INHIBITORS OF METASTASIS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application No. 61/808,966, filed April 5, 2013, which is herein incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] This invention relates to compositions and formulations comprising antibodies, nucleic acid molecules, polynucleotides and peptides, and methods of their use for the prevention and treatment of metastatic cancers, especially for the reduction, blocking, or inhibition of cancer cell proliferation, metastasis and/or angiogenesis.

DESCRIPTION OF THE TEXT FILE SUBMITTED ELECTRONICALLY

[0003] The contents of the text file submitted electronically herewith are incorporated herein by reference in their entirety: A computer readable format copy of the Sequence Listing (filename: BMRK_006_01WO_SeqList_ST25.txt, date recorded: April 4, 2014, file size 58 kilobytes).

BACKGROUND OF THE INVENTION

[0004] MARCKS protein (Myristoylated Alanine-Rich C Kinase Substrate) is a ubiquitous phosphorylation target of protein kinase C (PKC) (Li *et al.*, *Journal of Biological Chemistry* 276; 40982 (2002)). MARCKS has three evolutionarily-conserved regions (Aderem et al., Nature 1988; 332:362-364; Thelen et al., Nature 1991; 351:320-322; Hartwig et al., Nature 1992; 356:618-622; Seykora et al., J Biol Chem 1996; 271:18797-18802): an N-terminus, a phosphorylation site domain (or PSD; also known as the effector domain), and a multiple homology 2 (MH2) domain. The N-terminus, an alpha-amino acid sequence comprising 24 amino acid residues with a myristic acid moiety attached via an amide bond to the N-terminal

glycine residue is involved in binding of MARCKS to membranes in cells (Seykora et al., J Biol Chem 1996; 271:18797-18802) and possibly to calmodulin (Matsubara et al., J Biol Chem 2003; 278:48898-48902). This 24 amino acid sequence is known as the MANS peptide. MANS peptide and related peptides are disclosed in U.S. Patent Nos. 7,265,088; 7,529,926; 7,544,772; 8,492,518; 8,501,911; 7,918,293,870; and 8,563,689; the entire contents of each of which are incorporated by reference in their entireties.

[0005] There is a need in the art for new, safe therapies directed to preventing, treating, and inhibiting cancer, including inhibiting cancer cell metastasis, cancer cell proliferation, tumor growth, and/or angiogenesis. The present invention addresses these and other needs.

BRIEF SUMMARY OF THE INVENTION

[0006] This invention relates to methods and compositions useful for preventing or treating cancer. In one embodiment, methods and compositions for inhibiting cancer cell metastasis, cancer cell proliferation, tumor growth, or angiogeneis are provided. In one embodiment, methods and compositions for preventing and inhibiting cancer cell metastasis, cancer cell proliferation, tumor growth, or angiogeneis are provided, comprising inhibition of myristoylated alanine-rich C-kinase substrate (MARCKS). In one embodiment, the compositions comprise MARCKS-inhibitory compounds including peptides, polypeptides, antibodies or fragments thereof, and nucleic acid molecules such as antisense polynucleotides, aptamers, small interfering RNA (siRNA), micro RNA (miRNA), and short-hairpin RNA (shRNA). "MARCKS-inhibitory nucleic acid molecules" as used herein refer to polynucleotides or nucleic acid molecules such as siRNA, miRNA, shRNA, or antisense polynucleotides, that reduce expression and/or function of MARCKS. In one embodiment, the compositions comprise one or more MARCKS-related peptides. In another embodiment, the MARCKS-related peptides correspond to the MH2 domain of MARCKS. In another embodiment, the peptides are myristoylated N-terminal sequence (MANS peptide, which is a 24 amino-acid fragment of MARCKS)-related peptides (i.e., "MANS-related peptides"). In a further embodiment, MANS-related peptides are selected from the group consisting of: MANS peptide; unsubstituted fragments of MANS which contain four or more amino acids and which comprise the same sequence found in the N-terminal amino acid sequence in MANS peptide; peptides comprising a sequence substantially

identical to the sequence found in the MANS peptide or MANS peptide fragment; MANS peptide or fragments of MANS peptide with the identical or substantially identical amino acid sequence as the MANS peptide that are N-terminal myristoylated or N-terminal acylated with, for example, an acetyl group; and MANS peptide or fragments of MANS peptide with the identical or substantially identical amino acid sequence as the MANS peptide that are C-terminal chemically modified. In one embodiment, the MANS-related peptides are both N-terminal and C-terminal chemically modified. In one embodiment, the MARCKS-inhibitory compounds provided herein are antibodies or fragments thereof. In one embodiment, the antibody or fragment thereof inhibits the functions of the MARCKS protein. In another embodiment, the antibody or fragment thereof binds to the N-terminal of the MARCKS protein or the MH2 sequence of the MARCKS protein. We have found surprisingly that use of different types of MARCKS-inhibitory compounds exhibit an inhibitory effect on cancer cell migration *in vitro* and inhibit metastasis *in vivo*. In one embodiment, MARCKS-inhibitory compounds exhibit an inhibitory effect on migration of aggressive cancer cell lines. In one embodiment, the MARCKS-inhibitor compounds provided herein inhibit metastasis of cancer cells in a tumor in a mammal. In a further embodiment, the tumor is a solid tumor. In another embodiment, the tumor is a non-solid tumor. In one embodiment, the MARCKS-inhibitor compounds provided herein inhibit metastasis of cancer cells associated with a lymphoma or leukemia.

[0007] In one embodiment, MARCKS-inhibitory compounds comprise MARCKS-inhibitory polynucleotides or MARCKS-inhibitory nucleic acid molecules. In a further embodiment, the MARCKS–inhibitory compounds are antisense RNA, siRNA, shRNA, or microRNA polynucleotides that inhibit MARCKS expression and/or function. In one embodiment, the MARCKS-inhibitory compounds are mimics of proteins or polynucleotides that regulate MARCKS expression, such as mimics of miR21.

[0008] In one embodiment, the MARKS-inhibitory compounds are MARCKS-related or MANS-related peptides. In another embodiment, the MARCKS-related peptides correspond to the N-terminal myristoylated domain of MARCKS. Thus, in one embodiment, the MARCKS-related peptides are MANS-related peptides. In one embodiment, MANS-related peptides and certain chemically modified MANS-related peptides block migration of aggressive cancer cell lines. In one embodiment, MANS-related peptides are used to exert an inhibitory effect on metastasis of cancer cells. In one embodiment, MARCKS-inhibitory compounds exhibit

blocking effects on metastasis of cancer cells *in vivo*. *In vivo* sites of inhibition of metastatic disease include at least lung tissue, heart tissue, spleen tissue, intestine tissue, and diaphragm tissue. In one embodiment, MANS-related peptides are used to treat or prevent cancer cell metastasis, cancer cell proliferation, tumor cell growth, or angiogenesis.

[0009] In one aspect, compositions and methods are provided for treating or preventing cancer comprising administration of a MARCKS-inhibitory compound to a cancer cell or to a cell that plays a role in the development, maintence, proliferation, or metastasis of cancer cells. In one embodiment, a method is provided for inhibiting metastasis of a cancer cell comprising administration to the cancer cell of a metastasis-inhibiting amount of a MARCKS-inhibitory compound. In one embodiment, a method is provided for inhibiting metastasis of a cancer cell comprising administration to the cancer cell of a metastasis-inhibiting amount of a MANS-related peptide. In another embodiment, a method is provided for inhibiting metastasis of a cancer cell in a tumor comprising administration to the cancer cell of a metastasis-inhibiting amount of a peptide having an amino acid sequence selected from the group consisting of SEQ ID NO: 1 to SEQ ID NO: 231 (inclusive), SEQ ID NO: 234, and SEQ ID NO: 235; wherein the N-terminal and/or C-terminal amino acid of the peptide sequence is optionally chemically modified. In another embodiment, a method is provided for treating cancer in a subject in need thereof, the method comprising administering to the subject a therapeutically effective amount of a MANS-related peptide. In another embodiment, a method is provided for treating cancer in a subject in need thereof, the method comprising administering to the subject a therapeutically effective amount of a peptide having an amino acid sequence selected from the group consisting of SEQ ID NO: 1 to SEQ ID NO: 231 (inclusive), SEQ ID NO: 234, and SEQ ID NO: 235; wherein the N-terminal and/or C-terminal amino acid of the peptide sequence is optionally chemically modified.

[0010] In one embodiment, the N-terminal amino acid of the peptide is chemically modified by acylation of the N-terminal amino acid of the peptide in the form of an amide selected from the group consisting of:

- an amide of a C_2 (acetyl) to C_{24} aliphatic carboxylic acid which may be linear, branched, saturated, or unsaturated,
- an amide of trifluoroacetic acid,

- an amide of benzoic acid, and
- an amide of a C_1 to C_{24} aliphatic alkyl sulfonic acid; or
- the N-terminal amine group of the N-terminal amino acid of the peptide can be alkylated with a group selected from the group consisting of:
- a C_1 to C_{24} aliphatic alkyl group,
- a linear 2-(C_1 to C_{24} aliphatic alkyl)oxyethyl group,
- an omega-methoxy-poly(ethyleneoxy)$_n$-ethyl group, where n is from 0 to 10.

[0011] In a further embodiment, the N-terminal amide is selected from the group consisting of acetyl and myristoyl.

[0012] In another embodiment, the C-terminal amino acid of the peptide is chemically modified by amide formation at the C-terminal carboxylic acid group of the C-terminal amino acid of the peptide in the form of an amide selected from the group consisting of:

- an amide of ammonia,
- an amide of a C_1 to C_{24} aliphatic alkyl amine,
- an amide of a hydroxyl-substituted C_2 to C_{24} aliphatic alkyl amine,
- an amide of a linear 2-(C1 to C24 aliphatic alkyl)oxyethylamine group, and
- an amide of an omega-methoxy-poly(ethyleneoxy)$_n$-ethylamine group, where n is from 0 to 10.

[0013] In one embodiment, a method for inhibiting metastasis of a cancer cell, or for treating cancer, comprising administering a MANS-related peptide to the cancer cell or subject, respectively, is provided. In one embodiment, the peptide is selected from the group consisting of N-myristoyl-GAQFSKTAAKGEAAAERPGEAAVA (SEQ ID NO: 1); N-myristoyl-GAQFSKTAAKGEAAAERPGEAAV (SEQ ID No: 2); N-myristoyl-GAQFSKTAAKGEAAAERPGEAA (SEQ ID No: 4); N-myristoyl-GAQFSKTAAKGEAAAERPGEA (SEQ ID No: 7); N-myristoyl-GAQFSKTAAKGEAAAERPGE (SEQ ID No: 11); N-myristoyl-GAQFSKTAAKGEAAAERPG (SEQ ID No: 16); N-myristoyl-GAQFSKTAAKGEAAAERP (SEQ ID No: 22); N-myristoyl-GAQFSKTAAKGEAAAER (SEQ ID No: 29); N-myristoyl-GAQFSKTAAKGEAAAE (SEQ ID No: 37); N-myristoyl-GAQFSKTAAKGEAAA (SEQ ID

No: 46); N-myristoyl-GAQFSKTAAKGEAA (SEQ ID No: 56); N-myristoyl-GAQFSKTAAKGEA (SEQ ID No: 67); N-myristoyl-GAQFSKTAAKGE (SEQ ID No: 79); N-myristoyl-GAQFSKTAAKG (SEQ ID No: 92); N-myristoyl-GAQFSKTAAK (SEQ ID No: 106); N-myristoyl-GAQFSKTAA (SEQ ID No: 121); N-myristoyl-GAQFSKTA (SEQ ID No: 137); N-myristoyl-GAQFSKT (SEQ ID No: 154); N-myristoyl-GAQFSK (SEQ ID No: 172), N-myristoyl-GAQFS (SEQ ID No: 191), N-myristoyl-GAQF (SEQ ID No: 211), N-acetyl-RGAQFSKTAAK (SEQ ID No: 234), N-acetyl-RGAQFSKTAAK-NH2 (SEQ ID No: 234), N-acetyl-RAKGE (SEQ ID NO: 235), and a combination thereof.

[0014] In one embodiment, the peptide is selected from the group consisting of N-acetyl-GAQFSKTAAK (SEQ ID No: 106; BIO-11006); N-myristoyl-AKGE (SEQ ID No: 219; BIO-91200); N-myristoyl-GAQFSKTAAK-NH2 (SEQ ID No: 106; BIO-11002); N-myristoyl-GAQFSKTAAK (SEQ ID No: 106; BIO-11000); N-acetyl-GAQFSKTAA (SEQ ID No: 121; BIO-10901); N-myristoyl-GAQFSKTAAK (SEQ ID No: 121; BIO-10900); and N-acetyl-GAQFSKTAAK-NH2 (SEQ ID No: 106). In one embodiment, certain amino acids are present in d-configuration. For example, in one embodiment, the peptide is N-acetyl-GAQFS(d)KTAA(d)K (SEQ ID NO: 106; BIO-11037), in which the lysine (K) at positions 6 and 10 of the peptide are of d-configuration.

[0015] In some embodiments, MANS-related peptides exhibit properties that make them suitable for use in therapeutic applications, for example, in the treatment of cancers. For example, in one embodiment, certain MANS-related peptides disclosed herein exhibit enhanced solubility relative to MANS peptide or peptides other than MANS-related peptides. In another embodiment, certain MANS-related peptides provided herein exhibit longer half-lives in plasma than the MANS peptide or peptides other than MANS-related peptides.

