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(54) Titre : POLYTHERAPIES
(54) Title: COMBINATION THERAPIES

(57) Abrégé/Abstract:
The present invention relates to combination therapies for treating KRas G12C cancers. In particular, the present invention relates to methods of treating cancer in a subject in need thereof, comprising administering to the subject a therapeutically effective amount of a combination of a an agent that blocks Programmed Death-1 receptor (PD-1) and Programmed Death Ligand-1 (PD -L1) signaling and a KRAS G12C inhibitor of Formula (I), Formula I- A or Formula I-B, kits comprising the compositions and methods of use therefor.

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Abstract:

The present invention relates to combination therapies for treating KRas G12C cancers. In particular, the present invention relates to methods of treating cancer in a subject in need thereof, comprising administering to the subject a therapeutically effective amount of a combination of a an agent that blocks Programmed Death-1 receptor (PD-1) and Programmed Death Ligand-1 (PD -L1) signaling and a KRAS G12C inhibitor of Formula (I), Formula I- A or Formula I-B, kits comprising the compositions and methods of use therefor.

COMBINATION THERAPIES

FIELD OF THE INVENTION

[0001] The present invention relates to combination therapies useful for treating cancer. In particular, the present invention relates to therapeutically effective combinations of an agent that disrupts Programmed cell death protein 1 (PD-1) and Programmed death-ligand 1 (PD-L1) axis signaling (a "PD-1/PD-L1 inhibitor") and a KRas G12C inhibitor, kits comprising the compositions and methods of use therefor.

BACKGROUND OF THE INVENTION

[0002] Kirsten Rat Sarcoma 2 Viral Oncogene Homolog ("KRas") is a small GTPase and a member of the Ras family of oncogenes. KRas serves as a molecular switch cycling between inactive (GDP-bound) and active (GTP-bound) states to transduce upstream cellular signals received from multiple tyrosine kinases to downstream effectors regulating a wide variety of processes, including cellular proliferation (e.g., see Alamgeer et al., (2013) Current Opin Pharmcol. 13:394-401).

[0003] The role of activated KRas in malignancy was observed over thirty years ago (e.g., see Der et al., (1982) Proc. Natl Acad. Sci. USA 79(11):3637-3640). Aberrant expression of KRas accounts for up to 20% of all cancers and oncogenic KRas mutations that stabilize GTP binding and lead to constitutive activation of KRas and downstream signaling have been reported in 25 -30% of lung adenocarcinomas (e.g., see Samatar and Poulikakos (2014) Nat Rev Drug Disc 13(12): 928-942 doi: 10.1038/nrd428). Single nucleotide substitutions that result in missense mutations at codons 12 and 13 of the KRas primary amino acid sequence comprise approximately 40% of these KRas driver mutations in lung adenocarcinoma, with a G12C transversion being the most common activating mutation (e.g., see Dogan et al., (2012) Clin Cancer Res. 18(22):6169-6177, published online 2012 Sep 26. doi: 10.1158/1078-0432.CCR-11-3265).

[0004] Oncogenic KRas mutations create an immunosuppressive microenvironment which results in resistance to immune checkpoint blockade (ICB) therapy, including anti-PD-1 and anti-PD-L1 inhibitors. Activated KRas has been demonstrated to repress the expression of interferon regulatory factor 2 (IRF2), which directly represses CXCL3 expression. This KRas-mediated repression of IRF2 leads to increased expression of CXCL3, which binds to CXCR2 on myeloid-derived suppressor cells (MDSC) promoting migration of these cells to the tumor microenvironment. A role for KRAS in modulating the immune microenvironment and primary ICB resistance in advanced colorectal cancer has been established. In colorectal cancer, anti-PD-1 resistance of KRAS-expressing tumors can be overcome by enforced IRF2 expression or by inhibition of CXCR2. (e.g., see Liao et al., (2019) Cancer Cell 35:559 – 572).

[0005] In addition, oncogenic KRas signaling has been shown to promote tumor immunoresistance to ICB therapy by stabilizing PD-L1 mRNA via repression of the AU-rich element-binding protein tristetraprolin (TTP), which negatively regulates PD-L1 expression through AU-rich elements in the 3' UTR of PD-L1 mRNA (e.g., see Coelho et al., (2017) Immunity 47(6):1083-1099).

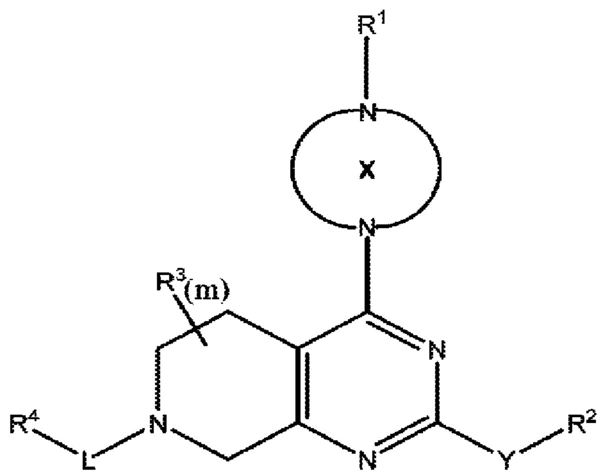
[0006] Oncogenic KRas also has been demonstrated to impair antigen presentation by repressing MHC I expression thereby allowing tumor cells to evade cytotoxic T-lymphocytes (e.g., see El-Jawhari et al., (2014) Molecular Immunology 58(2):160-168), and KRas activating mutations upregulate IL-8 expression in NSCLC, and IL-8 plays a role in cell growth and migration in KRas-associated NSCLC (e.g., see Sunaga et al., (2012) Int. J. Cancer 130(8):1733-1744).

[0007] Thus, activated KRas G12C expression modulates many aspects of the immune system and is responsible for the immunosuppressive tumor microenvironment in KRas G12C-associated tumors. As such, the direct inhibition of KRas G12C-mediated cell activity should reverse this reported immunosuppressive tumor microenvironment thereby improving the clinical activity of immune checkpoint blockade therapy, including the PD-1/PD-L1 pathway.

[0008] For all the foregoing reasons, there is a need to develop combination therapies using KRas G12C inhibitors and ICB therapy, including anti-PD-1 and anti-PD-L1 inhibitors, for treating KRas G12C-associated cancers that are resistant to ICB therapy.

