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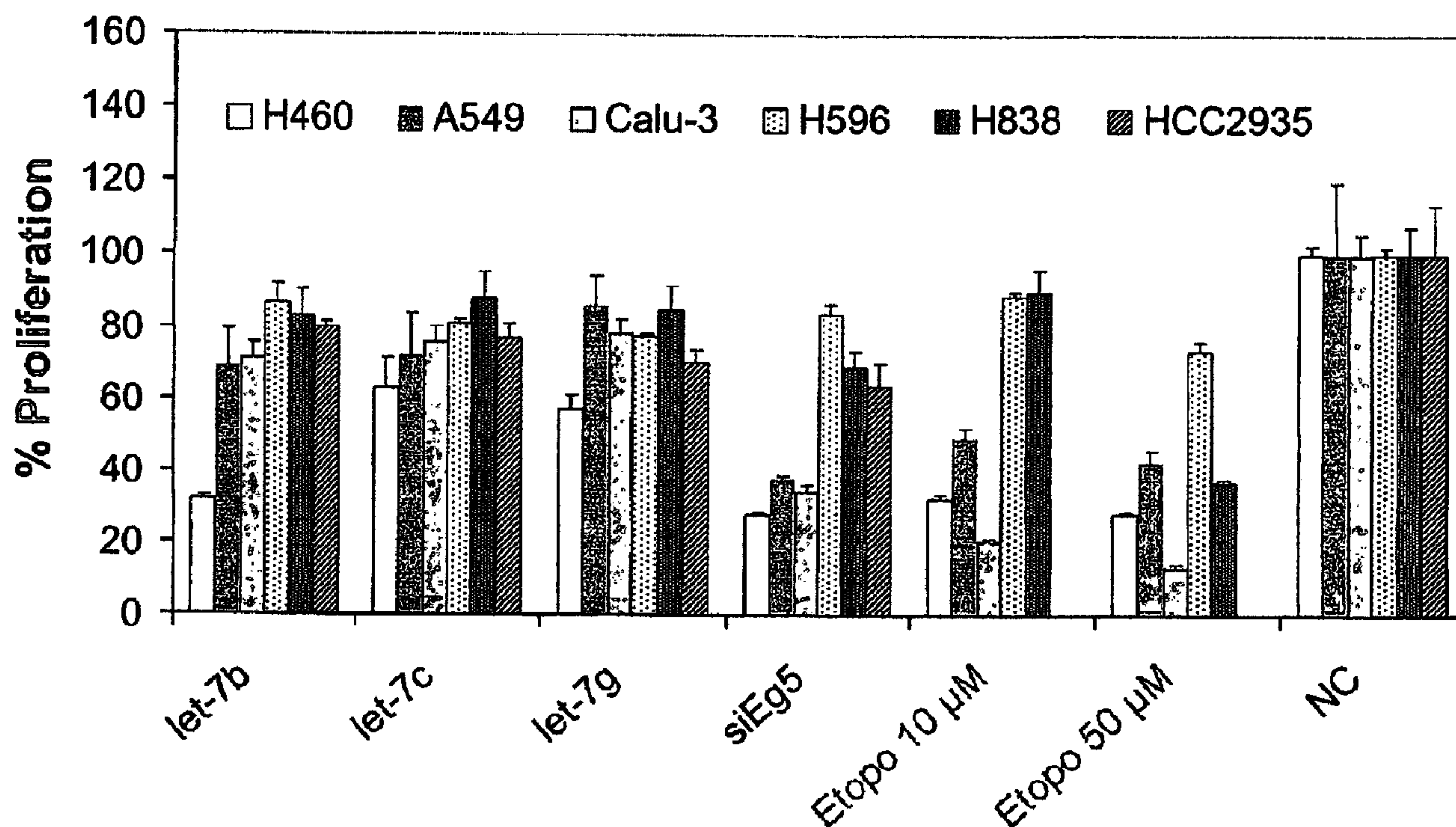


FIG. 1

(57) Abrégé/Abstract:

The present invention concerns methods and compositions for treating or assessing treatment of diseases related to mis-expression of genes or genetic pathways that can be modulated by let-7. Methods may include evaluating patients for genes or genetic pathways modulated by let-7, and/or using an expression profile to assess the condition of a patient or treating the patient with an appropriate miRNA.

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(54) Title: FUNCTIONS AND TARGETS OF LET-7 MICRO RNAS

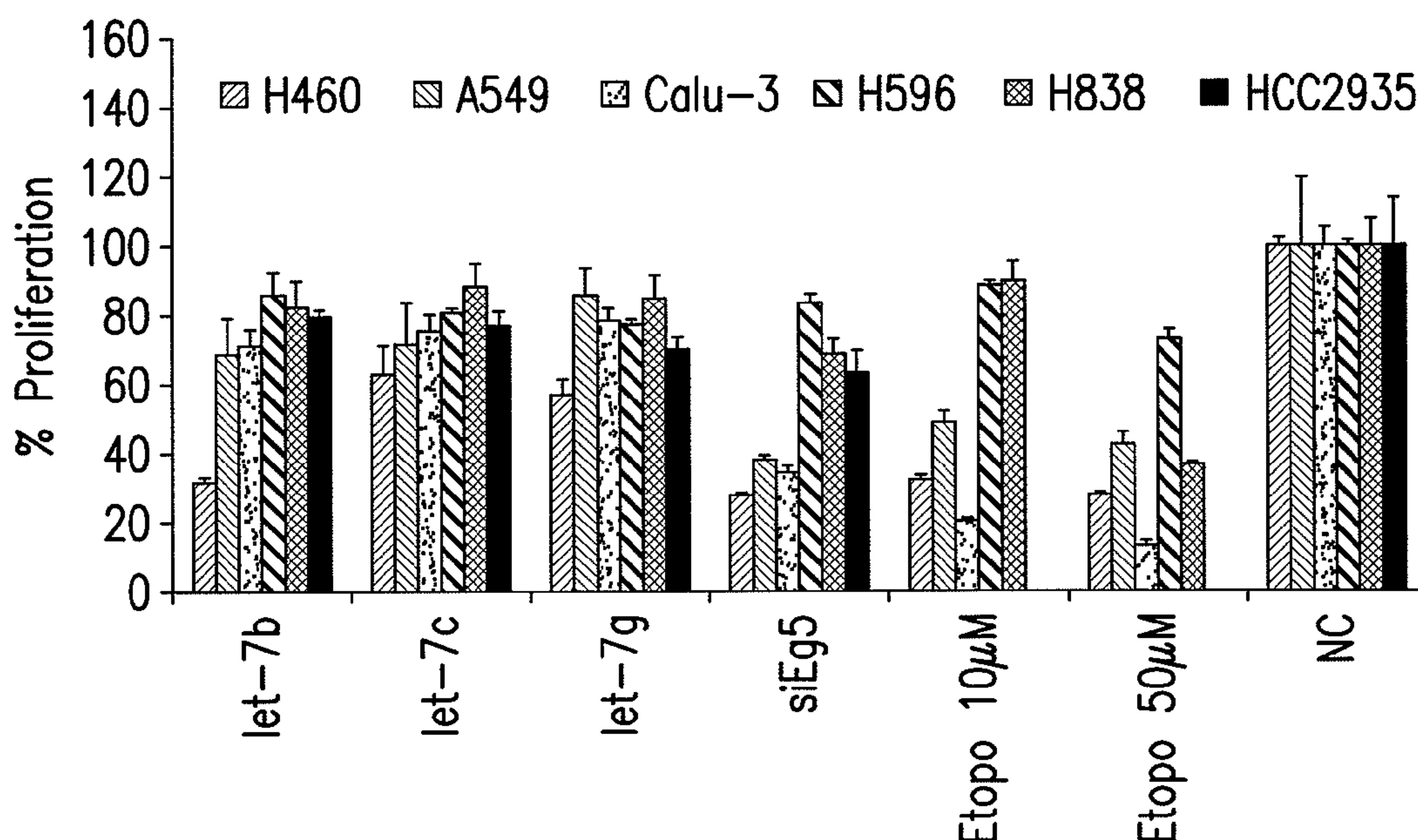


FIG. 1

(57) Abstract: The present invention concerns methods and compositions for treating or assessing treatment of diseases related to mis-expression of genes or genetic pathways that can be modulated by let-7. Methods may include evaluating patients for genes or genetic pathways modulated by let-7, and/or using an expression profile to assess the condition of a patient or treating the patient with an appropriate miRNA.

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DESCRIPTION

FUNCTIONS AND TARGETS OF LET-7 MICRO RNAS

[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 generally to the field of molecular biology. More particularly, it concerns methods and compositions involving diagnosis and treatment of disorders related to biologic pathways that are directly or indirectly modulated by the let-7 microRNA (miRNAs) family.

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 let-7 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] In humans, let-7 is thought to play a role in lung cancer development. Let-7 expression is reduced in many lung cancer cell lines (Takamizawa *et al.*, 2004) and in tumor samples relative to normal samples from lung cancer patients (Takamizawa *et al.*, 2004; Johnson *et al.*, 2005). Over-expression of let-7 inhibited growth of the lung cancer cell line, A549 (Takamizawa *et al.*, 2004). Let-7 has been shown to reduce expression of RAS oncogenes in HepG2 cells (Johnson *et al.*, 2005). Together these data suggest that let-7 miRNAs may act as tumor suppressors in lung tissues.

[0008] Regulation of target genes by let-7 is thought to occur primarily by translation inhibition, but mRNA instability may also be a mechanism (Bagga *et al.*, 2005, Reinhart *et al.*, 2000). Besides RAS, the genes, gene pathways, and gene networks that are regulated by let-7 in cancerous cells remain largely unknown. Currently, this represents a significant limitation for treatment of cancers in which let-7 may play a role.

[0009] In animals, most miRNAs are thought to regulate genes through imprecise base pairing within the 3' untranslated regions of their gene targets. Bioinformatics

analyses suggest that any given miRNA may bind to and alter the expression of up to several hundred different genes. Furthermore, 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 miRNA related regulatory pathways and networks are likely to contribute to the development of disorders, pathological conditions, and/or 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 precisely predict miRNA targets with bioinformatics tools alone.

[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 the details of the regulatory pathways and networks that are affected by any given miRNA remain largely unknown. As mentioned above, bioinformatics can provide only an imprecise estimate of the number and identity of miRNA targets. A need exists to identify the genes, genetic pathways, and genetic networks that are regulated by or that may regulate let-7 expression.

SUMMARY OF THE INVENTION

[0011] 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 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 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] The present invention provides methods and compositions for identifying genes that are direct targets for let-7 regulation or are downstream targets of regulation following the hsa-let-7-mediated modification of upstream gene expression. Furthermore, the invention describes gene pathways and networks that are influenced by hsa-let-7 expression in biological samples. Many of these genes and pathways are associated with various cancers and other diseases. The altered expression or function of let-7 in cells would lead to changes in the expression of these key genes and contribute to the development of disease or other condition. Introducing let-7 (for diseases where the miRNA is down-regulated) or a let-7 inhibitor (for diseases where the miRNA is up-regulated) into disease cells or tissues

or subjects would result in a therapeutic response. The identities of key genes that are regulated directly or indirectly by let-7 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. Let-7 could be used as a therapeutic target for any of these diseases. In certain embodiments let-7 can be used to modulate the activity of let-7 in a subject, organ, tissue, or cell.

[0015] 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.

[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 let-7 nucleic acid, mimetic, or inhibitor sequence in an amount sufficient to modulate the expression of a gene positively or

negatively modulated by a let-7 miRNA family member. A “let-7 nucleic acid sequence” includes the full length precursor of a let-7 or complement thereof or processed (i.e., mature) sequence of let-7 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 let-7 nucleic acid sequence or let-7 inhibitor contains the full-length processed miRNA sequence or complement thereof and is referred to as the “let-7 full-length processed nucleic acid sequence” or “let-7 full-length processed inhibitor sequence.” In still further aspects, the let-7 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 let-7 that is at least 75, 80, 85, 90, 95, 98, 99 or 100% identical to SEQ ID NO:1 to SEQ ID NO:11. The general term let-7 includes all members of the let-7 family that share at least part of a mature let-7 sequence.

[0017] In certain aspects, a let-7 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 let-7 nucleic acid sequence contains the full-length processed miRNA sequence and is referred to as the “let-7 full-length processed nucleic acid sequence.” In still further aspects, a let-7 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 let-7 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 let-7 or let-7 inhibitor containing nucleic acid is a hsa- let-7 or hsa- let-7 inhibitor or a variation thereof. In a further aspect, a let-7 nucleic acid or let-7 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 let-7 or let-7 inhibitor can be administered in combination with one or more of miR-15, miR-16, miR-20, miR-21, miR-26a, miR-34a, miR-124, miR-126, 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] let-7 nucleic acids or complement thereof may also include various heterologous nucleic acid sequences, *i.e.*, those sequences not typically found operatively coupled with let-7 in nature, such as promoters, enhancers, and the like. The let-7 nucleic acid is a recombinant nucleic acid, and can be a ribonucleic acid or a deoxyribonucleic acid. The recombinant nucleic acid may comprise a let-7 or let-7 inhibitor expression cassette, *i.e.*, a nucleic acid segment that expresses a nucleic acid when introduced 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 let-7 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 1×10^2 , 1×10^3 , 1×10^4 , 1×10^5 , 1×10^6 , 1×10^7 , 1×10^8 , 1×10^9 , 1×10^{10} , 1×10^{11} , 1×10^{12} , 1×10^{13} , 1×10^{14} pfu or viral particle (vp).

[0020] In a particular aspect, the let-7 nucleic acid or let-7 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] 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 combinations of genes identified in Table 2, 3, 4, 5, 6, 7, and 8. 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, or all of ATRX, AURKA/STK6, AURKB/STK12, BRCA1, BRCA2, BUB1, BUB1B, BZRP, CCNA2, CCNB1, CCNE2, CCNG2, CDC2, CDC20, CDC23, CDC25A, CDC6, CDCA7, CDK2, CDK6, CDKN2B, CDT1, CEBPD, CKS1B, CSF1, EIF4E, EPHB2, ERBB3, FASN, FGFBP1, FGFR4, FH, GMNN, IGFBP, IL8, ITGA6, JUN, JUNB, LHFP, MCAM, MET, MVP, MXI1, MYBL1, MYBL2, NRAS, P8, PDCC4, PLK1, PRKCA, RASSF2, SIVA, SKP2, SMAD4, TACC3, TFDP1, TGFBR3, TNFSF10, and/or VIM, in various combinations and permutations. In certain embodiments a gene modulated or selected to be modulated is from Table 2. In further embodiments a gene modulated or selected to be modulated is from Table 3. In still further embodiments a gene modulated or selected to be modulated is from Table 4. In certain embodiments a gene modulated or selected to be modulated is from 5. In further embodiments a gene modulated or selected to be modulated is from 6. In still further embodiments a gene modulated or selected to be modulated is from 7. In certain embodiments a gene modulated or selected to be modulated is from 8. 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 let-7 nucleic acid, inhibitor of let-7, or mimetics thereof. 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. . In certain aspects of the invention one or more miRNA or miRNA inhibitor may modulate a single gene. In a further aspect, one or more genes in one or more genetic, cellular, or physiologic pathways can be modulated by one or more miRNAs or complements thereof, including let-7 nucleic acids and let-7 inhibitors in combination with other miRNAs.

[0023] In still further aspects, the let-7 nucleic acid comprises at least one of hsa-let-7a-1, hsa-let-7a-2, hsa-let-7a-3, hsa-let-7b, hsa-let-7c, hsa-let-7d, hsa-let-7e, hsa-let-7f-1, hsa-let-7f-2, hsa-let-7g, hsa-let-7i, or a segment thereof. A cell, tissue, or subject may be a cancer cell, a cancerous tissue or harbor cancerous tissue, or a cancer patient. In a particular aspect the cancer is blood, leukemic, colon, endometrial, stomach, skin, ovarian, esophageal, pancreatic, prostate, salivary gland, small intestine, thyroid, lung or liver cancer.

[0024] Let-7 nucleic acids may also include various heterologous nucleic acid sequences, *i.e.*, those sequences not typically found operatively coupled with let-7 in nature, such as promoters, enhancers, and the like. The let-7 nucleic acid is a recombinant nucleic acid, and can be a ribonucleic acid or a deoxyribonucleic acid. The recombinant nucleic acid may comprise a let-7 expression cassette. In a further aspect, the expression cassette is comprised in a viral, or plasmid DNA vector or other therapeutic nucleic acid vector or delivery vehicle, including liposomes and the like. In a particular aspect, the let-7 nucleic acid is a synthetic nucleic acid.

[0025] 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 let-7 nucleic acid sequence in an amount sufficient to modulate the expression, function, status, or state of a cellular pathway described in Table 13 or the pathways known to include one or more genes identified herein as modulated by let-7. Modulation of a cellular pathway includes, but is not limited to modulating the expression of one or more gene identified in Table 2, 3, 4, 5, 6, 7, and 8. 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.

[0026] 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 let-7 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 the Tables herein or a pathway that is known to include one or more genes listed in the Tables. A second therapy can include administration of a second miRNA or therapeutic nucleic acid, or may include various standard therapies, such as chemotherapy, radiation therapy, drug therapy, immunotherapy, and the like. Embodiments of the invention may also include the determination or assessment of a gene expression profile for the selection of an appropriate therapy.

[0027] 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 2, 3, 4, 5, 6, 7, and 8; (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 2, 3, 4, 5, 6, 7, and 8.

[0028] Further embodiments include the identification and assessment of an expression profile indicative of let-7 status in a cell or tissue comprising expression assessment of one or more gene from Table 2, 3, 4, 5, 6, 7, and 8, or any combination thereof.

[0029] 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.

[0030] 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 2); 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 nucleotides, 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 2, 3, 4, 5, 6, 7, and 8 or identified by the methods described herein.

[0031] 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 (*e.g.*, 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 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and/or 13, including any combination thereof.

[0032] 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 Table 2, 3, 4, 5, 6, 7, 8, 12 and/or 13, including any combination thereof.

[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 let-7 nucleic acid sequence or a let-7 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.

[0034] 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 let-7 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, 3, 4, 5, 6, 7, and 8 or the pathways known to include one or more genes from Table 2, 3, 4, 5, 6, 7, and 8. 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).

[0035] 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 let-7 nucleic acid sequence or a let-7 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 in Table 2, 3, 4, 5, 6, 7, and 8 below or a pathway that is known to include one or more genes of Table 2, 3, 4, 5, 6, 7, and 8. The second therapy may be administered before, during, and/or after the isolated nucleic acid or miRNA or inhibitor is administered

[0036] 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.

[0037] 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 Table 2, 3, 4, 5, 6, 7, and 8; (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 of Table 2, 3, 4, 5, 6, 7, and 8.

[0038] 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 let-7 or a let-7 inhibitor with another miRNA. Further embodiments include the identification and assessment of an expression profile indicative of let-7 status in a cell or tissue comprising expression assessment of one or more gene from Table 2, 3, 4, 5, 6, 7, and 8, or any combination thereof.

[0039] 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.

[0040] 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 Table 2, 3, 4, 5, 6, 7, and 8); 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 of one or more genes or miRNAs, are indicative of which miRNAs to be administered.

[0041] In certain aspects, let-7 or let-7 inhibitor and miR-10 or miR-10 inhibitor are administered to patients with astrocytoma, acute lymphoblastic leukemia, acute myeloid leukemia, breast carcinoma, bladder carcinoma, cervical carcinoma, chronic lymphoblastic leukemia, chronic myeloid leukemia, colorectal carcinoma, endometrial carcinoma, fibrosarcoma, glioma, glioblastoma, glioblastoma multiforme,

gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, leukemia, lung carcinoma, leiomyoma, melanoma, multiple myeloma, mesothelioma, neuroblastoma, non-Hodgkin lymphoma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, osteosarcoma, pancreatic carcinoma, prostate carcinoma, retinoblastoma, renal cell carcinoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, T-cell leukemia.

[0042] In yet another aspect, let-7 or let-7 inhibitor and miR-15 or miR-15 inhibitor can be administered to patients with astrocytoma, acute myeloid leukemia, breast carcinoma, bladder carcinoma, cervical carcinoma, carcinoma of the head and neck, chronic myeloid leukemia, colorectal carcinoma, endometrial carcinoma, glioma, glioblastoma, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, lung carcinoma, larynx carcinoma, melanoma, medulloblastoma, myxofibrosarcoma, myeloid leukemia, multiple myeloma, neuroblastoma, non-Hodgkin lymphoma, 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.

[0043] Further aspects include administering let-7 or let-7 inhibitor and miR-16 or miR-16 inhibitor to patients with astrocytoma, breast carcinoma, bladder carcinoma, colorectal carcinoma, endometrial carcinoma, glioblastoma, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, 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.

[0044] In still further aspects, let-7 or let-7 inhibitor and miR-20 or miR-20 inhibitor are administered to patients with astrocytoma, acute myeloid leukemia, breast carcinoma, bladder carcinoma, cervical carcinoma, colorectal carcinoma, endometrial carcinoma, glioma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, Hodgkin lymphoma, leukemia, lipoma, melanoma, myxofibrosarcoma, multiple myeloma, neuroblastoma, non-Hodgkin lymphoma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, osteosarcoma, pancreatic

carcinoma, prostate carcinoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, urothelial carcinoma.

[0045] In certain aspects, let-7 or let-7 inhibitor and miR-21 or miR-21 inhibitor are administered to patients with astrocytoma, acute lymphoblastic leukemia, acute myeloid leukemia, breast carcinoma, Burkitt's lymphoma, bladder carcinoma, colorectal carcinoma, endometrial carcinoma, glioma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, melanoma, myeloid leukemia, neuroblastoma, 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.

[0046] Aspects of the invention include methods where let-7 or let-7 inhibitor and miR-26 or miR-26 inhibitor are administered to patients with acute lymphoblastic leukemia, acute myeloid leukemia, angiosarcoma, breast carcinoma, Burkitt's lymphoma, bladder carcinoma, cervical carcinoma, carcinoma of the head and neck, chronic lymphoblastic leukemia, chronic myeloid leukemia, colorectal carcinoma, glioma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, Kaposi's sarcoma, leukemia, lung carcinoma, leiomyosarcoma, larynx carcinoma, melanoma, multiple myeloma, neuroblastoma, non-Hodgkin lymphoma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, osteosarcoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, rhabdomyosarcoma.

[0047] In still further aspects, let-7 or let-7 inhibitor and miR-34 or miR-34 inhibitor are administered to patients with astrocytoma, acute lymphoblastic leukemia, acute myeloid leukemia, angiosarcoma, breast carcinoma, bladder carcinoma, cervical carcinoma, carcinoma of the head and neck, chronic lymphoblastic leukemia, chronic myeloid leukemia, colorectal carcinoma, endometrial carcinoma, glioma, glioblastoma, gastric carcinoma, gastrinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, Kaposi's sarcoma, leukemia, lung carcinoma, leiomyosarcoma, melanoma, medulloblastoma, myeloid leukemia, multiple myeloma, mesothelioma, non-Hodgkin lymphoma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, oropharyngeal carcinoma, osteosarcoma, pancreatic carcinoma, papillary carcinoma, prostate carcinoma, rhabdomyosarcoma,

squamous cell carcinoma of the head and neck, salivary gland tumor, sporadic papillary renal carcinoma, thyroid carcinoma, urothelial carcinoma.

[0048] In still a further aspect, let-7 or let-7 inhibitor and miR-124 or miR-124 inhibitor are administered to patients with astrocytoma, acute lymphoblastic leukemia, acute myeloid leukemia, angiosarcoma, breast carcinoma, Burkitt's lymphoma, bladder carcinoma, cervical carcinoma, carcinoma of the head and neck, chronic lymphoblastic leukemia, chronic myeloid leukemia, colorectal carcinoma, endometrial carcinoma, glioma, glioblastoma, glioblastoma multiforme, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, Kaposi's sarcoma, leukemia, lung carcinoma, lipoma, leiomyosarcoma, melanoma, medulloblastoma, myxofibrosarcoma, multiple myeloma, neuroblastoma, non-Hodgkin lymphoma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, oropharyngeal carcinoma, osteosarcoma, pancreatic carcinoma, papillary carcinoma, prostate carcinoma, retinoblastoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, salivary gland tumor, thyroid carcinoma, urothelial carcinoma.

[0049] In yet further aspects, let-7 or let-7 inhibitor and miR-126 or miR-126 inhibitor are administered to patients with astrocytoma, acute myeloid leukemia, breast carcinoma, Burkitt's lymphoma, bladder carcinoma, cervical carcinoma, colorectal carcinoma, endometrial carcinoma, glioma, glioblastoma, gastric carcinoma, gastrinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, leukemia, lung carcinoma, melanoma, myeloid leukemia, mesothelioma, non-Hodgkin lymphoma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, oropharyngeal carcinoma, osteosarcoma, pancreatic carcinoma, papillary carcinoma, prostate carcinoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, sporadic papillary renal carcinoma, thyroid carcinoma.

[0050] In yet further aspects, let-7 or let-7 inhibitor and miR-143 or miR-143 inhibitor are administered to patients with astrocytoma, acute lymphoblastic leukemia, acute myeloid leukemia, breast carcinoma, bladder carcinoma, cervical carcinoma, chronic lymphoblastic leukemia, chronic myeloid leukemia, colorectal carcinoma, endometrial carcinoma, glioma, glioblastoma, gastric carcinoma, hepatocellular

carcinoma, Hodgkin lymphoma, leukemia, lung carcinoma, melanoma, medulloblastoma, multiple myeloma, non-Hodgkin lymphoma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, osteosarcoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, squamous cell carcinoma of the head and neck, thyroid carcinoma.

[0051] In a further aspect, let-7 or let-7 inhibitor and miR-147 or miR-147 inhibitor are administered to patients with astrocytoma, breast carcinoma, bladder carcinoma, cervical carcinoma, colorectal carcinoma, endometrial carcinoma, glioma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, Hodgkin lymphoma, leukemia, lipoma, melanoma, myxofibrosarcoma, multiple myeloma, non-Hodgkin lymphoma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, osteosarcoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, squamous cell carcinoma of the head and neck, thyroid carcinoma.

[0052] In still a further aspect, let-7 or let-7 inhibitor and miR-188 or miR-188 inhibitor are administered to patients with astrocytoma, acute myeloid leukemia, breast carcinoma, Burkitt's lymphoma, bladder carcinoma, cervical carcinoma, chronic lymphoblastic leukemia, colorectal carcinoma, endometrial carcinoma, glioma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, leukemia, lung carcinoma, melanoma, multiple myeloma, non-Hodgkin lymphoma, 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.

[0053] In a further aspect, let-7 or let-7 inhibitor and miR-200 or miR-200 inhibitor are administered to patients with breast carcinoma, cervical carcinoma, chronic lymphoblastic leukemia, colorectal carcinoma, glioma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, leukemia, lung carcinoma, lipoma, multiple myeloma, mesothelioma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, osteosarcoma, pancreatic carcinoma, prostate carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, thyroid carcinoma.

[0054] In yet another aspect, let-7 or let-7 inhibitor and miR-215 or miR-215 inhibitor are administered to patients with astrocytoma, acute lymphoblastic leukemia, acute myeloid leukemia, angiosarcoma, breast carcinoma, bladder carcinoma, cervical carcinoma, chronic lymphoblastic leukemia, chronic myeloid leukemia, colorectal carcinoma, endometrial carcinoma, glioma, glioblastoma, gastric carcinoma, gastrinoma, hepatoblastoma, hepatocellular carcinoma, Hodgkin lymphoma, Kaposi's sarcoma, leukemia, lung carcinoma, lipoma, leiomyosarcoma, melanoma, myxofibrosarcoma, myeloid leukemia, multiple myeloma, mesothelioma, neuroblastoma, non-Hodgkin lymphoma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, osteosarcoma, pancreatic carcinoma, prostate carcinoma, retinoblastoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, salivary gland tumor, thyroid carcinoma, urothelial carcinoma.

[0055] In yet a further aspect, let-7 or let-7 inhibitor and miR-216 or miR-216 inhibitor are administered to patients with astrocytoma, breast carcinoma, cervical carcinoma, carcinoma of the head and neck, colorectal carcinoma, endometrial carcinoma, glioma, glioblastoma, gastric carcinoma, hepatocellular carcinoma, Hodgkin lymphoma, leukemia, lung carcinoma, myeloid leukemia, non-Hodgkin lymphoma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, osteosarcoma, prostate carcinoma, squamous cell carcinoma of the head and neck.

[0056] In other aspects, let-7 or let-7 inhibitor and miR-292-3p or miR-292-3p inhibitor are administered to patients with astrocytoma, acute lymphoblastic leukemia, acute myeloid leukemia, angiosarcoma, breast carcinoma, bladder carcinoma, cervical carcinoma, chronic myeloid leukemia, colorectal carcinoma, endometrial carcinoma, fibrosarcoma, glioma, glioblastoma, gastric carcinoma, hepatoblastoma, hepatocellular carcinoma, Kaposi's sarcoma, leukemia, lung carcinoma, lipoma, leiomyosarcoma, melanoma, myxofibrosarcoma, multiple myeloma, neuroblastoma, non-Hodgkin lymphoma, non-small cell lung carcinoma, ovarian carcinoma, oesophageal carcinoma, osteosarcoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, thyroid carcinoma, urothelial carcinoma.

[0057] In certain aspects, let-7 or let-7 inhibitor and miR-331 or miR-331 inhibitor are administered to patients with astrocytoma, acute lymphoblastic leukemia, acute myeloid leukemia, angiosarcoma, breast carcinoma, bladder carcinoma, cervical carcinoma, carcinoma of the head and neck, chronic lymphoblastic leukemia, colorectal carcinoma, endometrial carcinoma, glioma, glioblastoma, gastric carcinoma, gastrinoma, hepatocellular carcinoma, Kaposi's sarcoma, leukemia, lung carcinoma, leiomyosarcoma, larynx carcinoma, melanoma, myxofibrosarcoma, myeloid leukemia, multiple myeloma, neuroblastoma, non-Hodgkin lymphoma, ovarian carcinoma, oesophageal carcinoma, osteosarcoma, pancreatic carcinoma, prostate carcinoma, renal cell carcinoma, rhabdomyosarcoma, squamous cell carcinoma of the head and neck, sporadic papillary renal carcinoma, thyroid carcinoma.

[0058] It is contemplated that when let-7 or a let-7 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.

[0059] Further embodiments include the identification and assessment of an expression profile indicative of let-7 status in a cell or tissue comprising expression assessment of one or more gene from Table 2, 3, 4, 5, 6, 7, and 8, or any combination thereof.

[0060] 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.

[0061] 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 Table 2, 3, 4, 5, 6, 7, and 8); 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 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 Table 2, 3, 4, 5, 6, 7, and 8 or identified by the methods described herein.

[0062] 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 Table 2, 3, 4, 5, 6, 7, and 8, including any combination thereof.

[0063] 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 Table 2, 3, 4, 5, 6, 7, and 8, including any combination thereof.

[0064] 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, or mass spectrometry or other methods known to those of ordinary skill in the art.

[0065] 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. 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 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.

[0066] 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.

[0067] 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.

[0068] 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.

[0069] 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 Table 2, 3, 4, 5, 6, 7, 8, and/or 12.

[0070] 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.

[0071] 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 mature sequence of the specified miRNA.

[0072] 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 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, let-7d, let-7e, I and the like. Exceptions to this shorthand notation will be otherwise identified.

Table 1. Listing of miRNA for diagnosis and therapy.

miRNA	Probe segment	miR Base Information	Precursor sequence
hsa-let-7a-1	SEQ ID NO:1	>hsa-let-7a MIMAT0000062	SEQ ID NO:12

hsa-let-7a-2	SEQ ID NO:2		SEQ ID NO:13
hsa-let-7a-3	SEQ ID NO:3		SEQ ID NO:14
hsa-let-7b	SEQ ID NO:4	>hsa-let-7b MIMAT0000063	SEQ ID NO:15
hsa-let-7c	SEQ ID NO:5	>hsa-let-7c MIMAT0000064	SEQ ID NO:16
hsa-let-7d	SEQ ID NO:6	>hsa-let-7d MIMAT0000065	SEQ ID NO:17
hsa-let-7e	SEQ ID NO:7	>hsa-let-7e MIMAT0000066	SEQ ID NO:18
hsa-let-7f-1	SEQ ID NO:8	>hsa-let-7f MIMAT0000067	SEQ ID NO:19
hsa-let-7f-2	SEQ ID NO:9		SEQ ID NO:20
hsa-let-7g	SEQ ID NO:10	>hsa-let-7g MIMAT0000414	SEQ ID NO:21
hsa-let-7i	SEQ ID NO:11	>hsa-let-7i MIMAT0000415	SEQ ID NO:22

[0073] 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.