[0016] In one embodiment, the MARCKS-related peptide exhibits reduced cancer cell migration. For example, in one embodiment, pretreatment of cancer cells with a MANS-related peptide (e.g., BIO-11006, BIO11002, BIO10901, BIO10900, BIO11000, or BIO-91200) may reduce migration of the cancer cells when cells are pretreated with from about 10μm peptide to about 200μm peptide; or pretreated with from about 20μm to about 200μm; or pretreated with from about 25μm peptide to about 75μm peptide. In one embodiment, the MARCKS-related peptide exhibits reduced cancer cell migration when administered at concentrations of about 1μM to about 500μM, about 5μM to about 250μM, or about 10μM to about 200μM. In one

embodiment, the MARCKS-related peptide exhibits reduced cancer cell migration when administered at concentrations of about 1μM, about 5μM, about 10μM, about 25μM, about 50μM, about 100μM, about 150μM, about 200μM, or about 500μM. In one embodiment, cancer cells are treated with the peptide *in vitro* to determine the effects of the peptide. In one embodiment, the cancer cells are derived from a patient. In a further embodiment, the cancer cells are treated with the peptide *in vitro* to determine if the patient is likely to respond to treatment with the peptide.

[0017] In one embodiment, the MARCKS-related peptide exhibits reduced cancer cell metastasis when administered to a patient at concentrations of about 0.01 mg/kg/day to about 10 mg/kg/day. In a further embodiment, the MARCKS-related peptide exhibits reduced cancer cell metastasis when administered to a patient at concentrations of about 0.1 mg/kg/day to about 5.0 mg/kg/day. In a yet further embodiment, the MARCKS-related peptide exhibits reduced cancer cell metastasis when administered to a patient at concentrations of about 0.5 mg/kg/day to about 2.5 mg/kg/day. For example, the MARCKS-related peptide exhibits reduced cancer cell migration when administered to a patient at concentrations of about 0.01, about 0.05, about 0.1, about 0.5, about 0.75, about 1.0, about 1.25, about 1.5, about 1.75, about 2.0, about 2.25, about 2.5, about 2.75, about 3.0, about 3.5, about 4.0, about 5.0, about 6.0, about 7.0, about 8.0, about 9.0, about 10.0, or more mg/kg/day.

[0018] In one embodiment, the peptide is administered by inhalation of a liquid solution or suspension, or by inhalation of a dry powder formulation of the peptide. In another embodiment, the peptide is administered by injection of a liquid formulation or suspension of the peptide. In a further embodiment, the injection is into a primary tumor region, wherein the region contains the cancer cell. In a further embodiment, the cancer cell resides in a tumor in a mammal. In one embodiment, the tumor is a solid tumor. In another embodiment, the tumor is a non-solid tumor. In one embodiment, the MARCKS-inhibitor compounds provided herein inhibit metastasis of cancer cells associated with a lymphoma or leukemia. In another embodiment, the liquid formulation is isotonic. In another embodiment, the liquid formulation is buffered.

[0019] In one embodiment, the metastasis-inhibiting amount of the peptide is in the range from about 0.1 to about 100 micromoles per milliliter. In a further embodiment, the metastasis-inhibiting amount of the peptide is in the range from about 1 to about 10 micromoles per

milliliter. In another embodiment, the peptide is in a formulation comprising an additional drug useful in the treatment of cancer, or is formulated for administration with an additional drug.

[0020] In one aspect, a method for treating or preventing cancer or inhibiting metastasis of a cancer cell in a mammal is provided, wherein the method comprises administering to said mammal a MARCKS-inhibitory compound. In one embodiment, the MARCKS-inhibitory compound is a polynucleotide or nucleic acid molecule that reduces expression or activity of MARCKS. In a further embodiment, the MARCKS-inhibitory polynucleotide is an antisense RNA, siRNA, shRNA, or miRNA. In one embodiment, the MARCKS-inhibitory polynucleotide is administered in an amount from about 10nM to 10μM, or from about 20nM to about 500nM, or from about 30nM to about 300nM, or from about 40nM to about 200nM, or from about 50nM to about 100nM. In one embodiment, the MARCKS-inhibitory polynucleotide is a mimic of an miRNA that regulates MARCKS expression. For example, in one embodiment, the MARCKS-inhibitory polynucleotide is a mimic of miR21. In one embodiment, the polynucleotides and nucleic acid molecules are administered together with a delivery agent such as a peptide, protein, lipid, sterol, polymer, transfection reagent, or any polynucleotide or nucleic acid delivery agent known in the art.

[0021] In one aspect, a method for treating or preventing cancer or inhibiting metastasis of a cancer cell in a mammal is provided, wherein the method comprises administering to said mammal a MANS-related peptide, wherein said peptide exhibits a migration index of at least about 1.5, at least about 1.6, at least about 1.7, at least about 1.8, at least about 1.9, at least about 2.0, at least about 2.1, at least about 2.2, at least about 2.3, at least about 2.4, at least about 2.5, at least about 2.6, at least about 2.7, at least about 2.8 at least about 2.9, at least about 3.0, or more, following pretreatment of non-small-cell lung carcinoma (NSCLC) cells. In a further embodiment, the MANS-related peptide is present at a concentration of about 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 125, 150, 175, or 200μmolar of said peptide. In another embodiment, the migration period is 3, 4, 5, 6, 7, 8, 12, 15, 20, 21, 22, 23, or 24 hours. In one embodiment, the MANS-related peptide exhibits a migration index of at least about 1.5 following pretreatment of NSCLC cells with a concentration of 50μmolar of said peptide and a migration period of about 12 hours. In another embodiment, the MANS-related peptide exhibits a migration index of at least about 2.0 following pretreatment of NSCLC cells with a

concentration of at least about 100 µmolar of said peptide and a migration period of about 12 hours.

[0022] In one aspect, a method for treating or preventing cancer including cancer metastasis in a subject in need thereof is provided, the method comprising administering a MANS-related peptide to the subject at a dose of about 0.01 mg/kg/day to about 10 mg/kg/day. In a further embodiment, the MANS-related peptide is administered at concentrations of about 0.1 mg/kg/day to about 5.0 mg/kg/day. In a yet further embodiment, the MANS-related peptide is administered at concentrations of about 0.5 mg/kg/day to about 2.5 mg/kg/day. For example, the MANS-related peptide is administered at a dose of about 0.01, about 0.05, about 0.1, about 0.5, about 0.75, about 1.0, about 1.25, about 1.5, about 1.75, about 2.0, about 2.25, about 2.5, about 2.75, about 3.0, about 3.5, about 4.0, about 5.0, about 6.0, about 7.0, about 8.0, about 9.0, about 10.0, or more mg/kg/day for the treatment or prevention of cancer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Figure 1 displays a cell count field of a negative control after a migration time of 12 hours.

[0024] Figure 2A displays a cell count field obtained after pretreatment with 50 µµmolar of MANS peptide followed by a migration time of 12 hours.

[0025] Figure 2B displays a cell count field obtained after pretreatment with 100 µmolar of MANS peptide followed by a migration time of 12 hours.

[0026] Figure 3A displays a cell count field obtained after pretreatment with 50 µmolar of RNS peptide followed by a migration time of 12 hours.

[0027] Figure 3B displays a cell count field obtained after pretreatment with 100 µmolar of RNS peptide followed by a migration time of 12 hours.

[0028] Figure 4A displays a cell count field obtained after pretreatment with 50 µmolar of MANS-related peptide BIO-11002 followed by a migration time of 12 hours.

[0029] Figure 4B displays a cell count field obtained after pretreatment with 100 µmolar of MANS-related peptide BIO-11002 followed by a migration time of 12 hours.

[0030] Figure 5A displays a cell count field obtained after pretreatment with 50 µmolar of MANS-related peptide BIO-10901 followed by a migration time of 12 hours.

[0031] Figure 5B displays a cell count field obtained after pretreatment with 100 μmolar of MANS-related peptide BIO-10901 followed by a migration time of 12 hours.

[0032] Figure 6A displays a cell count field obtained after pretreatment with 50 μmolar of MANS-related peptide BIO-91200 followed by a migration time of 12 hours.

[0033] Figure 6B displays a cell count field obtained after pretreatment with 100 μmolar of MANS-related peptide BIO-91200 followed by a migration time of 12 hours.

[0034] Figure 7A graphically displays migrated cell numbers obtained 12 hours after pretreatment at 50 μmolar with MANS peptide, BIO11002, BIO10901, BIO91200, or RNS peptide, or no peptide (control).

[0035] Figure 7B graphically displays migrated cell numbers obtained 12 hours after pretreatment at 100 μmolar with MANS peptide, BIO11002, BIO10901, BIO91200, or RNS peptide, or no peptide (control).

[0036] Figure 8A graphically displays the migration index of aggressive human NSCLC cell line cells, wherein a higher value of the migration index signifies less migration after pretreatment with peptides of the invention at 50 μmolar followed by 12 hours of treatment according to the protocol.

[0037] Figure 8B graphically displays the migration index of aggressive human NSCLC cell line cells, wherein a higher value of the migration index signifies less migration after pretreatment with peptides of the invention at 100 μmolar followed by 12 hours of treatment according to the protocol.

[0038] Figure 9 graphically displays respective cell numbers (left panel) and migration index number (right panel) for MANS, RNS, BIO-11000, or BIO-11006, or control (no peptide) in experiments using 50 μmolar of the indicated peptide and the aggressive human NSCLC cell line.

[0039] Figure 10 graphically displays respective cell numbers (left panel) and migration index number (right panel) for MANS, RNS, BIO-11000, BIO-11006, BIO-91200, or control (no peptide) in experiments using 100 μmolar of the indicated peptide and the aggressive human NSCLC cell line.

[0040] Figure 11 shows the migrated cell numbers 12 hours after pretreatment of A549 cells with no peptide or with the indicated test peptide (MANS, RNS, BIO-11006, BIO-11000,

BIO-11002, BIO-91200, or BIO-10901) at 10 μmolar(top left panel), 25 μmolar(top right panel) or 50 μmolar (bottom panel) of peptide.

[0041] Figure 12 shows the average number of tumors per mouse in the left lung, right lung, heart, and diaphragm in animals treated with BIO-11006. BIO-11006 (100μM in PBS) was administered once daily for 22 days, starting at 3 days post cancer cell inoculation, via intraperitoneal injection (50 μL) or inhalation (30 mins, Nebulizer Delivery System, Aeroneb Lab).

[0042] Figure 13 shows the average number of tumors per mouse in the left lung, right lung, heart, and diaphragm in mice administered BIO-11006 (100μM in PBS) by inhalation using a Nebulizer Delivery System (Aeroneb Lab) over 30 days, once daily beginning on Day 15 or on Day 4 relative to injection of human adenocarcinoma cells (PC-9).

[0043] Figure 14 shows the total number of tumors in mice administered BIO-11006 (100μM in PBS) by inhalation using a Nebulizer Delivery System (Aeroneb Lab) over 30 days, once daily beginning on Day 15 or on Day 4 relative to injection of PC-9 cells.

[0044] Figure 15 depicts the number of metastatic nodules found in mice treated with every other day with vehicle control, aerosolized BIO-11006 beginning on day -1 or day +3 relative to A549 cancer cell injection, or aerosolized MANS beginning on day -1 or day +3 relative to A549 cancer cell injection. Aerosolized peptides (100μM in PBS) were administered by inhalation using the Nebulizer Delivery System (Aeroneb Lab). *, $p<0.05$, statistically significant compared to control group; *a,* statistically non-significant in comparison among the groups.

[0045] Figure 16 shows the level of MARCKS protein following administration of 100nM MARCKS siRNA or control siRNA in PC9 cells.

[0046] Figure 17 shows the level of MARCKS protein following administration of 100nM MARCKS siRNA or control siRNA in A549 cells.

[0047] Figure 18 shows the migration of PC9 cancer cells following treatment with 100nMMARCKS siRNA or control siRNA.

[0048] Figure 19 shows the migration of A549 cancer cells following treatment with 100nM MARCKS siRNA or control siRNA.

[0049] Figure 20 shows expression of MARCKS in PC9 cells by Western Blot following treatment with 50nM negative control (HiPerfect vehicle; lane A) or 50nM miR21 inhibitor (lane B).

[0050] Figure 21 shows the migration of PC9 cancer cells following miR21 inhibition (50 nM or 100 nM mir-21 inhibitor) or miR21 activation (50 nM or 100 nM miR-21 mimic).

DETAILED DESCRIPTION OF THE INVENTION

[0051] Myristoylated alanine-rich protein kinase C substrate (MARCKS) protein has been implicated previously in multiple cell processes. For example, it has been shown that MARCKS protein is involved integrally in cellular secretion, degranulation, migration and gene expression. These studies were based on the ability of a peptide identical to the myristoylated N-terminal sequence of MARCKS protein (i.e., MANS peptide) to affect processes in disparate cell types when the cells were pre-treated with the MANS peptide prior to stimulation. In all of these instances, a missense control peptide (consisting of a random amino acid sequence of the amino acids of the MANS peptide, and which is referred to herein as the RNS peptide) was without effect relative to activity exhibited by MANS peptide.

[0052] In one embodiment, the compositions comprise MARCKS-inhibitory compounds such as any type of inhibitory compound known in the art including peptides, polypeptides, antibodies or fragments thereof, and polynucleotides or nucleic acid molecules, such as antisense polynucleotides, aptamers, small interfering RNA (siRNA), micro RNA (miRNA), and short-hairpin RNA (shRNA). In one embodiment, the compositions comprise one or more myristoylated alanine-rich C-kinase substrate (MARCKS)-related peptides. In another embodiment, the MARCKS-related peptides correspond to the MH2 domain of MARCKS. In another embodiment, the compositions comprise MARCKS-inhibitory peptides, including peptides corresponding to the N-terminal sequence.

[0053] In one embodiment, the MARCKS-inhibitory compound provided herein is an antibody. As used herein, the term "antibody" refers to a binding protein having at least one antigen-binding domain and includes monoclonal antibodies, polyclonal antibodies, and antibody fragments and/or variants, including recombinant polypeptides, fusion proteins, and immunoconjugates. Examples of antibody fragments of the invention include, but are not limited

to, the Fab fragment, the Fc fragment, the Fv fragment, the dAb fragment, isolated CDR regions, $F(ab')_2$, bivalent fragments comprising two linked Fab fragments, and single chain Fv molecules (scFv). The skilled artisan will recognize that antibodies or fragments provided herein may be generated from any species including, but not limited to, mouse, rat, rabbit, primate, llama and human. The skilled artisan will further recognize that the antibodies or fragments provided herein may be chimeric, humanized, or fully human.