SUMMARY OF THE INVENTION

[0009] In one aspect of the invention, provided herein are methods of treating cancer in a subject in need thereof, comprising administering to the subject a therapeutically effective amount of a combination of an agent that disrupts Programmed cell death protein 1 (PD-1) and Programmed death-ligand 1 (PD-L1) axis signaling (a "PD-1/PD-L1 inhibitor) and a KRAS G12C inhibitor of Formula (I):



Formula (I)

[0010] or a pharmaceutically acceptable salt thereof, wherein:

[0011] X is a 4-12 membered saturated or partially saturated monocyclic, bridged or spirocyclic ring, wherein the saturated or partially saturated monocyclic ring is optionally substituted with one or more R^8;

[0012] Y is a bond, O, S or NR^5;

[0013] R^1 is $-C(O)C(R^A) \equiv C(R^B)_p$ or $-SO_2C(R^A) \equiv C(R^B)_p$;

[0014] R^2 is hydrogen, alkyl, hydroxyalkyl, dihydroxyalkyl, alkylaminylalkyl, dialkylaminylalkyl, $-Z-NR^5R^{10}$, heterocyclyl, heterocyclylalkyl, aryl, heteroaryl, or heteroarylalkyl, wherein each of the Z, heterocyclyl, heterocyclylalkyl, aryl, heteroaryl, and heteroarylalkyl may be optionally substituted with one or more R^9;

[0015] Z is C1 – C4 alkylene;

[0016] each R^3 is independently C1 – C3 alkyl, oxo, or haloalkyl;

[0017] L is a bond, -C(O)-, or C1 – C3 alkylene;

[0018] R^4 is hydrogen, cycloalkyl, heterocyclyl, aryl, aralkyl or heteroaryl, wherein each of the cycloalkyl, heterocyclyl, aryl, aralkyl and heteroaryl may be optionally substituted with one or more R^6 or R^7;

[0019] each R^5 is independently hydrogen or C1 – C3 alkyl;

[0020] R^6 is cycloalkyl, heterocyclyl, heterocyclylalkyl, aryl, or heteroaryl, wherein each of the cycloalkyl, heterocyclyl, aryl, or heteroaryl may be optionally substituted with one or more R^7;

[0021] each R^7 is independently halogen, hydroxyl, C1 – C6 alkyl, cycloalkyl, alkoxy, haloalkyl, amino, cyano, heteroalkyl, hydroxyalkyl or Q-haloalkyl, wherein Q is O or S;

[0022] R^8 is oxo, C1 – C3 alkyl, C2 – C4 alkynyl, heteroalkyl, cyano, -C(O)OR^5, -C(O)N(R^5)$_2$, -N(R^5)$_2$, wherein the C1 – C3 alkyl may be optionally substituted with cyano, halogen, -OR^5, -N(R^5)$_2$, or heteroaryl

[0023] each R^9 is independently hydrogen, oxo, acyl, hydroxyl, hydroxyalkyl, cyano, halogen, C1 – C6 alkyl, aralkyl, haloalkyl, heteroalkyl, cycloalkyl, heterocyclylalkyl, alkoxy, dialkylaminyl, dialkylamidoalkyl, or dialkylaminylalkyl, wherein the C1 – C6 alkyl may be optionally substituted with cycloalkyl;

[0024] each R^{10} is independently hydrogen, acyl, C1 – C3 alkyl, heteroalkyl or hydroxyalkyl;

[0025] R^{11} is haloalkyl;

[0026] R^A is absent, hydrogen, deuterium, cyano, halogen, C1 - C-3 alkyl, haloalkyl, heteroalkyl, -C(O)N(R^5)$_2$, or hydroxyalkyl;

[0027] each R^B is independently hydrogen, deuterium, cyano, C1 – C3 alkyl, hydroxyalkyl, heteroalkyl, C1 – C3 alkoxy, halogen, haloalkyl, -ZNR^{5}R^{11}, -C(O)N(R^5)$_2$, -NHC(O)C1 – C3 alkyl, -CH$_2$NHC(O)C1 – C3 alkyl, heteroaryl, heteroarylalkyl, dialkylaminylalkyl, or

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heterocyclylalkyl wherein the heterocyclyl portion is substituted with one or more substituents independently selected from halogen, hydroxyl, alkoxy and C1 – C3 alkyl, wherein the heteroaryl or the heteroaryl portion of the heteroarylalkyl is optionally substituted with one or more R^7;

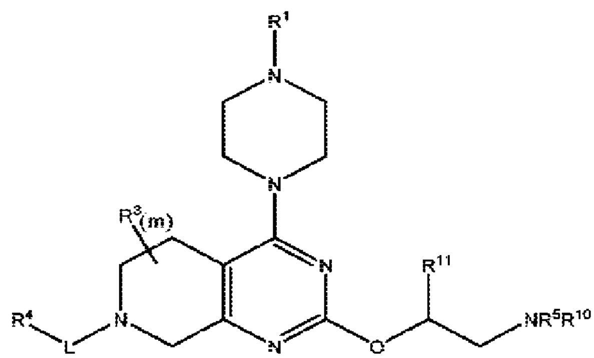
[0028] m is zero or an integer between 1 and 2;

[0029] p is one or two; and wherein,

[0030] when ═══ is a triple bond then R^A is absent, R^B is present and p equals one,

[0031] or when ═══ is a double bond then R^A is present, R^B is present and p equals two, or R^A, R^B and the carbon atoms to which they are attached form a 5-8 membered partially saturated cycloalkyl optionally substituted with one or more R^7.

[0032] Also included for use in the methods provided herein are KRas G12C inhibitor compounds of Formula I having the Formula I-A:



Formula I-A

[0033] or a pharmaceutically acceptable salt thereof, wherein R^1, R^3, R^4, R^5, R^{10}, R^{11}, L and m are as defined for Formula I, and the piperazinyl ring is optionally substituted with R^8 wherein R^8 is as defined for Formula I.

[0034] Also included for use in the methods provided herein are KRas G12C inhibitor compounds of Formula I having the Formula I-B:

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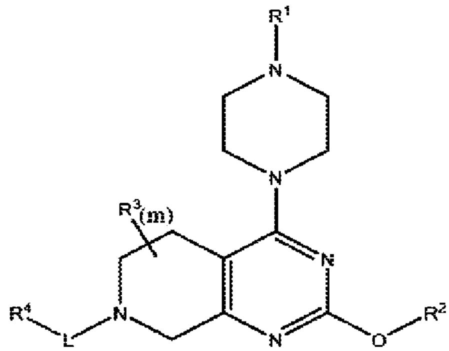

Formula I-B

[0035] or a pharmaceutically acceptable salt thereof, wherein R^1, R^3, R^4, L and m are as defined for Formula I, R^2 is heterocyclylalkyl optionally substituted with one or more R^9 where R^9 is as defined for Formula I, and the piperazinyl ring is optionally substituted with R^8, where R^8 is as defined for Formula I.

[0036] In another aspect of the invention, pharmaceutical combinations are provided for use in the methods comprising a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof and a KRas G12C inhibitor compound Formula I, Formula I-A, or Formula 1-B or a pharmaceutically acceptable salt thereof, and a pharmaceutically acceptable excipient. In one embodiment, the PD-1/PD-L1 inhibitor binds to and/or inhibits the activity of the PD-1 receptor. In one embodiment, the PD-1/PD-L1 inhibitor binds to and/or inhibits the signaling of the PD-L1 ligand.

