_014207	CD5 antigen (p56-62)
CD6	NM_006725	CD6 antigen
CD69	NM_001781	CD69 antigen (p60, early T-cell activation
CD80	NM_005191	CD80 antigen (CD28 antigen ligand 1, B7-1
CD82	NM_001024844	CD82 antigen isoform 2
CD83	NM_004233	CD83 antigen isoform a
CD93	NM_012072	CD93 antigen precursor
CD97	NM_001025160	CD97 antigen isoform 3 precursor
CD99L2	NM_031462	CD99 antigen-like 2 isoform E3'-E4'-E3-E4
CDADC1	NM_030911	cytidine and dCMP deaminase domain containing 1
CDC14A	NM_003672	CDC14 homolog A isoform 1
CDC14B	NM_003671	CDC14 homolog B isoform 1
CDC23	NM_004661	cell division cycle protein 23
CDC25A	NM_001789	cell division cycle 25A isoform a
CDC25B	NM_004358	cell division cycle 25B isoform 2
CDC25C	NM_001790	cell division cycle 25C protein isoform a
CDC27	NM_001256	cell division cycle protein 27
CDC34	NM_004359	cell division cycle 34
CDC37L1	NM_017913	cell division cycle 37 homolog (S.
CDC42	NM_044472	cell division cycle 42 isoform 2
CDC42BPA	NM_003607	CDC42-binding protein kinase alpha isoform B
CDC42BPB	NM_006035	CDC42-binding protein kinase beta
CDC42EP2	NM_006779	Cdc42 effector protein 2
CDC42EP4	NM_012121	Cdc42 effector protein 4
CDC7	NM_003503	CDC7 cell division cycle 7
CDCA4	NM_017955	cell division cycle associated 4
CDCA5	NM_080668	cell division cycle associated 5
CDCA7L	NM_018719	transcription factor RAM2
CDCP2	NM_201546	hypothetical protein LOC200008
CDH1	NM_004360	cadherin 1, type 1 preproprotein
CDH22	NM_021248	cadherin 22 precursor
CDK10	NM_052988	cyclin-dependent kinase 10 isoform 3
CDK5R1	NM_003885	cyclin-dependent kinase 5, regulatory subunit 1
CDK5RAP1	NM_016082	CDK5 regulatory subunit associated protein 1
CDK5RAP3	NM_025197	CDK5 regulatory subunit associated protein 3
CDK6	NM_001259	cyclin-dependent kinase 6
CDKN1A	NM_000389	cyclin-dependent kinase inhibitor 1A
CDKN2A	NM_058197	cyclin-dependent kinase inhibitor 2A isoform 3
CDKN2B	NM_078487	cyclin-dependent kinase inhibitor 2B isoform 2
CDKN2D	NM_001800	cyclin-dependent kinase inhibitor 2D
CDR2	NM_001802	cerebellar degeneration-related protein 2
CDS2	NM_003818	phosphatidate cytidylyltransferase 2
CDT1	NM_030928	DNA replication factor
CDV3	NM_017548	CDV3 homolog
CDX1	NM_001804	caudal type homeo box transcription factor 1
CDX2	NM_001265	caudal type homeo box transcription factor 2
CEACAM19	NM_020219	carcinoembryonic antigen-like 1

CEACAM6	NM_002483	carcinoembryonic antigen-related cell adhesion
CEACAM7	NM_006890	carcinoembryonic antigen-related cell adhesion
CEBPG	NM_001806	CCAAT/enhancer binding protein gamma
CECR1	NM_017424	cat eye syndrome critical region protein 1
CECR6	NM_031890	cat eye syndrome chromosome region, candidate 6
CENTA1	NM_006869	centaurin, alpha 1
CENTD1	NM_015230	centaurin delta 1 isoform a
CENTG1	NM_014770	centaurin, gamma 1
CEP152	NM_014985	hypothetical protein LOC22995
CEP170	NM_014812	centrosomal protein 170kDa
CEP27	NM_018097	hypothetical protein LOC55142
CEP350	NM_014810	centrosome-associated protein 350
CEP55	NM_018131	centrosomal protein 55kDa
CERK	NM_022766	ceramide kinase isoform a
CERKL	NM_201548	ceramide kinase-like isoform a
CGGBP1	NM_001008390	CGG triplet repeat binding protein 1
CGI-38	NM_015964	hypothetical protein LOC51673
CGI-69	NM_016016	hypothetical protein LOC51629
CGN	NM_020770	cingulin
CGNL1	NM_032866	cingulin-like 1
CHAC1	NM_024111	hypothetical protein LOC79094
CHD5	NM_015557	chromodomain helicase DNA binding protein 5
CHD6	NM_032221	chromodomain helicase DNA binding protein 6
CHD7	NM_017780	chromodomain helicase DNA binding protein 7
CHD8	NM_020920	chromodomain helicase DNA binding protein 8
CHD9	NM_025134	chromodomain helicase DNA binding protein 9
CHDH	NM_018397	choline dehydrogenase
CHEK1	NM_001274	CHK1 checkpoint homolog
CHERP	NM_006387	calcium homeostasis endoplasmic reticulum
CHFR	NM_018223	checkpoint with forkhead and ring finger
CHGA	NM_001275	chromogranin A precursor
CHID1	NM_023947	hypothetical protein LOC66005
CHKB	NM_152253	choline/ethanolamine kinase isoform b
CHMP4B	NM_176812	chromatin modifying protein 4B
CHMP6	NM_024591	chromatin modifying protein 6
CHORDC1	NM_012124	cysteine and histidine-rich domain
CHP	NM_007236	calcium binding protein P22
CHPT1	NM_020244	choline phosphotransferase 1
CHRAC1	NM_017444	chromatin accessibility complex 1
CHRD	NM_177978	chordin isoform b
CHRFAM7A	NM_139320	CHRNA7-FAM7A fusion isoform 1
CHRNA3	NM_000743	cholinergic receptor, nicotinic, alpha
CHRNA4	NM_000744	cholinergic receptor, nicotinic, alpha 4 subunit
CHRNA5	NM_000745	cholinergic receptor, nicotinic, alpha
CHRNB2	NM_000748	cholinergic receptor, nicotinic, beta
CHRNB3	NM_000749	cholinergic receptor, nicotinic, beta
CHRNB4	NM_000750	cholinergic receptor, nicotinic, beta
CHRNE	NM_000080	nicotinic acetylcholine receptor epsilon
CHST10	NM_004854	HNK-1 sulfotransferase
CHST3	NM_004273	carbohydrate (chondroitin 6) sulfotransferase 3
CHST6	NM_021615	carbohydrate (N-acetylglucosamine 6-O)
CHUK	NM_001278	conserved helix-loop-helix ubiquitous kinase

CHX10	NM_182894	ceh-10 homeo domain containing homolog
CIAPIN1	NM_020313	cytokine induced apoptosis inhibitor 1
CIB2	NM_006383	DNA-dependent protein kinase catalytic
CIDEB	NM_014430	cell death-inducing DFFA-like effector b
CINP	NM_032630	cyclin-dependent kinase 2-interacting protein
CKAP5	NM_001008938	colonic and hepatic tumor over-expressed protein
CKB	NM_001823	brain creatine kinase
CLASP1	NM_015282	CLIP-associating protein 1
CLASP2	NM_015097	CLIP-associating protein 2
CLCN3	NM_001829	chloride channel 3 isoform b
CLCN4	NM_001830	chloride channel 4
CLCN5	NM_000084	chloride channel 5
CLCN6	NM_001286	chloride channel 6 isoform ClC-6a
CLCN7	NM_001287	chloride channel 7
CLDN1	NM_021101	claudin 1
CLDN12	NM_012129	claudin 12
CLDN14	NM_012130	claudin 14
CLDN2	NM_020384	claudin 2
CLDN4	NM_001305	claudin 4
CLDN5	NM_003277	claudin 5
CLDN6	NM_021195	claudin 6
CLEC12A	NM_201625	myeloid inhibitory C-type lectin-like receptor
CLEC12B	NM_205852	macrophage antigen h
CLEC2D	NM_001004419	osteoclast inhibitory lectin isoform 2
CLEC4F	NM_173535	C-type lectin, superfamily member 13
CLEC4M	NM_214677	CD299 antigen isoform 3
CLIC5	NM_016929	chloride intracellular channel 5
CLK1	NM_001024646	CDC-like kinase 1 isoform 2
CLK4	NM_020666	CDC-like kinase 4
CLLU1	NM_001025233	hypothetical protein LOC574028
CLN8	NM_018941	CLN8 protein
CLOCK	NM_004898	clock
CLSTN1	NM_001009566	calsyntenin 1 isoform 1
CLTB	NM_001834	clathrin, light polypeptide isoform a
CLU	NM_001831	clusterin isoform 1
CLUAP1	NM_024793	clusterin associated protein 1 isoform 2
CMIP	NM_030629	c-Maf-inducing protein Tc-mip isoform
CMPK	NM_016308	cytidylate kinase
CMTM1	NM_052999	chemokine-like factor superfamily 1 isoform 13
CMTM3	NM_144601	chemokine-like factor superfamily 3 isoform a
CMTM4	NM_178818	chemokine-like factor superfamily 4 isoform 1
CMTM6	NM_017801	CKLF-like MARVEL transmembrane domain containing
CNIH2	NM_182553	cornichon homolog 2
CNIH3	NM_152495	cornichon homolog 3
CNN1	NM_001299	calponin 1, basic, smooth muscle
CNNM2	NM_017649	cyclin M2 isoform 1
CNNM3	NM_017623	cyclin M3 isoform 1
CNOT6	NM_015455	CCR4-NOT transcription complex, subunit 6
CNTD2	NM_024877	hypothetical protein LOC79935
CNTN3	NM_020872	contactin 3
CNTNAP1	NM_003632	contactin associated protein 1

COBLL1	NM_014900	COBL-like 1
COG3	NM_031431	component of golgi transport complex 3
COG7	NM_153603	component of oligomeric golgi complex 7
COL11A2	NM_080679	collagen, type XI, alpha 2 isoform 3
COL12A1	NM_004370	collagen, type XII, alpha 1 long isoform
COL23A1	NM_173465	collagen, type XXIII, alpha 1
COL24A1	NM_152890	collagen, type XXIV, alpha 1
COL3A1	NM_000090	procollagen, type III, alpha 1
COL4A1	NM_001845	alpha 1 type IV collagen preproprotein
COL6A1	NM_001848	collagen, type VI, alpha 1 precursor
COL8A2	NM_005202	collagen, type VIII, alpha 2
COL9A2	NM_001852	alpha 2 type IX collagen
COLEC12	NM_030781	collectin sub-family member 12 isoform II
COLQ	NM_005677	acetylcholinesterase collagen-like tail subunit
COMMD5	NM_014066	hypertension-related calcium-regulated gene
COMMD9	NM_014186	COMM domain containing 9
COPA	NM_004371	coatomer protein complex, subunit alpha
COPG2	NM_012133	coatomer protein complex, subunit gamma 2
COPS2	NM_004236	COP9 constitutive photomorphogenic homolog
COPS7A	NM_016319	COP9 complex subunit 7a
COPS7B	NM_022730	COP9 constitutive photomorphogenic homolog
COQ10B	NM_025147	hypothetical protein LOC80219
COQ5	NM_032314	hypothetical protein LOC84274
COQ9	NM_020312	hypothetical protein LOC57017
CORO6	NM_032854	coronin 6
CORO7	NM_024535	coronin 7
COX10	NM_001303	heme A:farnesyltransferase
COX15	NM_078470	COX15 homolog isoform 1 precursor
CPD	NM_001304	carboxypeptidase D precursor
CPEB2	NM_182485	cytoplasmic polyadenylation element binding
CPEB3	NM_014912	cytoplasmic polyadenylation element binding
CPEB4	NM_030627	cytoplasmic polyadenylation element binding
CPLX1	NM_006651	complexin 1
CPLX3	NM_001030005	complexin 3
CPLX4	NM_181654	complexin 4
CPNE1	NM_003915	copine I
CPSF3L	NM_032179	related to CPSF subunits 68 kDa isoform 2
CPT1B	NM_004377	carnitine palmitoyltransferase 1B isoform a
CPXM2	NM_198148	carboxypeptidase X (M14 family), member 2
CRAMP1L	NM_020825	Crm, cramped-like
CRB2	NM_173689	crumbs homolog 2
CREB3L1	NM_052854	cAMP responsive element binding protein 3-like
CREB5	NM_001011666	cAMP responsive element binding protein 5
CREBL1	NM_004381	cAMP responsive element binding protein-like 1
CREBL2	NM_001310	cAMP responsive element binding protein-like 2
CREG1	NM_003851	cellular repressor of E1A-stimulated genes
CREG2	NM_153836	cellular repressor of E1A-stimulated genes 2
CRELD1	NM_001031717	cysteine-rich with EGF-like domains 1 isoform 1
CRHR1	NM_004382	corticotropin releasing hormone receptor 1
CRIM1	NM_016441	cysteine-rich motor neuron 1
CRISPLD2	NM_031476	cysteine-rich secretory protein LCCL domain
CRKL	NM_005207	v-crk sarcoma virus CT10 oncogene homolog

CRP	NM_000567	C-reactive protein, pentraxin-related
CRSP7	NM_004831	cofactor required for Sp1 transcriptional
CRSP8	NM_004269	cofactor required for Sp1 transcriptional
CRSP9	NM_004270	cofactor required for Sp1 transcriptional
CRTAC1	NM_018058	cartilage acidic protein 1
CRY2	NM_021117	cryptochrome 2 (photolyase-like)
CRYM	NM_001014444	crystallin, mu isoform 2
CRYZL1	NM_145858	crystallin, zeta-like 1
CSDC2	NM_014460	RNA-binding protein pippin
CSDE1	NM_001007553	upstream of NRAS isoform 1
CSF2	NM_000758	colony stimulating factor 2 precursor
CSH1	NM_022640	chorionic somatomammotropin hormone 1 isoform 2
CSH2	NM_022644	chorionic somatomammotropin hormone 2 isoform 2
CSNK1A1	NM_001025105	casein kinase 1, alpha 1 isoform 1
CSNK1G1	NM_022048	casein kinase 1, gamma 1 isoform S
CSNK1G2	NM_001319	casein kinase 1, gamma 2
CSNK2A1	NM_001895	casein kinase II alpha 1 subunit isoform a
CSPG4	NM_001897	melanoma-associated chondroitin sulfate
CSPG5	NM_006574	chondroitin sulfate proteoglycan 5 (neuroglycan
CST6	NM_001323	cystatin M precursor
CST9	NM_001008693	cystatin 9
CST9L	NM_080610	cystatin 9-like precursor
CSTA	NM_005213	cystatin A
CTAGE1	NM_172241	cutaneous T-cell lymphoma-associated antigen 1
CTDP1	NM_004715	CTD (carboxy-terminal domain, RNA polymerase II,
CTDSP1	NM_021198	CTD (carboxy-terminal domain, RNA polymerase II,
CTDSP2	NM_005730	nuclear LIM interactor-interacting factor 2
CTDSPL	NM_001008392	small CTD phosphatase 3 isoform 1
CTH	NM_001902	cystathionase isoform 1
CTNNA1	NM_001903	catenin, alpha 1
CTNNBIP1	NM_001012329	catenin, beta interacting protein 1
CTNND1	NM_001331	catenin (cadherin-associated protein), delta 1
CTSB	NM_001908	cathepsin B preproprotein
CTSC	NM_148170	cathepsin C isoform b precursor
CTSF	NM_003793	cathepsin F
CTSO	NM_001334	cathepsin O preproprotein
CTTN	NM_005231	cortactin isoform a
CUL2	NM_003591	cullin 2
CUL3	NM_003590	cullin 3
CX3CL1	NM_002996	chemokine (C-X3-C motif) ligand 1
CX3CR1	NM_001337	chemokine (C-X3-C motif) receptor 1
CXCL10	NM_001565	small inducible cytokine B10 precursor
CXCR3	NM_001504	chemokine (C-X-C motif) receptor 3
CXCR6	NM_006564	G protein-coupled receptor TYMSTR
CXorf1	NM_004709	hypothetical protein LOC9142
CXorf40A	NM_178124	chromosome X open reading frame 40
CXorf40B	NM_001013845	hypothetical protein LOC541578
CXorf6	NM_005491	hypothetical protein LOC10046
CYB561	NM_001017916	cytochrome b-561 isoform 1
CYB561D1	NM_182580	cytochrome b-561 domain containing 1
CYB5D1	NM_144607	hypothetical protein LOC124637
CYBASC3	NM_153611	cytochrome b, ascorbate dependent 3

CYBRD1	NM_024843	cytochrome b reductase 1
CYCS	NM_018947	cytochrome c
CYFIP1	NM_001033028	cytoplasmic FMR1 interacting protein 1 isoform
CYGB	NM_134268	cytoglobin
CYP1B1	NM_000104	cytochrome P450, family 1, subfamily B,
CYP26B1	NM_019885	cytochrome P450, family 26, subfamily b,
CYP27A1	NM_000784	cytochrome P450, family 27, subfamily A,
CYP27B1	NM_000785	cytochrome P450, family 27, subfamily B,
CYP2C8	NM_000770	cytochrome P450, family 2, subfamily C,
CYP2C9	NM_000771	cytochrome P450, family 2, subfamily C,
CYP2S1	NM_030622	cytochrome P450, family 2, subfamily S,
CYP2U1	NM_183075	cytochrome P450, family 2, subfamily U,
CYP4F3	NM_000896	cytochrome P450, family 4, subfamily F,
D2HGDH	NM_152783	D-2-hydroxyglutarate dehydrogenase
D4S234E	NM_014392	brain neuron cytoplasmic protein 1
D4ST1	NM_130468	dermatan 4 sulfotransferase 1
DAB2IP	NM_032552	DAB2 interacting protein isoform 1
DACH1	NM_004392	dachshund homolog 1 isoform c
DACT2	NM_214462	dapper homolog 2, antagonist of beta-catenin
DAPK3	NM_001348	death-associated protein kinase 3
DBF4B	NM_025104	DBF4 homolog B isoform 2
DBH	NM_000787	dopamine beta-hydroxylase precursor
DBNDD2	NM_033542	SCF apoptosis response protein 1 isoform 2
DCAKD	NM_024819	dephospho-CoA kinase domain containing
DCAMKL1	NM_004734	doublecortin and CaM kinase-like 1
DCBLD2	NM_080927	discoidin, CUB and LCCL domain containing 2
DCTN3	NM_024348	dynactin 3 isoform 2
DCTN4	NM_016221	dynactin 4 (p62)
DCTN5	NM_032486	dynactin 4
DCUN1D1	NM_020640	RP42 homolog
DCUN1D2	NM_001014283	hypothetical protein LOC55208 isoform b
DCUN1D4	NM_015115	DCN1, defective in cullin neddylation 1, domain
DCX	NM_000555	doublecortin isoform a
DDEF1	NM_018482	development and differentiation enhancing factor
DDEF2	NM_003887	development- and differentiation-enhancing
DDHD2	NM_015214	DDHD domain containing 2
DDI1	NM_001001711	hypothetical protein LOC414301
DDX11	NM_030655	DEAD/H (Asp-Glu-Ala-Asp/His) box polypeptide 11
DDX17	NM_006386	DEAD box polypeptide 17 isoform p82
DDX19A	NM_018332	DDX19-like protein
DDX26B	NM_182540	hypothetical protein LOC203522
DDX28	NM_018380	DEAD (Asp-Glu-Ala-Asp) box polypeptide 28
DDX31	NM_138620	DEAD (Asp-Glu-Ala-Asp) box polypeptide 31
DDX3X	NM_001356	DEAD/H (Asp-Glu-Ala-Asp/His) box polypeptide 3
DDX3Y	NM_004660	DEAD (Asp-Glu-Ala-Asp) box polypeptide 3,
DDX52	NM_007010	ATP-dependent RNA helicase ROK1 isoform a
DDX54	NM_024072	DEAD (Asp-Glu-Ala-Asp) box polypeptide 54
DDX59	NM_031306	DEAD (Asp-Glu-Ala-Asp) box polypeptide 59
DEADC1	NM_182503	deaminase domain containing 1
DEC1	NM_017418	deleted in esophageal cancer 1
DEDD	NM_032998	death effector domain-containing protein
DEFB4	NM_004942	defensin, beta 4 precursor

DENND1A	NM_020946	hypothetical protein LOC57706 isoform 1
DENND2C	NM_198459	DENN/MADD domain containing 2C
DENND4A	NM_005848	c-myc promoter binding protein
DENR	NM_003677	density-regulated protein
DEPDC4	NM_152317	DEP domain containing 4
DEPDC5	NM_014662	DEP domain containing 5 isoform 1
DERL3	NM_001002862	derlin-3 protein isoform b
DFFB	NM_001004285	DNA fragmentation factor, 40 kD, beta
DGAT2L4	NM_001002254	diacylglycerol O-acyltransferase 2-like 4
DGCR13	NM_001024733	DiGeorge syndrome gene H
DGCR2	NM_005137	integral membrane protein DGCR2
DGCR6	NM_005675	DiGeorge syndrome critical region protein 6
DGCR6L	NM_033257	DiGeorge syndrome critical region gene 6 like
DGCR8	NM_022720	DiGeorge syndrome critical region gene 8
DGKD	NM_003648	diacylglycerol kinase, delta 130kDa isoform 1
DHDDS	NM_024887	dehydrodolichyl diphosphate synthase isoform a
DHFR	NM_000791	dihydrofolate reductase
DHFRL1	NM_176815	dihydrofolate reductase-like 1
DHTKD1	NM_018706	dehydrogenase E1 and transketolase domain
DHX30	NM_138614	DEAH (Asp-Glu-Ala-His) box polypeptide 30
DHX33	NM_020162	DEAH (Asp-Glu-Ala-His) box polypeptide 33
DHX35	NM_021931	DEAH (Asp-Glu-Ala-His) box polypeptide 35
DIAPH1	NM_005219	diaphanous 1
DICER1	NM_030621	dicer1
DIO2	NM_000793	deiodinase, iodothyronine, type II isoform a
DIP	NM_015124	death-inducing-protein
DIP2A	NM_015151	DIP2-like protein isoform a
DIRAS1	NM_145173	small GTP-binding tumor suppressor 1
DIRAS2	NM_017594	Di-Ras2
DIRC1	NM_052952	hypothetical protein LOC116093
DISC1	NM_001012957	disrupted in schizophrenia 1 isoform Lv
DISP2	NM_033510	dispatched B
DIXDC1	NM_033425	DIX domain containing 1 isoform b
dJ341D10.1	NM_001007535	hypothetical protein LOC286453
DKC1	NM_001363	dyskerin
DKFZp434I1020	NM_194295	hypothetical protein LOC196968
DKFZp434K191	NM_001029950	hypothetical protein LOC29797
DKFZp434N035	NM_032262	hypothetical protein LOC84222
DKFZp451A211	NM_001003399	hypothetical protein LOC400169
DKFZP564O0823	NM_015393	DKFZP564O0823 protein
DKFZP586D0919	NM_206914	hypothetical protein LOC25895 isoform b
DKFZp666G057	NM_001008226	hypothetical protein LOC283726
DKFZp667M2411	NM_207323	hypothetical protein LOC147172
DKFZp686I15217	NM_207495	hypothetical protein LOC401232
DKFZp686O24166	NM_001009913	hypothetical protein LOC374383
DKFZp761E198	NM_138368	hypothetical protein LOC91056
DKFZP761H1710	NM_031297	hypothetical protein LOC83459
DKFZp761I2123	NM_031449	hypothetical protein LOC83637 isoform 1
DKFZp779B1540	NM_001010903	hypothetical protein LOC389384
DLEC1	NM_007335	deleted in lung and esophageal cancer 1 isoform
DLEU7	NM_198989	deleted in lymphocytic leukemia, 7
DLGAP2	NM_004745	discs large-associated protein 2

DLGAP4	NM_014902	disks large-associated protein 4 isoform a
DLK1	NM_001032997	delta-like 1 homolog isoform 2
DLL1	NM_005618	delta-like 1
DLL4	NM_019074	delta-like 4 protein precursor
DLST	NM_001933	dihydrolipoamide S-succinyltransferase (E2
DMAP1	NM_019100	DNA methyltransferase 1 associated protein 1
DMD	NM_000109	dystrophin Dp427c isoform
DMPK	NM_004409	myotonic dystrophy protein kinase
DMRT2	NM_006557	doublesex and mab-3 related transcription factor
DMRTB1	NM_033067	DMRT-like family B with proline-rich C-terminal,
DMTF1	NM_021145	cyclin D binding myb-like transcription factor
DNAJA2	NM_005880	DnaJ subfamily A member 2
DNAJA3	NM_005147	DnaJ (Hsp40) homolog, subfamily A, member 3
DNAJA4	NM_018602	DnaJ (Hsp40) homolog, subfamily A, member 4
DNAJB12	NM_001002762	DnaJ (Hsp40) homolog, subfamily B, member 12
DNAJB14	NM_024920	DnaJ (Hsp40) homolog, subfamily B, member 14
DNAJB4	NM_007034	DnaJ (Hsp40) homolog, subfamily B, member 4
DNAJB5	NM_012266	DnaJ (Hsp40) homolog, subfamily B, member 5
DNAJB6	NM_058246	DnaJ (Hsp40) homolog, subfamily B, member 6
DNAJC18	NM_152686	DnaJ (Hsp40) homolog, subfamily C, member 18
DNAJC5G	NM_173650	DnaJ (Hsp40) homolog, subfamily C, member 5
DNAJC9	NM_015190	DnaJ homolog, subfamily C, member 9
DNAL4	NM_005740	dynein light chain 4, axonemal
DNALI1	NM_003462	axonemal dynein light chain
DNASE1L1	NM_001009932	deoxyribonuclease I-like 1 precursor
DNASE1L2	NM_001374	deoxyribonuclease I-like 2
DNM1L	NM_012062	dynamin 1-like protein isoform 1
DOCK2	NM_004946	dedicator of cytokinesis 2
DOCK3	NM_004947	dedicator of cytokinesis 3
DOCK5	NM_024940	dedicator of cytokinesis 5
DOK2	NM_003974	docking protein 2
DOK4	NM_018110	downstream of tyrosine kinase 4
DOLPP1	NM_020438	dolichyl pyrophosphate phosphatase 1
DPF3	NM_012074	D4, zinc and double PHD fingers, family 3
DPH2	NM_001384	diphthamide biosynthesis protein 2 isoform a
DPP9	NM_139159	dipeptidylpeptidase 9
DPPA4	NM_018189	developmental pluripotency associated 4
DPT	NM_001937	dermatopontin precursor
DPY19L4	NM_181787	hypothetical protein LOC286148
DPYSL2	NM_001386	dihydropyrimidinase-like 2
DPYSL3	NM_001387	dihydropyrimidinase-like 3
DRD1	NM_000794	dopamine receptor D1
DRD2	NM_000795	dopamine receptor D2 isoform long
DRD5	NM_000798	dopamine receptor D5
DREV1	NM_016025	hypothetical protein LOC51108
DSC3	NM_024423	desmocollin 3 isoform Dsc3b preproprotein
DSCR10	NM_148676	hypothetical protein LOC259234
DSCR3	NM_006052	Down syndrome critical region protein 3
DTNA	NM_001390	dystrobrevin alpha isoform 1
DUOX2	NM_014080	dual oxidase 2 precursor
DUS1L	NM_022156	PP3111 protein
DUSP10	NM_007207	dual specificity phosphatase 10 isoform a

DUSP13	NM_001007271	muscle-restricted dual specificity phosphatase
DUSP2	NM_004418	dual specificity phosphatase 2
DUSP26	NM_024025	dual specificity phosphatase 26
DUSP3	NM_004090	dual specificity phosphatase 3
DUSP9	NM_001395	dual specificity phosphatase 9
DUX1	NM_012146	double homeobox, 1
DUXA	NM_001012729	hypothetical protein LOC503835
DVL1	NM_004421	dishevelled 1 isoform a
DVL2	NM_004422	dishevelled 2
DVL3	NM_004423	dishevelled 3
DXYS155E	NM_005088	DNA segment on chromosome X and Y (unique) 155
DYNC1I1	NM_004411	dynein, cytoplasmic, intermediate polypeptide 1
DYNC1LI2	NM_006141	dynein, cytoplasmic, light intermediate
DYNLT3	NM_006520	t-complex-associated-testis-expressed 1-like
DYRK1A	NM_101395	dual-specificity tyrosine-(Y)-phosphorylation
DYRK1B	NM_004714	dual-specificity tyrosine-(Y)-phosphorylation
DZIP1	NM_014934	DAZ interacting protein 1 isoform 1
DZIP3	NM_014648	zinc finger DAZ interacting protein 3
E2F3	NM_001949	E2F transcription factor 3
E2F7	NM_203394	E2F transcription factor 7
EBI3	NM_005755	Epstein-Barr virus induced gene 3 precursor
ECE2	NM_014693	endothelin converting enzyme 2 isoform A
ECHDC1	NM_018479	enoyl Coenzyme A hydratase domain containing 1
ECHS1	NM_004092	mitochondrial short-chain enoyl-coenzyme A
ECOP	NM_030796	EGFR-coamplified and overexpressed protein
EDA	NM_001005609	ectodysplasin A isoform EDA-A2
EDA2R	NM_021783	X-linked ectodysplasin receptor
EDAR	NM_022336	ectodysplasin A receptor
EDARADD	NM_080738	EDAR-associated death domain isoform B
EDG1	NM_001400	endothelial differentiation, sphingolipid
EDN2	NM_001956	endothelin 2
EED	NM_152991	embryonic ectoderm development isoform b
EEFSEC	NM_021937	elongation factor for selenoprotein translation
EFCAB1	NM_024593	EF-hand calcium binding domain 1
EFCAB4A	NM_173584	hypothetical protein LOC283229
EFCAB5	NM_198529	EF-hand calcium binding domain 5 isoform 1
EFNA3	NM_004952	ephrin A3
EFNB1	NM_004429	ephrin-B1 precursor
EFNB2	NM_004093	ephrin B2
EFNB3	NM_001406	ephrin-B3 precursor
EFTUD1	NM_024580	elongation factor Tu GTP binding domain
EGFL7	NM_016215	EGF-like-domain, multiple 7
EGLN1	NM_022051	egl nine homolog 1
EGLN2	NM_017555	EGL nine (C.elegans) homolog 2 isoform 2
EGR3	NM_004430	early growth response 3
EHD1	NM_006795	EH-domain containing 1
EHMT1	NM_024757	euchromatic histone methyltransferase 1
EHMT2	NM_006709	HLA-B associated transcript 8 isoform a
EIF1AX	NM_001412	X-linked eukaryotic translation initiation
EIF2B2	NM_014239	eukaryotic translation initiation factor 2B,
EIF2B5	NM_003907	eukaryotic translation initiation factor 2B,
EIF2C1	NM_012199	eukaryotic translation initiation factor 2C, 1