[0074] 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.

[0075] 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.”

[0076] 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.

[0077] 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.”

[0078] 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.

[0079] 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.

DESCRIPTION OF THE DRAWINGS

[0080] The following drawings form part of the present specification and are included to further demonstrate certain aspects of the present invention. The invention may be better understood by reference to one or more of these drawings in combination with the detailed description of specific embodiments presented herein.

[0081] **FIG. 1.** Percent (%) proliferation of hsa-let-7 treated cells relative to cells treated with negative control miRNA (100%). Abbreviations: let-7b, hsa-let-7b; let-7c, hsa-let-7c; let-7g, hsa-let-7g; siEg5, siRNA against the motor protein kinesin 11 (Eg5); Etopo, etoposide; NC, negative control miRNA. Standard deviations are indicated in the graph.

[0082] **FIG. 2.** Dose dependent inhibition of various cell lines by hsa-let-7 using Alamar Blue proliferation assays. Cell proliferation is reported as % proliferation relative to % proliferation of mock-transfected cells (0 pM = 100% proliferation). Standard deviations are indicated in the graphs. Abbreviations: NC, negative control miRNA.

[0083] **FIG. 3.** 1×10^6 H226 cells were electroporated with 1.6 μ M hsa-let-7b or negative control miRNA (NC) and grown in standard growth media (day 0). On days 6, 10 and 17, cells were counted and repeatedly electroporated with 1.6 μ M miRNA (indicated by arrowheads). To accommodate exponential cell growth, a fraction of the total cell population was re-seeded after miRNA delivery on days 10 and 17. Cell

counts were extrapolated and plotted onto a linear scale. The graph shows one representative experiment.

[0084] **FIG. 4.** Percent (%) proliferation of H460 lung cancer cells following administration of various combinations of microRNAs. A positive sign under each bar in the graph indicates that the microRNA was present in the administered combination. Synergistic activity of two microRNAs is indicated by the letter "S" under the bar; additive activity of two microRNAs is indicated by the letter "A" under the bar. Standard deviations are shown in the graph. Abbreviations: Etopo, etoposide; NC, negative control miRNA.

[0085] **FIG. 5.** Average tumor volumes in mice harboring xenografts of A549 lung cancer cells treated with hsa-let-7b or with a negative control (NC) miRNA. Standard deviations are shown in the graph. Data points with p values <0.05 are indicated by an asterisk.

DETAILED DESCRIPTION OF THE INVENTION

[0086] 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, particularly those methods and compositions related to assessing and/or identifying pathological conditions directly or indirectly related to let-7 expression or the aberrant expression thereof.

[0087] 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 the any one or a combination of let-7 family members (7a-1, 7a-2, 7a-3, 7b, 7c, 7d, 7e, 7f-1, 7f-2, 7g, and/or 7i) and/or genes with an increased expression (relative to normal) as a result of an increased or decreased expression of one or a combination of let-7 family members (7a-1, 7a-2, 7a-3, 7b, 7c, 7d, 7e, 7f-1, 7f-2, 7g, and/or 7i). The expression profile and/or response to let-7 expression or lack of expression are indicative of an individual with a pathological condition, *e.g.*, cancer.

[0088] 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

[0089] 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.

[0090] 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 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."

[0091] 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.

[0092] In certain embodiments, synthetic miRNA have (a) an "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 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.

[0093] The term “complementary region” or “complement” refers to a region of a nucleic acid, mimetic, or synthetic miRNA 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.

[0094] 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 or probe sequence can be altered so that it is still comprises the appropriate percentage of complementarity to the sequence of a mature miRNA.

[0095] 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.

[0096] 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.

[0097] 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, a 2'F modification, a 2'H modification, a 2' amino modification, a 4'thioribose modification or a phosphorothioate modification on the carboxy group linked to the carbon at position 6'. 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.

[0098] 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.

[0099] 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.

[00100] 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.

[00101] 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.

[00102] 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.

[00103] 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.

[00104] 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.

[00105] 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).

[00106] 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.

[00107] 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.

[00108] 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.

[00109] 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.

[00110] 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 within a cell. Modulation may also be effected by the inhibition or enhancement of miRNA activity within 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.

[00111] 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 understood that the term "providing" an agent is used to include "administering" the agent to a patient.

[00112] 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).

[00113] 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.

[00114] 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.

[00115] 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.

[00116] 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, gemcitabine, 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.

[00117] 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

[00118] 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

[00119] 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).

[00120] 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.

[00121] 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.

[00122] 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 catheterization 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.

[00123] 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.

[00124] 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.

[00125] 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.

[00126] 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

[00127] 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).

[00128] 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).

[00129] 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.

[00130] 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.

[00131] 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.

[00132] 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.

[00133] 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.

[00134] 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

[00135] 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.

[00136] 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.

[00137] 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.

[00138] Various combinations may be employed, for example miRNA therapy is “A” and a second therapy is “B”:

[00139] 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

[00140] B/B/B/A B/B/A/B A/A/B/B A/B/A/B A/B/B/A B/B/A/A

[00141] B/A/B/A B/A/A/B A/A/A/B B/A/A/A A/B/A/A A/A/B/A

[00142] 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.

[00143] 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

[00144] 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

[00145] 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. Troglitazone can be used to treat cancer in combination with any one or more of these alkylating agents.

b. Antimetabolites

[00146] 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.

[00147] 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

[00148] 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/m² at 21 day intervals for adriamycin, to 35-100 mg/m² for etoposide intravenously or orally.

d. Mitotic Inhibitors

[00149] 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

[00150] Nitrosureas, like alkylating agents, inhibit DNA repair proteins. They are used to treat non-Hodgkin's lymphomas, multiple myeloma, and malignant melanoma, in addition to brain tumors. Examples include carmustine and lomustine.

2. Radiotherapy

[00151] 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 them 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).

[00152] 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.

[00153] 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

[00154] 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.

[00155] 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.

[00156] 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 (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- $\alpha 5\beta 1$ integrin), GC1008 (TGF β), 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.

[00157] 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-idiotypic antibodies; and finally, purging of tumor cells in bone marrow.

4. Gene Therapy

[00158] 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.

[00159] 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.

[00160] 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.

[00161] 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).

[00162] 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

[00163] 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.

[00164] 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.

[00165] 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

[00166] 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.

[00167] 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).

[00168] 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.

[00169] 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.

[00170] 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.

[00171] 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.

[00172] 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

[00173] 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.

[00174] 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

[00175] 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 probe) or identical (over the length of the probe) 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 let-7 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.

[00176] 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.

[00177] 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.

[00178] 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

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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.

[00179] 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 .

[00180] 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

[00181] 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

[00182] 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.

[00183] 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.

[00184] 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 μ l or less, including volumes of about or less than about 5, 10, 25, 50, 60, 70, 80, 90, 100 μ l, or any range derivable therein). In small volumes, hybridization may proceed very rapidly.

D. Differential Expression Analyses

[00185] 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.

[00186] 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.

[00187] 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.

[00188] 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.

[00189] 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.

[00190] 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

[00191] 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

[00192] 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.

[00193] 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.

[00194] 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.

[00195] 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.

[00196] 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.

[00197] 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.

[00198] 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.

[00199] 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."

[00200] 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.

[00201] 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.

[00202] 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*.

[00203] 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.

[00204] 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)."

[00205] 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.

[00206] 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.

[00207] 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

[00208] 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).

[00209] “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, carboxyalkyl, 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-methylcytosine, 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-dimethyladenine, an azaadenines, a 8-bromoadenine, a 8-hydroxyadenine, a 6-hydroxyaminopurine, a 6-thiopurine, a 4-(6-aminoethyl/cytosine), and the like. Other examples are well known to those of skill in the art.

[00210] 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).

[00211] 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.

[00212] 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).

[00213] 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.

[00214] 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.

[00215] 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.

[00216] 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

[00217] 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.

[00218] 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.

[00219] 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* chemical 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.

[00220] A non-limiting example of an enzymatically produced nucleic acid include one produced by enzymes in amplification reactions such as PCRTM (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).

[00221] 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.

[00222] 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

[00223] 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.

[00224] 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.

[00225] 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.

[00226] 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

[00227] 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

[00228] 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.

[00229] 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.

[00230] 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

[00231] 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.

[00232] 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 DyeTM; 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.

[00233] 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.

[00234] 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.

[00235] 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.

[00236] 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).

[00237] 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

[00238] 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.

[00239] 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

[00240] 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.

[00241] 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.

[00242] 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.

[00243] 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.

[00244] 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.

[00245] 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.

[00246] 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, 130, 140, 150, 160, 170, 180, 190, 200, 300, 400, 500, 600, 700, 800, 900, 1000 μ g 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.

[00247] 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.

[00248] 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.

[00249] 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.

[00250] 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

[00251] 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

METHODS FOR THE ANALYSIS OF GENE EXPRESSION FOLLOWING MIRNA TRANSFECTION

[00252] Synthetic pre-miR miRNAs (Ambion) were reverse transfected into quadruplicate samples of A549, HepG2 or HL-60 cells. A549 and HepG2 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 miRNAs in 2.5 ml. Cells were harvested at 72 hours post transfection. HL-60 cells were transfected using the Gene Pulser Xcell System (Bio-Rad Laboratories, Inc.; Hercules, CA, USA) according to the manufacturer's instructions and the following parameters: 500,000 cells per reaction in a volume of 150 µl, in a 2-mm electroporation cuvette using a single square wave pulse of 25 msec.

[00253] Total RNA was extracted using RNAqueous-4PCR (Ambion) according to the manufacturer's recommended protocol. 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 labelling 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 hours 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 an 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 v1.4). Data were normalized for the effect observed by the average of two negative control microRNA sequences and then were averaged together for presentation. The genes determined to be altered by treatment were determined by filtering all genes by fold-change relative to the two control transfections. Statistical significance was assessed by a t-test after the omnibus F-test was shown to be significant.

EXAMPLE 2:

GENE EXPRESSION ANALYSIS IN A549, HEPG2, AND HL-60 CELLS FOLLOWING TRANSFECTION WITH HSA-LET-7B

[00254] miRNAs are believed to primarily influence gene expression at the level of translation. However, it has recently been reported that in some instances, hsa-let-7 (Bagga *et al.*, 2005) and other miRNAs (Lim *et al.*, 2005) may reduce the mRNA levels of direct targets, and such changes can be observed upon microarray gene expression analysis.

[00255] The experiments described here identify genes whose mRNA levels are affected by expression of hsa-let-7 in human lung cancer (A549), human liver cancer (HepG2) and human acute myeloid leukemia (HL-60) cell lines. A549, HepG2 or HL-60 cells were transfected with pre-miR hsa-let-7b (as a representative member of the hsa-let-7 miRNA family) as described in Example 1. The results of the microarray gene expression analyses are shown in Table 2, 3 and 4.

Table 2. Genes with altered mRNA expression levels in A549 cells, following transfection with pre-miR hsa-let-7b.

Gene Symbol	RefSeq (incorporated herein by reference in their entirety)	Fold Change
2'-PDE	NM_177966	-2.031
AADACL1	NM_020792	4.169
AASDHPPT	NM_015423	-2.596
ACF	NM_014576 /// NM_138932 /// NM_138933	-2.342
ACPL2	NM_152282	2.568
ACVR1B	NM_004302 /// NM_020327 /// NM_020328	-2.020
ADA	NM_000022	-2.614
ADAM12	NM_003474 /// NM_021641	2.004
ADCY1	NM_021116	2.255
ADFP	NM_001122	2.038

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AK5	NM_012093 /// NM_174858	2.096
AKAP2 /// PALM2-AKAP2	NM_001004065 /// NM_007203 /// NM_147150	3.107
ALCAM	NM_001627	2.591
ALDH1A3	NM_000693	2.164
ALDH3A1	NM_000691	2.814
ANGEL2	NM_144567	-2.238
ANKRD22	NM_144590	2.134
ANKRD44	NM_153697	5.186
ANP32A	NM_006305	-2.037
ANPEP	NM_001150	3.502
ANXA8	NM_001630	2.076
AOX1	NM_001159	2.132
AP1S1	NM_001283 /// NM_057089	-2.326
AQP3	NM_004925	2.111
ARF7	NM_025047	4.907
ARID1A	NM_006015 /// NM_018450 /// NM_139135	-2.031
ARL6IP6	NM_152522	-2.914
ARL7	NM_005737	2.141
ASAM	NM_024769	3.795
ASK	NM_006716	-2.251
ASNS	NM_001673 /// NM_133436 /// NM_183356	-2.206
ATF2	NM_001880	2.120
ATG10	NM_031482	-2.333
ATP11C	NM_001010986 /// NM_173694	2.676
ATP2B4	NM_001001396 /// NM_001684	2.022
ATP6V1C1	NM_001007254 /// NM_001695	-2.311
ATP6V1F	NM_004231	-2.102
ATP9A	NM_006045	2.552
AURKB	NM_004217	-2.989
AVEN	NM_020371	-2.156
BAI2	NM_001703	2.098
BCAT1	NM_005504	-2.520
BCCIP	NM_016567 /// NM_078468 /// NM_078469	-2.304
BEX2	NM_032621	2.154
BEXL1	XM_043653	2.181
BTF3L4	NM_152265	-2.174
BTNL9	NM_152547	3.114
C10orf9	NM_145012 /// NM_181698	-2.502
C13orf1	NM_020456	-2.607
C14orf111	NM_015962	-2.044
C14orf2	NM_004894	-2.455
C14orf46	NM_001024674	-2.290
C16orf45	NM_033201	2.342
C17orf63	NM_018182	-2.058
C18orf17	NM_153211	-2.153
C18orf21	NM_031446	-2.171
C1orf121	NM_016076	-2.042
C1orf139	NM_001002292 /// NM_024911	2.025
C1orf24	NM_022083 /// NM_052966	2.225
C1orf25	NM_030934	-2.193
CIQDC1	NM_001002259 /// NM_023925 /// NM_032156	2.649

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C1R	NM_001733	2.135
C2orf100	NM_032883	3.548
C2orf177	NM_022106	-2.455
C2orf32	NM_015463	2.558
C3orf17	NM_001025072 /// NM_001025073 /// NM_015412	-2.577
C6orf120	NM_001029863	-2.347
C6orf141	NM_153344	2.511
C6orf176	XM_499048	-3.962
C6orf211	NM_024573	-2.278
C8orf1	NM_004337	2.660
C9orf125	NM_032342	-3.962
C9orf3	NM_032823	-2.289
CAMTA1	NM_015215	2.232
CANT1	NM_138793	-2.128
CAPG	NM_001747	2.353
CBX5	NM_012117	-3.718
CCL26	NM_006072	2.353
CCNA2	NM_001237	-2.474
CCNG2	NM_004354	2.005
CD164	NM_006016	-2.243
CD44	NM_000610 /// NM_001001389 /// NM_001001390 /// NM_001001391 /// NM_001001392	2.071
CD47	NM_001025079 /// NM_001025080 /// NM_001777 /// NM_198793	2.465
CD59	NM_000611 /// NM_203329 /// NM_203330 /// NM_203331	2.185
CD9	NM_001769	2.197
CDA	NM_001785	2.456
CDC25A	NM_001789 /// NM_201567	-2.588
CDC34	NM_004359	-2.990
CDC42EP3	NM_006449	2.057
CDCP1	NM_022842 /// NM_178181	2.642
CDH19	NM_021153	2.019
CDK5R1	NM_003885	2.003
CDK8	NM_001260	-3.292
CEBPD	NM_005195	-3.131
CFLAR	NM_003879	2.273
CHD7	NM_017780	-2.006
CHEK1	NM_001274	-2.070
ChGn	NM_018371	2.090
CHIC1	XR_000216	-2.169
CITED2	NM_006079	2.212
CLDN3	NM_001306	3.246
CLIC4	NM_013943	2.128
CNFN	NM_032488	2.206
COL12A1	NM_004370 /// NM_080645	2.146
COL13A1	NM_005203 /// NM_080798 /// NM_080799 /// NM_080800 /// NM_080801 /// NM_080802	3.227
COL4A5	NM_000495 /// NM_033380 /// NM_033381	2.073
COL5A1	NM_000093	2.365
COL6A1	NM_001848	2.767
COL6A2	NM_001849 /// NM_058174 /// NM_058175	3.792
CORO2B	NM_006091	3.570

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CPOX	NM_000097	-2.163
CREB5	NM_001011666 /// NM_004904 /// NM_182898 /// NM_182899	2.031
CSDE1	NM_001007553 /// NM_007158	-2.306
CSF2RA	NM_006140 /// NM_172245 /// NM_172246 /// NM_172247 /// NM_172248 /// NM_172249	2.365
CTPS	NM_001905	-2.212
CTPS2	NM_019857 /// NM_175859	-2.346
CTSS	NM_004079	2.570
CXCL1	NM_001511	4.396
CXCL2	NM_002089	4.868
CXCL3	NM_002090	4.152
CXCL5	NM_002994	3.654
CXorf45	NM_024810	3.034
CYP3A5	NM_000777	2.050
CYR61	NM_001554	-2.818
DAF	NM_000574	2.590
DCAMKL1	NM_004734	2.780
DDC	NM_000790	-4.408
DDX3Y	NM_004660	2.138
DGKA	NM_001345 /// NM_201444 /// NM_201445 /// NM_201554	2.187
DHX40	NM_024612	2.033
DIAPH2	NM_006729 /// NM_007309	-2.003
DICER1	NM_030621 /// NM_177438	-4.505
DKFZp434J1015	XM_496849 /// XM_499257	2.216
DKFZp667M2411	NM_207323	2.475
DKK3	NM_001018057 /// NM_013253 /// NM_015881	3.449
DNER	NM_139072	2.811
DOCK11	NM_144658	2.066
DOCK2	NM_004946	2.488
DOCK9	NM_015296	3.245
DPAGT1	NM_001382 /// NM_203316	-2.632
DPYSL4	NM_006426	2.671
DUSP16	NM_030640	-2.565
DUSP6	NM_001946 /// NM_022652	2.124
E2F5	NM_001951	-2.923
EDIL3	NM_005711	3.471
EGFL3	XM_031401	3.200
EGFL4	NM_001410	2.310
EHD1	NM_006795	2.112
EHF	NM_012153	2.530
EIF2C2	NM_012154	2.750
EIF4E3	NM_173359	2.081
ELF4	NM_001421	-2.175
ELOVL7	NM_024930	3.863
EMP1	NM_001423	2.211
EMP2	NM_001424	2.628
ENTPD7	NM_020354	2.157
EPHB2	NM_004442 /// NM_017449	2.018
EPLIN	NM_016357	2.303
ERO1L	NM_014584	-3.927
EYA2	NM_005244 /// NM_172110 /// NM_172111 ///	2.022

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	NM_172112 /// NM_172113	
F2R	NM_001992	3.514
F2RL2	NM_004101	-2.807
F5	NM_000130	-2.066
FAM54A	NM_138419	-2.026
FAM61A	NM_015578	2.251
FAM96A	NM_001014812 /// NM_032231	-2.015
FBN1	NM_000138	2.407
FCGBP	NM_003890	4.974
FDXR	NM_004110 /// NM_024417	2.103
FGA	NM_000508 /// NM_021871	-3.480
FGB	NM_005141	-5.014
FGFBP1	NM_005130	2.232
FGFR4	NM_002011 /// NM_022963 /// NM_213647	-2.029
FGG	NM_000509 /// NM_021870	-2.461
FHL1	NM_001449	2.089
FHL2	NM_001450 /// NM_201555 /// NM_201556 /// NM_201557	2.036
FIGN	NM_018086	-2.842
FLJ10700	NM_018182	-2.822
FLJ11259	NM_018370	3.624
FLJ20160	NM_017694	2.143
FLJ22313	NM_022373	2.391
FLJ22833	NM_001031716 /// NM_022837	2.060
FLJ30655	NM_144643	-2.028
FLJ36031	NM_175884	2.051
FLJ36748	NM_152406	2.337
FLJ39370	NM_152400	3.186
FLJ43339	NM_207380	2.435
FLJ90709	NM_173514	-2.574
FLRT3	NM_013281 /// NM_198391	-2.146
FMNL2	NM_001004417 /// NM_001004421 /// NM_001004422 /// NM_052905	2.219
FOXO3A	NM_001455 /// NM_201559	2.187
FOXQ1	NM_033260	3.010
FRMD6	NM_152330	2.959
FSTL1	NM_007085	3.378
FVT1	NM_002035	2.179
FYN	NM_002037 /// NM_153047 /// NM_153048	2.199
GALC	NM_000153	-2.359
GALE	NM_000403 /// NM_001008216	-2.420
GALNACT-2	NM_018590	2.008
GALNT12	NM_024642	2.588
GALNT2	NM_004481	-3.061
GARS	NM_002047	-2.134
GBP3	NM_018284	3.721
GCH1	NM_000161 /// NM_001024024 /// NM_001024070 /// NM_001024071	2.242
GDA	NM_004293	2.477
GEMIN7	NM_001007269 /// NM_001007270 /// NM_024707	-2.505
GFPT2	NM_005110	2.175
GLB1	NM_000404	-3.416

GLIPR1	NM_006851	2.448
GLUL	NM_001033044 /// NM_001033056 /// NM_002065	2.125
GMNN	NM_015895	-2.286
GNB1	NM_002074	2.371
GNG2	NM_053064	2.067
GNG5	NM_005274	-2.613
GOLT1B	NM_016072	-2.532
GTF2I	NM_001518 /// NM_032999 /// NM_033000 /// NM_033001	-2.190
H1FX	NM_006026	-2.033
H2BFS	NM_017445	-2.382
HAS3	NM_005329 /// NM_138612	2.710
HDHD1A	NM_012080	-7.596
HERC4	NM_001017972 /// NM_015601 /// NM_022079	3.356
HH114	NM_032499	-2.084
HHIP	NM_022475	2.009
HIPK3	NM_005734	2.241
HIST1H2BK	NM_080593	-2.344
HK1	NM_000188 /// NM_033496 /// NM_033497 /// NM_033498 /// NM_033500	2.622
HLF	NM_002126	2.501
HMGA2	NM_001015886 /// NM_003483 /// NM_003484	-4.655
HMMR	NM_012484 /// NM_012485	-3.297
HNRPC	NM_004500 /// NM_031314	-3.742
HOXA1	NM_005522 /// NM_153620	-2.535
HTRA1	NM_002775	2.315
ICF45	NM_017872	2.015
IFI16	NM_005531	2.148
IFNE1	NM_176891	3.464
IGFBP1	NM_000596 /// NM_001013029	2.598
IGFBP6	NM_002178	2.555
IL10RB	NM_000628	2.039
IL11	NM_000641	-2.922
IL17RD	NM_017563	2.014
IL32	NM_001012631 /// NM_001012632 /// NM_001012633 /// NM_001012634 /// NM_001012635	2.085
IL8	NM_000584	7.197
ILF3	NM_004516 /// NM_012218 /// NM_153464	2.143
IMP-1	NM_006546	-2.676
IMP-2	NM_001007225 /// NM_006548	-2.534
INSIG1	NM_005542 /// NM_198336 /// NM_198337	2.011
INSL4	NM_002195	-2.131
ITGA2	NM_002203	2.284
ITGA6	NM_000210	2.013
ITGB4	NM_000213 /// NM_001005619 /// NM_001005731	3.702
ITGB8	NM_002214	2.362
ITPR2	NM_002223	2.831
IVNS1ABP	NM_006469 /// NM_016389	2.978
JUB	NM_032876 /// NM_198086	-2.858
JUN	NM_002228	2.092
KCNJ16	NM_018658 /// NM_170741 /// NM_170742	-3.743
KCNK1	NM_002245	2.064

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KCNMA1	NM_001014797 /// NM_002247	2.962
KCNN4	NM_002250	2.109
KDELC1	NM_024089	2.341
KDELC2	NM_153705	2.794
KIAA0100	NM_014680	2.041
KIAA0179	NM_015056	-2.032
KIAA0507	---	-2.326
KIAA1287	NM_020748	-2.130
KIAA1462	XM_166132	2.220
KIAA1571	XM_371590	2.125
KIAA1641	NM_020970	2.107
KIAA1702	---	-2.308
KIAA1815	NM_024896	2.031
KIAA1946	NM_177454	3.307
KIAA1971	XM_058720	2.057
KLF11	NM_003597	3.448
KRT15	NM_002275	2.859
KRT19	NM_002276	2.910
KYNU	NM_001032998 /// NM_003937	-2.413
L1CAM	NM_000425 /// NM_024003	2.090
LAMB3	NM_000228 /// NM_001017402	2.156
LAMP2	NM_002294 /// NM_013995	2.548
LARP6	NM_018357 /// NM_197958	2.025
LCAT	NM_000229	2.127
LEPR	NM_001003679 /// NM_001003680 /// NM_002303	-2.759
LEPROTL1	NM_015344	-2.689
LGALS3 /// GALIG	NM_002306 /// NM_194327	2.380
LGR4	NM_018490	-2.472
LGR6	NM_001017403 /// NM_001017404 /// NM_021636	2.447
LHFP	NM_005780	2.520
LIN28B	NM_001004317	-6.529
LOC116238	NM_138463	-2.322
LOC150759	XM_498456 /// XM_499585	2.713
LOC201651	XM_114355	-2.280
LOC283464	XM_290597	-3.353
LOC284611	NM_001010883	2.128
LOC285513	NM_198281	-2.702
LOC285943	---	-2.652
LOC399959	XM_378316	2.719
LOC440737	XM_496446	2.720
LOC441027	XM_496707	2.910
LOC492304	NM_001007139	2.604
LOC51315	NM_016618	2.208
LOC554202	---	2.368
LOXL2	NM_002318	2.583
LPGAT1	NM_014873	-2.141
LRP12	NM_013437	2.092
LSM6	NM_007080	-2.442
LTBP3	NM_021070	2.405
LTBP4	NM_003573	2.407
LYST	NM_000081 /// NM_001005736	2.480
MAFF	NM_012323 /// NM_152878	3.282

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MAFK	NM_002360	-2.183
MAP3K9	NM_033141	-2.349
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MARS	NM_004990	-2.018
MCAM	NM_006500	2.079
MDH2	NM_005918	-2.057
MED6	NM_005466	-2.300
MED8	NM_001001651 /// NM_001001653 /// NM_001001654 /// NM_052877 /// NM_201542	-2.082
MGC11102	NM_032325	-2.106
MGC11308	NM_032889	-2.003
MGC13204	NM_031465	-2.951
MGC14289	NM_080660	-2.993
MGC18216	---	-2.441
MGC23909	NM_174909	-2.925
MGC2408	NM_032331	-2.471
MGC2560	NM_031452	-3.112
MICAL2	NM_014632	2.124
MICB	NM_005931	-3.386
MMP7	NM_002423	2.127
MN1	NM_002430	-2.037
M-RIP	NM_015134 /// NM_201274	2.082
MRS2L	NM_020662	-2.336
MSRB3	NM_001031679 /// NM_198080	2.261
MT1E	NM_175617	2.263
MT1F	NM_005949	2.583
MT1G	NM_005950	2.162
MT1H	NM_005951	2.635
MT1M	NM_176870	2.021
MT1X	NM_005952	2.407
MT2A	NM_005953	2.913
MTPN	NM_145808	2.033
MTUS1	NM_001001924 /// NM_001001925 /// NM_001001927 /// NM_001001931 /// NM_020749	-2.159
MUC5B	XM_039877	3.213
MYO1D	NM_015194	2.120
NANOS1	NM_001009553 /// NM_199461	3.060
NAP1L1	NM_004537 /// NM_139207	-2.253
NAP1L3	NM_004538	2.028
NARG1	NM_057175	-2.372
NAV3	NM_014903	2.160
NDRG1	NM_006096	2.039
NDUFA5	NM_005000	2.270
NEIL3	NM_018248	-2.344
NEK3	NM_002498 /// NM_152720	-2.099
NEXN	NM_144573	2.374
NFIB	NM_005596	2.161
NGEF	NM_019850	2.259
NHSL1	XM_496826	2.602
NID1	NM_002508	13.062
NLN	NM_020726	-2.344

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NME4	NM_005009	-2.386
NME6	NM_005793	-2.601
NOV	NM_002514	2.008
NPC2	NM_006432	2.065
NR2F6	NM_005234	-2.073
NRAS	NM_002524	-3.277
NT5E	NM_002526	2.176
NUDT15	NM_018283	3.077
NUDT4	NM_019094 /// NM_199040	-2.548
NUP98	NM_005387 /// NM_016320 /// NM_139131 /// NM_139132	-3.260
OBSL1	XM_051017	2.368
OLFM1	NM_006334 /// NM_014279 /// NM_058199	2.392
OSTbeta	NM_178859	-3.403
P18SRP	NM_173829	-2.162
PABPC4	NM_003819	-2.222
PALM2-AKAP2	NM_007203 /// NM_147150	3.034
PANK3	NM_024594	2.076
PAPOLA	NM_032632	-2.205
PBEF1	NM_005746 /// NM_182790	2.004
PCTP	NM_021213	-2.334
PDCD4	NM_014456 /// NM_145341	-2.068
PDE3A	NM_000921	-2.340
PDLIM5	NM_001011513 /// NM_001011514 /// NM_001011515 /// NM_001011516 /// NM_006457	2.028
PELI1	NM_020651	2.011
PGM2L1	NM_173582	-2.235
PGRMC1	NM_006667	-2.561
PHF19	NM_001009936 /// NM_015651	-2.126
PHLDA1	NM_007350	2.276
PIGA	NM_002641 /// NM_020472 /// NM_020473	-2.240
PJA2	NM_014819	2.280
PLAGL1	NM_002656 /// NM_006718	-2.228
PLAGL2	NM_002657	-2.732
PLAT	NM_000930 /// NM_000931 /// NM_033011	2.110
PLAU	NM_002658	3.175
PLCL2	NM_015184	2.480
PLEKHH2	NM_172069	2.299
PLSCR4	NM_020353	2.853
PODXL	NM_001018111 /// NM_005397	3.975
POLR2D	NM_004805	-2.153
PPARG	NM_005037 /// NM_015869 /// NM_138711 /// NM_138712	-2.074
PPFIA1	NM_003626 /// NM_177423	2.111
PPP1R15A	NM_014330	2.075
PPP4C	NM_002720	-2.099
PRICKLE1	NM_153026	2.766
PRKAR2A	NM_004157	-3.057
PRKCDBP	NM_145040	3.685
PRP2	NM_173490	2.459
PRRG4	NM_024081	2.910
PRSS1 /// PRSS2 /// PRSS3 /// TRY6	NM_002769 /// NM_002770 /// NM_002771 /// NR_001296	2.040

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PRSS3	NM_002771	4.893
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PTRF	NM_012232	2.131
PTX1	NM_016570	-2.305
PURB	NM_033224	2.076
PYCARD	NM_013258 /// NM_145182 /// NM_145183	2.136
QKI	NM_006775 /// NM_206853 /// NM_206854 /// NM_206855	3.366
RAB3B	NM_002867	3.180
RABEP2	NM_024816	2.453
RAGE	NM_014226	2.470
RAP2B	NM_002886	2.237
RASGEF1A	NM_145313	3.000
RASSF2	NM_014737 /// NM_170773 /// NM_170774	2.639
RBP4	NM_006744	2.172
RBPM5	NM_001008710 /// NM_001008711 /// NM_001008712 /// NM_006867	-2.326
RBPM52	NM_194272	2.002
RECK	NM_021111	2.557
RGS2	NM_002923	2.250
RHOB	NM_004040	-2.028
RHOBTB1	NM_001032380 /// NM_014836 /// NM_198225	-2.150
RIG	---	3.819
RIOK2	NM_018343	-2.405
RIS1	NM_015444	5.424
RIT1	NM_006912	2.140
RNF13	NM_007282 /// NM_183381 /// NM_183382 /// NM_183383 /// NM_183384	-2.104
RNF144	NM_014746	2.327
RNF157	NM_052916	2.030
RNF182	NM_152737	3.611
RPS6KA5	NM_004755 /// NM_182398	2.203
RPUSD3	NM_173659	-3.416
RRM2B	NM_015713	2.230
RTCD1	NM_003729	-2.683
RTN4IP1	NM_032730	-2.594
RTN4RL2	NM_178570	-2.193
RUNX2	NM_001015051 /// NM_001024630 /// NM_004348	2.185
RY1	NM_006857	2.393
S100PBPR	NM_001017406 /// NM_022753	-2.194
SAR1B	NM_001033503 /// NM_016103	3.112
SAT	NM_002970	2.446
SCAMP1	NM_004866 /// NM_052822	2.468
SCARA3	NM_016240 /// NM_182826	2.572
SCD5	NM_024906	2.401
SCEL	NM_003843 /// NM_144777	-2.043
SCN1B	NM_001037 /// NM_199037	2.728
SEC24A	XM_094581	2.064
SEMA4B	NM_020210 /// NM_198925	2.978
SEPT6 /// N-PAC	NM_015129 /// NM_032569 /// NM_145799 /// NM_145800 /// NM_145802	2.002
SERP1	NM_014445	-2.398

