

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

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
22 July 2010 (22.07.2010)

(10) International Publication Number
WO 2010/083162 A2

PCT

(51) International Patent Classification:
A61K 48/00 (2006.01)

(21) International Application Number:
PCT/US2010/020764

(22) International Filing Date:
12 January 2010 (12.01.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/144,296 13 January 2009 (13.01.2009) US

(71) Applicant (for all designated States except US): **THE BOARD OF REGENTS OF THE UNIVERSITY OF TEXAS SYSTEM** [US/US]; 201 West 7th Street, Austin, Texas 78701 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **EPSTEIN, Henry F.** [US/US]; 201 West 7th Street, Austin, Texas 78701 (US). **GUO, Wei** [CN/US]; 201 West 7th Street, Austin, Texas 78701 (US). **CHEN, Daisi** [CN/US]; 201 West 7th Street, Austin, Texas 78701 (US). **SINGH, Ram** [IN/US]; 201 West 7th Street, Austin, Texas 78701 (US).

(74) Agents: **DEVADAS, Sendil K.** et al.; Barnes & Thornburg LLP, P.O. Box 2786, Chicago, Illinois 60690-2786 (US).

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

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

Published:

— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: UNC-45A SPLICE VARIANTS BASED CANCER DIAGNOSTICS AND THERAPEUTICS

(57) Abstract: Methods and compositions to diagnose and treat cancers using UNC-45A splice variants are disclosed. Expression of a human UNC-45A929 splice variant that is shorter than UNC-45A944 splice variant is increased in cancer cells including metastatic cancers. siRNA to inhibit or downregulate UNC-45A splice variants in cancers are disclosed.



WO 2010/083162 A2

UNC-45A SPLICE VARIANTS BASED CANCER DIAGNOSTICS AND THERAPEUTICS

[0001] This application claims priority to U.S. provisional application no. 61/144,296, filed January 13, 2009, the content of which is herein incorporated by reference in its entirety.

BACKGROUND

[0002] The present disclosure relates to UNC-45A splice variants and their use in cancer therapeutics and diagnostics.

[0003] Approximately 90% of breast cancer deaths are caused by metastasis to bones, liver, lungs, or brain with a survival time for patients of 2 years. Cancer metastasis is tightly related to cell motility including cell invasion and migration in breast cancer.

[0004] UNC-45 functions as a molecular chaperone for myosin motors and as a co-chaperone for Hsp90 in both vertebrate and invertebrate animals. Myosins are actin-based motors that play critical roles in a variety of cellular processes, including cytokinesis, cellular trafficking, phagocytosis, maintenance of cell shape, and muscle contraction. Myosin-based movement results from a specific cycle of the myosin head binding and releasing ATP and actin. During this process, the myosin head goes through multiple folding conformations. Evidence from a variety of experimental systems indicates that myosins use specialized chaperones during their activity, folding, and assembly.

[0005] Molecular chaperones are necessary for *de novo* folding and structural maintenance of the myosin head. Expression of the myosin motor domain in bacteria results in misfolding. In vertebrate systems, the chaperonin containing TCP-1 (CCT), as well as molecular chaperones Hsp90 and Hsc70, are necessary but not sufficient in the folding of striated muscle myosin.

[0006] The UNC-45 family of molecular chaperones is necessary for the proper functions of myosins, the motor proteins of the actin cytoskeleton and the contractile thick filaments of the muscle and heart. In humans and other vertebrates, two genes have been discovered which encode UNC-45 chaperones. One encodes UNC-45A that is essential for embryonic development, cell migration, and cell division because of its role in the activation of both myosin IIA (MYH9) and

Myosin IIB (MyH10). UNC-45A or its mouse ortholog UNC-45a is necessary for cell proliferation in mouse myoblasts and for cell migration and proliferation in metastatic human ovarian cancer cells.

[0007] Mutations in UNC-45/Cro1p/ She4p(Dim1p) domain (UCS) proteins result in phenotypes related to defects in myosin folding and assembly. Reduced UCS domain protein function in fungal mutants produces myosins defective in actin:ATP transduction. In *Caenorhabditis elegans*, null unc-45 alleles results in embryonic arrest of body wall muscle development, and temperature-sensitive mutations lead to a paralyzed or uncoordinated phenotype at the restrictive temperature with marked disorganization of myofibrils. UNC-45 exerts chaperone activity *in vitro* on the myosin head and acts as a cochaperone that specifically binds Hsp90.

[0008] Mice and humans each have two genes that are located on different chromosomes, which encode distinct UNC-45-like protein isoforms, and are expressed either in multiple tissues or only in cardiac and skeletal muscles. Their expression is regulated during muscle differentiation *in vitro*, with the striated muscle isoform mRNA appearing during myoblast fusion.

[0009] UNC-45 is a substrate of an E3/E4-multiubiquitination complex containing CHN-1 (the *C. elegans* homologue of CHIP) and UFD-2. *chn-1-null* worms are viable and appear morphologically normal. However, UNC-45 overexpression leads to an uncoordinated phenotype in these worms, suggesting that increased levels of UNC-45 may cause muscle defects.

[00010] RNA interference (RNAi) pathway is often used in experimental biology to study the function of genes in a variety of *in vitro* and *in vivo* model systems. Double-stranded RNA is synthesized with a sequence complementary to a gene of interest and introduced into a cell or organism, where it is recognized as exogenous genetic material and activates the RNAi pathway. Using this mechanism, researchers induce a drastic decrease in the expression of a targeted gene. Since RNAi may not totally eliminate the expression of the target gene, this technique is sometimes referred as a "knockdown", to distinguish it from "knockout" procedures in which expression of a gene is entirely eliminated..

SUMMARY

[00011] Methods and compositions to selectively suppress or down regulate the 929 amino acid residue splice variant of UNC-45A are disclosed. Agents including

short/small interfering RNAs (siRNA) and short/small hairpin RNAs (shRNA) that specifically target the 929 residue splice variant (hereinafter “UNC-45A929”) are disclosed.

[00012] Methods and compositions to diagnose cancer based on the expression level of the UNC-45A929 splice variant are also disclosed. For example, the 929 residue splice variant of UNC-45A is elevated in several cancers including breast, cervical and ovarian, when compared to the 944 splice variant. In addition, the mRNA for the 929 splice variant has unique sequences in its 5' untranslated region compared to the 944 splice variant. These differences also permit design of nucleic acid sequences that specifically target UNC-45A929 splice variant.

[00013] In an aspect, shRNA and siRNA sequences are designed to selectively downregulate (e.g., knockdown) UNC-45A929 mRNA and protein when compared to the 944 residue splice variant UNC-45A mRNA and protein. These UNC-45A929 specific reagents have therapeutic uses. Any cancer type that has the UNC-45A929 expressed to a greater level than the 944 residue splice variant is capable of being treated by the methods and compositions disclosed herein.

[00014] A short interfering RNA (siRNA) or a short hairpin RNA (shRNA) molecule for selectively reducing the expression of a human UNC-45A splice variant in a cell, wherein the RNA molecule is substantially complementary to at least a part of a mRNA encoding the splice variant, wherein the splice variant comprises a nucleic acid sequence as in SEQ ID NO: 1 (nucleotide positions 1-835) or SEQ ID NO: 2.

[00015] In an aspect, the siRNA targets TGGCCGTCCTACCCTGGTTTCTTT or GGACAGAGGTGGTAGTGAAC of the UNC-45A929 splice variant. In an aspect, the siRNA targets GGTCCAGGGACCCCGAGCCCG or GTGAGTGGTCCAGGGACCCC of UNC-45A944.

[00016] A pharmaceutical composition includes an effective amount of a siRNA or shRNA that specifically inhibits the expression of a human UNC-45A929 splice variant in a cancer cell. In an aspect, the pharmaceutical composition contains the siRNA that includes one or more modified nucleotides. In an aspect, the shRNA is expressed from a vector.

[00017] A method of reducing the proliferation of a cancer cell includes contacting the cancer cell with an RNAi agent that specifically downregulates the expression

of UNC-45A splice variants. In an aspect, the RNAi agent is a siRNA molecule that specifically targets UNC-45A929 splice variant.

[00018] In an aspect, the cancer cell is selected from the group consisting of breast cancer, cervical cancer and colon cancer. In an aspect, the cancer cell is a metastatic breast cancer cell.

[00019] A method of diagnosing a malignant or a pre-malignant cell includes determining that the cell is malignant or pre-malignant based on the increased expression level of one or more UNC-45A splice variants in the malignant or pre-malignant cell as compared to a non-cancerous cell.

[00020] In an aspect, the expression level is determined by reverse transcriptase (RT)-PCR or determined by immunohistochemistry.

[00021] In an aspect, the expression level of the UNC-45A splice variant is determined RNA expression or protein levels.

[00022] In an aspect, the expression level is determined in a tissue sample.

[00023] A method of diagnosing whether a subject has cancer includes determining the expression of a splice variant UNC-45A929 in an isolated sample, wherein the UNC-45A929 splice variant includes an untranslated nucleotide sequence of 1-835 of SEQ ID NO: 1.

[00024] In an aspect, the expression level of the UNC-45A929 splice variant is determined in the isolated tissue by the RNA levels of UNC-45A929.

[00025] In an aspect, the expression level of the UNC-45A929 splice variant is determined in the isolated tissue by the protein or peptide levels of UNC-45A929.

[00026] In an aspect, the expression levels of the splice variant UNC-45A929 is higher than the expression levels of a splice variant UNC-45A944.

BRIEF DESCRIPTION OF THE DRAWINGS

[00027] **FIG. 1** shows (A) Immunohistochemistry of normal and tumorous breast tissue. The three tumor samples were graded by a certified pathologist. Monoclonal antibody to human UNC-45A was used detect the elevated levels. (B) Multiple samples were coded by blinded laboratory personnel for testing. UNC-45A protein elevation by histochemical stain consistently correlates with the metastatic grade. The bars are standard observations ($p < .001$ for all pair comparisons).

[00028] **FIG. 2** shows UNC-45A levels in breast cancer cell lines. HMEC (normal breast) and T47D, MCF7, MB231 (breast cancer) cell lines were homogenized, and

the protein lysates were separated on 8% SDS-PAGE and Western blotted with monoclonal antibody to human UNC-45A protein. The bars represent standard deviations.

[00029] **FIG. 3** shows siRNA oligos for knockdown of UNC-45A929 and 944.

[00030] **FIG. 4** illustrates shRNA target sequence for UNC-45A929 and UNC-45A944 splice variants.

[00031] **FIG. 5** illustrates shRNA design for UNC-45A944 and UNC-45A929 splice variants.

DETAILED DESCRIPTION

[00032] The molecular interaction of UNC-45A with its protein partner Hsp90 and the target myosin motors, is exploited for molecular strategies for effective therapy of breast cancer.

[00033] In UNC-45A929, exons 1-4 have unique sequences that are not present in UNC-45A944. Therefore target sequences were selected from, for example, exon 2 to design shRNA for down regulating UNC-45A929. In UNC-45A944, about 45 nucleotides are unique when compared to UNC-45A929 and were therefore was selected as target sequences.

[00034] Antisense sequences generally loop with sense sequences to form hairpin. In an aspect, these oligonucleotides are ligated in “BLOCK-iT inducible RNAi” vector to transfect mammalian cells. This vector is tetracycline inducible to trigger the RNAi for down regulating UNC-45A929.

[00035] Knockdown experiments demonstrate that reduction of UNC-45A reduces the rates of cancer cell proliferation and migration whereas overexpression increases them. Data presented herein demonstrate that the elevation of UNC-45A in e.g., both breast tumor samples and breast cancer-derived cell lines is due to overexpression of only one of two alternative splice variants. This differential expression enables the use of UNC-45A as a specific biomarker and for highly specific RNA-based cancer therapeutics.

[00036] UNC-45A and its specific splice variant expression as correlating with established human breast carcinomas in terms of grade, metastasis, and prognosis are validated. Tissue block sections are analyzed by for example, immunohistochemistry and immunoblotting using specific monoclonal antibodies.