EIF2C2	NM_012154	eukaryotic translation initiation factor 2C, 2
EIF2C4	NM_017629	eukaryotic translation initiation factor 2C, 4
EIF2S2	NM_003908	eukaryotic translation initiation factor 2 beta
EIF3S10	NM_003750	eukaryotic translation initiation factor 3,
EIF3S8	NM_003752	eukaryotic translation initiation factor 3,
EIF4B	NM_001417	eukaryotic translation initiation factor 4B
EIF4E	NM_001968	eukaryotic translation initiation factor 4E
EIF4E3	NM_173359	eukaryotic translation initiation factor 4E
EIF4EBP2	NM_004096	eukaryotic translation initiation factor 4E
EIF4G1	NM_004953	eukaryotic translation initiation factor 4
EIF5A	NM_001970	eukaryotic translation initiation factor 5A
EIF5A2	NM_020390	eIF-5A2 protein
ELAC1	NM_018696	elaC homolog 1
ELAVL1	NM_001419	ELAV-like 1
ELF4	NM_001421	E74-like factor 4 (ets domain transcription
ELL	NM_006532	elongation factor RNA polymerase II
ELL2	NM_012081	elongation factor, RNA polymerase II, 2
Ells1	NM_152793	hypothetical protein LOC222166
ELMO2	NM_133171	engulfment and cell motility 2
ELMOD1	NM_018712	ELMO domain containing 1
ELOVL1	NM_022821	elongation of very long chain fatty acids
ELOVL2	NM_017770	elongation of very long chain fatty acids
ELOVL5	NM_021814	homolog of yeast long chain polyunsaturated
ELOVL6	NM_024090	ELOVL family member 6, elongation of long chain
ELOVL7	NM_024930	ELOVL family member 7, elongation of long chain
ELP3	NM_018091	elongation protein 3 homolog
EMCN	NM_016242	endomucin
EMILIN3	NM_052846	elastin microfibril interfacer 3
EML5	NM_183387	echinoderm microtubule associated protein like
EMR2	NM_013447	egf-like module containing, mucin-like, hormone
EMR3	NM_152939	egf-like module-containing mucin-like receptor 3
EMX1	NM_004097	empty spiracles homolog 1 isoform 1
EN2	NM_001427	engrailed homolog 2
ENAH	NM_001008493	enabled homolog isoform a
ENC1	NM_003633	ectodermal-neural cortex (with BTB-like domain)
ENG	NM_000118	endoglin precursor
ENPP4	NM_014936	ectonucleotide pyrophosphatase/phosphodiesterase
ENSA	NM_207043	endosulfine alpha isoform 2
ENTPD6	NM_001247	ectonucleoside triphosphate diphosphohydrolase
ENTPD7	NM_020354	ectonucleoside triphosphate diphosphohydrolase
EPB41L1	NM_012156	erythrocyte membrane protein band 4.1-like 1
EPB41L4B	NM_018424	erythrocyte membrane protein band 4.1 like 4B
EPB41L5	NM_020909	erythrocyte membrane protein band 4.1 like 5
EPB49	NM_001978	erythrocyte membrane protein band 4.9 (dematin)
EPHA1	NM_005232	ephrin receptor EphA1
EPHA7	NM_004440	ephrin receptor EphA7
EPHB2	NM_004442	ephrin receptor EphB2 isoform 2 precursor
EPHB4	NM_004444	ephrin receptor EphB4 precursor
EPHX2	NM_001979	epoxide hydrolase 2, cytoplasmic
EPM2AIP1	NM_014805	EPM2A interacting protein 1
EPS8L2	NM_022772	epidermal growth factor receptor pathway
ERGIC1	NM_001031711	endoplasmic reticulum-golgi intermediate
ERN2	NM_033266	endoplasmic reticulum to nucleus signalling 2

ESAM	NM_138961	endothelial cell adhesion molecule
ESPN	NM_031475	espin
ESR1	NM_000125	estrogen receptor 1
ESRRA	NM_004451	estrogen-related receptor alpha
ESRRG	NM_001438	estrogen-related receptor gamma isoform 1
ET	NM_024311	hypothetical protein LOC79157
ETS1	NM_005238	v-ets erythroblastosis virus E26 oncogene
ETS2	NM_005239	v-ets erythroblastosis virus E26 oncogene
ETV1	NM_004956	ets variant gene 1
ETV6	NM_001987	ets variant gene 6
EVI5	NM_005665	ecotropic viral integration site 5
EVL	NM_016337	Enah/Vasp-like
EXOC2	NM_018303	Sec5 protein
EXOC4	NM_021807	SEC8 protein isoform a
EXOC5	NM_006544	SEC10 protein
EXOC7	NM_001013839	exocyst complex component 7 isoform a
EXOD1	NM_080663	hypothetical protein LOC112479
EXOSC1	NM_016046	exosomal core protein CSL4
EXOSC10	NM_001001998	exosome component 10 isoform 1
EXT2	NM_000401	exostosin 2
EXTL3	NM_001440	Reg receptor
EYA1	NM_000503	eyes absent 1 isoform b
EZH1	NM_001991	enhancer of zeste homolog 1
F11R	NM_016946	F11 receptor isoform a precursor
F2RL1	NM_005242	coagulation factor II (thrombin) receptor-like 1
F7	NM_000131	coagulation factor VII precursor, isoform a
FABP2	NM_000134	intestinal fatty acid binding protein 2
FADS1	NM_013402	fatty acid desaturase 1
FADS2	NM_004265	fatty acid desaturase 2
FADS6	NM_178128	fatty acid desaturase domain family, member 6
FAIM2	NM_012306	Fas apoptotic inhibitory molecule 2
FALZ	NM_004459	fetal Alzheimer antigen isoform 2
FAM101A	NM_181709	hypothetical protein LOC144347
FAM102A	NM_203305	early estrogen-induced gene 1 protein isoform b
FAM107A	NM_007177	downregulated in renal cell carcinoma
FAM107B	NM_031453	hypothetical protein LOC83641
FAM111A	NM_022074	hypothetical protein LOC63901
FAM116A	NM_152678	hypothetical protein LOC201627
FAM11A	NM_032508	family with sequence similarity 11, member A
FAM18B	NM_016078	hypothetical protein LOC51030
FAM20B	NM_014864	family with sequence similarity 20, member B
FAM29A	NM_017645	hypothetical protein LOC54801
FAM32A	NM_014077	hypothetical protein LOC26017
FAM38A	NM_014745	family with sequence similarity 38, member A
FAM3A	NM_021806	family 3, member A protein
FAM43B	NM_207334	hypothetical protein LOC163933
FAM46C	NM_017709	hypothetical protein LOC54855
FAM50A	NM_004699	XAP-5 protein
FAM53A	NM_001013622	dorsal neural-tube nuclear protein
FAM54B	NM_019557	hypothetical protein LOC56181
FAM55C	NM_145037	hypothetical protein LOC91775
FAM57B	NM_031478	hypothetical protein LOC83723
FAM58A	NM_152274	hypothetical protein LOC92002

FAM59A	NM_022751	hypothetical protein LOC64762
FAM60A	NM_021238	family with sequence similarity 60, member A
FAM62A	NM_015292	family with sequence similarity 62 (C2 domain
FAM63A	NM_018379	hypothetical protein LOC55793 isoform 1
FAM63B	NM_019092	hypothetical protein LOC54629
FAM70A	NM_017938	hypothetical protein LOC55026
FAM73A	NM_198549	hypothetical protein LOC374986
FAM78A	NM_033387	hypothetical protein LOC286336
FAM78B	NM_001017961	hypothetical protein LOC149297
FAM79A	NM_182752	hypothetical protein LOC127262
FAM79B	NM_198485	hypothetical protein LOC285386
FAM81A	NM_152450	hypothetical protein LOC145773
FAM84B	NM_174911	breast cancer membrane protein 101
FAM86B1	NM_032916	hypothetical protein LOC85002
FAM86C	NM_018172	hypothetical protein LOC55199 isoform 1
FAM89A	NM_198552	hypothetical protein LOC375061
FAM89B	NM_152832	Mouse Mammary Turmor Virus Receptor homolog 1
FAM91A1	NM_144963	hypothetical protein LOC157769
FAM98B	NM_173611	hypothetical protein LOC283742
FAM99A	NM_001014374	hypothetical protein LOC387742
FANCA	NM_000135	Fanconi anemia, complementation group A isoform
FANCE	NM_021922	Fanconi anemia, complementation group E
FARSLA	NM_004461	phenylalanine-tRNA synthetase-like protein
FASN	NM_004104	fatty acid synthase
FAT2	NM_001447	FAT tumor suppressor 2 precursor
FBLN1	NM_006487	fibulin 1 isoform A precursor
FBXO17	NM_024907	F-box protein FBG4 isoform 2
FBXO21	NM_015002	F-box only protein 21 isoform 2
FBXO22	NM_147188	F-box only protein 22 isoform a
FBXO24	NM_012172	F-box only protein 24 isoform 2
FBXO27	NM_178820	F-box protein 27
FBXO31	NM_024735	F-box protein 31
FBXO33	NM_203301	F-box protein 33
FBXO44	NM_001014765	F-box protein 44 isoform 1
FBXW11	NM_012300	F-box and WD-40 domain protein 1B isoform C
FBXW4	NM_022039	F-box and WD-40 domain protein 4
FBXW5	NM_018998	F-box and WD-40 domain protein 5
FBXW7	NM_001013415	F-box protein FBW7 isoform 3
FCHO1	NM_015122	FCH domain only 1
FCHSD1	NM_033449	FCH and double SH3 domains 1
FCHSD2	NM_014824	FCH and double SH3 domains 2
FCMD	NM_006731	fukutin
FCRL2	NM_030764	Fc receptor-like 2 isoform b
FCRL5	NM_031281	Fc receptor-like 5
FDFT1	NM_004462	farnesyl-diphosphate farnesyltransferase 1
FECH	NM_000140	ferrochelatase isoform b precursor
FEM1C	NM_020177	feminization 1 homolog a
FES	NM_002005	V-FES feline sarcoma viral/V-FPS fujinami avian
FEZ1	NM_022549	zygin 1 isoform 2
FEZ2	NM_005102	zygin 2
FFAR3	NM_005304	G protein-coupled receptor 41
FGD3	NM_033086	FYVE, RhoGEF and PH domain containing 3
FGF11	NM_004112	fibroblast growth factor 11

FGF19	NM_005117	fibroblast growth factor 19 precursor
FGF2	NM_002006	fibroblast growth factor 2
FGF23	NM_020638	fibroblast growth factor 23 precursor
FGF7	NM_002009	fibroblast growth factor 7 precursor
FGFR1	NM_023107	fibroblast growth factor receptor 1 isoform 5
FGFR1OP	NM_007045	FGFR1 oncogene partner isoform a
FGFR2	NM_000141	fibroblast growth factor receptor 2 isoform 1
FGFR3	NM_000142	fibroblast growth factor receptor 3 isoform 1
FGFR4	NM_002011	fibroblast growth factor receptor 4 isoform 1
FGL1	NM_004467	fibrinogen-like 1 precursor
FGR	NM_005248	Gardner-Rasheed feline sarcoma viral (v-fgr)
FHL1	NM_001449	four and a half LIM domains 1
FHL2	NM_001450	four and a half LIM domains 2
FIBCD1	NM_032843	fibrinogen C domain containing 1
FIGF	NM_004469	vascular endothelial growth factor D
FIS	NM_175616	hypothetical protein LOC202299
FKBP10	NM_021939	FK506 binding protein 10, 65 kDa
FKBP1A	NM_000801	FK506-binding protein 1A
FKBP1B	NM_004116	FK506-binding protein 1B isoform a
FKBP5	NM_004117	FK506 binding protein 5
FKBP9	NM_007270	FK506 binding protein 9
FKBP9L	NM_182827	FK506 binding protein 9-like
FKRP	NM_024301	fukutin-related protein
FKSG44	NM_031904	FKSG44 protein
FLCN	NM_144997	folliculin isoform 1
FLJ10159	NM_018013	hypothetical protein LOC55084
FLJ10324	NM_018059	hypothetical protein LOC55698
FLJ10769	NM_018210	hypothetical protein LOC55739
FLJ10803	NM_018224	hypothetical protein LOC55744
FLJ10916	NM_018271	hypothetical protein LOC55258
FLJ10945	NM_018280	hypothetical protein LOC55267
FLJ11259	NM_018370	hypothetical protein LOC55332
FLJ11292	NM_018382	hypothetical protein LOC55338
FLJ11506	NM_024666	hypothetical protein LOC79719
FLJ11783	NM_024891	hypothetical protein LOC79951
FLJ11806	NM_024824	nuclear protein UKp68 isoform 1
FLJ12118	NM_024537	hypothetical protein LOC79587
FLJ12529	NM_024811	pre-mRNA cleavage factor I, 59 kDa subunit
FLJ12700	NM_024910	hypothetical protein LOC79970
FLJ12716	NM_199053	hypothetical protein LOC60684 isoform b
FLJ12788	NM_022492	hypothetical protein LOC64427
FLJ13841	NM_024702	hypothetical protein LOC79755
FLJ14001	NM_024677	hypothetical protein LOC79730
FLJ14107	NM_025026	hypothetical protein LOC80094
FLJ14154	NM_024845	hypothetical protein LOC79903
FLJ14213	NM_024841	hypothetical protein LOC79899
FLJ14816	NM_032845	hypothetical protein LOC84931
FLJ16008	NM_001001665	hypothetical protein LOC339761
FLJ16165	NM_001004318	hypothetical protein LOC390928
FLJ20032	NM_017628	hypothetical protein LOC54790
FLJ20186	NM_207514	differentially expressed in FDCP 8 isoform 1
FLJ20232	NM_019008	hypothetical protein LOC54471
FLJ20298	NM_017752	hypothetical protein LOC54885 isoform a

FLJ20487	NM_017841	hypothetical protein LOC54949
FLJ20551	NM_017875	hypothetical protein LOC54977
FLJ20558	NM_017880	hypothetical protein LOC54980
FLJ20699	NM_017931	hypothetical protein LOC55020
FLJ20701	NM_017933	hypothetical protein LOC55022
FLJ20758	NM_017952	hypothetical protein LOC55037
FLJ20850	NM_017967	hypothetical protein LOC55049
FLJ21125	NM_024627	hypothetical protein LOC79680
FLJ21687	NM_024859	PDZ domain containing, X chromosome
FLJ21736	NM_024922	esterase 31
FLJ21742	NM_032207	hypothetical protein LOC84167
FLJ21945	NM_025203	hypothetical protein LOC80304
FLJ21986	NM_024913	hypothetical protein LOC79974
FLJ22349	NM_024821	hypothetical protein LOC79879
FLJ22374	NM_032222	hypothetical protein LOC84182
FLJ23436	NM_024671	hypothetical protein LOC79724
FLJ25102	NM_182626	hypothetical protein LOC348738
FLJ25143	NM_182500	hypothetical protein LOC130813
FLJ25169	NM_152568	hypothetical protein LOC157848
FLJ25222	NM_199163	hypothetical protein LOC374666
FLJ25410	NM_144605	hypothetical protein LOC124404
FLJ25476	NM_152493	hypothetical protein LOC149076
FLJ27255	NM_207501	hypothetical protein LOC401281
FLJ30294	NM_144632	hypothetical protein LOC130827
FLJ30313	NM_152757	hypothetical protein LOC253868
FLJ31132	NM_001004355	hypothetical protein LOC441522
FLJ32011	NM_182516	hypothetical protein LOC148930
FLJ32028	NM_152680	hypothetical protein LOC201799
FLJ32063	NM_153031	hypothetical protein LOC150538
FLJ32252	NM_182510	hypothetical protein LOC146336
FLJ33708	NM_173675	hypothetical protein LOC285780
FLJ35220	NM_173627	hypothetical protein LOC284131
FLJ35424	NM_173661	hypothetical protein LOC285492
FLJ35429	NM_001003807	hypothetical protein LOC285830
FLJ35530	NM_207467	hypothetical protein LOC400798
FLJ35695	NM_207444	hypothetical protein LOC400359
FLJ35740	NM_147195	FLJ35740 protein
FLJ35767	NM_207459	hypothetical protein LOC400629
FLJ35880	NM_153264	hypothetical protein LOC256076
FLJ36070	NM_182574	hypothetical protein LOC284358
FLJ36208	NM_176677	hypothetical protein LOC283948
FLJ36492	NM_182568	hypothetical protein LOC284047
FLJ36888	NM_178830	hypothetical protein LOC126526
FLJ37357	NM_173645	hypothetical protein LOC284944
FLJ37478	NM_178557	hypothetical protein LOC339983
FLJ37538	NM_173564	hypothetical protein FLJ37538
FLJ37543	NM_173667	hypothetical protein LOC285668
FLJ38723	NM_173805	hypothetical protein FLJ38723
FLJ38973	NM_153689	hypothetical protein LOC205327
FLJ39237	NM_198571	hypothetical protein LOC375607
FLJ39827	NM_152424	hypothetical protein LOC139285
FLJ40142	NM_207435	hypothetical protein LOC400073
FLJ40172	NM_173649	hypothetical protein LOC285051

FLJ40288	NM_173682	hypothetical protein LOC286023
FLJ40432	NM_152523	hypothetical protein LOC151195
FLJ40504	NM_173624	hypothetical protein LOC284085
FLJ41046	NM_207479	hypothetical protein LOC400940
FLJ41423	NM_001001679	hypothetical protein LOC399886
FLJ41821	NM_001001697	hypothetical protein LOC401011
FLJ41993	NM_001001694	hypothetical protein LOC400935
FLJ42102	NM_001001680	hypothetical protein LOC399923
FLJ42133	NM_001001690	hypothetical protein LOC400844
FLJ42289	NM_207383	hypothetical protein LOC388182
FLJ42291	NM_207367	hypothetical protein LOC346547
FLJ43093	NM_207498	hypothetical protein LOC401258
FLJ43339	NM_207380	hypothetical protein LOC388115
FLJ43582	NM_207412	hypothetical protein LOC389649
FLJ43980	NM_001004299	hypothetical protein LOC124149
FLJ44385	NM_207478	hypothetical protein LOC400934
FLJ44815	NM_207454	hypothetical protein LOC400591
FLJ44968	NM_198537	hypothetical protein LOC374887
FLJ45079	NM_001001685	hypothetical protein LOC400624
FLJ45121	NM_207451	hypothetical protein LOC400556
FLJ45248	NM_207505	hypothetical protein LOC401472
FLJ45300	NM_001001681	hypothetical protein LOC399957
FLJ45422	NM_001004349	hypothetical protein LOC441140
FLJ45455	NM_207386	hypothetical protein LOC388336
FLJ45537	NM_001001709	hypothetical protein LOC401535
FLJ45645	NM_198557	hypothetical protein LOC375287
FLJ45684	NM_207462	hypothetical protein LOC400666
FLJ45831	NM_001001684	hypothetical protein LOC400576
FLJ45964	NM_207483	hypothetical protein LOC401040
FLJ45966	NM_001001700	hypothetical protein LOC401120
FLJ45974	NM_001001707	hypothetical protein LOC401337
FLJ46020	NM_207472	hypothetical protein LOC400863
FLJ46026	NM_207458	hypothetical protein LOC400627
FLJ46082	NM_207417	hypothetical protein LOC389799
FLJ46154	NM_198462	FLJ46154 protein
FLJ46210	NM_001004315	hypothetical protein LOC389152
FLJ46230	NM_207463	hypothetical protein LOC400679
FLJ46257	NM_001001693	hypothetical protein LOC400932
FLJ46347	NM_001005303	hypothetical protein LOC389064
FLJ46358	NM_207439	hypothetical protein LOC400110
FLJ46363	NM_207434	hypothetical protein LOC400002
FLJ46365	NM_207504	hypothetical protein LOC401459
FLJ46385	NM_001001675	hypothetical protein LOC390963
FLJ46481	NM_207405	hypothetical protein LOC389197
FLJ46831	NM_207426	forkhead box I2
FLJ46838	NM_001007546	hypothetical protein LOC440865
FLJ90166	NM_153360	hypothetical protein LOC164284
FLJ90579	NM_173591	hypothetical protein LOC283310
FLJ90650	NM_173800	laeverin
FLJ90709	NM_173514	hypothetical protein LOC153129
FLNA	NM_001456	filamin 1 (actin-binding protein-280)
FLNB	NM_001457	filamin B, beta (actin binding protein 278)
FLOT2	NM_004475	flotillin 2

FLRT2	NM_013231	fibronectin leucine rich transmembrane protein
FLT3	NM_004119	fms-related tyrosine kinase 3
FLYWCH1	NM_032296	FLYWCH-type zinc finger 1 isoform a
FMNL1	NM_005892	formin-like 1
FMNL3	NM_175736	formin-like 3 isoform 1
FN3KRP	NM_024619	fructosamine-3-kinase-related protein
FNDC3A	NM_014923	fibronectin type III domain containing 3A
FNDC3B	NM_022763	fibronectin type III domain containing 3B
FNDC4	NM_022823	fibronectin type III domain containing 4
FNDC5	NM_153756	fibronectin type III domain containing 5
FNDC7	NM_173532	hypothetical protein LOC163479
FNDC8	NM_017559	hypothetical protein LOC54752
FNTA	NM_001018676	farnesyltransferase, CAAX box, alpha isoform b
FNTB	NM_002028	farnesyltransferase, CAAX box, beta
FOLR2	NM_000803	folate receptor 2 precursor
FOSB	NM_006732	FBJ murine osteosarcoma viral oncogene homolog
FOSL1	NM_005438	FOS-like antigen 1
FOSL2	NM_005253	FOS-like antigen 2
FOXA3	NM_004497	forkhead box A3
FOXF1	NM_001451	forkhead box F1
FOXL2	NM_023067	forkhead box L2
FOXN1	NM_003593	forkhead box N1
FOXO1A	NM_002015	forkhead box O1A
FOXP4	NM_001012426	forkhead box P4 isoform 1
FOXRED1	NM_017547	FAD-dependent oxidoreductase domain containing
FRAG1	NM_014489	FGF receptor activating protein 1
FRAS1	NM_032863	Fraser syndrome 1 isoform 4
FRAT1	NM_005479	GSK-3 binding protein FRAT1
FREQ	NM_014286	frequenin homolog
FRMD4A	NM_018027	FERM domain containing 4A
FRMD6	NM_152330	FERM domain containing 6
FRMPD1	NM_014907	FERM and PDZ domain containing 1
FRMPD2	NM_152428	FERM and PDZ domain containing 2 isoform 1
FRMPD4	NM_014728	PDZ domain containing 10
FRY	NM_023037	hypothetical protein CG003
FSD1	NM_024333	fibronectin type III and SPRY domain containing
FSD2	NM_001007122	SPRY domain containing 1
FSIP2	NM_173651	fibrous sheath interacting protein 2
FSTL1	NM_007085	follistatin-like 1 precursor
FSTL3	NM_005860	follistatin-like 3 glycoprotein precursor
FSTL4	NM_015082	follistatin-like 4
FUBP1	NM_003902	far upstream element-binding protein
FUCA1	NM_000147	fucosidase, alpha-L- 1, tissue
FURIN	NM_002569	furin preproprotein
FUT1	NM_000148	fucosyltransferase 1
FUT2	NM_000511	fucosyltransferase 2 (secretor status included)
FUT3	NM_000149	fucosyltransferase 3 (galactoside
FUT4	NM_002033	fucosyltransferase 4
FVT1	NM_002035	follicular lymphoma variant translocation 1
FXN	NM_000144	frataxin isoform 1 preproprotein
FXYD2	NM_001680	FXYD domain-containing ion transport regulator 2
FXYD6	NM_022003	FXYD domain-containing ion transport regulator
FYCO1	NM_024513	FYVE and coiled-coil domain containing 1

FZD10	NM_007197	frizzled 10
FZD4	NM_012193	frizzled 4
FZD6	NM_003506	frizzled 6
FZD7	NM_003507	frizzled 7
FZD9	NM_003508	frizzled 9
G0S2	NM_015714	putative lymphocyte G0/G1 switch gene
G3BP2	NM_012297	Ras-GTPase activating protein SH3 domain-binding
G6PD	NM_000402	glucose-6-phosphate dehydrogenase
GAA	NM_000152	acid alpha-glucosidase preproprotein
GAB2	NM_012296	GRB2-associated binding protein 2 isoform b
GAB3	NM_080612	Gab3 protein
GABARAPL1	NM_031412	GABA(A) receptor-associated protein like 1
GABBR1	NM_001470	gamma-aminobutyric acid (GABA) B receptor 1
GABPA	NM_002040	GA binding protein transcription factor, alpha
GABRA1	NM_000806	gamma-aminobutyric acid (GABA) A receptor, alpha
GABRE	NM_004961	gamma-aminobutyric acid (GABA) A receptor,
GABRP	NM_014211	gamma-aminobutyric acid (GABA) A receptor, pi
GADD45G	NM_006705	growth arrest and DNA-damage-inducible, gamma
GAGE1	NM_001468	G antigen 1
GAK	NM_005255	cyclin G associated kinase
GALC	NM_000153	galactosylceramidase isoform a precursor
GALM	NM_138801	galactose mutarotase (aldose 1-epimerase)
GALNT1	NM_020474	polypeptide N-acetylgalactosaminyltransferase 1
GALNT11	NM_022087	GALNAC-T11
GALNT13	NM_052917	UDP-N-acetyl-alpha-D-galactosamine:polypeptide
GALNT2	NM_004481	polypeptide N-acetylgalactosaminyltransferase 2
GALNT4	NM_003774	polypeptide N-acetylgalactosaminyltransferase 4
GALNT7	NM_017423	polypeptide N-acetylgalactosaminyltransferase 7
GALNT9	NM_021808	polypeptide N-acetylgalactosaminyltransferase 9
GAN	NM_022041	gigaxonin
GANAB	NM_198334	alpha glucosidase II alpha subunit isoform 2
GARNL1	NM_014990	GTPase activating Rap/RanGAP domain-like 1
GARNL4	NM_015085	GTPase activating Rap/RanGAP domain-like 4
GAS2L1	NM_152237	growth arrest-specific 2 like 1 isoform b
GAS7	NM_003644	growth arrest-specific 7 isoform a
GATA2	NM_032638	GATA binding protein 2
GATA4	NM_002052	GATA binding protein 4
GATA5	NM_080473	GATA binding protein 5
GATAD2A	NM_017660	GATA zinc finger domain containing 2A
GATAD2B	NM_020699	GATA zinc finger domain containing 2B
GBA	NM_000157	glucocerebrosidase precursor
GBF1	NM_004193	golgi-specific brefeldin A resistance factor 1
GBL	NM_022372	G protein beta subunit-like
GCC1	NM_024523	Golgi coiled-coil protein 1
GCC2	NM_014635	GRIP and coiled-coil domain-containing 2 isoform
GCK	NM_000162	glucokinase isoform 1
GCLC	NM_001498	glutamate-cysteine ligase, catalytic subunit
GCM1	NM_003643	glial cells missing homolog a
GCNT3	NM_004751	glucosaminyl (N-acetyl) transferase 3, mucin
GDI2	NM_001494	GDP dissociation inhibitor 2
GDPD2	NM_017711	osteoblast differentiation promoting factor
Gene_symbol	hsa-miR-16 targets	Gene_name
GFAP	NM_002055	glial fibrillary acidic protein

GFER	NM_005262	erv1-like growth factor
GFI1B	NM_004188	growth factor independent 1B (potential
GFM1	NM_024996	G elongation factor, mitochondrial 1
GFPT1	NM_002056	glucosamine-fructose-6-phosphate
GFRA4	NM_022139	GDNF family receptor alpha 4 isoform a
GGA2	NM_015044	ADP-ribosylation factor binding protein 2
GGA3	NM_014001	ADP-ribosylation factor binding protein 3
GH1	NM_022562	growth hormone 1 isoform 5
GH2	NM_022557	growth hormone 2 isoform 2
GHR	NM_000163	growth hormone receptor precursor
GIMAP5	NM_018384	GTPase, IMAP family member 5
GIT1	NM_014030	G protein-coupled receptor kinase interactor 1
GJA4	NM_002060	connexin 37
GLCE	NM_015554	D-glucuronyl C5-epimerase
GLIS3	NM_152629	GLIS family zinc finger 3
GLRX	NM_002064	glutaredoxin (thioltransferase)
GLS	NM_014905	glutaminase C
GLS2	NM_013267	glutaminase GA isoform a
GLT1D1	NM_144669	hypothetical protein LOC144423
GLT25D2	NM_015101	glycosyltransferase 25 domain containing 2
GLTP	NM_016433	glycolipid transfer protein
GLUD1	NM_005271	glutamate dehydrogenase 1
GLUD2	NM_012084	glutamate dehydrogenase 2
GM2A	NM_000405	GM2 ganglioside activator precursor
GM632	NM_020713	hypothetical protein LOC57473
GMEB2	NM_012384	glucocorticoid modulatory element binding
GNA12	NM_007353	guanine nucleotide binding protein (G protein)
GNA15	NM_002068	guanine nucleotide binding protein (G protein),
GNAI3	NM_006496	guanine nucleotide binding protein (G protein),
GNAL	NM_002071	guanine nucleotide binding protein (G protein),
GNAO1	NM_020988	guanine nucleotide binding protein, alpha
GNAQ	NM_002072	guanine nucleotide binding protein (G protein),
GNAS	NM_016592	guanine nucleotide binding protein, alpha
GNB1	NM_002074	guanine nucleotide-binding protein, beta-1
GNG12	NM_018841	G-protein gamma-12 subunit
GNG2	NM_053064	guanine nucleotide binding protein (G protein),
GNG7	NM_052847	guanine nucleotide binding protein (G protein),
GNL3L	NM_019067	guanine nucleotide binding protein-like 3
GOLGA	NM_018652	golgin-like protein
GOLGA1	NM_002077	golgin 97
GOLGA2	NM_004486	Golgi autoantigen, golgin subfamily a, 2
GOLGA3	NM_005895	Golgi autoantigen, golgin subfamily a, 3
GOLGA4	NM_002078	golgi autoantigen, golgin subfamily a, 4
GOLGA7	NM_001002296	golgi autoantigen, golgin subfamily a, 7
GOLPH4	NM_014498	golgi phosphoprotein 4
GOLT1B	NM_016072	golgi transport 1 homolog B
GORASP1	NM_031899	Golgi reassembly stacking protein 1
GORASP2	NM_015530	golgi reassembly stacking protein 2
GOSR1	NM_001007024	golgi SNAP receptor complex member 1 isoform 3
GOT2	NM_002080	aspartate aminotransferase 2 precursor
GPA33	NM_005814	transmembrane glycoprotein A33 precursor
GPAM	NM_020918	mitochondrial glycerol 3-phosphate
GPATC4	NM_015590	G patch domain containing 4 protein isoform 1