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SERPINB9	NM_004155	-3.543
SERPINE2	NM_006216	3.237
SEZ6L2	NM_012410 /// NM_201575	2.092
SFRP1	NM_003012	2.192
SGK2	NM_016276 /// NM_170693	-2.167
SLC11A2	NM_000617	2.236
SLC16A2	NM_006517	2.756
SLC17A5	NM_012434	-2.453
SLC1A1	NM_004170	3.319
SLC22A4	NM_003059	2.499
SLC25A13	NM_014251	-2.391
SLC25A24	NM_013386 /// NM_213651	-2.411
SLC25A32	NM_030780	-2.231
SLC25A37	NM_016612 /// NM_018579	2.030
SLC35D2	NM_007001	-2.779
SLC44A1	NM_022109 /// NM_080546	2.091
SLC4A11	NM_032034	2.448
SLC4A5	NM_021196 /// NM_033323 /// NM_133478 /// NM_133479	-2.439
SLC5A6	NM_021095	-2.965
SLC6A15	NM_018057 /// NM_182767	2.160
SLC6A6	NM_003043	2.012
SLC7A5	NM_003486	-2.555
SLC7A6	NM_003983	-2.172
SLC7A7	NM_003982	-2.071
SMAD2	NM_001003652 /// NM_005901	2.035
SMARCC1	NM_003074	-2.107
SMURF2	NM_022739	3.642
SNAP23	NM_003825 /// NM_130798	-2.270
SNX5	NM_014426 /// NM_152227	-2.012
SOCS3	NM_003955	2.401
SOD2	NM_000636 /// NM_001024465 /// NM_001024466	2.039
SPCS3	NM_021928	-2.631
SPOCK	NM_004598	2.958
SQRDL	NM_021199	2.004
SRP46	NM_032102	-2.244
SRPK2	NM_182691 /// NM_182692	2.012
SS18L1	NM_015558 /// NM_198935	2.202
ST6GALNAC2	NM_006456	-2.414
STARD3NL	NM_032016	-2.311
STAT1	NM_007315 /// NM_139266	-2.063
STC1	NM_003155	2.166
STEAP3	NM_001008410 /// NM_018234 /// NM_182915	2.414
STK6	NM_003600 /// NM_198433 /// NM_198434 /// NM_198435 /// NM_198436 /// NM_198437	-2.773
STRA6	NM_022369	2.165
STS-1	NM_032873	-2.023
SUSD2	NM_019601	2.326
SUV39H2	NM_024670	-2.173
SYNGR3	NM_004209	2.531
SYT13	NM_020826	2.280
TAGLN	NM_001001522 /// NM_003186	2.210
TBC1D2	NM_018421	2.085

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TBC1D7	NM_016495	2.136
TCEAL3	NM_001006933 /// NM_032926	2.373
TDO2	NM_005651	2.248
TFAP2C	NM_003222	2.730
TFPI2	NM_006528	3.936
TFRC	NM_003234	-2.539
TGFA	NM_003236	2.602
TGFBR1	NM_004612	-2.453
THBS1	NM_003246	-2.022
THEM4	NM_053055 /// NM_176853	-2.147
THUMPD1	NM_017736	2.138
TIGA1	NM_053000	-2.341
TK2	NM_004614	2.448
TKT	NM_001064	-2.520
TLN1	NM_006289	2.138
TM4SF20	NM_024795	-5.746
TMED5	NM_016040	-2.165
TMEM16A	NM_018043	2.204
TMEM2	NM_013390	-2.525
TMEM50B	NM_006134	2.193
TMEM87B	NM_032824	2.282
TNFAIP3	NM_006290	2.275
TNFAIP6	NM_007115	5.084
TNFRSF11A	NM_003839	2.148
TNFRSF25	NM_003790 /// NM_148965 /// NM_148966 /// NM_148967 /// NM_148968 /// NM_148969	2.002
TNNT1	NM_003283	2.014
TNRC6A	NM_014494 /// NM_020847	2.135
TOP1MT	NM_052963	2.799
TRIM8	NM_030912	2.355
TSPAN5	NM_005723	2.208
TSPYL5	NM_033512	-2.025
TTC7B	NM_001010854	2.287
TTC9C	NM_173810	-2.004
TWIST1	NM_000474	2.353
UHMK1	NM_175866	2.058
ULBP2	NM_025217	3.094
VGCNL1	NM_052867	2.307
VGL-3	NM_016206	-3.767
VPS33A	NM_022916	-2.356
VPS54	NM_001005739 /// NM_016516	-2.769
XDH	NM_000379	3.375
XK	NM_021083	-2.366
YES1	NM_005433	2.261
YWHAH	NM_003405	3.251
ZC3H12C	XM_370654	2.474
ZCCHC9	NM_032280	-2.537
ZCSL2	NM_206831	-3.789
ZDHHC20	NM_153251	2.934
ZDHHC3	NM_016598	-2.172
ZFHX1B	NM_014795	3.267
ZNF294	NM_015565	-2.085

ZNF680	NM_178558	2.224
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Table 3. Genes with altered mRNA expression levels in HepG2 cells, following transfection with pre-miR hsa-let-7b.

Gene Symbol	RefSeq (incorporated herein by reference in their entirety)	Fold Change
2'-PDE	NM_177966	-3.346
AADAC	NM_001086	2.432
AADACL1	NM_020792	2.175
AASDHPPT	NM_015423	-2.081
ABCB10	NM_012089	-2.443
ABCC3	NM_003786 /// NM_020037 /// NM_020038	2.245
ABT1	NM_013375	-2.413
ACF	NM_014576 /// NM_138932 /// NM_138933	-2.141
ACVR1B	NM_004302 /// NM_020327 /// NM_020328	-2.699
ACYP2	NM_138448	2.082
ADCY7	NM_001114	2.676
ADH6	NM_000672	-2.172
AER61	NM_173654	-2.171
AFAP	NM_021638 /// NM_198595	2.049
AGA	NM_000027	2.001
AGPS	NM_003659	-2.047
AGTR1	NM_000685 /// NM_004835 /// NM_009585 /// NM_031850 /// NM_032049	2.127
AGXT2L1	NM_031279	-2.445
AIG1	NM_016108	2.629
AK2	NM_001625 /// NM_013411	-2.247
AKR1D1	NM_005989	-13.748
ALCAM	NM_001627	2.286
ALDH3A1	NM_000691	16.662
ALDH9A1	NM_000696	2.105
AMPD3	NM_000480 /// NM_001025389 /// NM_001025390	2.389
ANGPTL1	NM_004673	2.022
ANKRD17	NM_032217 /// NM_198889	-2.602
ANKRD32	NM_032290	-2.668
ANP32A	NM_006305	-2.046
ANP32E	NM_030920	-2.028
ANXA3	NM_005139	2.222
AOX1	NM_001159	2.232
APIN	NM_017855	-4.347
APOB	NM_000384	-3.680
APOC3 /// LOC440838	NM_000040 /// XM_496537	-2.843
APP	NM_000484 /// NM_201413 /// NM_201414	2.774
AQP11	NM_173039	2.381
AQP3	NM_004925	2.202
AQP8	NM_001169	2.442
ARG2	NM_001172	2.069
ARID3A	NM_005224	-2.839
ARID5B	NM_032199	2.199
ARL5A	NM_012097 /// NM_177985	-2.022
ARL6IP6	NM_152522	-3.416
ARL7	NM_005737	3.082

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ARL8	NM_178815	-2.383
ARMCX3	NM_016607 /// NM_177947 /// NM_177948	2.371
ARRDC3	NM_020801	2.928
ASCIZ	NM_015251	2.427
ASH1L	NM_018489	2.226
ASK	NM_006716	-4.157
ASPH	NM_004318 /// NM_020164 /// NM_032466 /// NM_032467 /// NM_032468	2.311
ATAD2	NM_014109	-3.130
ATP6V0A2	NM_012463	-2.109
ATP7B	NM_000053 /// NM_001005918	-2.013
ATP8B3	NM_138813	2.446
ATP9A	NM_006045	2.408
ATPAF1	NM_022745	-2.127
ATRX	NM_000489 /// NM_138270 /// NM_138271	2.115
AURKB	NM_004217	-5.040
AXL	NM_001699 /// NM_021913	2.796
AZGP1	NM_001185	2.369
BAZ1A	NM_013448 /// NM_182648	-2.140
BAZ2B	NM_013450	2.304
BCCIP	NM_016567 /// NM_078468 /// NM_078469	-3.087
BIRC3	NM_001165 /// NM_182962	-2.491
BLVRA	NM_000712	2.084
BLVRB	NM_000713	2.394
BM039	NM_018455	-2.987
BMPR2	NM_001204	2.066
BNIP3L	NM_004331	2.241
BRCA1	NM_007294 /// NM_007295 /// NM_007296 /// NM_007297 /// NM_007298 /// NM_007299	-3.100
BRCA2	NM_000059	-3.286
BRIP1	NM_032043	-2.013
BRN1	NM_015341	-2.266
BST2	NM_004335	2.029
BTF3L4	NM_152265	-2.149
BTG1	NM_001731	2.292
BUB1	NM_004336	-2.280
BUB1B	NM_001211	-2.314
BXDC2	NM_018321	-2.367
BZRP	NM_000714 /// NM_007311	2.936
C10orf10	NM_007021	3.682
C10orf11	NM_032024	2.105
C10orf3	NM_018131	-2.537
C10orf38	NM_001010924	2.289
C10orf6	NM_018121	-2.088
C10orf9	NM_145012 /// NM_181698	-2.422
C13orf23	NM_025138 /// NM_170719	-2.698
C14orf2	NM_004894	-2.044
C14orf46	NM_001024674	-3.545
C14orf78	XM_290629	3.185
C14orf94	NM_017815	-2.021
C15orf23	NM_033286	-2.128
C16orf45	NM_033201	2.182

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C16orf52	NM_173501	2.334
C17orf27	NM_020914	2.512
C18orf19	NM_152352	-2.151
C18orf21	NM_031446	-2.129
C18orf24	NM_145060	-2.872
C19orf33	NM_033520	3.232
C1orf112	NM_018186	-2.649
C1orf131	NM_152379	-2.087
C1orf135	NM_024037	-2.115
C1orf25	NM_030934	-2.046
C1orf33	NM_016183	-2.093
C1orf55	NM_152608	-2.042
C1orf85	NM_144580	2.077
C1S	NM_001734 /// NM_201442	2.131
C2	NM_000063	2.093
C20orf112	NM_080616	-2.117
C20orf19	NM_018474	2.131
C21orf45	NM_018944	-2.111
C2orf17	NM_024293	2.063
C2orf3	NM_003203	-2.170
C3orf23	NM_001029839 /// NM_001029840 /// NM_173826	2.103
C4orf13	NM_001029998 /// NM_001030316 /// NM_032128	-2.038
C4orf9	NM_003703	-2.260
C5	NM_001735	3.563
C6orf139	NM_018132	-2.640
C6orf211	NM_024573	-2.048
C7orf23	NM_024315	-3.610
C8orf1	NM_004337	2.629
C9orf150	NM_203403	2.195
C9orf152	NM_001012993	2.906
C9orf40	NM_017998	-2.071
C9orf41	NM_152420	-3.137
C9orf52	NM_152574	-2.479
C9orf76	NM_024945	-2.028
C9orf95	NM_017881	2.838
CACNA2D4	NM_001005737 /// NM_001005766 /// NM_172364	2.297
CAMTA1	NM_015215	2.015
CAPN2	NM_001748	2.097
CAV2	NM_001233 /// NM_198212	2.115
CCDC5	NM_138443	-2.022
CCNA2	NM_001237	-4.693
CCNB1	NM_031966	-2.221
CCNE2	NM_057735 /// NM_057749	-3.087
CCNF	NM_001761	-2.070
CCNG2	NM_004354	3.578
CCNJ	NM_019084	-3.368
CCPG1	NM_004748 /// NM_020739	2.128
CD109	NM_133493	2.253
CD36	NM_000072 /// NM_001001547 /// NM_001001548	2.002
CD58	NM_001779	2.081
CD59	NM_000611 /// NM_203329 /// NM_203330 /// NM_203331	2.188
CD7	NM_006137	2.042

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CD9	NM_001769	4.674
CD99L2	NM_031462 /// NM_134445 /// NM_134446	2.191
CDA	NM_001785	3.653
CDC2	NM_001786 /// NM_033379	-2.199
CDC20	NM_001255	-2.172
CDC23	NM_004661	-2.419
CDC25A	NM_001789 /// NM_201567	-8.007
CDC34	NM_004359	-2.829
CDC45L	NM_003504	-2.495
CDC6	NM_001254	-4.395
CDCA1	NM_031423 /// NM_145697	-2.322
CDCA2	NM_152562	-2.917
CDCA3	NM_031299	-2.220
CDCA5	NM_080668	-2.247
CDCA7	NM_031942 /// NM_145810	-3.452
CDCA8	NM_018101	-2.359
CDK2	NM_001798 /// NM_052827	-2.069
CDK8	NM_001260	-2.537
CDKAL1	NM_017774	-2.134
CDKN2B	NM_004936 /// NM_078487	2.569
CDT1	NM_030928	-2.913
CG018	NM_052818	2.905
CGI-116	NM_016053	2.130
CHD6	NM_032221	2.017
CHD7	NM_017780	-2.384
CHEK1	NM_001274	-3.280
ChGn	NM_018371	5.004
CHPF	NM_024536	2.615
CHST9	NM_031422	-2.248
CKS1B	NM_001826	-2.437
CLIC3	NM_004669	4.155
CLTB	NM_001834 /// NM_007097	2.099
COIL	NM_004645	-2.160
COL4A5	NM_000495 /// NM_033380 /// NM_033381	3.563
COL4A6	NM_001847 /// NM_033641	2.124
COL6A1	NM_001848	2.159
COL7A1	NM_000094	2.391
COTL1	NM_021149	2.018
CPB2	NM_001872 /// NM_016413	-2.402
CPEB2	NM_182485 /// NM_182646	-2.193
CPOX	NM_000097	-3.630
CPT1A	NM_001031847 /// NM_001876	2.306
CREB3L2	NM_194071	-2.106
CREB5	NM_001011666 /// NM_004904 /// NM_182898 /// NM_182899	2.205
CRIP1	NM_001311	2.474
CSPG6	NM_005445	-2.099
CTDSPL2	NM_016396	-2.289
CTPS	NM_001905	-2.733
CTSB	NM_001908 /// NM_147780 /// NM_147781 /// NM_147782 /// NM_147783	2.067
CTSC	NM_001814 /// NM_148170	-2.180
CTSD	NM_001909	2.244

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CTTN	NM_005231 /// NM_138565	2.692
CXorf12	NM_003492	2.048
CXorf15	NM_018360	-2.089
CXorf45	NM_024810	2.755
CXX1	NM_003928	2.227
CXXC6	NM_030625	-2.424
CYGB	NM_134268	3.437
CYLN2	NM_003388 /// NM_032421	2.479
CYP3A5	NM_000777	2.238
CYP3A7	NM_000765	2.963
CYP4F11	NM_021187	2.318
CYP4F3	NM_000896	2.420
DAF	NM_000574	2.418
DBN1	NM_004395 /// NM_080881	2.361
DCC1	NM_024094	-3.401
DCDC2	NM_016356	-2.019
DDC	NM_000790	-4.057
DDX18	NM_006773	-2.225
DDX19A	NM_018332	-2.032
DDX58	NM_014314	2.159
DENND1A	NM_020946 /// NM_024820	-2.026
DEPDC1	NM_017779	-3.205
DEPDC1B	NM_018369	-2.577
DFNA5	NM_004403	2.045
DGAT1	NM_012079	-2.129
DHFR	NM_000791	-2.868
DICER1	NM_030621 /// NM_177438	-6.058
DIO1	NM_000792 /// NM_213593	-4.696
DISC1	NM_001012957 /// NM_001012958 /// NM_001012959 /// NM_018662	2.337
DKC1	NM_001363	-2.271
DKFZp434B1231	NM_178275	2.069
DKFZp434J1015	XM_496849 /// XM_499257	2.004
DKFZp434N035	NM_032262	2.077
DKK3	NM_001018057 /// NM_013253 /// NM_015881	2.244
DLC1	NM_006094 /// NM_024767 /// NM_182643	-2.088
DLEU2 /// BCMSUNL	NM_006021	-2.452
DLG7	NM_014750	-2.223
DMD	NM_000109 /// NM_004006 /// NM_004007 /// NM_004009 /// NM_004010 /// NM_004011	-2.648
DNA2L	XM_166103	-2.547
DNAJB9	NM_012328	-2.347
DNAJC12	NM_021800 /// NM_201262	2.478
DNASE2	NM_001375	2.224
DOC1	NM_014890 /// NM_182909	4.474
DOK6	NM_152721	2.547
DONSON	NM_017613 /// NM_145794 /// NM_145795	-3.186
DOT1L	NM_032482	-2.692
DPAGT1	NM_001382 /// NM_203316	-2.224
DPH5	NM_015958	-2.050
DST	NM_001723 /// NM_015548 /// NM_020388 /// NM_183380	2.099

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DTL	NM_016448	-4.310
DTNA	NM_001390 /// NM_001391 /// NM_001392 /// NM_032975 /// NM_032978 /// NM_032979	2.365
DUSP7	NM_001947	-2.552
DUSP9	NM_001395	-5.552
DZIP1	NM_014934 /// NM_198968	-2.582
E2F5	NM_001951	-4.074
E2F6	NM_001952 /// NM_198256 /// NM_198257 /// NM_198258 /// NM_198325 /// NM_212540	-2.349
E2F8	NM_024680	-3.332
EAF2	NM_018456	-2.674
EGFL5	XM_376905	2.405
EGR1	NM_001964	-2.716
EIF2C2	NM_012154	-2.272
EIF2C4	NM_017629	4.100
EIF4E	NM_001968	-2.069
Ells1	NM_152793	2.372
ELOVL7	NM_024930	3.606
EMP2	NM_001424	2.553
ENOSF1	NM_017512	2.638
EPB41L5	NM_020909	-2.170
EPPK1	NM_031308	2.097
ERBB3	NM_001005915 /// NM_001982	2.078
ERCC1	NM_001983 /// NM_202001	2.049
ERO1L	NM_014584	-2.297
ESCO2	NM_001017420	-2.220
EXOSC8	NM_181503	-2.327
EZH2	NM_004456 /// NM_152998	-2.605
F2R	NM_001992	4.586
FABP1	NM_001443	-4.106
FABP5	NM_001444	-2.278
FAM19A5	NM_015381	-2.176
FAM29A	NM_017645	-2.176
FAM3B	NM_058186 /// NM_206964	-2.097
FAM54A	NM_138419	-3.764
FAM55C	NM_145037	2.106
FAM57A	NM_024792	-2.319
FAM61A	NM_015578	2.138
FAM72A	NM_207418	-2.954
FANCD2	NM_001018115 /// NM_033084	-2.722
FANCM	NM_020937	-2.201
FBL	NM_001436	-2.413
FBLIM1	NM_001024215 /// NM_001024216 /// NM_017556	2.093
FBXO25	NM_012173 /// NM_183420 /// NM_183421	-2.279
FBXO5	NM_012177	-2.306
FEN1	NM_004111	-2.334
FIBCD1	NM_032843	2.122
FIGN	NM_018086	-3.415
FIGNL1	NM_022116	-2.272
FIP1L1	NM_030917	-2.116
FKSG14	NM_022145	-3.151

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FLAD1	NM_025207 /// NM_201398	-2.062
FLJ10038	---	2.139
FLJ10292	NM_018048	-2.071
FLJ10534	NM_018128	-2.397
FLJ10700	NM_018182	-2.646
FLJ10719	NM_018193	-2.610
FLJ11000	NM_018295	2.120
FLJ11155	NM_018342	-2.201
FLJ11259	NM_018370	2.103
FLJ11273	NM_018374	2.079
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RFC4	NM_002916 /// NM_181573	-2.337
RFC5	NM_007370 /// NM_181578	-3.462
RFFL	NM_001017368 /// NM_057178	-2.044
RFWD3	NM_018124	-3.699
RGS3	NM_017790 /// NM_021106 /// NM_130795 /// NM_134427 /// NM_144488 /// NM_144489	-2.786
RHOB	NM_004040	-2.149
RHOQ	NM_012249	2.563
RHOQ /// LOC284988	NM_012249 /// XM_209429	3.585
RIF1	NM_018151	-2.269
RIMS3	NM_014747	2.204
RIPK5	NM_015375 /// NM_199462	2.354
RIT1	NM_006912	2.081
RNF144	NM_014746	2.113
RNU22	NR_000008	-2.920
RNU47	XR_000223	-2.614
RPS6	NM_001010	-2.315
RPS6KA3	NM_004586	-2.009
RPUSD3	NM_173659	-3.293
RRAGD	NM_021244	2.188
RRM1	NM_001033	-2.328
RRM2	NM_001034	-4.193
RRM2B	NM_015713	2.704
RRN3	NM_018427	-2.007
RSC1A1	NM_006511	-3.230
RTCD1	NM_003729	-2.223
RTF1	NM_015138	2.048
RTN2	NM_005619 /// NM_206900 /// NM_206901 /// NM_206902	2.095
RTN4IP1	NM_032730	-2.407
RY1	NM_006857	2.180
S100A2	NM_005978	5.992
S100A4	NM_002961 /// NM_019554	2.395
S100A6	NM_014624	3.585
S100PBPR	NM_001017406 /// NM_022753	-2.885
SACS	NM_014363	-2.165
SAR1B	NM_001033503 /// NM_016103	2.287
SASS6	NM_194292	-2.493

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SAT	NM_002970	2.290
SCAMP1	NM_004866 /// NM_052822	2.098
SCARB2	NM_005506	2.032
SCD	NM_005063	-2.328
SCGN	NM_006998	-2.461
SCN9A	NM_002977	3.362
SCPEP1	NM_021626	2.260
SELM	NM_080430	2.480
SEMA3B	NM_001005914 /// NM_004636	2.142
SEMA3G	NM_020163	2.055
SEPT6 /// N-PAC	NM_015129 /// NM_032569 /// NM_145799 /// NM_145800 /// NM_145802	2.143
SERP1	NM_014445	-2.007
SERPINA3	NM_001085	2.456
SERPINA6	NM_001756	-2.066
SERPINE1	NM_000602	2.400
SEZ6L2	NM_012410 /// NM_201575	2.116
SFRS1	NM_006924	-2.031
SGCB	NM_000232	2.304
SGK3	NM_001033578 /// NM_013257 /// NM_170709	-2.097
SGOL2	NM_152524	-2.263
SH3BGRL	NM_003022	2.010
SH3BGRL3	NM_031286	2.340
SH3BP5	NM_001018009 /// NM_004844	2.097
SH3GLB1	NM_016009	2.256
SHCBP1	NM_024745	-2.480
SIL	NM_003035	-2.173
SIP1	NM_001009182 /// NM_001009183 /// NM_003616	-2.194
SKP2	NM_005983 /// NM_032637	-4.277
SLC16A10	NM_018593	-2.944
SLC16A6	NM_004694	2.408
SLC17A2	NM_005835	-2.411
SLC20A1	NM_005415	-2.298
SLC22A18	NM_002555 /// NM_183233	2.717
SLC22A7	NM_006672 /// NM_153320	-2.377
SLC23A2	NM_005116 /// NM_203327	2.410
SLC25A13	NM_014251	-2.585
SLC25A24	NM_013386 /// NM_213651	-2.124
SLC25A32	NM_030780	-2.835
SLC26A11	NM_173626	2.537
SLC2A3	NM_006931	-6.221
SLC2A3 /// SLC2A14	NM_006931 /// NM_153449	-5.017
SLC2A8	NM_014580	-2.078
SLC30A10	NM_001004433 /// NM_018713	-2.129
SLC35D2	NM_007001	-2.343
SLC35F5	NM_025181	-3.794
SLC38A5	NM_033518	-2.093
SLC39A14	NM_015359	-3.916
SLC40A1	NM_014585	5.218
SLC43A1	NM_003627	-2.391
SLC44A1	NM_022109 /// NM_080546	2.114
SLC44A5	NM_152697	2.821

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SLC4A11	NM_032034	4.907
SLC4A5	NM_021196 /// NM_033323 /// NM_133478 /// NM_133479	-2.069
SLC5A6	NM_021095	-2.583
SLC6A14	NM_007231	-2.725
SLC6A6	NM_003043	2.081
SLC7A11	NM_014331	2.056
SLC7A2	NM_001008539 /// NM_003046	2.115
SLC7A6	NM_003983	-2.170
SLCO4C1	NM_180991	-6.128
SMAD2	NM_001003652 /// NM_005901	2.496
SMARCA2	NM_003070 /// NM_139045	2.328
SMARCC1	NM_003074	-2.014
SMC1L1	NM_006306	-2.248
SMC2L1	NM_006444	-2.288
SMPD1	NM_000543 /// NM_001007593	2.164
SMURF2	NM_022739	2.381
SNAP23	NM_003825 /// NM_130798	-2.346
SNAPC5	NM_006049	-2.093
SNX5	NM_014426 /// NM_152227	-2.669
SOAT2	NM_003578	-2.669
SOCS1	NM_003745	-2.760
SOLH	NM_005632	-2.134
SOX4	NM_003107	2.011
SPBC25	NM_020675	-2.506
SPCS3	NM_021928	-3.408
SPIN2 /// SPIN-2	NM_001006681 /// NM_001006682 /// NM_001006683 /// NM_019003	2.031
SPON2	NM_012445	4.946
SPTAN1	NM_003127	2.050
SPTBN1	NM_003128 /// NM_178313	2.029
SPTLC2L	---	-2.194
SQSTM1	NM_003900	2.525
SR140	XM_031553	-2.333
SSX2IP	NM_014021	-2.558
ST6GALNAC2	NM_006456	-3.504
STEAP3	NM_001008410 /// NM_018234 /// NM_182915	2.363
STK17A	NM_004760	2.089
STK40	NM_032017	-2.417
STK6	NM_003600 /// NM_198433 /// NM_198434 /// NM_198435 /// NM_198436 /// NM_198437	-4.188
STS-1	NM_032873	-3.120
STX3A	NM_004177	-2.978
SULT1C1	NM_001056 /// NM_176825	2.091
SUPT16H	NM_007192	-2.214
SUSD2	NM_019601	3.786
SUV39H2	NM_024670	-3.885
SYNGR3	NM_004209	2.892
SYTL1	NM_032872	2.936
SYTL2	NM_032379 /// NM_032943 /// NM_206927 /// NM_206928 /// NM_206929 /// NM_206930	4.644
TACC2	NM_006997 /// NM_206860 /// NM_206861 /// NM_206862	2.436
TACC3	NM_006342	-2.037

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TAF5	NM_006951	-3.117
TAF5L	NM_001025247 /// NM_014409	-2.378
TAGLN	NM_001001522 /// NM_003186	2.095
TBC1D3 /// TBC1D3C	NM_001001418 /// NM_032258	3.067
TBRG4	NM_004749 /// NM_030900 /// NM_199122	-2.044
TBX3	NM_005996 /// NM_016569	2.237
TCERG1	NM_006706	-2.015
TCOF1	NM_000356 /// NM_001008656 /// NM_001008657	-2.455
TCTE1L	NM_006520	2.633
TDE2L	NM_178865	3.110
TDP1	NM_001008744 /// NM_018319	-2.141
TEAD4	NM_003213 /// NM_201441 /// NM_201443	-2.730
TEP1	NM_007110	2.202
TFAM	NM_003201	-2.004
TFDP1	NM_007111	-2.046
TFRC	NM_003234	-2.504
TGFA	NM_003236	2.034
TGFB1	NM_000660	2.104
TGFB1I1	NM_015927	2.701
TGFBR3	NM_003243	-3.258
THEM4	NM_053055 /// NM_176853	-2.356
TIMM8A	NM_004085	-2.159
TIMP2	NM_003255	2.818
TK1	NM_003258	-2.182
TK2	NM_004614	3.123
TM4SF5	NM_003963	2.404
TMCO3	NM_017905	2.169
TMEFF1	NM_003692	2.028
TMEM16K	NM_018075	2.391
TMEM48	NM_018087	-2.540
TMEM55A	NM_018710	2.227
TMEM57 /// LOC159090	NM_018202 /// NM_145284	2.295
TMEM8	NM_021259	-2.039
TMEM87B	NM_032824	2.540
TMPO	NM_001032283 /// NM_001032284 /// NM_003276	-2.608
TMSB4X /// TMSL3	NM_021109 /// NM_183049	2.137
TncRNA	---	2.342
TNFRSF11A	NM_003839	2.156
TNFRSF14	NM_003820	2.220
TNFSF10	NM_003810	-2.099
TNRC6A	NM_014494 /// NM_020847	2.038
TNRC8	---	2.767
TOP1MT	NM_052963	2.350
TOP2A	NM_001067	-2.202
TOPBP1	NM_007027	-2.021
TP53I3	NM_004881 /// NM_147184	2.473
TP53INP1	NM_033285	2.382
TPBG	NM_006670	3.351
TPM2	NM_003289 /// NM_213674	3.855
TPR	NM_003292	-2.385
TPX2	NM_012112	-2.044

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TRAF5	NM_001033910 /// NM_004619 /// NM_145759	2.173
TRIB2	NM_021643	2.122
TRIM2	NM_015271	3.066
TRIM22	NM_006074	3.115
TRIM24	NM_003852 /// NM_015905	2.249
TRIM56	NM_030961	2.327
TRIP13	NM_004237	-2.384
TRPV2	NM_016113	2.038
TSC22D1	NM_006022 /// NM_183422	2.076
TTC3	NM_001001894 /// NM_003316	2.040
TTC7B	NM_001010854	2.297
TTK	NM_003318	-2.295
TTLL4	NM_014640	-4.693
TTYH2	NM_032646 /// NM_052869	2.176
TUBA3	NM_006009	6.172
TUBB2	NM_001069	2.343
TUBB-PARALOG	NM_178012	3.758
TUBE1	NM_016262	-2.325
TUBG1	NM_001070	-2.279
TUSC2	NM_007275	-2.216
TUSC3	NM_006765 /// NM_178234	2.119
UBE2H	NM_003344 /// NM_182697	2.381
UBE2Q2	NM_173469	2.207
UBE2T	NM_014176	-2.756
UCHL5	NM_015984	-2.974
UGCG	NM_003358	-2.081
UHMK1	NM_175866	2.111
UHRF1	NM_013282	-4.543
UIP1	NM_017518 /// NM_207106 /// NM_207107	-2.016
ULK1	NM_003565	2.003
UNC93A	NM_018974	-2.304
USP10	NM_005153	-2.312
UTP15	NM_032175	-2.352
VAMP1	NM_014231 /// NM_016830 /// NM_199245	2.079
VAMP3	NM_004781	-2.043
VLDLR	NM_001018056 /// NM_003383	2.084
VNN1	NM_004666	2.180
VPS33A	NM_022916	-2.148
VPS54	NM_001005739 /// NM_016516	-2.421
VRK1	NM_003384	-3.224
WBP11	NM_016312	-2.777
WDHD1	NM_001008396 /// NM_007086	-3.432
WDR45	NM_001029896 /// NM_007075	2.493
WIG1	NM_022470 /// NM_152240	2.413
WNK4	NM_032387	2.064
XPO4	NM_022459	-3.104
XPO5	NM_020750	-2.248
YIPF4	NM_032312	2.158
YOD1	NM_018566	-3.320
YPEL3	NM_031477	3.060
YPEL5	NM_016061	3.006
YWHAH	NM_003405	2.764

ZA20D3	NM_019006	2.086
ZBTB20	NM_015642	2.163
ZBTB4	NM_020899	2.731
ZCCHC10	NM_017665	-2.061
ZCCHC9	NM_032280	-3.491
ZCSL2	NM_206831	-4.066
ZDHC2	NM_016353	2.520
ZFP90	NM_133458	2.099
ZHX3	NM_015035	2.008
ZNF117	NM_024498	2.157
ZNF161	NM_007146	2.163
ZNF200	NM_003454 /// NM_198087 /// NM_198088	-2.419
ZNF226	NM_001032372 /// NM_001032373 /// NM_001032374 /// NM_001032375 /// NM_015919	3.068
ZNF267	NM_003414	-2.131
ZNF329	NM_024620	2.017
ZNF432	NM_014650	2.618
ZNF514	NM_032788	2.073
ZNF678	NM_178549	-2.169
ZNF680	NM_178558	2.339
ZNF689	NM_138447	-2.188
ZNF706	NM_016096	2.074
ZNF708	NM_021269	2.382
ZNF83	NM_018300	2.269
ZRF1	XM_168590 /// XM_379909	-2.004
ZWILCH	NM_017975	-3.135
ZWINT	NM_001005413 /// NM_001005414 /// NM_007057 /// NM_032997	-2.272
ZYX	NM_001010972 /// NM_003461	2.039

Table 4. Genes with altered mRNA expression levels in HL-60 cells, following transfection with pre-miR hsa-let-7b.