- [00037]** UNC-45A splice variants are validated as biomarkers using e.g., fresh serum and breast tissue samples from cancer patients. These samples are analyzed by for example, immunohistochemistry and immunoblotting using specific monoclonal antibodies and compared to standard histopathological methods.
- [00038]** RNAi using UNC-45A929 specific siRNA or shRNA or microRNA are developed as therapeutic agents against cancer. The effects of the RNAi agents on proliferation, migration and invasion in normal, non-metastatic, and metastatic cancer cell lines including breast cancer are tested.
- [00039]** RNA interference (RNAi) is the pathway by which short interfering RNA (siRNA) or short hairpin RNA (shRNA) are used to inactivate the expression of target genes. Synthetic small interfering (siRNAs) or expressed stem-loop RNAs (short-hairpin RNAs (shRNAs) or artificial microRNAs (miRNAs) have been delivered to cultured cells and organisms to inhibit or down regulate expression of a variety of genes. Expressed shRNA is transcribed in cells from a DNA template as a single-stranded RNA molecule (~50 – 100 bases). Complementary regions spaced by a small 'loop' cause the transcript to fold back on itself forming a 'short hairpin' in a manner analogous to natural microRNA. Recognition and processing by the RNAi machinery converts the shRNA into the corresponding siRNA. Some exemplary design strategies for creating shRNA templates can be found in McIntyre & Fanning (2006), BMC Biotechnology 6:1 (incorporated herein by reference).
- [00040]** The term short interfering nucleic acid, siRNA, short interfering RNA, short interfering nucleic acid molecule, short interfering oligonucleotide molecule, or chemically-modified short interfering nucleic acid molecule as used herein refers to any nucleic acid molecule capable of inhibiting or down regulating gene expression or viral replication, for example by mediating RNA interference "RNAi" or gene silencing in a sequence-specific manner.
- [00041]** Generally, shRNA or short hairpin RNA is an RNA molecule that contains a sense strand, antisense strand, and a short loop sequence between the sense and antisense fragments. Due to the complementarity of the sense and antisense fragments in their sequence, such RNA molecules tend to form hairpin-shaped double-stranded RNA (dsRNA). shRNA is cloned into a vector, allowing for expression by a pol III type promoter. The expressed shRNA is then exported into the cytoplasm where it is processed by dicer into siRNA which then get incorporated into the siRNA induced silencing complex (RISC). Small Interfering

RNA (siRNA) are about 21-23 nucleotide double-stranded RNA molecules. Once incorporated into RISC they facilitate the cleavage and degradation of its recognized mRNA.

[00042] MicroRNAs (miRNA) are single-stranded RNA molecules of about 21–23 nucleotides in length, which regulate gene expression. miRNAs are encoded by genes from whose DNA they are transcribed but miRNAs are not translated into protein (non-coding RNA); instead each primary transcript (a pri-miRNA) is processed into a short stem-loop structure called a pre-miRNA and finally into a functional miRNA. Mature miRNA molecules are partially complementary to one or more messenger RNA (mRNA) molecules, and their main function is to down-regulate gene expression.

[00043] By RNA is meant a molecule comprising at least one ribonucleotide residue. By ribonucleotide" is meant a nucleotide with a hydroxyl group at the 2' position of a β D-ribofuranose moiety. The terms include double-stranded RNA, single-stranded RNA, isolated RNA such as partially purified RNA, essentially pure RNA, synthetic RNA, recombinantly produced RNA, as well as altered RNA that differs from naturally occurring RNA by the addition, deletion, substitution and/or alteration of one or more nucleotides. Such alterations can include addition of non-nucleotide material, such as to the end(s) of the siRNA or internally, for example at one or more nucleotides of the RNA. Nucleotides in the RNA molecules can also comprise non-standard nucleotides, such as non-naturally occurring nucleotides or chemically synthesized nucleotides or deoxynucleotides. These altered RNAs can be referred to as analogs or analogs of naturally-occurring RNA.

[00044] A subject can be a mammal or mammalian cells, including a human or human cells.

[00045] The dsRNA molecules (e.g., siRNA and shRNA) can include naturally occurring nucleotides or can be comprised of at least one modified nucleotide, such as a 2'-O-methyl modified nucleotide, a nucleotide comprising a 5'-phosphorothioate group, and a terminal nucleotide linked to a cholesteryl derivative or dodecanoic acid bisdecylamide group. Alternatively, the modified nucleotide may be selected from the group of: a 2'-deoxy-2'-fluoro modified nucleotide, a 2'-deoxy-modified nucleotide, a locked nucleotide, an abasic nucleotide, 2'-amino-modified nucleotide, 2'-alkyl-modified nucleotide, morpholino nucleotide, a phosphoramidate, and a non-natural base comprising nucleotide.

[00046] In an aspect, polyethylene glycol (PEG) can be covalently attached to siRNA compounds disclosed herein. The attached PEG can be any molecular weight, preferably from about 2,000 to about 50,000 daltons (Da).

[00047] As used herein, "target sequence" refers to a contiguous portion of the nucleotide sequence of an mRNA molecule formed during the transcription of the UNC-45A929 splice variant, including mRNA that is a product of RNA processing of a primary transcription product. By "gene", or "target gene", is meant a nucleic acid that encodes an RNA, for example, nucleic acid sequences including, but not limited to, structural genes encoding a polypeptide. A gene or target gene can also encode a functional RNA (fRNA) or non-coding RNA (ncRNA), such as small temporal RNA (stRNA), micro RNA (miRNA), small nuclear RNA (snRNA), short interfering RNA (siRNA), small nucleolar RNA (snRNA), ribosomal RNA (rRNA), transfer RNA (tRNA) and precursor RNAs thereof. Such non-coding RNAs can serve as target nucleic acid molecules for siRNA mediated RNA interference in modulating the activity of FRNA or ncRNA involved in functional or regulatory cellular processes.

[00048] The term complementary, when used to describe a first nucleotide sequence in relation to a second nucleotide sequence, refers to the ability of an oligonucleotide or polynucleotide comprising the first nucleotide sequence to hybridize and form a duplex structure under certain conditions with an oligonucleotide or polynucleotide comprising the second nucleotide sequence, as will be understood by the skilled person. Such conditions can, for example, be stringent conditions.

[00049] Oligonucleotide probes that specifically target UNC-45A 929 splice variant are disclosed herein. These probes range from about 10-100, 10-50, 100-750, 100-800 or 10-500 contiguous nucleotide residues of SEQ ID NO: 1 and may be specifically directed to nucleotide positions 1-835 of SEQ ID NO: 1.

[00050] Stringency of hybridization reactions is readily determinable by one of ordinary skill in the art, and generally is an empirical calculation dependent upon probe length, washing temperature, and salt concentration. In general, longer probes require higher temperatures for proper annealing, while shorter probes need lower temperatures. Hybridization generally depends on the ability of denatured DNA to reanneal when complementary strands are present in an environment below their melting temperature. The higher the degree of desired homology between the probe

and hybridizable sequence, the higher the relative temperature which can be used. As a result, it follows that higher relative temperatures would tend to make the reaction conditions more stringent, while lower temperatures less so. For explanation of stringency of hybridization reactions, see Ausubel et al., *Current Protocols in Molecular Biology*, Wiley Interscience Publishers, (1995).

[00051] Stringent conditions or high stringency conditions, as defined herein, may be identified by those that: (1) employ low ionic strength and high temperature for washing, for example 0.015 M sodium chloride/0.0015 M sodium citrate/0.1% sodium dodecyl sulfate at 50°C.; (2) employ during hybridization a denaturing agent, such as formamide, for example, 50% (v/v) formamide with 0.1% bovine serum albumin/0.1% Ficoll/0.1% polyvinylpyrrolidone/50 mM sodium phosphate buffer at pH 6.5 with 750 mM sodium chloride, 75 mM sodium citrate at 42°C.; or (3) employ 50% formamide, 5XSSC (0.75 M NaCl, 0.075 M sodium citrate), 50 mM sodium phosphate (pH 6.8), 0.1% sodium pyrophosphate, 5.times.Denhardt's solution, sonicated salmon sperm DNA (50 µg/ml), 0.1% SDS, and 10% dextran sulfate at 42°C., with washes at 42°C. in 0.2XSSC (sodium chloride/sodium citrate) and 50% formamide at 55°C. followed by a high-stringency wash consisting of 0.1XSSC containing EDTA at 55°C.

[00052] Moderately stringent conditions may be identified as described by Sambrook et al., *Molecular Cloning: A Laboratory Manual*, New York: Cold Spring Harbor Press, 1989, and include the use of washing solution and hybridization conditions (e.g., temperature, ionic strength and % SDS) less stringent than those described above. An example of moderately stringent conditions is overnight incubation at 37°C. in a solution comprising: 20% formamide, 5XSSC (150 mM NaCl, 15 mM trisodium citrate), 50 mM sodium phosphate (pH 7.6), 5X Denhardt's solution, 10% dextran sulfate, and 20 mg/mL denatured sheared salmon sperm DNA, followed by washing the filters in 1XSSC at about 37-50°C. The skilled artisan will recognize how to adjust the temperature, ionic strength, etc. as necessary to accommodate factors such as probe length and the like. The skilled person will be able to determine the set of conditions most appropriate for a test of complementarity of two sequences in accordance with the ultimate application of the hybridized nucleotides.

[00053] This includes base-pairing of the oligonucleotide or polynucleotide comprising the first nucleotide sequence to the oligonucleotide or polynucleotide

comprising the second nucleotide sequence over the entire length of the first and second nucleotide sequence. Such sequences can be referred to as "fully complementary" with respect to each other herein. However, where a first sequence is referred to as "substantially complementary" with respect to a second sequence herein, the two sequences can be fully complementary, or they may form one or more, but preferably not more than 4, 3 or 2 mismatched base pairs upon hybridization, while retaining the ability to hybridize under the conditions most relevant to their ultimate application. However, where two oligonucleotides are designed to form, upon hybridization, one or more single stranded overhangs, such overhangs shall not be regarded as mismatches with regard to the determination of complementarity. For example, a dsRNA that includes one oligonucleotide 21 nucleotides in length and another oligonucleotide 23 nucleotides in length, wherein the longer oligonucleotide comprises a sequence of 21 nucleotides that is fully complementary to the shorter oligonucleotide, may yet be referred to as "fully complementary" for the purposes disclosed herein.

[00054] Complementary sequences, as used herein, may also include, or be formed entirely from, non-Watson-Crick base pairs and/or base pairs formed from non-natural and modified nucleotides, in as far as the above requirements with respect to their ability to hybridize are fulfilled.

[00055] The terms complementary, fully complementary and substantially complementary herein may be used with respect to the base matching between the sense strand and the antisense strand of a dsRNA, or between the antisense strand of a dsRNA and a target sequence, as will be understood from the context of their use.

[00056] As used herein, a polynucleotide which is substantially complementary to at least part of a messenger RNA (mRNA) refers to a polynucleotide which is substantially complementary to a contiguous portion of the mRNA of interest (e.g., encoding UNC-45A929). For example, a polynucleotide is complementary to at least a part of a UNC-45A929 mRNA if the sequence is substantially complementary to a non-interrupted portion of a mRNA encoding UNC-45A929.

[00057] The term double-stranded RNA or dsRNA, as used herein, refers to a ribonucleic acid molecule, or complex of ribonucleic acid molecules, having a duplex structure comprising two anti-parallel and substantially complementary, as defined above, nucleic acid strands. The two strands forming the duplex structure may be different portions of one larger RNA molecule, or they may be separate

RNA molecules. Where the two strands are part of one larger molecule, and therefore are connected by an uninterrupted chain of nucleotides between the 3'-end of one strand and the 5' end of the respective other strand forming the duplex structure, the connecting RNA chain is referred to as a "hairpin loop". Where the two strands are connected covalently by means other than an uninterrupted chain of nucleotides between the 3'-end of one strand and the 5' end of the respective other strand forming the duplex structure, the connecting structure is referred to as a "linker". The RNA strands may have the same or a different number of nucleotides. The maximum number of base pairs is the number of nucleotides in the shortest strand of the dsRNA. In addition to the duplex structure, a dsRNA may comprise one or more nucleotide overhangs.

[00058] As used herein, a "nucleotide overhang" refers to the unpaired nucleotide or nucleotides that protrude from the duplex structure of a dsRNA when a 3'-end of one strand of the dsRNA extends beyond the 5'-end of the other strand, or vice versa. "Blunt" or "blunt end" means that there are no unpaired nucleotides at that end of the dsRNA, i.e., no nucleotide overhang. A "blunt ended" dsRNA is a dsRNA that is double-stranded over its entire length, i.e., no nucleotide overhang at either end of the molecule.

[00059] The term "antisense strand" refers to the strand of a dsRNA which includes a region that is substantially complementary to a target sequence. As used herein, the term "region of complementarity" refers to the region on the antisense strand that is substantially complementary to a sequence, for example a target sequence, as defined herein. Where the region of complementarity is not fully complementary to the target sequence, the mismatches are most tolerated in the terminal regions and, if present, are preferably in a terminal region or regions, e.g., within 6, 5, 4, 3, or 2 nucleotides of the 5' and/or 3' terminus.

[00060] The term sense strand, as used herein, generally refers to the strand of a dsRNA that includes a region that is substantially complementary to a region of the antisense strand.

[00061] The term asymmetric hairpin generally means a linear siRNA molecule comprising an antisense region, a loop portion that can comprise nucleotides or non-nucleotides, and a sense region that comprises fewer nucleotides than the antisense region to the extent that the sense region has enough complementary nucleotides to base pair with the antisense region and form a duplex with loop. For

example, an asymmetric hairpin siRNA molecule can comprise an antisense region having length sufficient to mediate RNAi in a cell or in vitro system (e.g. about 15 to about 30, or about 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30 nucleotides) and a loop region comprising about 4 to about 12 (e.g., about 4, 5, 6, 7, 8, 9, 10, 11, or 12) nucleotides, and a sense region having about 3 to about 25 (e.g., about 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, or 25) nucleotides that are complementary to the antisense region. The asymmetric hairpin siRNA molecule can also include a 5'-terminal phosphate group that can be chemically modified. The loop portion of the asymmetric hairpin siRNA molecule can comprise nucleotides, non-nucleotides, linker molecules, or conjugate molecules as described herein.