[0037] In one aspect of the invention, provided herein are methods of treating cancer in a subject in need thereof, comprising administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof. In one embodiment, the cancer is a KRas G12C-associated cancer. In one embodiment, the KRas G12C-associated cancer is lung cancer. In one embodiment, the PD-1/PD-L1 inhibitor binds to and/or inhibits the activity of the PD-1 receptor. In one embodiment, the PD-1/PD-L1 inhibitor binds to and/or inhibits the signaling of the PD-L1 ligand.

[0038] Also provided are methods of treating a KRas G12C-associated cancer in a subject in need thereof, wherein the KRas G12C-associated cancer is resistant to treatment with a PD-1/PD-L1 inhibitor, comprising administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0039] Also provided are methods of treating a subject identified or diagnosed as having a KRas G12C-associated cancer and determined to have previously developed resistance to treatment with a PD-1/PD-L1 inhibitor that include administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0040] Also provided are methods of suppressing resistance to treatment with a PD-1/PD-L1 inhibitor in a subject having a KRas G12C-associated cancer that include administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0041] Also provided herein are methods of treating a subject identified or diagnosed as having a KRAS G12C-associated cancer that include (a) detecting resistance of the KRas G12C-associated cancer in the subject to treatment with a PD-1/PD-L1 inhibitor that was previously administered to the patient; and (b) after (a), administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0042] Also provided herein are methods of treating a subject identified or diagnosed as having a KRas G12C-associated cancer and determined to have previously developed resistance to treatment with a KRAS G12C inhibitor that include administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0043] Also provided here a methods of treating a subject identified or diagnosed as having a KRas G12C-associated cancer, comprising (a) administering a KRAS G12C inhibitor as monotherapy until disease progression, and (b) after (a), administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0044] In some aspects of the invention, KRas G12C inhibitor compounds and PD-1/PD-L1 inhibitors are the only active agents in the provided combinations and methods.

[0045] Examples of PD-1/PD-L1 inhibitors that bind to and/or inhibit the activity of PD-1 receptor suitable for the provided combinations and methods include nivolumab (Opdivo®), pembrolizumab (Keytruda®), cemiplimab (Libtayo®) and tislelizumab, and biosimilars thereof. Examples of PD-1/PD-L1 inhibitors that bind to and/or inhibit the activity of PD-L1 ligand suitable for the provided combinations and methods include atezolizumab (Tecentriq®), avelumab (Bavencio®) and durvalumab (Imfinzi®), and biosimilars thereof.

[0046] Also provided herein are methods for treating cancer in a subject in need thereof, the method comprising (a) determining that cancer is associated with a KRas G12C mutation (e.g., a KRas G12C-associated cancer) (e.g., as determined using a regulatory agency-approved, e.g., FDA-approved, assay or kit); and (b) administering to the patient a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRas G12C inhibitor compound of Formula I, Formula I-A, Formula 1-B or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, wherein the combination induces a durable complete response in the patient compared to either the PD-1/PD-L1 inhibitor or KRas G12C inhibitor alone.

[0047] In one embodiment of the method, the PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, are administered concurrently. In one embodiment of the method, the PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof is administered weekly for three weeks and a KRas G12C inhibitor, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, is administered daily for about 28 days.

[0048] Also provided herein are kits comprising a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B or a pharmaceutically acceptable salt or a pharmaceutical composition thereof. Also provided is a kit comprising a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, for use in treating a KRas G12C cancer.

[0049] In a related aspect, the invention provides a kit containing a dose of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B or a pharmaceutically acceptable salt or a pharmaceutical composition thereof in an amount effective to inhibit proliferation of cancer cells in a subject. The kit in some cases includes an insert with instructions for administration of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof. The insert may provide a user with one set of instructions for using the PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof in combination with the KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0050] In some embodiments of any of the methods described herein, before treatment with the compositions or methods of the invention, the patient was treated with one or more of a chemotherapy, a targeted anticancer agent, radiation therapy, and surgery, and optionally, the prior treatment was unsuccessful; and/or the patient has been administered surgery and optionally, the surgery was unsuccessful; and/or the patient has been treated with a platinum-based chemotherapeutic agent, and optionally, the patient has been previously determined to be non-responsive to treatment with the platinum-based chemotherapeutic agent; and/or the patient has been treated with a kinase inhibitor, and optionally, the prior treatment with the kinase inhibitor was unsuccessful; and/or the patient was treated with one or more other therapeutic agent(s).

DETAILED DESCRIPTION OF THE INVENTION

[0051] The present invention relates to combination therapies for treating KRas G12C cancers. In particular, the present invention relates to methods of treating cancer in a subject in need thereof, comprising administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt thereof or a pharmaceutical composition thereof, kits comprising the compositions and methods of use therefor.

[0052] In one embodiment, the combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, induces a durable complete response in animals harboring KRas G12C-associated cancer compared to the KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, administered as a single agent.

DEFINITIONS

[0053] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as is commonly understood by one of skill in the art to which this invention belongs. All patents, patent applications, and publications referred to herein are incorporated by reference.

[0054] As used herein, "KRas G12C" refers to a mutant form of a mammalian KRas protein that contains an amino acid substitution of a cysteine for a glycine at amino acid position 12. The assignment of amino acid codon and residue positions for human KRas is based on the amino acid sequence identified by UniProtKB/Swiss-Prot P01116: Variant p.Gly12Cys.

[0055] As used herein, a "KRas G12C inhibitor" refers to compounds of the present invention that are represented by Formula (I), Formula I-A and Formula I-B as described herein. These compounds are capable of negatively modulating or inhibiting all or a portion of the enzymatic activity of KRas G12C. The KRas G12C inhibitors of the present invention interact with and irreversibly bind to KRas G12C by forming a covalent adduct with the sulfhydryl side chain of the cysteine residue at position 12 resulting in the inhibition of the enzymatic activity of KRas G12C. In one embodiment, the KRas G12C inhibitor is a compound selected from compound Nos 1-678 (as numbered in WO2019099524), or pharmaceutically acceptable salts thereof (e.g., Example Nos 234, 359, 478 or 507, or a pharmaceutically acceptable salt thereof).

[0056] A "KRas G12C-associated disease or disorder" as used herein refers to diseases or disorders associated with or mediated by or having a KRas G12C mutation. A non-limiting example of a KRas G12C-associated disease or disorder is a KRas G12C-associated cancer.

[0057] As used herein, Programmed cell death protein 1 (PD-1) is a 55 kDa type I transmembrane protein that is part of the Ig gene superfamily that delivers negative cellular signals upon interaction with its two ligands, PD-L1 or PD-L2, to suppress the immune response.