Gene Symbol	RefSeq Transcript ID (Pruitt <i>et al.</i> , 2005)	Fold Change
AATF	NM_012138	-2.27
AB020674, AF245481	AB020674, AF245481	-2.89
AB032979	AB032979	-2.41
AB033091, SLC39A10	AB033091, NM_020342	-3.26
AB058774	AB058774	2.43
AB062477	AB062477	3.08
AB083483	AB083483	3.71
ABCA3	BC062779, NM_001089	2.05
ABCF2	NM_005692	-2.88
ACADVL	BC020218, NM_000018	-2.65
ACPI	NM_004300, NM_007099, NM_177554	-2.71
ADIPOR2	NM_024551	-2.64
AF011390	AF011390	2.32
AF090928	AF090928	-3.71

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AF116680	AF116680	2.75
AF240698	AF240698	-2.14
AF277180	AF277180	-2.27
AF289562	AF289562	2.29
AF289565	AF289565	2.55
AF346307	AF346307	2.55
AF439711	AF439711	2.73
AF445026	AF445026	2.17
AF502589	AF502589	-2.11
AHCY	M61831, NM_000687	-3.55
AJ515384	AJ515384	-3.09
AK001073, BC080641	AK001073, BC080641	2.72
AK001987	AK001987	2.28
AK001998	AK001998	2.31
AK022118	AK022118	2.54
AK024110	AK024110	2.08
AK024190	AK024190	-2.94
AK026367	AK026367	2.11
AK026780	AK026780	2.36
AK027395, AL136861, AY358413, BC063012, CR593410	AK027395, AL136861, AY358413, BC063012, CR593410	2.65
AK027583	AK027583	2.06
AK054654	AK054654	2.7
AK054935, MGC33962	AK054935, NM_152479	2.27
AK056176	AK056176	2.7
AK057017	AK057017	2.65
AK057222, MGC16372	AK057222, NM_145038	3.2
AK057372	AK057372	2.23
AK058196	AK058196	2.19
AK090733, BC003505	AK090733, BC003505	2.92
AK091523	AK091523	2.63
AK093431	AK093431	2.17
AK094354	AK094354	3.32
AK095939, BC003083	AK095939, BC003083	-2.39
AK096571	AK096571	2.1
AK097091, AK097411, LOC153561	AK097091, AK097411, NM_207331	4.51
AK097411, BC050737, LOC153561	AK097411, BC050737, NM_207331	4.51
AK123855,	AK123855, BC006300	2.89

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BC006300		
AK124968	AK124968	-2.22
AK125351	AK125351	2.67
AK125522, ATP6V0D1	AK125522, NM_004691	-2.35
AK125850	AK125850	-2.91
AK125850, AL833349	AK125850, AL833349	-2.91
AK126051	AK126051	2.47
AK126465	AK126465	-2.88
AK127284	AK127284	-2.03
AK127639	AK127639	2.17
AK127692, NDUFA11	AK127692, NM_175614	-4.14
AK128554	AK128554	-2.12
AK131383	AK131383	-2.3
AK131517, BC063666	AK131517, BC063666	2.62
AK2	NM_013411	-3.48
AKAP5	NM_004857	4.41
AKAP8L	NM_014371	-2.23
AKR1CL2	AB040821, AB040822, AF263242, NM_031436	2.93
ALDH3A2	NM_000382	3.22
ALG1	NM_019109	-2.31
ALOX15B	AF468053	3.81
ALOX5AP	NM_001629	-2.86
ALS2CR19	AB073472, AF428250, AF428251, AF466152, NM_152526, NM_205863	-3.48
ALS2CR7	NM_139158	3.02
AMD1	BC000171	-2.78
ANP32C	NM_012403	2.65
ANTXR1	AK001463, NM_053034	3.75
ANXA6	AK130077, NM_001155, NM_004033	-2.37
APBA3	NM_004886	2.01
APG3L	NM_022488	-3.43
APLP2	BC000373	-2.81
ARHGAP18	AL834511, NM_033515	3.11
ARHGAP26	BC068555, NM_015071	2.01
ARID1A	AF231056, AF268913, AF521670, NM_006015, NM_018450, NM_139135	-3.37
ARPC5, BC057237, BC071857	BC057237, BC071857, NM_005717	-2.51
ASF1B	NM_018154	-2.61
ASNA1	NM_004317	-2.03
ATF3	AB078026, AY313926, AY313927	-3.8
ATF4	NM_001675	-2.09
ATP2A2	NM_001681, NM_170665	-4.57

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ATP5G3	NM_001002256	-2.27
ATP6V1F	NM_004231	-2.76
ATRX	NM_000489, NM_138270, NM_138271, U72937	2.1
ATXN7L2	BC036849	3.95
AY081145	AY081145	-2.05
AY099328, BC002509	AY099328, BC002509	2.53
AY345239, FLJ13798	AY345239, NM_024773	-2.5
AY358738	AY358738	4.71
AY692447, BC040622, LOC340069	AY692447, BC040622, NM_182761	-2.93
AYP1	NM_032193	3.72
BAG1	AFI16273	-2.94
BAG2	NM_004282	-2.84
BAG5	NM_001015049, NM_004873	-2.24
BANF1	NM_003860	-2.92
BAT2	NM_004638, NM_080686	-2.53
BC004492	BC004492	2.02
BC006177	BC006177	-4.17
BC007516	BC007516	4.53
BC009792	BC009792	3.08
BC011671	BC011671	2.63
BC013796	BC013796	-2.96
BC014654	BC014654	-2.39
BC016050	BC016050	-2.4
BC016654	BC016654	-2.16
BC020256	BC020256	-2.36
BC020670	BC020670	2.37
BC021187	BC021187	-2.62
BC025700	BC025700	-3.61
BC029496	BC029496	2.3
BC029580	BC029580	3.49
BC030200	BC030200	2.64
BC032334	BC032334	-2.39
BC032396, BC041379	BC032396, BC041379	2.14
BC032420	BC032420	2.74
BC035554	BC035554	-3.11
BC035875	BC035875	-2.74
BC035935, BC056271, LOC51321	BC035935, BC056271, NM_016627	-3.34
BC036832	BC036832	-4.43
BC040013	BC040013	4.24
BC040441, BC068599	BC040441, BC068599	2.12

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BC041860, BC047720, BX647229	BC041860, BC047720, BX647229	2.25
BC045618, BC057784	BC045618, BC057784	-3.92
BC062325	BC062325	-4.02
BC064430	BC064430	-3.1
BC064479	BC064479	2.05
BC065557	BC065557	2.03
BC066124, BC066775	BC066124, BC066775	-2.43
BC066644	BC066644	-2.35
BC073829	BC073829	-2.5
BC093044	BC093044	-3.07
BEXL1	BC015794	-2.54
BFAR	NM_016561	-2.77
BIN1	AF068916, NM_139346, NM_139348	2.42
BIN2	BC047686, NM_016293	4.57
BMP2	NM_001200	-5.22
BPI	BC032230, NM_001725	2.96
BRAP	NM_006768	-2.09
BST2	AK223124, NM_004335	-2.06
BZRP	NM_000714, NM_007311	-3.32
C10orf45	BC064407, NM_031453	-2.48
C10orf67	BC035732, NM_153714	2.26
C10orf94	BC034821	-2.45
C12orf12	NM_152638	3.91
C14orf103	NM_018036	2.12
C14orf153	NM_032374	-2.55
C14orf48	AK097741, NM_152777	-3.86
C15orf12	NM_018285	-3.2
C17orf27	BC032220, BX647946, NM_020914	-2.41
C19orf25	BC018441, NM_152482	3.8
C1orf26	BC030781, NM_017673	2.98
C1orf64	NM_178840	2.08
C1QBP	NM_001212	-2.72
C1QTNF2	NM_031908	2.36
C1QTNF3	NM_030945, NM_181435	2.13
C20orf27	BC024036, CR615129, NM_017874	4.34
C2orf29	NM_017546	-2.92
C3orf10	NM_018462	-3
C4orf16	BC009485, BX647702, NM_018569	-2.7
C5orf19	AK223611, NM_016606	3.03
C6orf108	NM_006443	-2.49
C6orf128	BC026012, BC029657, NM_145316	3.24
C6orf136	BC073975, NM_145029	-2.41

C6orf155	NM_024882	-2.56
C6orf62	NM_030939	-2.58
C6orf69	AY305862, BC023525, NM_173562	-4.01
C6orf96	AK000634, NM_017909	-2.69
C8orf6	AJ307469	-2.59
C9orf156	BC002863, NM_016481	2.66
C9orf16	NM_024112	-2.69
C9orf46	NM_018465	3.54
CABP7	NM_182527	-2.56
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CACNA2D3	AF516696, AJ272213, NM_018398	2.23
CAD	NM_004341	-3.71
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CAMK2N1	NM_018584	2.1
CAPNS1	BC011903, NM_001749	-2.89
CASC3	BC044656	3.03
CASP6	NM_001226	-2.27
CAST	NM_015576	2.29
CBX1	NM_006807	-2.72
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CCT4	NM_006430	-2.77
CCT7	NM_006429	-2.92
CD81	NM_004356	-2.48
CDC2L1	AB209095, AF067519, AF067520, AF067521, AF067522, AF067523, AF067525, NM_001787, NM_024011, NM_033486, NM_033488, NM_033489, NM_033490, NM_033492, NM_033493, NM_033528, NM_033529, NM_033531, NM_033534, NM_033537, U04816, U04817, U04818, U04824, U07705	-2.18
CDC2L2	AB209095, AF067512, AF067514, AF067516, AF067520, AF067521, AF067522, AF067523, AF067525, NM_033534, NM_033536, NM_033537	-2.18
CDC45L	AJ223728, CR604288, NM_003504	-3.47
CDKL1	NM_004196	2.35
CEACAM6	BC005008, M18728, NM_002483	3.85
CEBPE	NM_001805	-3.42
CGI-128	NM_016062	-3.04
CGI-63	BC001419, NM_016011	-3.3
CHAD	NM_001267	-4.68
CHCHD1	NM_203298	-2.64
CHMP2A	NM_198426	-2.93
CHRNA1	NM_000747	2.12
CHST3	NM_004273	2.23
CINP	NM_032630	-2.09
CIP29	NM_033082	-2.9
CLC	NM_001828	2.59
CLIC1	NM_001288, X87689	-3.8

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CLTA	NM_001833	-3.71
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CNTNAP3	AK054645, NM_033655	2.31
COL1A2	NM_000089	2.35
COPA	BC038447, NM_004371	-3.21
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CORO1A	AB209221, NM_007074	-4.94
COTL1	AK127352, NM_021149	-4.4
COX8A	NM_004074	-2.48
CPNE1	NM_152930	-2.68
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CR605850	CR605850	-4.54
CR607440	CR607440	2.35
CR933646	CR933646	-2.56
CRHBP	NM_001882	2.31
CRR9	AK126225, BC025305, NM_030782	-2.85
CSF1	NM_000757, NM_172211	2.57
CSMD2	AK122603, AK127722	-3.29
CSNK2B	CR592250, NM_001320	-2.73
CTNS	BC032850, NM_004937	2.58
CUL1	BC034318, NM_003592, U58087	-2.34
CUL7	NM_014780	4.34
CXorf9	NM_018990	-2.24
CXXC1	BC015733, NM_014593	-2.94
CYC1	NM_001916	-3.41
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DDOST	D29643	-2.41
DDX39	BC032128, NM_005804, NM_138998	-4.77
DDX50	NM_024045	2.67
DGCR6	BC047039, NM_005675	-2.45
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DHX35	AK025541, BC033453, NM_021931	-2.09
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DKFZP564J0863	NM_015459	-2.77
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DNAJC12	NM_201262	-2.07
DNAJC6	NM_014787	2
DNCLI1	NM_016141	-2.56
DNCLI2	NM_006141	4.94
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DRG1	NM_004147	-2.5
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EDIL3	BC053656, NM_005711	2.06
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EEF1D	NM_001960, NM_032378	-3.63
EEF1G	AF119850, NM_001404	-2.67
EEF2	NM_001961	-3.58
EIF2S3	BC019906	-3.08
EIF3S4	NM_003755	-2.83
EIF3S8	BC001571, NM_003752	-3.92
EIF4A1	NM_001416	-4.52
EIF4EBP1	NM_004095	-2.42
ELF1	BC030507, NM_172373	-3.56
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ENO1	BC073991, NM_001428	-6.06
ENO3	NM_001976	2.02
EPB41	BC039079	4.22
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FAM54B	AF173891, AK056721, BC017175, NM_019557	-3.41
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FBL	NM_001436	-4.61
FBP2	NM_003837	2.01
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FBXO42	NM_018994	2.73
FH	NM_000143	-2.05
FIBP	NM_004214, NM_198897	-3.44
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FLJ10490	NM_018111	2.01
FLJ10774	NM_024662	-3.89
FLJ11305	NM_018386	-2.45
FLJ12760	NM_001005372	-2.8
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FLJ37794	NM_173588	-3.02
FLJ42461	NM_198501	-5.18
FLJ90650	BC094716, NM_173800	2.32
FOXP3	NM_014009	-4.42
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FTSJ1	NM_012280, NM_177439	-2.97
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FXYS5	AF177940, NM_144779	-2.56
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GAPDH	NM_002046, X53778	-3.7
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GCHFR	NM_005258	-2.56
GDI2	NM_001494	-3.77
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GIP	NM_004123	2.16
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GMDS	AF040260, BC000117, NM_001500	-2.83
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GPR3	NM_005281	-2.04
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HAND2	NM_021973	2.07
HAX1	NM_006118	-2.45
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HIST1H2BN	BC009783, BC011372, NM_003520	2.1
HIST1H3G	NM_003534	-2.62
HIST1H4C	NM_003542	-2.19
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HLCS	NM_000411	2.08
HMG2L1	NM_001003681, NM_005487	-2.97
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HMGB1	NM_002128	-3.34
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HNRPL	BC069184, NM_001533	-4.23
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IFIT5	BC025786	2.13
IFRD2	NM_006764, Y12395	-2.45
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IL6ST	AB102799, NM_002184, NM_175767	2.3
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ILF2	NM_004515	-3.78
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INO80	NM_017553	3.37
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LETMD1	AK127540, AY259835, AY259836, BC064943, NM_015416	-2.46
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LGALS1	NM_002305	-3.19
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MCM5	NM_006739	-2.85
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MSH2	NM_000251	-2.16
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MUSTN1	NM_205853	3.94
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PAF53	AK091294, NM_022490	-2.77
PARK7	NM_007262	-2.19
PCBP1	NM_006196	-3.81
PCBP2	AB188306, AB208825, NM_005016, NM_031989, X78136	-3.42
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PDXK	BC000123, BC005825	-2.41
PECI	AB209917, AF244138, BC002668, BC034702, NM_006117, NM_206836	-2.25
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PFN1	NM_005022	-4.27
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PRDX1	NM_002574	-2.87
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PRTN3	M29142, NM_002777	-2.55
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PSMB8	NM_004159, NM_148919	-3.33
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PTD008	NM_016145	-2.93
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PUS1	AF318369, NM_025215	3.01
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RABGGTB	NM_004582	-2.37
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RALB	AK127675, NM_002881	-2.16
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RASGRP2	AK092882, NM_005825, NM_153819	-2.8
RASGRP3	AB020653, NM_170672	2.06

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RBP3	J03912, NM_002900	-2.23
RFC2	NM_002914, NM_181471	-3.01
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RHBDL1	AJ272344, NM_003961	4.81
RHOA	NM_001664	-4.04
RHOG	NM_001665	-2.7
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RNPEP	NM_020216	-3.57
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RPL18	NM_000979	-4.27
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RPL22	NM_000983	-2.27
RPL29	NM_000992	-2.19
RPL3	AY320405, NM_000967	-2.97
RPL5	AB208980, BC001882, NM_000969	-3.82
RPL6	BC022444, NM_000970	-2.69
RPL8	NM_033301	-5.39
RPN2	AK096243, NM_002951	-3.92
RPS14	NM_005617	-3.06
RPS19	NM_001022	-2.96
RPS3	BC034149, BC071669, NM_001005	-4.08
RPS5	NM_001009	-3.23
RPS9	NM_001013	-4.54
RSL1D1	NM_015659	-3.37
RUVBL1	NM_003707	-2.63
S82297	S82297	-2.64
SAFB2	NM_014649	5.33
SCGB1C1	NM_145651	2.06
SCN8A	NM_014191	-2.15
SCN9A	NM_002977	2.76
SEC10L1	NM_006544	-3.38
SELO	AY324823, NM_031454	-2.66
SEPT10	BC020502, NM_144710, NM_178584	2.61
SEPT6	AF403061	-3.51
SERF2	BC008214, NM_005770	-4.61

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SETDB1	BC009362, D31891, NM_012432	-2.08
SFRP2	NM_003013	2.85
SH3BGR	NM_007341	3.69
SH3YL1	BC008374, BC008375, NM_015677	2.28
SHMT2	BC011911, BC032584, NM_005412	-4.13
SIDT1	NM_017699	-2.84
SIM1	NM_005068	2.28
SIVA	AK128704, NM_006427, NM_021709	-2.66
SLC16A3	NM_004207	-2.43
SLC22A4	NM_003059	2.16
SLC25A3	NM_005888, NM_213611, NM_213612	-2.77
SLC25A6	NM_001636	-4.89
SLC35E1	AK027850, BC062562, NM_024881	-2.3
SLC39A3	NM_144564	-2.69
SLC40A1	NM_014585	2.41
SLC6A13	NM_016615	2.16
SLC7A1	NM_003045	2.28
SLC8A3	AF510501, AF510502, NM_033262, NM_058240, NM_182932, NM_182933, NM_182936, NM_183002	3.82
SMARCB1	AK024025, NM_001007468, NM_003073	-2.27
SND1	BC017180, NM_014390	-3.44
SNRP70	BC001315, CR592978, NM_001009820, NM_003089	2.83
SNRPA	NM_004596	-4.38
SNRPB	NM_198216	-4.7
SNX17	NM_014748	-2.81
SPHK1	BC030553, NM_021972, NM_182965	2.15
SRM	NM_003132	-4.07
SSR2	BC000341, BX649192, CR600571, NM_003145	-3.46
SSR4	NM_006280	-3.35
STAR	NM_000349	4.48
STIM1	NM_003156	-2.14
STX16	AF038897, AF305817, AF428146, BC073876, NM_001001433, NM_001001434, NM_003763	-3.49
SULF2	AY358461, BC020962, NM_018837, NM_198596	2.06
SUPT16H	NM_007192	-3.16
SUV420H1	BC012933, NM_017635	3.27
SYNCRIP	AF155568, BC032643, BC040844	-4
SYT9	BC046367, NM_175733	2.76
TBC1D2	AF318370, AK124772, BC028918, BC071978, NM_018421	2.11
TCEA3	AY540752, NM_003196	2.21
TCF2	NM_000458	2.05
TCP1	NM_030752	-2.98
TEGT	NM_003217	-2.29
TFDP1	NM_007111	-2.66
TGM6	AF540970, NM_198994	2.24

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TH1L	AJ238379, AK023310, NM_198976	-3.38
THEM2	NM_018473	2.81
THOC4	NM_005782	-3.1
TIGD5	BC032632, NM_032862	4.05
TIMM17B	BC091473, NM_005834	-2.65
TIMM50	CR617826, NM_001001563	-4.13
TIMP1	BC000866, NM_003254	-2.69
TKT	BC002433, NM_001064	-3.34
TM4SF5	NM_003963	2.91
TMEM49	NM_030938	-2.88
TMPRSS11E	AF064819, NM_014058	2.27
TNFAIP2	NM_006291	2.37
TOMM22	NM_020243	-4.55
TOMM70A	NM_014820	-2.27
TOP1	NM_003286	2.36
TPM3	AK056889, AK056921, AK092712, BC072428, BX648485, NM_153649	-3.5
TPST2	NM_001008566	-2.27
TRIM28	BC052986, NM_005762	-3.66
TRIM6	CR749260, NM_001003818, NM_058166	2.37
TRIP3	NM_004773	-2.48
TRPM4	AJ575813, AY297046, NM_017636	2.78
TSC	BC015221, NM_017899	-2.77
TSK	NM_015516	3
TTC11	NM_016068	-3.32
TTC19	AK025958, AK056878, NM_017775	-2.46
TUBA6	NM_032704	-2.67
TUBB	BC007605, NM_178014	-3.23
TUFM	BC001633, NM_003321, S75463	-3.29
U16258	U16258	2.05
U5-116KD	BC002360, NM_004247	-2.96
U78723	U78723	-2.57
UBADC1	NM_016172	-2.64
UBE1	AK097343, NM_003334, X52897	-3.72
UBE2L3	NM_003347	-3.22
UBE2M	NM_003969	-3.39
UBE2NL	NM_001012989	-2.88
UBE2S	NM_014501	-3.25
UBE4B	AF043117, BC093696, NM_006048	3.16
UGP2	NM_001001521, NM_006759	-2.35
UNC5B	AY126437, NM_170744	2.19
UNQ473	NM_198477	2.52
UNQ9391	NM_198464	2.19
UQCRC1	CR618343, NM_003365	-2.35
UQCRC2	NM_003366	-3.57

URP2	NM_031471, NM_178443	3.55
UVRAG	NM_003369	2.65
UXT	NM_004182, NM_153477	-2.31
VAMP8	NM_003761	-2.61
VAPB	AF086629, AK127252, AK128422, NM_004738	2.4
VDAC1	NM_003374	-4.67
VDAC2	BC000165, L08666, NM_003375	-3.64
VGLL4	NM_014667	-3.21
VIM	AK093924, NM_003380	-2.71
VIP	NM_003381, NM_194435	2.29
WDR58	AK075330, BC050674, NM_024339	-2.02
WDR60	BC014491, NM_018051	2.42
WDR61	NM_025234	-2.93
WIG1	AK122768, NM_022470	-2.21
XAB2	BC007208, NM_020196	5.29
XRCC6	AK055786, CR456492, NM_001469	-3.91
Y00638	Y00638	-3
YWHAE	NM_006761	-2.37
YWHAH	BC003047, NM_003405	-3.07
ZBTB1	BC050719, NM_014950	2.05
ZDHHC8	AK131238, BC053544, NM_013373	2.37
ZKSCAN1	NM_003439	-2.32
ZNF167	NM_025169	2.2
ZNF207	BC002372, BC008023, CR616570, NM_003457	-3.31
ZNF323	BC008490, NM_030899, NM_145909	2.53
ZNF407	NM_017757	2.31
ZNF436	NM_030634	2.88
ZSWIM4	AK024452	2
ZYX	NM_003461	-2.87

Negative fold change values in Table 4 indicate a reduction in mRNA levels for a given gene compared to that observed for the negative controls.

[00256] Negative fold change values in Table 2, 3 and 4 indicate a reduction in mRNA levels for a given gene compared to that observed for the negative controls.

[00257] The results demonstrate that let-7 expression altered the expression levels, by at least two-fold, of 558 genes (217 down-regulated, 341 up-regulated) in A549 cells, 1035 genes (531 down-regulated, 504 up-regulated) in HepG2 cells and 721 genes (441 down-regulated, 280 up-regulated) in HL-60 cells.

EXAMPLE 3:
PREDICTED GENE TARGETS OF LET-7

[00258] Gene targets for binding of hsa-let-7a, hsa-let-7b, and hsa-let-7g were predicted using the proprietary algorithm miRNA Target™ (Asuragen) and are shown in Table 5, the content of all database submission incorporated herein by reference in its entirety, as presented on the filing date of this application.

Table 5. Target genes of hsa-let-7a, hsa-let-7b, and hsa-let-7g.

Gene Symbol	RefSeq	Gene Name
2'-PDE	NM_177966	2'-phosphodiesterase
ABCB9	NM_019624	ATP-binding cassette, sub-family B (MDR/TAP),
ABCC10	NM_033450	ATP-binding cassette, sub-family C, member 10
ABCC5	NM_005688	ATP-binding cassette, sub-family C, member 5
ACSL6	NM_001009185	acyl-CoA synthetase long-chain family member 6
ACTR2	NM_001005386	actin-related protein 2 isoform a
ACVR1B	NM_004302	activin A type IB receptor isoform a precursor
ACVR2A	NM_001616	activin A receptor, type IIA precursor
ADAM15	NM_207191	a disintegrin and metalloproteinase domain 15
ADAMTS5	NM_007038	ADAM metalloproteinase with thrombospondin type 1
ADAMTS8	NM_007037	ADAM metalloproteinase with thrombospondin type 1
ADCY9	NM_001116	adenylate cyclase 9
ADIPOR2	NM_024551	adiponectin receptor 2
ADRB2	NM_000024	adrenergic, beta-2-, receptor, surface
ADRB3	NM_000025	adrenergic, beta-3-, receptor
AHCTF1	NM_015446	transcription factor ELYS
AKAP6	NM_004274	A-kinase anchor protein 6
ANGPTL2	NM_012098	angiopoietin-like 2 precursor
ANKFY1	NM_016376	ankyrin repeat and FYVE domain containing 1
ANKRD43	NM_175873	ankyrin repeat domain 43
ANKRD49	NM_017704	fetal globin inducing factor
AP1S1	NM_057089	adaptor-related protein complex 1, sigma 1
APBB3	NM_006051	amyloid beta precursor protein-binding, family
APPBP2	NM_006380	amyloid beta precursor protein-binding protein
ARHGAP20	NM_020809	Rho GTPase activating protein 20
ARHGAP28	NM_001010000	Rho GTPase activating protein 28 isoform a
ARHGEF15	NM_173728	Rho guanine exchange factor 15
ARID3A	NM_005224	AT rich interactive domain 3A (BRIGHT-like)
ARID3B	NM_006465	AT rich interactive domain 3B (BRIGHT-like)
ARL5A	NM_012097	ADP-ribosylation factor-like 5A isoform 1
ARPP-19	NM_006628	cyclic AMP phosphoprotein, 19 kD
ASAH3L	NM_001010887	N-acylsphingosine amidohydrolase 3-like
ATG16L1	NM_017974	APG16 autophagy 16-like isoform 2
ATP2A2	NM_170665	ATPase, Ca ⁺⁺ transporting, cardiac muscle, slow
ATP2B1	NM_001001323	plasma membrane calcium ATPase 1 isoform 1 ^a
ATP2B3	NM_021949	plasma membrane calcium ATPase 3 isoform 3 ^a
ATP2B4	NM_001001396	plasma membrane calcium ATPase 4 isoform 4 ^a
ATXN1	NM_000332	ataxin 1
BACH1	NM_001186	BTB and CNC homology 1 isoform a
BCAP29	NM_001008405	B-cell receptor-associated protein BAP29 isoform
BCL2L1	NM_001191	BCL2-like 1 isoform 2
BCL7A	NM_001024808	B-cell CLL/lymphoma 7A isoform b

BIN3	NM_018688	bridging integrator 3
BNC2	NM_017637	basonuclein 2
BRD3	NM_007371	bromodomain containing protein 3
BTBD3	NM_014962	BTB/POZ domain containing protein 3 isoform a
BTG2	NM_006763	B-cell translocation gene 2
BZW1	NM_014670	basic leucine zipper and W2 domains 1
BZW2	NM_014038	basic leucine zipper and W2 domains 2
C10orf6	NM_018121	hypothetical protein LOC55719
C11orf11	NM_006133	neural stem cell-derived dendrite regulator
C11orf51	NM_014042	hypothetical protein LOC25906
C11orf57	NM_018195	hypothetical protein LOC55216
C15orf29	NM_024713	hypothetical protein LOC79768
C15orf41	NM_032499	hypothetical protein LOC84529
C1orf22	NM_025191	hypothetical protein LOC80267
C21orf29	NM_144991	chromosome 21 open reading frame 29
C22orf8	NM_017911	hypothetical protein LOC55007
C3orf64	NM_173654	AER61 glycosyltransferase
C3orf9	NM_152305	hypothetical protein LOC56983
C6orf120	NM_001029863	hypothetical protein LOC387263
C6orf211	NM_024573	hypothetical protein LOC79624
C8orf36	NM_173685	hypothetical protein LOC286053
C9orf28	NM_033446	hypothetical protein LOC89853 isoform 1
C9orf7	NM_017586	hypothetical protein LOC11094
CALD1	NM_004342	Caldesmon 1 isoform 2
CAP1	NM_006367	adenylyl cyclase-associated protein
CASP3	NM_004346	caspase 3 preproprotein
CBL	NM_005188	Cas-Br-M (murine) ecotropic retroviral
CBX2	NM_005189	chromobox homolog 2 isoform 1
CCND1	NM_053056	cyclin D1
CCND2	NM_001759	cyclin D2
CCNJ	NM_019084	cyclin J
CCR7	NM_001838	Chemokine (C-C motif) receptor 7 precursor
CD164	NM_006016	CD164 antigen, sialomucin
CDC25A	NM_001789	cell division cycle 25A isoform a
CDC34	NM_004359	cell division cycle 34
CDV3	NM_017548	CDV3 homolog
CDYL	NM_004824	chromodomain protein, Y chromosome-like isoform
CEECAM1	NM_016174	cerebral endothelial cell adhesion molecule 1
CEP164	NM_014956	hypothetical protein LOC22897
CGNL1	NM_032866	cingulin-like 1
CHD7	NM_017780	chromodomain helicase DNA binding protein 7
CHD9	NM_025134	chromodomain helicase DNA binding protein 9
CHES1	NM_005197	checkpoint suppressor 1
CLASP2	NM_015097	CLIP-associating protein 2
CLDN12	NM_012129	claudin 12
COIL	NM_004645	Coilin
COL14A1	NM_021110	collagen, type XIV, alpha 1
COL15A1	NM_001855	alpha 1 type XV collagen precursor
COL19A1	NM_001858	alpha 1 type XIX collagen precursor
COL1A1	NM_000088	alpha 1 type I collagen preproprotein
COL1A2	NM_000089	alpha 2 type I collagen
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
COL4A5	NM_000495	alpha 5 type IV collagen isoform 1, precursor
COL5A2	NM_000393	alpha 2 type V collagen preproprotein
CPA4	NM_016352	carboxypeptidase A4 preproprotein
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
CPM	NM_001005502	carboxypeptidase M precursor
CPSF4	NM_006693	cleavage and polyadenylation specific factor 4,
CROP	NM_016424	cisplatin resistance-associated overexpressed
CRTAP	NM_006371	cartilage associated protein precursor
CTDSPL2	NM_016396	CTD (carboxy-terminal domain, RNA polymerase II,
CTNS	NM_004937	Cystinosis, nephropathic isoform 2
CTSC	NM_148170	cathepsin C isoform b precursor
CYP19A1	NM_000103	cytochrome P450, family 19
DCUN1D2	NM_001014283	hypothetical protein LOC55208 isoform b
DCUN1D3	NM_173475	hypothetical protein LOC123879
DCX	NM_000555	doublecortin isoform a
DDI2	NM_032341	DNA-damage inducible protein 2
DDX19A	NM_018332	DDX19-like protein
DDX19B	NM_001014449	DEAD (Asp-Glu-Ala-As) box polypeptide 19 isoform
DDX19-DDX19L	NM_001015047	DDX19-DDX19L protein
DHX57	NM_198963	DEAH (Asp-Glu-Ala-Asp/His) box polypeptide 57
DKFZp686K16132	NM_001012987	hypothetical protein LOC388957
DLC1	NM_006094	deleted in liver cancer 1 isoform 2
DLST	NM_001933	dihydrolipoamide S-succinyltransferase (E2
DMD	NM_000109	Dystrophin Dp427c isoform
DMP1	NM_004407	dentin matrix acidic phosphoprotein
DNAJC1	NM_022365	DnaJ (Hsp40) homolog, subfamily C, member 1
DOCK3	NM_004947	dedicator of cytokinesis 3
DPP3	NM_005700	dipeptidyl peptidase III
DSCAM	NM_206887	Down syndrome cell adhesion molecule isoform
DST	NM_015548	dystonin isoform 1eA precursor
DTX2	NM_020892	deltex 2
DUSP1	NM_004417	dual specificity phosphatase 1
DUSP16	NM_030640	dual specificity phosphatase 16
DUSP9	NM_001395	dual specificity phosphatase 9
DYRK1A	NM_001396	dual-specificity tyrosine-(Y)-phosphorylation
DZIP1	NM_014934	DAZ interacting protein 1 isoform 1
E2F5	NM_001951	E2F transcription factor 5
EFHD2	NM_024329	EF hand domain family, member D2
EIF2C4	NM_017629	Eukaryotic translation initiation factor 2C, 4
EIF4G2	NM_001418	Eukaryotic translation initiation factor 4
ELOVL4	NM_022726	Elongation of very long chain fatty acids
EPHA3	NM_005233	ephrin receptor EphA3 isoform a precursor
EPHA4	NM_004438	ephrin receptor EphA4
ERCC6	NM_000124	excision repair cross-complementing rodent
ERGIC1	NM_001031711	endoplasmic reticulum-golgi intermediate
FAM104A	NM_032837	hypothetical protein LOC84923
FAM84B	NM_174911	breast cancer membrane protein 101
FAM96A	NM_001014812	hypothetical protein FLJ22875 isoform b
FARP1	NM_005766	FERM, RhoGEF, and pleckstrin domain protein 1
FASLG	NM_000639	fas ligand
FBXL19	NM_019085	F-box and leucine-rich repeat protein 19
FGF11	NM_004112	fibroblast growth factor 11
FIGN	NM_018086	Fidgetin
FLJ20232	NM_019008	hypothetical protein LOC54471
FLJ20309	NM_017759	hypothetical protein LOC54891
FLJ21986	NM_024913	hypothetical protein LOC79974
FLJ25476	NM_152493	hypothetical protein LOC149076
FLJ31818	NM_152556	hypothetical protein LOC154743
FLJ36031	NM_175884	hypothetical protein LOC168455

