pancreatic neuroendocrine tumors, advanced renal cell carcinoma, and subependymal giant cell astrocytoma (SEGA) associated with Tuberous Sclerosis. The mode of action of sirolimus is to bind the cytosolic protein FK-binding protein 12 (FKBP12), and the sirolimus-FKBP12 complex in turn inhibits the mTOR pathway by directly binding to the mTOR Complex 1 (mTORC1).

[0005] Albumin-based nanoparticle compositions have been developed as a drug delivery system for delivering substantially water insoluble drugs. *See*, for example, U. S. Pat. Nos.5,916,596; 6,506,405; 6,749,868, and 6,537,579, 7,820,788, and 7,923,536. Abraxane®, an albumin stabilized nanoparticle formulation of paclitaxel, was approved in the United States in 2005 and subsequently in various other countries for treating metastatic breast cancer. It was recently approved for treating non-small cell lung cancer in the United States, and has also shown therapeutic efficacy in various clinical trials for treating difficult-to-treat cancers such as bladder cancer and melanoma. Albumin derived from human blood has been used for the manufacture of Abraxane® as well as various other albumin-based nanoparticle compositions.

[0006] The disclosures of all publications, patents, patent applications and published patent applications referred to herein are hereby incorporated herein by reference in their entirety.

SUMMARY

[0006a] In a first aspect, there is provided use of an effective amount of a composition comprising nanoparticles comprising an mTOR inhibitor and an albumin in the manufacture of a medicament for treating a hematological malignancy in an individual, wherein said medicament is to be administered to an individual in combination with an effective amount of a second therapeutic agent, wherein the second therapeutic agent is selected from the group consisting of an immunomodulator, a histone deacetylase inhibitor, a kinase inhibitor, and a cancer vaccine.

[0007] The present disclosure provides methods of treating a hematological malignancy (such as lymphoma, leukemia, and myeloma) in an individual, comprising administering to the individual a) an effective amount of a composition comprising nanoparticles comprising an mTOR inhibitor (such as a limus drug, *e.g.*, sirolimus or a derivative thereof) and an albumin; and b) an effective amount of a second therapeutic agent. In some embodiments, the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) and the second therapeutic agent act synergistically to inhibit cell proliferation. In some embodiments, the mTOR inhibitor is a limus drug. In some embodiments, the mTOR inhibitor is sirolimus or a derivative thereof. In some embodiments, the mTOR inhibitor is sirolimus. In some embodiments, the albumin is human albumin (such as human serum albumin). In some embodiments, the nanoparticles comprise sirolimus or a derivative thereof associated (*e.g.*, coated) with albumin. In some embodiments, the nanoparticles comprise sirolimus or a derivative thereof coated with albumin. In some embodiments, the average particle size of the nanoparticles in the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) is no greater than about 150 nm (such as no greater than about 120

nm). In some embodiments, the average particle size of the nanoparticles in the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) is no more than about 120 nm. In some embodiments, the nanoparticles in the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) are sterile filterable. In some embodiments, the mTOR inhibitor nanoparticle composition comprises the albumin stabilized nanoparticle formulation of sirolimus (*nab*-sirolimus, a formulation of sirolimus stabilized by human albumin USP, where the weight ratio of human albumin and sirolimus is about 8:1 to about 9:1). In some embodiments, the mTOR inhibitor nanoparticle composition is *nab*-sirolimus. In some embodiments, the mTOR inhibitor nanoparticle composition is administered intravenously, intraarterially, intraperitoneally, intravesicularly, subcutaneously, intrathecally, intrapulmonarily, intramuscularly, intratracheally, intraocularly, transdermally, orally, or by inhalation. In some embodiments, the mTOR inhibitor nanoparticle composition is administered intravenously. In some embodiments, the mTOR inhibitor nanoparticle composition is administered subcutaneously. In some embodiments, the individual is a human.