[00062] The term asymmetric duplex generally refers to a siRNA molecule having two separate strands comprising a sense region and an antisense region, wherein the sense region comprises fewer nucleotides than the antisense region to the extent that the sense region has enough complementary nucleotides to base pair with the antisense region and form a duplex. For example, an asymmetric duplex siRNA molecule can comprise an antisense region having length sufficient to mediate RNAi in a cell or in vitro system (e.g. about 15 to about 30, or about 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30 nucleotides) and a sense region having about 3 to about 25 (e.g., about 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, or 25) nucleotides that are complementary to the antisense region.

[00063] Introducing into a cell, when referring to a dsRNA, means facilitating uptake or absorption into the cell, as is understood by those skilled in the art. Absorption or uptake of dsRNA can occur through unaided diffusive or active cellular processes, or by auxiliary agents or devices. The meaning of this term is not limited to cells in vitro; a dsRNA may also be "introduced into a cell", wherein the cell is part of a living organism. In such instance, introduction into the cell will include the delivery to the organism. For example, for in vivo delivery, dsRNA can be injected into a tissue site or administered systemically. In vitro introduction into a cell includes methods known in the art such as electroporation and lipofection.

[00064] The terms silence and inhibit the expression of, refer to the at least partial suppression of the expression of the UNC-45A929 splice variant or the 944 variant, as manifested by a reduction of the amount of mRNA transcribed from the UNC-

45A929 splice variant which may be isolated from a first cell or group of cells in which the UNC-45A929 splice variant is transcribed and which has or have been treated such that the expression of the UNC-45A929 splice variant is inhibited, as compared to a second cell or group of cells substantially identical to the first cell or group of cells but which has or have not been so treated (control cells). The degree of inhibition can be greater than 50%, 60%, 75%, 80%, 90%, 95%, and 99%.

[00065] Alternatively, the degree of inhibition may be given in terms of a reduction of a parameter that is functionally linked to UNC-45A929 transcription, e.g. the amount of protein encoded by the UNC-45A929, or the number of cells displaying a certain phenotype, e.g apoptosis. In principle, UNC-45A929 silencing may be determined in any cell expressing the target, either constitutively or by genomic engineering, and by any appropriate assay.

[00066] For example, in certain instances, expression of the UNC-45A929 splice variant is suppressed by at least about 20%, 25%, 35%, or 50% by administration of the RNAi agents disclosed herein. In an aspect, the UNC-45A929 splice variant is suppressed by at least about 60%, 70%, or 80% by administration of the RNAi agents disclosed herein. In an aspect, the UNC-45A929 splice variant is suppressed by at least about 85%, 90%, or 95% by administration of the RNAi agents disclosed herein. In an aspect, the UNC-45A929 splice variant is suppressed by at least about 98%, 99% or more by administration of the RNAi agents disclosed herein.

[00067] The term "biomarker" as used in the present application refers generally to a DNA, RNA, protein, carbohydrate, or glycolipid-based molecular marker, the expression or presence of which in a subject's sample can be detected by standard methods (or methods disclosed herein) and is predictive or prognostic of the effective responsiveness or sensitivity of a mammalian subject with cancer. Expression of such a biomarker may be determined to be higher than that observed for a control sample. The terms "marker" and "biomarker" are used herein interchangeably. The terms "predictive" and "prognostic" as used herein are also interchangeable, in the sense of meaning that the methods for prediction or prognostication are to allow the person practicing the method to select patients that are deemed (usually in advance of treatment, but not necessarily) more likely to respond to treatment with a B-cell antagonist.

[00068] The terms "level of expression" or "expression level" in general are used interchangeably and generally refer to the amount of a polynucleotide or an amino

acid product or protein in a biological sample. "Expression" generally refers to the process by which gene-encoded information is converted into the structures present and operating in the cell. Expression of a gene or a nucleic acid sequence may refer to transcription into a polynucleotide, translation into a protein, or even posttranslational modification of the protein. Fragments of the transcribed polynucleotide, the translated protein, or the post-translationally modified protein shall also be regarded as expressed whether they originate from a transcript generated by alternative splicing or a degraded transcript, or from a post-translational processing of the protein, e.g., by proteolysis. Expressed genes include those that are transcribed into a polynucleotide as mRNA and then translated into a protein, and also those that are transcribed into RNA but not translated into a protein (for example, transfer and ribosomal RNAs).

[00069] Methods for detecting any genetic biomarkers desired to be assessed in addition to the expression of UNC-45A929 include protocols that examine the presence and/or expression of a SNP, for example, in a sample. Tissue or cell samples from mammals can be conveniently assayed for, e.g., genetic-marker mRNAs or DNAs using Northern, dot-blot, or polymerase chain reaction (PCR) analysis, array hybridization, RNase protection assay, or using DNA SNP chip microarrays, which are commercially available, including DNA microarray snapshots. For example, real-time PCR (RT-PCR) assays such as quantitative PCR assays are well known in the art. In an aspect, a method for detecting a SNP mRNA in a biological sample comprises producing cDNA from the sample by reverse transcription using at least one primer; amplifying the cDNA so produced using a SNP polynucleotide as sense and antisense primers to amplify SNP cDNAs therein; and detecting the presence of the amplified SNP cDNA. In addition, such methods can include one or more steps that allow one to determine the levels of SNP mRNA in a biological sample (e.g., by simultaneously examining the levels a comparative control mRNA sequence of a "housekeeping" gene such as an actin family member). Optionally, the sequence of the amplified SNP cDNA can be determined.

[00070] In an aspect, genotyping of a polymorphism can be performed by RT-PCR technology, using the TAQMANTM 5'-allele discrimination assay, a restriction fragment-length polymorphism PCR-based analysis, or any sequencing instrument.

[00071] Probes used for PCR may be labeled with a detectable marker, such as, for example, a radioisotope, fluorescent compound, bioluminescent compound, a

chemiluminescent compound, metal chelator, or enzyme. Such probes and primers can be used to detect the presence of a SNP in a sample and as a means for detecting a cell expressing SNP-encoded proteins. As will be understood by the skilled artisan, a great many different primers and probes may be prepared based on known sequences and used effectively to amplify, clone, and/or determine the presence and/or levels of SNP mRNAs.

[00072] Other methods include protocols that examine or detect mRNAs in a tissue or cell sample by microarray technologies. Using nucleic acid microarrays, test and control mRNA samples from test and control tissue samples are reverse transcribed and labeled to generate cDNA probes. The probes are then hybridized to an array of nucleic acids immobilized on a solid support. The array is configured such that the sequence and position of each member of the array is known. For example, a selection of genes that have potential to be expressed in certain disease states may be arrayed on a solid support. Hybridization of a labeled probe with a particular array member indicates that the sample from which the probe was derived expresses that gene. Differential gene expression analysis of disease tissue can provide valuable information. Microarray technology utilizes nucleic acid hybridization techniques and computing technology to evaluate the mRNA expression profile of thousands of genes within a single experiment.

[00073] Diagnostic antibodies include monoclonal antibodies or antibody fragments that specifically bind to UNC-45A929 protein or a peptide thereof and antibodies or antibody fragments that specifically bind to UNC-45A944. The antibodies are used in a variety of samples including serum, tissue biopsies, isolated and purified tissue samples to perform antibody-based detection assays including western blotting; ELISA, sandwich ELISA and other known techniques. Antibodies that are able selectively bind to one or more epitopes present only on the 929 splice variant or the 944 splice variant are contemplated. For example, monoclonal antibodies directed specifically to bind to an epitope that include the additional 15 amino acids (3-17) of SEQ ID NO: 4 (UNC-45944 protein sequence) are contemplated.

[00074] The term treatment or therapeutics refers to the application or administration of a therapeutic agent to a patient, or application or administration of a therapeutic agent to an isolated tissue or cell line from a patient, who has a disorder, e.g., a disease or condition, a symptom of disease, or a predisposition toward a disease, with the purpose to cure, heal, alleviate, relieve, alter, remedy, ameliorate, improve,

or affect the disease, the symptoms of disease, or the predisposition toward disease. A patient or subject may be a human, but can also be a non-human animal, e.g., vertebrate mammal. Treatment may generally refer to the reduction of one or more symptoms associated with cancer including extending the survival rate of an individual.

[00075] As used herein, the phrases therapeutically effective amount and prophylactically effective amount generally refer to an amount that provides a therapeutic benefit in the treatment or prevention of cancer or to minimize an overt symptom of the cancer. The specific amount that is therapeutically effective can be routinely determined by skilled artisans, and may vary depending on factors known in the art, such as, e.g. the type of cancer, the stage of the cancer and the patient's history and age and the administration of other anti-cancer agents. For example, if a given clinical treatment is considered effective when there is at least a 25% to 30% reduction in a measurable parameter associated with a disease or disorder, a therapeutically effective amount of a drug for the treatment of that disease or disorder is the amount necessary to effect at least a 25% reduction in that parameter.

[00076] As used herein, a pharmaceutical composition generally is intended to include a pharmacologically effective amount of an RNAi agent and a pharmaceutically acceptable carrier as this term is used in inhibiting or downregulating the expression of one or more UNC-45A splice variants.

[00077] The term "pharmaceutically acceptable carrier" refers to a carrier for administration of a therapeutic agent. Such carriers include, but are not limited to, saline, buffered saline, dextrose, water, glycerol, ethanol, and combinations thereof. The term specifically excludes cell culture medium. For drugs administered orally, pharmaceutically acceptable carriers include, but are not limited to pharmaceutically acceptable excipients such as inert diluents, disintegrating agents, binding agents, lubricating agents, sweetening agents, flavoring agents, coloring agents and preservatives. Suitable inert diluents include sodium and calcium carbonate, sodium and calcium phosphate, and lactose, while corn starch and alginic acid are suitable disintegrating agents. Binding agents may include starch and gelatin, while the lubricating agent, if present, will generally be magnesium stearate, stearic acid or talc. If desired, the tablets may be coated with a material such as glyceryl monostearate or glyceryl distearate, to delay absorption in the gastrointestinal tract.

- [00078]** As used herein, a transformed cell is a cell into which a vector has been introduced from which a dsRNA molecule (e.g., shRNA) may be expressed to downregulate one or more splice variants of UNC-45A.
- [00079]** The reagents and compositions disclosed herein are used alone or as a component of a kit having at least one of the reagents necessary to carry out the in vitro or in vivo introduction of RNA to test samples and/or subjects. For example, some of the components of the kit include a siRNA molecule and a vehicle that facilitates introduction of the siRNA into cells of interest as described herein (e.g., using lipids, liposomes and non-liposomal formulations, viral vectors, nanoparticle-based delivery of nucleic acids and other methods of transfection known in the art). Such a kit can also include instructions to allow a user of the kit to practice the methods disclosed herein.
- [00080]** The term modulate or modulating generally means that the expression of the gene, or level of RNA molecule or the equivalent RNA molecules (e.g., splice variants) encoding one or more proteins or protein subunits, or activity of one or more proteins or protein subunits is up regulated or down regulated, such that the expression, level, or activity is greater than or less than that observed in the absence of the modulator. For example, the term modulate can mean inhibit or substantially reduced depending on the context in which the term is used.
- [00081]** The terms inhibit, down-regulate, or reduce, mean that the expression of the gene, or level of RNA molecules or equivalent RNA molecules (e.g., splice variants) encoding one or more proteins or protein subunits, or activity of one or more proteins or protein subunits, is reduced below that observed in the absence of the nucleic acid molecules (e.g., siRNA) disclosed herein. In an aspect, inhibition, down-regulation or reduction with an siRNA molecule is below that level observed in the presence of an inactive or attenuated molecule. In an aspect, inhibition, down-regulation, or reduction with siRNA molecules is below that level observed in the presence of, for example, an siRNA molecule with scrambled sequence or with mismatches. In an aspect, inhibition, down regulation, or reduction of gene expression is associated with post transcriptional silencing, such as RNAi mediated cleavage of a target nucleic acid molecule (e.g. RNA) or inhibition of translation. In an aspect, inhibition, down regulation, or reduction of gene expression is associated with pretranscriptional silencing.