FLJ36090	NM_153223	hypothetical protein LOC153241
FLJ39779	NM_207442	hypothetical protein LOC400223
FLJ90709	NM_173514	hypothetical protein LOC153129
FNDC3A	NM_014923	Fibronectin type III domain containing 3A
FNDC3B	NM_022763	Fibronectin type III domain containing 3B
FRAS1	NM_025074	Fraser syndrome 1 isoform 1
GAB2	NM_012296	GRB2-associated binding protein 2 isoform b
GABPA	NM_002040	GA binding protein transcription factor, alpha
GALE	NM_000403	UDP-galactose-4-epimerase
GALNT1	NM_020474	polypeptide N-acetylgalactosaminyltransferase 1
GALNTL2	NM_054110	UDP-N-acetyl-alpha-D-galactosamine:polypeptide
GAN	NM_022041	Gigaxonin
GAS7	NM_003644	growth arrest-specific 7 isoform a
GCNT4	NM_016591	core 2 beta-1,6-N-acetylglucosaminyltransferase
GDPD1	NM_182569	glycerophosphodiester phosphodiesterase domain
GGA3	NM_014001	ADP-ribosylation factor binding protein 3
GHR	NM_000163	growth hormone receptor precursor
GIPC1	NM_005716	regulator of G-protein signaling 19 interacting
GM632	NM_020713	hypothetical protein LOC57473
GNAL	NM_002071	guanine nucleotide binding protein (G protein),
GNG5	NM_005274	guanine nucleotide binding protein (G protein),
GNS	NM_002076	glucosamine (N-acetyl)-6-sulfatase precursor
GOLT1B	NM_016072	golgi transport 1 homolog B
GPATC3	NM_022078	G patch domain containing 3
GPR137	NM_020155	hypothetical protein LOC56834
GTF2I	NM_001518	general transcription factor II, i isoform 4
HAND1	NM_004821	basic helix-loop-helix transcription factor
HDHD1A	NM_012080	haloacid dehalogenase-like hydrolase domain
HDLBP	NM_005336	high density lipoprotein binding protein
HEAB	NM_006831	ATP/GTP-binding protein
HECTD2	NM_182765	HECT domain containing 2 isoform a
HIC2	NM_015094	hypermethylated in cancer 2
HK2	NM_000189	hexokinase 2
HMGA2	NM_001015886	high mobility group AT-hook 2 isoform c
HOMER2	NM_199331	homer 2 isoform 3
HOXA1	NM_153620	Homeobox A1 isoform b
HOXA9	NM_152739	Homeobox A9
HOXC11	NM_014212	Homeobox C11
HOXD1	NM_024501	Homeobox D1
HTR4	NM_000870	5-hydroxytryptamine (serotonin) receptor 4
IDH2	NM_002168	isocitrate dehydrogenase 2 (NADP+),
IGF2BP1	NM_006546	insulin-like growth factor 2 mRNA binding
IGF2BP2	NM_001007225	insulin-like growth factor 2 mRNA binding
IGF2BP3	NM_006547	insulin-like growth factor 2 mRNA binding
IKBKAP	NM_003640	inhibitor of kappa light polypeptide gene
IKBKE	NM_014002	IKK-related kinase epsilon
IL10	NM_000572	Interleukin 10 precursor
IL6	NM_000600	Interleukin 6 (interferon, beta 2)
INPP5A	NM_005539	inositol polyphosphate-5-phosphatase A
IRS2	NM_003749	insulin receptor substrate 2
ITGB3	NM_000212	integrin beta chain, beta 3 precursor
ITSN1	NM_001001132	Intersectin 1 isoform ITSN-s
JMJD1A	NM_018433	jumonji domain containing 1A
KIAA0179	NM_015056	hypothetical protein LOC23076
KIAA0664	NM_015229	hypothetical protein LOC23277
KIAA1539	NM_025182	hypothetical protein LOC80256
KIAA1961	NM_001008738	hypothetical protein LOC96459 isoform 2
KIF2	NM_004520	kinesin heavy chain member 2

KLF9	NM_001206	Kruppel-like factor 9
KLHL6	NM_130446	kelch-like 6
KPNA4	NM_002268	karyopherin alpha 4
LBH	NM_030915	hypothetical protein DKFZp566J091
LEPROTL1	NM_015344	leptin receptor overlapping transcript-like 1
LGR4	NM_018490	leucine-rich repeat-containing G protein-coupled
LIMD1	NM_014240	LIM domains containing 1
LIMD2	NM_030576	hypothetical protein LOC80774
LIN28B	NM_001004317	lin-28 homolog B
LNK	NM_005475	lymphocyte adaptor protein
LOC144097	NM_138471	hypothetical protein LOC144097
LOC220594	NM_145809	TL132 protein
LOC51136	NM_016125	PTD016 protein
LOXL4	NM_032211	lysyl oxidase-like 4 precursor
LPGAT1	NM_014873	lysophosphatidylglycerol acyltransferase 1
LRIG2	NM_014813	leucine-rich repeats and immunoglobulin-like
LRIG3	NM_153377	leucine-rich repeats and immunoglobulin-like
LRRC1	NM_018214	leucine rich repeat containing 1
LRRC17	NM_005824	leucine rich repeat containing 17 isoform 2
LRRFIP1	NM_004735	leucine rich repeat (in FLII) interacting
LSM11	NM_173491	LSM11, U7 small nuclear RNA associated
LYPLA3	NM_012320	lysophospholipase 3 (lysosomal phospholipase
MAP3K3	NM_002401	mitogen-activated protein kinase kinase kinase 3
MAP3K7IP2	NM_015093	mitogen-activated protein kinase kinase kinase 7
MAP4K3	NM_003618	mitogen-activated protein kinase kinase kinase
MAPK6	NM_002748	mitogen-activated protein kinase 6
MARCH9	NM_138396	Membrane-associated RING-CH protein IX
MDFI	NM_005586	MyoD family inhibitor
MECP2	NM_004992	methyl CpG binding protein 2
MED6	NM_005466	mediator of RNA polymerase II transcription,
MEF2D	NM_005920	MADS box transcription enhancer factor 2,
MEIS2	NM_002399	Homeobox protein Meis2 isoform f
MEIS3	NM_001009813	Meis1, myeloid ecotropic viral integration site
MGAT4A	NM_012214	Mannosyl (alpha-1,3-)-glycoprotein
MGC17330	NM_052880	HGFL protein
MGC61598	NM_001004354	hypothetical protein LOC441478
MGLL	NM_001003794	monoglyceride lipase isoform 2
MIB1	NM_020774	Mindbomb homolog 1
MLL5	NM_182931	myeloid/lymphoid or mixed-lineage leukemia 5
MLLT10	NM_001009569	myeloid/lymphoid or mixed-lineage leukemia
MLR1	NM_153686	transcription factor MLR1
MLR2	NM_032440	ligand-dependent corepressor
MMP11	NM_005940	matrix metalloproteinase 11 preproprotein
MNT	NM_020310	MAX binding protein
MTPN	NM_145808	Myotrophin
MYCL1	NM_001033081	l-myc-1 proto-oncogene isoform 1
MYCN	NM_005378	v-myc myelocytomatosis viral related oncogene,
MYRIP	NM_015460	myosin VIIA and Rab interacting protein
NAB1	NM_005966	NGFI-A binding protein 1
NAP1L1	NM_004537	nucleosome assembly protein 1-like 1
NAT12	NM_001011713	hypothetical protein LOC122830
NAT5	NM_181528	N-acetyltransferase 5 isoform c
NCOA1	NM_003743	nuclear receptor coactivator 1 isoform 1
NCOA3	NM_006534	nuclear receptor coactivator 3 isoform b
NDST2	NM_003635	N-deacetylase/N-sulfotransferase (heparan
NID2	NM_007361	nidogen 2
NKIRAS2	NM_001001349	NFKB inhibitor interacting Ras-like 2
NME4	NM_005009	Nucleoside-diphosphate kinase 4

NME6	NM_005793	Nucleoside diphosphate kinase type 6
NOPE	NM_020962	DDM36
NOVA1	NM_002515	neuro-oncological ventral antigen 1 isoform 1
NRAS	NM_002524	neuroblastoma RAS viral (v-ras) oncogene
NRK	NM_198465	Nik related kinase
NUMBL	NM_004756	numb homolog (Drosophila)-like
NUP98	NM_005387	nucleoporin 98kD isoform 3
NXT2	NM_018698	nuclear transport factor 2-like export factor 2
OLR1	NM_002543	oxidised low density lipoprotein (lectin-like)
OSBPL3	NM_015550	oxysterol-binding protein-like protein 3 isoform
OSMR	NM_003999	Oncostatin M receptor
P18SRP	NM_173829	P18SRP protein
P4HA2	NM_001017973	prolyl 4-hydroxylase, alpha II subunit isoform 2
PAK1	NM_002576	p21-activated kinase 1
PANX2	NM_052839	pannexin 2
PAPPA	NM_002581	Pregnancy-associated plasma protein A
PAX3	NM_181457	paired box gene 3 isoform PAX3
PBX2	NM_002586	pre-B-cell leukemia transcription factor 2
PBX3	NM_006195	pre-B-cell leukemia transcription factor 3
PCDH19	NM_020766	protocadherin 19
PCGF3	NM_006315	ring finger protein 3
PCYT1B	NM_004845	Phosphate cytidylyltransferase 1, choline, beta
PGM2L1	NM_173582	phosphoglucomutase 2-like 1
PGRMC1	NM_006667	progesterone receptor membrane component 1
PHF8	NM_015107	PHD finger protein 8
PIGA	NM_002641	phosphatidylinositol
PLCXD3	NM_001005473	phosphatidylinositol-specific phospholipase C, X
PLDN	NM_012388	Pallidin
PLEKHG6	NM_018173	pleckstrin homology domain containing, family G
PLEKHO1	NM_016274	OC120
PLXND1	NM_015103	plexin D1
POM121	NM_172020	nuclear pore membrane protein 121
PPAPDC2	NM_203453	phosphatidic acid phosphatase type 2 domain
PPARGC1A	NM_013261	peroxisome proliferative activated receptor
PPP1R12B	NM_002481	protein phosphatase 1, regulatory (inhibitor)
PPP1R15B	NM_032833	protein phosphatase 1, regulatory subunit 15B
PPP1R16B	NM_015568	protein phosphatase 1 regulatory inhibitor
PPP3CA	NM_000944	protein phosphatase 3 (formerly 2B), catalytic
PRDM2	NM_001007257	retinoblastoma protein-binding zinc finger
PREI3	NM_015387	preimplantation protein 3 isoform 1
PRPF38B	NM_018061	PRP38 pre-mRNA processing factor 38 (yeast)
PSCD3	NM_004227	Pleckstrin homology, Sec7 and coiled/coil
PSD3	NM_015310	ADP-ribosylation factor guanine nucleotide
PYGO2	NM_138300	pygopus homolog 2
PYY2	NM_021093	peptide YY, 2 (seminalplasmin)
RAB11FIP4	NM_032932	RAB11 family interacting protein 4 (class II)
RAB15	NM_198686	Ras-related protein Rab-15
RAB40C	NM_021168	RAR (RAS like GTPASE) like
RAI16	NM_022749	retinoic acid induced 16
RALB	NM_002881	v-ral simian leukemia viral oncogene homolog B
RALGPS1	NM_014636	Ral GEF with PH domain and SH3 binding motif 1
RANBP2	NM_006267	RAN binding protein 2
RASL10B	NM_033315	RAS-like, family 10, member B
RAVER2	NM_018211	ribonucleoprotein, PTB-binding 2
RB1	NM_000321	retinoblastoma 1
RBM9	NM_001031695	RNA binding motif protein 9 isoform 1
RDH10	NM_172037	retinol dehydrogenase 10
REEP1	NM_022912	receptor expression enhancing protein 1

RFXDC1	NM 173560	Regulatory factor X domain containing 1
RGAG1	NM 020769	retrotransposon gag domain containing 1
RGS16	NM 002928	regulator of G-protein signalling 16
RICTOR	NM 152756	Rapamycin-insensitive companion of mTOR
RIOK3	NM 003831	sudD suppressor of bimD6 homolog isoform 1
RNF38	NM 022781	ring finger protein 38 isoform 1
RNF44	NM 014901	ring finger protein 44
RNF5	NM 006913	ring finger protein 5
RNF7	NM 014245	ring finger protein 7 isoform 1
RNPC1	NM 017495	RNA-binding region containing protein 1 isoform
RORC	NM 001001523	RAR-related orphan receptor C isoform b
RPS6KA3	NM 004586	ribosomal protein S6 kinase, 90kDa, polypeptide
RRM2	NM 001034	ribonucleotide reductase M2 polypeptide
RRP22	NM 001007279	RAS-related on chromosome 22 isoform b
RSPO2	NM 178565	R-spondin family, member 2
RUFY3	NM 014961	rap2 interacting protein x isoform 2
SBK1	NM 001024401	SH3-binding domain kinase 1
SCN5A	NM 000335	voltage-gated sodium channel type V alpha
SCUBE3	NM 152753	signal peptide, CUB domain, EGF-like 3
SEC14L1	NM 003003	SEC14 (S. cerevisiae)-like 1 isoform a
SEC24C	NM 004922	SEC24-related protein C
SEMA3F	NM 004186	semaphorin 3F
SEN2	NM 021627	SUMO1/sentrin/SMT3 specific protease 2
SEN5	NM 152699	SUMO1/sentrin specific protease 5
SFRS12	NM 139168	splicing factor, arginine/serine-rich 12
SFRS8	NM 152235	splicing factor, arginine/serine-rich 8 isoform
SGCD	NM 000337	delta-sarcoglycan isoform 1
SLC20A1	NM 005415	solute carrier family 20 (phosphate
SLC25A18	NM 031481	solute carrier
SLC25A24	NM 013386	solute carrier family 25 member 24 isoform 1
SLC25A27	NM 004277	solute carrier family 25, member 27
SLC25A4	NM 001151	solute carrier family 25 (mitochondrial carrier;
SLC26A9	NM 052934	solute carrier family 26, member 9 isoform a
SLC30A4	NM 013309	solute carrier family 30 (zinc transporter),
SLC5A6	NM 021095	solute carrier family 5 (sodium-dependent
SLC6A1	NM 003042	solute carrier family 6 (neurotransmitter
SLC9A9	NM 173653	solute carrier family 9 (sodium/hydrogen
SLCO5A1	NM 030958	organic anion transporter polypeptide-related
SMARCAD1	NM 020159	SWI/SNF-related, matrix-associated
SNAP23	NM 003825	synaptosomal-associated protein 23 isoform
SNN	NM 003498	Stannin
SNX16	NM 022133	sorting nexin 16 isoform a
SOCS1	NM 003745	Suppressor of cytokine signaling 1
SOCS4	NM 080867	Suppressor of cytokine signaling 4
SOX13	NM 005686	SRY-box 13
SPATA2	NM 006038	spermatogenesis associated 2
SPRYD4	NM 207344	hypothetical protein LOC283377
STARD3NL	NM 032016	MLN64 N-terminal homolog
STAT3	NM 213662	signal transducer and activator of transcription
STK40	NM 032017	SINK-homologous serine/threonine kinase
STRBP	NM 018387	Spermatid perinuclear RNA-binding protein
STX17	NM 017919	syntaxin 17
STX3A	NM 004177	syntaxin 3A
STXBP5	NM 139244	Tomosyn
SURF4	NM 033161	surfeit 4
SYT1	NM 005639	synaptotagmin I
SYT11	NM 152280	synaptotagmin 12
TARBP2	NM 134324	TAR RNA binding protein 2 isoform b

TBKBP1	NM_014726	ProSAPiP2 protein
TBX5	NM_000192	T-box 5 isoform 1
TMED5	NM_016040	transmembrane emp24 protein transport domain
TMEM65	NM_194291	hypothetical protein LOC157378
TMPRSS2	NM_005656	transmembrane protease, serine 2
TNFRSF1B	NM_001066	tumor necrosis factor receptor 2 precursor
TOB2	NM_016272	Transducer of ERBB2, 2
TPP1	NM_000391	Tripeptidyl-peptidase I precursor
TRHDE	NM_013381	thyrotropin-releasing hormone degrading enzyme
TRIB1	NM_025195	G-protein-coupled receptor induced protein
TRIB2	NM_021643	tribbles homolog 2
TRIM33	NM_015906	tripartite motif-containing 33 protein isoform
TRIM41	NM_033549	tripartite motif-containing 41 isoform 1
TRPM6	NM_017662	transient receptor potential cation channel,
TSC22D2	NM_014779	TSC22 domain family 2
TTL	NM_153712	tubulin tyrosine ligase
TTL4	NM_014640	tubulin tyrosine ligase-like family, member 4
TUSC2	NM_007275	tumor suppressor candidate 2
UBXD2	NM_014607	UBX domain containing 2
UGCG1	NM_001025777	UDP-glucose ceramide glucosyltransferase-like 1
UHRF2	NM_152896	Np95-like ring finger protein isoform b
ULK2	NM_014683	unc-51-like kinase 2
UNC5A	NM_133369	netrin receptor Unc5h1
USP21	NM_001014443	ubiquitin-specific protease 21
USP32	NM_032582	ubiquitin specific protease 32
USP47	NM_017944	ubiquitin specific protease 47
VANGL2	NM_020335	vang-like 2 (van gogh, Drosophila)
VCPIP1	NM_025054	valosin containing protein (p97)/p47 complex
VSNL1	NM_003385	visinin-like 1
WAPAL	NM_015045	KIAA0261
WDFY3	NM_014991	WD repeat and FYVE domain containing 3 isoform
WNT1	NM_005430	wingless-type MMTV integration site family,
XKR8	NM_018053	X Kell blood group precursor-related family,
YOD1	NM_018566	hypothetical protein LOC55432
ZBTB10	NM_023929	zinc finger and BTB domain containing 10
ZBTB39	NM_014830	zinc finger and BTB domain containing 39
ZBTB5	NM_014872	zinc finger and BTB domain containing 5
ZCCHC5	NM_152694	zinc finger, CCHC domain containing 5
ZFYVE26	NM_015346	zinc finger, FYVE domain containing 26
ZMAT1	NM_001011656	zinc finger, matrin type 1 isoform 2
ZNF294	NM_015565	zinc finger protein 294
ZNF644	NM_016620	zinc finger protein 644 isoform 2
ZNF710	NM_198526	zinc finger protein 710
ZNF740	NM_001004304	zinc finger protein 740
ZSWIM4	NM_023072	zinc finger, SWIM domain containing 4

[00259] The predicted gene targets that exhibited altered mRNA expression levels in HepG2 and A549 cells, following transfection with pre-miR hsa-let-7b, are shown in Table 6 below.

Table 6. Predicted hsa-let-7 targets that exhibited altered mRNA expression levels in HepG2 and A549 cells 72 hrs after transfection with pre-miR hsa-let-7b.

Gene Symbol	RefSeq	Gene Name
Expression Altered in HepG2 & A549		
2'-PDE	NM_177966	2'-phosphodiesterase
ACVR1B	NM_004302	activin A type IB receptor isoform a precursor
C6orf211	NM_024573	hypothetical protein LOC79624
CDC25A	NM_001789	cell division cycle 25A isoform a
CDC34	NM_004359	cell division cycle 34
CHD7	NM_017780	chromodomain helicase DNA binding protein 7
COL4A5	NM_000495	alpha 5 type IV collagen isoform 1, precursor
E2F5	NM_001951	E2F transcription factor 5
FIGN	NM_018086	Fidgetin
GALE	NM_000403	UDP-galactose-4-epimerase
GNG5	NM_005274	guanine nucleotide binding protein (G protein),
HDHD1A	NM_012080	haloacid dehalogenase-like hydrolase domain
HMGA2	NM_001015886	high mobility group AT-hook 2 isoform c
KIAA0179	NM_015056	hypothetical protein LOC23076
LEPROTL1	NM_015344	leptin receptor overlapping transcript-like 1
LIN28B	NM_001004317	Lin-28 homolog B
MED6	NM_005466	mediator of RNA polymerase II transcription,
NAP1L1	NM_004537	nucleosome assembly protein 1-like 1
NME6	NM_005793	nucleoside diphosphate kinase type 6
NRAS	NM_002524	neuroblastoma RAS viral (v-ras) oncogene
NUP98	NM_005387	nucleoporin 98kD isoform 3
PGRMC1	NM_006667	progesterone receptor membrane component 1
PIGA	NM_002641	phosphatidylinositol
SLC25A24	NM_013386	solute carrier family 25 member 24 isoform 1
SLC5A6	NM_021095	solute carrier family 5 (sodium-dependent
SNAP23	NM_003825	synaptosomal-associated protein 23 isoform
Expression Altered in HepG2 Only		
ARID3A	NM_005224	AT rich interactive domain 3A (BRIGHT- like)
ARL5A	NM_012097	ADP-ribosylation factor-like 5A isoform 1
C10orf6	NM_018121	hypothetical protein LOC55719
CCNJ	NM_019084	cyclin J
COIL	NM_004645	coilin
CPEB2	NM_182485	cytoplasmic polyadenylation element binding
CTDSPL2	NM_016396	CTD (carboxy-terminal domain, RNA polymerase II,
CTSC	NM_148170	cathepsin C isoform b precursor
DDX19A	NM_018332	DDX19-like protein
DLC1	NM_006094	deleted in liver cancer 1 isoform 2
DMD	NM_000109	dystrophin Dp427c isoform
DST	NM_015548	dystonin isoform 1eA precursor
DUSP9	NM_001395	dual specificity phosphatase 9
DZIP1	NM_014934	DAZ interacting protein 1 isoform 1
EIF2C4	NM_017629	eukaryotic translation initiation factor 2C, 4
FLJ21986	NM_024913	hypothetical protein LOC79974
GNS	NM_002076	glucosamine (N-acetyl)-6-sulfatase precursor
HEAB	NM_006831	ATP/GTP-binding protein
HIC2	NM_015094	hypermethylated in cancer 2

IGF2BP1	NM_006546	insulin-like growth factor 2 mRNA binding
LRIG3	NM_153377	leucine-rich repeats and immunoglobulin-like
LSM11	NM_173491	LSM11, U7 small nuclear RNA associated
MAPK6	NM_002748	mitogen-activated protein kinase 6
MGAT4A	NM_012214	mannosyl (alpha-1,3-)-glycoprotein
NAB1	NM_005966	NGFI-A binding protein 1
PCYT1B	NM_004845	phosphate cytidyltransferase 1, choline, beta
RAB11FIP4	NM_032932	RAB11 family interacting protein 4 (class II)
RPS6KA3	NM_004586	ribosomal protein S6 kinase, 90kDa, polypeptide
RRM2	NM_001034	ribonucleotide reductase M2 polypeptide
SLC20A1	NM_005415	solute carrier family 20 (phosphate
SOCS1	NM_003745	suppressor of cytokine signaling 1
STK40	NM_032017	SINK-homologous serine/threonine kinase
STX3A	NM_004177	syntaxin 3A
TRIB2	NM_021643	tribbles homolog 2
TTLL4	NM_014640	tubulin tyrosine ligase-like family, member 4
TUSC2	NM_007275	tumor suppressor candidate 2
YOD1	NM_018566	hypothetical protein LOC55432
Expression Altered in A549 Only		
AP1S1	NM_057089	adaptor-related protein complex 1, sigma 1
ATP2B4	NM_001001396	plasma membrane calcium ATPase 4 isoform 4a
C6orf120	NM_001029863	hypothetical protein LOC387263
CD164	NM_006016	CD164 antigen, sialomucin
DUSP16	NM_030640	dual specificity phosphatase 16
FAM96A	NM_001014812	hypothetical protein FLJ22875 isoform b
FLJ36031	NM_175884	hypothetical protein LOC168455
FLJ90709	NM_173514	hypothetical protein LOC153129
GOLT1B	NM_016072	golgi transport 1 homolog B
GTF2I	NM_001518	general transcription factor II, i isoform 4
HOXA1	NM_153620	homeobox A1 isoform b
LGR4	NM_018490	leucine-rich repeat-containing G protein-coupled
LPGAT1	NM_014873	lysophosphatidylglycerol acyltransferase 1
MTPN	NM_145808	myotrophin
NME4	NM_005009	nucleoside-diphosphate kinase 4
P18SRP	NM_173829	P18SRP protein
PGM2L1	NM_173582	phosphoglucomutase 2-like 1
STARD3NL	NM_032016	MLN64 N-terminal homolog
TMED5	NM_016040	transmembrane emp24 protein transport domain
ZNF294	NM_015565	zinc finger protein 294

[00260] The data indicate that these predicted targets of hsa-let-7 exhibit altered mRNA expression within 72 hours of hsa-let-7b transfection into A549 or HepG2 cells. Under these experimental conditions, 26 predicted gene targets had altered mRNA levels in both cell types, 37 additional predicted gene targets had altered mRNA levels in HepG2 cells only, and twenty additional gene targets had altered mRNA levels in A549 cells only.

EXAMPLE 4:**FUNCTIONAL IDENTIFICATION OF GENES MIS-REGULATED BY LET-7
IN A549 AND HEPG2 CELLS**

[00261] Over-expression of hsa-let-7 in A549 and HepG2 cells results in the mis-regulation of numerous genes associated with cell division, cell proliferation, and the cell cycle. A list of those genes, their gene products, and associated protein functions are shown in Table 7.

Table 7. Cell cycle, cell division, cell proliferation, and DNA synthesis/replication genes, gene products, and gene functions that respond to excess hsa-let-7.

Gene	Product	Function
Gene expression reduced in HepG2 & A549		
CCNA2	cyclin A2	Binds CDK2 and CDC2 to promote cell cycle G1/S and G2/M phase transition; aberrantly expressed in acute myeloid and promyelocytic leukemias
CDC25A	Cell division cycle 25A, a protein tyrosine-threonine phosphatase	binds cyclins and regulates G1-S phase transition, over expressed in many cancers
CDC34	cell division defective 34	modifies CDKN1B increases the ubiquitination and degradation of CDKN1B
ASK/DBF4	activator of S-phase kinase	Binds to and activates kinase activity of CDC7, required for the initiation of DNA replication at the G1 to S transition
AURKA/STK6 AURKB/STK12	Aurora A and Aurora B kinases	maximally expressed during G2/M phases and may function in cytokinesis, up regulation in multiple neoplasms
E2F5	E2F transcription factor 5	oncogenic in primary rodent cells and is amplified in human breast tumors
CDK8	cyclin-dependent kinase 8	forms a complex with cyclin C that phosphorylates cyclin H (CCNH), plays a role in the regulation of transcription and as component of the RNA polymerase II holoenzyme
PLAGL1 & PLAGL2	pleomorphic adenoma gene-like transcription factors	transcription activators, regulate cell proliferation
LIN28	homologue of heterochronic LIN-28	Putative RNA binding protein
DICER1	RNaseIII	RNase processes pre-miRNAs and dsRNA
GMNN	Geminin	Geminin, regulates DNA replication and proliferation, binds to the licensing factor CDT1 and negatively regulates its ubiquitination, up regulated in breast, colon, rectal, and biliary tract neoplasms
CHEK1	checkpoint homolog 1 Kinase	required for mitotic G2 checkpoint in response to radiation-induced DNA damage, associated with lung cancer
NRAS	Ras GTPase	signaling molecule, mutated in multiple tumors
Gene expression reduced in HepG2 only		
CDC2	cell division cycle 2, a cyclin-	binds B-type cyclins, regulates G2 to M phase transition, promotes cell proliferation

	dependent kinase	
CCNB1	cyclin B1	regulatory subunit of the CCNB1 - CDC2 maturation-promoting factor complex that mediates G2-M phase transition, up-regulated in various cancers
CCNE2	cyclin E2	G1-specific cyclin-dependent kinase regulatory subunit that interacts with CDK2 and CDK3, over-expressed in transformed cells and up regulated in breast and lung cancer
CCNF	cyclin F	a member of the cyclin family of CDK kinase regulatory subunits, forms a complex with cyclin B1 (CCNB1) and CDC2
CCNJ	cyclin J	Protein containing cyclin C-terminal and N-terminal domains, has a region of low similarity to a region of cyclin A2 (human CCNA2)
SKP2	S-phase kinase – associated protein 2	a component of a ubiquitin E3 ligase complex, mediates cell cycle regulatory protein degradation, promotes cell proliferation and invasion, inhibits cell adhesion and apoptosis; over-expressed in many cancers
CKS1B	CDC28 protein kinase regulatory subunit 1B	Binds SKP2 and targets it to its substrates, required for ubiquitination of p21 Cip1 (CDKN1A) and p27 Kip1 (CDKN1B), highly expressed in non-small cell lung, gastric, and colon carcinoma
CDC20	cell division cycle 20	activates the mitotically phosphorylated form of the anaphase promoting complex as well as the mitotic spindle checkpoint, over-expressed in gastric cancer
CDCA1	cell division cycle associated 1	mediates stable attachment of microtubules to the kinetochore during mitosis and play a role in the spindle checkpoint
CDAC2	cell division cycle associated 2	Novel protein
CDAC3/TOME1	cell division cycle associated 3/ trigger of mitotic entry 1	a cytosolic protein that is degraded during G1 phase and whose gene promoter activity is stimulated at the G2/M phase
CDCA5	cell division cycle associated 5	Novel protein
CDAC7	cell division cycle associated 7	a nuclear protein expressed highly in thymus and small intestine, has a role in anchorage-dependent growth, up regulated in Burkitt lymphoma cell lines; corresponding gene may be a MYC target
CDCA8	cell division cycle associated 8 (borealin)	a chromosomal passenger complex component, may target survivin (BIRC5) and INCENP to centromere, required for kinetochore function, mitotic spindle stability, and metaphase chromosome alignment during mitosis
RRM1 & RRM2	ribonucleotide reductase M1 and M2 polypeptides	DNA synthesis
CDC6	encoding cell division cycle 6 homologue	DNA replication, up regulated in cervical intraepithelial neoplasia and cervical cancer
CDC45L	cell division cycle 45 like	associates with ORC2L, MCM7, and POLA2, predicted to be involved in the initiation of DNA replication
CDT1	chromatin licensing factor	ensures replication occurs once per cell cycle, up regulated in non small cell lung carcinomas
ORC1L & ORC6L	origin recognition complex proteins	DNA replication
MCM2/3/4/5	mini	DNA replication, up-regulated in multiple cancers

MCM6/7/8/10	chromosome maintenance deficient complex	
RFC2/3/4/5	replication factor C complex	DNA replication
E2F6 & E2F8	E2F transcription factors	Regulators of cell cycle
BUB1 & BUB1B	Budding uninhibited by benzimidazoles 1 homologs	acts in spindle assembly checkpoint and chromosome congression, may regulate vesicular traffic; mutations are associated with lung cancer, T cell leukemia and colorectal cancer cell chromosomal instability ; a protein kinase of the mitotic spindle checkpoint, inhibits anaphase-promoting complex activation, marker for colorectal cancer; mutation causes mosaic variegated aneuploidy with tumors
MAD2L1	MAD2 mitotic arrest deficient-like 1	component with BUB1B
CDC23	cell division cycle 23	a putative component of the anaphase promoting complex (APC) which promotes the metaphase to anaphase transition, considered a tumor antigen in ovarian carcinoma; mutation in corresponding gene is associated with colon cancer
FANCD2	Fanconi anemia complementation group D2	involved in DNA damage response
BRCA1 & BRCA2	Breast Cancer Susceptibility loci	tumor suppressors; mutations are linked to breast and ovarian cancer
Gene expression increased in HepG2 & A549		
CCNG2	cyclin G2	Down-regulated in thyroid papillary carcinoma
RRM2B	ribonucleotide reductase M2B	DNA Synthesis, up regulated by p53
Gene expression increased in HepG2 only		
CDKN2B	cyclin-dependent kinase inhibitor 2B	interacts with the D type cyclin dependent kinases CDK4 and CDK6, inhibits cell proliferation; gene deletion and promoter hypermethylation are associated with many different neoplasms
MXI1	MAX-interacting protein 1	transcription regulator, antagonizes MYC, tumor suppressor in prostatic neoplasms

[00262] These data indicate that hsa-let-7 is a key regulator of cell cycle progression. Many of the hsa-let-7-responsive genes are known oncogenes or are over-expressed in tumors. It is likely that in cancer cells with hsa-let-7 deletions or with reduced hsa-let-7 expression, many of these genes would be up-regulated, which would likely stimulate cell cycle and DNA synthesis and hence, cell division.