[0054] In one aspect, compositions and methods for treating or preventing cancer are provided. Methods for treating or preventing cancer disclosed herein include treating or preventing all aspects of cancer including, but not limited to, metastasis, tumor growth, cancer cell proliferation, and angiogenesis. In one embodiment, compositions and methods are provided for treating or preventing cancer comprising administration of a MARCKS-inhibitory compound to a cancer cell or to a cell that plays a role in the development, maintence, proliferation, or metastasis of cancer cells, such as, for example, an endothelial cell.

[0055] In one aspect, compositions and methods for inhibiting the metastasis of cancer cells are provided, wherein the method comprises administering MARCKS-inhibitory compounds. In one embodiment, the MARCKS-inhibitory compounds are MARCKS-inhibitory peptides, antibodies or fragments thereof that bind to MARCKS or MARCKS peptides, or polynucleotides or nucleic acid molecules including antisense polynucleotides, aptamers, siRNA, miRNA, and shRNA that inhibit the functions of the MARCKS protein. In a further embodiment, the peptides are MANS-related peptides, wherein the peptides inhibit the metastasis of cancer cells. In one embodiment, MARCKS-inhibitory peptides that inhibit the metastasis of cancer cells are provided. In another aspect, methods of treating cancers using the compositions disclosed herein are provided. In one embodiment, the methods provided comprise contacting a cancer cell with a MARCKS-inhibitory peptide. In a further embodiment, the cancer cell is present in a tumor. In one embodiment, the MARCKS-inhibitory peptide is MANS-related peptide. As used herein, the term "MANS-related peptide" refers to MANS peptide or a peptide substantially identical to MANS; or a fragment of MANS peptide that contains at least four contiguous amino acids found in MANS peptide, or is substantially identical to a peptide containing at least 4 contiguous amino acids found in MANS peptide. Thus, MANS-related peptides are from 4 to 24 amino acids in length. As used herein, the term "substantially identical" means, with respect to comparison of the amino acid sequences of two peptides or comparison of

the amino acid sequences of two peptide segments (e.g., segments of a reference peptide amino acid sequence), that the amino acid sequence of the peptides or segments of peptides have at least about 75% sequence identity, at least about 80% sequence identity, at least about 90% sequence identity, or at least about 95% sequence identity. Preferably, the amino acid sequence of the peptides have at least about 80% sequence identity to MANS peptide or the MANS peptide fragment. In one embodiment, the MANS-related peptide may comprise a peptide from 4 to 24 amino acids in length that is identical to or substantially identical to MANS peptide and may further comprise one or more additional amino acids. For example, in one embodiment, the MANS-related peptide comprises from 4 to 24 contiguous amino acids identical to or substantially identical to MANS peptide and further comprises at least one N-terminal amino acid that is not present in MANS peptide such as, for example, arginine.

[0056] In one embodiment, the MARCKS-inhibitory peptide is chemically modified. In one embodiment, the MARCKS-inhibitory peptide is a MANS-related peptide that is acylated at the N-terminal position. In a further embodiment, the MANS-related peptide is acylated with an acetyl group at the N-terminal position. In another embodiment, the MANS-related peptide is myristoylated at the N-terminal position. In another embodiment, the MANS-related peptide is chemically modified at the C-terminal position. In a further embodiment, the MANS-related peptide is chemically modified at the C-terminal position by formation of an amide with an amine (e.g., ammonia). In another embodiment, the MANS-related peptide is chemically modified at both the N-terminal and C-terminal position. Table 1 lists peptides relevant to the current invention which are myristoylated at their N-terminal position but unsubstituted at their C-terminal position. Certain control peptides (RNS peptides) are listed in Tables 1 and 2, and are myristoylated. However, the RNS peptides are not considered to reside within the scope of the current invention.

Table 1. MANS-related peptides of the invention which are N-terminal myristoylated and which can be further chemically modified at the C-terminal position as described herein

Peptide No.	**N –myristoyl Amino Acid Sequences**	**SEQ ID No:**	
peptide 1	GAQFSKTAAKGEAAAERPGEAAVA	SEQ ID NO: 1	MANS
peptide 2	GAQFSKTAAKGEAAAERPGEAAV	SEQ ID NO: 2	

peptide 4	GAQFSKTAAKGEAAAERPGEAA	SEQ ID NO: 4	
peptide 7	GAQFSKTAAKGEAAAERPGEA	SEQ ID NO: 7	
peptide 11	GAQFSKTAAKGEAAAERPGE	SEQ ID NO: 11	
peptide 16	GAQFSKTAAKGEAAAERPG	SEQ ID NO: 16	
peptide 22	GAQFSKTAAKGEAAAERP	SEQ ID NO: 22	
peptide 29	GAQFSKTAAKGEAAAER	SEQ ID NO: 29	
peptide 37	GAQFSKTAAKGEAAAE	SEQ ID NO: 37	
peptide 46	GAQFSKTAAKGEAAA	SEQ ID NO: 46	
peptide 56	GAQFSKTAAKGEAA	SEQ ID NO: 56	
peptide 67	GAQFSKTAAKGEA	SEQ ID NO: 67	
peptide 79	GAQFSKTAAKGE	SEQ ID NO: 79	
peptide 92	GAQFSKTAAKG	SEQ ID NO: 92	
peptide 106	GAQFSKTAAK	SEQ ID NO: 106	
peptide 121	GAQFSKTAA	SEQ ID NO: 121	
peptide 137	GAQFSKTA	SEQ ID NO: 137	
peptide 154	GAQFSKT	SEQ ID NO: 154	
peptide 172	GAQFSK	SEQ ID NO: 172	
peptide 191	GAQFS	SEQ ID NO: 191	
peptide 211	GAQF	SEQ ID NO: 211	
Peptide 232	GTAPAAEGAGAEVKRASAEAKQAF	SEQ ID NO: 232	RNS

[0057] Table 2 lists MANS-related peptide fragments of the invention, which can be substituted or chemically modified at the N-terminal and/or C-terminal position. In one embodiment, these active fragments of MANS peptide may be myristoylated at the N-terminal position as are those in Table 1. In another embodiment, chemical modification at the C-terminal position comprises amidation, for example, formation of an amide with an amine, such as, for example, ammonia. Peptide 234 (SEQ ID NO: 234) is an N-terminal arginine- substituted peptide homolog of peptide 106 (SEQ ID NO: 106; RGAQFSKTAAK), which may be chemically modified at the N-terminus (e.g., N-terminal acetyl analog, Ac-RGAQFSKTAAK), and which also may be chemically modified at its N-terminus and its C-terminus (e.g., N-

terminal acetyl-, -C-terminal amide with ammonia analog, Ac-RGAQFSKTAAK-NH2). Peptide 235 (SEQ ID NO: 235) is an N-terminal arginine-substituted peptide homolog of peptide 219, (SEQ ID NO: 219; RAKGE) which may be chemically modified at the N-terminus (e.g., N-terminal acetyl analog, Ac-RAKGE), and which also may be chemically modified at its N-terminus and its C-terminus (e.g., N-terminal acetyl-, -C-terminal amide with ammonia analog, Ac-RAKGE-NH2). Preferred N-terminal modifications or substitutions include myristoyl and acetyl groups as well as N-terminal arginine groups, N-terminal acetyl—arginine groups, and N-terminal myristoyl-arginine groups. Preferred C-terminal modification includes the amide group from ammonia.

Table 2. MARCKS-related peptide sequences which may be chemically modified at the N-terminal and/or C-terminal position as described herein.

Table 2	**MANS peptide and active MANS-related peptide fragments**		
Peptide No.	**Amino Acid Sequence**	**SEQ ID No:**	
peptide 1	GAQFSKTAAKGEAAAERPGEAAVA	SEQ ID NO: 1	MANS
peptide 2	GAQFSKTAAKGEAAAERPGEAAV	SEQ ID NO: 2	
peptide 3	AQFSKTAAKGEAAAERPGEAAVA	SEQ ID NO: 3	
peptide 4	GAQFSKTAAKGEAAAERPGEAA	SEQ ID NO: 4	
peptide 5	AQFSKTAAKGEAAAERPGEAAV	SEQ ID NO: 5	
peptide 6	QFSKTAAKGEAAAERPGEAAVA	SEQ ID NO: 6	
peptide 7	GAQFSKTAAKGEAAAERPGEA	SEQ ID NO: 7	
peptide 8	AQFSKTAAKGEAAAERPGEAA	SEQ ID NO: 8	
peptide 9	QFSKTAAKGEAAAERPGEAAV	SEQ ID NO: 9	
peptide 10	FSKTAAKGEAAAERPGEAAVA	SEQ ID NO: 10	
peptide 11	GAQFSKTAAKGEAAAERPGE	SEQ ID NO: 11	
peptide 12	AQFSKTAAKGEAAAERPGEA	SEQ ID NO: 12	
peptide 13	QFSKTAAKGEAAAERPGEAA	SEQ ID NO: 13	
peptide 14	FSKTAAKGEAAAERPGEAAV	SEQ ID NO: 14	
peptide 15	SKTAAKGEAAAERPGEAAVA	SEQ ID NO: 15	

peptide 16	GAQFSKTAAKGEAAAERPG	SEQ ID NO: 16	
peptide 17	AQFSKTAAKGEAAAERPGE	SEQ ID NO: 17	
peptide 18	QFSKTAAKGEAAAERPGEA	SEQ ID NO: 18	
peptide 19	FSKTAAKGEAAAERPGEAA	SEQ ID NO: 19	
peptide 20	SKTAAKGEAAAERPGEAAV	SEQ ID NO: 20	
peptide 21	KTAAKGEAAAERPGEAAVA	SEQ ID NO: 21	
peptide 22	GAQFSKTAAKGEAAAERP	SEQ ID NO: 22	
peptide 23	AQFSKTAAKGEAAAERPG	SEQ ID NO: 23	
peptide 24	QFSKTAAKGEAAAERPGE	SEQ ID NO: 24	
peptide 25	FSKTAAKGEAAAERPGEA	SEQ ID NO: 25	
peptide 26	SKTAAKGEAAAERPGEAA	SEQ ID NO: 26	
peptide 27	KTAAKGEAAAERPGEAAV	SEQ ID NO: 27	
peptide 28	TAAKGEAAAERPGEAAVA	SEQ ID NO: 28	
peptide 29	GAQFSKTAAKGEAAAER	SEQ ID NO: 29	
peptide 30	AQFSKTAAKGEAAAERP	SEQ ID NO: 30	
peptide 31	QFSKTAAKGEAAAERPG	SEQ ID NO: 31	
peptide 32	FSKTAAKGEAAAERPGE	SEQ ID NO: 32	
peptide 33	SKTAAKGEAAAERPGEA	SEQ ID NO: 33	
peptide 34	KTAAKGEAAAERPGEAA	SEQ ID NO: 34	
peptide 35	TAAKGEAAAERPGEAAV	SEQ ID NO: 35	
peptide 36	AAKGEAAAERPGEAAVA	SEQ ID NO: 36	
peptide 37	GAQFSKTAAKGEAAAE	SEQ ID NO: 37	
peptide 38	AQFSKTAAKGEAAAER	SEQ ID NO: 38	
peptide 39	QFSKTAAKGEAAAERP	SEQ ID NO: 39	
peptide 40	FSKTAAKGEAAAERPG	SEQ ID NO: 40	
peptide 41	SKTAAKGEAAAERPGE	SEQ ID NO: 41	
peptide 42	KTAAKGEAAAERPGEA	SEQ ID NO: 42	
peptide 43	TAAKGEAAAERPGEAA	SEQ ID NO: 43	
peptide 44	AAKGEAAAERPGEAAV	SEQ ID NO: 44	
peptide 45	AKGEAAAERPGEAAVA	SEQ ID NO: 45	

peptide 46	GAQFSKTAAKGEAAA	SEQ ID NO: 46	
peptide 47	AQFSKTAAKGEAAAE	SEQ ID NO: 47	
peptide 48	QFSKTAAKGEAAAER	SEQ ID NO: 48	
peptide 49	FSKTAAKGEAAAERP	SEQ ID NO: 49	
peptide 50	SKTAAKGEAAAERPG	SEQ ID NO: 50	
peptide 51	KTAAKGEAAAERPGE	SEQ ID NO: 51	
peptide 52	TAAKGEAAAERPGEA	SEQ ID NO: 52	
peptide 53	AAKGEAAAERPGEAA	SEQ ID NO: 53	
peptide 54	AKGEAAAERPGEAAV	SEQ ID NO: 54	
peptide 55	KGEAAAERPGEAAVA	SEQ ID NO: 55	
peptide 56	GAQFSKTAAKGEAA	SEQ ID NO: 56	
peptide 57	AQFSKTAAKGEAAA	SEQ ID NO: 57	
peptide 58	QFSKTAAKGEAAAE	SEQ ID NO: 58	
peptide 59	FSKTAAKGEAAAER	SEQ ID NO: 59	
peptide 60	SKTAAKGEAAAERP	SEQ ID NO: 60	
peptide 61	KTAAKGEAAAERPG	SEQ ID NO: 61	
peptide 62	TAAKGEAAAERPGE	SEQ ID NO: 62	
peptide 63	AAKGEAAAERPGEA	SEQ ID NO: 63	
peptide 64	AKGEAAAERPGEAA	SEQ ID NO: 64	
peptide 65	KGEAAAERPGEAAV	SEQ ID NO: 65	
peptide 66	GEAAAERPGEAAVA	SEQ ID NO: 66	
peptide 67	GAQFSKTAAKGEA	SEQ ID NO: 67	
peptide 68	AQFSKTAAKGEAA	SEQ ID NO: 68	
peptide 69	QFSKTAAKGEAAA	SEQ ID NO: 69	
peptide 70	FSKTAAKGEAAAE	SEQ ID NO: 70	
peptide 71	SKTAAKGEAAAER	SEQ ID NO: 71	
peptide 72	KTAAKGEAAAERP	SEQ ID NO: 72	
peptide 73	TAAKGEAAAERPG	SEQ ID NO: 73	
peptide 74	AAKGEAAAERPGE	SEQ ID NO: 74	
peptide 75	AKGEAAAERPGEA	SEQ ID NO: 75	