[0058] As used herein, a "PD-1/PD-L1 inhibitor" refers to an agent that is capable of negatively modulating or inhibiting all or a portion of the PD-1/PD-L1 axis signaling activity and include agents that block PD-1 or PD-L1 Examples include PD-1 and PD-L1 binding antagonists such as anti-PD-1 antibodies, antigen binding fragments thereof, immunoadhesins, aptamers, fusion proteins, and oligopeptides. In some embodiments, the PD-1 binding antagonist is an anti-PD-1 antibody. In some embodiments, the PD-L1 binding antagonist is an anti-PD-L1 antibody.

[0059] The term "PD-1 binding antagonist" as used herein refers to a PD-1 inhibitor, i.e., a molecule that decreases, blocks, inhibits, abrogates or interferes with signal transduction resulting from the interaction of PD-1 with one or more of its binding partners, such as PD-L1 and/or PD-L2. In some embodiments, the PD-1 inhibitor is a molecule that inhibits the binding of PD-1 to its binding partners. In a specific aspect, the PD-1 inhibitor inhibits the binding of PD-1 to PD-L1 and/or PD-L2. For example, PD-1 inhibitors include anti-PD-1 antibodies, antigen binding fragments thereof, immunoadhesins, fusion proteins, oligopeptides and other molecules that decrease, block, inhibit, abrogate or interfere with signal transduction resulting from the interaction of PD-1 with PD-L1 and/or PD-L2. In one embodiment, a PD-1 inhibitor reduces the negative co-stimulatory signal mediated by or through cell surface proteins expressed on T lymphocytes mediated signaling through PD-1 so as render a dysfunctional T-cell less non-dysfunctional. In some embodiments, the PD-1 inhibitor is an anti-PD-1 antibody. In one embodiment, the PD-1 antibody is pembrolizumab, or a biosimilar thereof. In one embodiment, the PD-1 antibody is cemiplimab, or a biosimilar thereof. In one embodiment, the PD-1 antibody is tislelizumab, or a biosimilar thereof.

[0060] The term "PD-L1 binding antagonist" as used herein refers to a PD-L1 inhibitor, i.e., a molecule that decreases, blocks, inhibits, abrogates or interferes with signal transduction resulting from the interaction of PD-L1 with either one or more of its binding partners, such as PD-1 and/or B7-1. In some embodiments, a PD-L1 inhibitor is a molecule that inhibits the binding of PD-L1 to its binding partners. In a specific aspect, the PD-L1 inhibitor inhibits binding of PD-L1 to PD-1 and/or B7-1. In some embodiments, the PD-L1 inhibitors include anti-PD-L1 antibodies, antigen binding fragments thereof, immunoadhesins, fusion proteins, oligopeptides and other molecules that decrease, block, inhibit, abrogate or interfere with signal transduction resulting from the interaction of PD-L1 with one or more of its binding partners, such as PD-1 and/or B7-1. In one embodiment, a PD-L1 inhibitor reduces the negative co-stimulatory signal mediated by or through cell surface proteins expressed on T lymphocytes mediated signaling through PD-L1 so as render a dysfunctional T-cell less non-dysfunctional. In some embodiments, a PD-L1 inhibitor is an anti-PD-L1 antibody. In a specific aspect, an anti-PD-L1 antibody is avelumab or a biosimilar thereof. In another specific aspect, an anti-PD-L1 antibody is atezolizumab or a biosimilar thereof. In another specific aspect, an anti-PD-L1 antibody is durvalumab or a biosimilar thereof. In another specific aspect, an anti-PD-L1 antibody is BMS-936559 (MDX-1105) or a biosimilar thereof.

[0061] A "biosimilar" means an antibody or antigen-binding fragment that has the same primary amino acid sequence as compared to a reference antibody (e.g., nivolumab or pembrolizumab) and optionally, may have detectable differences in post-translation modifications (e.g., glycosylation and/or phosphorylation) as compared to the reference antibody (e.g., a different glycoform).

[0062] As used herein a "complete response" refers to a subject having a KRas G12C-associated cancer that has been treated with the combination of a PD-1/PD-L1 inhibitor and a KRas G12C inhibitor of the present invention in which the treated tumor at some stage of treatment is no longer detectable by palpation, by calibration or by standard-of-care methodologies for detecting such tumors that eventually relapse. The duration of a complete response is typically measured in days.

[0063] As used herein a "durable complete response" refers to a subject having a KRas G12C-associated cancer that has been treated with the combination of a PD-1/PD-L1 inhibitor and a KRas G12C inhibitor of the present invention in which the treated tumor is no longer detectable by palpation, by calibration or by standard-of-care methodologies for detecting such tumors and the tumor fails to relapse due to an induced anti-tumor immunological memory in the subject, remaining undetectable after treatment and/or in patient-derived animal models (PDX) is recalcitrant to re-challenge using the same tumor cells of the initial tumor type. The duration of a durable complete response is typically measured in weeks, months or years.

[0064] As used herein, the term "subject," "individual," or "patient," used interchangeably, refers to any animal, including mammals such as mice, rats, other rodents, rabbits, dogs, cats, swine, cattle, sheep, horses, primates, and humans. In some embodiments, the patient is a human. In some embodiments, the subject has experienced and/or exhibited at least one symptom of the disease or disorder to be treated and/or prevented. In some embodiments, the subject has been identified or diagnosed as having a cancer having a KRas G12C mutation (e.g., as determined using a regulatory agency-approved, e.g., FDA-approved, assay or kit). In some embodiments, the subject has a tumor that is positive for a KRas G12C mutation (e.g., as determined using a regulatory agency-approved assay or kit). The subject can be a subject with a tumor(s) that is positive for a KRas G12C mutation (e.g., identified as positive using a regulatory agency-approved, e.g., FDA-approved, assay or kit). The subject can be a subject whose tumors have a KRas G12C mutation (e.g., where the tumor is identified as such using a regulatory agency-approved, e.g., FDA-approved, kit or assay). In some embodiments, the subject is suspected of having a KRas G12C gene-associated cancer. In some embodiments, the subject has a clinical record indicating that the subject has a tumor that has a KRas G12C mutation (and optionally the clinical record indicates that the subject should be treated with any of the compositions provided herein).

[0065] The term "pediatric patient" as used herein refers to a patient under the age of 16 years at the time of diagnosis or treatment. The term "pediatric" can be further be divided into various subpopulations including: neonates (from birth through the first month of life); infants (1 month up to two years of age); children (two years of age up to 12 years of age); and adolescents (12 years of age through 21 years of age (up to, but not including, the twenty-second birthday)). Berhman RE, Kliegman R, Arvin AM, Nelson WE. Nelson Textbook of Pediatrics, 15th Ed. Philadelphia: W.B. Saunders Company, 1996; Rudolph AM, et al. Rudolph's Pediatrics, 21st Ed. New York: McGraw-Hill, 2002; and Avery MD, First LR. Pediatric Medicine, 2nd Ed. Baltimore: Williams & Wilkins; 1994.