- [00082]** In an aspect, the siRNA molecules are used to treat cancer or other proliferative diseases, disorders, and/or conditions in a subject or organism.
- [00083]** The terms cancer or proliferative disease generally mean any disease characterized by unregulated cell growth or replication as is known in the art; breast cancers; bone cancers such as Osteosarcoma, Chondrosarcomas, Ewing's sarcoma, fibrosarcomas, giant cell tumors, Adamantinomas, and Chordomas; brain cancers such as Meningiomas, Glioblastomas, Lower-Grade Astrocytomas, Oligodendrocytomas, Pituitary Tumors, Schwannomas, and Metastatic brain cancers; cancers of the head and neck including various lymphomas such as mantle cell lymphoma, non-Hodgkins lymphoma, adenoma, squamous cell carcinoma, laryngeal carcinoma, gallbladder and bile duct cancers, cancers of the retina such as retinoblastoma, cancers of the esophagus, gastric cancers, multiple myeloma, ovarian cancer, uterine cancer, thyroid cancer, testicular cancer, endometrial cancer, melanoma, colorectal cancer, lung cancer, bladder cancer, prostate cancer, lung cancer (including non-small cell lung carcinoma), pancreatic cancer, sarcomas, Wilms' tumor, cervical cancer, head and neck cancer, skin cancers, nasopharyngeal carcinoma, liposarcoma, epithelial carcinoma, renal cell carcinoma, gallbladder adeno carcinoma, parotid adenocarcinoma, endometrial sarcoma, multidrug resistant cancers; and proliferative diseases and conditions, such as neovascularization associated with tumor angiogenesis, macular degeneration, corneal neovascularization, diabetic retinopathy, neovascular glaucoma, myopic degeneration and other proliferative diseases that can respond to the modulation of disease related gene (e.g., "UNC-45A929") expression in a cell or tissue, alone or in combination with other therapies.
- [00084]** The terms cell proliferative disorder and proliferative disorder generally refer to disorders that are associated with some degree of abnormal cell proliferation. In an aspect, the cell proliferative disorder is cancer.
- [00085]** The terms neoplasm or neoplastic cell refer to an abnormal tissue or cell that proliferates more rapidly than corresponding normal tissues or cells and continues to grow after removal of the stimulus that initiated the growth.
- [00086]** In an aspect, the disclosure provides double-stranded ribonucleic acid (dsRNA) molecules for inhibiting the expression of the UNC-45A929 splice variant (or the UNC-45A929 splice variant or both) in a cell or mammal, wherein the dsRNA comprises an antisense strand comprising a region of complementarity

which is complementary to at least a part of an mRNA formed in the expression of the UNC-45A929 splice variant (or the UNC-45A929 splice variant or both), and wherein the region of complementarity is less than 30 nucleotides in length and wherein said dsRNA, upon contact with a cell expressing the UNC-45A929 splice variant (or the UNC-45A929 splice variant or both), inhibits the expression of said UNC-45A929 gene by at least 20%. The dsRNA comprises two RNA strands that are sufficiently complementary to hybridize to form a duplex structure. One strand of the dsRNA (the antisense strand) includes a region of complementarity that is substantially complementary, and preferably fully complementary, to a target sequence, derived from the sequence of an mRNA formed during the expression of the UNC-45A929 splice variant (or the UNC-45A929 splice variant or both), the other strand (the sense strand) comprises a region which is complementary to the antisense strand, such that the two strands hybridize and form a duplex structure when combined under suitable conditions. Preferably, the duplex structure is between 15 and 30, more preferably between 18 and 25, yet more preferably between 19 and 24, and most preferably between 21 and 23 base pairs in length. Similarly, the region of complementarity to the target sequence is between 15 and 30, more preferably between 18 and 25, yet more preferably between 19 and 24, and most preferably between 21 and 23 nucleotides in length. The dsRNA may further include one or more single-stranded nucleotide overhang(s). The dsRNA can be synthesized by standard methods known in the art as further discussed below, e.g., by use of an automated DNA synthesizer, such as are commercially available from, for example, Biosearch, Applied Biosystems, Inc.

[00087]

The dsRNA for the target molecules disclosed herein can contain one or more mismatches to the target sequence. In an aspect, the dsRNA contains no more than 3 mismatches. If the antisense strand of the dsRNA contains mismatches to a target sequence, it is preferable that the area of mismatch not be located in the center of the region of complementarity. If the antisense strand of the dsRNA contains mismatches to the target sequence, it is preferable that the mismatch be restricted to 5 nucleotides from either end, for example 5, 4, 3, 2, or 1 nucleotide from either the 5' or 3' end of the region of complementarity. For example, for a 23 nucleotide dsRNA strand which is complementary to a region of the UNC-45A929 splice variant (or the UNC-45A929 splice variant or both), the dsRNA preferably does not contain any mismatch within the central 13 nucleotides. The methods

described herein can be used to determine whether a dsRNA containing a mismatch to a target sequence is effective in inhibiting the expression of the UNC-45A929 splice variant. Consideration of the efficacy of dsRNAs with mismatches in inhibiting expression of the UNC-45A929 splice variant (or the UNC-45A929 splice variant or both) is relevant, if the particular region of complementarity in the UNC-45A gene is known to have polymorphic sequence variation within the population.

[00088] In an aspect, the dsRNA is chemically modified to enhance stability. The nucleic acids may be synthesized and/or modified by methods well established in the art, such as those described in "Current protocols in nucleic acid chemistry", Beaucage, S. L. et al. (Edrs.), John Wiley & Sons, Inc., New York, N.Y., USA, which is hereby incorporated herein by reference. Chemical modifications may include, but are not limited to 2' modifications, introduction of non-natural bases, covalent attachment to a ligand, and replacement of phosphate linkages with thiophosphate linkages. In an aspect, the 5'-end of the antisense strand and the 3'-end of the sense strand are chemically linked via a hexaethylene glycol linker. In an aspect, at least one nucleotide of the dsRNA includes a phosphorothioate or phosphorodithioate groups. The chemical bond at the ends of the dsRNA is formed e.g., by triple-helix bonds. In an aspect, the integrity of the duplex structure is strengthened by at least one, and preferably two, chemical linkages. Chemical linking may be achieved by any of a variety of well-known techniques, for example by introducing covalent, ionic or hydrogen bonds; hydrophobic interactions, van der Waals or stacking interactions; by means of metal-ion coordination, or through use of purine analogues. The chemical groups that can be used to modify the dsRNA include, without limitation, methylene blue; bifunctional groups, preferably bis-(2-chloroethyl)amine; N-acetyl-N'-(p-glyoxybenzoyl) cystamine; 4-thiouracil; and psoralen.

[00089] In some aspects, a chemical bond may be formed by means of one or several bonding groups, wherein such bonding groups are preferably poly-(oxyphosphinicooxy-1,3-propandiol)- and/or polyethylene glycol chains. In some aspects, a chemical bond may also be formed by means of purine analogs introduced into the double-stranded structure instead of purines. In some aspects, a chemical bond may be formed by azabenzene units introduced into the double-stranded structure.

[00090] In an aspect, the nucleotides at one or both of the two single strands may be modified to prevent or inhibit the activation of cellular enzymes, such as, for example, certain nucleases. Techniques for inhibiting the activation of cellular enzymes are known in the art including, but not limited to, 2'-amino modifications, 2'-amino sugar modifications, 2'-F sugar modifications, 2'-F modifications, 2'-alkyl sugar modifications, uncharged backbone modifications, morpholino modifications, 2'-O-methyl modifications, and phosphoramidate. For example, at least one 2'-hydroxyl group of the nucleotides on a dsRNA is replaced by a chemical group, such as for example, by a 2'-amino or a 2'-methyl group. A nucleotide may also be modified to form a locked nucleotide. Such locked nucleotide contains a methylene bridge that connects the 2'-oxygen of ribose with the 4'-carbon of ribose.

[00091] In certain aspects, conjugating a ligand to a dsRNA enhances cellular absorption for in vivo applications. In certain instances, a hydrophobic ligand is conjugated to the dsRNA to facilitate direct permeation of the cellular membrane. Alternatively, the ligand conjugated to the dsRNA is a substrate for receptor-mediated endocytosis. These approaches facilitate cell permeation of antisense oligonucleotides.

[00092] A siRNA or shRNA molecule can include any contiguous UNC-45A929 or 944 sequence (e.g., about 15 to about 25 or more, or about 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, or 25 or more contiguous UNC-45A929 or 944 nucleotides).

[00093] In an aspect, a siRNA or shRNA molecule comprises an antisense strand having about 15 to about 30 (e.g., about 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30) nucleotides, wherein the antisense strand is complementary to a RNA sequence or a portion thereof encoding a UNC-45A929 protein, and wherein said siRNA or shRNA further comprises a sense strand having about 15 to about 30 (e.g., about 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30) nucleotides, and wherein said sense strand and said antisense strand are distinct nucleotide sequences where at least about 15 nucleotides in each strand are complementary to the other strand.

[00094] In an aspect, a siRNA or shRNA molecule includes an antisense region having about 15 to about 30 (e.g., about 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30) nucleotides, wherein the antisense region is complementary to a RNA sequence encoding a UNC-45A929 protein, and wherein said siRNA or shRNA further comprises a sense region having about 15 to about 30 (e.g., about

15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30) nucleotides, wherein said sense region and said antisense region are comprised in a linear molecule where the sense region comprises at least about 15 nucleotides that are complementary to the antisense region.

[00095] In an aspect, nucleic acid molecules that act as mediators of the RNA interference gene silencing response are double-stranded nucleic acid molecules. In an aspect, the siRNA or shRNA molecules consist of duplex nucleic acid molecules containing about 15 to about 30 base pairs between oligonucleotides comprising about 15 to about 30 (e.g., about 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30) nucleotides. In an aspect, siRNA or shRNA molecules include duplex nucleic acid molecules with overhanging ends of about 1 to about 3 (e.g., about 1, 2, or 3) nucleotides, for example, about 21-nucleotide duplexes with about 19 base pairs and 3'-terminal mononucleotide, dinucleotide, or trinucleotide overhangs. In an aspect, siRNA or shRNA molecules include duplex nucleic acid molecules with blunt ends, where both ends are blunt, or alternatively, where one of the ends is blunt.

[00096] In an aspect, one or more chemically-modified siRNA or shRNA constructs having specificity for UNC-45A929 or 944 expressing nucleic acid molecules, such as RNA encoding a UNC-45A929 protein. In an aspect, the disclosure includes a RNA based siRNA or shRNA molecule (e.g., a siRNA or shRNA comprising 2'-OH nucleotides) having specificity for UNC-45A929 expressing nucleic acid molecules that includes one or more chemical modifications described herein. Non-limiting examples of such chemical modifications include without limitation phosphorothioate internucleotide linkages, 2'-deoxyribonucleotides, 2'-O-methyl ribonucleotides, 2'-deoxy-2'-fluoro ribonucleotides, "universal base" nucleotides, "acyclic" nucleotides, 5-C-methyl nucleotides, and terminal glyceryl and/or inverted deoxy abasic residue incorporation. These chemical modifications, when used in various siRNA or shRNA constructs, (e.g., RNA based siRNA or shRNA constructs), are shown to preserve RNAi activity in cells while at the same time, dramatically increasing the serum stability of these compounds.

[00097] In an aspect, a siRNA or shRNA molecule includes modified nucleotides while maintaining the ability to mediate RNAi. The modified nucleotides can be used to improve *in vitro* or *in vivo* characteristics such as stability, activity, and/or bioavailability. For example, a siRNA or shRNA includes modified nucleotides as a

percentage of the total number of nucleotides present in the siRNA or shRNA molecule. As such, a siRNA or shRNA molecule generally includes about 5% to about 100% modified nucleotides (e.g., about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% modified nucleotides). The actual percentage of modified nucleotides present in a given siRNA or shRNA molecule will depend on the total number of nucleotides present in the siRNA or shRNA. If the siRNA or shRNA molecule is single stranded, the percent modification can be based upon the total number of nucleotides present in the single stranded siRNA molecules. Likewise, if the siRNA or shRNA molecule is double stranded, the percent modification can be based upon the total number of nucleotides present in the sense strand, antisense strand, or both the sense and antisense strands.

[00098] In an aspect, a double-stranded short interfering nucleic acid (siRNA or shRNA) molecule that down-regulates expression of a UNC-45A929/944 splice variant that includes an antisense region, wherein the antisense region includes a nucleotide sequence that is complementary to a nucleotide sequence of the UNC-45A929/944 splice variant or a portion thereof, and a sense region, wherein the sense region comprises a nucleotide sequence substantially similar to the nucleotide sequence of the UNC-45A929/944 splice variant or a portion thereof. In an aspect, the antisense region and the sense region independently comprise about 15 to about 30 (e.g. about 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30) nucleotides, wherein the antisense region comprises about 15 to about 30 (e.g. about 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30) nucleotides that are complementary to nucleotides of the sense region.

[00099] In an aspect, a double-stranded short interfering nucleic acid (siRNA or shRNA) molecule that down-regulates expression of a UNC-45A929/944 splice variant comprising a sense region and an antisense region, wherein the antisense region comprises a nucleotide sequence that is complementary to a nucleotide sequence of RNA encoded by the UNC-45A929/944 splice variant or a portion thereof and the sense region comprises a nucleotide sequence that is complementary to the antisense region.