peptide 76	KGEAAAERPGEAA	SEQ ID NO: 76	
peptide 77	GEAAAERPGEAAV	SEQ ID NO: 77	
peptide 78	EAAAERPGEAAVA	SEQ ID NO: 78	
peptide 79	GAQFSKTAAKGE	SEQ ID NO: 79	
peptide 80	AQFSKTAAKGEA	SEQ ID NO: 80	
peptide 81	QFSKTAAKGEAA	SEQ ID NO: 81	
peptide 82	FSKTAAKGEAAA	SEQ ID NO: 82	
peptide 83	SKTAAKGEAAAE	SEQ ID NO: 83	
peptide 84	KTAAKGEAAAER	SEQ ID NO: 84	
peptide 85	TAAKGEAAAERP	SEQ ID NO: 85	
peptide 86	AAKGEAAAERPG	SEQ ID NO: 86	
peptide 87	AKGEAAAERPGE	SEQ ID NO: 87	
peptide 88	KGEAAAERPGEA	SEQ ID NO: 88	
peptide 89	GEAAAERPGEAA	SEQ ID NO: 89	
peptide 90	EAAAERPGEAAV	SEQ ID NO: 90	
peptide 91	AAAERPGEAAVA	SEQ ID NO: 91	
peptide 92	GAQFSKTAAKG	SEQ ID NO: 92	
peptide 93	AQFSKTAAKGE	SEQ ID NO: 93	
peptide 94	QFSKTAAKGEA	SEQ ID NO: 94	
peptide 95	FSKTAAKGEAA	SEQ ID NO: 95	
peptide 96	SKTAAKGEAAA	SEQ ID NO: 96	
peptide 97	KTAAKGEAAAE	SEQ ID NO: 97	
peptide 98	TAAKGEAAAER	SEQ ID NO: 98	
peptide 99	AAKGEAAAERP	SEQ ID NO: 99	
peptide 100	AKGEAAAERPG	SEQ ID NO: 100	
peptide 101	KGEAAAERPGE	SEQ ID NO: 101	
peptide 102	GEAAAERPGEA	SEQ ID NO: 102	
peptide 103	EAAAERPGEAA	SEQ ID NO: 103	
peptide 104	AAAERPGEAAV	SEQ ID NO: 104	
peptide 105	AAERPGEAAVA	SEQ ID NO: 105	

peptide 106	GAQFSKTAAK	SEQ ID NO: 106	
peptide 107	AQFSKTAAKG	SEQ ID NO: 107	
peptide 108	QFSKTAAKGE	SEQ ID NO: 108	
peptide 109	FSKTAAKGEA	SEQ ID NO: 109	
peptide 110	SKTAAKGEAA	SEQ ID NO: 110	
peptide 111	KTAAKGEAAA	SEQ ID NO: 111	
peptide 112	TAAKGEAAAE	SEQ ID NO: 112	
peptide 113	AAKGEAAAER	SEQ ID NO: 113	
peptide 114	AKGEAAAERP	SEQ ID NO: 114	
peptide 115	KGEAAAERPG	SEQ ID NO: 115	
peptide 116	GEAAAERPGE	SEQ ID NO: 116	
peptide 117	EAAAERPGEA	SEQ ID NO: 117	
peptide 118	AAAERPGEAA	SEQ ID NO: 118	
peptide 119	AAERPGEAAV	SEQ ID NO: 119	
peptide 120	AERPGEAAVA	SEQ ID NO: 120	
peptide 121	GAQFSKTAA	SEQ ID NO: 121	
peptide 122	AQFSKTAAK	SEQ ID NO: 122	
peptide 123	QFSKTAAKG	SEQ ID NO: 123	
peptide 124	FSKTAAKGE	SEQ ID NO: 124	
peptide 125	SKTAAKGEA	SEQ ID NO: 125	
peptide 126	KTAAKGEAA	SEQ ID NO: 126	
peptide 127	TAAKGEAAA	SEQ ID NO: 127	
peptide 128	AAKGEAAAE	SEQ ID NO: 128	
peptide 129	AKGEAAAER	SEQ ID NO: 129	
peptide 130	KGEAAAERP	SEQ ID NO: 130	
peptide 131	GEAAAERPG	SEQ ID NO: 131	
peptide 132	EAAAERPGE	SEQ ID NO: 132	
peptide 133	AAAERPGEA	SEQ ID NO: 133	
peptide 134	AAERPGEAA	SEQ ID NO: 134	
peptide 135	AERPGEAAV	SEQ ID NO: 135	

peptide 136	ERPGEAAVA	SEQ ID NO: 136	
peptide 137	GAQFSKTA	SEQ ID NO: 137	
peptide 138	AQFSKTAA	SEQ ID NO: 138	
peptide 139	QFSKTAAK	SEQ ID NO: 139	
peptide 140	FSKTAAKG	SEQ ID NO: 140	
peptide 141	SKTAAKGE	SEQ ID NO: 141	
peptide 142	KTAAKGEA	SEQ ID NO: 142	
peptide 143	TAAKGEAA	SEQ ID NO: 143	
peptide 144	AAKGEAAA	SEQ ID NO: 144	
peptide 145	AKGEAAAE	SEQ ID NO: 145	
peptide 146	KGEAAAER	SEQ ID NO: 146	
peptide 147	GEAAAERP	SEQ ID NO: 147	
peptide 148	EAAAERPG	SEQ ID NO: 148	
peptide 149	AAAERPGE	SEQ ID NO: 149	
peptide 150	AAERPGEA	SEQ ID NO: 150	
peptide 151	AERPGEAA	SEQ ID NO: 151	
peptide 152	ERPGEAAV	SEQ ID NO: 152	
peptide 153	RPGEAAVA	SEQ ID NO: 153	
peptide 154	GAQFSKT	SEQ ID NO: 154	
peptide 155	AQFSKTA	SEQ ID NO: 155	
peptide 156	QFSKTAA	SEQ ID NO: 156	
peptide 157	FSKTAAK	SEQ ID NO: 157	
peptide 158	SKTAAKG	SEQ ID NO: 158	
peptide 159	KTAAKGE	SEQ ID NO: 159	
peptide 160	TAAKGEA	SEQ ID NO: 160	
peptide 161	AAKGEAA	SEQ ID NO: 161	
peptide 162	AKGEAAA	SEQ ID NO: 162	
peptide 163	KGEAAAE	SEQ ID NO: 163	
peptide 164	GEAAAER	SEQ ID NO: 164	
peptide 165	EAAAERP	SEQ ID NO: 165	

peptide 166	AAAERPG	SEQ ID NO: 166	
peptide 167	AAERPGE	SEQ ID NO: 167	
peptide 168	AERPGEA	SEQ ID NO: 168	
peptide 169	ERPGEAA	SEQ ID NO: 169	
peptide 170	RPGEAAV	SEQ ID NO: 170	
peptide 171	PGEAAVA	SEQ ID NO: 171	
peptide 172	GAQFSK	SEQ ID NO: 172	
peptide 173	AQFSKT	SEQ ID NO: 173	
peptide 174	QFSKTA	SEQ ID NO: 174	
peptide 175	FSKTAA	SEQ ID NO: 175	
peptide 176	SKTAAK	SEQ ID NO: 176	
peptide 177	KTAAKG	SEQ ID NO: 177	
peptide 178	TAAKGE	SEQ ID NO: 178	
peptide 179	AAKGEA	SEQ ID NO: 179	
peptide 180	AKGEAA	SEQ ID NO: 180	
peptide 181	KGEAAA	SEQ ID NO: 181	
peptide 182	GEAAAE	SEQ ID NO: 182	
peptide 183	EAAAER	SEQ ID NO: 183	
peptide 184	AAAERP	SEQ ID NO: 184	
peptide 185	AAERPG	SEQ ID NO: 185	
peptide 186	AERPGE	SEQ ID NO: 186	
peptide 187	ERPGEA	SEQ ID NO: 187	
peptide 188	RPGEAA	SEQ ID NO: 188	
peptide 189	PGEAAV	SEQ ID NO: 189	
peptide 190	GEAAVA	SEQ ID NO: 190	
peptide 191	GAQFS	SEQ ID NO: 191	
peptide 192	AQFSK	SEQ ID NO: 192	
peptide 193	QFSKT	SEQ ID NO: 193	
peptide 194	FSKTA	SEQ ID NO: 194	
peptide 195	SKTAA	SEQ ID NO: 195	

peptide 196	KTAAK	SEQ ID NO: 196	
peptide 197	TAAKG	SEQ ID NO: 197	
peptide 198	AAKGE	SEQ ID NO: 198	
peptide 199	AKGEA	SEQ ID NO: 199	
peptide 200	KGEAA	SEQ ID NO: 200	
peptide 201	GEAAA	SEQ ID NO: 201	
peptide 202	EAAAE	SEQ ID NO: 202	
peptide 203	AAAER	SEQ ID NO: 203	
peptide 204	AAERP	SEQ ID NO: 204	
peptide 205	AERPG	SEQ ID NO: 205	
peptide 206	ERPGE	SEQ ID NO: 206	
peptide 207	RPGEA	SEQ ID NO: 207	
peptide 208	PGEAA	SEQ ID NO: 208	
peptide 209	GEAAV	SEQ ID NO: 209	
peptide 210	EAAVA	SEQ ID NO: 210	
peptide 211	GAQF	SEQ ID NO: 211	
peptide 212	AQFS	SEQ ID NO: 212	
peptide 213	QFSK	SEQ ID NO: 213	
peptide 214	FSKT	SEQ ID NO: 214	
peptide 215	SKTA	SEQ ID NO: 215	
peptide 216	KTAA	SEQ ID NO: 216	
peptide 217	TAAK	SEQ ID NO: 217	
peptide 218	AAKG	SEQ ID NO: 218	
peptide 219	AKGE	SEQ ID NO: 219	
peptide 220	KGEA	SEQ ID NO: 220	
peptide 221	GEAA	SEQ ID NO: 221	
peptide 222	EAAA	SEQ ID NO: 222	
peptide 223	AAAE	SEQ ID NO: 223	
peptide 224	AAER	SEQ ID NO: 224	
peptide 225	AERP	SEQ ID NO: 225	

peptide 226	ERPG	SEQ ID NO: 226	
peptide 227	RPGE	SEQ ID NO: 227	
peptide 228	PGEA	SEQ ID NO: 228	
peptide 229	GEAA	SEQ ID NO: 229	
peptide 230	EAAV	SEQ ID NO: 230	
peptide 231	AAVA	SEQ ID NO: 231	
Peptide 232	GTAPAAEGAGAEVKRASAEAKQAF	SEQ ID NO: 232	RNS
Peptide 233	GKASQFAKTA	SEQ ID NO: 233	RNS2
Peptide 234	RGAQFSKTAAK	SEQ ID NO: 234	
Peptide 235	RAKGE	SEQ ID NO: 235	

[0058] The MANS peptide is myristoylated (denoted as MA), and contains the 24 amino acid sequence MA-GAQFSKTAAKGEAAARPGEAAVA. Without wishing to be bound by theory, the peptide is theorized to interfere with the full length MARCKS protein attaching naturally to the cell membrane and interfering with phosphorylation of MARCKS protein by protein kinase C (PKC).

[0059] MANS peptide has been shown to provide a significant reduction in degranulation of goblet cells both *in vitro* and *in vivo*. MANS also affects the rate of migration of neutrophils and mesenchymal stem cells. Degranulation of human leukocytes is also inhibited by MANS. In one aspect of this invention, treatment of certain cancer cell lines with MANS-related peptides decreases migration of those cancer cell lines. In one embodiment, MANS-related peptides exhibit inhibition of metastasis of cancer cells. Thus, in one embodiment, the MANS-related peptides provided may be used to treat or prevent metastatic cancer in a subject in need thereof. In some embodiments, MANS-related peptides exhibit properties that make them suitable for use in therapeutic applications, for example, in the treatment of cancers. For example, in one embodiment, MANS-related peptides exhibit enhanced solubility relative to MANS peptide. In another embodiment, some MANS-related peptides exhibit longer half-lives in plasma than the MANS peptide or relative to peptides other than MANS-related peptides. In one embodiment, MANS-related peptides may be useful in the treatment of proliferation of cancer cells. For example, in one embodiment, MANS-related peptides may inhibit proliferation and or migration

of cancer cells. In another embodiment, some MANS-related peptides may provide greater inhibition of proliferation and or migration of cancer cells at lower concentrations than the MANS peptide or than other MANS-related peptides.

[0060] In one aspect, the MANS-related peptide is selected from the group consisting of:

[0061] N-myristoyl-GAQFSKTAAK (SEQ ID No: 106; BIO-11000)

[0062] N-acetyl-GAQFSKTAAK (SEQ ID No: 106; BIO-11006);

[0063] N-myristoyl-AKGE (SEQ ID No: 219; BIO-91200);

[0064] N-myristoyl-GAQFSKTAAK-NH2 (SEQ ID No: 106; BIO-11002);

[0065] N-acetyl-GAQFSKTAA (SEQ ID No. 121; BIO-10901);

[0066] N-acetyl-GAQFSKTAAK-NH2 (SEQ ID No: 106; BIO-11026);

[0067] N-acetyl-GAQFS(d)KTAA(d)K (SEQ ID No: 106; BIO-11037) (Lys at positions positions 6 and 10 of the peptide are of d-configuration;

[0068] N-acetyl-RGAQFSKTAAK (SEQ ID No: 234; BIO-11027);

[0069] N-acetyl-RGAQFSKTAAK-NH2 (SEQ ID No: 234; BIO-11028); and

[0070] N-acetyl-RAKGE (SEQ ID NO: 235; BIO-91204).