[0008] In some embodiments, according to any of the use or methods described above, the second therapeutic agent is selected from the group consisting of an immunomodulator (such as an immunostimulator or an immune checkpoint inhibitor), a histone deacetylase inhibitor, a kinase inhibitor (such as a tyrosine kinase inhibitor), and a cancer vaccine (such as a vaccine prepared from a tumor cell or at least one tumor-associated antigen). In some embodiments, the second therapeutic agent is an immunomodulator. In some embodiments, the immunomodulator is an IMiDs® (small molecule immunomodulator, such as lenalidomide and pomalidomide). In some embodiments, the immunomodulator is small molecule or antibody-based IDO inhibitor. In some embodiments, the second therapeutic agent is an immunomodulator that stimulates the immune system (hereinafter also referred to as an "immunostimulator"). In some embodiments, the immunomodulator is an agonistic antibody that targets an activating receptor (including co-stimulatory receptors) on a T cell. In some embodiments, the immunomodulator is an immune checkpoint inhibitor. In some embodiments, the immune checkpoint inhibitor is an antagonistic antibody that targets an immune checkpoint protein. In some embodiments, the second therapeutic agent is an immunomodulator selected from the group consisting of pomalidomide and lenalidomide. In some embodiments, the second therapeutic agent is a histone deacetylase inhibitor. In some embodiments, the histone deacetylase inhibitor is selected from the group

consisting of romidepsin, panobinostat, ricolinostat, and belinostat. In some embodiments, the second therapeutic agent is a kinase inhibitor. In some embodiments, the kinase inhibitor is selected from the group consisting of nilotinib and sorafenib. In some embodiments, the second therapeutic agent is a cancer vaccine. In some embodiments, the cancer vaccine is a vaccine prepared from a tumor cell or a vaccine prepared from at least one tumor-associated antigen.

[0009] In some embodiments, according to any of the use or methods described above, the hematological malignancy is selected from the group consisting of multiple myeloma, mantle cell lymphoma, T cell lymphoma, chronic myeloid leukemia, and acute myeloid leukemia. In some embodiments, the hematological malignancy is a relapsed hematological malignancy. In some embodiments, the hematological malignancy is refractory to a standard therapy for the hematological malignancy. In some embodiments, the second therapeutic agent is an immunomodulator (such as an immunostimulator or an immune checkpoint inhibitor), a histone deacetylase inhibitor, a kinase inhibitor (such as a tyrosine kinase inhibitor), or a cancer vaccine (such as a vaccine prepared using tumor cells or at least one tumor-associated antigen).

[0010] In some embodiments, according to any of the use or methods described above, the hematological malignancy is multiple myeloma, and the second therapeutic agent is pomalidomide. In some embodiments, the hematological malignancy is mantle cell lymphoma, and the second therapeutic agent is lenalidomide. In some embodiments, the hematological malignancy is multiple myeloma, and the second therapeutic agent is romidepsin. In some embodiments, the hematological malignancy is T cell lymphoma, and the second therapeutic agent is romidepsin. In some embodiments, the hematological malignancy is chronic myeloid leukemia, and the second therapeutic agent is nilotinib. In some embodiments, the hematological malignancy is acute myeloid leukemia, and the second therapeutic agent is sorafenib.

[0011] In some embodiments, according to any of the use or methods described above, the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) and the second therapeutic agent are administered simultaneously. In other embodiments, the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) and the second therapeutic agent are not administered simultaneously. In some embodiments, the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) and the second therapeutic agent are administered sequentially.

[0012] In some embodiments, according to any of the use or methods described above, the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) and the second therapeutic agent are present in amounts that produce a synergistic effect in the treatment of a hematological malignancy (such as lymphoma, leukemia, and myeloma) in an individual in need thereof.

[0013] In some embodiments, according to any of the use or methods described above, the use or method is carried out in a neoadjuvant setting. In some embodiments, the use or method is carried out in an adjuvant setting.

[0014] In some embodiments, according to any of the use or methods described above, the hematological malignancy is refractory to a standard therapy or recurrent after the standard therapy. In some embodiments, the treatment is first line treatment. In some embodiments, the treatment is second line treatment.