[000100] In some aspects, the siRNA molecules are added directly, or can be complexed with cationic lipids, packaged within liposomes, or otherwise delivered to target cells or tissues. The nucleic acid or nucleic acid complexes can be locally

administered to relevant tissues *ex vivo*, or *in vivo* through direct dermal application, transdermal application, or injection, with or without their incorporation in biopolymers.

[000101] In another aspect, mammalian cells containing one or more siRNA or shRNA molecules disclosed herein are included. The one or more siRNA or shRNA molecules can independently be targeted to the same or different sites.

[000102] The nucleic acid molecules, individually, or in combination or in conjunction with other drugs, can be used to for preventing or treating cancer or proliferative diseases and conditions in a subject or organism.

[000103] For example, the siRNA or shRNA molecules can be administered to a subject or can be administered to other appropriate cells evident to those skilled in the art, individually or in combination with one or more drugs under conditions suitable for the treatment.

[000104] In an aspect, the siRNA or shRNA molecules can be used in combination with other known treatments to prevent or treat cancer, proliferative, or ocular diseases and conditions in a subject or organism. For example, the described molecules could be used in combination with one or more known compounds, treatments, or procedures to prevent or treat cancer in a subject or organism as are known in the art. Such available therapies include chemotherapy and radiation therapy. For chemotherapy, some of the known active ingredients include for example, doxorubicin, irinotecan, cyclophosphamide, chlorambucil, melphalan, methotrexate, cytarabine, fludarabine, 6-mercaptopurine, 5- fluorouracil, cisplatin, carboplatin, oxaliplatin, and a combination thereof. Some of the biological drugs include for example, antibody drugs to specific receptors such as for example, Gemtuzumab, cetuximab, and Bevicizumab.

[000105] In an aspect, the methods and compositions disclosed herein include an expression vector comprising a nucleic acid sequence encoding at least one siRNA or shRNA molecule to allow expression of the siRNA or shRNA molecule. For example, the vector can contain sequence(s) encoding both strands of a siRNA or shRNA molecule comprising a duplex. The vector can also contain sequence(s) encoding a single nucleic acid molecule that is self-complementary and thus forms a siRNA or shRNA molecule. Non-limiting examples of such expression vectors are described in Paul et al., 2002, *Nature Biotechnology*, 19, 505; Miyagishi and Taira,

2002, Nature Biotechnology, 19, 497; Lee et al., 2002, Nature Biotechnology, 19, 500.

[000106] In an aspect, the methods and compositions disclosed herein include a mammalian cell, for example, a human cell, including an expression vector.

[000107] In another aspect a siRNA or shRNA molecule include one or more 5' and/or a 3'-cap structure, for example, on only the sense siRNA or shRNA strand, the antisense siRNA or shRNA strand, or both siRNA or shRNA strands.

[000108] Cap structure generally means chemical modifications that are included at either terminus of the oligonucleotides. These end modifications protect the nucleic acid molecule from exonuclease degradation, and may also help in delivery and/or localization within a cell. The cap may be present at the 5'-terminus (5'-cap) or at the 3'-terminal (3'-cap) or may be present on both the ends. Examples for the 5'-cap include, glyceryl, inverted deoxy abasic residue (moiety); 4',5'-methylene nucleotide; 1-(beta-D-erythrofuransyl)nucleotide, 4'-thio nucleotide; carbocyclic nucleotide; 1,5-anhydrohexitol nucleotide; L-nucleotides; alpha-nucleotides; modified base nucleotide; phosphorodithioate linkage; threo-pentofuransyl nucleotide; acyclic 3',4'-seco nucleotide; acyclic 3,4-dihydroxybutyl nucleotide; acyclic 3,5-dihydroxypentyl nucleotide, 3'-3'-inverted nucleotide moiety; 3'-3'-inverted abasic moiety; 3'-2'-inverted nucleotide moiety; 3'-2'-inverted abasic moiety; 1,4-butanediol phosphate; 3'-phosphoramidate; hexylphosphate; aminohexyl phosphate; 3'-phosphate; 3'-phosphorothioate; phosphorodithioate; or bridging or non-bridging methylphosphonate moiety.

[000109] A siRNA or shRNA or miRNA molecule can be adapted for use to prevent or treat cancer. For example, a siRNA or shRNA or miRNA molecule includes a delivery vehicle, including liposomes, for administration to a subject, carriers and diluents and their salts, and/or can be present in pharmaceutically acceptable formulations. These protocols can be utilized for the delivery of virtually any nucleic acid molecule. Nucleic acid molecules can be administered to cells by a variety of methods known to those of skill in the art, including, but not restricted to, encapsulation in liposomes, by iontophoresis, or by incorporation into other vehicles, such as biodegradable polymers, hydrogels, cyclodextrins, biodegradable nanocapsules, and bioadhesive microspheres, or by proteinaceous vectors. In an aspect, the nucleic acid molecules can also be formulated or complexed with polyethyleneimine and derivatives thereof, such as polyethyleneimine-

polyethyleneglycol-N-acetylgalactosamine (PEI-PEG-GAL) or polyethyleneimine-polyethyleneglycol-tri-N-acetylgalactosamine (PEI-PEG-triGAL) derivatives.

[000110] In an aspect, a siRNA or shRNA or miRNA molecule is complexed with membrane disruptive agents. In an aspect, the membrane disruptive agent or agents and the siRNA molecule are also complexed with a cationic lipid or helper lipid molecule.

[000111] In an aspect, delivery systems include, for example, liposomes, permeation enhancers (e.g., fatty acids, fatty acid esters, fatty alcohols and amino acids), and hydrophilic polymers (e.g., polycarbophil and polyvinylpyrrolidone). In one aspect, the pharmaceutically acceptable carrier is a liposome or a transdermal enhancer.

[000112] In an aspect, siRNA or shRNA or miRNA molecules are administered to a subject by systemic administration in a pharmaceutically acceptable composition or formulation. By "systemic administration" is meant in vivo systemic absorption or accumulation of drugs in the blood stream followed by distribution throughout the entire body. Administration routes that lead to systemic absorption include, without limitation: intravenous, subcutaneous, intraperitoneal, inhalation, oral, intrapulmonary and intramuscular. Each of these administration routes exposes the siRNA or shRNA or miRNA molecules to an accessible diseased tissue. A liposome formulation that can enhance the association of drug with the surface of cells, such as, lymphocytes and macrophages is also useful.

[000113] The pharmaceutically effective dose depends on the type of disease, the composition used, the route of administration, the type of mammal being treated, the physical characteristics of the specific mammal under consideration, concurrent medication, and other factors that those skilled in the medical arts will recognize. Generally, an amount between 0.1 mg/kg and 100 mg/kg body weight/day of active ingredients is administered dependent upon potency of the negatively charged polymer.

[000114] The term selectively inhibiting or selectively reducing generally means that the siRNA or shRNA sequences preferentially targets the 929 or the 944 splice variant and specifically downregulates the expression of the particular splice variant.

[000115] The term consisting essentially of refers to compositions that contain siRNA or shRNA or miRNA and may optionally contain any other components that do not materially affect the functional attributes of siRNA or shRNA or miRNA disclosed

herein. When the term consists essentially of consisting essentially of is used in the context of sequences, it generally means that the recited sequences are required for the intended function and that other sequences may be included on either end that do not materially affect the intended function.

[000116] **Table 1:** UNC-45A 929 target and siRNA sequences

Name	Sequence
UNC-45A 929 Target Sequence-1	TGGCCGTCACTACCCTGGTTTCTTT
UNC-45A 929 Target Sequence-2	GGACAGAGGTGGTAGTGAAC
UNC-45A 944 Target Sequence-1	GGTCCAGGGACCCCCGAGCCCCG
UNC-45A 944 Target Sequence-2	GTGAGTGGTCCAGGGACCCC
UNC-45A 929 siRNA Sense Sequence	UGGCCGUCACUACCCUGGUUUCUUU
UNC-45A 929 siRNA Anti-Sense Sequence	AAAGAAACCAGGGUAGUGACGGCCA
UNC-45A 944 siRNA Sense Sequence	GGUCCAGGGACCCCCGAGCCCCG
UNC-45A 944 siRNA Anti-Sense Sequence	CGGGGCUCGGGGGUCCCUGGACC

[000117] **Table 2:** Exemplary siRNA target sequences for UNC-45A929 splice variant

siRNA sequence targets
GTGGTAGTGAACCTCTCATG
ACCGAAGTAACCCGCAATG
GAGTCACGGCCTAGAAAGA
AGGACAGAGGTGGTAGTGA
GACAGAGGTGGTAGTGAAC
GCTGAATTTGAGGCCCTGT
TGCTGACAGGCCTATCTGT
GTCTGATTCTCCAGAGGAA
CCTCTACAACCTACTGGTT

EXAMPLES

[000118] The following examples are for illustrative purposes and are not intended to limit the scope of the disclosure.

EXAMPLE 1: UNC-45A Splice Variants Levels in Breast Cancer Tissue.

[000119] Immunohistochemistry was used to study the UNC-45A expression patterns in human breast cancer specimens. The UNC-45A mRNA and protein levels were quantified in several human breast cancer cell lines by qRT-PCR and Western Blots. In vitro cell lines were used to assess the effect of UNC-45A on cell growth, migration, and invasion.

[000120] Humans and other vertebrates produce two isoforms encoded in separate genes, UNC-45A expressed generally and UNC-45B expressed in heart and skeletal muscle. Humans and other mammals alternatively splice the UNC-45A mRNA to produce two spliceoform proteins, differing by a 15 amino acid-residue, proline-rich sequence near the N-terminus. In human breast cancer patient specimens, UNC-45A level is up-regulated dramatically in high grade groups. In metastatic breast cancer cell lines and other cancer cell lines including cervical and colon adenocarcinoma cell lines, the shorter spliceoform is over-expressed. Recombinant human UNC-45A pulls down myosins IIA, IIB and Hsp90 beta, which have been implicated in cell proliferation, migration, and critical processes in cancer metastasis.

[000121] Experiments are designed to validate that downregulation of UNC-45A splice variants prevent cancer progression both *in vitro* and *in vivo*. Interactions of UNC-45A, myosinII and Hsp90 are mechanistically linked to the metastatic behavior.

[000122] Human breast cancer tissues express higher levels of the UNC-45A gene products than normal breast tissues as shown in FIG. 1 illustrating immunohistochemistry of normal and tumorous breast tissue. UNC-45A levels in various breast cancer cell lines are also shown in FIG. 2.

[000123] The later stage tumors express higher levels of the UNC-45A gene products than the early stage tumors. Tumorigenic non-metastatic cell lines (MCF-7, T47D) express higher levels of UNC-45A proteins than non-tumorigenic cell line (HMEC). Tumorigenic metastatic cell line (MDA-MB-231) also expresses higher UNC-45A levels than non-tumorigenic cell lines.

[000124] These results show that UNC-45A levels are elevated in breast cancer and that UNC-45A929 splice variant is expressed to a higher level in metastatic cancers.

EXAMPLE 2: UNC-45A Splice Variants Phosphorylation Status and Degradation.

[000125] The extra 15 amino acids (VSGPGTPEPRPATPG) of the 944 variant confer about 5-fold higher degradation rate for the 944 variant than the 929 variant. In addition, the 15 additional amino acids present only in the 944 variant contain the only phosphorylatable site, T15 (as in the entire protein SEQ ID NO: 4) in the UNC-45A protein. Therefore, the 944 variant is regulated but degraded more rapidly whereas the 929 builds up to higher levels in several cancers and is not regulated by phosphorylation. The 929 splice variant does not contain the phosphorylatable T15.

[000126] The increased degradation of the 944 splice variant is used as both a diagnostic tool and a therapeutic target for the detection and treatment of cancers.

Sequence Information:

[000127] UNC-45A Human homolog A encoding the splice variants (944 and 929) splice is accessible at SwissProt by Acc. No. Q9H3U1. *Homo sapiens* (human) UNC-45A gene sequence is also accessible at NCBI by using a unigene identifier UniGene Hs.389461.