GPC1	NM_002081	glypican 1 precursor
GPC3	NM_004484	glypican 3
GPD1	NM_005276	glycerol-3-phosphate dehydrogenase 1 (soluble)
GPIAP1	NM_005898	membrane component chromosome 11 surface marker
GPR109A	NM_177551	G protein-coupled receptor 109A
GPR109B	NM_006018	G protein-coupled receptor 109B
GPR114	NM_153837	G-protein coupled receptor 114
GPR124	NM_032777	G protein-coupled receptor 124
GPR126	NM_001032394	G protein-coupled receptor 126 alpha 2
GPR132	NM_013345	G protein-coupled receptor 132
GPR146	NM_138445	G protein-coupled receptor 146
GPR171	NM_013308	G protein-coupled receptor 171
GPR180	NM_180989	G protein-coupled receptor 180 precursor
GPR23	NM_005296	G protein-coupled receptor 23
GPR26	NM_153442	G protein-coupled receptor 26
GPR30	NM_001505	G protein-coupled receptor 30
GPR55	NM_005683	G protein-coupled receptor 55
GPR6	NM_005284	G protein-coupled receptor 6
GPR63	NM_030784	G protein-coupled receptor 63
GPR68	NM_003485	G protein-coupled receptor 68
GPR78	NM_080819	G protein-coupled receptor 78
GPR83	NM_016540	G protein-coupled receptor 83
GPR88	NM_022049	G-protein coupled receptor 88
GPR92	NM_020400	putative G protein-coupled receptor 92
GPS1	NM_004127	G protein pathway suppressor 1 isoform 2
GPSM3	NM_022107	G-protein signalling modulator 3 (AGS3-like, C.
GPX1	NM_000581	glutathione peroxidase 1 isoform 1
GRAMD2	NM_001012642	hypothetical protein LOC196996
GRAMD3	NM_023927	GRAM domain containing 3
GRB10	NM_001001549	growth factor receptor-bound protein 10 isoform
GRB2	NM_002086	growth factor receptor-bound protein 2 isoform
GRB7	NM_001030002	growth factor receptor-bound protein 7
GREM2	NM_022469	gremlin 2 precursor
GRIA3	NM_000828	glutamate receptor 3 isoform flop precursor
GRIK3	NM_000831	glutamate receptor 7 precursor
GRIN1	NM_000832	NMDA receptor 1 isoform NR1-1 precursor
GRIN2B	NM_000834	N-methyl-D-aspartate receptor subunit 2B
GRIN2C	NM_000835	N-methyl-D-aspartate receptor subunit 2C
GRIN3A	NM_133445	glutamate receptor, ionotropic,
GRK6	NM_001004106	G protein-coupled receptor kinase 6 isoform A
GRM1	NM_000838	glutamate receptor, metabotropic 1
GRM7	NM_000844	glutamate receptor, metabotropic 7 isoform a
GRPR	NM_005314	gastrin-releasing peptide receptor
GRTP1	NM_024719	growth hormone regulated TBC protein 1
GRWD1	NM_031485	glutamate-rich WD repeat containing 1
GSDMDC1	NM_024736	gasdermin domain containing 1
GSG1	NM_153823	germ cell associated 1 isoform 2
GSTT2	NM_000854	glutathione S-transferase theta 2
GTDC1	NM_001006636	glycosyltransferase-like domain containing 1
GTF3C5	NM_012087	general transcription factor IIIC, polypeptide
GTPBP1	NM_004286	GTP binding protein 1
GTPBP8	NM_001008235	hypothetical protein LOC29083 isoform 3
GUCA1B	NM_002098	guanylate cyclase activator 1B (retina)

GUSBL2	NM_206910	hypothetical protein LOC375513 isoform 2
GYLTL1B	NM_152312	glycosyltransferase-like 1B
GYS1	NM_002103	glycogen synthase 1 (muscle)
H2AFJ	NM_018267	H2A histone family, member J isoform 1
H2-ALPHA	NM_080386	alpha-tubulin isotype H2-alpha
H6PD	NM_004285	hexose-6-phosphate dehydrogenase precursor
HADHSC	NM_005327	L-3-hydroxyacyl-Coenzyme A dehydrogenase
HAPLN4	NM_023002	brain link protein 2
HARSL	NM_012208	histidyl-tRNA synthetase-like
HAS1	NM_001523	hyaluronan synthase 1
HAS2	NM_005328	hyaluronan synthase 2
HAS3	NM_005329	hyaluronan synthase 3 isoform a
HCCA2	NM_053005	HCCA2 protein
HCFC1	NM_005334	host cell factor C1 (VP16-accessory protein)
HD	NM_002111	huntingtin
HDGF	NM_004494	hepatoma-derived growth factor (high-mobility
HECTD1	NM_015382	HECT domain containing 1
HECW1	NM_015052	NEDD4-like ubiquitin-protein ligase 1
HELZ	NM_014877	helicase with zinc finger domain
HEMK1	NM_016173	HemK methyltransferase family member 1
HERC2	NM_004667	hect domain and RLD 2
HERC4	NM_001017972	hect domain and RLD 4 isoform c
HERC6	NM_001013000	hect domain and RLD 6 isoform c
HERV-FRD	NM_207582	HERV-FRD provirus ancestral Env polyprotein
HES2	NM_019089	hairy and enhancer of split homolog 2
HES5	NM_001010926	hairy and enhancer of split 5
HEXA	NM_000520	hexosaminidase A preproprotein
HEY1	NM_012258	hairy/enhancer-of-split related with YRPW motif
HEY2	NM_012259	hairy/enhancer-of-split related with YRPW motif
HEYL	NM_014571	hairy/enhancer-of-split related with YRPW
HIC1	NM_006497	hypermethylated in cancer 1
HIC2	NM_015094	hypermethylated in cancer 2
HIGD1A	NM_014056	HIG1 domain family, member 1A
HIP1	NM_005338	huntingtin interacting protein 1
HIRA	NM_003325	HIR (histone cell cycle regulation defective, S.
HIST1H2AG	NM_021064	H2A histone family, member P
HIST2H2BE	NM_003528	H2B histone family, member Q
HK1	NM_000188	hexokinase 1 isoform HKI
HK2	NM_000189	hexokinase 2
HKR2	NM_181846	GLI-Kruppel family member HKR2
HLA-DQA1	NM_002122	major histocompatibility complex, class II, DQ
HMBOX1	NM_024567	hypothetical protein LOC79618
HMBS	NM_000190	hydroxymethylbilane synthase isoform 1
HMG20A	NM_018200	high-mobility group 20A
HMG2L1	NM_001003681	high-mobility group protein 2-like 1 isoform b
HMGA1	NM_002131	high mobility group AT-hook 1 isoform b
HMGA2	NM_001015886	high mobility group AT-hook 2 isoform c
HMGB3	NM_005342	high-mobility group box 3
HMOX2	NM_002134	heme oxygenase (decyclizing) 2
HNF4A	NM_000457	hepatocyte nuclear factor 4 alpha isoform b
HNF4G	NM_004133	hepatocyte nuclear factor 4, gamma
HNRPA0	NM_006805	heterogeneous nuclear ribonucleoprotein A0
HNRPA1	NM_002136	heterogeneous nuclear ribonucleoprotein A1

HNRPDL	NM_005463	heterogeneous nuclear ribonucleoprotein D-like
HNRPU	NM_004501	heterogeneous nuclear ribonucleoprotein U
HOXA10	NM_018951	homeobox A10 isoform a
HOXA3	NM_030661	homeobox A3 isoform a
HOXB13	NM_006361	homeobox B13
HOXB4	NM_024015	homeobox B4
HOXB7	NM_004502	homeobox B7
HOXC11	NM_014212	homeobox C11
HOXC13	NM_017410	homeobox C13
HOXC8	NM_022658	homeobox C8
HOXD1	NM_024501	homeobox D1
HOXD9	NM_014213	homeobox D9
HPCAL4	NM_016257	hippocalcin-like protein 4
HPS1	NM_182637	Hermansky-Pudlak syndrome 1 protein isoform b
HPS4	NM_022081	light ear protein isoform a
HPSE2	NM_021828	heparanase 2
HR	NM_005144	hairless protein isoform a
HRH2	NM_022304	histamine receptor H2
HRH3	NM_007232	histamine receptor H3
HS2ST1	NM_012262	heparan sulfate 2-O-sulfotransferase 1
HS6ST1	NM_004807	heparan sulfate 6-O-sulfotransferase
HS6ST2	NM_147175	heparan sulfate 6-O-sulfotransferase 2
HSDL2	NM_032303	hydroxysteroid dehydrogenase like 2
HSF2BP	NM_007031	heat shock transcription factor 2 binding
HSPA1B	NM_005346	heat shock 70kDa protein 1B
HSPA4L	NM_014278	heat shock 70kDa protein 4-like
HSPA8	NM_006597	heat shock 70kDa protein 8 isoform 1
HSPB7	NM_014424	heat shock 27kDa protein family, member 7
HSPBAP1	NM_024610	Hspb associated protein 1
HSPC049	NM_014149	HSPC049 protein
HSPC117	NM_014306	hypothetical protein LOC51493
HSPG2	NM_005529	heparan sulfate proteoglycan 2
HSU79303	NM_013301	hypothetical protein LOC29903
HTF9C	NM_022727	HpaII tiny fragments locus 9C
HTR2A	NM_000621	5-hydroxytryptamine (serotonin) receptor 2A
HTR2C	NM_000868	5-hydroxytryptamine (serotonin) receptor 2C
HTR4	NM_000870	serotonin 5-HT4 receptor isoform b
HTRA2	NM_013247	HtrA serine peptidase 2 isoform 1 preproprotein
HTRA3	NM_053044	HtrA serine peptidase 3
HYOU1	NM_006389	oxygen regulated protein precursor
IARS	NM_002161	isoleucine-tRNA synthetase
IBRDC1	NM_152553	IBR domain containing 1
IBRDC2	NM_182757	IBR domain containing 2
ICA1	NM_022307	islet cell autoantigen 1
ICMT	NM_012405	isoprenylcysteine carboxyl methyltransferase
ICOS	NM_012092	inducible T-cell co-stimulator precursor
ICOSLG	NM_015259	inducible T-cell co-stimulator ligand
IDH3A	NM_005530	isocitrate dehydrogenase 3 (NAD+) alpha
IER2	NM_004907	immediate early response 2
IFIT1	NM_001548	interferon-induced protein with
IFNAR1	NM_000629	interferon-alpha receptor 1 precursor
IFNGR2	NM_005534	interferon-gamma receptor beta chain precursor
IFT140	NM_014714	intraflagellar transport 140

IFT20	NM_174887	intraflagellar transport protein IFT20
IFT57	NM_018010	estrogen-related receptor beta like 1
IFT74	NM_025103	coiled-coil domain containing 2
IGF1	NM_000618	insulin-like growth factor 1 (somatomedin C)
IGF1R	NM_000875	insulin-like growth factor 1 receptor precursor
IGF2BP1	NM_006546	insulin-like growth factor 2 mRNA binding
IGF2R	NM_000876	insulin-like growth factor 2 receptor
IGFBP3	NM_000598	insulin-like growth factor binding protein 3
IGSF22	NM_173588	hypothetical protein LOC283284
IGSF3	NM_001007237	immunoglobulin superfamily, member 3 isoform 2
IGSF4	NM_014333	immunoglobulin superfamily, member 4D
IHPK1	NM_001006115	inositol hexaphosphate kinase 1 isoform 2
IHPK3	NM_054111	inositol hexaphosphate kinase 3
IKBKAP	NM_003640	inhibitor of kappa light polypeptide gene
IKBKB	NM_001556	inhibitor of kappa light polypeptide gene
IKBKE	NM_014002	IKK-related kinase epsilon
IKBKG	NM_003639	inhibitor of kappa light polypeptide gene
IL10RA	NM_001558	interleukin 10 receptor, alpha precursor
IL10RB	NM_000628	interleukin 10 receptor, beta precursor
IL13	NM_002188	interleukin 13 precursor
IL15	NM_000585	interleukin 15 preproprotein
IL16	NM_004513	interleukin 16 isoform 1 precursor
IL17D	NM_138284	interleukin 17D precursor
IL17E	NM_022789	interleukin 17E isoform 1 precursor
IL17RB	NM_172234	interleukin 17B receptor isoform 2 precursor
IL17RC	NM_032732	interleukin 17 receptor C isoform 3 precursor
IL17RD	NM_017563	interleukin 17 receptor D
IL17RE	NM_144640	interleukin 17 receptor E isoform 3
IL18BP	NM_173042	interleukin 18 binding protein precursor
IL18R1	NM_003855	interleukin 18 receptor 1 precursor
IL1F5	NM_012275	interleukin 1 family, member 5
IL1F8	NM_173178	interleukin 1 family, member 8 isoform 2
IL1F9	NM_019618	interleukin 1 family, member 9
IL1R1	NM_000877	interleukin 1 receptor, type I precursor
IL1RAP	NM_134470	interleukin 1 receptor accessory protein isoform
IL1RAPL1	NM_014271	interleukin 1 receptor accessory protein-like 1
IL1RL1	NM_003856	interleukin 1 receptor-like 1 isoform 2
IL20	NM_018724	interleukin 20 precursor
IL28RA	NM_170743	interleukin 28 receptor, alpha isoform 1
IL2RA	NM_000417	interleukin 2 receptor, alpha chain precursor
IL2RB	NM_000878	interleukin 2 receptor beta precursor
IL3	NM_000588	interleukin 3 precursor
IL3RA	NM_002183	interleukin 3 receptor, alpha precursor
IL6R	NM_000565	interleukin 6 receptor isoform 1 precursor
IL9R	NM_176786	interleukin 9 receptor isoform 2
ILDR1	NM_175924	immunoglobulin-like domain containing receptor
ILF3	NM_004516	interleukin enhancer binding factor 3 isoform b
IMMP2L	NM_032549	IMP2 inner mitochondrial membrane protease-like
IMPA2	NM_014214	inositol(myo)-1(or 4)-monophosphatase 2
INCENP	NM_020238	inner centromere protein antigens 135/155kDa
ING5	NM_032329	inhibitor of growth family, member 5
INPP5A	NM_005539	inositol polyphosphate-5-phosphatase A
INSM2	NM_032594	insulinoma-associated protein IA-6

INSR	NM_000208	insulin receptor
INVS	NM_014425	inversin isoform a
IPO8	NM_006390	importin 8
IPPK	NM_022755	inositol 1,3,4,5,6-pentakisphosphate 2-kinase
IQCE	NM_152558	IQ motif containing E
IQGAP1	NM_003870	IQ motif containing GTPase activating protein 1
IQGAP3	NM_178229	IQ motif containing GTPase activating protein 3
IRAK1	NM_001025242	interleukin-1 receptor-associated kinase 1
IRAK2	NM_001570	interleukin-1 receptor-associated kinase 2
IRF2BP1	NM_015649	interferon regulatory factor 2 binding protein
IRF4	NM_002460	interferon regulatory factor 4
IRF5	NM_002200	interferon regulatory factor 5 isoform a
IRS1	NM_005544	insulin receptor substrate 1
IRS2	NM_003749	insulin receptor substrate 2
IRX3	NM_024336	iroquois homeobox protein 3
ISLR	NM_005545	immunoglobulin superfamily containing
ISOC1	NM_016048	isochorismatase domain containing 1
ISOC2	NM_024710	isochorismatase domain containing 2
ITFG3	NM_032039	integrin alpha FG-GAP repeat containing 3
ITGA10	NM_003637	integrin, alpha 10 precursor
ITGA2	NM_002203	integrin alpha 2 precursor
ITGAM	NM_000632	integrin alpha M precursor
ITGAX	NM_000887	integrin alpha X precursor
ITGB4BP	NM_002212	integrin beta 4 binding protein isoform a
ITGB5	NM_002213	integrin, beta 5
ITGBL1	NM_004791	integrin, beta-like 1 (with EGF-like repeat
ITIH1	NM_002215	inter-alpha (globulin) inhibitor H1
ITIH5	NM_001001851	inter-alpha trypsin inhibitor heavy chain
ITK	NM_005546	IL2-inducible T-cell kinase
ITPK1	NM_014216	inositol 1,3,4-triphosphate 5/6 kinase
ITPR1	NM_002222	inositol 1,4,5-triphosphate receptor, type 1
ITSN1	NM_001001132	intersectin 1 isoform ITSN-s
IVNS1ABP	NM_006469	influenza virus NS1A binding protein isoform a
JAGN1	NM_032492	jagunal homolog 1
JAK2	NM_004972	Janus kinase 2
JARID1B	NM_006618	Jumonji, AT rich interactive domain 1B
JARID2	NM_004973	jumonji, AT rich interactive domain 2 protein
JMJD2D	NM_018039	jumonji domain containing 2D
JMJD4	NM_023007	jumonji domain containing 4
JMJD5	NM_024773	hypothetical protein LOC79831
JOSD1	NM_014876	Josephin domain containing 1
JPH1	NM_020647	junctophilin 1
JPH2	NM_020433	junctophilin 2 isoform 1
JUB	NM_032876	jub, ajuba homolog isoform 1
JUP	NM_002230	junction plakoglobin
K6HF	NM_004693	cytokeratin type II
K6IRS3	NM_175068	keratin 6 irs3
K6IRS4	NM_175053	keratin 6 irs4
KAL1	NM_000216	Kallmann syndrome 1 protein
KALRN	NM_001024660	kalirin, RhoGEF kinase isoform 1
KARS	NM_005548	lysyl-tRNA synthetase
KATNAL1	NM_001014380	katanin p60 subunit A-like 1
KATNB1	NM_005886	katanin p80 subunit B 1

KBTBD2	NM_015483	kelch repeat and BTB (POZ) domain containing 2
KBTBD4	NM_016506	kelch repeat and BTB (POZ) domain containing 4
KBTBD5	NM_152393	kelch repeat and BTB (POZ) domain containing 5
KCNA3	NM_002232	potassium voltage-gated channel, shaker-related
KCNAB1	NM_003471	potassium voltage-gated channel, shaker-related
KCNAB2	NM_003636	potassium voltage-gated channel, shaker-related
KCNC2	NM_139136	Shaw-related voltage-gated potassium channel
KCND3	NM_004980	potassium voltage-gated channel, Shal-related
KCNE1L	NM_012282	potassium voltage-gated channel, Isk-related
KCNG3	NM_133329	potassium voltage-gated channel, subfamily G,
KCNG4	NM_133490	potassium voltage-gated channel, subfamily G,
KCNH4	NM_012285	potassium voltage-gated channel, subfamily H,
KCNIP1	NM_014592	Kv channel interacting protein 1 isoform 2
KCNIP3	NM_013434	Kv channel interacting protein 3 isoform 1
KCNJ11	NM_000525	potassium inwardly-rectifying channel J11
KCNJ16	NM_018658	potassium inwardly-rectifying channel J16
KCNJ2	NM_000891	potassium inwardly-rectifying channel J2
KCNJ9	NM_004983	potassium inwardly-rectifying channel subfamily
KCNK1	NM_002245	potassium channel, subfamily K, member 1
KCNK2	NM_001017424	potassium channel, subfamily K, member 2 isoform
KCNK7	NM_005714	potassium channel, subfamily K, member 7 isoform
KCNMA1	NM_001014797	large conductance calcium-activated potassium
KCNN4	NM_002250	intermediate conductance calcium-activated
KCNQ1	NM_000218	potassium voltage-gated channel, KQT-like
KCNQ2	NM_004518	potassium voltage-gated channel KQT-like protein
KCNQ5	NM_019842	potassium voltage-gated channel, KQT-like
KCNRG	NM_173605	potassium channel regulator isoform 1
KCNS1	NM_002251	potassium voltage-gated channel
KCNT1	NM_020822	potassium channel, subfamily T, member 1
KCNT2	NM_198503	potassium channel, subfamily T, member 2
KCTD1	NM_198991	potassium channel tetramerisation domain
KCTD12	NM_138444	potassium channel tetramerisation domain
KCTD15	NM_024076	potassium channel tetramerisation domain
KCTD2	NM_015353	potassium channel tetramerisation domain
KCTD3	NM_016121	potassium channel tetramerisation domain
KCTD5	NM_018992	potassium channel tetramerisation domain
KCTD7	NM_153033	potassium channel tetramerisation domain
KCTD8	NM_198353	potassium channel tetramerisation domain
KGFLP1	NM_174950	hypothetical protein LOC387628
KIAA0125	NM_014792	hypothetical protein LOC9834
KIAA0143	NM_015137	hypothetical protein LOC23167
KIAA0152	NM_014730	hypothetical protein LOC9761
KIAA0174	NM_014761	putative MAPK activating protein PM28
KIAA0179	NM_015056	hypothetical protein LOC23076
KIAA0182	NM_014615	hypothetical protein LOC23199
KIAA0232	NM_014743	hypothetical protein LOC9778
KIAA0240	NM_015349	hypothetical protein LOC23506
KIAA0241	NM_015060	hypothetical protein LOC23080
KIAA0247	NM_014734	hypothetical protein LOC9766
KIAA0251	NM_015027	hypothetical protein LOC23042
KIAA0265	NM_014997	hypothetical protein LOC23008
KIAA0284	NM_015005	hypothetical protein LOC283638
KIAA0286	NM_015257	hypothetical protein LOC23306

KIAA0319L	NM_024874	polycystic kidney disease 1-like isoform a
KIAA0323	NM_015299	hypothetical protein LOC23351
KIAA0329	NM_014844	hypothetical protein LOC9895
KIAA0350	NM_015226	hypothetical protein LOC23274
KIAA0355	NM_014686	hypothetical protein LOC9710
KIAA0376	NM_015330	cytospin A
KIAA0423	NM_015091	hypothetical protein LOC23116
KIAA0427	NM_014772	hypothetical protein LOC9811
KIAA0446	NM_014655	hypothetical protein LOC9673
KIAA0494	NM_014774	hypothetical protein LOC9813
KIAA0495	NM_207306	KIAA0495
KIAA0513	NM_014732	hypothetical protein LOC9764
KIAA0523	NM_015253	hypothetical protein LOC23302
KIAA0553	NM_001002909	hypothetical protein LOC23131
KIAA0556	NM_015202	hypothetical protein LOC23247
KIAA0562	NM_014704	glycine-, glutamate-,
KIAA0564	NM_001009814	hypothetical protein LOC23078 isoform b
KIAA0649	NM_014811	1A6/DRIM (down-regulated in metastasis)
KIAA0652	NM_014741	hypothetical protein LOC9776
KIAA0664	NM_015229	hypothetical protein LOC23277
KIAA0672	NM_014859	hypothetical protein LOC9912
KIAA0676	NM_015043	hypothetical protein LOC23061 isoform b
KIAA0683	NM_016111	hypothetical protein LOC9894
KIAA0746	NM_015187	hypothetical protein LOC23231
KIAA0773	NM_014690	hypothetical protein LOC9715
KIAA0789	NM_014653	hypothetical protein LOC9671
KIAA0804	NM_001009921	hypothetical protein LOC23355 isoform a
KIAA0828	NM_015328	KIAA0828 protein
KIAA0831	NM_014924	hypothetical protein LOC22863
KIAA0853	NM_015070	KIAA0853
KIAA0859	NM_001007239	CGI-01 protein isoform 3
KIAA0863	NM_014913	hypothetical protein LOC22850
KIAA0895	NM_015314	hypothetical protein LOC23366
KIAA1161	NM_020702	hypothetical protein LOC57462
KIAA1166	NM_018684	hepatocellular carcinoma-associated antigen 127
KIAA1199	NM_018689	KIAA1199
KIAA1267	NM_015443	hypothetical protein LOC284058
KIAA1274	NM_014431	KIAA1274
KIAA1303	NM_020761	raptor
KIAA1333	NM_017769	hypothetical protein LOC55632
KIAA1411	NM_020819	hypothetical protein LOC57579
KIAA1434	NM_019593	hypothetical protein LOC56261
KIAA1456	NM_020844	hypothetical protein LOC57604
KIAA1522	NM_020888	hypothetical protein LOC57648
KIAA1530	NM_020894	hypothetical protein LOC57654
KIAA1542	NM_020901	CTD-binding SR-like protein rA9
KIAA1559	NM_020917	zinc finger protein 14-like
KIAA1576	NM_020927	hypothetical protein LOC57687
KIAA1600	NM_020940	hypothetical protein LOC57700
KIAA1609	NM_020947	hypothetical protein LOC57707
KIAA1618	NM_020954	hypothetical protein LOC57714
KIAA1688	NM_025251	KIAA1688 protein
KIAA1715	NM_030650	Lunapark

KIAA1727	NM_033393	hypothetical protein LOC85462
KIAA1729	NM_053042	hypothetical protein LOC85460
KIAA1737	NM_033426	KIAA1737 protein
KIAA1772	NM_024935	hypothetical protein LOC80000
KIAA1804	NM_032435	mixed lineage kinase 4
KIAA1815	NM_024896	hypothetical protein LOC79956
KIAA1853	NM_194286	KIAA1853 protein
KIAA1862	NM_032534	KIAA1862 protein
KIAA1875	NM_032529	KIAA1875 protein
KIAA1909	NM_052909	hypothetical protein LOC153478
KIAA1920	NM_052919	hypothetical protein LOC114817
KIAA1924	NM_145294	hypothetical protein LOC197335
KIAA1961	NM_001008738	hypothetical protein LOC96459 isoform 2
KIAA2022	NM_001008537	hypothetical protein LOC340533
KIF12	NM_138424	kinesin family member 12
KIF13B	NM_015254	kinesin family member 13B
KIF1A	NM_004321	axonal transport of synaptic vesicles
KIF1B	NM_015074	kinesin family member 1B isoform b
KIF1C	NM_006612	kinesin family member 1C
KIF2	NM_004520	kinesin heavy chain member 2
KIF21A	NM_017641	kinesin family member 21A
KIF23	NM_004856	kinesin family member 23 isoform 2
KIF2C	NM_006845	kinesin family member 2C
KIF3B	NM_004798	kinesin family member 3B
KIF5A	NM_004984	kinesin family member 5A
KIF5B	NM_004521	kinesin family member 5B
KIF6	NM_145027	kinesin family member 6
KIFC3	NM_005550	kinesin family member C3
KIR2DS4	NM_012314	killer cell immunoglobulin-like receptor, two
KITLG	NM_000899	KIT ligand isoform b precursor
KL	NM_004795	klotho isoform a
KLC2	NM_022822	likely ortholog of kinesin light chain 2
KLC4	NM_201521	kinesin-like 8 isoform a
KLF12	NM_016285	Kruppel-like factor 12 isoform b
KLF13	NM_015995	Kruppel-like factor 13
KLHDC6	NM_207335	hypothetical protein LOC166348
KLHDC8B	NM_173546	hypothetical protein LOC200942
KLHL18	NM_025010	kelch-like 18
KLHL2	NM_007246	kelch-like 2, Mayven
KLHL21	NM_014851	kelch-like 21
KLHL26	NM_018316	hypothetical protein LOC55295
KLHL3	NM_017415	kelch-like 3 (Drosophila)
KLHL4	NM_019117	kelch-like 4 isoform 1
KLK2	NM_001002231	kallikrein 2, prostatic isoform 2
KLKB1	NM_000892	plasma kallikrein B1 precursor
KNDC1	NM_152643	kinase non-catalytic C-lobe domain (KIND)
KNS2	NM_005552	kinesin 2 60/70kDa isoform 1
KPNA3	NM_002267	karyopherin alpha 3
KPNA4	NM_002268	karyopherin alpha 4
KRAS	NM_004985	c-K-ras2 protein isoform b
KRT1B	NM_175078	keratin 1B
KRT20	NM_019010	keratin 20
KRT2B	NM_015848	cytokeratin 2

KRTAP10-1	NM_198691	keratin associated protein 10-1
KRTAP10-12	NM_198699	keratin associated protein 10-12
KRTAP10-8	NM_198695	keratin associated protein 10-8
KRTAP11-1	NM_175858	keratin associated protein 11-1
KRTAP26-1	NM_203405	hypothetical protein LOC388818
KRTAP4-4	NM_032524	keratin associated protein 4.4
KRTAP9-2	NM_031961	keratin associated protein 9.2
KRTAP9-3	NM_031962	keratin associated protein 9.3
KRTAP9-4	NM_033191	keratin associated protein 9-4
KRTHA3B	NM_002279	type I hair keratin 3B
KRTHB4	NM_033045	keratin, hair, basic, 4
KSR1	NM_014238	kinase suppressor of ras
Kua-UEV	NM_003349	ubiquitin-conjugating enzyme E2 Kua-UEV isoform
KU-MEL-3	NM_001011540	KU-MEL-3 protein
LAMC1	NM_002293	laminin, gamma 1 precursor
LAMP1	NM_005561	lysosomal-associated membrane protein 1
LAMP2	NM_013995	lysosomal-associated membrane protein 2
LAMP3	NM_014398	lysosomal-associated membrane protein 3
LANCL1	NM_006055	lanthionine synthetase C-like protein 1
LANCL2	NM_018697	LanC lantibiotic synthetase component C-like 2
LARP2	NM_032239	La ribonucleoprotein domain family member 2
LASP1	NM_006148	LIM and SH3 protein 1
LASS1	NM_021267	longevity assurance gene 1 isoform 1
LASS3	NM_178842	hypothetical protein LOC204219
LASS6	NM_203463	longevity assurance homolog 6
LAT	NM_001014987	linker for activation of T cells isoform b
LATS1	NM_004690	LATS homolog 1
LATS2	NM_014572	LATS, large tumor suppressor, homolog 2
LCE1E	NM_178353	late cornified envelope 1E
LCN2	NM_005564	lipocalin 2 (oncogene 24p3)
LCP1	NM_002298	L-plastin
LDB3	NM_007078	LIM domain binding 3
LDLRAD2	NM_001013693	hypothetical protein LOC401944
LDLRAP1	NM_015627	low density lipoprotein receptor adaptor protein
LDOC1	NM_012317	leucine zipper, down-regulated in cancer 1
LDOC1L	NM_032287	hypothetical protein LOC84247
LEMD1	NM_001001552	LEM domain containing 1
LENG12	NM_033206	hypothetical protein LOC90011
LEP	NM_000230	leptin precursor
LETM1	NM_012318	leucine zipper-EF-hand containing transmembrane
LGALS8	NM_006499	galectin 8 isoform a
LGI2	NM_018176	leucine-rich repeat LGI family, member 2
LGI4	NM_139284	leucine-rich repeat LGI family, member 4
LGR6	NM_001017403	leucine-rich repeat-containing G protein-coupled
LHFPL5	NM_182548	lipoma HMGIC fusion partner-like 5
LHPP	NM_022126	phospholysine phosphohistidine inorganic
LHX3	NM_014564	LIM homeobox protein 3 isoform b
LIF	NM_002309	leukemia inhibitory factor (cholinergic
LIMD1	NM_014240	LIM domains containing 1
LIMS3	NM_033514	LIM and senescent cell antigen-like domains 3
LIN28	NM_024674	lin-28 homolog
LIN28B	NM_001004317	lin-28 homolog B
LIPE	NM_005357	hormone-sensitive lipase