[0015] In some embodiments, according to any of the use or methods described above, the individual has progressed from an earlier therapy for a hematological malignancy. In some embodiments, the individual is refractory to an earlier therapy for a hematological malignancy. In some embodiments, the individual has recurrent hematological malignancy.

[0016] In some embodiments, according to any of the use or methods described above, the amount of the nanoparticles in the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) is about 10 mg/m^2 to about 200 mg/m^2 (such as about any of 10, 20, 30, 45, 75, 100, 150, or 200 mg/m^2, including any range between these values). In some embodiments, the amount of the nanoparticles in the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) is about 45 mg/m^2. In some embodiments, the amount of the nanoparticles in the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) is about 75 mg/m^2. In some embodiments, the amount of the nanoparticles in the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) is about 100 mg/m^2. In some embodiments, the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) is administered weekly (such as 3 out of 4 weeks, *e.g.*, on days 1, 8, and 15 of a 28-day cycle). In some embodiments, the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) is administered at least twice (such as at least 2, 3, or 4 times) in a 28-day cycle for at least one (such at least 2, 3, 4, 5, 6, 7, 8, 9, 10, or more) cycle. In some

embodiments, the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) is administered at least twice (such as at least 2, 3, or 4 times) at weekly intervals in a 28-day cycle (such as on days 1, 8, and 15 of the 28-day cycle) for at least one (such at least 2, 3, 4, 5, 6, 7, 8, 9, 10, or more) cycle. In some embodiments, the mTOR inhibitor nanoparticle composition (such as sirolimus/albumin nanoparticle composition) is administered three times in a 28-day cycle (such as on days 1, 8, and 15 of the 28-day cycle) for at least one (such at least 2, 3, 4, 5, 6, 7, 8, 9, 10, or more) cycle.

[0017] Also provided are methods of treating a hematological malignancy according to any of the use or methods described above, wherein the treatment is based on the level of at least one biomarker. In some embodiments, the use or method further comprises selecting the individual for treatment based on the presence of at least one mTOR-activating aberration. In some embodiments, the mTOR-activating aberration comprises a mutation in an mTOR-associated gene. In some embodiments, the mTOR-activating aberration is in at least one mTOR-associated gene selected from the group consisting of protein kinase B (PKB/Akt), fms-like tyrosine kinase 3 internal tandem duplication (FLT-3ITD), mechanistic target of rapamycin (mTOR), phosphoinositide 3-kinase (PI3K), TSC1, TSC2, RHEB, STK11, NF1, NF2, Kirsten rat sarcoma viral oncogene homolog (KRAS), neuroblastoma RAS viral (v-ras) oncogene homolog (NRAS) and PTEN. In some embodiments, the treatment is based on the presence of at least one genetic variant in a gene selected from the group consisting of drug metabolism genes, cancer genes, and drug target genes.

[0018] In some embodiments, according to any of the use or methods described above, wherein the use or method comprises administration of an immunomodulator, the use or method further comprised selecting the individual for treatment based on the presence of at least one biomarker indicative of favorable response to treatment with an immunomodulator. In some embodiments, the at least one biomarker comprises a mutation in an immunomodulator-associated gene.

[0019] In some embodiments, according to any of the use or methods described above, wherein the use or method comprises administration of a histone deacetylase inhibitor, the use or method further comprised selecting the individual for treatment based on the presence of at least one biomarker indicative of favorable response to treatment with a histone deacetylase inhibitor (HDACi). In some embodiments, the at least one biomarker comprises a mutation in an HDAC-associated gene.

[0020] In some embodiments, according to any of the use or methods described above, wherein the use or method comprises administration of a kinase inhibitor, the use or method further comprised selecting the individual for treatment based on the presence of at least one biomarker indicative of favorable response to treatment with a kinase inhibitor. In some embodiments, the at least one biomarker comprises a mutation in a kinase-associated gene.

[0021] In some embodiments, according to any of the use or methods described above, the use or method further comprises selecting the individual for treatment based on the presence of at least one biomarker indicative of favorable response to treatment with a cancer vaccine. In some embodiments, the at least one biomarker comprises a tumor-associated antigen (TAA) expressed in tumor cells in the individual, such as an aberrantly expressed protein or a neo-antigen.