[00263] While the vast majority of altered cell cycle genes exhibited reduced expression following hsa-let-7 application, a few cell cycle genes were up-regulated under the same conditions, indicating a 2° or 3° effect of hsa-let-7 application. These genes (Table 7) included those encoding CDK inhibitor 2B (CDKN2B), the MAX-

interacting protein 1 (MXI1) - a transcription regulator that antagonizes MYC, and cyclin G2 (CCNG2), which is down-regulated in thyroid papillary carcinoma (Ito *et al.*, 2003), showing that in tumor cells it has the propensity to act as a tumor antagonist. In let-7-deficient tumor cells, these three genes would likely be down-regulated, which would most likely disable their tumor-suppressing functions.

[00264] Hsa-let-7 addition repressed expression of a number of known and putative tumor suppressor genes (Table 7) such as BRCA1, BRCA2, FANCD2, PLAGL1, E2F6, E2F8, and the cell cycle checkpoint genes CHEK1, BUB1, BUB1B, MAD2L1 and CDC23.

EXAMPLE 5:

IDENTIFICATION OF GENES DIRECTLY TARGETED BY HSA-LET-7

[00265] Genes directly targeted by hsa-let-7 may exhibit modified expression prior to 72 hours following hsa-let-7 administration to cells. Therefore, the inventors analyzed gene expression in HepG2 cells harvested at 4, 8, 16, 24, 36, 48, 72, and 128 hours after hsa-let-7 transfection as described in Example 1. Affymetrix U133 plus 2 GeneChips were used in the time course study and processed using Affymetrix MAS 5.0 algorithm as the scaling (value set to 500) and summarization method (Affymetrix Statistical Algorithms Description Document Part Number 701137 Rev 3). Because the time course study was un-replicated, the Wilcoxon Signed Rank test (Wilcoxon, 1945) as implemented in the Affymetrix GCOS 1.4 software, was utilized to determine those genes that were differentially expressed relative to time zero. Those genes that were calculated to be absent in 100% of time points were discarded.

[00266] Within 36 hours of hsa-let-7 transfection, 167 genes were down-regulated and were designated early-repressed genes (Table 8). The early-repressed genes include many of the same cell cycle genes listed in Table 13 above (*e.g.*, CCNA2, CDC25A, CDK8, SKP2, AURKA/STK6) as well as additional genes (*e.g.*, CDC16, CDK6) whose expression levels were repressed early but returned to normal levels by 72 hours. Of the 167 early-repressed genes, 125 genes first appeared down-regulated at or before 16 hours, 32 genes first appeared down-regulated between 16 and 24 hours, and 10 first appeared down-regulated between 24 and 36 hours. Several

transcription factors besides E2F6, including ID2, CBFB, ZNF336, SMAD4, SOX9, NR1H4, ARID3A, PLAGL2, YAP1 and GTF2I, were among the early repressed genes. It is likely that these genes propagate the let-7 effect to their downstream targets. For example, multiple members of the MCM and RFC DNA synthesis complexes were repressed only at later time points and could be targets of these transcription factors.

Table 8. Early-repressed genes following transfection of HepG2 cells with hsa-let-7b.

Gene Symbol	RefSeq Transcript ID
Genes repressed by 16 hours	
SEPTIN	NM_018243
ACTB	NM_001101
AGPS	NM_003659
AHCYL1	NM_006621 /// NM_014121
AK3	NM_001005353 /// NM_013410 /// NM_203464
ALDH5A1	NM_001080 /// NM_170740
ANLN	NM_018685
ANP32E	NM_030920
ARHGAP18	NM_033515
ARS2	NM_015908 /// NM_182800
BRP44L	NM_016098
C20orf36	NM_018257
C20orf59	NM_022082
C3	NM_000064
C6orf96	NM_017909
C9orf64	NM_032307
CANX	NM_001746
CAT	NM_001752
CBFB	NM_001755 /// NM_022845
CDC16	NM_003903
CDK6	NM_001259
CDW92	NM_022109 /// NM_080546
CGI-48	NM_016001
CHP	NM_007236
CKAP4	NM_006825
CTSC	NM_001814 /// NM_148170
CTSH	NM_004390 /// NM_148979
CYP51A1	NM_000786
DENR	NM_003677
DKFZP586L0724	NM_015462
DLC1	NM_006094 /// NM_024767 /// NM_182643
DNCL12	NM_006141
DSCR1	NM_004414 /// NM_203417 /// NM_203418
EIF5	NM_001969 /// NM_183004
ELOVL1	NM_016031 /// NM_022821
FARP1	NM_001001715 /// NM_005766
FBXO2	NM_012168
FLJ10826	NM_018233
FLJ21924	NM_024774
G3BP	NM_005754 /// NM_198395
GIPC2	NM_017655
GLUD1	NM_005271

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GORASP2	NM_015530
GRLF1	NM_004491 /// NM_024342
GRSF1	NM_002092
GTF2I /// GTF2IP1	NM_001518 /// NM_032999 /// NM_033000 /// NM_033001 /// NM_033003 /// XR_000285
HERPUD1	NM_014685
HMGCS1	NM_002130
HP	NM_005143
HRB	NM_004504
ID2	NM_002166
IF	NM_000204
IFNGR1	NM_000416
ITGA6	NM_000210
ITGB1	NM_002211 /// NM_033666 /// NM_033667 /// NM_033668 /// NM_033669 /// NM_133376
KBTBD6	NM_152903
KIAA0650	---
LAMP2	NM_002294 /// NM_013995
LIPA	NM_000235
LOC145786	---
LOC163590	NM_145034
LYAR	NM_017816
LYRIC	NM_178812
MAP3K7IP2	NM_015093 /// NM_145342
MAPRE1	NM_012325
MAT2A	NM_005911
MCCC2	NM_022132
ME2	NM_002396
MGC15396	NM_052855
MGC15397	NM_080652
MGC17943	NM_152261
MGC33302	NM_152778
MINA	NM_032778 /// NM_153182
MLLT4	NM_005936
NDFIP1	NM_030571
NFIL3	NM_005384
NR1H4	NM_005123
NUDT4	NM_019094 /// NM_199040
NXT2	NM_018698
OBRGRP	NM_017526
OK/SW-cl.56 (TUBB)	NM_178014
PAPOLA	NM_032632
PCYOX1	NM_016297
PGM2	NM_018290
PIGW	NM_178517
PLOD2	NM_000935 /// NM_182943
PNN	NM_002687
PPAP2B	NM_003713 /// NM_177414
PPIF	NM_005729
PPP2R5E	NM_006246
PPP4R1	NM_005134
PRPF4	NM_004697
PS1TP4	---
QKI	NM_006775 /// NM_206853 /// NM_206854 /// NM_206855
RAB10	NM_016131
RAB14	NM_016322
RNP24	NM_006815
RRBP1	NM_004587

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RRM2	NM_001034
SARA1	NM_020150
SARA2	NM_016103
SC4MOL	NM_006745
SDC2	NM_002998
SERP1	NM_014445
SLC35F5	NM_025181
SMAD4	NM_005359
SNRPB2	NM_003092 /// NM_198220
SNX5	NM_014426 /// NM_152227
SNX6	NM_021249 /// NM_152233
SOX9	NM_000346
SPR	NM_003124
SRP68	NM_014230
SRP72	NM_006947
SRPRB	NM_021203
SSR1	NM_003144
STK6	NM_003158 /// NM_003600 /// NM_198433 /// NM_198434 /// NM_198435 /// NM_198436
SYNCRIP	NM_006372
TIA1	NM_022037 /// NM_022173
TLOC1	NM_003262
TOMM70A	NM_014820
USP14	NM_005151
VAMP3	NM_004781
XPOT	NM_007235
YAP1	NM_006106
ZNF336	NM_022482
Genes repressed by 24 hours	
2'-PDE	NM_177966
ARID3A	NM_005224
C13orf23	NM_025138 /// NM_170719
C14orf46	---
C9orf41	NM_152420
CDC25A	NM_001789 /// NM_201567
CDCA7	NM_031942 /// NM_145810
CEBPA	NM_004364
CPN2	---
CSNK2A1	NM_001895 /// NM_177559 /// NM_177560
DGAT1	NM_012079
DMD	NM_000109 /// NM_004006 /// NM_004007 /// NM_004009 /// NM_004010 /// NM_004011
DZIP1	NM_014934 /// NM_198968
ERO1L	NM_014584
FLJ21986	NM_024913
IL6R	NM_000565 /// NM_181359
KLHL14	---
LOC163782	NM_181712
LOC201194	---
MAL2	NM_052886
MGC12916	---
MGC14289	NM_080660
MOV10	NM_020963
MSH6	NM_000179
PAH	NM_000277
PLAGL2	NM_002657
RAMP	NM_016448

SGKL	NM_013257 /// NM_170709
SKP2	NM_005983 /// NM_032637
SLC13A5	NM_177550
SLC5A9	---
SLCO4C1	NM_018515 /// NM_180991
Genes repressed by 36 hours	
AGXT2L1	NM_031279
CCNA2	NM_001237
E2F6	NM_001952 /// NM_198256 /// NM_198257 /// NM_198258 /// NM_198325 /// NM_212540
GPX7	NM_015696
GSTA1	NM_145740
MCAM	NM_006500
NAP1L1	NM_004537 /// NM_022348 /// NM_139207
OPRS1	NM_005866 /// NM_147157 /// NM_147158 /// NM_147159 /// NM_147160
Pfs2	NM_016095
SLC30A10	NM_001004433 /// NM_018713

EXAMPLE 6:**IDENTIFICATION OF HSA-LET-7 EARLY REPRESSED GENES WITH
LET-7 COMPLEMENTARY SITES**

[00267] The 3' untranslated regions (3'UTRs) of let-7 early repressed genes and of genes repressed after 36 hours were examined for the presence of sequences that displayed features of let-7 complementary sites (LCS) in validated let-7 target genes (Johnson *et al.*, 2005; Reinhart *et al.*, 2000; Grosshans *et al.*, 2005; Lin *et al.*, 2003; Slack *et al.*, 2000; Vella *et al.*, 2004a; Vella *et al.*, 2004b). Results are shown in Table 9 below.

Table 9. Hsa-let-7 repressed genes with let-7 complementary sites (LCSs)

Genes repressed by 16 hours	# of let-7 LCSs
CDK6	10
SSR1	3
RRM2	3
DLC1	3
YAP1	3
SOX9	3
STK6	3
NXT2	3
ZNF336	3
CBFB	2
DSCR1	2
FARP1	2
MAP3K7IP2	1
GTF2I /// GTF2IP1	1
Genes repressed by 24 hours	# of let-7 LCSs
PLAGL2	9
2'-PDE	5
CDC25A	4

DZIP1	4
CDCA7	2
FLJ21986	2
ARID3A	1
DMD	1
Genes repressed by 36 hours	# of let-7 LCSs
OPRS1	4
GPX7	3
E2F6	3
Genes repressed after 36 hours	# of let-7 LCSs
CCNF	4
CCNJ	3
CDC34	2
E2F5	2
LIN28	2

[00268] At least 25 of the early-repressed genes contained LCSs in their 3'UTRs and likely represent direct let-7 targets. This set includes the cell cycle regulators CDK6, CDC25A, AURKA/STK6, CDCA7, the DNA synthesis regulator RRM2, and the transcription factors CBFB, PLAGL2, E2F6, SOX9, ZNF336, YAP1, GTF2I, and ARID3A. In addition, other cell cycle genes with LCSs in their 3'UTRs were repressed later than 36 hours (E2F5, CDC34, CCNF CCNJ) suggesting that later repressed genes are also direct let-7 targets. The non-LCS containing genes with altered expression upon let-7 addition are likely to be downstream genes indirectly affected by let-7 expression, perhaps as downstream targets of the transcription factors affected directly by let-7.

EXAMPLE 7:

GENE PATHWAYS ALTERED BY HSA-LET-7 EXPRESSION IN A549 AND HEPG2 CELLS

[00269] miRNAs can directly affect mRNA levels of their target genes and will also directly affect protein levels following translational regulation upon binding to target mRNAs. 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. The identity and nature of the cellular pathways affected by the regulatory cascade induced by hsa-let-7 expression were determined. Cellular pathway analysis was performed using Ingenuity Pathways Analysis (Ingenuity® Systems, Redwood City,

CA). The most significantly affected pathways following over-expression of hsa-let7b in A549 and HepG2 cells are shown in Table 10.

Table 10. Significantly affected functional cellular pathways following hsa-let-7b over-expression in A549 and HepG2 cells.

Functional Cellular Pathways Altered by hsa-let-7 Over-Expression	
A549	HepG2
Amino Acid Metabolism	Amino Acid Metabolism
Behavior	
Cancer	Cancer
Carbohydrate Metabolism	Carbohydrate Metabolism
Cardiovascular Disease	Cardiovascular Disease
Cardiovascular System Development and Function	Cardiovascular System Development and Function
Cell Cycle	Cell Cycle
Cell Death	Cell Death
Cell Morphology	Cell Morphology
Cell Signaling	Cell Signaling
Cell-To-Cell Signaling and Interaction	Cell-To-Cell Signaling and Interaction
Cellular Assembly and Organization	Cellular Assembly and Organization
Cellular Compromise	Cellular Compromise
Cellular Development	Cellular Development
Cellular Function and Maintenance	Cellular Function and Maintenance
Cellular Growth and Proliferation	Cellular Growth and Proliferation
Cellular Movement	Cellular Movement
Cellular Response to Therapeutics	
Connective Tissue Development and Function	Connective Tissue Development and Function
Connective Tissue Disorders	Connective Tissue Disorders
Dermatological Diseases and Conditions	Dermatological Diseases and Conditions
	Developmental Disorder
Digestive System Development and Function	Digestive System Development and Function
DNA Replication, Recombination, and Repair	DNA Replication, Recombination, and Repair
Drug Metabolism	Drug Metabolism
Embryonic Development	Embryonic Development
Endocrine System Development and Function	Endocrine System Development and Function
Endocrine System Disorders	Endocrine System Disorders
Free Radical Scavenging	
Gastrointestinal Disease	Gastrointestinal Disease
Gene Expression	Gene Expression
Genetic Disorder	Genetic Disorder
Hair and Skin Development and Function	Hair and Skin Development and Function
Hematological Disease	Hematological Disease
Hematological System Development and Function	Hematological System Development and Function
Hepatic System Development and Function	Hepatic System Development and Function
Hepatic System Disease	Hepatic System Disease
Immune and Lymphatic System Development and Function	Immune and Lymphatic System Development and Function
Immune Response	Immune Response

Immunological Disease	Immunological Disease
	Infectious Disease
Inflammatory Disease	Inflammatory Disease
Lipid Metabolism	Lipid Metabolism
Metabolic Disease	Metabolic Disease
Molecular Transport	Molecular Transport
Nervous System Development and Function	Nervous System Development and Function
Neurological Disease	Neurological Disease
Nucleic Acid Metabolism	Nucleic Acid Metabolism
	Ophthalmic Disease
Organ Development	Organ Development
Organ Morphology	Organ Morphology
Organismal Development	Organismal Development
Organismal Functions	Organismal Functions
Organismal Injury and Abnormalities	Organismal Injury and Abnormalities
Organismal Survival	
	Post-Translational Modification
	Protein Synthesis
Protein Trafficking	Protein Trafficking
Renal and Urological Disease	Renal and Urological Disease
Renal and Urological System Development and Function	Renal and Urological System Development and Function
Reproductive System Development and Function	Reproductive System Development and Function
Reproductive System Disease	Reproductive System Disease
Respiratory Disease	Respiratory Disease
Respiratory System Development and Function	Respiratory System Development and Function
	RNA Damage and Repair
	RNA Post-Transcriptional Modification
Skeletal and Muscular Disorders	Skeletal and Muscular Disorders
Skeletal and Muscular System Development and Function	Skeletal and Muscular System Development and Function
Small Molecule Biochemistry	Small Molecule Biochemistry
Tissue Development	Tissue Development
Tissue Morphology	Tissue Morphology
Tumor Morphology	Tumor Morphology
Viral Function	Viral Function
	Viral Infection
	Visual System Development and Function
Vitamin and Mineral Metabolism	Vitamin and Mineral Metabolism

[00270] Additional cellular pathway analyses were performed with gene expression data from HepG2 cells, by grouping differentially expressed genes according to their biological functions and using the Gene Ontology (GO) database (Ashburner *et al.*, 2000). The most significantly affected Gene Ontology categories in HepG2 cells are shown in Table 11 (following hsa-let-7 over-expression for 72 hours as described in Example 1) and in Table 12 (following hsa-let-7 over-expression for 4-108 hours as described in Example 5). mRNAs whose expression levels were affected by greater

than 2-fold with p-values below 0.05 were identified and classified using Gene Ontology categories. P-values were calculated with hypergeometric tests to determine whether there was a significant enrichment of affected genes in a Gene Ontology category when compared to all genes represented on the arrays.

Table 11. Most significantly affected Gene Ontology categories following hsa-let-7 over expression in HepG2 cells for 72 hours.

GO ID	GO description	P value
GO:0006260	DNA replication	5.8E-16
GO:0000087	M phase of mitotic cell cycle	6.2E-13
GO:0000278	Mitotic cell cycle	6.4E-13
GO:0000075	cell cycle checkpoint	1.2E-10
GO:0051301	cell division	8.1E-10
GO:0006270	DNA replication initiation	1.2E-09
GO:0007093	Mitotic checkpoint	2.3E-06
GO:0007051	spindle organization and biogenesis	3.4E-06

Table 12. Most significantly affected Gene Ontology categories following let-7 over expression in HepG2 cells over a period of 4 hours to 108 hours.

GO ID	GO category description	# of altered genes	# of genes in category	% of genes in GO category altered	P value
GO:0000278	Mitotic cell cycle	19	192	10	5.5E-08
GO:0051301	cell division	15	135	11	3.1E-07
GO:0000279	M phase	15	165	9	3.8E-06
GO:0007088	regulation of mitosis	6	34	18	8.9E-05
GO:0016126	sterol biosynthesis	5	24	21	1.5E-04
GO:0005525	GTP binding	16	262	6	2.0E-04
GO:0006260	DNA replication	11	138	8	2.2E-04
GO:0051325	Interphase	8	76	11	2.5E-04

[00271] These data demonstrate that hsa-let-7 directly or indirectly affects the expression of many cell cycle-related genes and thus primarily affects cellular functional pathways related to the cell cycle, cell division, and DNA replication. Those cellular processes all have integral roles in the development and progression of various cancers.

EXAMPLE 8:**GENES ALTERED BY HSA-LET-7 REPRESENT THERAPEUTIC TARGETS FOR TREATMENT OF CANCERS**

[00272] Proliferation and survival pathways are commonly altered in tumors (Hanahan and Weinberg, 2000). The inventors have shown that hsa-let-7 expression directly or indirectly regulates multiple cell proliferation genes. Hsa-let-7 directly regulates a few key cell cycle proto-oncogenes, thus controlling cell proliferation pathways. These data strongly support the assertion that let-7 is a tumor suppressor miRNA.

[00273] A review of the genes and related pathways that are regulated by let-7 indicates that introduction of hsa-let-7 or an anti-hsa-let-7 (anti-miR) into a variety of cancer cell types would likely result in a therapeutic response. Hsa-let-7 targets that have prognostic and/or therapeutic value for the treatment of various malignancies are shown in Table 13.

Table 13. Hsa-let-7 targets having prognostic or therapeutic value for the treatment of various malignancies.

Gene Symbol	Gene Title	Cellular Process	Cancer Type	References
ATRX	ATR-X	transcription	AML, alpha thalassemia	(Lacayo <i>et al.</i> , 2004; Steensma <i>et al.</i> , 2005; Serrano <i>et al.</i> , 2006)
AURKA/STK6	aurora kinase A	chromosomal stability	BC, CRC, PaC, OC, GC, SCCHN, TC	Reiter <i>et al.</i> , 2006; Ullisse <i>et al.</i> , 2006; Keen and Taylor, 2004
AURKB/STK12	aurora kinase B	chromosomal stability	PC, NSCLC, BC, CRC	Keen and Taylor, 2004; Chieffi <i>et al.</i> , 2006; Smith <i>et al.</i> , 2005
BRCA1	BRCA-1	chromosomal stability	BC, OC	Wooster and Weber, 2003
BRCA2	BRCA-2	chromosomal stability	BC, OC	Wooster and Weber, 2003
BUB1	BUB1	chromosomal stability	AML, SGT, ALL, HL, L, CRC, GC	Shigeishi <i>et al.</i> , 2006; Grabsch <i>et al.</i> , 2003; Qian <i>et al.</i> , 2002; Ru <i>et al.</i> , 2002; Cahill <i>et al.</i> , 1998
BUB1B	BUBR1	chromosomal stability	LC, GC	Grabsch <i>et al.</i> , 2003; Seike <i>et al.</i> , 2002
BZRP	benzodiazepine receptor, peripheral type	apoptosis	L, BC, G, CRC, AC, PC, FS, OepC	(Hardwick <i>et al.</i> , 1999; Sutter <i>et al.</i> , 2002; Han <i>et al.</i> , 2003; Kleitsas <i>et al.</i> , 2004; Furre <i>et al.</i> , 2005; Maaser <i>et al.</i> , 2005; Pretner <i>et al.</i> , 2006; Vlodavsky and Soustiel, 2007)
CCNA2	cyclin A2	cell cycle	AML	Qian <i>et al.</i> , 2002
CCNB1	cyclin B1	cell cycle	HCC, BC, CHN, PC, CRC, LC	Egloff <i>et al.</i> , 2006
CCNE2	cyclin E2	cell cycle	BC, LC, OC, EC	Payton & Coats, 2002; Payton <i>et al.</i> , 2002
CCNG2	cyclin G2	cell cycle	TC, SCCHN	Alevizos <i>et al.</i> , 2001; Ito <i>et al.</i> , 2003

CDC2	CDK1	cell cycle	NHL, CRC, SCCHN, OepC	(Wolowiec <i>et al.</i> , 1999; Egilmez <i>et al.</i> , 2001; Chang <i>et al.</i> , 2005a; Hansel <i>et al.</i> , 2005)
CDC20	cell division cycle 20	cell cycle	GC	Kim <i>et al.</i> , 2005
CDC23	cell division cycle 23	cell cycle	CRC	Wang <i>et al.</i> , 2003
CDC25A	cell division cycle 25A	cell cycle	HCC, OepC, BC, CRC, CHN, NSCLC, OC, TC, NHL	Kristjansdottir & Rudolph, 2004
CDC6	cell division cycle 6	cell cycle	PC, CeC	Murphy <i>et al.</i> , 2005; Robles <i>et al.</i> , 2002
CDCA7	JPO1/CD CA7	cell cycle	CRC, OC, LC, GC, EC, AML, CML	Osthus <i>et al.</i> , 2005
CDK2	CDK-2	cell cycle	OC, CRC, PC	Cipriano & Chen, 1998; Marone <i>et al.</i> , 1998; Yamamoto <i>et al.</i> , 1998
CDK6	CDK-6	cell cycle	G, GB, GBM, MB, B-cell CLL	Costello <i>et al.</i> , 1997; Lam <i>et al.</i> , 2000; Hayette <i>et al.</i> , 2003; Mendrzyk <i>et al.</i> , 2005
CDKN2 B	CDK inhibitor 2B/p15IN K4B	cell cycle	PML, BldC, NHL, MM, AML	Christiansen <i>et al.</i> , 2003; Teofili <i>et al.</i> , 2003; le Frere-Belda <i>et al.</i> , 2001; Martinez-Delgado <i>et al.</i> , 2000; Ng <i>et al.</i> , 1997
CDT1	Cdt1	chromosomal stability	NSCLC	Karakaidos <i>et al.</i> , 2004
CEBPD	C/EBP delta	transcription	PC	(Yang <i>et al.</i> , 2001)
CKS1B	Cks1	cell cycle	NSCLC, BC, CRC	Inui <i>et al.</i> , 2003; Slotky <i>et al.</i> , 2005; Shapira <i>et al.</i> , 2005
CSF1	CSF-1	signal transduction	HCC, LC	(Budhu <i>et al.</i> , 2006; Uemura <i>et al.</i> , 2006)
EIF4E	eIF-4e	translation	BC, CRC, NHL, NB, CHN, LXC, BldC, PC, GC	(Graff and Zimmer, 2003; Huusko <i>et al.</i> , 2004; Nakada <i>et al.</i> , 2004; Wu <i>et al.</i> , 2004; Jubb <i>et al.</i> , 2005; Guo <i>et al.</i> , 2006; Kokko <i>et al.</i> , 2006; Wu <i>et al.</i> , 2006; Davalos <i>et al.</i> , 2007)
EPHB2	EPH receptor B2	signal transduction	PC, GC, CRC, OC, G, BC	(Huusko <i>et al.</i> , 2004; Nakada <i>et al.</i> , 2004; Wu <i>et al.</i> , 2004; Jubb <i>et al.</i> , 2005; Guo <i>et al.</i> , 2006; Kokko <i>et al.</i> , 2006; Wu <i>et al.</i> , 2006; Davalos <i>et al.</i> , 2007)
ERBB3	HER-3	signal transduction	PC, BC, pilocytic AC, GC, CRC, OC, BldC	(Lemoine <i>et al.</i> , 1992; Rajkumar <i>et al.</i> , 1996; Leng <i>et al.</i> , 1997; Maurer <i>et al.</i> , 1998; Kobayashi <i>et al.</i> , 2003; Koumakpayi <i>et al.</i> , 2006; Xue <i>et al.</i> , 2006)
FASN	fatty acid synthase	fat metabolism	OC, BC, BldC, CeC, PC, RB, CRC	(Ye <i>et al.</i> , 2000; Camassei <i>et al.</i> , 2003; Menendez <i>et al.</i> , 2004; Kuhajda, 2006)
FGFBP1	FGF-BP	signal transduction	SCCHN, BC, CRC, PC, PaC	(Abuharbeid <i>et al.</i> , 2006; Tassi <i>et al.</i> , 2006)
FGFR4	FGF receptor-4	signal transduction	TC, BC, OC, PaC	(Jaakkola <i>et al.</i> , 1993; Shah <i>et al.</i> , 2002; Ezzat <i>et al.</i> , 2005)
FH	fumarase	sugar	RCC, LM	(Eng <i>et al.</i> , 2003)

		metabolism		
GMNN	Geminin	DNA replication	CRC, BC, CeC	Shetty <i>et al.</i> , 2005; Bravou <i>et al.</i> , 2005; Wohlschlegel <i>et al.</i> , 2002
IGFBP1	IGFBP-1	signal transduction	BC, CRC	(Firth and Baxter, 2002)
IL8	IL-8	signal transduction	BC, CRC, PaC, NSCLC, PC, HCC	(Akiba <i>et al.</i> , 2001; Sparmann and Bar-Sagi, 2004)
ITGA6	integrin alpha-6	cell adhesion	BC, CeC, HCC, LC	Wewer <i>et al.</i> , 1997; Aplin <i>et al.</i> , 1996; Begum <i>et al.</i> , 1995; Rabinovitz <i>et al.</i> , 1995; Mariani Costantini <i>et al.</i> , 1990
JUN	c-Jun	transcription	HL, HCC	(Eferl <i>et al.</i> , 2003; Weiss and Bohmann, 2004)
JUNB	Jun B	transcription	L, CML, HCC, TCL, HL, FS	(Bossy-Wetzel <i>et al.</i> , 1992; Mathas <i>et al.</i> , 2002; Mao <i>et al.</i> , 2003; Yang <i>et al.</i> , 2003; Passegue <i>et al.</i> , 2004; Chang <i>et al.</i> , 2005b; Liu <i>et al.</i> , 2006; Ott <i>et al.</i> , 2007)
LHFP	lipoma HMGIC fusion partner	transcription	Li	(Petit <i>et al.</i> , 1999)
MCAM	MCAM	cell adhesion	M, AS, KS, LMS	McGary <i>et al.</i> , 2002
MET	c-Met	signal transduction	SPRC, HCC, GC, SCCHN, OS, RMS, GB, BC, M, CRC, GI, PaC, PC, OC	(Boccaccio and Comoglio, 2006)
MVP	major vault protein	multi drug resistance	AML, CML, ALL, OC, BC, M, OS, NB, NSCLC	(Mossink <i>et al.</i> , 2003)
MXI1	Max-interacting protein 1	transcription	M, PC, GB	Ariyanayagam-Baksh <i>et al.</i> , 2003; Prochownik <i>et al.</i> , 1998; Wechsler <i>et al.</i> , 1997
MYBL1	A-Myb	transcription	BL	(Golay <i>et al.</i> , 1996)
MYBL2	Myb L2	transcription	BC, NSCLC, PC, OC	(Tanner <i>et al.</i> , 2000; Bar-Shira <i>et al.</i> , 2002; Borczuk <i>et al.</i> , 2003; Ginestier <i>et al.</i> , 2006)
NRAS	N-Ras	signal transduction	M, TC, MM, CRC, AML, BC, GC, GB	Demunter <i>et al.</i> , 2001; Oyama <i>et al.</i> , 1995; Shi <i>et al.</i> , 1991; Paquette, <i>et al.</i> , 1990; Neri <i>et al.</i> , 1989; Gerosa <i>et al.</i> , 1989; Bos, 1988
P8	P8	transcription	BC, TC, PaC	(Ree <i>et al.</i> , 1999; Su <i>et al.</i> , 2001; Ito <i>et al.</i> , 2005)
PDCD4	Pdcd-4	apoptosis	G, HCC, L, RCC	(Chen <i>et al.</i> , 2003; Jansen <i>et al.</i> , 2004; Zhang <i>et al.</i> , 2006; Gao <i>et al.</i> , 2007)
PLK1	polo-like kinase 1	chromosomal stability	NSCLC, OrpC, OepC, GC, M, BC, OC, EC, CRC, GB, PapC, PaC, PC, HB, NHL	(Strebhardt and Ullrich, 2006)
PRKCA	PKC alpha	signal transduction	BldC, PC, EC, BC, CRC, HCC, M, GC, OC	(Weichert <i>et al.</i> , 2003; Jiang <i>et al.</i> , 2004; Lahn and Sundell, 2004; Koivunen <i>et al.</i> , 2006)
RASSF2	RASSF2	signal transduction	GC, CRC, OC	(Akino <i>et al.</i> , 2005; Endoh <i>et al.</i> , 2005; Lambros <i>et al.</i> , 2005)