LIPG	NM_006033	endothelial lipase precursor
LIPH	NM_139248	lipase, member H precursor
LITAF	NM_004862	LPS-induced TNF-alpha factor
LKAP	NM_014647	limkain b1
LMAN2L	NM_030805	lectin, mannose-binding 2-like
LMNA	NM_170707	lamin A/C isoform 1 precursor
LMO7	NM_005358	LIM domain only 7
LMOD1	NM_012134	leiomodin 1 (smooth muscle)
LNX1	NM_032622	multi-PDZ-domain-containing protein
LNX2	NM_153371	PDZ domain containing ring finger 1
LOC112714	NM_207312	hypothetical protein LOC112714
LOC115648	NM_145326	hypothetical protein LOC115648
LOC116143	NM_138458	monad
LOC133308	NM_178833	hypothetical protein LOC133308
LOC144233	NM_181708	hypothetical protein LOC144233
LOC144363	NM_001001660	hypothetical protein LOC144363
LOC144983	NM_001011724	heterogeneous nuclear ribonucleoprotein A1-like
LOC147650	NM_207324	hypothetical protein LOC147650
LOC147804	NM_001010856	hypothetical protein LOC147804
LOC150383	NM_001008917	hypothetical protein LOC150383 isoform 2
LOC151194	NM_145280	hypothetical protein LOC151194
LOC153222	NM_153607	hypothetical protein LOC153222
LOC155060	NM_001004302	hypothetical protein LOC155060
LOC158381	NM_001029857	hypothetical protein LOC158381
LOC159090	NM_145284	hypothetical protein LOC159090
LOC161931	NM_139174	hypothetical protein LOC161931
LOC162427	NM_178126	hypothetical protein LOC162427
LOC165186	NM_199280	hypothetical protein LOC165186
LOC196463	NM_173542	hypothetical protein LOC196463
LOC197322	NM_174917	hypothetical protein LOC197322
LOC201164	NM_178836	hypothetical protein LOC201164
LOC203427	NM_145305	mitochondrial solute carrier protein
LOC203547	NM_001017980	hypothetical protein LOC203547
LOC220594	NM_145809	TL132 protein
LOC221442	NM_001010871	hypothetical protein LOC221442
LOC255374	NM_203397	hypothetical protein LOC255374
LOC283487	NM_178514	hypothetical protein LOC283487
LOC283537	NM_181785	hypothetical protein LOC283537
LOC283849	NM_178516	hypothetical protein LOC283849
LOC284434	NM_001007525	hypothetical protein LOC284434
LOC284757	NM_001004305	hypothetical protein LOC284757
LOC284861	NM_201565	hypothetical protein LOC284861
LOC285074	NM_001012626	hypothetical protein LOC285074
LOC285382	NM_001025266	hypothetical protein LOC285382
LOC285498	NM_194439	hypothetical protein LOC285498
LOC285636	NM_175921	hypothetical protein LOC285636
LOC286526	NM_001031834	Ras-like GTPase-like
LOC317671	NM_173362	hypothetical protein LOC317671
LOC339768	NM_194312	hypothetical protein LOC339768
LOC340156	NM_001012418	hypothetical protein LOC340156
LOC340529	NM_001012977	hypothetical protein LOC340529
LOC348174	NM_182619	secretory protein LOC348174
LOC348262	NM_207368	hypothetical protein LOC348262

LOC348840	NM_182631	hypothetical protein LOC348840
LOC352909	NM_001031802	hypothetical protein LOC352909 isoform 2
LOC387646	NM_001006604	hypothetical protein LOC387646
LOC387720	NM_001013633	hypothetical protein LOC387720
LOC387758	NM_203371	hypothetical protein LOC387758
LOC387856	NM_001013635	hypothetical protein LOC387856
LOC388886	NM_207644	hypothetical protein LOC388886
LOC389541	NM_001008395	hypothetical protein LOC389541
LOC390980	NM_001023563	similar to Zinc finger protein 264
LOC391356	NM_001013663	hypothetical protein LOC391356
LOC399706	NM_001010910	hypothetical protein LOC399706
LOC399900	NM_001013667	hypothetical protein LOC399900
LOC400120	NM_203451	hypothetical protein LOC400120
LOC400145	NM_001013669	hypothetical protein LOC400145
LOC400258	NM_001008404	hypothetical protein LOC400258
LOC400451	NM_207446	hypothetical protein LOC400451
LOC400464	NM_001013670	hypothetical protein LOC400464
LOC400696	NM_207646	hypothetical protein LOC400696
LOC400707	NM_001013673	hypothetical protein LOC400707
LOC400891	NM_001013675	hypothetical protein LOC400891
LOC400924	NM_001013676	hypothetical protein LOC400924
LOC400965	NM_001013677	hypothetical protein LOC400965
LOC401152	NM_001001701	hypothetical protein LOC401152
LOC401233	NM_001013680	hypothetical protein LOC401233
LOC401252	NM_001013681	hypothetical protein LOC401252
LOC401286	NM_001023565	hypothetical protein LOC401286
LOC401431	NM_001008745	hypothetical protein LOC401431
LOC401498	NM_212558	hypothetical protein LOC401498
LOC401589	NM_001013687	hypothetical protein LOC401589
LOC401720	NM_001013690	hypothetical protein LOC401720
LOC402055	NM_001013694	hypothetical protein LOC402055
LOC405753	NM_207581	Numb-interacting protein
LOC440157	NM_001013701	hypothetical protein LOC440157
LOC440248	NM_199045	hypothetical protein LOC440248
LOC440742	NM_001013710	hypothetical protein LOC440742
LOC440944	NM_001013713	hypothetical protein LOC440944
LOC441046	NM_001011539	hypothetical protein LOC441046
LOC441087	NM_001013716	hypothetical protein LOC441087
LOC441120	NM_001013718	hypothetical protein LOC441120
LOC441177	NM_001013720	hypothetical protein LOC441177
LOC441193	NM_001013722	hypothetical protein LOC441193
LOC441208	NM_001013723	hypothetical protein LOC441208
LOC441257	NM_001023562	hypothetical protein LOC441257
LOC441426	NM_001013727	hypothetical protein LOC441426
LOC442582	NM_001025202	STAG3-like
LOC493856	NM_001008388	hypothetical protein LOC493856
LOC497190	NM_001011880	hypothetical protein LOC497190
LOC51057	NM_015910	hypothetical protein LOC51057
LOC541469	NM_001013617	hypothetical protein LOC541469
LOC55565	NM_017530	hypothetical protein LOC55565
LOC56964	NM_020212	hypothetical protein LOC56964
LOC619208	NM_001033564	hypothetical protein LOC619208
LOC89944	NM_138342	hypothetical protein LOC89944

LOC90321	NM_001010851	hypothetical protein LOC90321
LOC90639	NM_001031617	hypothetical protein LOC90639
LOC90693	NM_138771	hypothetical protein LOC90693
LOC91461	NM_138370	hypothetical protein LOC91461
LOC91689	NM_033318	hypothetical protein LOC91689
LOC93349	NM_138402	hypothetical protein LOC93349
LOC93622	NM_138699	hypothetical protein LOC93622
LOXL2	NM_002318	lysyl oxidase-like 2 precursor
LPHN1	NM_001008701	latrophilin 1 isoform 1 precursor
LPHN2	NM_012302	latrophilin 2 precursor
LPIN2	NM_014646	lipin 2
LPIN3	NM_022896	lipin 3
LPP	NM_005578	LIM domain containing preferred translocation
LPPR2	NM_022737	lipid phosphate phosphatase-related protein type
LRCH1	NM_015116	leucine-rich repeats and calponin homology (CH)
LRCH4	NM_002319	leucine-rich repeats and calponin homology (CH)
LRIG1	NM_015541	leucine-rich repeats and immunoglobulin-like
LRIG2	NM_014813	leucine-rich repeats and immunoglobulin-like
LRP10	NM_014045	low density lipoprotein receptor-related protein
LRP12	NM_013437	suppression of tumorigenicity
LRP1B	NM_018557	low density lipoprotein-related protein 1B
LRP6	NM_002336	low density lipoprotein receptor-related protein
LRP8	NM_001018054	low density lipoprotein receptor-related protein
LRPPRC	NM_133259	leucine-rich PPR motif-containing protein
LRRC1	NM_018214	leucine rich repeat containing 1
LRRC14	NM_014665	leucine rich repeat containing 14
LRRC15	NM_130830	leucine rich repeat containing 15
LRRC21	NM_015613	retina specific protein PAL
LRRC22	NM_001017924	leucine rich repeat containing 22
LRRC25	NM_145256	leucine rich repeat containing 25
LRRC27	NM_030626	leucine rich repeat containing 27
LRRC3	NM_030891	leucine-rich repeat-containing 3 precursor
LRRC32	NM_005512	leucine rich repeat containing 32 precursor
LRRC47	NM_020710	leucine rich repeat containing 47
LRRC55	NM_001005210	hypothetical protein LOC219527
LRRC57	NM_153260	hypothetical protein LOC255252
LRRC61	NM_023942	hypothetical protein LOC65999
LRRC8A	NM_019594	leucine-rich repeat-containing 8
LRRFIP2	NM_017724	leucine rich repeat (in FLII) interacting
LRRK1	NM_024652	leucine-rich repeat kinase 1
LRRN3	NM_018334	leucine rich repeat neuronal 3
LRRN6A	NM_032808	leucine-rich repeat neuronal 6A
LRRTM2	NM_015564	leucine rich repeat transmembrane neuronal 2
LRSAM1	NM_001005373	leucine rich repeat and sterile alpha motif
LSM11	NM_173491	LSM11, U7 small nuclear RNA associated
LSM16	NM_025083	LSM16 homolog (EDC3, S. cerevisiae)
LSM4	NM_012321	U6 snRNA-associated Sm-like protein 4
LSM7	NM_016199	U6 snRNA-associated Sm-like protein LSm7
LSP1	NM_001013253	lymphocyte-specific protein 1 isoform 2
LSS	NM_002340	lanosterol synthase
LTB	NM_009588	lymphotoxin-beta isoform b
LTBP1	NM_000627	latent transforming growth factor beta binding
LTC4S	NM_000897	leukotriene C4 synthase isoform 2

LUZP1	NM_033631	leucine zipper protein 1
LY6E	NM_002346	lymphocyte antigen 6 complex, locus E
LY6G5C	NM_001002848	lymphocyte antigen 6 complex G5C isoform C
LY6K	NM_017527	lymphocyte antigen 6 complex, locus K
LY86	NM_004271	MD-1, RP105-associated
LY9	NM_001033667	lymphocyte antigen 9 isoform b
LYCAT	NM_001002257	lysocardiolipin acyltransferase isoform 2
LYK5	NM_001003786	protein kinase LYK5 isoform 2
LYPD5	NM_001031749	LY6/PLAUR domain containing 5
LYPLA2	NM_007260	lysophospholipase II
LYPLA3	NM_012320	lysophospholipase 3 (lysosomal phospholipase
LYSMD4	NM_152449	hypothetical protein LOC145748
LYST	NM_000081	lysosomal trafficking regulator isoform 1
LYZL4	NM_144634	lysozyme-like 4
LZTFL1	NM_020347	leucine zipper transcription factor-like 1
LZTR1	NM_006767	leucine-zipper-like transcription regulator, 1
LZTS1	NM_021020	leucine zipper, putative tumor suppressor 1
LZTS2	NM_032429	leucine zipper, putative tumor suppressor 2
M6PR	NM_002355	cation-dependent mannose-6-phosphate receptor
MACF1	NM_012090	microfilament and actin filament cross-linker
MADD	NM_003682	MAP-kinase activating death domain-containing
MAF	NM_001031804	v-maf musculoaponeurotic fibrosarcoma oncogene
MAFB	NM_005461	transcription factor MAFB
MAFG	NM_002359	v-maf musculoaponeurotic fibrosarcoma oncogene
MAG	NM_080600	myelin associated glycoprotein isoform b
MAGEB4	NM_002367	melanoma antigen family B, 4
MAK	NM_005906	male germ cell-associated kinase
MAMDC2	NM_153267	MAM domain containing 2
MAN2A2	NM_006122	mannosidase, alpha, class 2A, member 2
MANBAL	NM_001003897	mannosidase, beta A, lysosomal-like
MAP1A	NM_002373	microtubule-associated protein 1A
MAP2K1	NM_002755	mitogen-activated protein kinase kinase 1
MAP2K1IP1	NM_021970	mitogen-activated protein kinase kinase 1
MAP2K2	NM_030662	mitogen-activated protein kinase kinase 2
MAP2K3	NM_002756	mitogen-activated protein kinase kinase 3
MAP2K4	NM_003010	mitogen-activated protein kinase kinase 4
MAP2K7	NM_145185	mitogen-activated protein kinase kinase 7
MAP3K14	NM_003954	mitogen-activated protein kinase kinase kinase
MAP3K3	NM_002401	mitogen-activated protein kinase kinase kinase 3
MAP3K4	NM_005922	mitogen-activated protein kinase kinase kinase 4
MAP3K7	NM_003188	mitogen-activated protein kinase kinase kinase 7
MAP3K9	NM_033141	mitogen-activated protein kinase kinase kinase
MAP4	NM_002375	microtubule-associated protein 4 isoform 1
MAP6	NM_207577	microtubule-associated protein 6 isoform 2
MAP7	NM_003980	microtubule-associated protein 7
MAPK1	NM_002745	mitogen-activated protein kinase 1
MAPK14	NM_001315	mitogen-activated protein kinase 14 isoform 1
MAPK3	NM_002746	mitogen-activated protein kinase 3 isoform 1
MAPK8	NM_002750	mitogen-activated protein kinase 8 isoform 2
MAPK8IP1	NM_005456	mitogen-activated protein kinase 8 interacting
MAPK8IP2	NM_012324	mitogen-activated protein kinase 8 interacting
MAPK8IP3	NM_015133	mitogen-activated protein kinase 8 interacting
MAPK9	NM_002752	mitogen-activated protein kinase 9 isoform 1

MAPKAP1	NM_001006617	mitogen-activated protein kinase associated
MAPKAPK2	NM_004759	mitogen-activated protein kinase-activated
MAPKBP1	NM_014994	mitogen-activated protein kinase binding protein
MAPRE1	NM_012325	microtubule-associated protein, RP/EB family,
MAPRE3	NM_012326	microtubule-associated protein, RP/EB family,
MARCH4	NM_020814	membrane-associated ring finger (C3HC4) 4
MARCH5	NM_017824	ring finger protein 153
MARCH9	NM_138396	membrane-associated RING-CH protein IX
MARK4	NM_031417	MAP/microtubule affinity-regulating kinase 4
MASP1	NM_001031849	mannan-binding lectin serine protease 1 isoform
MAT1A	NM_000429	methionine adenosyltransferase I, alpha
MBD1	NM_002384	methyl-CpG binding domain protein 1 isoform 4
MBD3	NM_003926	methyl-CpG binding domain protein 3
MBD6	NM_052897	methyl-CpG binding domain protein 6
MBNL2	NM_144778	muscleblind-like 2 isoform 1
MBP	NM_001025100	Golli-mbp isoform 2
MCART1	NM_033412	mitochondrial carrier triple repeat 1
MCART6	NM_001012755	hypothetical protein LOC401612
MCFD2	NM_139279	multiple coagulation factor deficiency 2
MCM2	NM_004526	minichromosome maintenance protein 2
MDGA1	NM_153487	MAM domain containing
MECP2	NM_004992	methyl CpG binding protein 2
MECR	NM_001024732	nuclear receptor-binding factor 1 isoform b
MED11	NM_001001683	hypothetical protein LOC400569
MED9	NM_018019	mediator of RNA polymerase II transcription,
MEFV	NM_000243	Mediterranean fever protein
MEOX1	NM_004527	mesenchyme homeobox 1 isoform 1
MEOX2	NM_005924	mesenchyme homeobox 2
MESDC2	NM_015154	mesoderm development candidate 2
METTL4	NM_022840	methyltransferase like 4
MFAP5	NM_003480	microfibrillar associated protein 5
MFN2	NM_014874	mitofusin 2
MFSD2	NM_032793	major facilitator superfamily domain containing
MGAT5	NM_002410	alpha-1,3(6)-mannosylglycoprotein
MGC10911	NM_032302	hypothetical protein LOC84262
MGC11102	NM_032325	hypothetical protein LOC84285
MGC14289	NM_080660	hypothetical protein LOC92092
MGC16385	NM_145039	hypothetical protein LOC92806
MGC17330	NM_052880	HGFL protein
MGC20470	NM_145053	hypothetical protein LOC143630
MGC21675	NM_052861	hypothetical protein LOC92070
MGC21830	NM_182563	hypothetical protein LOC283870
MGC24381	NM_001001410	hypothetical protein LOC115939
MGC26694	NM_178526	hypothetical protein LOC284439
MGC26718	NM_001029999	hypothetical protein LOC440482
MGC26885	NM_152339	hypothetical protein LOC124044
MGC29671	NM_182538	hypothetical protein LOC201305
MGC3123	NM_024107	hypothetical protein LOC79089 isoform 1
MGC3265	NM_024028	hypothetical protein LOC78991
MGC33214	NM_153354	hypothetical protein LOC153396
MGC33556	NM_001004307	hypothetical protein LOC339541
MGC34761	NM_173619	hypothetical protein LOC283971
MGC35308	NM_175922	hypothetical protein MGC35308

MGC35361	NM_147194	hypothetical protein LOC222234
MGC3731	NM_024313	hypothetical protein LOC79159
MGC40405	NM_152789	hypothetical protein LOC257415 isoform 1
MGC4093	NM_030578	hypothetical protein LOC80776
MGC42105	NM_153361	hypothetical protein LOC167359
MGC4268	NM_031445	hypothetical protein LOC83607
MGC52000	NM_198943	CXYorf1-related protein
MGC5242	NM_024033	hypothetical protein LOC78996
MGC57359	NM_001004351	hypothetical protein LOC441272
MGC87631	NM_001004306	hypothetical protein LOC339184
MGC9712	NM_152689	hypothetical protein LOC202915
MGC9850	NM_152705	hypothetical protein MGC9850
MGC99813	NM_001005209	hypothetical protein LOC130612
MGRN1	NM_015246	mahogunin, ring finger 1
MIB1	NM_020774	mindbomb homolog 1
MICB	NM_005931	MHC class I polypeptide-related sequence B
MID1	NM_000381	midline 1 isoform alpha
MIER2	NM_017550	hypothetical protein LOC54531
MINK1	NM_001024937	misshapen/NIK-related kinase isoform 4
MIOX	NM_017584	myo-inositol oxygenase
MKL2	NM_014048	megakaryoblastic leukemia 2 protein
MKNK1	NM_003684	MAP kinase interacting serine/threonine kinase 1
MKX	NM_173576	hypothetical protein LOC283078
MLC1	NM_015166	megalencephalic leukoencephalopathy with
MLCK	NM_182493	MLCK protein
MLR1	NM_153686	transcription factor MLR1
MLXIPL	NM_032951	Williams Beuren syndrome chromosome region 14
MLYCD	NM_012213	malonyl-CoA decarboxylase
MMAB	NM_052845	cob(I)alamin adenosyltransferase
MMACHC	NM_015506	hypothetical protein LOC25974
MMD	NM_012329	monocyte to macrophage
MMD2	NM_198403	monocyte-to-macrophage differentiation factor 2
MME	NM_000902	membrane metallo-endopeptidase
MMP14	NM_004995	matrix metalloproteinase 14 preproprotein
MMP15	NM_002428	matrix metalloproteinase 15 preproprotein
MMP19	NM_001032360	matrix metalloproteinase 19 isoform 2 precursor
MMP24	NM_006690	matrix metalloproteinase 24 preproprotein
MMP3	NM_002422	matrix metalloproteinase 3 preproprotein
MMS19L	NM_022362	MMS19-like (MET18 homolog, S. cerevisiae)
MN1	NM_002430	meningioma 1
MNT	NM_020310	MAX binding protein
MOBKL2A	NM_130807	MOB-LAK
MOBKL2B	NM_024761	MOB1, Mps One Binder kinase activator-like 2B
MOCS1	NM_005942	molybdenum cofactor synthesis-step 1 protein
MON1B	NM_014940	MON1 homolog B
MORF4L1	NM_006791	MORF-related gene 15 isoform 1
MOSC1	NM_022746	MOCO sulphurase C-terminal domain containing 1
MOV10	NM_020963	Mov10, Moloney leukemia virus 10, homolog
MOV10L1	NM_018995	MOV10-like 1
MPDU1	NM_004870	mannose-P-dolichol utilization defect 1
MPL	NM_005373	myeloproliferative leukemia virus oncogene
MPP2	NM_005374	palmitoylated membrane protein 2
MPPED1	NM_001585	hypothetical protein LOC758

MPZL1	NM_003953	myelin protein zero-like 1 isoform a
MRAS	NM_012219	muscle RAS oncogene homolog
MRPL11	NM_170739	mitochondrial ribosomal protein L11 isoform c
MRPL12	NM_002949	mitochondrial ribosomal protein L12
MRPL14	NM_032111	mitochondrial ribosomal protein L14
MRPL35	NM_016622	mitochondrial ribosomal protein L35 isoform a
MRPL37	NM_016491	mitochondrial ribosomal protein L37
MRPL4	NM_146388	mitochondrial ribosomal protein L4 isoform b
MRPL40	NM_003776	mitochondrial ribosomal protein L40
MRPL45	NM_032351	mitochondrial ribosomal protein L45
MRPS18A	NM_018135	mitochondrial ribosomal protein S18A
MRPS2	NM_016034	mitochondrial ribosomal protein S2
MRPS25	NM_022497	mitochondrial ribosomal protein S25
MRRF	NM_138777	mitochondrial ribosome recycling factor isoform
MS4A10	NM_206893	membrane-spanning 4-domains, subfamily A, member
MS4A2	NM_000139	membrane-spanning 4-domains, subfamily A, member
MS4A7	NM_021201	membrane-spanning 4-domains, subfamily A, member
MSH5	NM_002441	mutS homolog 5 isoform c
MSRB2	NM_012228	methionine sulfoxide reductase B2
MST150	NM_032947	putative small membrane protein NID67
MTAP	NM_002451	5'-methylthioadenosine phosphorylase
MTCP1	NM_001018024	mature T-cell proliferation 1 isoform p8
MTG1	NM_138384	GTP_binding protein
MTHFR	NM_005957	5,10-methylenetetrahydrofolate reductase
MTM1	NM_000252	myotubularin
MTMR11	NM_181873	myotubularin related protein 11
MTMR3	NM_021090	myotubularin-related protein 3 isoform c
MTMR4	NM_004687	myotubularin related protein 4
MTMR8	NM_017677	myotubularin related protein 8
MTMR9	NM_015458	myotubularin-related protein 9
MTNR1B	NM_005959	melatonin receptor 1B
MTPN	NM_145808	myotrophin
MTRR	NM_002454	methionine synthase reductase isoform 1
MTSS1	NM_014751	metastasis suppressor 1
MUC1	NM_001018021	MUC1 mucin isoform 4 precursor
MUCDHL	NM_031265	mu-protocadherin isoform 4
MULK	NM_018238	multiple substrate lipid kinase
MUM1	NM_032853	melanoma ubiquitous mutated protein
MXD3	NM_031300	MAX dimerization protein 3
MXD4	NM_006454	MAD4
MYADM	NM_001020818	myeloid-associated differentiation marker
MYB	NM_005375	v-myb myeloblastosis viral oncogene homolog
MYBPC1	NM_002465	myosin binding protein C, slow type isoform 1
MYCL1	NM_001033081	l-myc-1 proto-oncogene isoform 1
MYD88	NM_002468	myeloid differentiation primary response gene
MYEF2	NM_016132	myelin gene expression factor 2
MYH14	NM_024729	myosin, heavy polypeptide 14
MYL1	NM_079420	fast skeletal myosin alkali light chain 1
MYLK	NM_005965	myosin light chain kinase isoform 6
MYO18A	NM_078471	myosin 18A isoform a
MYO1D	NM_015194	myosin ID
MYO1E	NM_004998	myosin IE
MYO5C	NM_018728	myosin VC

MYO9B	NM_004145	myosin IXB
MYOHD1	NM_001033579	myosin head domain containing 1 isoform 2
MYOM3	NM_152372	myomesin family, member 3
MYOZ3	NM_133371	myozenin 3
MYRIP	NM_015460	myosin VIIA and Rab interacting protein
MYT1L	NM_015025	myelin transcription factor 1-like
N4BP1	NM_153029	Nedd4 binding protein 1
N4BP3	NM_015111	Nedd4 binding protein 3
NAALADL2	NM_207015	N-acetylated alpha-linked acidic dipeptidase 2
NAG8	NM_014411	nasopharyngeal carcinoma associated gene
NANOG	NM_024865	Nanog homeobox
NANOS1	NM_001009553	nanos homolog 1 isoform 2
NAP1L4	NM_005969	nucleosome assembly protein 1-like 4
NAPA	NM_003827	N-ethylmaleimide-sensitive factor attachment
NAPE-PLD	NM_198990	N-acyl-phosphatidylethanolamine-hydrolyzing
NARF	NM_012336	nuclear prelamin A recognition factor isoform a
NARFL	NM_022493	nuclear prelamin A recognition factor-like
NARG1	NM_057175	NMDA receptor regulated 1
NARS	NM_004539	asparaginyl-tRNA synthetase
NAT10	NM_024662	N-acetyltransferase-like protein
NAT11	NM_024771	hypothetical protein LOC79829
NAV1	NM_020443	neuron navigator 1
NBEA	NM_015678	neurobeachin
NBR1	NM_005899	neighbor of BRCA1 gene 1
NCAM1	NM_181351	neural cell adhesion molecule 1 isoform 2
NCF4	NM_013416	neutrophil cytosolic factor 4 (40kD) isoform 2
NCKIPSD	NM_016453	NCK interacting protein with SH3 domain isoform
NCOA4	NM_005437	nuclear receptor coactivator 4
NCOR2	NM_006312	nuclear receptor co-repressor 2
NDNL2	NM_138704	necdin-like 2
NDOR1	NM_014434	NADPH dependent diflavin oxidoreductase 1
NDP	NM_000266	norrin
NDRG2	NM_016250	N-myc downstream-regulated gene 2 isoform b
NDRG4	NM_020465	NDRG family member 4
NDST1	NM_001543	N-deacetylase/N-sulfotransferase (heparan
NDUFA4L2	NM_020142	NADH:ubiquinone oxidoreductase MLRQ subunit
NEBL	NM_006393	nebulette sarcomeric isoform
NECAP1	NM_015509	adaptin-ear-binding coat-associated protein 1
NEDD9	NM_182966	neural precursor cell expressed, developmentally
NEK10	NM_001031741	NIMA (never in mitosis gene a)- related kinase
NEK6	NM_014397	putative serine-threonine protein kinase
NEK8	NM_178170	NIMA-related kinase 8
NELF	NM_015537	nasal embryonic LHRH factor
NEU4	NM_080741	sialidase 4
NEURL	NM_004210	neuralized-like
NEUROG3	NM_020999	neurogenin 3
NF2	NM_000268	neurofibromin 2 isoform 1
NFASC	NM_015090	neurofascin precursor
NFAT5	NM_006599	nuclear factor of activated T-cells 5 isoform c
NFATC3	NM_004555	cytoplasmic nuclear factor of activated T-cells
NFATC4	NM_004554	cytoplasmic nuclear factor of activated T-cells
NFE2L1	NM_003204	nuclear factor (erythroid-derived 2)-like 1
NFIC	NM_005597	nuclear factor I/C isoform 1

NFKB1	NM_003998	nuclear factor kappa-B, subunit 1
NFKBIB	NM_001001716	nuclear factor of kappa light polypeptide gene
NFKBIL1	NM_005007	nuclear factor of kappa light polypeptide gene
NFKBIL2	NM_013432	I-kappa-B-related protein
NFS1	NM_021100	NFS1 nitrogen fixation 1 isoform a precursor
NFYC	NM_014223	nuclear transcription factor Y, gamma
NGFR	NM_002507	nerve growth factor receptor precursor
NHEJ1	NM_024782	XRCC4-like factor
NHLH1	NM_005598	nescient helix loop helix 1
NHS	NM_198270	Nance-Horan syndrome protein
NIBP	NM_031466	NIK and IKK(beta) binding protein
NID1	NM_002508	nidogen (enactin)
NIN	NM_020921	ninein isoform 2
NISCH	NM_007184	nischarin
NKD1	NM_033119	naked cuticle homolog 1
NKIRAS2	NM_001001349	NFKB inhibitor interacting Ras-like 2
NKX2-8	NM_014360	NK2 transcription factor related, locus 8
NKX3-1	NM_006167	NK3 transcription factor related, locus 1
NLGN1	NM_014932	neuroligin 1
NMD3	NM_015938	NMD3 homolog
NME3	NM_002513	nucleoside-diphosphate kinase 3
NMNAT2	NM_015039	nicotinamide mononucleotide adenylyltransferase
NMT1	NM_021079	N-myristoyltransferase 1
NMT2	NM_004808	glycylpeptide N-tetradecanoyltransferase 2
NOB1	NM_014062	nin one binding protein
NOC2L	NM_015658	nucleolar complex associated 2 homolog
NOD9	NM_024618	NOD9 protein isoform 1
NODAL	NM_018055	mouse nodal homolog precursor
NOL3	NM_003946	nucleolar protein 3
NOMO1	NM_014287	nodal modulator 1
NOMO2	NM_173614	nodal modulator 2 isoform 2
NOMO3	NM_001004067	nodal modulator 3
NOS1	NM_000620	nitric oxide synthase 1 (neuronal)
NOS1AP	NM_014697	nitric oxide synthase 1 (neuronal) adaptor
NOS2A	NM_000625	nitric oxide synthase 2A isoform 1
NOTCH2	NM_024408	notch 2 preproprotein
NP	NM_000270	purine nucleoside phosphorylase
NPAL3	NM_020448	NIPA-like domain containing 3
NPC2	NM_006432	Niemann-Pick disease, type C2 precursor
NPEPPS	NM_006310	aminopeptidase puromycin sensitive
NPHP4	NM_015102	nephroretinin
NPLOC4	NM_017921	nuclear protein localization 4
NPNT	NM_001033047	nephronectin
NPR2	NM_003995	natriuretic peptide receptor B precursor
NPTXR	NM_014293	neuronal pentraxin receptor isoform 1
NR2F6	NM_005234	nuclear receptor subfamily 2, group F, member 6
NR4A1	NM_002135	nuclear receptor subfamily 4, group A, member 1
NR4A3	NM_173199	nuclear receptor subfamily 4, group A, member 3
NR5A1	NM_004959	nuclear receptor subfamily 5, group A, member 1
NRBP1	NM_013392	nuclear receptor binding protein
NRG1	NM_013958	neuregulin 1 isoform HRG-beta3
NRIP2	NM_031474	nuclear receptor interacting protein 2
NRN1	NM_016588	neuritin precursor