[0066] In some embodiments of any of the methods or uses described herein, an assay is used to determine whether the patient has KRas G12C mutation using a sample (e.g., a biological sample or a biopsy sample such as a paraffin-embedded biopsy sample) from a patient (e.g., a patient suspected of having a KRas G12C-associated cancer, a patient having one or more symptoms of a KRas G12C-associated cancer, and/or a patient that has an increased risk of developing a KRas G12C-associated cancer) can include, for example, next generation sequencing, immunohistochemistry, fluorescence microscopy, break apart FISH analysis, Southern blotting, Western blotting, FACS analysis, Northern blotting, and PCR-based amplification (e.g., RT-PCR, quantitative real-time RT-PCR, allele-specific genotyping or ddPCR). As is well-known in the art, the assays are typically performed, e.g., with at least one labelled nucleic acid probe or at least one labelled antibody or antigen-binding fragment thereof.

[0067] The term "regulatory agency" is a country's agency for the approval of the medical use of pharmaceutical agents with the country. For example, a non-limiting example of a regulatory agency is the U.S. Food and Drug Administration (FDA).

[0068] The term "amino" refers to $-NH_2$;

[0069] The term "acyl" refers to $-C(O)CH_3$.

[0070] The term "alkyl" as employed herein refers to straight and branched chain aliphatic groups having from 1 to 12 carbon atoms, 1-8 carbon atoms 1-6 carbon atoms, or 1-3 carbon atoms which is optionally substituted with one, two or three substituents. Examples of alkyl groups include, without limitation, methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl, tert-butyl, pentyl, and hexyl.

[0071] The term “haloalkyl” refers to an alkyl chain in which one or more hydrogen has been replaced by a halogen. Examples of haloalkyls are trifluoromethyl, difluoromethyl and fluoromethyl.

[0072] The term “haloalkyloxy” refers to -O-haloalkyl.

[0073] An "alkylene," group is an alkyl group, as defined hereinabove, that is positioned between and serves to connect two other chemical groups. Exemplary alkylene groups include, without limitation, methylene, ethylene, propylene, and butylene.

[0074] The term “alkoxy” refers to –OC1 – C6 alkyl.

[0075] The term "cycloalkyl" as employed herein includes saturated and partially unsaturated cyclic hydrocarbon groups having 3 to 12 carbons, for example 3 to 8 carbons, and as a further example 3 to 6 carbons, wherein the cycloalkyl group additionally is optionally substituted. Examples of cycloalkyl groups include, without limitation, cyclopropyl, cyclobutyl, cyclopentyl, cyclopentenyl, cyclohexyl, cyclohexenyl, cycloheptyl, and cyclooctyl.

[0076] The term "heteroalkyl" refers to an alkyl group, as defined hereinabove, wherein one or more carbon atoms in the chain are replaced by a heteroatom selected from the group consisting of O, S, and N.

[0077] As used herein, the term “hydroxyalkyl” refers to –alkyl-OH.

[0078] The term “dihydroxyalkyl” refers to an alkyl group as defined herein wherein two carbon atoms are each substituted with a hydroxyl group.

[0079] The term “alkylaminyl” refers to $–NR^x$-alkyl, wherein R^x is hydrogen. In one embodiment, R^x is hydrogen.

[0080] The term “dialkylaminyl” refers to $–N(R^y)_2$, wherein each R^y is C1 – C3 alkyl.

[0081] The term “alkylaminylalkyl” refers to $–$alkyl-NR^x-alkyl, wherein R^x is hydrogen. In one embodiment, R^x is hydrogen.

[0082] The term "dialkylaminylalkyl" refers to –alkyl-N(R^y)$_2$, wherein each R^y is C1 – C4 alkyl, wherein the alkyl of the—alkyl-N(R^y)$_2$ may be optionally substituted with hydroxy or hydroxyalkyl.

[0083] An "aryl" group is a C_6-C_{14} aromatic moiety comprising one to three aromatic rings, which is optionally substituted. As one embodiment, the aryl group is a C_6-C_{10} aryl group. Examples of aryl groups include, without limitation, phenyl, naphthyl, anthracenyl, fluorenyl, and dihydrobenzofuranyl.

[0084] An "aralkyl" or "arylalkyl" group comprises an aryl group covalently linked to an alkyl group, either of which may independently be optionally substituted or unsubstituted. An example of an aralkyl group is (C_1- C_6)alkyl(C_6-C_{10})aryl, including, without limitation, benzyl, phenethyl, and naphthylmethyl. An example of a substituted aralkyl is wherein the alkyl group is substituted with hydroxyalkyl.

[0085] A "heterocyclyl" or "heterocyclic" group is a ring structure having from about 3 to about 12 atoms, for example 4 to 8 atoms, wherein one or more atoms are selected from the group consisting of N, O, and S, the remainder of the ring atoms being carbon. The heterocyclyl may be a monocyclic, a bicyclic, a spirocyclic or a bridged ring system. The heterocyclic group is optionally substituted with R^7 on carbon or nitrogen at one or more positions, wherein R^7 is as defined for Formula I. The heterocyclic group is also independently optionally substituted on nitrogen with alkyl, aryl, aralkyl, alkylcarbonyl, alkylsulfonyl, arylcarbonyl, arylsulfonyl, alkoxycarbonyl, aralkoxycarbonyl, or on sulfur with oxo or lower alkyl. Examples of heterocyclic groups include, without limitation, epoxy, azetidinyl, aziridinyl, tetrahydrofuranyl, tetrahydropyranyl, pyrrolidinyl, pyrrolidinonyl, piperidinyl, piperazinyl, imidazolidinyl, thiazolidinyl, dithianyl, trithianyl, dioxolanyl, oxazolidinyl, oxazolidinonyl, decahydroquinolinyl, piperidonyl, 4-piperidinonyl, thiomorpholinyl, thiomorpholinyl 1,1 dioxide, morpholinyl, oxazepanyl, azabicyclohexanes, azabicycloheptanes and oxa azabiocycloheptanes. Specifically excluded from the scope of this term are compounds having adjacent annular O and/or S atoms.

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[0086] The term “heterocyclylalkyl” refers to a heterocyclyl group as defined herein linked to the remaining portion of the molecule via an alkyl linker, wherein the alkyl linker of the heterocyclylalkyl may be optionally substituted with hydroxy or hydroxyalkyl.