SIVA	CD27 binding	apoptosis	BC	(Chu <i>et al.</i> , 2005)
SKP2	SKP-2	proteasomal degradation	PaC, OC, BC, MFS, GB, EC, NSCLC, PC	Einama <i>et al.</i> , 2006; Traub <i>et al.</i> , 2006; Sui <i>et al.</i> , 2006; Huang <i>et al.</i> , 2006; Saigusa <i>et al.</i> , 2005; Shibahara <i>et al.</i> , 2005; Kamata <i>et al.</i> , 2005; Takanami, 2005
SMAD4	SMAD-4	signal transduction	PaC, CRC, BC, SCCHN, AML, GC, HCC, OC, SIC	Miyaki and Kuroki, 2003
TACC3	TACC3	cell cycle	OC, NSCLC	(Lauffart <i>et al.</i> , 2005; Jung <i>et al.</i> , 2006)
TFDP1	E2F dimerization partner	cell cycle	M, HCC, NHL	(Halaban <i>et al.</i> , 2000; Wang <i>et al.</i> , 2001; Chan <i>et al.</i> , 2002; Yasui <i>et al.</i> , 2002)
TGFBR3	TGF beta receptor III	signal transduction	CeC, high grade NHL, CRC, BC	Soufla <i>et al.</i> , 2005; Woszczyk <i>et al.</i> , 2004; Bandyopadhyay <i>et al.</i> , 2002; Venkatasubbarao <i>et al.</i> , 2000
TNFSF10	TRAIL	apoptosis	CRC, G, LC, PC, multiple ML	(Fesik, 2005)
VIM	vimentin	adhesion and migration	HCC, M, L, BC, PC, CeC, CRC, RCC, SCCHN, AC, CLL, MT, LC	(Caselitz <i>et al.</i> , 1983; Stark <i>et al.</i> , 1984; Ben-Ze'ev and Raz, 1985; Churg, 1985; Upton <i>et al.</i> , 1986; Ferrari <i>et al.</i> , 1990; Sommers <i>et al.</i> , 1992; Gilles <i>et al.</i> , 1996; Rutka <i>et al.</i> , 1999; Islam <i>et al.</i> , 2000; Khoury <i>et al.</i> , 2002; Singh <i>et al.</i> , 2003; Hu <i>et al.</i> , 2004; Fesik, 2005; McInroy and Maatta, 2007; Ngan <i>et al.</i> , 2007)

Abbreviations: AC, astrocytoma; ALL, acute lymphocytic leukemia; alpha thalassemia, alpha thalassemia; AML, acute myeloid leukemia; AS, angiosarcoma; BC, breast carcinoma; BL, Burkitt's lymphoma; BldC, bladder carcinoma; CeC, cervical carcinoma; CHN, carcinoma of the head and neck; CLL, chronic lymphocytic leukemia; CML, chronic myeloblastic leukemia; CRC, colorectal carcinoma; EC, endometrial carcinoma; FS, fibrosarcoma; G, glioma; GB, glioblastoma; GBM, glioblastoma multiforme; GC, gastric carcinoma; GI, gastrinoma; HB, hepatoblastoma; HCC, hepatocellular carcinoma; HL, Hodgkin lymphoma; KS, Kaposi's sarcoma; L, leukemia; LC, lung carcinoma; Li, lipoma; LM, leiomyoma; LMS, leiomyosarcoma; LXC, larynx carcinoma; M, melanoma; MB, medulloblastoma; MFS, myxofibrosarcoma; ML, myeloid leukemia; MM, multiple myeloma; MT, mesothelioma; NB, neuroblastoma; NHL, non-Hodgkin lymphoma; NSCLC, non-small cell lung carcinoma; OC, ovarian carcinoma; OecP, oesophageal carcinoma; OrpC, oropharyngeal carcinoma; OS, osteosarcoma; PaC, pancreatic carcinoma; PapC, papillary carcinoma; PC, prostate carcinoma; PML, promyelocytic leukemia; RB, retinoblastoma; RCC, renal cell carcinoma; RMS, rhabdomyosarcoma; SCCHN, squamous cell carcinoma of the head and neck; SGT, salivary gland tumor; SIC, small intestinal carcinoma; SPRC, sporadic papillary renal carcinoma; TC, thyroid carcinoma; TCL, T-cell leukemia; UC, urothelial carcinoma

[00274] These targets are critical regulators of angiogenesis, chromosomal stability, cell adhesion, invasion, cell cycle progression, transcription, DNA replication and intracellular signal transduction. Hsa-let-7 affects intracellular signaling at various layers and controls the expression of secretory proteins, transmembrane growth factor receptors as well as cytoplasmic signaling molecules. Among secretory proteins are fibroblast growth factor binding protein (FGFBP1), insulin growth factor binding protein (IGFBP1) and the inflammatory chemokine

interleukin 8 (IL8). FGFBP1 is a secretory protein stored in an inactive form on heparin sulfate proteoglycans in the extracellular matrix (Tassi *et al.*, 2001; Abuharbeid *et al.*, 2006). It has high affinity for FGF-1 and FGF-2 and functions as chaperone to mobilize locally stored FGF. Thus, FGFBP1 is a positive regulator of FGFs enhancing FGF signaling and angiogenesis (Tassi *et al.* 2001). FGFBP1 expression is highly tissue specific and absent in most normal adult tissues. Yet, FGFBP1 is overexpressed in various types of cancer, including cancers of the breast, colon and prostate (Abuharbeid *et al.* 2006). High FGFBP1 expression is associated with early stages of tumor development, contributing to tumor angiogenesis. Similarly, IL-8 is frequently upregulated in various cancers and correlates with tumor vascularization, metastasis and poor prognosis (Sparmann *et al.*, 2004; Rosenkilde *et al.*, 2004).

[00275] Membrane-associated proteins regulated by hsa-let-7 are Met (MET), transforming growth factor-beta receptor 3 (TGFB3), ERBB3 and the Ras association domain family protein 2 (RASSF2). RASSF2 is a tumor suppressor candidate that is frequently downregulated in lung tumor cell lines (Vos *et al.*, 2003). RASSF2 interacts with K-Ras and promotes cell cycle arrest and apoptosis. Met acts as the receptor for hepatocyte growth factor (HGF) and was isolated as an oncogene from a chemically transformed human cell line (Cooper *et al.*, 1984; Dean *et al.*, 1985). Met activating mutations are found in sporadic papillary renal cancer, childhood hepatocellular carcinoma and gastric cancer (Danilkovitch-Miagkova *et al.*, 2002). These somatic mutations are associated with increased aggressiveness and extensive metastases in various carcinomas. In several other cancer types, autocrine and paracrine mechanisms lead to an activation of Met signaling. The most frequent mechanism of Met activation, however, is overexpression which occurs in colorectal cancer, hepatocellular carcinoma, gastrinomas as well as carcinomas of the stomach, pancreas, prostate, ovary and breast (Boccaccio *et al.*, 2006). Met is overexpression correlates with a metastatic tumor phenotype and poor prognosis (Birchmeier *et al.*, 2003). ERBB3 (also known as HER-3) belongs to the protein family of EGFRs and is a homolog of the avian v-Erb oncoprotein (Hynes *et al.*, 2005). In contrast to EGFR, ERBB3 transmits mitotic signals only when complexed as a heterodimer with other EGFR members such as ERBB2. Various cancer types show increased levels of ERBB3 and consequently an activation of the EGFR pathway (Table 13). TGFB3

is a putative tumor suppressor transmitting signals in response to TGF-beta. Central role of TGF-beta is inhibition of cellular growth of numerous cell types, such as epithelial, endothelial, hematopoietic neural and mesenchymal cells. TGFBR-3, also referred to as beta-glycan, binds all three TGF-beta isoforms with high affinity. TGFBR-3 associates with TGFBR-2 to signal to downstream effector molecules (Blobe *et al.*, 2001). TGFBR-3 is frequently downregulated in multiple cancer types (Hishikawa *et al.*, 1999; Lin *et al.*, 2005). PRKCA, a cytosolic signaling molecule, belongs to a family of serine-threonine kinases that are activated in response to signaling induced by receptor tyrosine kinases. Functional studies have suggested that PKCs play a role in carcinogenesis and maintenance of the malignant phenotype (Karakaidos *et al.*, 2004; Koivunen *et al.*, 2006). PRKCA is overexpressed in endometrial, prostate and high grade urinary bladder carcinomas (Koivunen *et al.*, 2006). PRKCA activity is linked to increased motility and invasion of cancer cells, a phenotype that can be reversed by PRKCA inhibition (Koivunen *et al.*, 2004).

[00276] Another class of genes and their corresponding proteins that are regulated by hsa-let-7, functions in the progression of the cell cycle. Some of these proteins are critical in the transition through G1 and S phases, such as cyclins A2 and E2 (CCNA2, CCNE2), cyclin dependent kinases 2 and 6 (CDK2, CDK6), the CDK inhibitor CDKN2B, CDC25A and cell division cycle 6 (CDC6). Others are required for progressing through the G2/M spindle checkpoint and proper segregation of sister chromatids during mitosis to maintain chromosomal stability. These include aurora kinases A and B (AURKA, a.k.a. STK6; AURKB, a.k.a. STK12), breast cancer 1 and 2 (BRCA1; BRCA2), budding uninhibited by benzimidazoles 1 (BUB1), budding uninhibited by benzimidazoles 1 beta (BUB1B), polo-like kinase 1 (PLK1), cyclin dependent kinase 1 (CDK1, a.k.a. CDC2), cyclin B1, and cell division cycle 20 and 23 (CDC20, CDC23, a.k.a. anaphase promoting complex subunit 8). Most of these transcripts are regulated in a manner that suggests that hsa-let-7 blocks cell cycle progression. All of these targets also have an evident role in carcinogenesis. For instance, the tumor suppressor proteins BRCA1 and BRCA2, as well as the growth-promoting aurora kinases A and B show deregulated expression in a various solid tumors, e.g. carcinomas of the breast, ovary, thyroid gland, lung, prostate and colorectum (Chieffi *et al.*, 2006; Keen *et al.*, 2004; Smith *et al.*, 2005; Ulisse *et al.*, 2006; Wooster *et al.*, 2003; Turner *et al.*, 2004). Aurora kinases are preferred drug

targets in the pharmaceutical industry. PLK1 (also referred to as serine-threonine protein kinase 13; STPK13) is a protein kinase that regulates mitotic spindle function to maintain chromosomal stability (Strebhardt *et al.*, 2006). PLK1 expression is tightly regulated during the cell cycle and peaks in M phase. PLK1 is inherently oncogenic and directly inhibits the tumor suppressor function of p53 (Ando *et al.*, 2004). Overexpression of PLK1 induces a polynucleated phenotype and cellular transformation of NIH3T3 cells (Mundt *et al.*, 1997; Smith *et al.*, 1997). Likewise, PLK1 shows increased expression levels in most solid tumors, including carcinomas of the breast, colon, lung, stomach and prostate (Table 13). PLK1 overexpression is associated with disease progression and – when depleted – induces apoptosis in cancer cells (Strebhardt *et al.* 2006; Liu *et al.*, 2003). Currently, PLK1 is being tested as a target of various small molecule inhibitors for future therapeutic intervention (Strebhardt *et al.* 2006). CDC6 is regulated in response to mitogenic signals through transcriptional control mechanisms involving E2F proteins and is required for initiation of DNA replication in mammalian cells. CDC6 is overexpressed in various human cancers and has inherent oncogenic potential (Karakaidos *et al.* 2004; Gonzalez *et al.*, 2006; Murphy *et al.*, 2005; Semple *et al.*, 2004). Cyclins are co-factors of cyclin-dependent kinases (CDKs) (Malumbres *et al.*, 2001). The expression of cyclins is tightly controlled during the cell cycle to govern the activity of individual CDKs. Cyclin A2 and cyclin E2 associate with CDK2 during S phase; cyclin D1 is the predominant co-factor of CDK4/6 in G1 phase. Since most cyclins are promoters of cell growth, cyclins – such as cyclin A2, B1 or E2 - are frequently expressed at high levels in various tumor types (Egloff *et al.*, 2006; Payton *et al.*, 2002; Payton *et al.*, 2002; Qian *et al.*, 2002). CDK6 forms active complexes with D-type cyclins, including D1, D2 and D3. The primary function of CDK2 and CDK6 is to inactivate members of the retinoblastoma protein family. CDK2 and CDK6 are overexpressed in numerous cancers and are currently being explored as a potential cancer drug targets (Malumbres *et al.* 2001; Cipriano *et al.*, 1998; Costello *et al.*, 1997; Hayette *et al.*, 2003; Lam *et al.*, 2000; Marone *et al.*, 1998; Mendrzyk *et al.*, 2005; Yamamoto *et al.*, 1998). CDK1 (CDC2) is a catalytic subunit of a protein kinase complex, called the M-phase promoting factor that induces entry into mitosis and is universal among eukaryotes. Activation of CDK1 requires binding to B cyclins and dephosphorylation by CDC25. Similar to other CDKs, CDK1 is expressed at increased levels in various cancers (Table 13). The CDC25 protein phosphatase family plays a critical role in

activating cyclin-dependent kinases (CDKs) via dephosphorylation of conserved threonine 15 and tyrosine 15 inhibitory phosphorylation sites. While CDC25C is primarily responsible for activating CDK1 to overcome G2/M checkpoint and allow mitotic entry, the primary substrate of CDC25A is CDK2 and CDK6 which – when active – allows progression through the G1/S and intra-S checkpoints (Kristjansdottir *et al.*, 2004). CDC25A is frequently amplified and overexpressed in human cancers, including cancers of the breast, lung, rectum and brain (Kristjansdottir *et al.* 2004). Other molecules regulated by hsa-let-7 that indirectly control cell cycle progression are SKP2 and PDCD4 (programmed cell death 4). Skp2 is a component of the multi-subunit E3 ubiquitin ligase complex that ear-marks proteins for proteasomal degradation. A well characterized target is the CDK inhibitor p27 which offers an explanation for the cell cycle promoting activity of Skp2 (Carrano *et al.*, 1999). Skp2 is inherently oncogenic and shows elevated levels in various cancer types (Gstaiger *et al.*, 2001; Einama *et al.*, 2006; Kamata *et al.*, 2005; Saigusa *et al.*, 2005). PDCD4 is a tumor suppressor that is induced in response to apoptosis in normal cells. The growth inhibitory properties of PDCD4 are due to PDCD4-mediated inhibition of the c-Jun proto-oncoprotein, inhibition of cap-dependent mRNA translation and activation of the p21Waf1/Cip1 CDK inhibitor (Bitomsky *et al.*, 2004; Goke *et al.*, 2004; Yang *et al.*, 2003). PDCD4 frequently shows reduced or lost expression in various human malignancies, such as gliomas, hepatocellular carcinomas, lung and renal cell carcinomas (Gao *et al.*, 2007; Jansen *et al.*, 2004; Zhang *et al.*, 2006). Expression of PDCD4 interferes with skin carcinogenesis in a mouse model and suppresses growth of human colon carcinoma cells (Jansen *et al.*, 2005; Yang *et al.*, 2006). Loss of PDCD4 also correlates with lung tumor progression (Chen *et al.*, 2003).

[00277] Hsa-let-7 also regulates vimentin (VIM) and fatty acid synthase (FASN). Vimentin is the major intermediate filament protein of mesenchymal cells and governs proteins that are critical in attachment, migration and cell signaling. Vimentin has key roles in adhesion by regulating integrin functions. Vimentin is often expressed at elevated levels in human malignancies which correlates with invasiveness and poor survival (Caselitz *et al.*, 1983; Churg 1985; Upton *et al.*, 1986; Gilles *et al.*, 1996; Islam *et al.*, 2000; Ngan *et al.*, 2007; Sommers *et al.*, 1992; Singh *et al.*, 2003). Downregulation of vimentin expression by RNA interference inhibits carcinoma cell migration and adhesion (McInroy *et al.*, 2007). FASN, often referred

to as FAS, is the sole protein in the human genome capable of the reductive de novo synthesis of long-chain fatty acids from acetyl-CoA, malonyl-CoA, and nicotinamide adenine dinucleotide phosphate (NADPH) (Kuhajda 2006). FAS is elevated and active in various cancer cells. Since fatty acid synthesis expends energy, FAS expression might confer some survival or growth advantage to human cancer cells. FAS expression correlates with poor prognosis of patients with carcinomas of the lung, breast, prostate, skin and soft-tissue sarcomas and is predictive for recurrence of prostate cancer (Kuhajda 2006).

[00278] In summary, let-7 controls a variety of cancer genes that play key roles in the development or progression of the disease. These targets are frequently deregulated in human cancer. Based on this review of the genes and related pathways that are regulated by hsa-let-7, introduction of hsa-let-7 or inhibitory anti-hsa-let-7 into a variety of cancer cell types would likely result in a therapeutic response

EXAMPLE 10:

DELIVERY OF SYNTHETIC HSA-LET-7 INHIBITS PROLIFERATION OF LUNG CANCER CELLS

[00279] The inventors have previously demonstrated that hsa-let-7 is involved in 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). For example, depending on the cell type, overexpression of hsa-let-7 may increase or decrease the proliferation and/or viability of certain normal or cancerous cell lines, and overexpression of let-7 in cells may also induce a significant shift toward or away from a specific stage of the cell cycle.

[00280] The development of effective therapeutic regimens requires evidence that demonstrates efficacy and utility of the therapeutic in various cancer models and multiple cancer cell lines that represent the same disease. The inventors assessed the therapeutic effect of hsa-let-7 for lung cancer by measuring cellular proliferation using six non-small cell lung cancer (NSCLC) cell lines, including cells derived from lung adenocarcinoma (A549, H838, Calu-3, HCC2935), cells derived from lung

squamous cell carcinoma (H226), and cells derived from lung adenosquamous cell carcinoma (H596). The inventors also measured proliferation of cells derived from lung large cell carcinoma (H460). Cancer cell lines were obtained from the American Type Culture Collection (Manassas, VA, USA). Synthetic hsa-let-7b, hsa-let-7c, or hsa-let-7g (Pre-miRTM-hsa-let-7, Ambion cat. no. AM17100) or negative control (NC) miRNA (Pre-miRTM microRNA Precursor Molecule-Negative Control #2; Ambion cat. no. AM17111) was delivered via lipid-based transfection into A549, H838, Calu-3, HCC2935, and H460 cells and via electroporation into H226 cells. Lipid-based reverse transfections were carried out in triplicate according to a published protocol (Ovcharenko *et al.*, 2005) and the following parameters: 5000-12000 cells per 96 well, 0.1-0.2 μ l LipofectamineTM 2000 (cat. no. 11668-019, Invitrogen Corp., Carlsbad, CA, USA) in 20 μ l OptiMEM (Invitrogen), 30 nM final concentration of miRNA in 100 μ l. A549, H838, H460, H596 and HCC2935 cells were harvested 72 hours post transfection to evaluate cellular proliferation; Calu-3 cells were analyzed 10 days post transfection. Proliferation assays were performed using Alamar Blue (Invitrogen) following the manufacturer's instructions. As a control for inhibition of cellular proliferation, siRNA against the motor protein kinesin 11, also known as Eg5, was used. Eg5 is essential for cellular survival of most eukaryotic cells and a lack thereof leads to reduced cell proliferation and cell death (Weil *et al.*, 2002). siEg5 was used in lipid-based transfection following the same experimental parameters that apply to miRNA. The inventors also used a topoisomerase II inhibitor, etoposide, at a final concentration of 10 μ M and 50 μ M as an internal standard for the potency of miRNAs. Etoposide is an FDA-approved topoisomerase II inhibitor in the treatment of lung cancer. IC₅₀ values for various lung cancer cells have been reported to range between <1-25 μ M for SCLC and NSCLC cells (Ohsaki *et al.*, 1992; Tsai *et al.*, 1993). Percent (%) proliferation values from the Alamar Blue assay were normalized to values from cells treated with negative control miRNA (NC). Percent proliferation of hsa-let-7 treated cells relative to cells treated with negative control miRNA (100%) is shown below in Table 14 and in FIG. 1.

[00281] Delivery of hsa-let-7b, hsa-let-7c or hsa-let-7g inhibits cellular proliferation of lung cancer cells A549, H838, Calu-3, HCC2935, H596, and H460 (Table 14 and FIG. 1). The inhibitory activity of the three let-7 members, hsa-let-7b, hsa-let-7c, and hsa-let-7g, were similar in all cell lines tested, suggesting a redundant

role for these miRNAs. On average, hsa-let-7 inhibits cellular proliferation by 26% (Table 14 and FIG. 1). Hsa-let-7b, hsa-let-7c and hsa-let-7g have maximal inhibitory activity in H460 cells, reducing proliferation by 68%, 37%, and 43%, respectively. The growth-inhibitory activity of hsa-let-7 is comparable to that of etoposide at concentrations $>10\ \mu\text{M}$. Since hsa-let-7 induces a therapeutic response in all lung cancer cells tested, hsa-let-7 may provide therapeutic benefit to patients with lung cancer and other malignancies.

[00282] The inventors determined sensitivity and specificity of hsa-let-7 by administering hsa-let-7b or negative control miRNA to H460 cells at increasing concentrations, ranging from 0 pM to 3000 pM (Table 15 and FIG. 2). Delivery of miRNA and assessment of cellular proliferation were done as described above. Proliferation values from the Alamar Blue assay were normalized to values obtained from mock-transfected cells (0 pM = 100% proliferation). Increasing amounts of negative control miRNA (NC) had no effect on cellular proliferation of H460 cells (Table 15 and FIG. 2). In contrast, the growth-inhibitory phenotype of hsa-let-7b is dose-dependent and correlates with increasing amounts of hsa-let-7b (Table 15 and FIG. 2). Hsa-let-7b induces a specific therapeutic response at concentrations as low as 300 pM.

Table 14. Percent (%) proliferation of lung cancer cell lines treated with hsa-let-7, Eg5-specific siRNA (siEg5), etoposide, or negative control miRNA (NC). Values are normalized to values obtained from cells transfected with negative control miRNA (100% proliferation). NC, negative control miRNA; siEg5, Eg5-specific siRNA; % SD, standard deviation; n.d., not determined.

Cells	hsa-let-7b		hsa-let-7c		hsa-let-7g		siEg5		etoposide (10 μ M)		etoposide (50 μ M)		NC (30 nM)	
	% proliferation	% SD	% proliferation	% SD	% proliferation	% SD	% proliferation	% SD	% proliferation	% SD	% proliferation	% SD	% proliferation	% SD
A549	69.05	10.53	72.31	11.31	86.00	7.93	37.84	1.06	49.13	2.55	42.18	3.57	100.00	19.53
H460	31.74	1.44	62.75	8.68	57.27	3.92	27.97	0.33	32.13	1.14	27.82	0.58	100.00	2.52
H838	82.75	7.49	88.00	7.21	84.87	6.57	69.14	4.15	89.71	6.17	36.97	0.62	100.00	7.74
H596	86.16	5.56	81.09	0.85	77.41	0.91	83.48	2.82	88.75	1.11	73.39	2.67	100.00	1.89
Calu-3	71.34	4.42	76.03	4.17	78.47	3.78	34.59	1.33	20.81	0.19	13.53	0.64	100.00	5.54
HCC2935	79.79	1.58	77.22	3.91	70.37	3.41	63.61	6.12	n.d.	n.d.	n.d.	n.d.	100.00	13.92

Table 15. Dose-dependent inhibition of cellular proliferation of H460 lung cancer cell lines by hsa-let-7b. Values are normalized to values obtained from mock-transfected cells (0 pM miRNA). NC, negative control miRNA; %SD, standard deviation.

Concentration [pM]	miRNA			
	hsa-let-7b		NC	
	% proliferation	% SD	% proliferation	% SD
0	100.00	8.84	100.00	8.84
3	108.28	0.92	107.60	0.79
30	101.96	1.14	108.04	1.46
300	74.14	1.32	106.99	4.74
3000	27.76	1.54	91.41	2.14

[00283] To evaluate the inhibitory phenotype of hsa-let-7 over an extended period of time, the inventors conducted growth curve experiments in the presence of hsa-let-7 for up to 21 days with H226 cells. Since *in vitro* transfections of naked interfering RNAs, such as synthetic miRNA, are transient by nature and compromised by the dilution of the oligonucleotide during ongoing cell divisions, hsa-let-7b was administered at multiple time points *via* electroporation (Bartlett *et al.*, 2006, Bartlett *et al.*, 2007). Equal numbers of H226 cells were electroporated with 1.6 μ M synthetic hsa-let-7b (Pre-miRTM-hsa-let-7b, Ambion cat. no. AM17100) or negative control miRNA (Pre-miRTM microRNA Precursor Molecule-Negative Control #2; Ambion cat. no. AM17111) using a Gene Pulser XcellTM electroporation system (BioRad Laboratories, Inc.; Hercules, CA, USA) (day 0) with the following settings: $>0-20 \times 10^6$ cells with 5 μ g hsa-let-7b in 200 μ l OptiMEM (Invitrogen) (1.6 μ M miRNA), square wave pulse at 250 V for 5 ms. Electroporated cells (10^6) were seeded and propagated in regular growth medium. On days 6, 10, and 17, cells were repeatedly harvested, counted, and electroporated with 1.6 μ M hsa-let-7b or negative control miRNA. After electroporation on day 6, all cells were re-seeded onto culture dishes. On days 10 and 17, 50% (cells treated with hsa-let-7b) or 25% (cells treated with negative control miRNA) of the actual cell count was electroporated and propagated to accommodate exponential cell growth. Cell counts from these electroporation events were extrapolated and plotted on a linear scale.

[00284] As shown in FIG. 3, four equal doses of synthetic hsa-let-7b miRNA over 21 days in 4-7 day intervals resulted in an approximate 85% inhibition of H226 cell

growth relative to cells that received negative control miRNA. The data suggest that multiple administrations of hsa-let-7b enhance the therapeutic effect of let-7 miRNA and reinforce previous data, indicating the therapeutic potential of hsa-let-7 miRNA.

EXAMPLE 11:

HSA-LET-7, IN COMBINATION WITH SPECIFIC HUMAN MICRO-RNAS, SYNERGISTICALLY INHIBITS PROLIFERATION OF LUNG CANCER CELL LINES

[00285] miRNAs function in multiple pathways controlling multiple cellular processes. Cancer cells frequently show aberrations in several different pathways, which determine their oncogenic properties. Therefore, administration of multiple miRNAs to cancer patients may result in a superior therapeutic benefit over administration of a single miRNA. The inventors assessed the efficacy of pair-wise miRNA combinations, administering hsa-let-7b, hsa-let-7c or hsa-let-7g concurrently with either hsa-miR-34a, hsa-miR-124a, hsa-miR-126 or hsa-miR-147 (Pre-miR™ miRNA, Ambion cat. no. AM17100). H460 lung cancer cells were transiently reverse-transfected in triplicates with each miRNA at a final concentration of 300 pM, resulting in 600 pM of total oligonucleotide. For negative controls, 600 pM of Pre-miR™ microRNA Precursor Molecule-Negative Control #2 (Ambion cat. no. AM17111) were used. To correlate the effect of various combinations with the effect of the sole miRNA, each miRNA at 300 pM was also combined with 300 pM negative control miRNA. Reverse transfections used the following parameters: 7,000 cells per 96 well, 0.15 µl Lipofectamine™ 2000 (Invitrogen) in 20 µl OptiMEM (Invitrogen), 100 µl total transfection volume. As an internal control for the potency of miRNA, etoposide was added at 10 µM and 50 µM to mock-transfected cells, 24 hours after transfection for the following 48 hours. Cells were harvested 72 hours after transfection and subjected to Alamar Blue assays (Invitrogen). Percent proliferation values from the Alamar Blue assay were normalized to those obtained from cells treated with 600 pM negative control miRNA. Data are expressed as % proliferation relative to negative control miRNA-treated cells (Table 16.).

[00286] Transfection of 300 pM hsa-let-7 reduces proliferation of H460 cells by 30.57% (Table 16 and FIG. 4). Additive activity of pair-wise combinations (e.g. hsa-let-7 plus hsa-let-7g) is defined as an activity that is greater than the sole activity of each miRNA (e.g., the activity of hsa-let-7b plus hsa-miR-126 is greater than that observed for hsa-let-7b plus NC and the activity of hsa-let-7b plus hsa-miR-126 is greater than that observed for hsa-miR-126 plus NC). Synergistic activity of pair-wise combinations is defined as an activity that is greater than the sum of the sole activity of each miRNA (e.g., the activity of hsa-let-7b plus hsa-miR-34a is greater than that observed for the sum of the activity of hsa-let-7b plus NC and the activity of hsa-miR-34a plus NC). The data indicate that hsa-let-7c or hsa-let-7g combined with either hsa-miR-34a, hsa-miR-124a, hsa-miR-126, hsa-miR-147, or hsa-let-7b results in synergistic activity (Table 16 and FIG. 4). Therefore, administering combinations of hsa-let-7 with other miRNAs to cancer patients may induce a superior therapeutic response in the treatment of lung cancer. The combinatorial use of miRNAs represents a potentially useful therapy for cancer and other diseases.

Table 16. Cellular proliferation of H460 lung cancer cells in the presence of pair-wise hsa-let-7 miRNA combinations. Values are normalized to values obtained from cells transfected with 600 pM negative control (NC) miRNA. SD, standard deviation S; synergistic effect; A, additive effect.

miRNA [300 pM] + miRNA [300 pM]	% Proliferation	% SD	Effect
NC + NC	100.00	1.45	
NC + miR-34a	99.58	1.66	
NC + miR-124a	69.43	1.38	
NC + miR-126	89.46	2.27	
NC + miR-147	76.97	1.46	
NC + let-7b	74.92	3.38	
NC + let-7c	86.74	2.28	
NC + let-7g	91.41	3.26	
miR-34a + let-7b	64.85	3.50	S
miR-34a + let-7c	76.41	3.81	S
miR-34a + let-7g	73.83	2.85	S
miR-124a + let-7b	39.77	7.61	S
miR-124a + let-7c	37.35	3.08	S
miR-124a + let-7g	35.15	0.84	S
miR-126 + let-7b	68.76	5.89	A
miR-126 + let-7c	57.03	5.15	S
miR-126 + let-7g	61.89	3.27	S
miR-147 + let-7b	56.55	3.85	A
miR-147 + let-7c	60.74	0.60	S
miR-147 + let-7g	56.19	2.95	S
let-7b + let-7c	48.07	3.75	S
let-7b + let-7g	43.19	1.71	S

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let-7c + let-7g	59.85	6.70	S
Etoposide (10 μ M)	20.19	1.89	
Etoposide (50 μ M)	14.94	0.31	

EXAMPLE 12:**DELIVERY OF SYNTHETIC HSA-LET-7 INHIBITS TUMOR GROWTH OF LUNG CANCER CELLS IN MICE**

[00287] The inventors assessed the growth-inhibitory activity of hsa-let-7b in human lung cancer xenografts grown in immunodeficient mice. Hsa-let-7b was delivered into A549 lung cancer cells via electroporation using the Gene Pulser XcellTM (BioRad) with the following settings: 15×10^6 cells with 5 μ g miRNA in 200 μ l OptiMEM, square wave pulse at 150 V for 10 ms. As a negative control, A549 cells were electroporated with negative control (NC) miRNA (Pre-miRTM microRNA Precursor Molecule-Negative Control #2; Ambion cat. no. AM17111) as described above. To assess the anti-oncogenic activity of hsa-let-7b, a group of 4 animals was injected with A459 cells. Electroporated cells (5×10^6) were mixed with BD MatrigelTM, (BD Biosciences; San Jose, CA, USA; cat. no. 356237) in a 1:1 ratio and injected subcutaneously into the flank of NOD/SCID mice (Charles River Laboratories, Inc.; Wilmington, MA, USA) (day 0). NC miRNA-treated cells were injected into the opposite flank of the same animal to control for animal-to-animal variability. Once tumors reached a measurable size (day 12), the length and width of tumors were determined daily or every other day for up to 18 days. Tumor volumes were calculated using the formula, Volume = length X width X width / 2, in which the length is greater than the width. Tumor volumes derived from NC-treated cells and hsa-let-7b-treated cells were averaged and plotted over time (FIG. 5). Data points with p values <0.05, indicating statistical significance, are indicated by asterisks (days 12-19).

[00288] Administration of hsa-let-7b into the A549 lung cancer xenografts inhibited tumor growth *in vivo* (FIG. 5). Cancer cells that received negative control miRNA developed tumors more rapidly than cells treated with hsa-let-7b. Administration of hsa-let-7b into A549 cells suppressed and delayed the onset of tumor growth.