UNC-45A929 splice variant sequences

[000128] Highlighted by underlining (1-835) is a unique sequence present only in the UNC-45A929 splice variant and is absent in UNC-45A944. This is a non-coding sequence at 5' region. The nucleic acid sequence of UNC-45A929 splice variant (SEQ ID NO: 1) is shown herein.

```

1  ACTTAACAACCGAAGTAACCCGCAATGCGGAAGGGCGAGGGGATTGCGAGTCACCGAGTT
   .....

61 TCCGCGCGGGCTTGAGTCACGGCCTAGAAAGAGAGATGTTGGGGTTCCAGGACCAGGAC
   .....

121 AGAGGTGGTAGTGAACCTCTCATGGGCATCCAGAGAAGGTCAGGCCCTTGCTGACAGGCC
     .....
```

181 TATCTGTGGGGCTACTGCTGCTCTTCAGCTGGGTGACCCTTGTCCAGCCAACCTCTCTCT
.....

241 CAGCTCTGGTCCACCACCCTCACTTGTGCCAGACCACCCGGGATGTCCATGGCCGTCAC
.....

301 ACCCTGGTTTCTTTTGCCCTCGTCTGTCTGATTCTCCAGAGGAAGCCTACTGCTGCCACC
.....

361 TGCAGGCTGCAGGGGGCTCCTGCTGCACCCGGGCTGAATTTGAGGCCCTGTACCAAGTCA
.....

421 ATCTGTCCGCTCTTCCGCCCCCGCCCATCCTCAGGGGCCAGGCCCGCTCCTAGTGCTGG
.....

481 GCCTCTACAACCTACTGGTTGTGACCCTGATGACCGTAGACCTCGTGCACCTTCTGCTGCG
.....

541 GTCGGGGCCGGAGTCTGGGCTGGAGCCACCGCAGGCCTCCCTCTGGGTCTCCGCCGCGA
.....

601 GCTCCCTGCAGGTCTCTGCGGGGACAGCTTAGGTGCGCCCGGAGCTTGCTGCACCTGCG
.....

661 ATCCAGAGCCAAGCGCCCCGCCCTGCCCCGGGCGCGCTCCCTCCTTAGCCCTGCCCTCT
.....

721 CTGACCCACCTCCGACGCAAGAGTGGGGCGGGGCGAGCTGCCGGTGGCGTCCCGAACCCA
.....

781 GACTCGCCCCGCCCCAGAGACTGCGCCTGCGCGGGCACGAGACAACCTCTCCGCGATGAC
.....-M--T

841 TGCCAGCTCAGTGGAGCAGCTGCGGAAGGAGGGCAATGAGCTGTTCAAATGTGGAGACTA
2 --A--S--S--V--E--Q--L--R--K--E--G--N--E--L--F--K--C--G--D--Y

901 CGGGGGCGCCCTGGCGGCCTACACTCAGGCCCTGGGTCTGGACGCGACGCCCCAGGACCA
22 --G--G--A--L--A--A--Y--T--Q--A--L--G--L--D--A--T--P--Q--D--Q

961 GGCCGTTCTGCACCGGAACCGGGCCGCTGCCACCTCAAGCTGGAAGATTACGACAAAGC
42 --A--V--L--H--R--N--R--A--A--C--H--L--K--L--E--D--Y--D--K--A

1021 AGAAACAGAGGCATCCAAAGCCATTGAAAAGGATGGTGGGGATGTCAAAGCACTCTACCG
62 --E--T--E--A--S--K--A--I--E--K--D--G--G--D--V--K--A--L--Y--R

1081 GCGGAGCCAAGCCCTAGAGAAGCTGGGCCCGCTGGACCAGGCTGTCCTTGACCTGCAGAG
82 --R--S--Q--A--L--E--K--L--G--R--L--D--Q--A--V--L--D--L--Q--R

1141 ATGTGTGAGCTTGGAGCCCAAGAACAAAGTTTTCCAGGAGGCCTTGCGGAACATCGGGGG
102 --C--V--S--L--E--P--K--N--K--V--F--Q--E--A--L--R--N--I--G--G

1201 CCAGATTCAGGAGAAGGTGCGATACATGTCCTCGACGGATGCCAAAGTGGAAACAGATGTT
122 --Q--I--Q--E--K--V--R--Y--M--S--S--T--D--A--K--V--E--Q--M--F

1261 TCAGATACTGTTGGACCCAGAAGAGAAGGGCACTGAGAAAAAGCAAAAGGCTTCTCAGAA
142 --Q--I--L--L--D--P--E--E--K--G--T--E--K--K--Q--K--A--S--Q--N

1321 CCTGGTGGTGCTGGCCAGGGAGGATGCTGGAGCGGAGAAGATCTTCCGGAGTAATGGGGT
162 --L--V--V--L--A--R--E--D--A--G--A--E--K--I--F--R--S--N--G--V

1381 TCAGCTCTTGCAACGTTTACTGGACATGGGAGAGACTGACCTCATGCTGGCGGCTCTGCG
182 --Q--L--L--Q--R--L--L--D--M--G--E--T--D--L--M--L--A--A--L--R

1441 TACGCTGGTTGGCATTGCTCTGAGCATCAGTCACGGACAGTGGCAACCCTGAGCATACT
202 --T--L--V--G--I--C--S--E--H--Q--S--R--T--V--A--T--L--S--I--L

1501 GGGAACTCGGCGAGTAGTCTCCATCCTGGGCGTGGAAGCCAGGCTGTGTCCCTGGCTGC
222 --G--T--R--R--V--V--S--I--L--G--V--E--S--Q--A--V--S--L--A--A

1561 CTGCCACCTGCTGCAGGTTATGTTTGATGCCCTCAAGGAAGGTGTCAAAAAAGGCTTCCG
242 --C--H--L--L--Q--V--M--F--D--A--L--K--E--G--V--K--K--G--F--R

1621 AGGCAAAGAAGGTGCCATCATTGTGGATCCTGCCCAGGAGCTGAAGGTCTCATCAGTAA
262 --G--K--E--G--A--I--I--V--D--P--A--R--E--L--K--V--L--I--S--N

1681 CCTCTTAGATCTGCTGACAGAGGTGGGGGTCTCTGGCCAAGGCCGAGACAATGCCCTGAC
282 --L--L--D--L--L--T--E--V--G--V--S--G--Q--G--R--D--N--A--L--T

1741 CCTCCTGATTAAAGCGGTGCCCCGGAAGTCTCTCAAGGACCCCAACAACAGCCTCACCT
302 --L--L--I--K--A--V--P--R--K--S--L--K--D--P--N--N--S--L--T--L

1801 CTGGGTCATCGACCAAGGTCTGAAAAAGATTTTGGGAAGTGGGGGGCTCTCTACAGGACCC
322 --W--V--I--D--Q--G--L--K--K--I--L--E--V--G--G--S--L--Q--D--P

1861 TCCTGGGGAGCTCGCAGTGACCGCAAACAGCCGCATGAGCGCCTCTATTCTCCTCAGCAA
342 --P--G--E--L--A--V--T--A--N--S--R--M--S--A--S--I--L--L--S--K

1921 GCTCTTTGATGACCTCAAGTGTGATGCGGAGAGGGAGAATTTCCACAGACTTTGTGAAAA
362 --L--F--D--D--L--K--C--D--A--E--R--E--N--F--H--R--L--C--E--N

1981 CTACATCAAGAGCTGGTTTGAGGGCCAAGGGCTGGCCGGGAAGCTACGGGCCATCCAGAC
382 --Y--I--K--S--W--F--E--G--Q--G--L--A--G--K--L--R--A--I--Q--T

2041 GGTGTCTCTGCTCCTGCAGGGCCCATGTGACGCTGGCAACCGGGCCTTGGAGCTGAGCGG
402 --V--S--C--L--L--Q--G--P--C--D--A--G--N--R--A--L--E--L--S--G

2101 TGTCAATGGAGAGTGTGATTGCTCTGTGTGCCTCTGAGCAGGAGGAGGAGCAGCTGGTGGC
422 --V--M--E--S--V--I--A--L--C--A--S--E--Q--E--E--E--Q--L--V--A

2161 CGTGGAGGCTCTGATCCATGCAGCCGGCAAGGCTAAGCGGGCCTCATTCACTACTGCCAA
442 --V--E--A--L--I--H--A--A--G--K--A--K--R--A--S--F--I--T--A--N

2221 TGGTGTCTCGCTGCTGAAGGACCTATATAAGTGCAGCGAGAAGGACAGCATCCGCATCCG
462 --G--V--S--L--L--K--D--L--Y--K--C--S--E--K--D--S--I--R--I--R

2281 GGCGCTAGTGGGACTCTGTAAAGCTCGGTTTCGGCTGGAGGGACTGACTTCAGCATGAAGCA
482 --A--L--V--G--L--C--K--L--G--S--A--G--G--T--D--F--S--M--K--Q

2341 GTTTGCTGAAGGCTCCACTCTCAAAGTGGCTAAGCAGTGTGCGAAAGTGGCTGTGCAATGA
502 --F--A--E--G--S--T--L--K--L--A--K--Q--C--R--K--W--L--C--N--D

2401 CCAGATCGACGCAGGCACTCGGCGCTGGGCAGTGGAGGGCCTGGCTTACCTGACCTTTGA
522 --Q--I--D--A--G--T--R--R--W--A--V--E--G--L--A--Y--L--T--F--D

2461 TGCCGACGTGAAGGAAGAGTTTGTGGAGGATGCGGCTGCTCTGAAAGCTCTGTTCCAGCT
542 --A--D--V--K--E--E--F--V--E--D--A--A--A--L--K--A--L--F--Q--L

2521 CAGCAGGTTGGAGGAGAGGTCAGTGCTCTTTGCGGTGGCCTCAGCGCTGGTGAAGTGCAC
562 --S--R--L--E--E--R--S--V--L--F--A--V--A--S--A--L--V--N--C--T

2581 CAACAGCTATGACTACGAGGAGCCCCGACCCCAAGATGGTGGAGCTGGCCAAGTATGCCAA
582 --N--S--Y--D--Y--E--E--P--D--P--K--M--V--E--L--A--K--Y--A--K

2641 GCAGCATGTGCCCCGAGCAGCACCCCAAGGACAAGCCAAGCTTCGTGCGGGCTCGGGTGAA
602 --Q--H--V--P--E--Q--H--P--K--D--K--P--S--F--V--R--A--R--V--K

2701 GAAGCTGCTGGCAGCGGGTGTGGTGTGCGCCATGGTGTGCATGGTGAAGACGGAGAGCCC
622 --K--L--L--A--A--G--V--V--S--A--M--V--C--M--V--K--T--E--S--P

2761 TGTGCTGACCAGTTCCTGCAGAGAGCTGCTCTCCAGGGTCTTCTTGGCTTTAGTGAAGA
642 --V--L--T--S--S--C--R--E--L--L--S--R--V--F--L--A--L--V--E--E

2821 GGTAGAGGACCGAGGCACTGTGGTTGCCCAGGGAGGCGGCAGGGCGCTGATCCCCTGGC
662 --V--E--D--R--G--T--V--V--A--Q--G--G--G--R--A--L--I--P--L--A

2881 CCTGGAAGGCACGGACGTGGGGCAGACAAAGGCAGCCCAGGCCCTTGCCAAGCTCACCAT
 682 --L--E--G--T--D--V--G--Q--T--K--A--A--Q--A--L--A--K--L--T--I

 2941 CACCTCCAACCCGGAGATGACCTTCCCTGGCGAGCGGATCTATGAGGTGGTCCGGCCCCCT
 702 --T--S--N--P--E--M--T--F--P--G--E--R--I--Y--E--V--V--R--P--L

 3001 CGTCTCCCTGTTGCACCTCAACTGCTCAGGCCTGCAGAACTTCGAGGCGCTCATGGCCCT
 722 --V--S--L--L--H--L--N--C--S--G--L--Q--N--F--E--A--L--M--A--L

 3061 AACAAACCTGGCTGGGATCAGCGAGAGGCTCCGGCAGAAGATCCTGAAGGAGAAGGCTGT
 742 --T--N--L--A--G--I--S--E--R--L--R--Q--K--I--L--K--E--K--A--V

 3121 GCCCATGATAGAAGGCTACATGTTTGAGGAGCATGAGATGATCCGCCGGGCAGCCACGGA
 762 --P--M--I--E--G--Y--M--F--E--E--H--E--M--I--R--R--A--A--T--E

 3181 GTGCATGTGTAACCTTGGCCATGAGCAAGGAGGTGCAGGACCTCTTCGAAGCCCAGGGCAA
 782 --C--M--C--N--L--A--M--S--K--E--V--Q--D--L--F--E--A--Q--G--N

 3241 TGACCGACTGAAGCTGCTGGTGCTGTACAGTGGAGAGGATGATGAGCTGCTACAGCGGGC
 802 --D--R--L--K--L--L--V--L--Y--S--G--E--D--D--E--L--L--Q--R--A

 3301 AGCTGCCGGGGGCTTGGCCATGCTTACCTCCATGCGGCCACGCTCTGCAGCCGCATTCC
 822 --A--A--G--G--L--A--M--L--T--S--M--R--P--T--L--C--S--R--I--P

 3361 CCAAGTGACCACACACTGGCTGGAGATCCTGCAGGCCCTGCTTCTGAGCTCCAACCAGGA
 842 --Q--V--T--T--H--W--L--E--I--L--Q--A--L--L--L--S--S--N--Q--E

 3421 GCTGCAGCACCGGGGTGCTGTGGTGGTGCTGAACATGGTGGAGGCCTCGAGGGAGATTGC
 862 --L--Q--H--R--G--A--V--V--V--L--N--M--V--E--A--S--R--E--I--A

 3481 CAGCACCTTGATGGAGAGTGAGATGATGGAGATCTTGTCAGTGCTAGCTAAGGGTGACCA
 882 --S--T--L--M--E--S--E--M--M--E--I--L--S--V--L--A--K--G--D--H