[0087] As used herein, the term "heteroaryl" refers to groups having 5 to 14 ring atoms, preferably 5, 6, 9, or 10 ring atoms; having 6, 10, or 14 π electrons shared in a cyclic array; and having, in addition to carbon atoms, from one to three heteroatoms per ring selected from the group consisting of N, O, and S. Examples of heteroaryl groups include acridinyl, azocinyl, benzimidazolyl, benzofuranyl, benzothiofuranyl, benzothiophenyl, benzoxazolyl, benzthiazolyl, benztriazolyl, benztetrazolyl, benzisoxazolyl, benzisothiazolyl, benzimidazolinyl, carbazolyl, 4aH-carbazolyl, carbolinyl, chromanyl, chromenyl, cinnolinyl, furanyl, furazanyl, imidazolinyl, imidazolyl, 1H-indazolyl, indolenyl, indolinyl, indolizinyl, indolyl, 3H-indolyl, isobenzofuranyl, isochromanyl, isoindazolyl, isoindolinyl, isoindolyl, isoquinolinyl, isothiazolyl, isoxazolyl, methylenedioxyphenyl, naphthyridinyl, octahydroisoquinolinyl, oxadiazolyl, 1,2,3-oxadiazolyl, 1,2,4-oxadiazolyl, 1,2,5-oxadiazolyl, 1,3,4-oxadiazolyl, oxazolidinyl, oxazolyl, oxazolidinyl, pyrimidinyl, phenanthridinyl, phenanthrolinyl, phenazinyl, phenothiazinyl, phenoxathiinyl, phenoxazinyl, phthalazinyl, piperonyl, pteridinyl, purinyl, pyranyl, pyrazinyl, pyrazolidinyl, pyrazolinyl, pyrazolyl, pyridazinyl, pyridooxazole, pyridoimidazole, pyridothiazole, pyridinyl, pyridyl, pyrimidinyl, pyrrolinyl, 2H-pyrrolyl, pyrrolyl, quinazolinyl, quinolinyl, 4H-quinolizinyl, quinoxalinyl, quinuclidinyl, tetrahydroisoquinolinyl, tetrahydroquinolinyl, tetrazolyl, 6H-1,2,5-thiadiazinyl, 1,2,3-thiadiazolyl, 1,2,4-thiadiazolyl, 1,2,5-thiadiazolyl, 1,3,4-thiadiazolyl, thianthrenyl, thiazolyl, thienyl, thienothiazolyl, thienooxazolyl, thienoimidazolyl, thiophenyl, triazinyl, 1,2,3-triazolyl, 1,2,4-triazolyl, 1,2,5-triazolyl, 1,3,4-triazolyl, and xanthenyl.

[0088] A "heteroarylalkyl" group comprises a heteroaryl group covalently linked to an alkyl group, wherein the radical is on the alkyl group, either of which is independently optionally substituted or unsubstituted. Examples of heteroarylalkyl groups include a heteroaryl group having 5, 6, 9, or 10 ring atoms bonded to a C1-C6 alkyl group. Examples of heteroaralkyl groups include pyridylmethyl, pyridylethyl, pyrrolylmethyl, pyrrolylethyl, imidazolylmethyl, imidazolylethyl, thiazolylmethyl, thiazolylethyl, benzimidazolylmethyl, benzimidazolylethyl quinazolinylmethyl, quinolinylmethyl, quinolinylethyl, benzofuranylmethyl, indolinylethyl isoquinolinylmethyl, isoinodylmethyl, cinnolinylmethyl, and benzothiophenylethyl. Specifically excluded from the scope of this term are compounds having adjacent annular O and/or S atoms.

[0089] As used herein, "an effective amount" of a compound is an amount that is sufficient to negatively modulate or inhibit the activity of the desired target, i.e., a PD-1/PD-L1 or KRas G12C. Such amount may be administered as a single dosage or may be administered according to a regimen, whereby it is effective.

[0090] As used herein, a "therapeutically effective amount" of a compound is an amount that is sufficient to ameliorate, or in some manner reduce a symptom or stop or reverse progression of a condition, or negatively modulate or inhibit the activity of PD-1/PD-L1 or KRas G12C. Such amount may be administered as a single dosage or may be administered according to a regimen, whereby it is effective.

[0091] As used herein, a "therapeutically effective amount of a combination" of two compounds is an amount that together synergistically increases the activity of the combination in comparison to the therapeutically effective amount of each compound in the combination,. For example, in vivo, the therapeutically effective amount of the combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, results in a complete durable response in subjects relative to treatment with only the KRas G12C inhibitor. In one embodiment, the therapeutically effective amount of the combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, results in an increased duration of overall survival ("OS") in subjects relative to treatment with only the KRas G12C inhibitor. In one embodiment, the therapeutically effective amount of the combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, results in an increased duration of progression-free survival ("PFS") in subjects relative to treatment with only the KRas G12C inhibitor. In one embodiment, the therapeutically effective amount of the combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, results in increased tumor regression in subjects relative to treatment with only the KRas G12C inhibitor. In one embodiment, the therapeutically effective amount of the combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, results in increased tumor growth inhibition in subjects relative to treatment with only the KRas G12C inhibitor. In one embodiment, the therapeutically effective amount of the combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, results in an improvement in the duration of stable disease in subjects compared to treatment with only the KRas G12C inhibitor. The amount of each compound in the combination may be the same or different than the therapeutically effective amount of each compound when administered alone as a monotherapy as long as the combination is synergistic. Such amounts may be administered as a single dosage or may be administered according to a regimen, whereby it is effective.

[0092] As used herein, treatment means any manner in which the symptoms or pathology of a condition, disorder or disease are ameliorated or otherwise beneficially altered. Treatment also encompasses any pharmaceutical use of the compositions herein.

[0093] As used herein, amelioration of the symptoms of a particular disorder by administration of a particular pharmaceutical combination refers to any lessening, whether permanent or temporary, lasting or transient that can be attributed to or associated with administration of the combination.

[0094] As used herein, the term “about” when used to modify a numerically defined parameter (e.g., the dose of a KRAS inhibitor or a PD-1/PD-L1 inhibitor or a pharmaceutically acceptable salt thereof, or the length of treatment time with a combination therapy described herein) means that the parameter may vary by as much as 10% below or above the stated numerical value for that parameter. For example, a dose of about 5 mg/kg may vary between 4.5 mg/kg and 5.5 mg/kg. “About” when used at the beginning of a listing of parameters is meant to modify each parameter. For example, about 0.5 mg, 0.75 mg or 1.0 mg means about 0.5 mg, about 0.75 mg or about 1.0 mg. Likewise, about 5% or more, 10% or more, 15% or more, 20% or more, and 25% or more means about 5% or more, about 10% or more, about 15% or more, about 20% or more, and about 25% or more.