NRP2	NM_003872	neuropilin 2 isoform 2 precursor
NSF	NM_006178	N-ethylmaleimide-sensitive factor
NSUN4	NM_199044	NOL1/NOP2/Sun domain family 4 protein
NT5DC3	NM_016575	hypothetical protein LOC51559 isoform 2
NTE	NM_006702	neuropathy target esterase
NTN2L	NM_006181	netrin 2-like
NTNG2	NM_032536	netrin G2
NTRK2	NM_001007097	neurotrophic tyrosine kinase, receptor, type 2
NTSR1	NM_002531	neurotensin receptor 1
NUAK1	NM_014840	AMPK-related protein kinase 5
NUAK2	NM_030952	NUAK family, SNF1-like kinase, 2
NUBP2	NM_012225	nucleotide binding protein 2 (MinD homolog, E.
NUCB1	NM_006184	nucleobindin 1
NUDCD3	NM_015332	NudC domain containing 3
NUDT1	NM_002452	nudix-type motif 1 isoform p18
NUDT11	NM_018159	nudix-type motif 11
NUDT8	NM_181843	nudix-type motif 8
NUP188	NM_015354	nucleoporin 188kDa
NUP210	NM_024923	nucleoporin 210
NUP35	NM_001008544	nucleoporin 35kDa isoform b
NUP50	NM_007172	nucleoporin 50kDa isoform b
NUP98	NM_005387	nucleoporin 98kD isoform 3
NUTF2	NM_005796	nuclear transport factor 2
NXF5	NM_033153	nuclear RNA export factor 5 isoform c
NXPH1	NM_152745	neurexophilin 1 precursor
NXPH4	NM_007224	neurexophilin 4
OAF	NM_178507	hypothetical protein LOC220323
OAS2	NM_001032731	2'-5'-oligoadenylate synthetase 2 isoform 3
OAS3	NM_006187	2'-5'oligoadenylate synthetase 3
OATL1	NM_001006113	ornithine aminotransferase-like 1 isoform 1
OBSCN	NM_052843	obscurin, cytoskeletal calmodulin and
OCRL	NM_000276	phosphatidylinositol polyphosphate 5-phosphatase
ODF2	NM_153437	outer dense fiber of sperm tails 2 isoform 2
OGDH	NM_002541	oxoglutarate (alpha-ketoglutarate) dehydrogenase
OGDHL	NM_018245	oxoglutarate dehydrogenase-like
OGFR	NM_007346	opioid growth factor receptor
OGT	NM_003605	O-linked GlcNAc transferase isoform 3
OIP5	NM_007280	Opa interacting protein 5
OLFM2	NM_058164	olfactomedin 2
OMG	NM_002544	oligodendrocyte myelin glycoprotein
OPHN1	NM_002547	oligophrenin 1
OPRL1	NM_000913	opiate receptor-like 1
ORMDL1	NM_016467	ORM1-like 1
ORMDL3	NM_139280	ORM1-like 3
OS9	NM_001017956	amplified in osteosarcoma isoform 2 precursor
OSBPL3	NM_015550	oxysterol-binding protein-like protein 3 isoform
OSCAR	NM_130771	osteoclast-associated receptor isoform 3
OSM	NM_020530	oncostatin M precursor
OSR1	NM_145260	odd-skipped related 1
OSTM1	NM_014028	osteopetrosis associated transmembrane protein
OTOF	NM_004802	otoferlin isoform b
OTUB1	NM_017670	OTU domain, ubiquitin aldehyde binding 1
OTUB2	NM_023112	OTU domain, ubiquitin aldehyde binding 2

OTUD4	NM_199324	OTU domain containing 4 protein isoform 1
OTUD6A	NM_207320	HIN-6 protease
OTX1	NM_014562	orthodenticle 1
OVOL1	NM_004561	OVO-like 1 binding protein
P15RS	NM_018170	hypothetical protein FLJ10656
P18SRP	NM_173829	P18SRP protein
P2RX2	NM_012226	purinergic receptor P2X2 isoform I
P2RX7	NM_177427	purinergic receptor P2X7 isoform b
P2RXL1	NM_005446	purinergic receptor P2X-like 1, orphan receptor
P2RY8	NM_178129	G-protein coupled purinergic receptor P2Y8
PA2G4	NM_006191	proliferation-associated 2G4, 38kDa
PABPN1	NM_004643	poly(A) binding protein, nuclear 1
PACRG	NM_152410	PARK2 co-regulated
PACSIN1	NM_020804	protein kinase C and casein kinase substrate in
PAEP	NM_001018049	glycodelin precursor
PAFAH1B1	NM_000430	platelet-activating factor acetylhydrolase,
PAFAH2	NM_000437	platelet-activating factor acetylhydrolase 2
PAG1	NM_018440	phosphoprotein associated with glycosphingolipid
PAGE1	NM_003785	P antigen family, member 1
PAICS	NM_006452	phosphoribosylaminoimidazole carboxylase
PAK2	NM_002577	p21-activated kinase 2
PAK6	NM_020168	p21-activated kinase 6
PAK7	NM_020341	p21-activated kinase 7
PALM2-AKAP2	NM_007203	PALM2-AKAP2 protein isoform 1
PAM	NM_000919	peptidylglycine alpha-amidating monooxygenase
PANK1	NM_138316	pantothenate kinase 1 isoform gamma
PANX1	NM_015368	pannexin 1
PAPD1	NM_018109	PAP associated domain containing 1
PAPOLG	NM_022894	poly(A) polymerase gamma
PAPPA	NM_002581	pregnancy-associated plasma protein A
PARD6B	NM_032521	PAR-6 beta
PARD6G	NM_032510	PAR-6 gamma protein
PARP11	NM_020367	poly (ADP-ribose) polymerase family, member 11
PARP12	NM_022750	zinc finger CCCH-type domain containing 1
PARP14	NM_017554	poly (ADP-ribose) polymerase family, member 14
PATE	NM_138294	expressed in prostate and testis
PAX2	NM_000278	paired box protein 2 isoform b
PAX8	NM_003466	paired box gene 8 isoform PAX8A
PAXIP1	NM_007349	PAX interacting protein 1
PBX3	NM_006195	pre-B-cell leukemia transcription factor 3
PCBP4	NM_020418	poly(rC) binding protein 4 isoform a
PCDH1	NM_032420	protocadherin 1 isoform 2 precursor
PCDH17	NM_014459	protocadherin 17
PCDH19	NM_020766	protocadherin 19
PCDH21	NM_033100	protocadherin 21 precursor
PCDH9	NM_020403	protocadherin 9 isoform 2 precursor
PCDHA1	NM_018900	protocadherin alpha 1 isoform 1 precursor
PCDHA10	NM_018901	protocadherin alpha 10 isoform 1 precursor
PCDHA11	NM_018902	protocadherin alpha 11 isoform 1 precursor
PCDHA12	NM_018903	protocadherin alpha 12 isoform 1 precursor
PCDHA13	NM_018904	protocadherin alpha 13 isoform 1 precursor
PCDHA2	NM_018905	protocadherin alpha 2 isoform 1 precursor
PCDHA3	NM_018906	protocadherin alpha 3 isoform 1 precursor

PCDHA4	NM_018907	protocadherin alpha 4 isoform 1 precursor
PCDHA5	NM_018908	protocadherin alpha 5 isoform 1 precursor
PCDHA6	NM_018909	protocadherin alpha 6 isoform 1 precursor
PCDHA7	NM_018910	protocadherin alpha 7 isoform 1 precursor
PCDHA8	NM_018911	protocadherin alpha 8 isoform 1 precursor
PCDHA9	NM_031857	protocadherin alpha 9 isoform 1 precursor
PCDHAC1	NM_018898	protocadherin alpha subfamily C, 1 isoform 1
PCDHAC2	NM_018899	protocadherin alpha subfamily C, 2 isoform 1
PCGF5	NM_032373	polycomb group ring finger 5
PCID2	NM_018386	PCI domain containing 2
PCMT1	NM_005389	protein-L-isoaspartate (D-aspartate)
PCNXL2	NM_014801	pecanex-like 2
PCOLN3	NM_002768	procollagen (type III) N-endopeptidase
PCQAP	NM_001003891	positive cofactor 2, glutamine/Q-rich-associated
PCSK2	NM_002594	proprotein convertase subtilisin/kexin type 2
PCSK6	NM_002570	paired basic amino acid cleaving system 4
PCSK9	NM_174936	proprotein convertase subtilisin/kexin type 9
PCTK2	NM_002595	PCTAIRE protein kinase 2
PCTP	NM_021213	phosphatidylcholine transfer protein
PCYOX1	NM_016297	prenylcysteine oxidase 1
PDAP1	NM_014891	PDGFA associated protein 1
PDCD1	NM_005018	programmed cell death 1 precursor
PDCD11	NM_014976	programmed cell death 11
PDCD4	NM_014456	programmed cell death 4 isoform 1
PDCD6IP	NM_013374	programmed cell death 6 interacting protein
PDCD7	NM_005707	programmed cell death 7
PDCL	NM_005388	phosducin-like
PDDC1	NM_182612	hypothetical protein LOC347862
PDE3B	NM_000922	phosphodiesterase 3B, cGMP-inhibited
PDE4D	NM_006203	cAMP-specific phosphodiesterase 4D
PDE7B	NM_018945	phosphodiesterase 7B
PDGFRA	NM_006206	platelet-derived growth factor receptor alpha
PDGFRB	NM_002609	platelet-derived growth factor receptor beta
PDIA6	NM_005742	protein disulfide isomerase-associated 6
PDIK1L	NM_152835	PDLIM1 interacting kinase 1 like
PDK2	NM_002611	pyruvate dehydrogenase kinase, isoenzyme 2
PDK4	NM_002612	pyruvate dehydrogenase kinase 4
PDLIM2	NM_176871	PDZ and LIM domain 2 isoform 1
PDLIM5	NM_001011513	PDZ and LIM domain 5 isoform b
PDPK1	NM_002613	3-phosphoinositide dependent protein kinase-1
PDPN	NM_001006624	lung type-I cell membrane-associated
PDPR	NM_017990	pyruvate dehydrogenase phosphatase regulatory
PDRG1	NM_030815	p53 and DNA damage-regulated protein
PDXK	NM_003681	pyridoxal kinase
PDYN	NM_024411	beta-neoendorphin-dynorphin preproprotein
PDZD2	NM_178140	PDZ domain containing 2
PELI2	NM_021255	pellino 2
PELI3	NM_145065	pellino 3 alpha
PEMT	NM_007169	phosphatidylethanolamine N-methyltransferase
PER3	NM_016831	period 3
PERLD1	NM_033419	CAB2 protein
PERP	NM_022121	PERP, TP53 apoptosis effector
PEX10	NM_002617	peroxisome biogenesis factor 10 isoform 2

PEX12	NM_000286	peroxisomal biogenesis factor 12
PEX13	NM_002618	peroxisome biogenesis factor 13
PEX16	NM_057174	peroxisomal biogenesis factor 16 isoform 2
PEX19	NM_002857	peroxisomal biogenesis factor 19
PEX5	NM_000319	peroxisomal biogenesis factor 5
PFKFB2	NM_006212	6-phosphofructo-2-kinase/fructose-2,
PFKFB4	NM_004567	6-phosphofructo-2-kinase/fructose-2,
PFKL	NM_001002021	liver phosphofructokinase isoform a
PGAM5	NM_138575	Bcl-XL-binding protein v68
PGD	NM_002631	phosphogluconate dehydrogenase
PGEA1	NM_001002880	PKD2 interactor, golgi and endoplasmic reticulum
PGLS	NM_012088	6-phosphogluconolactonase
PGM1	NM_002633	phosphoglucomutase 1
PGM2L1	NM_173582	phosphoglucomutase 2-like 1
PHACTR1	NM_030948	phosphatase and actin regulator 1
PHACTR2	NM_014721	phosphatase and actin regulator 2
PHACTR4	NM_023923	phosphatase and actin regulator 4
PHB	NM_002634	prohibitin
PHF13	NM_153812	PHD finger protein 13
PHF15	NM_015288	PHD finger protein 15
PHF17	NM_024900	Jade1 protein short isoform
PHF19	NM_015651	PHD finger protein 19 isoform a
PHF20	NM_016436	PHD finger protein 20
PHF20L1	NM_016018	PHD finger protein 20-like 1 isoform 1
PHIP	NM_017934	pleckstrin homology domain interacting protein
PHLDA3	NM_012396	pleckstrin homology-like domain, family A,
PHLDB3	NM_198850	pleckstrin homology-like domain, family B,
PHLPPL	NM_015020	PH domain and leucine rich repeat protein
PHOX2B	NM_003924	paired-like homeobox 2b
PHYHIP	NM_014759	phytanoyl-CoA hydroxylase interacting protein
PI4K2B	NM_018323	phosphatidylinositol 4-kinase type-II beta
PI4KII	NM_018425	phosphatidylinositol 4-kinase type II
PIAS1	NM_016166	protein inhibitor of activated STAT, 1
PIB5PA	NM_001002837	phosphatidylinositol (4,5) bisphosphate
PIGA	NM_002641	phosphatidylinositol
PIGB	NM_004855	phosphatidylinositol glycan, class B
PIGQ	NM_004204	phosphatidylinositol glycan, class Q isoform 2
PIGR	NM_002644	polymeric immunoglobulin receptor
PIGT	NM_015937	phosphatidylinositol glycan, class T precursor
PIK3C2B	NM_002646	phosphoinositide-3-kinase, class 2, beta
PIK3R1	NM_181504	phosphoinositide-3-kinase, regulatory subunit,
PIK3R2	NM_005027	phosphoinositide-3-kinase, regulatory subunit 2
PIK3R3	NM_003629	phosphoinositide-3-kinase, regulatory subunit 3
PIK4CB	NM_002651	phosphatidylinositol 4-kinase, catalytic, beta
PILRB	NM_013440	paired immunoglobulin-like type 2 receptor beta
PIM1	NM_002648	pim-1 oncogene
PIM3	NM_001001852	pim-3 oncogene
PIP3-E	NM_015553	phosphoinositide-binding protein PIP3-E
PIP5K1B	NM_001031687	phosphatidylinositol-4-phosphate 5-kinase, type
PIP5K1C	NM_012398	phosphatidylinositol-4-phosphate 5-kinase, type
PIP5K2C	NM_024779	phosphatidylinositol-4-phosphate 5-kinase, type
PIP5K3	NM_001002881	phosphatidylinositol-3-
PISD	NM_014338	phosphatidylserine decarboxylase

PITPNA	NM_006224	phosphatidylinositol transfer protein, alpha
PKD1	NM_000296	polycystin 1 isoform 2 precursor
PKD1L2	NM_182740	polycystin 1-like 2 isoform b
PKHD1	NM_138694	polyductin isoform 1
PKLR	NM_000298	pyruvate kinase, liver and RBC isoform 1
PKNOX1	NM_004571	PBX/knotted 1 homeobox 1 isoform 1
PKP1	NM_000299	plakophilin 1 isoform 1b
PLA2G2F	NM_022819	phospholipase A2, group IIF
PLA2G4D	NM_178034	phospholipase A2, group IVD
PLAC2	NM_153375	placenta-specific 2
PLAG1	NM_002655	pleiomorphic adenoma gene 1
PLAGL1	NM_002656	pleiomorphic adenoma gene-like 1 isoform 1
PLCD1	NM_006225	phospholipase C, delta 1
PLCXD1	NM_018390	phosphatidylinositol-specific phospholipase C, X
PLCXD3	NM_001005473	phosphatidylinositol-specific phospholipase C, X
PLD1	NM_002662	phospholipase D1, phophatidylcholine-specific
PLD2	NM_002663	phospholipase D2
PLDN	NM_012388	pallidin
PLEKHA1	NM_001001974	pleckstrin homology domain containing, family A
PLEKHA5	NM_019012	pleckstrin homology domain containing, family A
PLEKHA6	NM_014935	phosphoinositol 3-phosphate-binding protein-3
PLEKHA7	NM_175058	pleckstrin homology domain containing, family A
PLEKHB2	NM_017958	pleckstrin homology domain containing, family B
PLEKHC1	NM_006832	pleckstrin homology domain containing, family C
PLEKHG1	NM_001029884	pleckstrin homology domain containing, family G
PLEKHG3	NM_015549	pleckstrin homology domain containing, family G,
PLEKHG5	NM_198681	putative NFkB activating protein isoform b
PLEKHH1	NM_020715	pleckstrin homology domain containing, family H
PLEKHH2	NM_172069	pleckstrin homology domain containing, family H
PLEKHJ1	NM_018049	pleckstrin homology domain containing, family J
PLEKHK1	NM_145307	pleckstrin homology domain containing, family K
PLEKHM1	NM_014798	pleckstrin homology domain containing, family M
PLEKHQ1	NM_025201	PH domain-containing protein
PLRG1	NM_002669	pleiotropic regulator 1 (PRL1 homolog,
PLS1	NM_002670	plastin 1
PLSCR4	NM_020353	phospholipid scramblase 4
PLUNC	NM_130852	palate, lung and nasal epithelium carcinoma
PLXDC1	NM_020405	plexin domain containing 1 precursor
PLXNA1	NM_032242	plexin A1
PLXNA2	NM_025179	plexin A2
PLXNB1	NM_002673	plexin B1
PLXND1	NM_015103	plexin D1
PML	NM_033239	promyelocytic leukemia protein isoform 9
PMM1	NM_002676	phosphomannomutase 1
PMM2	NM_000303	phosphomannomutase 2
PMP2	NM_002677	peripheral myelin protein 2
PMP22	NM_000304	peripheral myelin protein 22
PNKD	NM_015488	myofibrillogenesis regulator 1 isoform 1
PNLIPRP1	NM_006229	pancreatic lipase-related protein 1
PNMA3	NM_013364	paraneoplastic cancer-testis-brain antigen
PNMA5	NM_052926	hypothetical protein LOC114824
PNMA6A	NM_032882	hypothetical protein LOC84968
PNPO	NM_018129	pyridoxine 5'-phosphate oxidase

PNRC2	NM_017761	proline-rich nuclear receptor coactivator 2
PODN	NM_153703	podocan
PODXL	NM_001018111	podocalyxin-like precursor isoform 1
POF1B	NM_024921	premature ovarian failure, 1B
POFUT1	NM_015352	protein O-fucosyltransferase 1 isoform 1
POFUT2	NM_015227	protein O-fucosyltransferase 2 isoform A
POLD3	NM_006591	polymerase (DNA directed), delta 3
POLDIP3	NM_032311	DNA polymerase delta interacting protein 3
POLE	NM_006231	DNA polymerase epsilon catalytic subunit
POLE4	NM_019896	DNA polymerase epsilon subunit 4
POLL	NM_013274	polymerase (DNA directed), lambda
POLR2D	NM_004805	DNA directed RNA polymerase II polypeptide D
POLR2E	NM_002695	DNA directed RNA polymerase II polypeptide E
POLR2G	NM_002696	DNA directed RNA polymerase II polypeptide G
POLR2J	NM_006234	DNA directed RNA polymerase II polypeptide J
POLR3B	NM_018082	polymerase (RNA) III (DNA directed) polypeptide
POLR3D	NM_001722	RNA polymerase III 53 kDa subunit RPC4
POLR3F	NM_006466	DNA-directed RNA polymerase III 39 kDa
POM121	NM_172020	nuclear pore membrane protein 121
POMT2	NM_013382	putative protein O-mannosyltransferase
POMZP3	NM_012230	POMZP3 fusion protein isoform 1
POU2AF1	NM_006235	POU domain, class 2, associating factor 1
POU3F2	NM_005604	POU domain, class 3, transcription factor 2
POU4F1	NM_006237	POU domain, class 4, transcription factor 1
POU4F2	NM_004575	POU domain, class 4, transcription factor 2
POU6F1	NM_002702	POU domain, class 6, transcription factor 1
PPAP2A	NM_003711	phosphatidic acid phosphatase type 2A isoform 1
PPAP2B	NM_003713	phosphatidic acid phosphatase type 2B
PPAP2C	NM_003712	phosphatidic acid phosphatase type 2C isoform 1
PPAPDC2	NM_203453	phosphatidic acid phosphatase type 2 domain
PPAPDC3	NM_032728	phosphatidic acid phosphatase type 2 domain
PPARA	NM_001001928	peroxisome proliferative activated receptor,
PPARD	NM_006238	peroxisome proliferative activated receptor,
PPARGC1A	NM_013261	peroxisome proliferative activated receptor
PPFIA3	NM_003660	PTPRF interacting protein alpha 3
PPFIA4	NM_015053	protein tyrosine phosphatase, receptor type, f
PPIE	NM_006112	peptidylprolyl isomerase E isoform 1
PPIF	NM_005729	peptidylprolyl isomerase F precursor
PPIH	NM_006347	peptidylprolyl isomerase H
PPIL1	NM_016059	peptidylprolyl isomerase-like 1
PPIL2	NM_014337	peptidylprolyl isomerase-like 2 isoform a
PPIL4	NM_139126	peptidylprolyl isomerase-like 4
PPL	NM_002705	periplakin
PPM1A	NM_021003	protein phosphatase 1A isoform 1
PPM1D	NM_003620	protein phosphatase 1D
PPM1E	NM_014906	protein phosphatase 1E
PPM1F	NM_014634	protein phosphatase 1F
PPM1L	NM_139245	protein phosphatase 1 (formerly 2C)-like
PPM1M	NM_144641	protein phosphatase 1M (PP2C domain containing)
PPM2C	NM_018444	pyruvate dehydrogenase phosphatase precursor
PPME1	NM_016147	protein phosphatase methylesterase-1
PPP1CA	NM_001008709	protein phosphatase 1, catalytic subunit, alpha
PPP1R11	NM_021959	protein phosphatase 1, regulatory (inhibitor)

PPP1R12A	NM_002480	protein phosphatase 1, regulatory (inhibitor)
PPP1R12B	NM_002481	protein phosphatase 1, regulatory (inhibitor)
PPP1R12C	NM_017607	protein phosphatase 1, regulatory subunit 12C
PPP1R13B	NM_015316	protein phosphatase 1, regulatory (inhibitor)
PPP1R14C	NM_030949	protein phosphatase 1, regulatory (inhibitor)
PPP1R16B	NM_015568	protein phosphatase 1 regulatory inhibitor
PPP1R1A	NM_006741	protein phosphatase 1, regulatory (inhibitor)
PPP1R2	NM_006241	protein phosphatase 1, regulatory (inhibitor)
PPP1R3B	NM_024607	protein phosphatase 1, regulatory (inhibitor)
PPP2CA	NM_002715	protein phosphatase 2, catalytic subunit, alpha
PPP2R1A	NM_014225	alpha isoform of regulatory subunit A, protein
PPP2R1B	NM_002716	beta isoform of regulatory subunit A, protein
PPP2R2C	NM_020416	gamma isoform of regulatory subunit B55, protein
PPP2R2D	NM_001003656	protein phosphatase 2, regulatory subunit B,
PPP2R4	NM_021131	protein phosphatase 2A, regulatory subunit B'
PPP2R5C	NM_002719	gamma isoform of regulatory subunit B56, protein
PPP3CB	NM_021132	protein phosphatase 3 (formerly 2B), catalytic
PPP4R1L	NM_018498	hypothetical protein LOC55370
PPP6C	NM_002721	protein phosphatase 6, catalytic subunit
PPRC1	NM_015062	PGC-1 related co-activator
PPT1	NM_000310	palmitoyl-protein thioesterase 1
PPT2	NM_005155	palmitoyl-protein thioesterase 2 isoform a
PPTC7	NM_139283	T-cell activation protein phosphatase 2C
PQLC1	NM_025078	PQ loop repeat containing 1
PRDM12	NM_021619	PR domain containing 12
PRDM16	NM_022114	PR domain containing 16 isoform 1
PRDM2	NM_001007257	retinoblastoma protein-binding zinc finger
PRDM4	NM_012406	PR domain containing 4
PREI3	NM_015387	preimplantation protein 3 isoform 1
PRELP	NM_002725	proline arginine-rich end leucine-rich repeat
PRF1	NM_005041	perforin 1 precursor
PRH2	NM_005042	proline-rich protein HaeIII subfamily 2
PRIC285	NM_033405	PPAR-alpha interacting complex protein 285
PRICKLE2	NM_198859	prickle-like 2
PRKAA1	NM_006251	protein kinase, AMP-activated, alpha 1 catalytic
PRKAB2	NM_005399	AMP-activated protein kinase beta 2
PRKACA	NM_002730	cAMP-dependent protein kinase catalytic subunit
PRKAR1A	NM_002734	cAMP-dependent protein kinase, regulatory
PRKAR2A	NM_004157	cAMP-dependent protein kinase, regulatory
PRKCA	NM_002737	protein kinase C, alpha
PRKCBP1	NM_012408	protein kinase C binding protein 1 isoform b
PRKCD	NM_006254	protein kinase C, delta
PRKCG	NM_002739	protein kinase C, gamma
PRKCI	NM_002740	protein kinase C, iota
PRKCZ	NM_001033581	protein kinase C, zeta isoform 2
PRKD2	NM_016457	protein kinase D2
PRKD3	NM_005813	protein kinase D3
PRKG1	NM_006258	protein kinase, cGMP-dependent, type I
PRNT	NM_177549	prion protein (testis specific)
PRO0149	NM_014117	hypothetical protein LOC29035
PROK2	NM_021935	prokineticin 2
ProSAPiP1	NM_014731	ProSAPiP1 protein
PROSC	NM_007198	proline synthetase co-transcribed homolog

PRPF38A	NM_032864	PRP38 pre-mRNA processing factor 38 (yeast)
PRPS2	NM_002765	phosphoribosyl pyrophosphate synthetase 2
PRR13	NM_001005354	hypothetical protein LOC54458 isoform 2
PRR3	NM_025263	proline-rich protein 3
PRRG1	NM_000950	proline rich Gla (G-carboxyglutamic acid) 1
PRRX1	NM_006902	paired mesoderm homeobox 1 isoform pmx-1a
PRSS12	NM_003619	neurotrypsin precursor
PRSS22	NM_022119	protease, serine, 22
PRSS23	NM_007173	protease, serine, 23 precursor
PRSS27	NM_031948	marapsin
PRSS33	NM_152891	protease, serine, 33
PRSS7	NM_002772	enterokinase precursor
PRX	NM_020956	periaxin isoform 1
PSAP	NM_002778	prosaposin
PSAT1	NM_021154	phosphoserine aminotransferase isoform 2
PSCA	NM_005672	prostate stem cell antigen preproprotein
PSCD3	NM_004227	pleckstrin homology, Sec7 and coiled/coil
PSD3	NM_015310	ADP-ribosylation factor guanine nucleotide
PSD4	NM_012455	pleckstrin and Sec7 domain containing 4
PSKH1	NM_006742	protein serine kinase H1
PSMB5	NM_002797	proteasome beta 5 subunit
PSMD13	NM_002817	proteasome 26S non-ATPase subunit 13 isoform 1
PSMD7	NM_002811	proteasome 26S non-ATPase subunit 7
PSMD9	NM_002813	proteasome 26S non-ATPase subunit 9
PSME3	NM_005789	proteasome activator subunit 3 isoform 1
PSME4	NM_014614	proteasome (prosome, macropain) activator
PSORS1C2	NM_014069	SPR1 protein
PSRC2	NM_144982	hypothetical protein LOC196441
PTBP1	NM_002819	polypyrimidine tract-binding protein 1 isoform
PTCH	NM_000264	patched
PTD008	NM_016145	hypothetical protein LOC51398
PTDSS1	NM_014754	phosphatidylserine synthase 1
PTER	NM_001001484	phosphotriesterase related
PTGER3	NM_198718	prostaglandin E receptor 3, subtype EP3 isoform
PTGES2	NM_198939	prostaglandin E synthase 2 isoform 3
PTGFRN	NM_020440	prostaglandin F2 receptor negative regulator
PTGIR	NM_000960	prostaglandin I2 (prostacyclin) receptor (IP)
PTGS1	NM_000962	prostaglandin-endoperoxide synthase 1 isoform 1
PTH	NM_000315	parathyroid hormone preproprotein
PTHLH	NM_198965	parathyroid hormone-like hormone isoform 1
PTK2B	NM_004103	PTK2B protein tyrosine kinase 2 beta isoform a
PTK6	NM_005975	PTK6 protein tyrosine kinase 6
PTK7	NM_152883	PTK7 protein tyrosine kinase 7 isoform e
PTPDC1	NM_152422	protein tyrosine phosphatase domain containing 1
PTPLAD2	NM_001010915	hypothetical protein LOC401494
PTPN18	NM_014369	protein tyrosine phosphatase, non-receptor type
PTPN20B	NM_015605	protein tyrosine phosphatase, non-receptor type
PTPN3	NM_002829	protein tyrosine phosphatase, non-receptor type
PTPN4	NM_002830	protein tyrosine phosphatase, non-receptor type
PTPN7	NM_002832	protein tyrosine phosphatase, non-receptor type
PTPRF	NM_002840	protein tyrosine phosphatase, receptor type, F
PTPRM	NM_002845	protein tyrosine phosphatase, receptor type, M
PTPRR	NM_002849	protein tyrosine phosphatase, receptor type, R

PTPRT	NM_007050	protein tyrosine phosphatase, receptor type, T
PURA	NM_005859	purine-rich element binding protein A
PURB	NM_033224	purine-rich element binding protein B
PURG	NM_013357	purine-rich element binding protein G isoform A
PUSL1	NM_153339	pseudouridylate synthase-like 1
PWWP2	NM_138499	PWWP domain containing 2
PXMP4	NM_007238	peroxisomal membrane protein 4 isoform a
PXN	NM_002859	paxillin
PYCR1	NM_006907	pyrroline-5-carboxylate reductase 1 isoform 1
PYCR2	NM_013328	pyrroline-5-carboxylate reductase family, member
PYCRL	NM_023078	pyrroline-5-carboxylate reductase-like
PYY2	NM_021093	peptide YY, 2 (seminalplasmin)
QKI	NM_206853	quaking homolog, KH domain RNA binding isoform
QPRT	NM_014298	quinolinate phosphoribosyltransferase
QSCN6L1	NM_181701	quiescin Q6-like 1
QTRTD1	NM_024638	queuine tRNA-ribosyltransferase domain
RAB10	NM_016131	ras-related GTP-binding protein RAB10
RAB11FIP1	NM_001002814	Rab coupling protein isoform 3
RAB11FIP2	NM_014904	RAB11 family interacting protein 2 (class I)
RAB11FIP3	NM_014700	rab11-family interacting protein 3
RAB11FIP4	NM_032932	RAB11 family interacting protein 4 (class II)
RAB11FIP5	NM_015470	RAB11 family interacting protein 5 (class I)
RAB15	NM_198686	Ras-related protein Rab-15
RAB1A	NM_004161	RAB1A, member RAS oncogene family
RAB22A	NM_020673	RAS-related protein RAB-22A
RAB23	NM_016277	Ras-related protein Rab-23
RAB2B	NM_032846	RAB2B protein
RAB39B	NM_171998	RAB39B, member RAS oncogene family
RAB3B	NM_002867	RAB3B, member RAS oncogene family
RAB3D	NM_004283	RAB3D, member RAS oncogene family
RAB40A	NM_080879	RAB40A, member RAS oncogene family
RAB40B	NM_006822	RAB40B, member RAS oncogene family
RAB43	NM_198490	RAB43 protein
RAB4B	NM_016154	ras-related GTP-binding protein 4b
RAB6B	NM_016577	RAB6B, member RAS oncogene family
RAB6IP2	NM_015064	RAB6-interacting protein 2 isoform alpha
RAB8B	NM_016530	RAB8B, member RAS oncogene family
RAB9A	NM_004251	RAB9A, member RAS oncogene family
RABAC1	NM_006423	Rab acceptor 1
RABEP2	NM_024816	rabaptin, RAB GTPase binding effector protein 2
RABL3	NM_173825	RAB, member of RAS oncogene family-like 3
RACGAP1	NM_013277	Rac GTPase activating protein 1
RAD23A	NM_005053	UV excision repair protein RAD23 homolog A
RAD23B	NM_002874	UV excision repair protein RAD23 homolog B
RAD50	NM_005732	RAD50 homolog isoform 1
RAD51L1	NM_133509	RAD51-like 1 isoform 3
RAD51L3	NM_002878	RAD51-like 3 isoform 1
RAD9A	NM_004584	RAD9 homolog
RAET1G	NM_001001788	retinoic acid early transcript 1G
RAF1	NM_002880	v-raf-1 murine leukemia viral oncogene homolog
RAGE	NM_014226	MAPK/MAK/MRK overlapping kinase
RAI14	NM_015577	retinoic acid induced 14
RAI17	NM_020338	retinoic acid induced 17