[0071] In one aspect, peptides having 4 to 24 amino acids and which have amino acid sequences that are identical to or are substantially identical to amino acid sequences found in the MANS peptide can be useful in one or more aspects of this invention. These peptides are herein referred to as MANS-related peptides, and exemplary MANS-related peptides are listed in Table 2 as SEQ ID NOs: 1 to 231, 234, and 235. Table 2 also includes the amino acid sequence of the random sequence (RNS) peptide No. 232 (SEQ ID NO: 232), which is used as a control and to demonstrate that amino acid sequence order can be relevant to efficacy in this invention, as well as a second random sequence control peptide 233 (RNS2; SEQ ID NO: 233). Peptides 234 and 235 (SEQ ID NO: 234 and 235) are N-terminal arginine-substituted peptide homologs of peptides 106 and 219, respectively. The arginine can be acylated with, for example, an acetyl group or a myristoyl group.

[0072] In one embodiment, peptides which can be useful in the current invention can be selected from the group consisting of synthetic peptides having amino acid sequences listed in Table 2 (excluding random sequence peptides 232 and 233).

[0073] In another embodiment, peptides which can be useful in the current invention can be selected from peptides of amino acid sequences as listed in Table 2 (SEQ ID NO: 1 to 231

(inclusive), 234, and 235) and which are optionally N-terminal- and/or C-terminal-chemically modified.

[0074] Preferred independent N-terminal chemical modifications of the peptides listed in Table 2 include N-terminal amine group modification by acylation of the N-terminal amino acid of the peptide in the form of an amide selected from the group consisting of:

- an amide of a C_2 (acetyl) to C_{24} aliphatic carboxylic acid which may be linear, branched, saturated, or unsaturated,
- an amide of trifluoroacetic acid,
- an amide of a benzoic acid, and
- an amide of a C_1 to C_{24} aliphatic alkyl sulfonic acid; or
- the N-terminal amine group of the N-terminal amino acid of the peptide can be alkylated with a group selected from the group consisting of:
- a C_1 (methyl) to C_{24} aliphatic alkyl group,
- a linear 2-(C_1 to C_{24} aliphatic alkyl)oxyethyl group,
- an omega-methoxy-poly(ethyleneoxy)$_n$-ethyl group, where n is from 0 to 10.

[0075] Preferred independent C-terminal chemical modifications of the peptides listed in Table 2 include amide formation at the C-terminal carboxylic acid group of the C-terminal amino acid of the peptide in the form of an amide selected from the group consisting of:

- an amide of ammonia,
- an amide of a C_1 to C_{24} aliphatic alkyl amine,
- an amide of a hydroxyl-substituted C_2 to C_{24} aliphatic alkyl amine,
- an amide of a linear 2-(C1 to C24 aliphatic alkyl)oxyethylamine group, and
- an amide of an omega-methoxy-poly(ethyleneoxy)$_n$-ethylamine group, where n is from 0 to 10.

[0076] In addition, the C-terminal carboxylic acid group of the C-terminal amino acid of the peptide is optionally in the form of an ester selected from the group consisting of:

- an ester of a C_1 to C_{24} aliphatic alkyl alcohol,

- an ester of a 2-(omega-methoxy-poly(ethyleneoxy)$_n$)-ethanol group, where n is from 0 to 10, and
- an ester of a linear PEG-amine, the PEG component of molecular weight from 1,000 to 25,000 Daltons.

[0077] In one embodiment, aliphatic portions of groups such as carboxylic acid groups and sulfonic acid groups and alcohol and amino groups can comprise a ring of at least C3 (i.e., at least a cyclopropyl ring).

[0078] In one embodiment, the peptide can be N-terminally modified, for example, by an acetyl group or a myristoyl group, as an N-terminal amide, such as Acetyl-GAQFSKTAAK (N-terminal acetyl SEQ ID No: 106) and myristoyl-GAQFSKTAAK (N-terminal myristoyl SEQ ID No: 106), respectively. In another embodiment, the peptide can be C-terminally modified (for example by an amide with ammonia) such as GAQFSKTAAK-NH_2 (SEQ ID No: 106 C-terminal amide). In another embodiment, the peptide can be N-terminally modified and C-terminally modified, for example as N-acetyl-peptide-C-amide (with ammonia) such as Acetyl-GAQFSKTAAK-NH_2. (N-terminal acetyl SEQ ID No: 106 C-terminal amide) and Myristoyl-GAQFSKTAAK-NH_2 (N-terminal myristoyl SEQ ID No: 106 C-terminal amide). These peptides can be used in the methods of this invention and to determine their ability to inhibit metastases of cancer cells.

[0079] In one embodiment, a peptide which may find use in this invention can be selected from the group of peptides which contain the amino acid sequence AKGE (SEQ ID No: 219). Such peptides include SEQ ID No: 1 through SEQ ID No: 54, SEQ ID No: 56 through SEQ ID No: 64, SEQ ID No: 67 through SEQ ID No: 75, SEQ ID No: 79 through SEQ ID No: 87, SEQ ID No: 93 through SEQ ID No: 100, SEQ ID No: 108 through SEQ ID No: 114, SEQ ID No: 124 through SEQ ID No: 129, SEQ ID No: 141 through SEQ ID No: 145, SEQ ID No: 159 through SEQ ID No: 162, SEQ ID No: 178 through SEQ ID No: 180, SEQ ID No: 198, SEQ ID No: 199, SEQ ID No: 219, and SEQ ID NO: 235. In one currently preferred embodiment, these peptides are myristoylated or acetylated at the N-terminal amino group.

[0080] In one embodiment, this invention discloses a method of attenuating the metastasis of a cancer cell toward an increasing concentration gradient of a chemotactic agent in a fluid or tissue, the method comprising treatment of said cancer cell with a migration-inhibiting

amount of a migration-modulating peptide and incubation of said cell with said peptide to form a migration-inhibited cancer cell, wherein the peptide is a MANS-related peptide.

[0081] In one aspect, the migration-modulating peptide is selected from the group consisting of MANS-related peptides. In another aspect, the MANS-related peptide comprises the amino acid sequence GAQFSKTAAK (SEQ ID No: 106).

[0082] In another aspect, the MANS-related peptide is selected from the group consisting of N-myristoyl-GAQFSKTAAKGEAAAERPGEAAVA (SEQ ID No: 1) N-myristoyl-GAQFSKTAAKGEAAAERPGEAAV (SEQ ID No: 2); N-myristoyl-GAQFSKTAAKGEAAAERPGEAA (SEQ ID No: 4); N-myristoyl-GAQFSKTAAKGEAAAERPGEA (SEQ ID No: 7); N-myristoyl-GAQFSKTAAKGEAAAERPGE (SEQ ID No: 11); N-myristoyl-GAQFSKTAAKGEAAAERPG (SEQ ID No: 16); N-myristoyl-GAQFSKTAAKGEAAAERP (SEQ ID No: 22); N-myristoyl-GAQFSKTAAKGEAAAER (SEQ ID No: 29); N-myristoyl-GAQFSKTAAKGEAAAE (SEQ ID No: 37); N-myristoyl-GAQFSKTAAKGEAAA (SEQ ID No: 46); N-myristoyl-GAQFSKTAAKGEAA (SEQ ID No: 56); N-myristoyl-GAQFSKTAAKGEA (SEQ ID No: 67); N-myristoyl-GAQFSKTAAKGE (SEQ ID No: 79); N-myristoyl-GAQFSKTAAKG (SEQ ID No: 92); N-myristoyl-GAQFSKTAAK (SEQ ID No: 106); N-myristoyl-GAQFSKTAA (SEQ ID No: 121); N-myristoyl-GAQFSKTA (SEQ ID No: 137); N-myristoyl-GAQFSKT (SEQ ID No: 154); N-myristoyl-GAQFSK (SEQ ID No: 172), N-myristoyl-GAQFS (SEQ ID No: 191), N-myristoyl-GAQF (SEQ ID No: 211), N-acetyl-RGAQFSKTAAK (SEQ ID No: 234), N-acetyl-RGAQFSKTAAK-NH2 (SEQ ID No: 234), N-acetyl-RAKGE (SEQ ID NO: 235), and a combination thereof.

[0083] In another aspect, the MANS-related peptide is selected from the group consisting of:

- N-myristoyl-GAQFSKTAAKGEAAAERPGEAAVA (SEQ ID No: 1; MANS peptide);
- N-myristoyl-GAQFSKTAAK (SEQ ID No: 106; BIO-11000);
- N-acetyl-GAQFSKTAAK (SEQ ID No: 106; BIO-11006);
- N-acetyl-GAQFSKTAAK-NH2 (SEQ ID No: 106; BIO-11026);
- N-myristoyl-AKGE (SEQ ID No: 219; BIO-91200);
- N-myristoyl-GAQFSKTAAK-NH2 (SEQ ID No: 106; BIO-11002);

- N-acetyl-GAQFSKTAA (SEQ ID No. 121; BIO-10901)
- N-acetyl-RGAQFSKTAAK (SEQ ID No: 234; BIO-11027)
- N-acetyl-RGAQFSKTAAK-NH2 (SEQ ID No: 234; BIO-11028), and
- N-acetyl-RAKGE (SEQ ID NO: 235; BIO-91204).

[0084] In one aspect, the metastasis-inhibiting dose of a peptide of this invention can be in the range of about 0.01 mg/kg/day to about 10 mg/kg/day. In a further embodiment, the metastasis-inhibiting dose of a peptide is about 0.1 mg/kg/day to about 5.0 mg/kg/day. In a yet further embodiment, the metastasis-inhibiting dose of a peptide is about 0.5 mg/kg/day to about 2.5 mg/kg/day. For example, the metastasis-inhibiting dose of a peptide of this invention is about 0.01, about 0.05, about 0.1, about 0.5, about 0.75, about 1.0, about 1.25, about 1.5, about 1.75, about 2.0, about 2.25, about 2.5, about 2.75, about 3.0, about 3.5, about 4.0, about 5.0, about 6.0, about 7.0, about 8.0, about 9.0, about 10.0, or more mg/kg/day.

[0085] In one embodiment, this invention provides a method for inhibiting metastasis of a cancer cell, wherein the administration is by oral, intravenous, intraperitoneal, intramuscular, inhalation, or suppository routes. In another embodiment, this invention discloses a method for inhibiting metastasis of a cancer cell, wherein the administration is by inhalation of a liquid solution or suspension or dry powder formulation of the MARCKS-inhibitory compound. In one embodiment, a method for treating cancer is provided, wherein a MARCKS-inhibitory compound is administered to a subject in need thereof by inhalation of a liquid solution or suspension or dry powder formulation of the MARCKS-inhibitory compound. For example, in one embodiment, a MANS-related peptide is administered to a subject in need thereof by inhalation of a liquid solution or suspension or dry powder formulation of the MANS-related peptide. In another embodiment, a MANS-related peptide is administered by intravenous, intraperitoneal, or intramuscular injection, or by oral or suppository administration.

[0086] In another aspect, this invention discloses a method for inhibiting metastasis of a cancer cell, or treating cancer in a subject in need thereof, wherein the MANS-related peptide is administered is by injection of a liquid formulation of the peptide, and wherein the liquid formulation is isotonic, and wherein the liquid or suspension formulation is buffered, and wherein the injection is systemic into a subject. In another embodiment, the injection is into the region of a tumor. In another embodiment, the injection is into the tumor.

[0087] In another aspect, this invention discloses a method for inhibiting metastasis of a cancer cell, wherein the cancer cell resides in a mammal. In one embodiment, a method for treating cancer is provided, wherein a MANS-related peptide is administered to the subject in need thereof, and wherein the subject has a tumor. The peptides of this invention can be formulated using one or more pharmaceutically acceptable excipients or ingredients to provide pharmaceutical compositions useful for administration to cancer cells, such as cancer cells in a primary tumor. Such compositions can be as solutions or suspensions in a liquid, especially in buffered solution, wherein phosphate buffer is useful, when administration by injection or by inhalation is useful. Isotonic solutions or suspensions are preferred embodiments.

[0088] It is anticipated that administration of an antibody, polynucleotide, nucleic acid molecule, or peptide composition of this invention in mammals such as canines, felines, and human patients, can be effective if done by injection into a primary tumor region (e.g., directly into a primary tumor, or into a margin of a primary tumor, or into a blood vessel feeding a primary tumor) in the mammal, wherein the injection is done at regular intervals (for example, every 1 to every 72 hours), optionally in combination with or separately with one or more other or additional chemotherapy drugs.

[0089] One or more additional therapeutic agents, including chemotherapeutic drugs and cancer specific antibodies, can be administered in addition to the MARCKS-inhibitory antibody, polynucleotide, nucleic acid molecule, or peptide formulation, before, during, or after the peptide administration. Exemplary chemotherapeutic drugs include, but are not limited to, carboplatin, cisplatin, oxaliplatin, cyclophosphamide, dacarbazine, temozolomide, gemcitabine, capecitabine, cladribine, clofarabine, cytarabine, floxuridine, fludarabine, hydroxyurea, methotrexate, pemetrexed, pentostatin, thioguanadine, daunorubicin, doxurubicin, epirubicin, idarubicin, topotecan, irinotecan, etoposide, eniposide, colchicine, vincristine, vinblastine, vinorelbine, paclitaxel, and docetaxel. . Exemplary cancer specific agents and antibodies include, but are not limited to, Afatinib, Aldesleukin, Alemtuzumab, Axitinib, Belimumab, Bevacizumab, Bortezomib , Bosutinib, Brentuximab vedotin, Cabozantinib, Canakinumab, Carfilzomib, Cetuximab, Crizotinib,Dabrafenib, Dasatinib, Denosumab, Erlotinib, Everolimus, Gefitinib, Ibritumomab tiuxetan, Ibrutinib, Imatinib, Ipilimumab, Lapatinib, Nilotinib, Obinutuzumab, Ofatumumab, Panitumumab, Pazopanib, Pertuzumab, Ponatinib, Regorafenib, Rituximab, Romidepsin, Ruxolitinib, Sipuleucel-T, Sorafenib, Temsirolimus,Tocilizumab, Tofacitinib,

Tositumomab, Trametinib, Trastuzumab, Vandetanib, Vemurafenib, Vismodegib, Vorinostat, and Ziv-aflibercept.