 3541 CAGCCCTGTCACAAGGGCTGCTGCAGCCTGCCTGGACAAAGCAGTGGAATATGGGCTTAT
 902 --S--P--V--T--R--A--A--A--A--C--L--D--K--A--V--E--Y--G--L--I

 3601 CCAACCCAACCAAGATGGAGAGTGA (SEQ ID NO: 1)
 922 --Q--P--N--Q--D--G--E--*- (SEQ ID NO: 3)

UNC-45A944 Splice variant

[000129]

Highlighted by underlining (7-50) is a unique nucleic sequence present only in UNC-45A944 splice variant and is absent in UNC-45A929. This coding sequence adds 15 unique amino acids (3-17) in the amino acid sequence of UNC-

45A944 shown herein. The nucleic acid sequence of UNC-45A944 splice variant (SEQ ID NO: 2) is shown herein.

```

1  ATGACTGTGAGTGGTCCAGGGACCCCCGAGCCCCGGCCGGCCACCCCCGGGGCCAGCTCA
1  -M--T--V--S--G--P--G--T--P--E--P--R--P--A--T--P--G--A--S--S--

61  GTGGAGCAGCTGCGGAAGGAGGGCAATGAGCTGTTCAAATGTGGAGACTACGGGGGCGCC
21  -V--E--Q--L--R--K--E--G--N--E--L--F--K--C--G--D--Y--G--G--A--

121  CTGGCGGCCTACACTCAGGCCCTGGGTCTGGACGCGACGCCCCAGGACCAGGCCGTTCTG
41  -L--A--A--Y--T--Q--A--L--G--L--D--A--T--P--Q--D--Q--A--V--L--

181  CACCGGAACCGGGCCGCCTGCCACCTCAAGCTGGAAGATTACGACAAAGCAGAAACAGAG
61  -H--R--N--R--A--A--C--H--L--K--L--E--D--Y--D--K--A--E--T--E--

241  GCATCCAAAGCCATTGAAAAGGATGGTGGGGATGTCAAAGCACTCTACCGGCGGAGCCAA
81  -A--S--K--A--I--E--K--D--G--G--D--V--K--A--L--Y--R--R--S--Q--

301  GCCCTAGAGAAGCTGGGCCGCCTGGACCAGGCTGTCCTTGACCTGCAGAGATGTGTGAGC
101  -A--L--E--K--L--G--R--L--D--Q--A--V--L--D--L--Q--R--C--V--S--

361  TTGGAGCCCCAAGAACAAAGTTTTCCAGGAGGCCTTGCGGAACATCGGGGGCCAGATTACG
121  -L--E--P--K--N--K--V--F--Q--E--A--L--R--N--I--G--G--Q--I--Q--

421  GAGAAGGTGCGATACATGTCCTCGACGGATGCCAAAGTGGAACAGATGTTTCAGATACTG
141  -E--K--V--R--Y--M--S--S--T--D--A--K--V--E--Q--M--F--Q--I--L--

481  TTGGACCCAGAAGAGAAGGGCACTGAGAAAAAGCAAAAGGCTTCTCAGAACCTGGTGGTG
161  -L--D--P--E--E--K--G--T--E--K--K--Q--K--A--S--Q--N--L--V--V--

541  CTGGCCAGGGAGGATGCTGGAGCGGAGAAGATCTTCCGGAGTAATGGGGTTTCAGCTCTTG
181  -L--A--R--E--D--A--G--A--E--K--I--F--R--S--N--G--V--Q--L--L--

601  CAACGTTTACTGACATGGGAGAGACTGACCTCATGCTGGCGGCTCTGCGTACGCTGGTT
201  -Q--R--L--L--D--M--G--E--T--D--L--M--L--A--A--L--R--T--L--V--

661  GGCATTTGCTCTGAGCATCAGTCACGGACAGTGGCAACCCTGAGCATACTGGGAACTCGG
221  -G--I--C--S--E--H--Q--S--R--T--V--A--T--L--S--I--L--G--T--R--

721  CGAGTAGTCTCCATCCTGGGCGTGGAAGCCAGGCTGTGTCCTGGCTGCCTGCCACCTG
241  -R--V--V--S--I--L--G--V--E--S--Q--A--V--S--L--A--A--C--H--L--

781  CTGCAGGTTATGTTTGATGCCCTCAAGGAAGGTGTCAAAAAAGGCTTCCGAGGCAAAGAA
261  -L--Q--V--M--F--D--A--L--K--E--G--V--K--K--G--F--R--G--K--E--

841  GGTGCCATCATTTGTGGATCCTGCCCCGGGAGCTGAAGGTCCTCATCAGTAACCTCTTAGAT
281  -G--A--I--I--V--D--P--A--R--E--L--K--V--L--I--S--N--L--L--D--

```

901 CTGCTGACAGAGGTGGGGGTCTCTGGCCAAGGCCGAGACAATGCCCTGACCCTCCTGATT
301 -L--L--T--E--V--G--V--S--G--Q--G--R--D--N--A--L--T--L--L--I--

961 AAAGCGGTGCCCCGGAAGTCTCTCAAGGACCCCAACAACAGCCTCACCTCTGGGTCATC
321 -K--A--V--P--R--K--S--L--K--D--P--N--N--S--L--T--L--W--V--I--

1021 GACCAAGGTCTGAAAAAGATTTTGGAAAGTGGGGGGCTCTCTACAGGACCCTCCTGGGGAG
341 -D--Q--G--L--K--K--I--L--E--V--G--G--S--L--Q--D--P--P--G--E--

1081 CTCGCAGTGACCGCAAACAGCCGCATGAGCGCCTCTATTCTCCTCAGCAAGCTCTTTGAT
361 -L--A--V--T--A--N--S--R--M--S--A--S--I--L--L--S--K--L--F--D--

1141 GACCTCAAGTGTGATGCGGAGAGGGAGAATTTCCACAGACTTTGTGAAAACACTACATCAAG
381 -D--L--K--C--D--A--E--R--E--N--F--H--R--L--C--E--N--Y--I--K--

1201 AGCTGGTTTGTAGGGCCAAGGGCTGGCCGGAAGCTACGGGCCATCCAGACGGTGTCTCTGC
401 -S--W--F--E--G--Q--G--L--A--G--K--L--R--A--I--Q--T--V--S--C--

1261 CTCCTGCAGGGCCCATGTGACGCTGGCAACCGGGCCTTGGAGCTGAGCGGTGTCTATGGAG
421 -L--L--Q--G--P--C--D--A--G--N--R--A--L--E--L--S--G--V--M--E--

1321 AGTGTGATTGCTCTGTGTGCCTCTGAGCAGGAGGAGGAGCAGCTGGTGGCCGTGGAGGCT
441 -S--V--I--A--L--C--A--S--E--Q--E--E--E--Q--L--V--A--V--E--A--

1381 CTGATCCATGCAGCCGGCAAGGCTAAGCGGGCCTCATTTCATCACTGCCAATGGTGTCTCG
461 -L--I--H--A--A--G--K--A--K--R--A--S--F--I--T--A--N--G--V--S--

1441 CTGCTGAAGGACCTATATAAGTGCAGCGAGAAGGACAGCATCCGCATCCGGGCGCTAGTG
481 -L--L--K--D--L--Y--K--C--S--E--K--D--S--I--R--I--R--A--L--V--

1501 GGACTCTGTAAAGCTCGGTTTCGGCTGGAGGGACTGACTTCAGCATGAAGCAGTTTGTCTGAA
501 -G--L--C--K--L--G--S--A--G--G--T--D--F--S--M--K--Q--F--A--E--

1561 GGCTCCACTCTCAAACCTGGCTAAGCAGTGTCTGAAAAGTGGCTGTGCAATGACCAGATCGAC
521 -G--S--T--L--K--L--A--K--Q--C--R--K--W--L--C--N--D--Q--I--D--

1621 GCAGGCACTCGGCGCTGGGCAGTGGAGGGCCTGGCTTACCTGACCTTTGATGCCGACGTG
541 -A--G--T--R--R--W--A--V--E--G--L--A--Y--L--T--F--D--A--D--V--

1681 AAGGAAGAGTTTGTGGAGGATGCGGCTGCTCTGAAAGCTCTGTTCCAGCTCAGCAGGTTG
561 -K--E--E--F--V--E--D--A--A--A--L--K--A--L--F--Q--L--S--R--L--

1741 GAGGAGAGGTCAGTGCTCTTTGCGGTGGCCTCAGCGCTGGTGAACCTGCCAACAGCTAT
581 -E--E--R--S--V--L--F--A--V--A--S--A--L--V--N--C--T--N--S--Y--

1801 GACTACGAGGAGCCCCGACCCCAAGATGGTGGAGCTGGCCAAGTATGCCAAGCAGCATGTG
601 -D--Y--E--E--P--D--P--K--M--V--E--L--A--K--Y--A--K--Q--H--V--

1861 CCCGAGCAGCACCCCAAGGACAAGCCAAGCTTCGTGCGGGCTCGGGTGAAGAAGCTGCTG
621 -P--E--Q--H--P--K--D--K--P--S--F--V--R--A--R--V--K--K--L--L--

1921 GCAGCGGGTGTGGTGTTCGGCCATGGTGTGCATGGTGAAGACGGAGAGCCCTGTGCTGACC
641 -A--A--G--V--V--S--A--M--V--C--M--V--K--T--E--S--P--V--L--T--

1981 AGTTCCTGCAGAGAGCTGCTCTCCAGGGTCTTCTTGGCTTTAGTGAAGAGGTAGAGGAC
661 -S--S--C--R--E--L--L--S--R--V--F--L--A--L--V--E--E--V--E--D--

2041 CGAGGCACTGTGGTTGCCCAGGGAGGCGGCAGGGCGCTGATCCCGCTGGCCCTGGAAGGC
681 -R--G--T--V--V--A--Q--G--G--G--R--A--L--I--P--L--A--L--E--G--

2101 ACGGACGTGGGGCAGACAAAGGCAGCCCAGGCCCTTGCCAAGCTCACCATCACCTCCAAC
701 -T--D--V--G--Q--T--K--A--A--Q--A--L--A--K--L--T--I--T--S--N--

2161 CCGGAGATGACCTTCCCTGGCGAGCGGATCTATGAGGTGGTCCGGCCCCCTCGTCTCCCTG
721 -P--E--M--T--F--P--G--E--R--I--Y--E--V--V--R--P--L--V--S--L--

2221 TTGCACCTCAACTGCTCAGGCCTGCAGAACTTCGAGGCGCTCATGGCCCTAACAAACCTG
741 -L--H--L--N--C--S--G--L--Q--N--F--E--A--L--M--A--L--T--N--L--

2281 GCTGGGATCAGCGAGAGGCTCCGGCAGAAGATCCTGAAGGAGAAGGCTGTGCCCATGATA
761 -A--G--I--S--E--R--L--R--Q--K--I--L--K--E--K--A--V--P--M--I--

2341 GAAGGCTACATGTTTGAGGAGCATGAGATGATCCGCCGGGCAGCCACGGAGTGCATGTGT
781 -E--G--Y--M--F--E--E--H--E--M--I--R--R--A--A--T--E--C--M--C--

2401 AACTTGGCCATGAGCAAGGAGGTGCAGGACCTCTTCGAAGCCCAGGGCAATGACCGACTG
801 -N--L--A--M--S--K--E--V--Q--D--L--F--E--A--Q--G--N--D--R--L--

2461 AAGCTGCTGGTGTGTACAGTGGAGAGGATGATGAGCTGCTACAGCGGGCAGCTGCCGGG
821 -K--L--L--V--L--Y--S--G--E--D--D--E--L--L--Q--R--A--A--A--G--

2521 GGCTTGGCCATGCTTACCTCCATGCGGCCCCACGCTCTGCAGCCGCATTCCCCAAGTGACC
841 -G--L--A--M--L--T--S--M--R--P--T--L--C--S--R--I--P--Q--V--T--

2581 ACACACTGGCTGGAGATCCTGCAGGCCCTGCTTCTGAGCTCCAACCAGGAGCTGCAGCAC
861 -T--H--W--L--E--I--L--Q--A--L--L--L--S--S--N--Q--E--L--Q--H--

2641 CGGGGTGCTGTGGTGGTGTGAACATGGTGGAGGCCCTCGAGGGAGATTGCCAGCACCCCTG
881 -R--G--A--V--V--V--L--N--M--V--E--A--S--R--E--I--A--S--T--L--

2701 ATGGAGAGTGAGATGATGGAGATCTTGTCAGTGCTAGCTAAGGGTGACCACAGCCCTGTC
901 -M--E--S--E--M--M--E--I--L--S--V--L--A--K--G--D--H--S--P--V--

2761 ACAAGGGCTGCTGCAGCCTGCCTGGACAAAGCAGTGGAATATGGGCTTATCCAACCCAAC
921 -T--R--A--A--A--A--C--L--D--K--A--V--E--Y--G--L--I--Q--P--N--