INHIBITOR COMPOUNDS

[0095] In one aspect of the invention, provided herein are methods of treating cancer in a subject in need thereof, comprising administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

1. PD-1/PD-L1 Inhibitors

[0096] Programmed death protein 1 (PD-1) is an immunoinhibitory receptor that is primarily expressed on activated T and B cells. PD-1 is a 55 kDa type I transmembrane protein that is part of the Ig gene superfamily (Agata et al. (1996) Int Immunol 8:765-72). PD-1 contains a membrane proximal immunoreceptor tyrosine inhibitory motif (ITIM) and a membrane distal tyrosine-based switch motif (ITSM). Two ligands that bind to PD-1 have been identified, PD-L1 and PD-L2, that have been shown to downregulate T cell activation upon binding to PD-1 (Freeman et al. (2000) J Exp Med 192:1027-34). PD-L1 is a ligand for PD-1 and is abundant in a variety of human cancers (Dong et al. (2002) Nat. Med. 8:787-9). The interaction between PD-1 and PD-L1 results in a decrease in tumor infiltrating lymphocytes, a decrease in T-cell receptor mediated proliferation, and immune evasion by the cancerous cells (Dong et al. (2003) J. Mol. Med. 81:281-7).

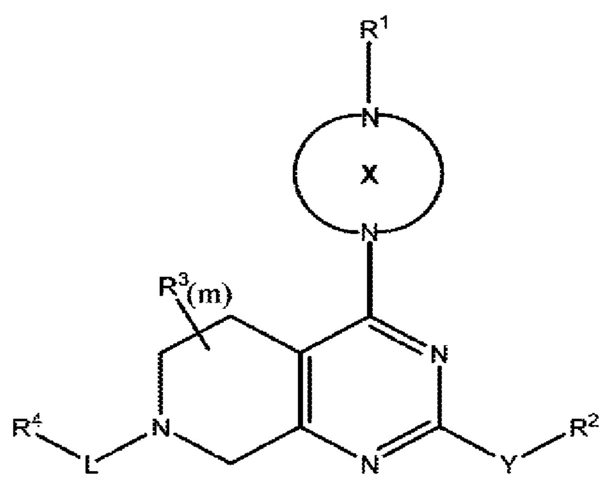
[0097] Immune suppression can be reversed by inhibiting the local interaction of PD-1 with PD-L1, and the effect is additive when the interaction of PD-1 with PD-L2 is blocked as well. For instance, disruption of the PD-1/PD-L1 interaction has been shown to increase T cell proliferation and cytokine production and block progression of the cell cycle.

[0098] Given PD-L1 is upregulated in many cancers and contributes to evasion of the host immune system, blocking the interaction between PD-1 and PD-L1 has garnered the attention of the pharmaceutical industry leading to a new break-through class of immune checkpoint therapies for a wide range of cancers. The PD-1/PD-L1 pathway is a well-validated target for the development of antibody therapeutics for cancer treatment and several anti-PD-1 and anti-PD-L1 antibodies have undergone human clinical trials for a wide-variety of cancers including NSCLC, renal cell carcinoma, melanoma, head and neck squamous cancer, ureothelial cancer, hepatocellular carcinoma, and other cancers. Exemplary anti-PD-1 antibodies include nivolumab (Opdivo®), pembrolizumab (Keytruda®), cemiplimab (Libtayo®) and tislelizumab, and biosimilars thereof. Exemplary anti-PD-L1 antibodies include atezolizumab (Tecentriq®), avelumab (Bavencio®), and durvalumab (Imfinzi®), and biosimilars thereof.

[0099] Methods for manufacturing agents that disrupt PD-1/PD-L1 signalling axis, including the antibodies described herein, are well known to those skilled in the art and agents that disrupt PD-1/PD-L1 signalling axis may be obtained from a wide-variety of commercial suppliers, in forms suitable for both research or approved human clinical use. In addition, suitable agents that disrupt PD-1/PD-L1 signalling for use in the compositions and methods disclosed herein and methods for preparing such agents, and diagnostic and efficacy markers useful for monitoring treatment are disclosed in US Patent Application Publication Nos: 20180327848; 20180237524; 20180148790; 20180111996; 20160305947; 20160304969; 20160304606; 20150232555; 20150079109; 20140348743; 20140294852; 20140271684; 20140234296; 20130133091; 20110123550; and 20090217401.

2. KRas G12C Inhibitors

[0100] In one embodiment, the KRas G12C inhibitors used in the methods are compounds of Formula (I), Formula I-A or Formula I-B:



Formula (I)

[0101] or a pharmaceutically acceptable salt thereof, wherein:

[0102] X is a 4-12 membered saturated or partially saturated monocyclic, bridged or spirocyclic ring, wherein the saturated or partially saturated monocyclic ring is optionally substituted with one or more R^8;

[0103] Y is a bond, O, S or NR^5;

[0104] R^1 is $-C(O)C(R^A) \overset{------}{=\!=\!=} C(R^B)_p$ or $-SO_2C(R^A) \overset{------}{=\!=\!=} C(R^B)_p$;

[0105] R^2 is hydrogen, alkyl, hydroxyalkyl, dihydroxyalkyl, alkylaminylalkyl, dialkylaminylalkyl, $-Z-NR^5R^{10}$, heterocyclyl, heterocyclylalkyl, aryl, heteroaryl, or heteroarylalkyl, wherein each of the Z, heterocyclyl, heterocyclylalkyl, aryl, heteroaryl, and heteroarylalkyl may be optionally substituted with one or more R^9;

[0106] Z is C1 – C4 alkylene;

[0107] each R^3 is independently C1 – C3 alkyl, oxo, or haloalkyl;

[0108] L is a bond, -C(O)-, or C1 – C3 alkylene;

[0109] R^4 is hydrogen, cycloalkyl, heterocyclyl, aryl, aralkyl or heteroaryl, wherein each of the cycloalkyl, heterocyclyl, aryl, aralkyl and heteroaryl may be optionally substituted with one or more R^6 or R^7;

[0110] each R^5 is independently hydrogen or C1 – C3 alkyl;

[0111] R^6 is cycloalkyl, heterocyclyl, heterocyclylalkyl, aryl, or heteroaryl, wherein each of the cycloalkyl, heterocyclyl, aryl, or heteroaryl may be optionally substituted with one or more R^7;

[0112] each R^7 is independently halogen, hydroxyl, C1 – C6 alkyl, cycloalkyl, alkoxy, haloalkyl, amino, cyano, heteroalkyl, hydroxyalkyl or Q-haloalkyl, wherein Q is O or S;

[0113] R^8 is oxo, C1 – C3 alkyl, C2 – C4 alkynyl, heteroalkyl, cyano, $-C(O)OR^5$, $-C(O)N(R^5)_2$, $-N(R^5)_2$, wherein the C1 – C3 alkyl may be optionally substituted with cyano, halogen, $-OR^5$, $-N(R^5)_2$, or heteroaryl;