[0090] Administration may be, for example, by inhalation as a liquid or dry powder aerosol or spray, such as into the airways of a patient with cancer, which spray may form a coating on a tissue containing a cancer cell, or as a liquid for injection into a fluid or tissue containing or in contact with a cancer cell prior to metastasis. Use of a mild surface active agent such as a phospholipid is contemplated to assist solubilization and transmembrane uptake of the MANS-related peptide. Administration may also be, for example, by a dry powder, preferably a nanoparticulate or a microparticulate powder, applicable by sprinkling onto a tissue containing a cancer cell. Addition of a microparticulate carbohydrate carrier to the preparation of the peptide will facilitate inhalation delivery of nanoparticulate peptide into airways and epithelial tissue areas.

[0091] A preferred method of application of the MARCKS-inhibitory antibody, polynucleotide, nucleic acid molecule, or peptide composition comprises injection into tissue in or proximal to a tumor, which tumor contains a cancer cell prior to metastasis.

[0092] As used herein, the phrase "effective amount" or "therapeutically effective amount" refers to a nontoxic but sufficient amount of the compositions used in the practice of the invention that is effective to achieve the desired effect, *i.e.*, to inhibit metastasis and/or proliferation of a cancer cell, and/or to inhibit, treat, or prevent cancer in a subject in need thereof. Thus, the activity contemplated by the present methods includes both medical therapeutic and/or prophylactic treatment, as appropriate, including, for example, a reduction and/or alleviation of the signs, symptoms, or causes of a cancer. A therapeutically effective amount of compound of this invention is typically an amount such that when it is administered in a physiologically tolerable excipient composition, it is sufficient to achieve an effective intracellular concentration and local concentration in the tissue.

[0093] "Cancer" herein refers to or describes the physiological condition in mammals that is typically characterized by unregulated cell growth. Examples of cancer include but are not limited to carcinoma, lymphoma, blastoma, sarcoma (including liposarcoma, osteogenic sarcoma, angiosarcoma, endotheliosarcoma, lymphangiosarcoma, lymphangioendotheliosarcoma, leiomyosarcoma, rhabdomyosarcoma, fibrosarcoma, myxosarcoma, chondrosarcoma,), osteoclastoma, neuroendocrine tumors, mesothelioma,

chordoma, synovioma, schwanoma, meningioma, adenocarcinoma, melanoma, and leukemia or lymphoid malignancies. More particular examples of such cancers include squamous cell cancer (e.g. epithelial squamous cell cancer), lung cancer including small- cell lung cancer, non-small cell lung cancer, adenocarcinoma of the lung and squamous carcinoma of the lung, small cell lung carcinoma, cancer of the peritoneum, hepatocellular cancer, gastric or stomach cancer including gastrointestinal cancer, pancreatic cancer, glioblastoma, cervical cancer, ovarian cancer, liver cancer, bladder cancer, hepatoma, breast cancer, colon cancer, rectal cancer, colorectal cancer, endometrial or uterine carcinoma, salivary gland carcinoma, kidney or renal cancer, prostate cancer, vulval cancer, thyroid cancer, hepatic carcinoma, anal carcinoma, penile carcinoma, testicular cancer, esophageal cancer, tumors of the biliary tract, Ewing's tumor, basal cell carcinoma, adenocarcinoma, sweat gland carcinoma, sebaceous gland carcinoma, papillary carcinoma, papillary adenocarcinomas, cystadenocarcinoma, medullary carcinoma, bronchogenic carcinoma, renal cell carcinoma, hepatoma, bile duct carcinoma, choriocarcinoma, seminoma, embryonal carcinoma, Wilms' tumor, testicular tumor, lung carcinoma, bladder carcinoma, epithelial carcinoma, glioma, astrocytoma, medulloblastoma, craniopharyngioma, ependymoma, pinealoma, hemangioblastoma, acoustic neuroma, oligodendroglioma, meningioma, melanoma, neuroblastoma, retinoblastoma, leukemia, lymphoma, multiple myeloma, Waldenstrom's macroglobulinemia, myelodysplastic disease, heavy chain disease, neuroendocrine tumors, Schwanoma, and other carcinomas, head and neck cancer, myeloid neoplasias such as acute myelogenous leukemias, including AML with maturation, AML without differentiation, acute promyelocytic leukemia, acute myelomonocytic leukemia, and acute monocytic leukemias, myelodysplastic syndromes, and chronic myeloproliferative disorders, including chronic myelogenous leukemia, tumors of the central nervous system, e.g., brain tumors (glioma, neuroblastoma, astrocytoma, medulloblastoma, ependymoma, and retinoblastoma), solid tumors (nasopharyngeal cancer, basal cell carcinoma, pancreatic cancer, cancer of the bile duct, Kaposi's sarcoma, testicular cancer, uterine, vaginal or cervical cancers, ovarian cancer, primary liver cancer or endometrial cancer, tumors of the vascular system (angiosarcoma and hemangiopericytoma), hematologic neoplasias and neoplastic-like conditions for example, Hodgkin's lymphoma; non-Hodgkin's lymphomas (Burkitt's lymphoma, small lymphocytic lymphoma/chronic lymphocytic leukemia, mycosis fungoides, mantle cell lymphoma, follicular lymphoma, diffuse large B-cell lymphoma, marginal zone lymphoma, hairy cell leukemia and

lymphoplasmacytic leukemia), tumors of lymphocyte precursor cells, including B-cell acute lymphoblastic leukemia/lymphoma, and T-cell acute lymphoblastic leukemia/lymphoma, thymoma, tumors of the mature T and NK cells, including peripheral T-cell leukemias, adult T-cell leukemia/T-cell lymphomas and large granular lymphocytic leukemia, osteolytic bone cancers, and bone metastasis.

[0094] The present invention is further illustrated by reference to the following Examples. However, it should be noted that these Examples, like the embodiments described above, are illustrative and are not to be construed as restricting the scope of the invention in any way.

EXAMPLES

EXAMPLE 1. Peptide effects on migration of cancer cell lines

[0095] **Protocol for a migration assay**

[0096] CL1-5 cells, an aggressively metastatic cell line derived from a human adenocarcinoma, were cultured in RPMI 1640 media with 10% FBS, 37°C at 95% Oxygen/ 5% CO_2 until ready for use. Transwell plates (24-well, 8-um pore size; Costar, Cambridge, MA, USA) were used to conduct the migration assay. The lower chambers of the Transwell plates were filled with 600 µl of basal media containing 10% FBS. The cells ($1x10^5$) were pretreated with 50 or 100 µM of the indicated test peptide for 30 min, and then suspended in 100 µl of basal media containing 1% BSA and added to the upper chamber, and the cells then were incubated at 37°C for 12 hr. The cells on the upper surface of the filters were removed using cotton swabs, and the cells that migrated to the lower surface of the filters were washed, fixed, and stained with hematoxylin and counted under the microscope. The percent change in migration was determined by counting the number of cells that migrated to the lower surface of the filters. At least 3 separate microscopic fields were counted per membrane (n=4).

[0097] **Alternative transwell method**

[0098] Primary CL1-5 cells originated from human adenocarcinoma lung cancer . Transwell plates with 24-wells, 8-µ pore size (Costar, Cambridge, MA, USA) were used to conduct the migration assay. The lower chambers of the transwell plates were filled with 600 µL of basal media containing 10% FBS. The cells ($1-2x10^5$) were suspended in 100 µL of basal media containing 1% BSA. The test peptide at desired concentration was added to the upper chamber directly or after preincubation with cancer cells. The plates were then incubated at 37°C

for 12 hours. The cells on the upper surface of the filters were removed using cotton swabs. The cells that migrated to the lower surface of the filters were washed, fixed, and stained with hematoxylin and counted under the microscope. At least five separate microscopic fields are counted per membrane (n=3). The percent change in migration was determined by counting the number of cells that migrated to the lower surface of the filters.

[0099] The count means the actual number of cells which migrated to the lower chamber and counted by a light microscope at 40x magnification, presented as the mean number of cells in 10 randomly chosen fields for each treatment.

[00100] The "index" was calculated by dividing the number of cells that migrated in the presence of peptides by the number of cells that migrated randomly (control group). Index = control cell count / treated cells count. This calculation can reflect the extent that the migration of cells was blocked by 30 minute pretreatment with MANS-related peptides.

[00101] Figure 1 displays a cell count field of a negative control after a migration time of 12 hours.

[00102] Figure 2A displays a cell count field obtained after pretreatment with 50 μmolar of MANS peptide followed by a migration time of 12 hours.

[00103] Figure 2B displays a cell count field obtained after pretreatment with 100 μmolar of MANS peptide followed by a migration time of 12 hours.

[00104] Figure 3A displays a cell count field obtained after pretreatment with 50 μmolar of RNS peptide followed by a migration time of 12 hours.

[00105] Figure 3B displays a cell count field obtained after pretreatment with 100 μmolar of RNS peptide followed by a migration time of 12 hours.

[00106] Figure 4A displays a cell count field obtained after pretreatment with 50 μmolar of MANS-related peptide BIO-11002 (N-myristoyl – SEQ ID NO: 106 – NH2) followed by a migration time of 12 hours.

[00107] Figure 4B displays a cell count field obtained after pretreatment with 100 μmolar of MANS-related peptide BIO-11002 followed by a migration time of 12 hours.

[00108] Figure 5A displays a cell count field obtained after pretreatment with 50 μmolar of MANS-related peptide BIO-10901 (N-acetyl – SEQ ID NO: 121) followed by a migration time of 12 hours.

[00109] Figure 5B displays a cell count field obtained after pretreatment with 100 µmolar of MANS-related peptide BIO-10901 followed by a migration time of 12 hours.

[00110] Figure 6A displays a cell count field obtained after pretreatment with 50 µmolar of MANS-related peptide BIO-91200 (N-myristoyl – SEQ ID NO: 219) followed by a migration time of 12 hours.

[00111] Figure 6B displays a cell count field obtained after pretreatment with 100 µmolar of MANS-related peptide BIO-91200 followed by a migration time of 12 hours.

[00112] Figure 7A displays migrated cell numbers obtained 12 hours after pretreatment at 50 µmolar with MANS peptide, RNS peptide, and MANS-related test peptides BIO-11002 (SEQ ID NO: 6), BIO-10901 (SEQ ID NO: 121), and BIO-9120 (SEQ ID NO: 219), and control (no peptide). For MANS peptide, the cell number was approximately 40; for RNS peptide, the cell number was approximately 95; for BIO-11002 (SEQ ID NO: 106), the cell number was approximately 50); for BIO-10901 (SEQ ID NO: 121), the cell number was approximately 60; and for BIO-91200 (SEQ ID NO: 219), the cell number was approximately 65. Each of the MANS-related peptides MANS, BIO-11002, BIO-10901, and BIO-91200 demonstrated significantly reduced migrated cell numbers of the aggressive human NSCLC cell line (CL1-5) relative to control and to RNS random sequence peptide.

[00113] Figure 7B displays migrated cell numbers obtained 12 hours after pretreatment at 100 µmolar with MANS peptide, RNS peptide, and MANS-related test peptides BIO-11002 (SEQ ID NO: 106), BIO-10901 (SEQ ID NO: 121), and BIO-91200 (SEQ ID NO: 219), and control (no peptide). For MANS peptide, the cell number was approximately 20); for RNS peptide, the cell number was approximately 90; for BIO-11002 (SEQ ID NO: 106), the cell number was approximately 25; for BIO-10901 (SEQ ID NO: 121), the cell number was approximately 35; and for BIO-91200 (SEQ ID NO: 219), the cell number was approximately 40; for the control (no peptide), the cell number was approximately 90. Each of the MANS-related peptides MANS, BIO-11002, BIO-10901, and BIO-91200 demonstrated significantly reduced migrated cell numbers of the aggressive human NSCLC cell line (CL1-5) relative to control and to RNS random sequence peptide.

[00114] Figure 8A displays the migration index of aggressive human NSCLC cell line cells, wherein a higher value of the migration index signifies less migration after pretreatment with a peptide or peptide composition of the invention at 50 µmolar followed by 12 hours of

treatment according to the protocol. The following are the migration index values: control = 1; MANS peptide = approximately 2.5; RNS peptide = approximately 1.1; BIO-11002 = approximately 2.7; BIO-10901 = approximately 1.75; and BIO-91200 = approximately 1.7. Each of the MANS-related peptides MANS, BIO-11002, BIO-10901, and BIO-91200 demonstrated significantly increased migration index numbers relative to control and to RNS peptide.

[00115] Figure 8B displays the migration index of aggressive human NSCLC cell line cells, wherein a higher value of the migration index signifies less migration after pretreatment with a peptide or peptide composition of the invention at 100 µmolar followed by 12 hours of treatment according to the protocol. The following are depicted migration index values: control = 1; MANS peptide = approximately 4.3; RNS peptide = approximately 1; BIO-11002 =approximately 3.8; BIO-10901 = approximately 2.7; and BIO-91200 = approximately 2.4. Each of the MANS-related peptides MANS, BIO-11002, BIO-10901, and BIO-91200 demonstrated significantly increased migration index numbers relative to control and to RNS peptide.

[00116] Figure 9 graphically displays side-by-side respective cell numbers and migration index number results of 50 µmolar peptide pretreatment in experiments using the aggressive human NSCLC cell line (CL1-5). Control with no peptide pretreatment gives a cell number of approximately 105; and migration index number = 1.0 Results after 50 µmolar pretreatment with MANS peptide followed by 12 hours according to the protocol gives a cell number of approximately 45; and migration index of approximately 2.5. Results after 50 µmolar pretreatment with RNS peptide gives a cell number of approximately 90; and migration index of approximately 1.3. Results after 50 µmolar pretreatment with BIO-11000 gives a cell number of approximately 70; and migration index of approximately 1.5. Results after 50 µmolar pretreatment with BIO-11006 give cell number of approximately 50; and migration index of approximately 2. The results demonstrate that higher values of migration index are associated with less migration, and less migration is associated with higher values of migration index. Each of the MANS-related peptides MANS, BIO-11000, and BIO-11006 demonstrated decreased migrated cell numbers and increased migration index numbers relative to control and to RNS peptide.