2821 CAAGATGGAGAGTGA (SEQ ID NO: 2)
941 -Q--D--G--E--*- (SEQ ID NO: 4)

CLAIMS:

1. A short interfering RNA (siRNA) or a short hairpin RNA (shRNA) molecule for selectively reducing the expression of a human UNC-45A splice variant in a cell, wherein the RNA molecule is substantially complementary to at least a part of a mRNA encoding the splice variant, wherein the splice variant comprises a nucleic acid sequence as in SEQ ID NO: 1 (nucleotide positions 1-835) or SEQ ID NO: 2.
2. The siRNA of claim 1, wherein the siRNA targets TGGCCGTCACCTACCCTGGTTTCTTT or GGACAGAGGTGGTAGTGAAC of the UNC-45A929 splice variant.
3. The siRNA of claim 1, wherein the siRNA targets GGTCCAGGGACCCCCGAGCCCCG or GTGAGTGGTCCAGGGACCCC of UNC-45A944.
4. A pharmaceutical composition comprising an effective amount of a siRNA or shRNA of claim 1 that specifically inhibits the expression of a human UNC-45A929 splice variant in a cancer cell.
5. The pharmaceutical composition of claim 4, wherein the siRNA comprises one or more modified nucleotides.
6. The pharmaceutical composition of claim 4, wherein the shRNA is expressed from a vector.
7. A method of reducing the proliferation of a cancer cell, the method comprising contacting the cancer cell with an RNAi agent of claim 1 that specifically downregulates the expression of UNC-45A splice variants.
8. The method of claim 7, wherein the RNAi agent is a siRNA molecule that specifically targets UNC-45A929 splice variant.
9. The method of claim 7, wherein the RNAi agent is a shRNA molecule.
10. The method of claim 7, wherein the cancer cell is selected from the group consisting of breast cancer, cervical cancer and colon cancer.
11. The method of claim 7, wherein the cancer cell is a metastatic breast cancer cell.
12. The method of claim 7, wherein the RNAi agent is a siRNA molecule that targets TGGCCGTCACCTACCCTGGTTTCTTT or GGACAGAGGTGGTAGTGAAC of the UNC-45A929 splice variant.

13. A method of diagnosing a malignant or a pre-malignant cell, the method comprising determining that the cell is malignant or pre-malignant based on the increased expression level of one or more UNC-45A splice variants in the malignant or pre-malignant cell as compared to a non-cancerous cell.
14. The method of claim 13, wherein the UNC-45A splice variant is UNC-45A929.
15. The method of claim 13, wherein the expression level is determined by reverse transcriptase (RT)-PCR.
16. The method of claim 13, wherein the expression level is determined by immunohistochemistry.
17. The method of claim 13, wherein the expression level of the UNC-45A splice variant is determined RNA expression or protein levels.
18. The method of claim 13, wherein the malignant cell is selected from the group consisting of breast cancer, cervical cancer and colon cancer.
19. The method of claim 13, wherein the malignant cell is a metastatic breast cancer cell.
20. The method of claim 13, wherein the expression level is determined in a tissue sample.
21. A method of diagnosing whether a subject has cancer, the method comprising determining the expression of a splice variant UNC-45A929 in an isolated sample, wherein the UNC-45A929 splice variant comprises an untranslated nucleotide sequence of 1-835 of SEQ ID NO: 1.
22. The method of claim 21, wherein the expression level of the UNC-45A929 splice variant is determined in the isolated tissue by the RNA levels of UNC-45A929.
23. The method of claim 21, wherein the expression level of the UNC-45A929 splice variant is determined in the isolated tissue by the protein or peptide levels of UNC-45A929.
24. The method of claim 21, wherein the cancer is selected from the group consisting of breast cancer, cervical cancer and colon cancer.
25. The method of claim 21, wherein the expression levels of the splice variant UNC-45A929 is higher than the expression levels of a splice variant UNC-45A944.

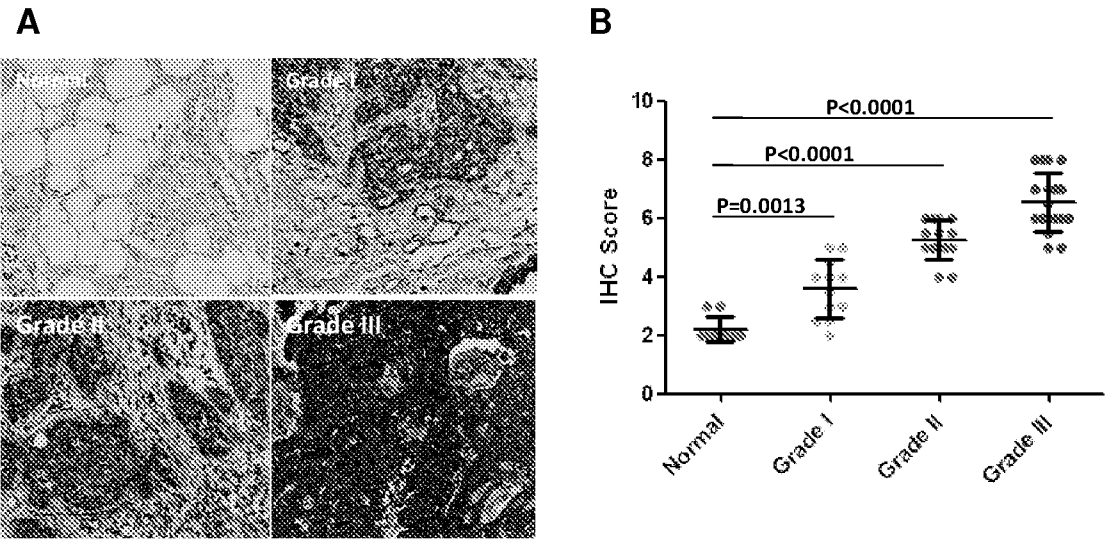


FIG. 1

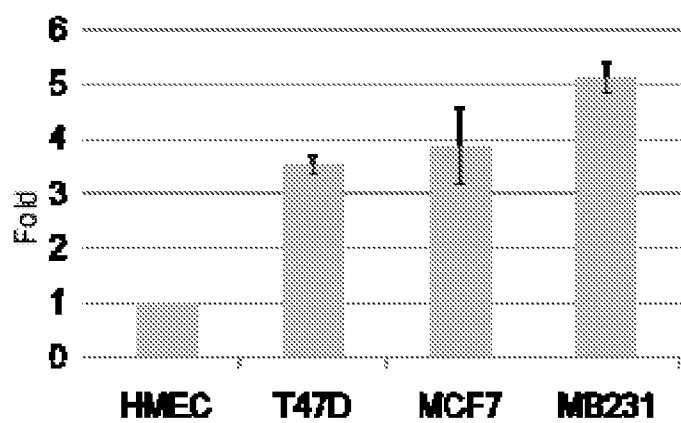
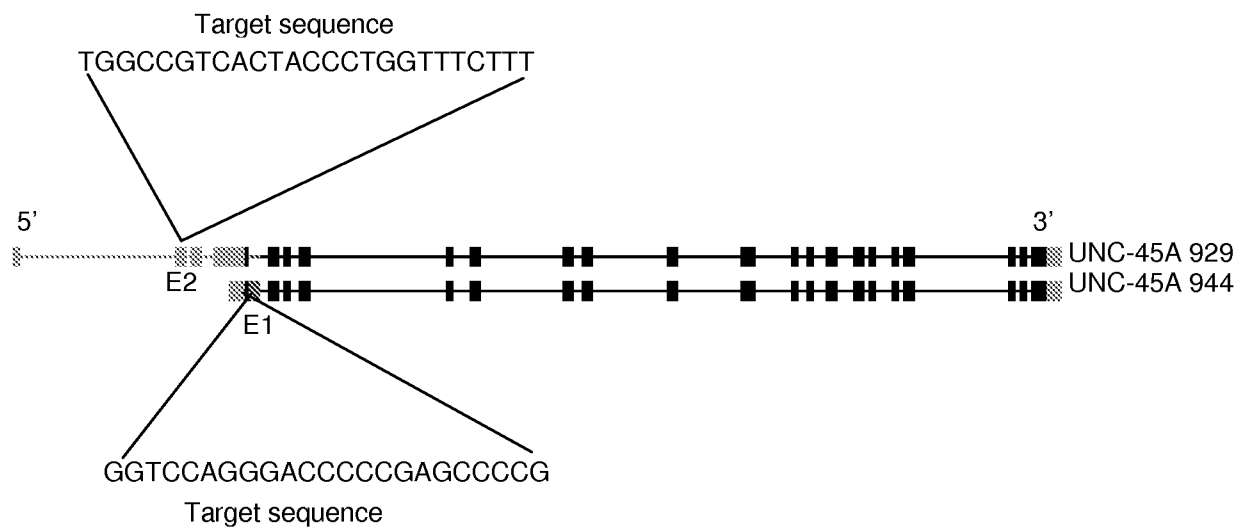


FIG. 2



UNC-45A 929:

sense sequence UGGCCGUCACUACCCUGGUUUCUUU

antisense sequence AAAGAAACCAGGGUAGUGACGGCCA

UNC-45A 944:

sense sequence GGUCCAGGGACCCCGAGCCCCG

antisense sequence CGGGGCUCGGGGGUCCCUGGACC

FIG. 3

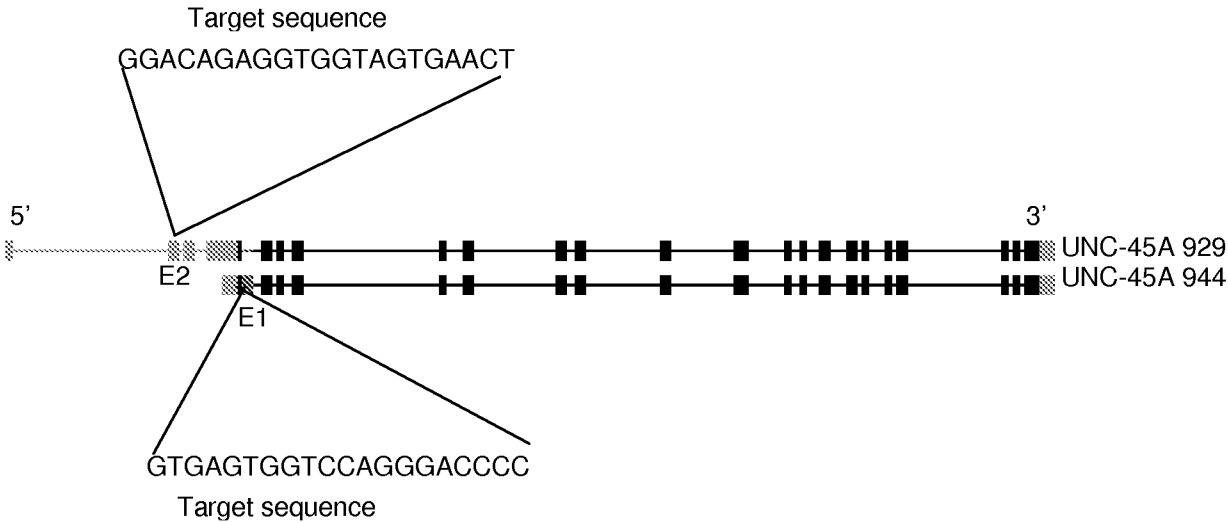


FIG. 4

shRNA design for UNC-45A944

Select	No.	Start	Oligo Type	Oligo Sequence
☒	1	7	Top Strand	5'- CACCCTGAGTGGTCCAGGGACCCCCGAAGGGGGTCCCTGGACCACTCAC -3'
			Bottom Strand	5'- AAAAAGTGAAGTGGTCCAGGGACCCCCCTTCGAGGGGGTCCCTGGACCACTCAC -3'
			ds Oligo	5'- CACCCTGAGTGGTCCAGGGACCCCCGAAGGGGGTCCCTGGACCACTCAC -3'
				3'- CACTCACCAGGTCCCTGGGGGGCTTCCCCCAGGGACCTGGTGAGTGAAAA -5'

Sense sequence Loop sequence Antisense sequence

shRNA design for UNC-45A929

Select	No.	Start	Oligo Type	Oligo Sequence
☒	1	117	Top Strand	5'- CACCCGACAGAGGTGCTAGTGAAGTCCAAAGTTCACCTACCACCTCTGTCC -3'
			Bottom Strand	5'- AAAAGGACAGAGGTGCTAGTGAAGTTTCGAGTTCACCTACCACCTCTGTCC -3'
			ds Oligo	5'- CACCCGACAGAGGTGCTAGTGAAGTCCAAAGTTCACCTACCACCTCTGTCC -3'
				3'- CCTGTCTCCACCATCACTTGAGCTTTCAAGTGATGGTGCAGACAGCAAAA -5'

Sense sequence Loop sequence Antisense sequence

FIG. 5