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[00289] These data suggest that hsa-let-7 represents a particularly useful candidate in the treatment of lung cancer and potentially other diseases.

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CLAIMS**WHAT IS CLAIMED IS:**

1. A method of modulating gene expression in a cell comprising administering to the cell an amount of an isolated nucleic acid comprising a let-7 nucleic acid sequence in an amount sufficient to modulate the expression of a gene modulated by a let-7 miRNA family member.
2. The method of claim 1, wherein the gene modulated comprises one or more gene identified in Table 2, 3, 4, 5, 6, 7, 8, and 9.
3. The method of claim 2, wherein the expression of a gene is down-regulated.
4. The method of claim 2, wherein the expression of a gene is up-regulated.
5. The method of claim 2, wherein the gene modulated comprises one or more of ATRX, AURKA/STK6, AURKB/STK12, BRCA1, BRCA2, BUB1, BUB1B, BZRP, CCNA2, CCNB1, CCNE2, CCNG2, CDC2, CDC20, CDC23, CDC25A, CDC6, CDCA7, CDK2, CDK6, CDKN2B, CDT1, CEBPD, CKS1B, CSF1, EIF4E, EPHB2, ERBB3, FASN, FGFBP1, FGFR4, FH, GMNN, IGFBP1, IL8, ITGA6, JUN, JUNB, LHFP, MCAM, MET, MVP, MXI1, MYBL1, MYBL2, NRAS, P8, PDCD4, PLK1, PRKCA, RASSF2, SIVA, SKP2, SMAD4, TACC3, TFDPI, TGFBR3, TNFSF10, or VIM.
6. The method of claim 5, wherein the genes modulated are ATRX, AURKA/STK6, AURKB/STK12, BRCA1, BRCA2, BUB1, BUB1B, BZRP, CCNA2, CCNB1, CCNE2, CCNG2, CDC2, CDC20, CDC23, CDC25A, CDC6, CDCA7, CDK2, CDK6, CDKN2B, CDT1, CEBPD, CKS1B, CSF1, EIF4E, EPHB2, ERBB3, FASN, FGFBP1, FGFR4, FH, GMNN, IGFBP1, IL8, ITGA6, JUN, JUNB, LHFP, MCAM, MET, MVP, MXI1, MYBL1, MYBL2, NRAS, P8, PDCD4, PLK1, PRKCA, RASSF2, SIVA, SKP2, SMAD4, TACC3, TFDPI, TGFBR3, TNFSF10, and VIM.
7. 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.

8. The method of claim 8, wherein the infectious disease or condition is a parasitic, bacterial, viral, or fungal infection.

9. The method of claim 7, wherein the cell is in a subject having, suspected of having, or at risk of developing acute lymphocytic leukemia; acute myeloid leukemia; alpha thalassemia; angiosarcoma; astrocytoma; breast carcinoma; bladder carcinoma; Burkitt's lymphoma; cervical carcinoma; carcinoma of the head and neck; chronic lymphocytic leukemia; chronic myeloblastic leukemia; colorectal carcinoma; endometrial carcinoma; fibrosarcoma glioma; glioblastoma; glioblastoma multiforme; gastric carcinoma; gastrinoma; hepatoblastoma; hepatocellular carcinoma; Hodgkin lymphoma; Kaposi's sarcoma; larynx carcinoma; leukemia; lung carcinoma; leiomyoma; leiomyosarcoma; lipoma; melanoma; medulloblastoma; myeloid leukemia; mesothelioma; myxofibrosarcoma; multiple myeloma; neuroblastoma; non-Hodgkin lymphoma; non small cell lung carcinoma; ovarian carcinoma; esophageal carcinoma; oropharyngeal carcinoma; osteosarcoma; pancreatic carcinoma; papillary carcinoma; prostate carcinoma; promyelocytic leukemia; renal cell carcinoma; retinoblastoma; rhabdomyosarcoma; sporadic papillary renal carcinoma; squamous cell carcinoma of the head and neck; salivary gland tumor; small intestinal carcinoma; T-cell leukemia; thyroid carcinoma; or orurothelial carcinoma, wherein the modulation of one or more gene is sufficient for a therapeutic response.

10. The method of claim 9, wherein a therapeutic response is reduced viability, reduced proliferation, or reduced metastasis of a cancer cell.

11. The method of claim 1, wherein the let-7 nucleic acid comprises at least one of hsa-let-7a-1, hsa-let-7a-2, hsa-let-7a-3, hsa-let-7b, hsa-let-7c, hsa-let-7d, hsa-let-7e, hsa-let-7f-1, hsa-let-7f-2, hsa-let-7g, hsa-let-7i, or a segment thereof.

12. The method of claim 1, wherein the let-7 nucleic acid is an inhibitor of let-7 function.

13. The method of claim 1, wherein the cell is an epithelial, a stromal, or a mucosal cell.
14. The method of claim 1, wherein the cell is a brain, a neuronal, a blood, a cervical, 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, a striated muscle cell.
15. The method of claim 1, wherein the cell is a cancer cell.
16. The method of claim 15, wherein the 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, uterine, testicular, epithelial, muscle, oropharyngeal, adrenal, gastrointestinal, mesothelial, salivary gland, small intestine, or thyroid cell.
17. The method of claim 1, wherein the isolated let-7 nucleic acid is a recombinant nucleic acid.
18. The method of claim 17, wherein the recombinant nucleic acid is RNA.
19. The method of claim 17, wherein the recombinant nucleic acid is DNA.
20. The method of claim 19, wherein the recombinant nucleic acid comprises a let-7 expression cassette.
21. The method of claim 20, wherein the expression cassette is comprised in a viral vector, or plasmid DNA vector.
22. The method of claim 21, wherein the viral vector is administered at a dose of 1×10^5 to 1×10^{14} viral particles per dose or the plasmid DNA vector is administered at a dose of 100 mg per patient to 4000 mg per patient.
23. The method of claim 1, wherein the let-7 nucleic acid is a synthetic nucleic acid.

24. The method of claim 23, wherein the nucleic acid is administered at a dose of 0.01 mg/kg of body weight to 10 mg/kg of body weight.
25. The method of claim 1, wherein the let-7 is a hsa- let-7.
26. The method of claim 1, wherein the nucleic acid is administered enterally or parenterally.
27. The method of claim 26, wherein enteral administration is orally.
28. The method of claim 26, wherein parenteral administration is intravascular, intracranial, intrapleural, intratumoral, intraperitoneal, intramuscular, intralymphatic, intraglandular, subcutaneous, topical, intrabronchial, intratracheal, intranasal, inhaled, or instilled.
29. The method of claim 1, wherein the nucleic acid is comprised in a pharmaceutical formulation.
30. The method of claim 29, wherein the pharmaceutical formulation is a lipid composition.
31. The method of claim 29, wherein the pharmaceutical formulation is a nanoparticle composition.
32. The method of claim 29, wherein the pharmaceutical formulation consists of biocompatible and/or biodegradable molecules.
33. 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 let-7 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 2, 3, 4, 5, 6, 7, 8 and 9.
34. The method of claim 33, wherein the gene modulated comprises one or more of ATRX, AURKA/STK6, AURKB/STK12, BRCA1, BRCA2, BUB1, BUB1B, BZRP, CCNA2, CCNB1, CCNE2, CCNG2, CDC2, CDC20, CDC23, CDC25A, CDC6, CDCA7, CDK2, CDK6, CDKN2B, CDT1, CEBPD, CKS1B, CSF1, EIF4E, EPHB2, ERBB3, FASN, FGFBP1, FGFR4, FH, GMNN, IGFBP1, IL8, ITGA6, JUN,

JUNB, LHFP, MCAM, MET, MVP, MXI1, MYBL1, MYBL2, NRAS, P8, PDCD4, PLK1, PRKCA, RASSF2, SIVA, SKP2, SMAD4, TACC3, TFDP1, TGFBR3, TNFSF10, or VIM.

35. The method of claim 33, wherein the let-7 nucleic acid comprises at least one of hsa-let-7a-1, hsa-let-7a-2, hsa-let-7a-3, hsa-let-7b, hsa-let-7c, hsa-let-7d, hsa-let-7e, hsa-let-7f-1, hsa-let-7f-2, hsa-let-7g, hsa-let-7i, or a segment thereof.

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

37. The method claim 36 wherein the miRNAs are comprised in a single composition.

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

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

40. The method of claim 33, wherein the expression of a gene or a gene product is down-regulated.

41. The method of claim 33, wherein the expression of a gene or a gene product is up-regulated.

42. The method of claim 33, wherein the cell is a cancer cell.

43. The method of claim 42, wherein the cancer cell is a lung, liver or acute myeloid leukemic cancer cell.

44. The method of claim 42, 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.

45. The method of claim 42, 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.

46. The method of claim 33, wherein the isolated let-7 nucleic acid is a recombinant nucleic acid.

47. The method of claim 46, wherein the recombinant nucleic acid is DNA.

48. The method of claim 47, wherein the recombinant nucleic acid is a viral vector or a plasmid DNA.

49. The method of claim 33, wherein the nucleic acid is RNA.

50. The method of claim 46, wherein the recombinant nucleic acid is a synthetic nucleic acid.

51. 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 let-7 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.

52. The method of claim 51, wherein one or more cellular pathway or physiologic pathway includes one or more genes identified in Table 2, 3, 4, 5, 6, 7, 8 and 9.

53. 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 2, 3, 4, 5, 6, 7, 8 and 9;
- (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.

54. The method of claim 53 further comprising treating the subject with 1, 2, 4, 5, 6, 7, 8, 9, 10, or more miRNAs.

55. The method of claim 54, wherein each miRNA is administered individually or one or more combinations.

56. The method of claim 55, wherein the miRNAs are in a single composition.

57. A method of assessing a cell, tissue, or subject comprising assessing expression of let-7 in combination with assessing expression of one or more gene from Table 2, 3, 4, 5, 6, 7, or 8 in at least one sample.

58. A method of assessing let-7 status in a sample comprising the steps of:

- (a) assessing expression of one or more genes from Table 2, 3, 4, 5, 6, 7, 8 or 9 in a sample; and
- (b) determining let-7 status based on level of let-7 expression in the sample.

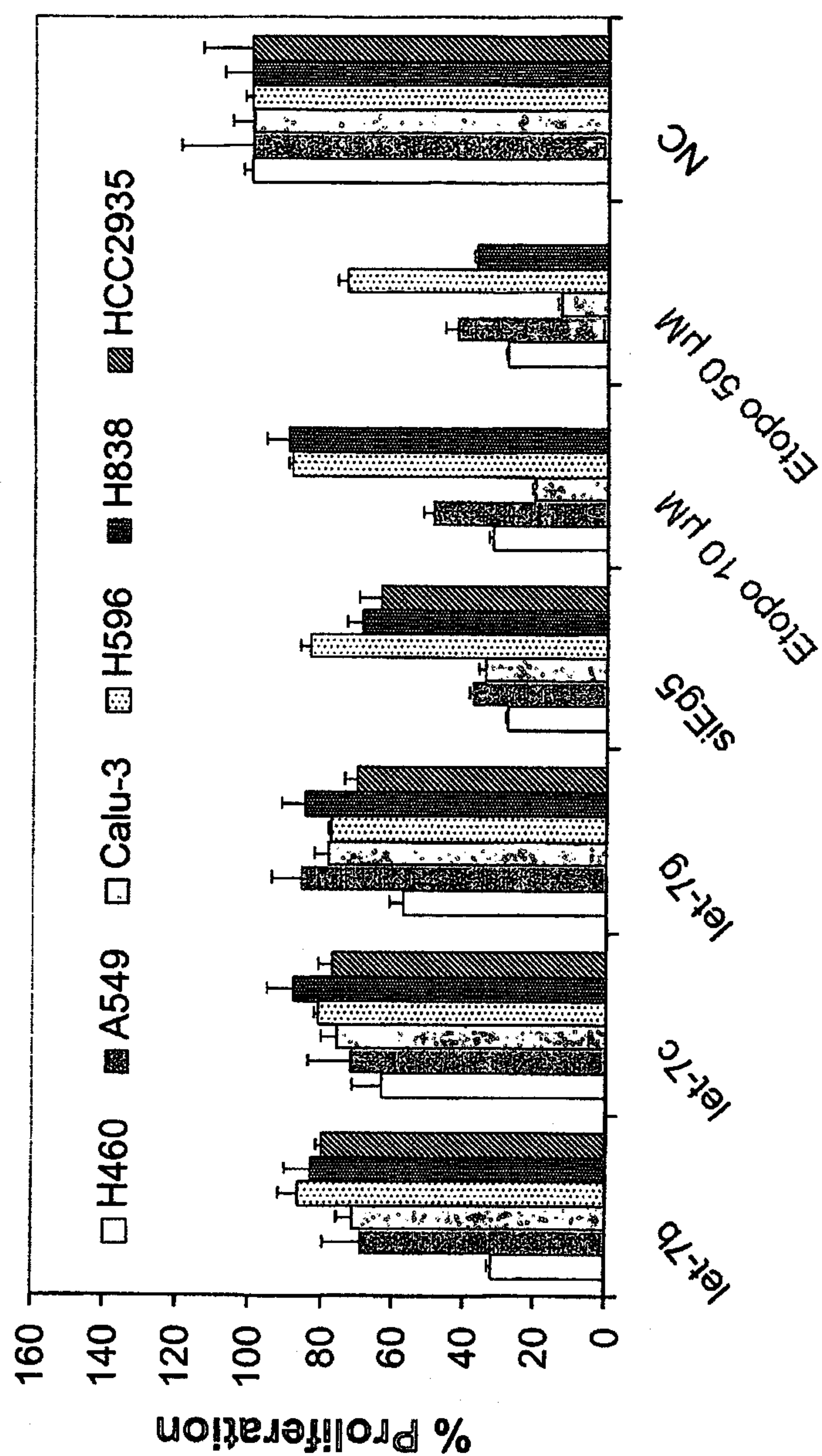


FIG. 1

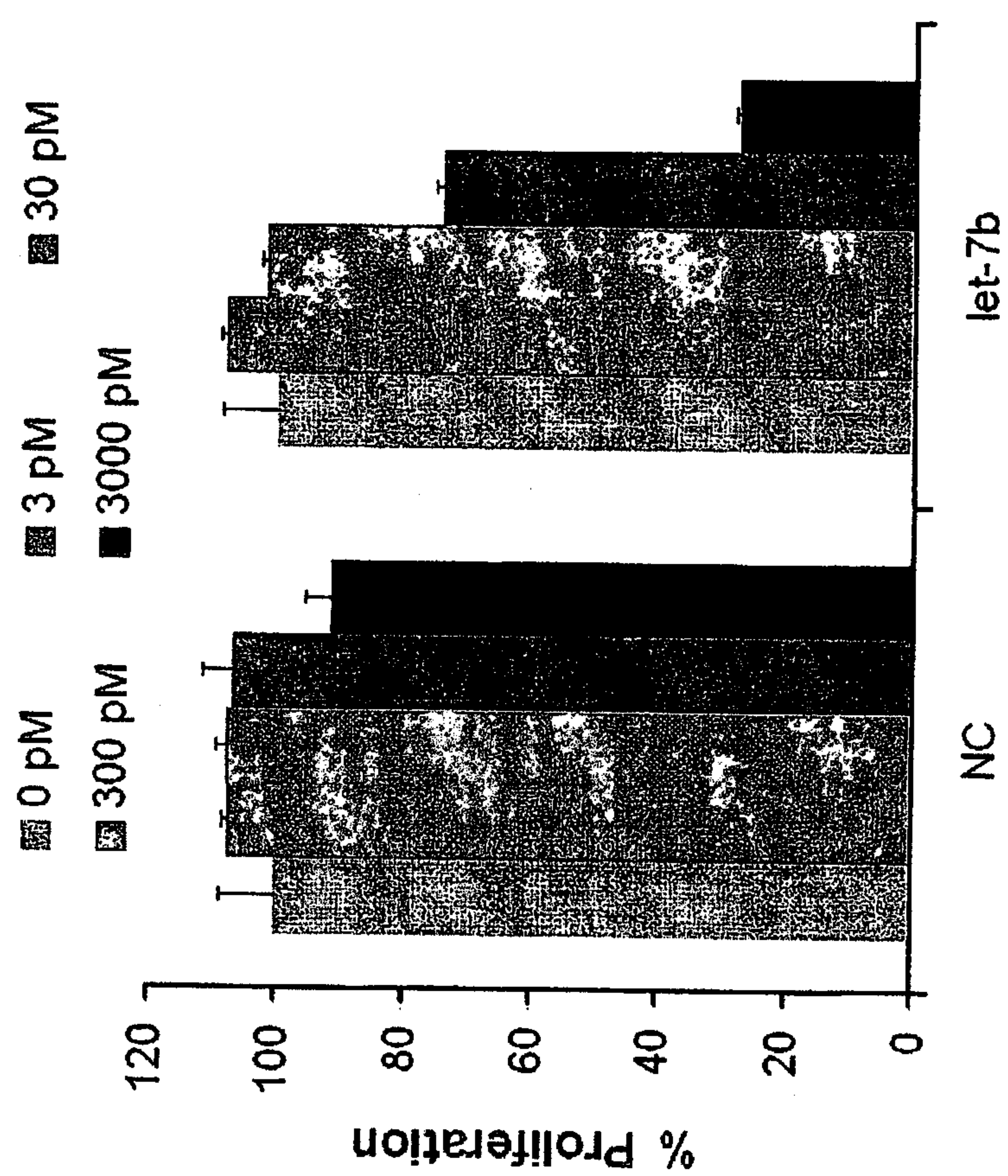


FIG. 2

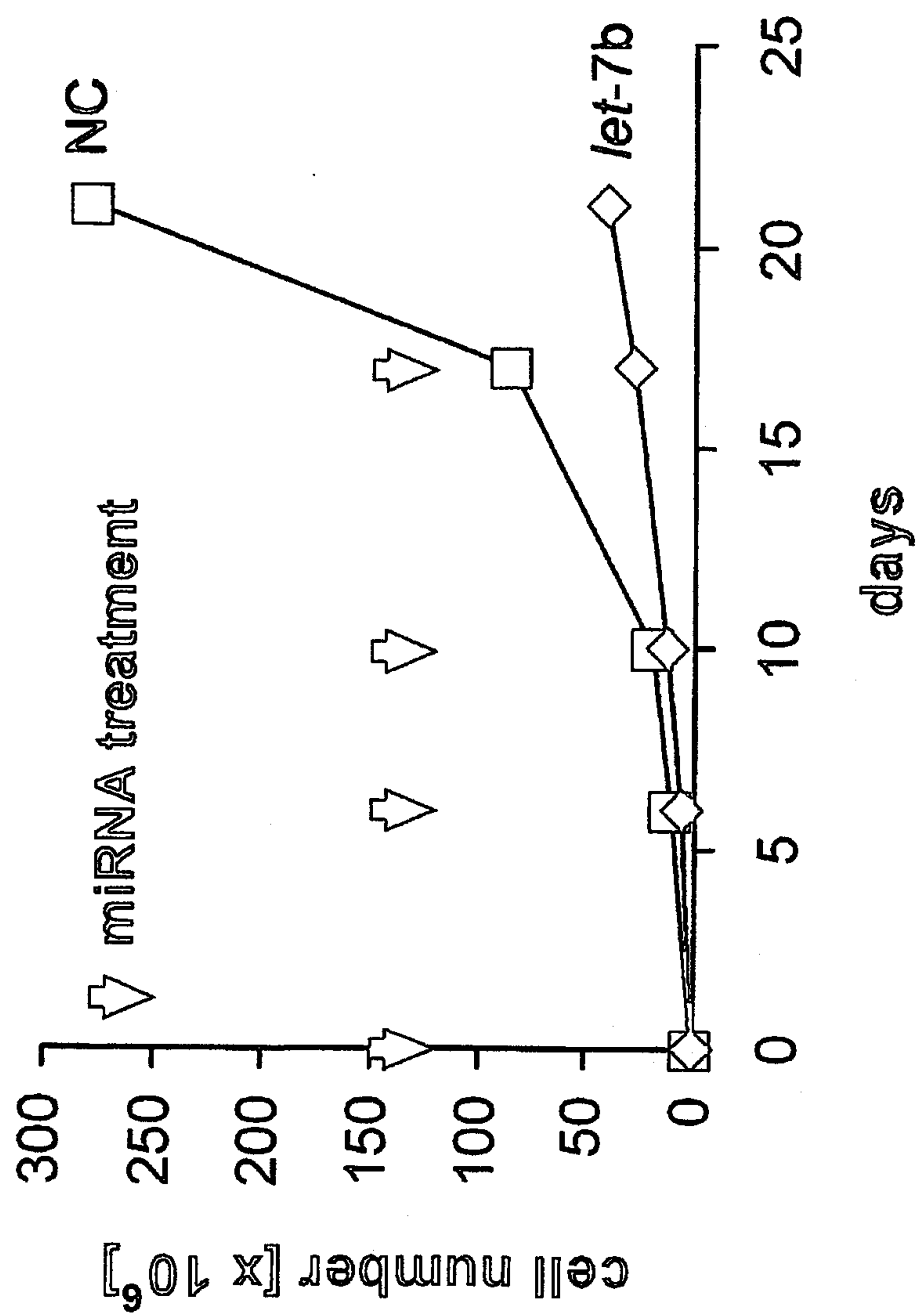


FIG. 3

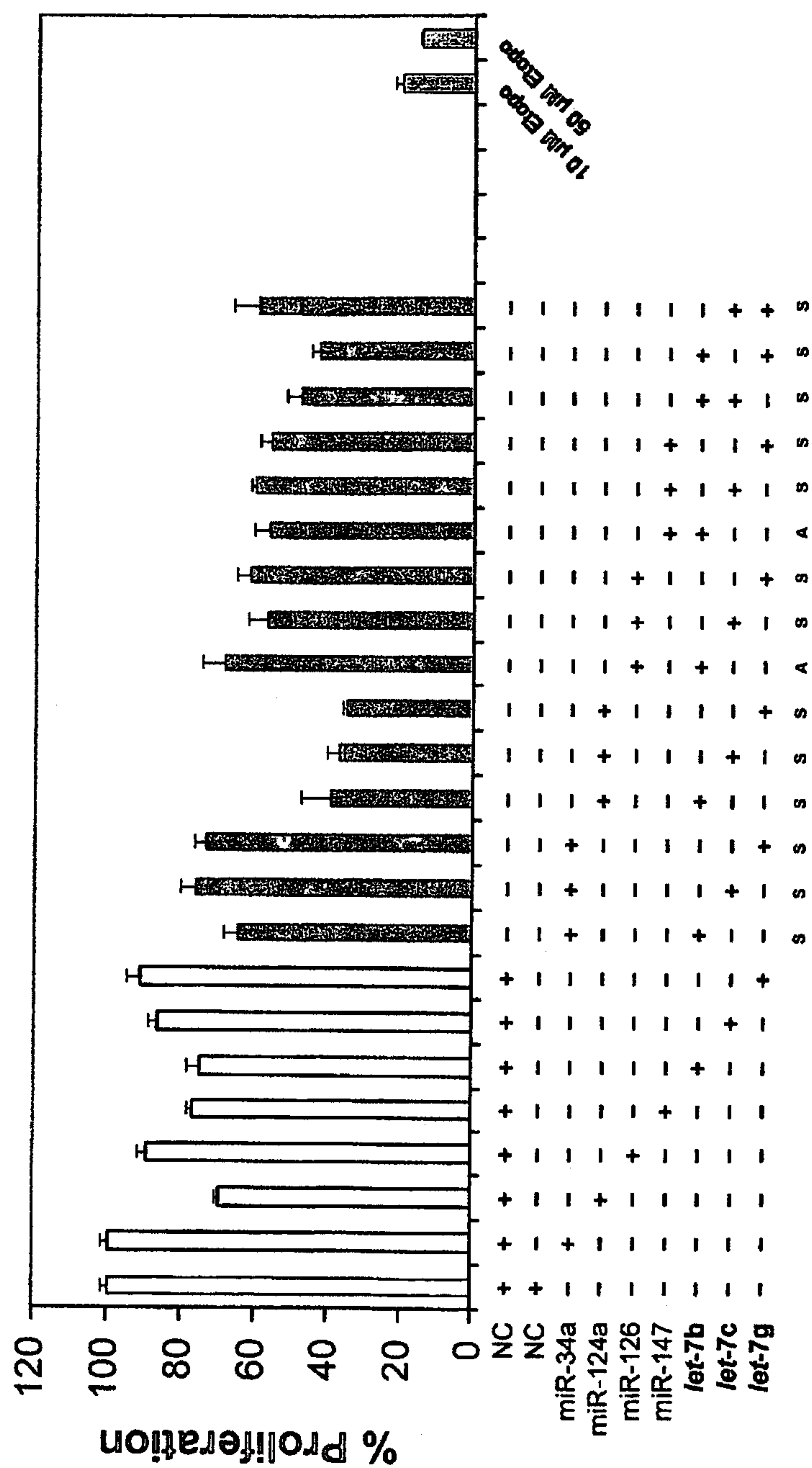


FIG. 4

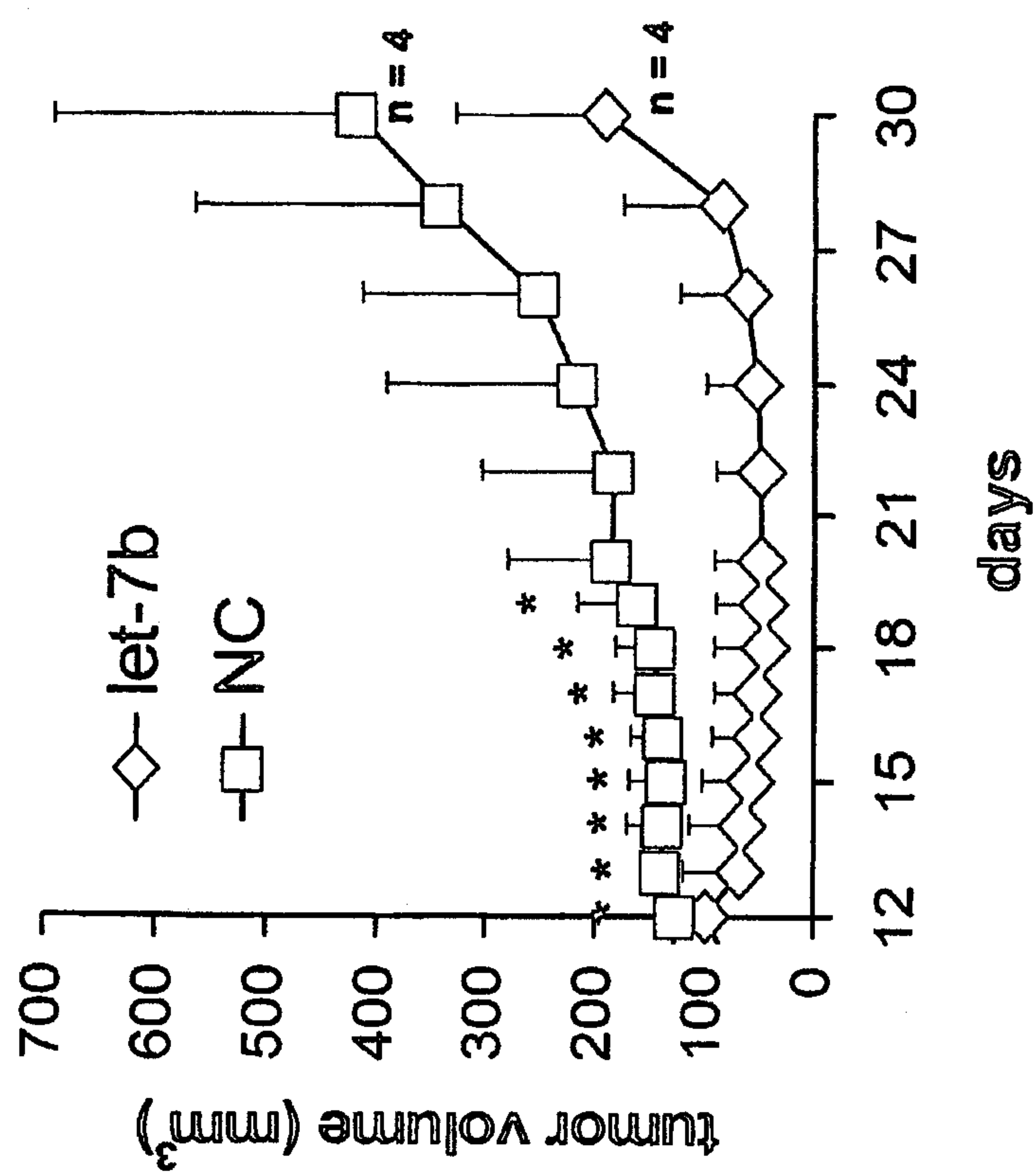


FIG. 5

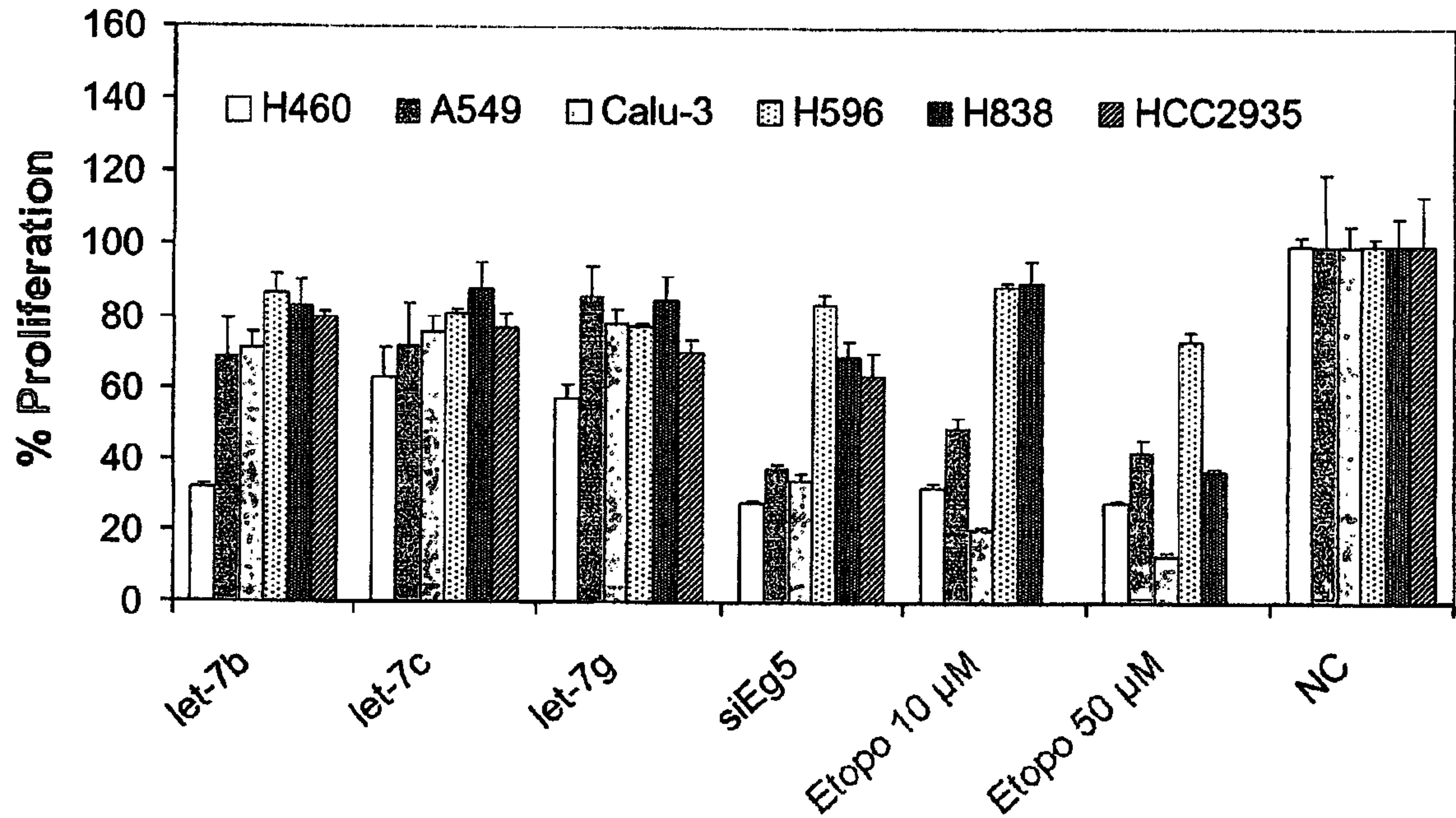


FIG. 1