[0022] The use or methods described herein can be used for any one or more of the following purposes: alleviating one or more symptoms of a hematological malignancy, delaying progressing of a hematological malignancy, shrinking tumor size in a hematological malignancy patient, inhibiting hematological malignancy tumor growth, prolonging overall survival, prolonging disease-free survival, prolonging time to hematological malignancy progression, preventing or delaying metastasis, reducing (such as eradicating) preexisting metastasis, reducing incidence or burden of preexisting metastasis, and preventing recurrence of hematological malignancy.

DETAILED DESCRIPTION OF THE INVENTION

[0023] The present invention provides methods and compositions for treating a hematological malignancy (such as lymphoma, leukemia, and myeloma) in an individual by administering to the individual a composition comprising nanoparticles comprising an mTOR inhibitor (such as a limus drug, *e.g.*, sirolimus or a derivative thereof) and an albumin (hereinafter also referred to as an "mTOR inhibitor nanoparticle composition") in conjunction with a second therapeutic agent. The second therapeutic agent may be an immunomodulator (such as an immunostimulator or an immune checkpoint inhibitor), a histone deacetylase inhibitor, a kinase inhibitor (such as a tyrosine kinase inhibitor), or a cancer vaccine (such as a vaccine prepared from a tumor cell or a vaccine prepared from at least one tumor-associated antigen).

[0024] The present application thus provides methods of combination therapy. It is to be understood by a person of ordinary skill in the art that the combination therapy methods

CLAIMS

What is claimed is:

1. Use of an effective amount of a composition comprising nanoparticles comprising an mTOR inhibitor and an albumin in the manufacture of a medicament for treating a hematological malignancy in an individual, wherein said medicament is to be administered to an individual in combination with an effective amount of a second therapeutic agent, wherein the second therapeutic agent is selected from the group consisting of an immunomodulator, a histone deacetylase inhibitor, a kinase inhibitor, and a cancer vaccine.
2. The use of claim 1, wherein the hematological malignancy is multiple myeloma, mantle cell lymphoma, T cell lymphoma, chronic myeloid leukemia, or acute myeloid leukemia.
3. The use of claim 1 or claim 2, wherein the hematological malignancy is relapsed or refractory to a standard therapy for the hematological malignancy.
4. The use of any one of claims 1-3, wherein the amount of the mTOR inhibitor in the mTOR inhibitor nanoparticle composition is from about 10 mg/m^2 to about 150 mg/m^2.
5. The use of any one of claims 1-4, wherein the mTOR inhibitor nanoparticle composition is to be administered weekly or 3 out of every 4 weeks.
6. The use of any one of claims 1-5, wherein the mTOR inhibitor nanoparticle composition and the second therapeutic agent are to be administered sequentially or simultaneously to the individual.
7. The use of any one of claims 1-6, wherein the mTOR inhibitor is a limus drug.
8. The use of claim 7, wherein the limus drug is sirolimus.
9. The use of any one of claims 1-8, wherein the average diameter of the nanoparticles in the composition is no greater than about 150 nm.
10. The use of any one of claims 1-9, wherein the weight ratio of the albumin to the mTOR inhibitor in the nanoparticle composition is no greater than about 9:1.
11. The use of any one of claims 1-10, wherein the nanoparticles comprise the mTOR inhibitor coated with the albumin.
12. The use of any one of claims 1-11, wherein the mTOR inhibitor nanoparticle composition is to be administered intravenously.
13. The use of any one of claims 1-12, wherein the individual is human.

14. The use of any one of claims 1-13, wherein the individual is selected for treatment based on the presence of at least one mTOR-activating aberration.
15. The use of any one of claims 1-14, wherein the second therapeutic agent is an immunomodulator.
16. The use of any one of claims 1-14, wherein the second therapeutic agent is a histone deacetylase inhibitor.
17. The use of any one of claims 1-14, wherein the second therapeutic agent is a kinase inhibitor.
18. The use of any one of claims 1-14, wherein the second therapeutic agent is a cancer vaccine.