[00117] Figure 10 graphically displays side-by-side respective cell numbers and migration index number results for 100 µmolar peptide pretreatment in experiments using the aggressive human NSCLC cell line (CL1-5). Control with no peptide pretreatment gives a cell number of

approximately 105; and migration index number = 1.0. Results after 100 µmolar pretreatment with MANS peptide followed by 12 hours according to the protocol to gives a cell number of approximately 35; and migration index of approximately 3.5. Results after 100 µmolar pretreatment with RNS peptide gives a cell number of approximately 95; and migration index of approximately 1.2. Results after 100 µmolar pretreatment with BIO-11000 gives a cell number of approximately 50; and migration index of approximately 2.3. Results after 100 µmolar pretreatment with BIO-11006 gives a cell number of approximately 50; and migration index of approximately 2.1. Results after 100 µmolar pretreatment with BIO-91200 gives a cell number of approximately 55; and migration index of approximately 2.1. The results demonstrate that higher values of migration index are associated with less cell migration, and less cell migration is associated with higher values of migration index. Each of the MANS-related peptides MANS, BIO-11000, BIO-11006, and BIO-91200 demonstrated decreased migrated cell numbers and increased migration index numbers relative to control and to RNS peptide.

EXAMPLE 2. Inhibition of lung cancer metastasis by MANS peptide or BIO-11006 using orthotopic lung injection xenograph model.

[00118] The metastatic activity of cancer cells in vivo after treatment with MANS peptide or BIO-11006 was assessed in the orthotopic lung injection xenograph model. After pretreatment with either PBS, or PBS + MANS, BIO-11006 (SEQ ID NO: 106), or the control RNS peptide at 100µM for 4 hours, PC-9 cells were injected into the left lobe of the lung of nude mice. Seven days later, these mice were given systemic treatment with either PBS only (Con), RNS (additional control peptide), MANS or BIO-11006 at 50 nmoles per intraperitoneal injection once every three days. At 25 days (6 injections) post - seeding of these tumor cells, mice were sacrificed and the number of metastasized tumor nodules in the contralateral lung and other organs was counted. As shown in Table 3 below, MANS, RNS or BIO-11006 - treated groups showed no difference in average size of the tumor at the site of injection compared to PBS – treated or to each other, suggesting that these treatments do not affect tumorigenesis. However, a significant decrease of metastatic nodules was noted in the contralateral lung and other organs in the MANS and BIO-11006 – treated mice compared to the PBS- or RNS-treated groups; in fact,

treatment with the MANS or BIO-11006 peptides essentially totally blocked all metastasis from the tumor to other lung sites as well as to other organs.

[00119] **Table 3.** The suppressive effect of MARCKS-related peptides on cancer metastasis *in vivo*

Group	Tumor Size (mm)	No. of Metastatic Lung Tumors	Metastases (affected mice/total mice)			
	Mean ±SE	Mean ±SE (L't; R't)	Heart	Spleen	Intestines	Diaphragm
PBS (n=3)	1.50±0.26	1.67±0.29; 5.67±0.77	1/1	2/3	1/3	2/3
RNS (n=4)	1.72±0.41	1.00±0.40; 5.75±2.01	3/4	2/4	1/4	3/4
MANS (n=4)	1.48±0.54	0;0	0/4	0/4	0/4	0/4
BIO-11006 (n=2)	1.61±0.37	0;0	0/2	0/2	0/2	0/2

[00120] These *in vivo* results support the concept that inhibition of MARCKS function by MANS-related peptides can reduce the metastatic spread of lung cancer cells *in vivo*.

EXAMPLE 3. Peptide effects on migration of cancer A549 cell lines

[00121] The human adenocarcinoma-derived alveolar epithelial cell line A549 (an invasive cell line) was obtained from the American Type Culture Collection (ATCC) and was cultured in RPMI-1640 supplemented with 10 % fetal bovine serum and 100 U/ml penicillin/streptomycin, in 75 cm^2 tissue culture flasks. The cells reached confluence by the third day of culture at 37°C in an atmosphere of 95% air and 5% CO_2 and were maintained by serial passage.

[00122] The test peptides (MANS, RNS, BIO-11006, BIO-11000, BIO-11002, BIO-91200, and BIO-10901) were dissolved in PBS at a pH of 7.0; slow vortex mixing for about two hours aided solubility.

[00123] Transwell plates (24-well, 8-μM pore size; Costar, Cambridge, MA, USA) were used to conduct the migration assay. The lower chambers of the transwell plates were filled with 600 μl of basal medium containing 10% FBS. The cells ($1x10^5$) were suspended in 100 μl of basal medium containing 1% BSA and added to the upper chamber, and the plates incubated at

37°C with 5% CO_2 for 12 hr in PBS (control), or the indicated test peptides at 10, 25 or 50 μM. The cells on the upper surface of the filters were removed using cotton swabs. The cells that migrated to the lower surface of the filters were washed, fixed, and stained with hematoxylin and counted under the microscope. The percent change in migration is determined by counting the number of cells that migrated to the lower surface of the filters. At least four separate microscopic fields are counted per membrane, with a total of three replicate experiments at each concentration. The statistics software "Prizm" was used for data analysis.

[00124] As shown in Figure 11, treatment with each of the test peptides resulted in a reduced cell number after treatment relative to control (no peptide) or to RNS peptide. At 50μm, each of the MANS-related peptides MANS, BIO-11006, BIO-11000, BIO-11002, BIO-91200, and BIO-10901 demonstrated decreased migrated cell numbers and increased migration index numbers relative to control and to RNS peptide. At lower concentrations, the effect of several MANS-related peptides was significantly different even in comparison to MANS peptide. In particular, at 25μm, treatment with BIO-11006, BIO-11002, or BIO-91200 resulted in a significantly reduced cell numbers in comparison to control (no peptide) or control RNS peptide, as well as in comparison to MANS peptide (Figure 11).

[00125] Taken together, the results of the studies showed that the MANS-related peptides can block migration of aggressive cancer cell lines, and that several different MANS-related peptides exhibited an effect on migration of at least three different cancer cell lines. The results of the studies also showed that at least two different MANS-related peptides were able to block or inhibit metastasis of cancer cells injected into mammals (i.e., mice).

EXAMPLE 4. Effects of peptide BIO-11006 in lung cancer implantation

[00126] In this study, inhibition of lung cancer metastasis by peptide BIO-11006 in an orthotopic lung cancer implantation model in SCID mice assessed. Human adenocarcinoma cells (PC-9) (1-2 x 10^5) were suspended in 40 μL of PBS, pH 7.4 containing 0.5 mg/mL of Matrigel™ (BD Bioscience) and injected into the left lung of SCID mice (n=3) using a syringe with 29 gauge needle. BIO-11006 (100 μM, in PBS) was administered either (a) by i.p. injection (50 μL) once daily for 22 days starting at 3 days post cancer cell inoculation or (b) by aerosol inhalation using a Nebulizer Delivery System (Aeroneb Lab) over 30 min once daily for 22 days starting at 3 days post cancer cell inoculation. The results of the study are depicted in Figure 12,

which graphically displays the average number of tumors in the right lung, heart, and diaphragm as a function of the route of administration of the test compound (ip injection versus inhalation). Both i.p. and aerosol administration of BIO-11006 reduced cancer cell metastasis by more than 50% in the right lung and heart, and 100% in the diaphragm. Thus, both routes of administration had significant inhibitory effects on cancer cell metastasis.

EXAMPLE 5. Inhibition of lung cancer metastasis

[00127] In this study, inhibition of lung cancer metastasis by BIO-11006 was investigated in an orthotopic lung cancer implantation model in SCID mice. Human adenocarcinoma cells (PC-9) (1-2 x 10^5) were suspended in 40 µL of PBS containing 0.5 mg/mL of Matrigel™ (BD Bioscience) and injected into the left lung of SCID mice (n=3) using a 29 gauge needle. BIO-11006 was administered starting either 4 days or 15 days post cancer cell inoculation by aerosol using 100 µM solution in PBS by Nebulizer Delivery System (Aeroneb Lab) over 30 min once daily for 25 days post cancer cell inoculation. At end of the experiment, the mice were sacrificed and lungs, heart, and diaphragm tissues collected and number of tumor nodules in each tissue measured. The results of this experiment are presented graphically in Figures 13 and 14. Figure 13 shows that when the treatment was started at 4 days post inoculation of cancer cells, the tumor metastasis was inhibited by 60-90% in the left lung, heart, and diaphragm, and by 100% in the right lung. When the treatment was initiated at 15 days post inoculation of cancer cells, the inhibition of tumor metastasis was about 50% in the lungs, heart, and diaphragm. Figure 14 depicts the total number of tumor nodules found in all tissues when peptide treatment was started at 15 days post cancer cell inoculation or 4 days post cancer cell inoculation. As shown in Figure 14, peptide treatment starting at 15 days post cancer cell inoculation resulted in reduced tumor nodules, and peptide treatment starting at 4 days post inoculation resulted in even further reduced tumor nodules.

EXAMPLE 6. Anti-metastatic efficacy of peptides

[00128] This example demonstrates the anti-metastatic efficacy of test compounds of the invention in SCID mice bearing human lung adenocarcinoma cells. Female NOD.CB17-Prkdc^{scid}/NCrHsd, *Mus musculus* mice (Harlan, The Netherlands), housed in individually ventilated cages, were randomized into six groups of eight mice each. A549 cells (2.5 x 10^6)

were injected into the mice via the tail vein. The control group received aerosolized vehicle PBS; while the groups 2 and 3 received the aerosolized test compound BIO-11006 either from -1 day before the cancer cells injection (group 2) or from +3 days after the cancer cell injection (group 3) on every other day for 7 weeks via nebulizer (Aeroneb Lab). Groups 4 and 5 received the aerosolized test compound MANS peptide either from -1 day before the cancer cell line injection (group 4) or from +3 days after the cell line injection (group 5) on every other day for 7 weeks via a nebulizer (Aeroneb Lab). For aerosol delivery, solution of each test compound (100 μM) was prepared in PBS, pH 7.0. For each treatment, 5 mL of test compound solution was aerosolized over 30 minutes into a chamber containing four mice at a time. The mice were monitored for body weight every other day for 7 weeks.

[00129] One group of mice (n=7) served as normal control. These were untreated naïve mice used to monitor the health status of mice during the study period. All animals from all groups were sacrificed on Day 53. The results are provided in Table 4 and Figure 15. Figure 15 compares number of metastatic nodules in lungs after respective administration of BIO-11006 and MANS peptide on Day 53 following A549 cell injection. Table 4 shows the number of metastatic nodules in the lungs, as well as the number of animals with focal tumor nodules and/or distant metastasis. Overall, the test peptides showed substantial inhibition of tumor metastasis (70-80%) in animals administered BIO-11006 or MANS peptide starting on day -1 or Day +3 relative to A549 cell injection (Figure 15). Moreover, the number of metastatic nodules in treated mice was significantly reduced relative to vehicle control recipients, and none of the treated mice exhibited evidence of distant metastases (Table 4). There were few focal tumor nodules in 7/8 of mice treated with BIO-11006 peptide starting at either Day -1 or Day +3 relative to A549 cell injection.

Table 4. Metastatic nodules and distant metastasis in mice treated with BIO-11006 or MANS

Group	No. of metastatic nodules in lungs Mean ± SEM	Remarks
Vehicle Control	97±21	Multi-focal tumor nodules in all animals (8/8) Evidence of distant metastasis in

		diaphragm and sternum (2/8)
BIO-11006 peptide (-1 Day treatment group)	34±14	Few focal tumor nodules in 7/8 animals No distant metastasis
BIO-11006 peptide (+3 Day treatment group)	21±6	Few focal tumor nodules in 7/8 animals No distant metastasis
MANS peptide (-1 Day treatment group)	22±7	Few focal tumor nodules in 4/8 animals No distant metastasis
MANS peptide (+3 Day treatment group)	13±4	Few focal tumor nodules in 7/8 animals No distant metastasis

EXAMPLE 7. Anti-metastatic activity of MANS-related peptides in murine melanoma

[00130] In this study, the relative anti-metastatic activity of MANS-related peptides administered by four different routes is determined using a syngeneic mouse model. Murine melanoma cell line B16F10 2 $X10^6$ cells in 200µl of cell suspension in DMEM media is injected in the footpad or between the skin and cartilage on the dorsal side of the ear; or by intravenous, intramuscular, or intraperitoneal injection..

[00131] Two days after cell inoculation, animals are randomized and divided into groups consisting of n=10 in each group. Animals in different groups are administered with MANS-related peptide by intraperitoneal (ip), intravenous (iv), or intramuscular (im) routes respectively at a dose of about 6.25 mg/kg. In some groups, animals are treated by inhalation route (5ml of 0.1mM MANS-related peptide in PBS) using preclinical nebulizer (Aeroneb Lab; Aerogen). One group of mice serves as vehicle control and treated with PBS by im route. Peptides are administered every other day for 6 weeks.

[00132] Tumor scoring is done weekly. After 6 weeks of treatment, all animals are humanely sacrificed and the lymph nodes & other tissue samples are collected, fixed in formalin and subjected to histopathology to assess the presence of metastatic melanoma cells. Clinical

toxic signs and symptoms are assessed during the 6 wee administration period. Tumor burden and mortalities are assessed at the end of the study period. The results of the study will show that MANS-related peptides inhibit tumor metastasis in a murine melanoma model.

EXAMPLE 8: siRNA knockdown of MARCKS in cancer cells

[00133] This study was conducted to determine the effects of siRNA knockdown of MARCKS expression on migration of cancer cells. PC- 9 or A-549 human lung cancer cells were seeded in plastic wells and cultured until cells reached 70% confluence. Cells were then transfected with 100nM of MARCKS siRNA or control siRNA (100nM) from Ambion (Austin, TX) by using the DharmaFECT DuoTransfection reagent (Dharmacon, Lafayette, CO). After 72 hours, the cells were harvested and equivalent amounts of proteins separated by SDS/PAGE for immunoblot analysis using MARKS specific antibodies. Western blot analysis was performed to confirm siRNA-induced down regulation of endogenous MARCKS. As shown in Figures 16 and 17, MARCKS protein was knocked down by approximately 60% in PC9 cells (Figure 16) and approximately 50% in A549 cells (Figure 17) compared to cells treated with control siRNA.