RALB	NM_002881	v-ral simian leukemia viral oncogene homolog B
RALBP1	NM_006788	ralA binding protein 1
RALGPS1	NM_014636	Ral GEF with PH domain and SH3 binding motif 1
RANBP10	NM_020850	RAN binding protein 10
RANBP3	NM_003624	RAN binding protein 3 isoform RANBP3-a
RANGAP1	NM_002883	Ran GTPase activating protein 1
RAP1GAP	NM_002885	RAP1, GTPase activating protein 1
RAP1GDS1	NM_021159	RAP1, GTP-GDP dissociation stimulator 1
RAP2C	NM_021183	RAP2C, member of RAS oncogene family
RAPGEF1	NM_005312	guanine nucleotide-releasing factor 2 isoform a
RAPGEFL1	NM_016339	Rap guanine nucleotide exchange factor
RAPH1	NM_213589	Ras association and pleckstrin homology domains
RARB	NM_000965	retinoic acid receptor, beta isoform 1
RARG	NM_000966	retinoic acid receptor, gamma
RARRES2	NM_002889	retinoic acid receptor responder (tazarotene
RASA3	NM_007368	RAS p21 protein activator 3
RASA4	NM_006989	RAS p21 protein activator 4
RASAL1	NM_004658	RAS protein activator like 1
RASGEF1B	NM_152545	RasGEF domain family, member 1B
RASGEF1C	NM_001031799	RasGEF domain family, member 1C isoform 2
RASL12	NM_016563	RAS-like, family 12 protein
RASSF1	NM_007182	Ras association domain family 1 isoform A
RASSF2	NM_014737	Ras association domain family 2
RASSF3	NM_178169	Ras association (RalGDS/AF-6) domain family 3
RASSF4	NM_032023	Ras association domain family 4 isoform a
RASSF5	NM_031437	Ras association (RalGDS/AF-6) domain family 5
RBBP6	NM_006910	retinoblastoma-binding protein 6 isoform 1
RBED1	NM_032213	RNA binding motif and ELMO domain 1
RBJ	NM_016544	Ras-associated protein Rap1
RBL2	NM_005611	retinoblastoma-like 2 (p130)
RBM12	NM_006047	RNA binding motif protein 12
RBM12B	NM_203390	hypothetical protein LOC389677
RBM16	NM_014892	RNA-binding motif protein 16
RBM19	NM_016196	RNA binding motif protein 19
RBM21	NM_022830	RNA binding motif protein 21
RBM23	NM_018107	hypothetical protein LOC55147
RBM24	NM_153020	hypothetical protein LOC221662
RBM33	NM_001008408	hypothetical protein LOC155435
RBM35B	NM_024939	hypothetical protein LOC80004
RBM6	NM_005777	RNA binding motif protein 6
RBM7	NM_016090	RNA binding motif protein 7
RBPMS2	NM_194272	RNA binding protein with multiple splicing 2
RCE1	NM_001032279	prenyl protein peptidase RCE1 isoform 2
RCL1	NM_005772	RNA cyclase homolog
RCOR3	NM_018254	REST corepressor 3
RDH13	NM_138412	retinol dehydrogenase 13 (all-trans and 9-cis)
RDM1	NM_145654	RAD52 motif 1 isoform 1
RDS	NM_000322	retinal degeneration slow protein
RECK	NM_021111	RECK protein precursor
RECQL5	NM_004259	RecQ protein-like 5 isoform 1
REEP1	NM_022912	receptor expression enhancing protein 1
REEP3	NM_001001330	receptor expression enhancing protein 3
RELN	NM_005045	reelin isoform a

RET	NM_020975	ret proto-oncogene isoform a
REXO1	NM_020695	transcription elongation factor B polypeptide 3
REXO4	NM_020385	XPMC2 prevents mitotic catastrophe 2 homolog
RFFL	NM_001017368	rififylin
RFK	NM_018339	riboflavin kinase
RFT1	NM_052859	hypothetical protein LOC91869
RFWD2	NM_001001740	ring finger and WD repeat domain 2 isoform d24
RFWD3	NM_018124	ring finger and WD repeat domain 3
RFX4	NM_002920	regulatory factor X4 isoform b
RGAG4	NM_001024455	retrotransposon gag domain containing 4
RGL1	NM_015149	ral guanine nucleotide dissociation
RGMA	NM_020211	RGM domain family, member A
RGMB	NM_001012761	RGM domain family, member B isoform 1 precursor
RGPD5	NM_005054	RANBP2-like and GRIP domain containing 5 isoform
RGS11	NM_003834	regulator of G-protein signalling 11 isoform 2
RGS12	NM_002926	regulator of G-protein signalling 12 isoform 2
RGS22	NM_015668	regulator of G-protein signalling 22
RGS3	NM_017790	regulator of G-protein signalling 3 isoform 3
RGS5	NM_003617	regulator of G-protein signalling 5
RGS9BP	NM_207391	RGS9 anchor protein
RHBDL3	NM_138328	rhomboid, veinlet-like 3
RHBG	NM_020407	Rhesus blood group, B glycoprotein
RHOB	NM_004040	ras homolog gene family, member B
RHOBTB2	NM_015178	Rho-related BTB domain containing 2
RHOD	NM_014578	ras homolog D
RHOJ	NM_020663	TC10-like Rho GTPase
RHOU	NM_021205	ras homolog gene family, member U
RHPN2	NM_033103	rhophilin-like protein
RIC8A	NM_021932	resistance to inhibitors of cholinesterase 8
RICTOR	NM_152756	rapamycin-insensitive companion of mTOR
RIF1	NM_018151	RAP1 interacting factor 1
RIMBP2	NM_015347	RIM-binding protein 2
RIMS3	NM_014747	regulating synaptic membrane exocytosis 3
RIPK4	NM_020639	ankyrin repeat domain 3
RIPK5	NM_015375	receptor interacting protein kinase 5 isoform 1
RKHD2	NM_016626	ring finger and KH domain containing 2
RKHD3	NM_032246	ring finger and KH domain containing 3
RNASEH1	NM_002936	ribonuclease H1
RNF10	NM_014868	ring finger protein 10
RNF111	NM_017610	ring finger protein 111
RNF125	NM_017831	ring finger protein 125
RNF138	NM_016271	ring finger protein 138 isoform 1
RNF144	NM_014746	ring finger protein 144
RNF149	NM_173647	ring finger protein 149
RNF165	NM_152470	ring finger protein 165
RNF166	NM_178841	ring finger protein 166
RNF183	NM_145051	ring finger protein 183
RNF190	NM_152598	hypothetical protein LOC162333
RNF24	NM_007219	ring finger protein 24
RNF31	NM_017999	ring finger protein 31
RNF38	NM_022781	ring finger protein 38 isoform 1
RNF39	NM_025236	HZFw1 protein isoform 1
RNF41	NM_005785	ring finger protein 41 isoform 1

RNF43	NM_017763	ring finger protein 43
RNF44	NM_014901	ring finger protein 44
RNF8	NM_003958	ring finger protein 8 isoform 1
RNGTT	NM_003800	RNA guanylyltransferase and 5'-phosphatase
RNH1	NM_002939	ribonuclease/angiogenin inhibitor
RNMT	NM_003799	RNA (guanine-7-) methyltransferase
RNPC1	NM_017495	RNA-binding region containing protein 1 isoform
RNPS1	NM_006711	RNA-binding protein S1, serine-rich domain
ROBO4	NM_019055	roundabout homolog 4, magic roundabout
ROGDI	NM_024589	leucine zipper domain protein
RP13-15M17.2	NM_001010866	hypothetical protein LOC199953
RP1-32F7.2	NM_173698	hypothetical protein LOC286499
RP3-473B4.1	NM_138819	hypothetical protein LOC159091
RPH3AL	NM_006987	rabphilin 3A-like (without C2 domains)
RPL10	NM_006013	ribosomal protein L10
RPL28	NM_000991	ribosomal protein L28
RPL32	NM_000994	ribosomal protein L32
RPP14	NM_007042	ribonuclease P 14kDa subunit
RPP25	NM_017793	ribonuclease P 25kDa subunit
RPRM	NM_019845	reprimo, TP53 dependant G2 arrest mediator
RPRML	NM_203400	reprimo-like
RPS23	NM_001025	ribosomal protein S23
RPS6KA3	NM_004586	ribosomal protein S6 kinase, 90kDa, polypeptide
RPS6KA5	NM_004755	ribosomal protein S6 kinase, 90kDa, polypeptide
RPS6KB1	NM_003161	ribosomal protein S6 kinase, 70kDa, polypeptide
RPS6KB2	NM_001007071	ribosomal protein S6 kinase, 70kDa, polypeptide
RPUSD1	NM_058192	RNA pseudouridylate synthase domain containing
RPUSD4	NM_032795	RNA pseudouridylate synthase domain containing
RRAGA	NM_006570	Ras-related GTP binding A
RRAGC	NM_022157	Ras-related GTP binding C
RREB1	NM_001003698	ras responsive element binding protein 1 isoform
RRH	NM_006583	peropsin
RRP22	NM_001007279	RAS-related on chromosome 22 isoform b
RS1	NM_000330	X-linked juvenile retinoschisis protein
RSBN1	NM_018364	round spermatid basic protein 1
RSNL2	NM_024692	restin-like 2
RSPO2	NM_178565	R-spondin family, member 2
RSPO3	NM_032784	thrombospondin, type I, domain containing 2
RSU1	NM_012425	ras suppressor protein 1 isoform 1
RTEL1	NM_032957	regulator of telomere elongation helicase 1
RTF1	NM_015138	Paf1/RNA polymerase II complex component
RTN2	NM_206902	reticulon 2 isoform D
RTN3	NM_006054	reticulon 3 isoform a
RTN4	NM_007008	reticulon 4 isoform C
RTN4RL1	NM_178568	reticulon 4 receptor-like 1
RUNX1	NM_001001890	runt-related transcription factor 1 isoform b
RUNX1T1	NM_004349	acute myelogenous leukemia 1 translocation 1
RUTBC1	NM_014853	RUN and TBC1 domain containing 1
RXRA	NM_002957	retinoid X receptor, alpha
RYBP	NM_012234	RING1 and YY1 binding protein
S100A5	NM_002962	S100 calcium binding protein A5
S100A7L1	NM_176823	S100 calcium binding protein A7-like 1
SACM1L	NM_014016	suppressor of actin 1

SAE1	NM_005500	SUMO-1 activating enzyme subunit 1
SALL2	NM_005407	sal-like 2
SALL3	NM_171999	sal-like 3
SALL4	NM_020436	sal-like 4
SAMD10	NM_080621	sterile alpha motif domain containing 10
SAPS2	NM_014678	hypothetical protein LOC9701
SAPS3	NM_018312	SAPS domain family, member 3
SARM1	NM_015077	sterile alpha and TIR motif containing 1
SAT	NM_002970	spermidine/spermine N1-acetyltransferase
SATB2	NM_015265	SATB family member 2
SAV1	NM_021818	WW45 protein
SBF1	NM_002972	SET binding factor 1 isoform a
SCAMP1	NM_004866	secretory carrier membrane protein 1 isoform 1
SCAMP4	NM_079834	secretory carrier membrane protein 4
SCAMP5	NM_138967	secretory carrier membrane protein 5
SCAND2	NM_022050	SCAN domain-containing protein 2 isoform 1
SCARB1	NM_005505	scavenger receptor class B, member 1
SCARF1	NM_145349	scavenger receptor class F, member 1 isoform 2
SCCPDH	NM_016002	saccharopine dehydrogenase (putative)
SCG3	NM_013243	secretogranin III
SCMH1	NM_001031694	sex comb on midleg homolog 1 isoform 1
SCML4	NM_198081	sex comb on midleg-like 4
SCN2B	NM_004588	sodium channel, voltage-gated, type II, beta
SCN3A	NM_006922	sodium channel, voltage-gated, type III, alpha
SCN4A	NM_000334	voltage-gated sodium channel type 4 alpha
SCN4B	NM_174934	sodium channel, voltage-gated, type IV, beta
SCN5A	NM_000335	voltage-gated sodium channel type V alpha
SCOC	NM_032547	short coiled-coil protein
SCOTIN	NM_016479	scotin
SCRN1	NM_014766	secernin 1
SDC1	NM_001006946	syndecan 1 precursor
SDCBP2	NM_015685	syndecan binding protein 2 isoform b
SDHC	NM_003001	succinate dehydrogenase complex, subunit C
SEC14L1	NM_003003	SEC14 (S. cerevisiae)-like 1 isoform a
SEC14L4	NM_174977	SEC14p-like protein TAP3
SEC22C	NM_004206	SEC22 vesicle trafficking protein homolog C
SEC61A1	NM_013336	Sec61 alpha 1 subunit
SECISBP2	NM_024077	SECIS binding protein 2
SEH1L	NM_001013437	sec13-like protein isoform 1
SEL1L	NM_005065	sel-1 suppressor of lin-12-like
SELE	NM_000450	selectin E precursor
SELENBP1	NM_003944	selenium binding protein 1
SELI	NM_033505	selenoprotein I
SELO	NM_031454	selenoprotein O
SELPLG	NM_003006	selectin P ligand
SELS	NM_018445	selenoprotein S
SEMA3B	NM_001005914	semaphorin 3B isoform 2 precursor
SEMA3D	NM_152754	semaphorin 3D
SEMA3E	NM_012431	semaphorin 3E
SEMA3G	NM_020163	semaphorin sem2
SEMA4B	NM_020210	semaphorin 4B precursor
SEMA4F	NM_004263	semaphorin W
SEMA5A	NM_003966	semaphorin 5A

SEMA5B	NM_001031702	semaphorin 5B isoform 1
SEMA6A	NM_020796	sema domain, transmembrane domain (TM), and
SEMA6B	NM_032108	semaphorin 6B isoform 3 precursor
SEMA6D	NM_020858	semaphorin 6D isoform 1 precursor
SEMA7A	NM_003612	semaphorin 7A
SENP1	NM_014554	sentrin/SUMO-specific protease 1
SENP2	NM_021627	SUMO1/sentrin/SMT3 specific protease 2
SEPN1	NM_020451	selenoprotein N, 1 isoform 1 precursor
SEPT11	NM_018243	septin 11
SEPT2	NM_001008491	septin 2
SEPT3	NM_019106	septin 3 isoform B
SEPT9	NM_006640	septin 9
SEPW1	NM_003009	selenoprotein W, 1
SERAC1	NM_032861	serine active site containing 1
SERBP1	NM_001018067	SERPINE1 mRNA binding protein 1 isoform 1
SERHL	NM_170694	serine hydrolase-like
SERINC2	NM_178865	tumor differentially expressed 2-like
SERPINA10	NM_016186	serine (or cysteine) proteinase inhibitor, clade
SERPINB13	NM_012397	serine (or cysteine) proteinase inhibitor, clade
SERPINB2	NM_002575	serine (or cysteine) proteinase inhibitor, clade
SERPINB7	NM_003784	serine (or cysteine) proteinase inhibitor, clade
SERPINB9	NM_004155	serine (or cysteine) proteinase inhibitor, clade
SERPINE1	NM_000602	plasminogen activator inhibitor-1
SERPINF2	NM_000934	alpha-2-plasmin inhibitor
SERPING1	NM_000062	complement component 1 inhibitor precursor
SESN1	NM_014454	sestrin 1
SESN2	NM_031459	sestrin 2
SETD3	NM_032233	hypothetical protein LOC84193 isoform a
SETD4	NM_001007258	hypothetical protein LOC54093 isoform b
SF1	NM_201997	splicing factor 1 isoform 4
SF3A1	NM_001005409	splicing factor 3a, subunit 1, 120kDa isoform 2
SF3A3	NM_006802	splicing factor 3a, subunit 3
SF4	NM_021164	splicing factor 4 isoform b
SFRS11	NM_004768	splicing factor p54
SFRS12	NM_139168	splicing factor, arginine/serine-rich 12
SFRS16	NM_007056	splicing factor, arginine/serine-rich 16
SFRS2	NM_003016	splicing factor, arginine/serine-rich 2
SFRS2IP	NM_004719	splicing factor, arginine/serine-rich 2,
SFRS5	NM_006925	splicing factor, arginine/serine-rich 5
SFRS8	NM_152235	splicing factor, arginine/serine-rich 8 isoform
SFT2D3	NM_032740	SFT2 domain containing 3
SFTPB	NM_000542	surfactant, pulmonary-associated protein B
SFXN1	NM_022754	sideroflexin 1
SFXN2	NM_178858	sideroflexin 2
SFXN3	NM_030971	sideroflexin 3
SFXN5	NM_144579	sideroflexin 5
SGCA	NM_000023	sarcoglycan, alpha (50kDa dystrophin-associated
SGCD	NM_000337	delta-sarcoglycan isoform 1
SGK	NM_005627	serum/glucocorticoid regulated kinase
SGK2	NM_016276	serum/glucocorticoid regulated kinase 2 isoform
SGK3	NM_001033578	serum/glucocorticoid regulated kinase 3 isoform
SH2D2A	NM_003975	SH2 domain protein 2A
SH2D3C	NM_170600	SH2 domain containing 3C isoform 2

SH3BGRL2	NM_031469	SH3 domain binding glutamic acid-rich protein
SH3BP2	NM_003023	SH3-domain binding protein 2
SH3BP4	NM_014521	SH3-domain binding protein 4
SH3BP5L	NM_030645	SH3-binding domain protein 5-like
SH3GL2	NM_003026	SH3-domain GRB2-like 2
SH3PX3	NM_153271	SH3 and PX domain containing 3
SH3PXD2B	NM_001017995	SH3 and PX domains 2B
SHANK2	NM_012309	SH3 and multiple ankyrin repeat domains 2
SHC3	NM_016848	src homology 2 domain containing transforming
SHF	NM_138356	hypothetical protein LOC90525
SHOC2	NM_007373	soc-2 suppressor of clear homolog
SHOX	NM_006883	short stature homeobox isoform b
SHOX2	NM_003030	short stature homeobox 2 isoform b
SHRM	NM_020859	shroom
SIAH1	NM_001006610	seven in absentia homolog 1 isoform b
SIAHBP1	NM_014281	fuse-binding protein-interacting repressor
SIDT1	NM_017699	SID1 transmembrane family, member 1
SIM2	NM_005069	single-minded homolog 2 long isoform
SIPA1L2	NM_020808	signal-induced proliferation-associated 1 like
SIRPA	NM_080792	signal-regulatory protein alpha precursor
SIRPB1	NM_006065	signal-regulatory protein beta 1 precursor
SIRT4	NM_012240	sirtuin 4
SIRT5	NM_031244	sirtuin 5 isoform 2
SIX4	NM_017420	sine oculis homeobox homolog 4
SKI	NM_003036	v-ski sarcoma viral oncogene homolog
SKIP	NM_030623	sphingosine kinase type 1-interacting protein
SLC11A2	NM_000617	solute carrier family 11 (proton-coupled
SLC12A2	NM_001046	solute carrier family 12
SLC12A5	NM_020708	solute carrier family 12 member 5
SLC12A7	NM_006598	solute carrier family 12 (potassium/chloride
SLC12A8	NM_024628	solute carrier family 12, member 8
SLC13A1	NM_022444	solute carrier family 13 (sodium/sulfate
SLC13A3	NM_001011554	solute carrier family 13 member 3 isoform b
SLC13A5	NM_177550	solute carrier family 13 (sodium-dependent
SLC15A4	NM_145648	solute carrier family 15, member 4
SLC16A14	NM_152527	solute carrier family 16 (monocarboxylic acid
SLC16A3	NM_004207	solute carrier family 16, member 3
SLC16A8	NM_013356	solute carrier family 16, member 8
SLC18A1	NM_003053	solute carrier family 18 (vesicular monoamine),
SLC18A3	NM_003055	solute carrier family 18 (vesicular
SLC19A2	NM_006996	solute carrier family 19, member 2
SLC1A2	NM_004171	solute carrier family 1, member 2
SLC20A2	NM_006749	solute carrier family 20, member 2
SLC22A13	NM_004256	organic cation transporter like 3
SLC22A15	NM_018420	solute carrier family 22 (organic cation
SLC22A17	NM_016609	solute carrier family 22 (organic cation
SLC22A2	NM_003058	solute carrier family 22 member 2 isoform a
SLC22A7	NM_153320	solute carrier family 22 member 7 isoform b
SLC24A1	NM_004727	solute carrier family 24
SLC24A3	NM_020689	solute carrier family 24
SLC24A4	NM_153646	solute carrier family 24 member 4 isoform 1
SLC24A6	NM_024959	solute carrier family 24 member 6
SLC25A12	NM_003705	solute carrier family 25 (mitochondrial carrier,

SLC25A15	NM_014252	solute carrier family 25 (mitochondrial carrier;
SLC25A19	NM_021734	solute carrier family 25 (mitochondrial
SLC25A2	NM_031947	solute carrier family 25 member 2
SLC25A22	NM_024698	mitochondrial glutamate carrier 1
SLC25A29	NM_152333	solute carrier family 25, member 29 isoform a
SLC25A3	NM_213612	solute carrier family 25 member 3 isoform c
SLC25A34	NM_207348	solute carrier family 25, member 34
SLC25A35	NM_201520	solute carrier family 25, member 35
SLC26A1	NM_022042	solute carrier family 26, member 1 isoform a
SLC26A10	NM_001018084	solute carrier family 26, member 10 isoform 1
SLC26A2	NM_000112	solute carrier family 26 member 2
SLC26A4	NM_000441	pendrin
SLC28A1	NM_201651	solute carrier family 28 (sodium-coupled
SLC29A2	NM_001532	solute carrier family 29 (nucleoside
SLC2A14	NM_153449	glucose transporter 14
SLC2A3	NM_006931	solute carrier family 2 (facilitated glucose
SLC2A4	NM_001042	glucose transporter 4
SLC2A8	NM_014580	solute carrier family 2, (facilitated glucose
SLC30A10	NM_001004433	solute carrier family 30 (zinc transporter),
SLC30A4	NM_013309	solute carrier family 30 (zinc transporter),
SLC30A8	NM_173851	solute carrier family 30 member 8
SLC31A1	NM_001859	solute carrier family 31 (copper transporters),
SLC35A4	NM_080670	solute carrier family 35, member A4
SLC35B2	NM_178148	solute carrier family 35, member B2
SLC35C1	NM_018389	solute carrier family 35, member C1
SLC35E1	NM_024881	solute carrier family 35, member E1
SLC36A1	NM_078483	solute carrier family 36 member 1
SLC36A2	NM_181776	solute carrier family 36 (proton/amino acid
SLC37A2	NM_198277	solute carrier family 37 (glycerol-3-phosphate
SLC38A3	NM_006841	solute carrier family 38, member 3
SLC38A4	NM_018018	solute carrier family 38, member 4
SLC39A1	NM_014437	solute carrier family 39 (zinc transporter),
SLC39A10	NM_020342	solute carrier family 39 (zinc transporter),
SLC39A7	NM_006979	solute carrier family 39 (zinc transporter),
SLC39A9	NM_018375	solute carrier family 39 (zinc transporter),
SLC3A1	NM_000341	solute carrier family 3, member 1
SLC41A2	NM_032148	solute carrier family 41, member 2
SLC41A3	NM_001008487	solute carrier family 41, member 3 isoform 4
SLC43A1	NM_003627	solute carrier family 43, member 1
SLC44A1	NM_080546	CDW92 antigen isoform 2
SLC44A2	NM_020428	CTL2 protein
SLC45A2	NM_001012509	membrane-associated transporter protein isoform
SLC45A3	NM_033102	prostein
SLC4A4	NM_003759	solute carrier family 4, sodium bicarbonate
SLC4A7	NM_003615	solute carrier family 4, sodium bicarbonate
SLC6A1	NM_003042	solute carrier family 6 (neurotransmitter
SLC6A14	NM_007231	solute carrier family 6 (amino acid
SLC6A17	NM_001010898	solute carrier family 6, member 17
SLC6A2	NM_001043	solute carrier family 6 member 2
SLC6A4	NM_001045	solute carrier family 6 member 4
SLC6A6	NM_003043	solute carrier family 6 (neurotransmitter
SLC6A8	NM_005629	solute carrier family 6 (neurotransmitter
SLC6A9	NM_001024845	solute carrier family 6 member 9 isoform 3

SLC7A1	NM_003045	solute carrier family 7 (cationic amino acid
SLC7A2	NM_001008539	solute carrier family 7, member 2 isoform 1
SLC7A5	NM_003486	solute carrier family 7 (cationic amino acid
SLC7A6	NM_003983	solute carrier family 7 (cationic amino acid
SLC8A3	NM_182933	solute carrier family 8 member 3 isoform E
SLC9A1	NM_003047	solute carrier family 9, isoform A1
SLC9A3R2	NM_004785	solute carrier family 9 isoform 3 regulator 2
SLC9A5	NM_004594	solute carrier family 9 (sodium/hydrogen
SLC9A6	NM_006359	solute carrier family 9 (sodium/hydrogen
SLC9A8	NM_015266	Na+/H+ exchanger isoform 8
SLCO2A1	NM_005630	solute carrier organic anion transporter family,
SLCO4C1	NM_180991	solute carrier organic anion transporter family,
SLFN11	NM_152270	schlafen family member 11
SLFN13	NM_144682	schlafen family member 13
SLFNL1	NM_144990	hypothetical protein LOC200172
SLITRK1	NM_052910	slit and trk like 1 protein
SLITRK2	NM_032539	SLIT and NTRK-like family, member 2
SLITRK6	NM_032229	slit and trk like 6
SLN	NM_003063	sarcolipin
SLURP1	NM_020427	ARS component B precursor
SMAD2	NM_001003652	Sma- and Mad-related protein 2
SMAD3	NM_005902	MAD, mothers against decapentaplegic homolog 3
SMAD5	NM_001001419	SMAD, mothers against DPP homolog 5
SMAD7	NM_005904	MAD, mothers against decapentaplegic homolog 7
SMAF1	NM_001018082	small adipocyte factor 1
SMAP1	NM_021940	stromal membrane-associated protein
SMAP1L	NM_022733	stromal membrane-associated protein 1-like
SMARCA1	NM_003069	SWI/SNF-related matrix-associated
SMARCD2	NM_003077	SWI/SNF-related matrix-associated
SMC1L1	NM_006306	SMC1 structural maintenance of chromosomes
SMC6L1	NM_024624	SMC6 protein
SMCR8	NM_144775	Smith-Magenis syndrome chromosome region,
SMG5	NM_015327	Est1p-like protein B
SMG6	NM_017575	Smg-6 homolog, nonsense mediated mRNA decay
SMPD1	NM_000543	sphingomyelin phosphodiesterase 1, acid
SMPD3	NM_018667	sphingomyelin phosphodiesterase 3, neutral
SMURF1	NM_020429	Smad ubiquitination regulatory factor 1 isoform
SMURF2	NM_022739	SMAD specific E3 ubiquitin protein ligase 2
SMYD1	NM_198274	SET and MYND domain containing 1
SMYD4	NM_052928	SET and MYND domain containing 4
SMYD5	NM_006062	SMYD family member 5
SNAP23	NM_003825	synaptosomal-associated protein 23 isoform
SNAP25	NM_003081	synaptosomal-associated protein 25 isoform
SNCG	NM_003087	synuclein, gamma (breast cancer-specific protein
SNF1LK	NM_173354	SNF1-like kinase
SNF1LK2	NM_015191	SNF1-like kinase 2
SNIP1	NM_024700	Smad nuclear interacting protein
SNN	NM_003498	Stannin
SNPH	NM_014723	syntaphilin
SNRK	NM_017719	SNF related kinase
SNRPA1	NM_003090	small nuclear ribonucleoprotein polypeptide A'
SNRPC	NM_003093	small nuclear ribonucleoprotein polypeptide C
SNRPD1	NM_006938	small nuclear ribonucleoprotein D1 polypeptide

SNTB2	NM_130845	basic beta 2 syntrophin isoform b
SNURF	NM_005678	SNRPN upstream reading frame protein
SNX1	NM_003099	sorting nexin 1 isoform a
SNX11	NM_013323	sorting nexin 11
SNX16	NM_022133	sorting nexin 16 isoform a
SNX19	NM_014758	sorting nexin 19
SNX6	NM_021249	sorting nexin 6 isoform a
SNX9	NM_016224	sorting nexin 9
SOCS5	NM_014011	suppressor of cytokine signaling 5
SOCS6	NM_004232	suppressor of cytokine signaling 6
SOD3	NM_003102	superoxide dismutase 3, extracellular
SON	NM_032195	SON DNA-binding protein isoform B
SORBS1	NM_015385	sorbin and SH3 domain containing 1 isoform 2
SORBS2	NM_003603	sorbin and SH3 domain containing 2 isoform 1
SORCS1	NM_001013031	SORCS receptor 1 isoform b
SORCS2	NM_020777	VPS10 domain receptor protein SORCS 2
SORT1	NM_002959	sortilin 1 preproprotein
SOST	NM_025237	sclerostin precursor
SOX1	NM_005986	SRY (sex determining region Y)-box 1
SOX11	NM_003108	SRY-box 11
SOX13	NM_005686	SRY-box 13
SOX3	NM_005634	SRY (sex determining region Y)-box 3
SOX4	NM_003107	SRY (sex determining region Y)-box 4
SOX5	NM_006940	SRY (sex determining region Y)-box 5 isoform a
SOX9	NM_000346	transcription factor SOX9
SP5	NM_001003845	Sp5 transcription factor
SP8	NM_182700	Sp8 transcription factor isoform 1
SPATA18	NM_145263	spermatogenesis associated 18 homolog
SPATA21	NM_198546	spermatogenesis associated 21
SPATA3	NM_139073	testis and spermatogenesis cell apoptosis
SPDEF	NM_012391	SAM pointed domain containing ets transcription
SPEN	NM_015001	spen homolog, transcriptional regulator
SPFH2	NM_007175	SPFH domain family, member 2 isoform 1
SPG20	NM_015087	spartin
SPG7	NM_199367	paraplegin isoform 2
SPHK2	NM_020126	sphingosine kinase type 2 isoform
SPINT2	NM_021102	serine protease inhibitor, Kunitz type, 2
SPIRE2	NM_032451	spire homolog 2
SPN	NM_001030288	sialophorin
SPOCK2	NM_014767	sparc/osteonectin, cwcv and kazal-like domains
SPON2	NM_012445	spondin 2, extracellular matrix protein
SPP2	NM_006944	secreted phosphoprotein 2, 24kDa
SPPL2B	NM_152988	signal peptide peptidase-like 2B isoform 2
SPPL3	NM_139015	SPPL3 protein
SPRED1	NM_152594	sprouty-related protein 1 with EVH-1 domain
SPRN	NM_001012508	shadow of prion protein
SPRR1B	NM_003125	small proline-rich protein 1B
SPRY3	NM_005840	sprouty homolog 3
SPRY4	NM_030964	sprouty homolog 4
SPRYD3	NM_032840	hypothetical protein LOC84926
SPSB2	NM_032641	SPRY domain-containing SOCS box protein SSB-2
SPSB3	NM_080861	SPRY domain-containing SOCS box protein SSB-3
SPSB4	NM_080862	SPRY domain-containing SOCS box protein SSB-4

SPTAN1	NM_003127	spectrin, alpha, non-erythrocytic 1
SPTB	NM_001024858	spectrin beta isoform a
SPTBN2	NM_006946	spectrin, beta, non-erythrocytic 2
SPTLC1	NM_006415	serine palmitoyltransferase subunit 1 isoform a
SPTY2D1	NM_194285	hypothetical protein LOC144108
SRC	NM_005417	proto-oncogene tyrosine-protein kinase SRC
SRD5A2	NM_000348	3-oxo-5 alpha-steroid 4-dehydrogenase 2
SREBF1	NM_001005291	sterol regulatory element binding transcription
SRP72	NM_006947	signal recognition particle 72kDa
SRPK1	NM_003137	SFRS protein kinase 1
SRPR	NM_003139	signal recognition particle receptor ('docking
SRPRB	NM_021203	signal recognition particle receptor, beta
SRPX	NM_006307	sushi-repeat-containing protein, X-linked
SRXN1	NM_080725	sulfiredoxin 1 homolog
SSH3	NM_017857	slingshot homolog 3 isoform 1
SSR1	NM_003144	signal sequence receptor, alpha
SSRP1	NM_003146	structure specific recognition protein 1
SSU72	NM_014188	Ssu72 RNA polymerase II CTD phosphatase homolog
ST3GAL4	NM_006278	ST3 beta-galactoside alpha-2,3-sialyltransferase
ST3GAL5	NM_003896	sialyltransferase 9
ST5	NM_005418	suppression of tumorigenicity 5 isoform 1
ST6GAL1	NM_003032	sialyltransferase 1 isoform a
ST7L	NM_017744	suppression of tumorigenicity 7-like isoform 1
ST8SIA3	NM_015879	ST8 alpha-N-acetyl-neuraminide
ST8SIA5	NM_013305	ST8 alpha-N-acetyl-neuraminide
STAC2	NM_198993	SH3 and cysteine rich domain 2
STARD13	NM_052851	START domain containing 13 isoform gamma
STARD3	NM_006804	steroidogenic acute regulatory protein related
STAT3	NM_003150	signal transducer and activator of transcription
STAT5B	NM_012448	signal transducer and activator of transcription
STC1	NM_003155	stanniocalcin 1 precursor
STEAP2	NM_152999	six transmembrane epithelial antigen of the
STEAP3	NM_001008410	dudulin 2 isoform b
STIM1	NM_003156	stromal interaction molecule 1 precursor
STIM2	NM_020860	stromal interaction molecule 2
STIP1	NM_006819	stress-induced-phosphoprotein 1
STK10	NM_005990	serine/threonine kinase 10
STK11	NM_000455	serine/threonine protein kinase 11
STK17A	NM_004760	serine/threonine kinase 17a
STK19	NM_004197	serine/threonine kinase 19 isoform 1
STK32B	NM_018401	serine/threonine kinase 32B
STK32C	NM_173575	serine/threonine kinase 32C
STK33	NM_030906	serine/threonine kinase 33
STK35	NM_080836	serine/threonine kinase 35
STK38	NM_007271	serine/threonine kinase 38
STK38L	NM_015000	serine/threonine kinase 38 like
STOML1	NM_004809	stomatin (EPB72)-like 1
STON1	NM_006873	stonin 1
STOX2	NM_020225	storkhead box 2
STX16	NM_001001433	syntaxin 16 isoform a
STX17	NM_017919	syntaxin 17
STX1A	NM_004603	syntaxin 1A (brain)
STX3	NM_004177	syntaxin 3A

STX5	NM_003164	syntaxin 5
STX6	NM_005819	syntaxin 6
STXBP1	NM_001032221	syntaxin binding protein 1 isoform b
STXBP3	NM_007269	syntaxin binding protein 3
STXBP4	NM_178509	syntaxin binding protein 4
STXBP5	NM_139244	tomosyn
SUFU	NM_016169	suppressor of fused
SUHW3	NM_017666	suppressor of hairy wing homolog 3
SUHW4	NM_001002843	suppressor of hairy wing homolog 4 isoform 2
SULT4A1	NM_014351	sulfotransferase family 4A, member 1
SUMO3	NM_006936	small ubiquitin-like modifier protein 3
SUPT16H	NM_007192	chromatin-specific transcription elongation
SUPT6H	NM_003170	suppressor of Ty 6 homolog
SUPT7L	NM_014860	SPTF-associated factor 65 gamma
SURF4	NM_033161	surfeit 4
SURF5	NM_133640	surfeit 5 isoform b
SUSD1	NM_022486	sushi domain containing 1
SUV420H1	NM_016028	suppressor of variegation 4-20 homolog 1 isoform
SUV420H2	NM_032701	suppressor of variegation 4-20 homolog 2
SUZ12	NM_015355	joined to JAZF1
SVH	NM_031905	SVH protein
SVIL	NM_003174	supervillin isoform 1
SWAP70	NM_015055	SWAP-70 protein
SYBL1	NM_005638	synaptobrevin-like 1
SYDE1	NM_033025	synapse defective 1, Rho GTPase, homolog 1
SYN2	NM_003178	synapsin II isoform IIb
SYNE1	NM_015293	nesprin 1 isoform beta
SYNGR1	NM_004711	synaptogyrin 1 isoform 1a
SYNGR3	NM_004209	synaptogyrin 3
SYNJ1	NM_003895	synaptojanin 1 isoform a
SYPL1	NM_006754	synaptophysin-like 1 isoform a
SYT10	NM_198992	synaptotagmin 10
SYT12	NM_177963	synaptotagmin XII
SYT15	NM_031912	synaptotagmin XV isoform a
SYT3	NM_032298	synaptotagmin 3
SYT4	NM_020783	synaptotagmin IV
SYT6	NM_205848	synaptotagmin VI
SYT8	NM_138567	synaptotagmin VIII
SYTL2	NM_032379	synaptotagmin-like 2 isoform b
SYTL4	NM_080737	synaptotagmin-like 4 (granuphilin-a)
TAB3	NM_152787	TAK1-binding protein 3 isoform 1
TACC1	NM_006283	transforming, acidic coiled-coil containing
TAF15	NM_003487	TBP-associated factor 15 isoform 2
TAF1C	NM_005679	TBP-associated factor 1C isoform 1
TAF5	NM_006951	TBP-associated factor 5
TAF7	NM_005642	TATA box-binding protein-associated factor 2F
TAF7L	NM_024885	TATA box binding protein-associated factor, RNA
TAF9B	NM_015975	transcription associated factor 9B
TAGLN2	NM_003564	transgelin 2
TAL1	NM_003189	T-cell acute lymphocytic leukemia 1
TAOK1	NM_020791	TAO kinase 1
TAP2	NM_000544	transporter 2, ATP-binding cassette, sub-family
TAPBP	NM_003190	tapasin isoform 1 precursor

TARBP1	NM_005646	TAR RNA binding protein 1
TARBP2	NM_004178	TAR RNA binding protein 2 isoform b
TASP1	NM_017714	taspase 1
TAT	NM_000353	tyrosine aminotransferase
TAX1BP3	NM_014604	Tax1 (human T-cell leukemia virus type I)
TAZ	NM_000116	tafazzin isoform 1
TBC1D1	NM_015173	TBC1 (tre-2/USP6, BUB2, cdc16) domain family,
TBC1D10B	NM_015527	TBC1 domain family, member 10B
TBC1D13	NM_018201	TBC1 domain family, member 13
TBC1D14	NM_020773	TBC1 domain family, member 14
TBC1D19	NM_018317	TBC1 domain family, member 19
TBC1D22A	NM_014346	TBC1 domain family, member 22A
TBC1D22B	NM_017772	TBC1 domain family, member 22B
TBC1D2B	NM_015079	TBC1 domain family, member 2B
TBC1D3C	NM_001001418	TBC1 domain family member 3C
TBC1D8	NM_007063	TBC1 domain family, member 8
TBC1D9	NM_015130	hypothetical protein LOC23158
TBCC	NM_003192	beta-tubulin cofactor C
TBCCD1	NM_018138	TBCC domain containing 1
TBK1	NM_013254	TANK-binding kinase 1
TBL1X	NM_005647	transducin beta-like 1X
TBL1XR1	NM_024665	nuclear receptor co-repressor/HDAC3 complex
TBL2	NM_012453	transducin (beta)-like 2
TBP	NM_003194	TATA box binding protein
TBPL1	NM_004865	TBP-like 1
TBRG1	NM_032811	transforming growth factor beta regulator 1
TBX1	NM_005992	T-box 1 isoform B
TBX2	NM_005994	T-box 2
TBX6	NM_004608	T-box 6 isoform 1
TCAP	NM_003673	telethonin
TCEB2	NM_007108	elongin B isoform a
TCF1	NM_000545	transcription factor 1, hepatic
TCF21	NM_198392	transcription factor 21
TCF3	NM_003200	transcription factor 3
TCF7	NM_003202	transcription factor 7 (T-cell specific,
TCFL5	NM_006602	transcription factor-like 5 protein
TCHP	NM_032300	trichoplein
TCL6	NM_014418	T-cell leukemia/lymphoma 6 isoform TCL6a2
TDGF1	NM_003212	teratocarcinoma-derived growth factor 1
TEAD1	NM_021961	TEA domain family member 1
TEDDM1	NM_172000	putative membrane protein HE9
TES	NM_015641	testin isoform 1
TEX261	NM_144582	testis expressed sequence 261
TFAP2A	NM_001032280	transcription factor AP-2 alpha isoform b
TFAP2C	NM_003222	transcription factor AP-2 gamma
TFAP2D	NM_172238	transcription factor AP-2 beta-like 1
TFAP2E	NM_178548	transcription factor AP-2 epsilon (activating
TFAP4	NM_003223	transcription factor AP-4 (activating enhancer
TFCP2L1	NM_014553	LBP-9
TFEC	NM_001018058	transcription factor EC isoform b
TFG	NM_001007565	TRK-fused gene
TFPI2	NM_006528	tissue factor pathway inhibitor 2
TGFBR1	NM_004612	transforming growth factor, beta receptor I

TGFBR3	NM_003243	transforming growth factor, beta receptor III
TGIF2	NM_021809	TGFB-induced factor 2
TGIF2LY	NM_139214	TGFB-induced factor 2-like, Y-linked
TGOLN2	NM_006464	trans-golgi network protein 2
THAP2	NM_031435	THAP domain containing, apoptosis associated
THAP6	NM_144721	THAP domain containing 6
THBS2	NM_003247	thrombospondin 2 precursor
THEM4	NM_053055	thioesterase superfamily member 4 isoform a
THSD3	NM_182509	thrombospondin, type I domain containing 3
THSD4	NM_024817	hypothetical protein LOC79875
THUMPD1	NM_017736	THUMP domain containing 1
THYN1	NM_014174	thymocyte nuclear protein 1 isoform 1
TIAF1	NM_004740	TGFB1-induced anti-apoptotic factor 1
TIGA1	NM_053000	hypothetical protein LOC114915
TIGD6	NM_030953	hypothetical protein LOC81789
TIMM13	NM_012458	translocase of inner mitochondrial membrane 13
TIMM22	NM_013337	translocase of inner mitochondrial membrane 22
TIMM50	NM_001001563	translocase of inner mitochondrial membrane 50
TIMP2	NM_003255	tissue inhibitor of metalloproteinase 2
TK2	NM_004614	thymidine kinase 2, mitochondrial
TKTL1	NM_012253	transketolase-like 1
TLE4	NM_007005	transducin-like enhancer protein 4
TLK1	NM_012290	tousled-like kinase 1
TLK2	NM_006852	tousled-like kinase 2
TLL1	NM_012464	tolloid-like 1
TLL2	NM_012465	tolloid-like 2
TLN1	NM_006289	talin 1
TLOC1	NM_003262	translocation protein 1
TLR1	NM_003263	toll-like receptor 1
TLR4	NM_138554	toll-like receptor 4 precursor
TLR7	NM_016562	toll-like receptor 7
TLX2	NM_016170	T-cell leukemia, homeobox 2
TM2D2	NM_001024380	TM2 domain containing 2 isoform b
TM4SF1	NM_014220	transmembrane 4 superfamily member 1
TM9SF4	NM_014742	transmembrane 9 superfamily protein member 4
TMCC1	NM_001017395	transmembrane and coiled-coil domains 1 isoform
TMCC3	NM_020698	transmembrane and coiled-coil domains 3
TMED3	NM_007364	transmembrane emp24 domain containing 3
TMED9	NM_017510	transmembrane emp24 protein transport domain
TMEM10	NM_033207	transmembrane protein 10 isoform a
TMEM100	NM_018286	hypothetical protein LOC55273
TMEM101	NM_032376	hypothetical protein LOC84336
TMEM104	NM_017728	hypothetical protein LOC54868
TMEM105	NM_178520	hypothetical protein LOC284186
TMEM106A	NM_145041	hypothetical protein LOC113277
TMEM109	NM_024092	transmembrane protein 109
TMEM113	NM_025222	hypothetical protein PRO2730
TMEM119	NM_181724	hypothetical protein LOC338773
TMEM123	NM_052932	pro-oncosis receptor inducing membrane injury
TMEM127	NM_017849	hypothetical protein LOC55654
TMEM134	NM_025124	hypothetical protein LOC80194
TMEM135	NM_022918	hypothetical protein LOC65084
TMEM138	NM_016464	hypothetical protein LOC51524

TMEM139	NM_153345	hypothetical protein LOC135932
TMEM143	NM_018273	hypothetical protein LOC55260
TMEM16C	NM_031418	transmembrane protein 16C
TMEM16F	NM_001025356	transmembrane protein 16F
TMEM16G	NM_001001891	transmembrane protein 16G isoform NGEP long
TMEM16K	NM_018075	hypothetical protein LOC55129
TMEM18	NM_152834	transmembrane protein 18
TMEM20	NM_153226	transmembrane protein 20
TMEM26	NM_178505	transmembrane protein 26
TMEM30B	NM_001017970	transmembrane protein 30B
TMEM33	NM_018126	transmembrane protein 33
TMEM35	NM_021637	transmembrane protein 35
TMEM43	NM_024334	transmembrane protein 43
TMEM45B	NM_138788	transmembrane protein 45B
TMEM47	NM_031442	transmembrane 4 superfamily member 10
TMEM49	NM_030938	transmembrane protein 49
TMEM50B	NM_006134	transmembrane protein 50B
TMEM52	NM_178545	transmembrane protein 52
TMEM55A	NM_018710	transmembrane protein 55A
TMEM55B	NM_144568	transmembrane protein 55B
TMEM63C	NM_020431	transmembrane protein 63C
TMEM79	NM_032323	hypothetical protein LOC84283
TMEM8	NM_021259	transmembrane protein 8 (five membrane-spanning
TMEM85	NM_016454	hypothetical protein LOC51234
TMEM86A	NM_153347	hypothetical protein LOC144110
TMEM86B	NM_173804	hypothetical protein LOC255043
TMEM87A	NM_015497	hypothetical protein LOC25963
TMEM87B	NM_032824	hypothetical protein LOC84910
TMEPAI	NM_020182	transmembrane prostate androgen-induced protein
TMIE	NM_147196	transmembrane inner ear protein
TMOD1	NM_003275	tropomodulin 1
TMPRSS13	NM_032046	transmembrane protease, serine 13
TMPRSS3	NM_024022	transmembrane protease, serine 3 isoform 1
TMPRSS4	NM_019894	transmembrane protease, serine 4 isoform 1
TMTC2	NM_152588	hypothetical protein LOC160335
TNFAIP1	NM_021137	tumor necrosis factor, alpha-induced protein 1
TNFAIP8L1	NM_152362	tumor necrosis factor, alpha-induced protein
TNFAIP8L3	NM_207381	tumor necrosis factor, alpha-induced protein
TNFRSF10B	NM_003842	tumor necrosis factor receptor superfamily,
TNFRSF10D	NM_003840	tumor necrosis factor receptor superfamily,
TNFRSF13B	NM_012452	tumor necrosis factor receptor 13B
TNFRSF14	NM_003820	tumor necrosis factor receptor superfamily,
TNFRSF19	NM_148957	tumor necrosis factor receptor superfamily,
TNFRSF19L	NM_032871	tumor necrosis factor receptor superfamily,
TNFSF7	NM_001252	tumor necrosis factor ligand superfamily, member
TNFSF9	NM_003811	tumor necrosis factor (ligand) superfamily,
TNIP1	NM_006058	Nef-associated factor 1
TNIP2	NM_024309	A20-binding inhibitor of NF-kappaB activation 2
TNK2	NM_001010938	tyrosine kinase, non-receptor, 2 isoform 2
TNNI1	NM_003281	troponin I, skeletal, slow
TNRC6B	NM_001024843	trinucleotide repeat containing 6B isoform 2
TNS1	NM_022648	tensin
TNS3	NM_022748	tensin-like SH2 domain containing 1

TNT	NM_182831	hypothetical protein LOC162083
TOB2	NM_016272	transducer of ERBB2, 2
TOLLIP	NM_019009	toll interacting protein
TOM1	NM_005488	target of myb1
TOM1L2	NM_001033551	target of myb1-like 2 isoform 1
TOMM20	NM_014765	translocase of outer mitochondrial membrane 20
TOMM34	NM_006809	translocase of outer mitochondrial membrane 34
TOR1B	NM_014506	torsin family 1, member B (torsin B)
TOR3A	NM_022371	torsin family 3, member A
TP53I11	NM_006034	p53-induced protein
TP53INP2	NM_021202	tumor protein p53 inducible nuclear protein 2
TP53TG3	NM_016212	hypothetical protein LOC24150
TP73L	NM_003722	tumor protein p73-like
TPCN2	NM_139075	two pore segment channel 2
TPD52L3	NM_033516	protein kinase NYD-SP25 isoform 1
TPM1	NM_001018004	tropomyosin 1 alpha chain isoform 3
TPM2	NM_003289	tropomyosin 2 (beta) isoform 1
TPM3	NM_153649	tropomyosin 3 isoform 2
TPPP	NM_007030	brain-specific protein p25 alpha
TPRX1	NM_198479	tetra-peptide repeat homeobox
TRAF1	NM_005658	TNF receptor-associated factor 1
TRAF4	NM_004295	TNF receptor-associated factor 4 isoform 1
TRAF5	NM_001033910	TNF receptor-associated factor 5
TRAF7	NM_032271	ring finger and WD repeat domain 1 isoform 1
TRAFD1	NM_006700	FLN29 gene product
TRAK1	NM_014965	OGT(O-Glc-NAc transferase)-interacting protein
TRAM1	NM_014294	translocating chain-associating membrane
TRAM2	NM_012288	translocation-associated membrane protein 2
TREML2	NM_024807	triggering receptor expressed on myeloid
TRIAD3	NM_207111	TRIAD3 protein isoform a
TRIM10	NM_006778	tripartite motif-containing 10 isoform 1
TRIM11	NM_145214	tripartite motif-containing 11
TRIM14	NM_014788	tripartite motif protein TRIM14 isoform alpha
TRIM2	NM_015271	tripartite motif-containing 2
TRIM29	NM_012101	tripartite motif protein TRIM29 isoform alpha
TRIM35	NM_015066	tripartite motif-containing 35 isoform 1
TRIM36	NM_018700	tripartite motif-containing 36 isoform 1
TRIM37	NM_015294	tripartite motif-containing 37 protein
TRIM56	NM_030961	tripartite motif-containing 56
TRIM6	NM_001003818	tripartite motif-containing 6 isoform 1
TRIM62	NM_018207	tripartite motif-containing 62
TRIM68	NM_018073	ring finger protein 137
TRIM7	NM_203293	tripartite motif-containing 7 isoform 1
TRIM9	NM_015163	tripartite motif protein 9 isoform 1
TRIP10	NM_004240	thyroid hormone receptor interactor 10
TRIT1	NM_017646	tRNA isopentenyltransferase 1
TRMT5	NM_020810	tRNA-(N1G37) methyltransferase
TRMU	NM_001008568	tRNA 5-methylaminomethyl-2-thiouridylate
TRPC1	NM_003304	transient receptor potential cation channel,
TRPC4AP	NM_015638	TRPC4-associated protein isoform a
TRPM2	NM_001001188	transient receptor potential cation channel,
TRPV1	NM_018727	transient receptor potential cation channel,
TSC1	NM_000368	tuberous sclerosis 1 protein isoform 1

TSC22D1	NM_006022	TSC22 domain family 1 isoform 2
TSC22D2	NM_014779	TSC22 domain family 2
TSC22D3	NM_001015881	TSC22 domain family, member 3 isoform 3
TSGA13	NM_052933	testis specific, 13
TSHR	NM_001018036	thyroid stimulating hormone receptor isoform 2
TSN	NM_004622	translin
TSPAN14	NM_030927	tetraspanin 14
TSPAN15	NM_012339	transmembrane 4 superfamily member 15
TSPAN17	NM_001006616	transmembrane 4 superfamily member 17 isoform c
TSPAN18	NM_130783	tetraspanin 18 isoform 2
TSPAN3	NM_005724	transmembrane 4 superfamily member 8 isoform 1
TSPAN33	NM_178562	penumbra
TSPAN5	NM_005723	transmembrane 4 superfamily member 9
TSPAN9	NM_006675	tetraspanin 9
TSPYL2	NM_022117	TSPY-like 2
TSPYL4	NM_021648	TSPY-like 4
TSPYL5	NM_033512	TSPY-like 5
TSPYL6	NM_001003937	TSPY-like 6
TSSK6	NM_032037	serine/threonine protein kinase SSTK
TTBK1	NM_032538	tau tubulin kinase 1
TTC1	NM_003314	tetratricopeptide repeat domain 1
TTC13	NM_024525	tetratricopeptide repeat domain 13
TTC21B	NM_024753	tetratricopeptide repeat domain 21B
TTC23	NM_001018029	tetratricopeptide repeat domain 23 isoform 1
TTC25	NM_031421	hypothetical protein LOC83538
TTLL12	NM_015140	hypothetical protein LOC23170
TTLL5	NM_015072	tubulin tyrosine ligase-like family, member 5
TTLL9	NM_001008409	tubulin tyrosine ligase-like family, member 9
TTYH3	NM_025250	tweety 3
TUB	NM_003320	tubby isoform a
TUBA2	NM_006001	tubulin, alpha 2 isoform 1
TUBA3	NM_006009	tubulin, alpha 3
TUBB	NM_178014	tubulin, beta polypeptide
TUBB3	NM_006086	tubulin, beta, 4
TUFT1	NM_020127	tuftelin 1
TULP3	NM_003324	tubby like protein 3
TUSC5	NM_172367	LOST1
TXLNA	NM_175852	taxilin
TXN2	NM_012473	thioredoxin 2 precursor
TXNDC5	NM_022085	thioredoxin domain containing 5 isoform 2
TXNIP	NM_006472	thioredoxin interacting protein
TXNL4A	NM_006701	thioredoxin-like 4A
TYRO3	NM_006293	TYRO3 protein tyrosine kinase
TYSND1	NM_173555	trypsin domain containing 1 isoform a
UAP1L1	NM_207309	UDP-N-acteylglucosamine pyrophosphorylase 1-like
UBADC1	NM_016172	ubiquitin associated domain containing 1
UBAP1	NM_016525	ubiquitin associated protein 1
UBASH3A	NM_001001895	ubiquitin associated and SH3 domain containing,
UBE2A	NM_003336	ubiquitin-conjugating enzyme E2A isoform 1
UBE2B	NM_003337	ubiquitin-conjugating enzyme E2B
UBE2H	NM_003344	ubiquitin-conjugating enzyme E2H isoform 1
UBE2I	NM_003345	ubiquitin-conjugating enzyme E2I
UBE2J1	NM_016021	ubiquitin-conjugating enzyme E2, J1

UBE2J2	NM_058167	ubiquitin conjugating enzyme E2, J2 isoform 2
UBE2O	NM_022066	ubiquitin-conjugating enzyme E2O
UBE2Q1	NM_017582	ubiquitin-conjugating enzyme E2Q
UBE2Q2	NM_173469	ubiquitin-conjugating enzyme E2Q (putative) 2
UBE2R2	NM_017811	ubiquitin-conjugating enzyme UBC3B
UBE2V1	NM_001032288	ubiquitin-conjugating enzyme E2 variant 1
UBE2Z	NM_023079	ubiquitin-conjugating enzyme E2Z (putative)
UBE3C	NM_014671	ubiquitin protein ligase E3C
UBE4A	NM_004788	ubiquitination factor E4A
UBE4B	NM_006048	ubiquitination factor E4B
UBL3	NM_007106	ubiquitin-like 3
UBL4A	NM_014235	ubiquitin-like 4
UBL4B	NM_203412	hypothetical protein LOC164153
UBN1	NM_016936	ubinuclein 1
UBOX5	NM_014948	U-box domain containing 5 isoform a
UBP1	NM_014517	upstream binding protein 1 (LBP-1a)
UBTD1	NM_024954	ubiquitin domain containing 1
UBXD2	NM_014607	UBX domain containing 2
UBXD3	NM_152376	UBX domain containing 3
UBXD8	NM_014613	UBX domain containing 8
UCP2	NM_003355	uncoupling protein 2
UHMK1	NM_175866	kinase interacting stathmin
ULK1	NM_003565	unc-51-like kinase 1
UMOD	NM_001008389	uromodulin precursor
UNC13D	NM_199242	unc-13 homolog D
UNC5D	NM_080872	netrin receptor Unc5h4
UNC84A	NM_025154	unc-84 homolog A
UNC84B	NM_015374	unc-84 homolog B
UNG	NM_003362	uracil-DNA glycosylase isoform UNG1 precursor
UNG2	NM_001024592	uracil-DNA glycosylase 2 isoform b
UNQ9370	NM_207447	hypothetical protein LOC400454
UPF1	NM_002911	regulator of nonsense transcripts 1
UQCR	NM_006830	ubiquinol-cytochrome c reductase, 6.4kDa
URG4	NM_017920	hypothetical protein LOC55665
UROS	NM_000375	uroporphyrinogen III synthase
USH2A	NM_206933	usherin isoform B
USP14	NM_005151	ubiquitin specific protease 14 isoform a
USP15	NM_006313	ubiquitin specific protease 15
USP18	NM_017414	ubiquitin specific protease 18
USP19	NM_006677	ubiquitin specific protease 19
USP2	NM_004205	ubiquitin specific protease 2 isoform a
USP20	NM_001008563	ubiquitin specific protease 20
USP25	NM_013396	ubiquitin specific protease 25
USP3	NM_006537	ubiquitin specific protease 3
USP32	NM_032582	ubiquitin specific protease 32
USP36	NM_025090	ubiquitin specific protease 36
UTX	NM_021140	ubiquitously transcribed tetratricopeptide
VAC14	NM_018052	Vac14 homolog
VAMP1	NM_014231	vesicle-associated membrane protein 1 isoform 1
VAMP2	NM_014232	vesicle-associated membrane protein 2
VAMP8	NM_003761	vesicle-associated membrane protein 8
VAPB	NM_004738	VAMP-associated protein B/C
VASH1	NM_014909	vasohibin 1

VAT1	NM_006373	vesicle amine transport protein 1
VAV2	NM_003371	vav 2 oncogene
VAX1	NM_199131	ventral anterior homeobox 1
VCL	NM_003373	vinculin isoform VCL
VDR	NM_000376	vitamin D (1,25-dihydroxyvitamin D3) receptor
VEGF	NM_001025366	vascular endothelial growth factor isoform a
VEZT	NM_017599	transmembrane protein vezatin
VGLL2	NM_153453	vestigial-like 2 isoform 2
VGLL3	NM_016206	colon carcinoma related protein
VIL2	NM_003379	villin 2
VIPR2	NM_003382	vasoactive intestinal peptide receptor 2
VISA	NM_020746	virus-induced signaling adapter
VIT	NM_053276	vitrin
VMD2L2	NM_153274	vitelliform macular dystrophy 2-like 2
VMD2L3	NM_152439	vitelliform macular dystrophy 2-like 3
VPS13B	NM_017890	vacuolar protein sorting 13B isoform 5
VPS13D	NM_015378	vacuolar protein sorting 13D isoform 1
VPS24	NM_001005753	vacuolar protein sorting 24 isoform 2
VPS33B	NM_018668	vacuolar protein sorting 33B (yeast homolog))
VPS36	NM_016075	vacuolar protein sorting 36
VPS37B	NM_024667	vacuolar protein sorting 37B
VPS37C	NM_017966	vacuolar protein sorting 37C
VPS41	NM_014396	vacuolar protein sorting 41 (yeast homolog)
VPS4A	NM_013245	vacuolar protein sorting factor 4A
VSIG4	NM_007268	V-set and immunoglobulin domain containing 4
VTI1B	NM_006370	vesicle transport through interaction with
VWF	NM_000552	von Willebrand factor preproprotein
WAPAL	NM_015045	wings apart-like homolog
WARS2	NM_015836	mitochondrial tryptophanyl tRNA synthetase 2
WASF2	NM_006990	WAS protein family, member 2
WASL	NM_003941	Wiskott-Aldrich syndrome gene-like protein
WASPIP	NM_003387	WASP-interacting protein
WBP11	NM_016312	WW domain binding protein 11
WBP2	NM_012478	WW domain binding protein 2
WBSCR17	NM_022479	UDP-GalNAc:polypeptide
WBSCR18	NM_032317	Williams Beuren syndrome chromosome region 18
WBSCR19	NM_175064	Williams Beuren syndrome chromosome region 19
WDFY3	NM_178583	WD repeat and FYVE domain containing 3 isoform
WDHD1	NM_001008396	WD repeat and HMG-box DNA binding protein 1
WDR13	NM_017883	WD repeat domain 13 protein
WDR20	NM_181291	WD repeat domain 20 isoform 1
WDR21A	NM_015604	WD repeat domain 21A isoform 1
WDR21C	NM_152418	hypothetical protein LOC138009
WDR22	NM_003861	Breakpoint cluster region protein, uterine
WDR31	NM_001006615	WD repeat domain 31 isoform 2
WDR33	NM_001006623	WD repeat domain 33 isoform 3
WDR37	NM_014023	WD repeat domain 37
WDR4	NM_018669	WD repeat domain 4 protein
WDR41	NM_018268	WD repeat domain 41
WDR42A	NM_015726	H326
WDR47	NM_014969	WD repeat domain 47
WDR59	NM_030581	WD repeat domain 59
WDR62	NM_173636	WD repeat domain 62