[00134] The effects MARCKS knockdown by siRNA on cell migration were determined using a transwell assay. Following siRNA knockdown, PC-9 or A549 cells were cultured in RPMI 1640 medium with 10% FBS at 37°C, with 5% CO2. Transwell ® plates (24-well, 8-um pore size) were used for the migration assays. The lower chambers contained 600 µl basal medium + 10% FBS. Cells ($1x10^5$) were suspended in 100 µl of basal medium + 1% BSA and added to the upper chamber; plates were incubated for 12 hr. Cells that migrated to the lower surface of the filters were stained with hematoxylin and counted. At least 3 separate microscopic fields were counted per membrane.

[00135] The results of the study are shown in Figures 18 and 19. Treatment with MARCKS siRNA significantly inhibited migration of both PC-9 and A549 cells. siRNA knockdown of MARCKS resulted in 90% reduction in cell migration for PC9 cell line (Figure 18) and resulted in approximately 50% reduction in cell migration for A549 cell line (Figure 19). Therefore, inhibition of MARCKS expression results in significant reduction in cancer cell migration.

EXAMPLE 9. microRNA21 inhibition increases MARCKS and enhances cancer cell migration

[00136] MicroRNA 21 (miR21) regulates levels of MARCKS in cells. In these studies, PC9 human lung cancer cells were transfected with 50 nM or 100 nM of miR21 inhibitor or a mir21 mimic, or a vehicle-only negative control. Levels of MARCKS were measured 48 hours later by Western Blot. Treatment with the miR21 inhibitor (50nM) increased levels of MARCKS in the cells by ~ 2.5 fold (Figure 20). These values correlated with the migration capability of the cells when placed in migration chambers over a 12 hour period. Cells treated with the miR21 inhibitor at 50 or 100 nM showed enhanced migration correlating with increased levels of MARCKS, while cells treated with miR21 mimic showed decreased migration correlating with decreased levels of MARCKS (Figure 21). Cells treated with HiPerfect vehicle control showed the same level of migration relative to untreated PC9 cells (Figure 21). The results of the study showed that an increase in MARCKS expression via miR21 inhibition increases cancer cell migration. Moreover, activation of miR21 resulted in decreased migration of PC9 cells.

[00137] Taken together, the studies showed that cancer cell migration, and metastasis of cancer cells, can be inhibited by targeting MARCKS using several different means of MARCKS inhibition, including MANS-related peptides and inhibitory microRNAs, i.e., a miR21 mimic.

[00138] Unless defined otherwise, all technical and scientific terms herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although any methods and materials, similar or equivalent to those described herein, can be used in the practice or testing of the present invention, the preferred methods and materials are described herein. All publications cited herein are incorporated herein by reference for the purpose of disclosing and describing specific aspects of the invention for which the publication is cited.

[00139] While the invention has been described in connection with specific embodiments thereof, it will be understood that it is capable of further modifications and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice within the art to which the invention pertains and as may be

applied to the essential features hereinbefore set forth and as follows in the scope of the appended claims.

CLAIMS

1. A method for treating or preventing cancer comprising administration of a MARCKS-inhibitory compound to a cancer cell or to other cells that play roles in the development, maintenance, proliferation, or metastasis of cancer cells.

2. The method of claim 1, wherein the method for treating or preventing cancer comprises treating, preventing, or inhibiting metastasis, cancer cell proliferation, tumor growth, or angiogenesis.

3. The method of claim 1, wherein the MARCKS-inhibitory compound is a peptide.

4. The method of claim 1, wherein the MARCKS-inhibitory compound is a peptide having an amino acid sequence selected from the group consisting of SEQ ID NO: 1 to SEQ ID NO: 231, SEQ ID NO: 234, and SEQ ID NO: 235; wherein the N-terminal and/or C-terminal amino acid of the peptide sequence is optionally chemically modified.

5. The method of claim 4, wherein the N-terminal amino acid of the peptide is chemically modified by acylation of the N-terminal amino acid of the peptide in the form of an amide selected from the group consisting of:

an amide of a C_2 (acetyl) to C_{24} aliphatic carboxylic acid which may be linear, branched, saturated, or unsaturated,

an amide of trifluoroacetic acid,

an amide of benzoic acid, and

an amide of a C_1 to C_{24} aliphatic alkyl sulfonic acid; or

the N-terminal amine group of the N-terminal amino acid of the peptide can be alkylated with a group selected from the group consisting of:

a C_1 to C_{24} aliphatic alkyl group,

a linear 2-(C_1 to C_{24} aliphatic alkyl)oxyethyl group,

an omega-methoxy-poly(ethyleneoxy)$_n$-ethyl group, where n is from 0 to 10.

6. The method of claim 5, wherein the N-terminal amide is selected from the group consisting of acetyl and myristoyl.

7. The method of claim 4, wherein the peptide comprises a substitution of d-configuration amino acids.

8. The method of claim 4, wherein the administration is by inhalation of a liquid solution or suspension, or by inhalation of a dry powder formulation of the peptide.

9. The method of claim 4, wherein the administration is by injection of a liquid formulation of the peptide.

10. The method of claim 1, wherein the MARCKS-inhibitory compound is administered to a subject by intravenous, intramuscular, or intraperitoneal injection or by oral or suppository administration.

11. The method of claim 10, wherein the injection is into a tumor containing the cancer cell.

12. The method of claim 10, wherein the injection is systemic.

13. The method of claim 11, wherein the tumor is a solid tumor.

14. The method of claim 11, wherein the tumor is a non-solid tumor.

15. The method of claim 4, wherein the C-terminal amino acid of the peptide is chemically modified by amide formation at the C-terminal carboxylic acid group of the C-terminal amino acid of the peptide in the form of an amide selected from the group consisting of:

an amide of ammonia,

an amide of a C_1 to C_{24} aliphatic alkyl amine,

an amide of a hydroxyl-substituted C_2 to C_{24} aliphatic alkyl amine,

an amide of a linear 2-(C1 to C24 aliphatic alkyl)oxyethylamine group, and

an amide of an omega-methoxy-poly(ethyleneoxy)$_n$-ethylamine group, where n is from 0 to 10.

16. The method of claim 4, wherein the peptide is selected from the group consisting of N-acetyl-GAQFSKTAAK (SEQ ID No: 106; BIO-11006); N-myristoyl-AKGE (SEQ ID No: 219; BIO-91200); N-myristoyl-GAQFSKTAAK-NH2 (SEQ ID No: 106; BIO-11002); N-myristoyl-GAQFSKTAAK (SEQ ID No: 106; BIO-11000); N-acetyl-GAQFSKTAA (SEQ ID No: 121; BIO-10901); N-myristoyl-GAQFSKTAA (SEQ ID No: 121; BIO-10900); N-acetyl-

GAQFSKTAAK-NH2 (SEQ ID No: 106 121; BIO-11026); and acetyl-GAQFS(d)KTAA(d)K (SEQ ID No. 106; BIO-11037).

17. The method of claim 4, wherein the peptide is administered in a dose from between about 0.01 mg/kg/day to about 10 mg/kg/day.

18. The method of claim 17, wherein the peptide is administered in a dose from between about 0.5 mg/kg/day to about 2.5 mg/kg/day.

19. The method of claim 1, wherein the MARCKS-inhibitory compound is a polynucleotide or nucleic acid molecule.

20. The method of claim 19, wherein the polynucleotide or nucleic acid molecule is an siRNA or an miRNA.

21. A method for inhibiting metastasis of a cancer cell comprising administration to the cancer cell of a metastasis-inhibiting amount of a formulation of a peptide selected from the group consisting of N-myristoyl-GAQFSKTAAKGEAAAERPGEAAVA (SEQ ID No: 1); N-myristoyl-GAQFSKTAAKGEAAAERPGEAAV (SEQ ID No: 2); N-myristoyl-GAQFSKTAAKGEAAAERPGEAA (SEQ ID No: 4); N-myristoyl-GAQFSKTAAKGEAAAERPGEA (SEQ ID No: 7); N-myristoyl-GAQFSKTAAKGEAAAERPGE (SEQ ID No: 11); N-myristoyl-GAQFSKTAAKGEAAAERPG (SEQ ID No: 16); N-myristoyl-GAQFSKTAAKGEAAAERP (SEQ ID No: 22); N-myristoyl-GAQFSKTAAKGEAAAER (SEQ ID No: 29); N-myristoyl-GAQFSKTAAKGEAAAE (SEQ ID No: 37); N-myristoyl-GAQFSKTAAKGEAAA (SEQ ID No: 46); N-myristoyl-GAQFSKTAAKGEAA (SEQ ID No: 56); N-myristoyl-GAQFSKTAAKGEA (SEQ ID No: 67); N-myristoyl-GAQFSKTAAKGE (SEQ ID No: 79); N-myristoyl-GAQFSKTAAKG (SEQ ID No: 92); N-myristoyl-GAQFSKTAAK (SEQ ID No: 106); N-myristoyl-GAQFSKTAA (SEQ ID No: 121); N-myristoyl-GAQFSKTA (SEQ ID No: 137); N-myristoyl-GAQFSKT (SEQ ID No: 154); N-myristoyl-GAQFSK (SEQ ID No: 172), N-myristoyl-GAQFS (SEQ ID No: 191), N-myristoyl-GAQF (SEQ ID No: 211), N-acetyl-RGAQFSKTAAK (SEQ ID No: 234), N-acetyl-RGAQFSKTAAK-NH2 (SEQ ID No: 234), N-acetyl-RAKGE (SEQ ID NO: 235), and a combination thereof.

22. The method of claim 21, wherein the peptide is N-myristoyl-GAQFSKTAAK (SEQ ID No: 106).

23. The method of claim 21, wherein the administration is by inhalation of a liquid solution or suspension or dry powder formulation of the peptide.

24. The method of claim 21, wherein the administration is by injection of a liquid formulation of the peptide.

25. The method of claim 21, wherein the formulation comprises an additional drug useful in the treatment of cancer.

26. A method of treating or preventing cancer in a subject in need thereof, the method comprising administering to the subject a therapeutically effective amount of a MARCKS-inhibitory compound.

27. The method of claim 26, wherein the MARCKS-inhibitory compound is a peptide, a polynucleotide, a nucleic acid molecule, or an antibody.

28. The method of claim 27, wherein the MARCKS-inhibitory compound is an antisense RNA, siRNA, shRNA, or miRNA that inhibits MARCKS expression.

29. The method of claim 27, where the MARCKs inhibitory compound is an antibody or antibody fragment that inhibits the functions of the MARCKS protein.

30. The method of claim 27, where the MARCKS inhibitory compound is an antibody or antibody fragment that is directed at the N-terminal of the MARCKS protein or the MH2 sequence of the MARCKS protein.

31. The method of claim 27, wherein the peptide has an amino acid sequence selected from the group consisting of SEQ ID NO: 1 to SEQ ID NO: 231, SEQ ID NO: 234, and SEQ ID NO: 235; wherein the N-terminal and/or C-terminal amino acid of the peptide sequence is optionally chemically modified.

32. A method of treating cancer in a subject in need thereof, the method comprising administering a therapeutically effective amount of a peptide selected from the group consisting of N-myristoyl-GAQFSKTAAKGEAAAERPGEAAVA (SEQ ID No: 1); N-myristoyl-GAQFSKTAAKGEAAAERPGEAAV (SEQ ID No: 2); N-myristoyl-

GAQFSKTAAKGEAAAERPGEAA (SEQ ID No: 4); N-myristoyl-GAQFSKTAAKGEAAAERPGEA (SEQ ID No: 7); N-myristoyl-GAQFSKTAAKGEAAAERPGE (SEQ ID No: 11); N-myristoyl-GAQFSKTAAKGEAAAERPG (SEQ ID No: 16); N-myristoyl-GAQFSKTAAKGEAAAERP (SEQ ID No: 22); N-myristoyl-GAQFSKTAAKGEAAAER (SEQ ID No: 29); N-myristoyl-GAQFSKTAAKGEAAAE (SEQ ID No: 37); N-myristoyl-GAQFSKTAAKGEAAA (SEQ ID No: 46); N-myristoyl-GAQFSKTAAKGEAA (SEQ ID No: 56); N-myristoyl-GAQFSKTAAKGEA (SEQ ID No: 67); N-myristoyl-GAQFSKTAAKGE (SEQ ID No: 79); N-myristoyl-GAQFSKTAAKG (SEQ ID No: 92); N-myristoyl-GAQFSKTAAK (SEQ ID No: 106); N-myristoyl-GAQFSKTAA (SEQ ID No: 121); N-myristoyl-GAQFSKTA (SEQ ID No: 137); N-myristoyl-GAQFSKT (SEQ ID No: 154); N-myristoyl-GAQFSK (SEQ ID No: 172), N-myristoyl-GAQFS (SEQ ID No: 191), N-myristoyl-GAQF (SEQ ID No: 211), N-acetyl-RGAQFSKTAAK (SEQ ID No: 234), N-acetyl-RGAQFSKTAAK-NH2 (SEQ ID No: 234), N-acetyl-RAKGE (SEQ ID NO: 235), and a combination thereof.

33. A method for inhibiting metastasis of a cancer cell in a mammal comprising administering to said mammal a peptide, wherein said peptide exhibits a migration index of at least about 1.5 following pretreatment of NSCLC cells with a concentration of 50 μmol of said peptide and a migration period of 12 hours.

34. A method for inhibiting metastasis of a cancer cell in a mammal comprising administering to said mammal a peptide, wherein said peptide exhibits a migration index of at least about 2.0 following pretreatment of NSCLC cells with a concentration of 100 μmol of said peptide and a migration period of 12 hours.