WDR68	NM_005828	WD-repeat protein
WDR7	NM_015285	rabconnectin-3 beta isoform 1
WDR73	NM_032856	WD repeat domain 73
WDTC1	NM_015023	WD and tetratricopeptide repeats 1
WEE1	NM_003390	wee1 tyrosine kinase
WFDC5	NM_145652	WAP four-disulfide core domain 5 precursor
WFIKKN2	NM_175575	WFIKKN2 protein
WHSC1	NM_007331	Wolf-Hirschhorn syndrome candidate 1 protein
WHSC2	NM_005663	Wolf-Hirschhorn syndrome candidate 2 protein
WIBG	NM_032345	within bgcn homolog
WIF1	NM_007191	Wnt inhibitory factor-1 precursor
WIPI2	NM_001033518	hypothetical protein LOC26100 isoform c
WIRE	NM_133264	WIRE protein
WISP1	NM_003882	WNT1 inducible signaling pathway protein 1
WNK3	NM_001002838	WNK lysine deficient protein kinase 3 isoform 2
WNT2B	NM_004185	wingless-type MMTV integration site family,
WNT3A	NM_033131	wingless-type MMTV integration site family,
WNT5A	NM_003392	wingless-type MMTV integration site family,
WNT5B	NM_030775	wingless-type MMTV integration site family,
WNT7A	NM_004625	wingless-type MMTV integration site family,
WNT8A	NM_058244	wingless-type MMTV integration site family,
WNT9A	NM_003395	wingless-type MMTV integration site family,
WSB1	NM_015626	WD repeat and SOCS box-containing 1 isoform 1
WT1	NM_000378	Wilms tumor 1 isoform A
WWC1	NM_015238	KIBRA protein
WWP1	NM_007013	WW domain containing E3 ubiquitin protein ligase
WWP2	NM_007014	WW domain containing E3 ubiquitin protein ligase
XAB1	NM_007266	XPA binding protein 1
XKR5	NM_207411	XK-related protein 5a
XKR8	NM_018053	X Kell blood group precursor-related family,
XPC	NM_004628	xeroderma pigmentosum, complementation group C
XPO4	NM_022459	exportin 4
XPO5	NM_020750	exportin 5
XPO6	NM_015171	exportin 6
XPR1	NM_004736	xenotropic and polytropic retrovirus receptor
XRN1	NM_019001	5'-3' exoribonuclease 1
XTP7	NM_138568	protein 7 transactivated by hepatitis B virus X
YAF2	NM_001012424	YY1 associated factor 2 isoform b
YAP1	NM_006106	Yes-associated protein 1, 65 kD
YARS2	NM_015936	tyrosyl-tRNA synthetase 2 (mitochondrial)
YEATS2	NM_018023	YEATS domain containing 2
YIF1B	NM_033557	Yip1 interacting factor homolog B isoform 2
YIPF7	NM_182592	Yip1 domain family, member 7
YKT6	NM_006555	YKT6 v-SNARE protein
YOD1	NM_018566	hypothetical protein LOC55432
YPEL1	NM_013313	yippee-like 1
YPEL4	NM_145008	yippee-like 4
YRDC	NM_024640	ischemia/reperfusion inducible protein
YTHDC1	NM_001031732	splicing factor YT521-B isoform 1
YTHDF1	NM_017798	YTH domain family, member 1
YWHAG	NM_012479	tyrosine 3-monooxygenase/tryptophan
YWHAH	NM_003405	tyrosine 3/tryptophan 5 -monooxygenase
YWHAQ	NM_006826	tyrosine 3/tryptophan 5 -monooxygenase

ZA20D2	NM_006007	zinc finger protein 216
ZA20D3	NM_019006	zinc finger, A20 domain containing 3
ZADH2	NM_175907	zinc binding alcohol dehydrogenase, domain
ZAK	NM_133646	MLK-related kinase isoform 2
ZBED1	NM_004729	Ac-like transposable element
ZBP1	NM_030776	tumor stroma and activated macrophage protein
ZBTB10	NM_023929	zinc finger and BTB domain containing 10
ZBTB11	NM_014415	zinc finger protein ZNF-U69274
ZBTB2	NM_020861	zinc finger and BTB domain containing 2
ZBTB24	NM_014797	zinc finger and BTB domain containing 24
ZBTB3	NM_024784	zinc finger and BTB domain containing 3
ZBTB32	NM_014383	testis zinc finger protein
ZBTB33	NM_006777	kaiso
ZBTB39	NM_014830	zinc finger and BTB domain containing 39
ZBTB40	NM_014870	zinc finger and BTB domain containing 40
ZBTB41	NM_194314	zinc finger and BTB domain containing 41
ZBTB43	NM_014007	zinc finger protein 297B
ZBTB5	NM_014872	zinc finger and BTB domain containing 5
ZBTB8	NM_144621	zinc finger and BTB domain containing 8
ZBTB9	NM_152735	zinc finger and BTB domain containing 9
ZC3H11A	NM_014827	hypothetical protein LOC9877
ZC3H12B	NM_001010888	hypothetical protein LOC340554
ZC3H6	NM_198581	zinc finger CCCH-type domain containing 6
ZCCHC2	NM_017742	zinc finger, CCHC domain containing 2
ZCCHC3	NM_033089	zinc finger, CCHC domain containing 3
ZCCHC5	NM_152694	zinc finger, CCHC domain containing 5
ZCSL3	NM_181706	zinc finger, CSL domain containing 3
ZDHHC11	NM_024786	zinc finger, DHHC domain containing 11
ZDHHC12	NM_032799	zinc finger, DHHC domain containing 12
ZDHHC14	NM_024630	NEW1 domain containing protein isoform 1
ZDHHC15	NM_144969	zinc finger, DHHC domain containing 15
ZDHHC16	NM_032327	Abl-philin 2 isoform 1
ZDHHC17	NM_015336	huntingtin interacting protein 14
ZDHHC18	NM_032283	zinc finger, DHHC domain containing 18
ZDHHC22	NM_174976	zinc finger, DHHC domain containing 22
ZDHHC23	NM_173570	zinc finger, DHHC domain containing 23
ZDHHC9	NM_001008222	zinc finger, DHHC domain containing 9
ZFAND3	NM_021943	testis expressed sequence 27
ZFP106	NM_022473	zinc finger protein 106 homolog
ZFP28	NM_020828	zinc finger protein 28
ZFP41	NM_173832	zinc finger protein 41 homolog
ZFP95	NM_014569	zinc finger protein 95 homolog
ZFYVE1	NM_021260	zinc finger, FYVE domain containing 1 isoform 1
ZFYVE20	NM_022340	FYVE-finger-containing Rab5 effector protein
ZFYVE28	NM_020972	zinc finger, FYVE domain containing 28
ZHX1	NM_001017926	zinc fingers and homeoboxes 1
ZHX3	NM_015035	zinc fingers and homeoboxes 3
ZIC1	NM_003412	zinc finger protein of the cerebellum 1
ZKSCAN1	NM_003439	zinc finger protein 36
ZMYM6	NM_007167	zinc finger protein 258
ZMYND10	NM_015896	zinc finger, MYND domain-containing 10
ZNF10	NM_015394	zinc finger protein 10
ZNF134	NM_003435	zinc finger protein 134

ZNF135	NM_003436	zinc finger protein 135 (clone pHZ-17)
ZNF187	NM_001023560	zinc finger protein 187
ZNF192	NM_006298	zinc finger protein 192
ZNF193	NM_006299	zinc finger protein 193
ZNF198	NM_003453	zinc finger protein 198
ZNF212	NM_012256	zinc finger protein 212
ZNF213	NM_004220	zinc finger protein 213
ZNF215	NM_013250	zinc finger protein 215
ZNF236	NM_007345	zinc finger protein 236
ZNF259	NM_003904	zinc finger protein 259
ZNF264	NM_003417	zinc finger protein 264
ZNF267	NM_003414	zinc finger protein 267
ZNF282	NM_003575	zinc finger protein 282
ZNF285	NM_152354	zinc finger protein 285
ZNF289	NM_032389	zinc finger protein 289, ID1 regulated
ZNF295	NM_020727	zinc finger protein 295
ZNF304	NM_020657	zinc finger protein 304
ZNF306	NM_024493	zinc finger protein 306
ZNF307	NM_019110	zinc finger protein 307
ZNF313	NM_018683	zinc finger protein 313
ZNF317	NM_020933	zinc finger protein 317
ZNF319	NM_020807	zinc finger protein 319
ZNF323	NM_030899	zinc finger protein 323 isoform 1
ZNF326	NM_181781	zinc finger protein 326 isoform 2
ZNF329	NM_024620	zinc finger protein 329
ZNF343	NM_024325	zinc finger protein 343
ZNF346	NM_012279	zinc finger protein 346
ZNF365	NM_014951	zinc finger protein 365 isoform A
ZNF367	NM_153695	zinc finger protein 367
ZNF395	NM_018660	zinc finger protein 395
ZNF406	NM_001029939	zinc finger protein 406 isoform TR-ZFAT
ZNF417	NM_152475	zinc finger protein 417
ZNF423	NM_015069	zinc finger protein 423
ZNF436	NM_030634	zinc finger protein 436
ZNF445	NM_181489	zinc finger protein 445
ZNF449	NM_152695	zinc finger protein 449
ZNF454	NM_182594	zinc finger protein 454
ZNF488	NM_153034	zinc finger protein 488
ZNF497	NM_198458	zinc finger protein 497
ZNF498	NM_145115	zinc finger protein 498
ZNF500	NM_021646	zinc finger protein 500
ZNF501	NM_145044	zinc finger protein 501
ZNF503	NM_032772	zinc finger protein 503
ZNF512	NM_032434	zinc finger protein 512
ZNF532	NM_018181	zinc finger protein 532
ZNF536	NM_014717	zinc finger protein 536
ZNF548	NM_152909	zinc finger protein 548
ZNF569	NM_152484	zinc finger protein 569
ZNF572	NM_152412	zinc finger protein 572
ZNF592	NM_014630	zinc finger protein 592
ZNF600	NM_198457	zinc finger protein 600
ZNF609	NM_015042	zinc finger protein 609
ZNF621	NM_198484	zinc finger protein 621

ZNF622	NM_033414	zinc finger protein 622
ZNF623	NM_014789	zinc finger protein 623
ZNF626	NM_145297	zinc finger protein 626
ZNF627	NM_145295	zinc finger protein 627
ZNF650	NM_172070	zinc finger protein 650
ZNF651	NM_145166	zinc finger protein 651
ZNF660	NM_173658	zinc finger protein 660
ZNF691	NM_015911	zinc finger protein 691
ZNF694	NM_001012981	zinc finger protein 694
ZNF695	NM_020394	zinc finger protein SBZF3
ZNF696	NM_030895	zinc finger protein 696
ZNF701	NM_018260	zinc finger protein 701
ZNF704	NM_001033723	zinc finger protein 704
ZNF705A	NM_001004328	hypothetical protein LOC440077
ZNF71	NM_021216	zinc finger protein 71
ZNF74	NM_003426	zinc finger protein 74 (Cos52)
ZNF747	NM_023931	hypothetical protein LOC65988
ZNF76	NM_003427	zinc finger protein 76 (expressed in testis)
ZNF81	NM_007137	zinc finger protein 81 (HFZ20)
ZNFN1A1	NM_006060	zinc finger protein, subfamily 1A, 1 (Ikaros)
ZNFN1A4	NM_022465	zinc finger protein, subfamily 1A, 4
ZNHIT3	NM_004773	thyroid hormone receptor interactor 3 isoform 2
ZNRF1	NM_032268	zinc and ring finger protein 1
ZNRF2	NM_147128	zinc finger/RING finger 2
ZPLD1	NM_175056	hypothetical protein LOC131368
ZSWIM3	NM_080752	zinc finger, SWIM domain containing 3
ZSWIM4	NM_023072	zinc finger, SWIM domain containing 4
ZW10	NM_004724	centromere/kinetochore protein zw10
ZYG11A	NM_001004339	hypothetical protein LOC440590
ZYG11BL	NM_006336	zyg-11 homolog B (C. elegans)-like
ZYX	NM_001010972	zyxin
ZZEF1	NM_015113	zinc finger, ZZ type with EF hand domain 1
ZZZ3	NM_015534	zinc finger, ZZ domain containing 3

[00251] The predicted gene targets that exhibited altered mRNA expression levels in human cancer cells, following transfection with pre-miR hsa-miR-16, are shown in Table 4 below.

Table 4. Predicted hsa-miR-16 targets that exhibited altered mRNA expression levels in human cancer cells after transfection with pre-miR hsa-miR-16.

Gene Symbol	RefSeq Transcript ID	Description
ACTR2	NM_001005386	actin-related protein 2 isoform a
ADARB1	NM_001033049	RNA-specific adenosine deaminase B1 isoform 4
ADRB2	NM_000024	adrenergic, beta-2-, receptor, surface
ANKRD12	NM_015208	ankyrin repeat domain 12
ARHGDIA	NM_004309	Rho GDP dissociation inhibitor (GDI) alpha
ARL2	NM_001667	ADP-ribosylation factor-like 2
CA12	NM_001218	carbonic anhydrase XII isoform 1 precursor
CCND1	NM_053056	cyclin D1
CDC37L1	NM_017913	cell division cycle 37 homolog (S.
CDH1	NM_004360	cadherin 1, type 1 preproprotein
CDS2	NM_003818	phosphatidate cytidylyltransferase 2
CHUK	NM_001278	conserved helix-loop-helix ubiquitous kinase
CYP4F3	NM_000896	cytochrome P450, family 4, subfamily F,
DIO2	NM_000793	deiodinase, iodothyronine, type II isoform a
FGF2	NM_002006	fibroblast growth factor 2
FGFR4	NM_002011	fibroblast growth factor receptor 4 isoform 1
GALNT7	NM_017423	polypeptide N-acetylgalactosaminyltransferase 7
HAS2	NM_005328	hyaluronan synthase 2
KCNJ2	NM_000891	potassium inwardly-rectifying channel J2
LCN2	NM_005564	lipocalin 2 (oncogene 24p3)
LRP12	NM_013437	suppression of tumorigenicity
MAP7	NM_003980	microtubule-associated protein 7
PHACTR2	NM_014721	phosphatase and actin regulator 2
PLSCR4	NM_020353	phospholipid scramblase 4
PODXL	NM_001018111	podocalyxin-like precursor isoform 1
PPAP2C	NM_003712	phosphatidic acid phosphatase type 2C isoform 1
QKI	NM_206853	quaking homolog, KH domain RNA binding isoform
RPS6KA3	NM_004586	ribosomal protein S6 kinase, 90kDa, polypeptide
RPS6KA5	NM_004755	ribosomal protein S6 kinase, 90kDa, polypeptide
SLC11A2	NM_000617	solute carrier family 11 (proton-coupled
SLC4A7	NM_003615	solute carrier family 4, sodium bicarbonate
STC1	NM_003155	stanniocalcin 1 precursor
SYNE1	NM_015293	nesprin 1 isoform beta
TACC1	NM_006283	transforming, acidic coiled-coil containing
TFG	NM_001007565	TRK-fused gene
THUMPD1	NM_017736	THUMP domain containing 1
TNFSF9	NM_003811	tumor necrosis factor (ligand) superfamily,
TPM1	NM_001018004	tropomyosin 1 alpha chain isoform 3
UBE2I	NM_003345	ubiquitin-conjugating enzyme E2I
VIL2	NM_003379	villin 2

[00252] The predicted gene targets of hsa-miR-16 whose mRNA expression levels are affected by hsa-miR-16 represent particularly useful candidate targets for cancer therapy and therapy of other diseases through manipulation of their expression levels.

EXAMPLE 4:

CANCER RELATED GENE EXPRESSION ALTERED BY HSA-MIR-16

[00253] Cell proliferation and survival pathways are commonly altered in tumors (Hanahan and Weinberg, 2000). The inventors have shown that hsa-miR-16 directly or indirectly regulates the transcripts of proteins that are critical in the regulation of these pathways. Many of these targets have inherent oncogenic or tumor suppressor activity. Hsa-miR-16 targets that are associated with various cancer types are shown in Table 5.

[00254] Among these targets are regulators of the cell cycle, including cyclin D1, cyclin G2 and the transforming acidic coiled coil 1 protein (TACC1). While cyclin D1 forms a functional complex with the cyclin-dependent kinases 4 and 6 (CDK4/6) and is necessary to promote cells from the G1 phase into S phase, cyclin G2 – unlike conventional cyclins – negatively regulates the cell cycle (Donnellan and Chetty, 1998; Horne *et al.*, 1997). The growth-promoting activity of cyclin D1 correlates with the observation that a broad roster of cancers show elevated levels of cyclin D1 (Donnellan and Chetty, 1998). In contrast, cyclin G2 is down-regulated in multiple cancers, such as oral cancer and papillary carcinomas (Alevizos *et al.*, 2001; Ito *et al.*, 2003). Since hsa-miR-16 over-expression leads to suppression of the cyclin D1 transcript and up regulation of cyclin G2, hsa-miR-16 may function as a tumor suppressor. This view is supported by the fact that hsa-miR-16 negatively regulates the TACC1 message which encodes a putative oncogene located within a breast cancer amplicon on chromosome 8p11 (Cully *et al.*, 2005). Over-expression of TACC1 induces oncogenic transformation of fibroblasts in culture and cooperates with Ras to form tumors in mice with a PTEN+/- background (Cully *et al.*, 2005).

[00255] Other hsa-miR-16 targets include the fibroblast growth factor 2 (FGF-2), fibroblast growth factor receptor 4 (FGF-R4) and IkappaB kinase alpha (IKKalpha, CHUK), all of which are components of the intracellular signaling network. FGF-2 is a secretory protein with potent mitogenic and angiogenic activity that transmits the signal into cells via transmembrane receptors (FGFRs) composed of 2-3 extracellular immunoglobulin-like domains and an intracellular tyrosine kinase domain (Chandler *et al.*, 1999). While FGF-2

mRNAs levels are increased in renal, oral, and non-small lung cancer cells, FGFR-4 is up-regulated in numerous types of cancer (Chandler *et al.*, 1999). Similarly, IKKalpha is a positive regulator of the intracellular signaling cascade and functions to activate the transcription factor nuclear factor kappa B (NFkappaB) (Karin *et al.* 2002). NFkappaB is constitutively activated in several cancer types and promotes anti-apoptotic and survival pathways. Based on our data, hsa-miR-16 negatively regulates these proteins and therefore is likely to function as a tumor-suppressor. In contrast, hsa-miR-16 may also have oncogenic activity. This view is supported by the observation that hsa-miR-16 negatively regulates the tumor-suppressor RBL-1 (p107) and induces an up-regulation of the oncogenic E3 ubiquitin ligase Skp2 (Gstaiger *et al.*, 2001; Huang *et al.*, 2005; Jiang *et al.*, 2005). In addition, hsa-miR-16 regulates genes that may have either oncogenic or growth-inhibitory activity, depending on the cellular context: among these are connective tissue growth factor (CTGF) and neutrophil gelatinase-associated lipocalin (NGAL), also known as lipocalin-2 (LCN2) (Croci *et al.*, 2004; Hishikawa *et al.*, 1999; Lin *et al.*, 2005; Yang *et al.*, 2005; Fernandez *et al.*, 2005; Lee *et al.*, 2006).

[00256] In summary, hsa-miR-16 governs the activity of proteins that are critical regulators of cell proliferation and survival. These targets are frequently deregulated in human cancer. Based on this review of the genes and related pathways that are regulated by miR-16, introduction of hsa-miR-16 or an anti-hsa-miR-16 into a variety of cancer cell types would likely result in a therapeutic response.

Table 5. Tumor associated mRNAs altered by hsa-miR-16 having prognostic or therapeutic value for the treatment of various malignancies.

Gene Symbol	Gene Title	Cellular Process	Cancer Type	Reference [PMID]
CCND1	cyclin D1	cell cycle	MCL, BC, SCCHN, OepC, HCC, CRC, BldC, EC, OC, M, AC, GB, GC, PaC	Donnellan and Chetty, 1998
CCNG2	cyclin G2	cell cycle	TC, SCCHN	Ito *et al.*, 2003b; Alevizos *et al.*, 2001
CDKN2C	CDK inhibitor 2C	cell cycle	HB, MB, HCC, HL, MM	Iolascon *et al.*, 1998; Kulkarni *et al.*, 2002; Morishita *et al.*, 2004; Sanchez-Aguilera *et al.*, 2004
CHUK	IKK alpha	signal transduction	LSCC, BC	Cao *et al.*, 2001; Nakayama *et al.*, 2001; Romieu-Mourez *et al.*, 2001
CTGF	CTGF/IGFBP-8	cell adhesion, migration	BC, GB, OepC, RMS, CRC, PC	Hishikawa *et al.*, 1999; Shimo *et al.*, 2001; Koliopanos *et al.*, 2002; Pan *et al.*, 2002; Croci *et al.*, 2004; Lin *et al.*, 2005; Yang *et al.*, 2005
FGF2	FGF-2	signal transduction	BC, RCC, OC, M, NSCLC	Chandler *et al.*, 1999
FGFR4	FGF-R4	signal transduction	TC, BC, OC, PaC	Jaakkola *et al.*, 1993; Shah *et al.*, 2002; Ezzat *et al.*, 2005
LCN2	lipocalin 2 / NGAL	cell adhesion	PaC, CRC, HCC, BC, OC	Bartsch and Tschesche, 1995; Furutani *et al.*, 1998; Fernandez *et al.*, 2005; Lee *et al.*, 2006
NF1	NF-1	signal transduction	G, AC, NF, PCC, ML	Rubin and Gutmann, 2005
RBL1	p107	cell cycle	BCL, PC, CRC, TC	Takimoto *et al.*, 1998; Claudio *et al.*, 2002; Wu *et al.*, 2002; Ito *et al.*, 2003a; Rubin and Gutmann, 2005
SKP2	SKP-2	proteasomal degradation	PaC, OC, BC, MFS, GB, EC, NSCLC, PC	Kamata *et al.*, 2005; Saigusa *et al.*, 2005; Shibahara *et al.*, 2005; Takanami, 2005; Einama *et al.*, 2006; Huang *et al.*, 2006; Sui *et al.*, 2006; Traub *et al.*, 2006
TACC1	TACC1	cell cycle	BC, OC	Cully *et al.*, 2005; Lauffart *et al.*, 2005
WISP2	WISP-2	signal transduction	CRC, BC	Pennica *et al.*, 1998; Saxena *et al.*, 2001

Abbreviations: AC, astrocytoma; BC, breast carcinoma; BCL, B-cell lymphoma; BldC, bladder carcinoma; CRC, colorectal carcinoma; EC, endometrial carcinoma; GB, glioblastoma; GC, gastric carcinoma; HB, hepatoblastoma; HCC, hepatocellular carcinoma; HL, Hodgkin lymphoma; LSCC, laryngeal squamous cell carcinoma; M, melanoma; MB, medulloblastoma; MCL, mantle cell lymphoma; MFS, myxofibrosarcoma; ML, myeloid leukemia; MM, multiple myeloma; NF, neurofibroma; NSCLC, non-small cell lung carcinoma; OC, ovarian carcinoma; OepC, oesophageal carcinoma; PaC, pancreatic carcinoma; PC, prostate carcinoma; PCC, pheochromocytoma; RCC, renal cell carcinoma; RMS, rhabdomyosarcoma; SCCHN, squamous cell carcinoma of the head and neck; TC, thyroid carcinoma.

REFERENCES

The following references, to the extent that they provide exemplary procedural or other details supplementary to those set forth herein, are specifically incorporated herein by reference.

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CLAIMS

1. A method of modulating gene expression in a cell comprising administering to the cell an amount of an isolated nucleic acid comprising a miR-16 nucleic acid sequence in an amount sufficient to modulate the expression of one or more gene identified in Table 1, 3, 4, or 5.

2. The method of claim 1, wherein the cell is in a subject having, suspected of having, or at risk of developing astrocytoma, breast carcinoma, B-cell lymphoma, bladder carcinoma, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, laryngeal squamous cell carcinoma, melanoma, medulloblastoma, mantle cell lymphoma, myxofibrosarcoma, myeloid leukemia, multiple myeloma, neurofibroma, non-small cell lung carcinoma, ovarian carcinoma, esophageal carcinoma, pancreatic carcinoma, prostate carcinoma, pheochromocytoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, or thyroid carcinoma, wherein the modulation of one or more gene is sufficient for a therapeutic response.

3. The method of claim 1, wherein the expression of a gene is down-regulated.

4. The method of claim 1, wherein the expression of a gene is up-regulated.

5. The method of claim 1, wherein the miR-16 nucleic acid is one or more of hsa-miR-16-1, hsa-miR-16-2, or a segment thereof.

6. The method of claim 1, wherein the miR-16 nucleic acid is an inhibitor of miR-16 function.

7. The method of claim 1, wherein the cell is a cancer cell.

8. The method of claim 7, wherein the cancer cell is a neuronal, glial, lung, liver, brain, breast, bladder, blood, leukemic, colon, endometrial, stomach, skin, ovarian, esophageal, pancreatic, prostate, kidney, or thyroid cell.

9. The method of claim 1, wherein the cell is in a subject having, suspected of having, or at risk of developing a metabolic, an immunologic, an infectious, a cardiovascular, a digestive, an endocrine, an ocular, a genitourinary, a blood, a musculoskeletal, a nervous system, a congenital, a respiratory, a skin, or a cancerous disease or condition.

10. The method of claim 9, wherein the infectious disease or condition is a parasitic, bacterial, viral, or fungal infection.

11. The method of claim 1, wherein the isolated miR-16 nucleic acid is a recombinant nucleic acid.

12. The method of claim 11, wherein the recombinant nucleic acid is an RNA.

13. The method of claim 11, wherein the recombinant nucleic acid is DNA.

14. The method of claim 13, wherein the recombinant nucleic acid comprises a miR-16 expression cassette.

15. The method of claim 14, wherein the expression cassette is comprised in a viral, or plasmid DNA vector.

16. The method of claim 1, wherein the miR-16 nucleic acid is a synthetic nucleic acid.

17. A method of modulating a cellular pathway comprising administering to a cell an amount of an isolated nucleic acid comprising a miR-16 nucleic acid sequence in an amount sufficient to modulate the expression of a cellular pathway that includes one or more gene identified in Table 1, 3, 4, or 5.

18. The method of claim 17, wherein the expression of a gene is down-regulated.

19. The method of claim 17, wherein the miR-16 nucleic acid one or more of hsa-miR-16-1, hsa-miR-16-2, or a segment thereof.

20. The method of claim 17, wherein the cell is a cancer cell.

21. The method of claim 20, wherein the modulation of a cellular pathway results in reduced viability, reduced proliferation, reduced metastasis, or increased sensitivity to therapy.

22. The method of claim 20, wherein the cancer cell is a neuronal, glial, lung, liver, brain, breast, bladder, blood, leukemic, colon, endometrial, stomach, skin, ovarian, esophageal, pancreatic, prostate, kidney, or thyroid cell.

23. The method of claim 17, wherein the isolated miR-16 nucleic acid is a recombinant nucleic acid.

24. The method of claim 23, wherein the recombinant nucleic acid is DNA.

25. The method of claim 24, wherein the recombinant nucleic acid is a viral or a plasmid DNA vector.

26. The method of claim 17, wherein the miR-16 nucleic acid is a synthetic nucleic acid.

27. A method of treating a patient with a pathological condition comprising the steps of:

(a) administering to the patient an amount of an isolated nucleic acid comprising a miR-16 nucleic acid sequence in an amount sufficient to modulate the expression of a cellular pathway; and

(b) administering a second therapy, wherein the modulation of the cellular pathway sensitizes the patient to the second therapy.

28. The method of claim 27, wherein the cellular pathway is one or more pathway including one or more gene identified in Table 1, 3, 4, or 5.

29. The method of claim 27, wherein the miR-16 nucleic acid comprises at least one of hsa-miR-16-1 or hsa-miR-16-2, or a segment thereof.

30. A method of treating a subject with a pathological condition comprising:

(a) determining an expression profile of one or more genes selected from Table 1, 3, 4, or 5;

(b) assessing the sensitivity of the subject to therapy based on the expression profile;

(c) selecting a therapy based on the assessed sensitivity; and

(d) treating the subject using selected therapy.

31. An expression profile indicative of miR-16 status in a cell or tissue comprising expression assessment of one or more gene from Table 1, 3, 4, or 5.

32. A method of modulating a cellular pathway or a physiologic pathway comprising administering to a cell an amount of an isolated nucleic acid comprising a miR-126 nucleic acid sequence in an amount sufficient to modulate the cellular pathway or physiologic pathway that includes one or more genes identified or gene products related to one or more genes identified in Table 1, 3, 4, or 5.

33. The method of claim 32, further comprising administering 2, 3, 4, 5, 6, or more miRNAs.

34. The method claim 33 wherein the miRNAs are comprised in a single composition.

35. The method of 33, wherein at least two cellular pathways or physiologic pathways are modulated.

36. The method of claim 33, wherein at least one gene is modulated by multiple miRNAs.

37. The method of claim 32, wherein the expression of a gene or a gene product is down-regulated.

38. The method of claim 32, wherein the expression of a gene or a gene product is up-regulated.

39. The method of claim 32, wherein the cell is a cancer cell.

40. The method of claim 39, wherein the cancer cell is a lung or a liver cancer cell.

41. The method of claim 39, wherein viability of the cell is reduced, proliferation of the cell is reduced, metastasis of the cell is reduced, or the cell's sensitivity to therapy is increased.

42. The method of claim 39, wherein the cancer cell is neuronal, glial, lung, liver, brain, breast, bladder, blood, leukemic, colon, endometrial, stomach, skin, ovarian, fat, bone, cervical, esophageal, pancreatic, prostate, kidney, uterine, testicular, epithelial, muscle, oropharyngeal, adrenal, gastrointestinal, mesothelial, or thyroid cell.

43. The method of claim 32, wherein the isolated miR-16 nucleic acid is a recombinant nucleic acid.

44. The method of claim 43, wherein the recombinant nucleic acid is DNA.

45. The method of claim 44, wherein the recombinant nucleic acid is a viral vector or a plasmid DNA.

46. The method of claim 32, wherein the nucleic acid is RNA.

47. The method of claim 43, wherein the recombinant nucleic acid is a synthetic nucleic acid.

48. A method of treating a patient diagnosed with or suspected of having or suspected of developing a pathological condition or disease related to a gene modulated by a miRNA comprising the steps of:

(a) administering to the patient an amount of an isolated nucleic acid comprising a miR-16 nucleic acid sequence in an amount sufficient to modulate a cellular pathway or a physiologic pathway; and

(b) administering a second therapy, wherein the modulation of the cellular pathway or physiologic pathway sensitizes the patient to the second therapy.

49. The method of claim 48, wherein one or more cellular pathway or physiologic pathway includes one or more genes identified in Table 1, 3, 4, and 5.

50. A method of selecting a miRNA to be administered to a subject with, suspected of having, or having a propensity for developing a pathological condition or disease comprising:

(a) determining an expression profile of one or more genes selected from Table 1, 3, 4, and 5;

(b) assessing the sensitivity of the subject to miRNA therapy based on the expression profile; and

(c) selecting one or more miRNA based on the assessed sensitivity.

51. The method of claim 50 further comprising treating the subject with 1, 2, 4, 5, 6, 7, 8, 9, 10, or more miRNAs.

52. The method of claim 51, wherein each miRNA is administered individually or one or more combinations.

53. The method of claim 52, wherein the miRNAs are in a single composition.

54. A method of assessing a cell, tissue, or subject comprising assessing expression of miR-16 in combination with assessing expression of one or more gene from Table 1, 3, 4, or 5 in at least one sample.

55. A method of assessing miR-16 status in a sample comprising the steps of:

(a) assessing expression of one or more genes from Table 1, 3, 4, or 5 in a sample; and

(b) determining miR-16 status based on level of miR-16 expression in the sample.