[0114] each R^9 is independently hydrogen, oxo, acyl, hydroxyl, hydroxyalkyl, cyano, halogen, C1 – C6 alkyl, aralkyl, haloalkyl, heteroalkyl, cycloalkyl, heterocyclylalkyl, alkoxy, dialkylaminyl, dialkylamidoalkyl, or dialkylaminylalkyl, wherein the C1 – C6 alkyl may be optionally substituted with cycloalkyl;

[0115] each R^{10} is independently hydrogen, acyl, C1 – C3 alkyl, heteroalkyl or hydroxyalkyl;

[0116] R^{11} is haloalkyl;

[0117] R^A is absent, hydrogen, deuterium, cyano, halogen, C1 - C-3 alkyl, haloalkyl, heteroalkyl, $-C(O)N(R^5)_2$, or hydroxyalkyl;

[0118] each R^B is independently hydrogen, deuterium, cyano, C1 – C3 alkyl, hydroxyalkyl, heteroalkyl, C1 – C3 alkoxy, halogen, haloalkyl, $-ZNR^5R^{11}$, $-C(O)N(R^5)_2$, -NHC(O)C1 – C3 alkyl, $-CH_2NHC(O)$C1 – C3 alkyl, heteroaryl, heteroarylalkyl, dialkylaminylalkyl, or heterocyclylalkyl wherein the heterocyclyl portion is substituted with one or more substituents independently selected from halogen, hydroxyl, alkoxy and C1 – C3 alkyl, wherein the heteroaryl or the heteroaryl portion of the heteroarylalkyl is optionally substituted with one or more R^7;

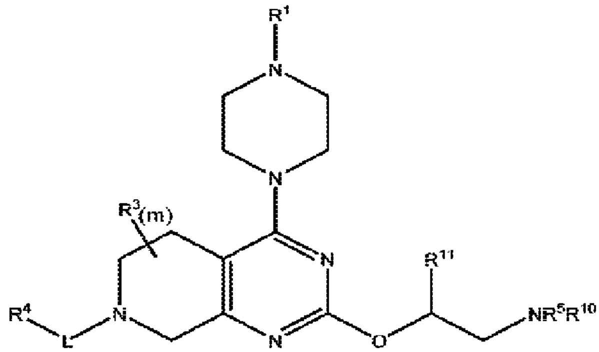
[0119] m is zero or an integer between 1 and 2;

[0120] p is one or two; and wherein,

[0121] when $\overset{-\,-\,-}{=\!=}$ is a triple bond then R^A is absent, R^B is present and p equals one;

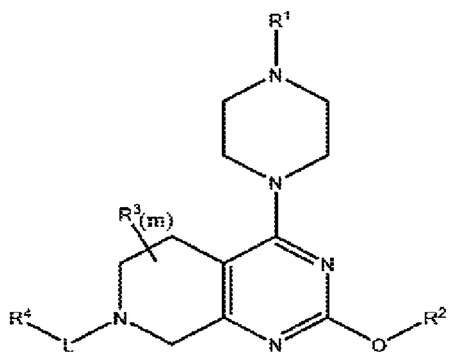
[0122] or when $\overset{-\,-\,-}{=\!=}$ is a double bond then R^A is present, R^B is present and p equals two, or R^A, R^B and the carbon atoms to which they are attached form a 5-8 membered partially saturated cycloalkyl optionally substituted with one or more R^7.

[0123] In one embodiment, KRas G12C inhibitors used in the methods herein includes compounds having the Formula I-A:



[0124] or a pharmaceutically acceptable salt thereof, wherein R^1, R^3, R^4, R^5, R^{10}, L and m are as defined for Formula I, R^{11} is hydrogen, methyl or hydroxyalkyl, and the piperidinyl ring is optionally substituted with R^8 wherein R^8 is as defined for Formula I.

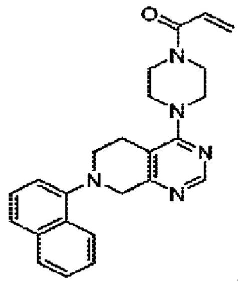
[0125] In one embodiment, KRas G12C inhibitors used in the methods herein include compounds having the Formula I-B:



Formula I-B

[0126] or a pharmaceutically acceptable salt thereof, wherein R^1, R^3, R^4, R^9, R^{11}, L and m are as defined for Formula I.

[0127] Nonlimiting examples of KRas G12C inhibitor compounds of Formula (I), Formula I-A and Formula I-B useful in the methods disclosed herein are selected from the group consisting of Example Nos 1-678 (as numbered in international patent publication No WO2019099524) including the following structures: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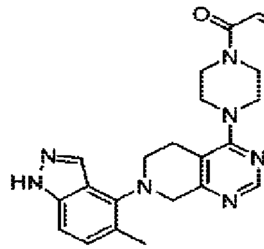
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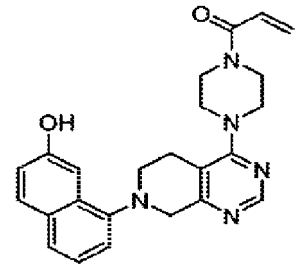
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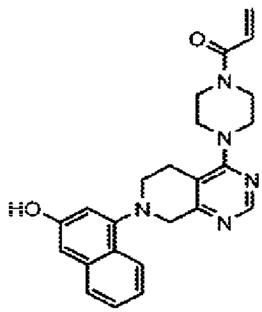
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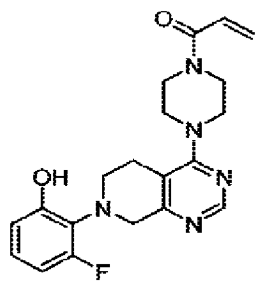
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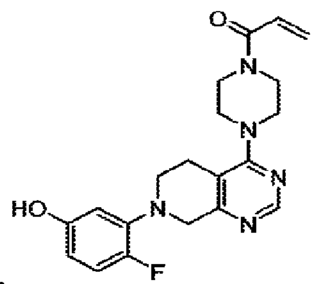
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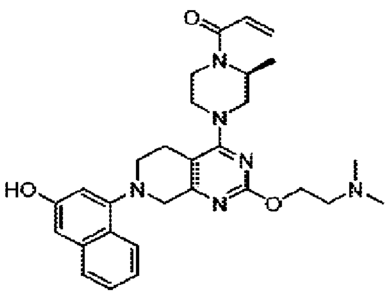
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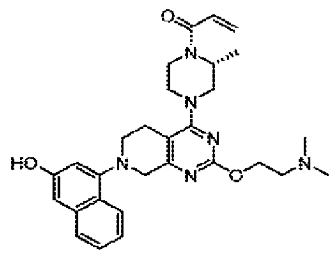
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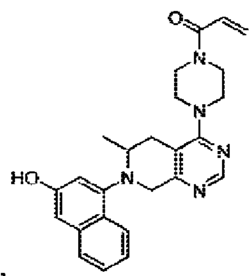
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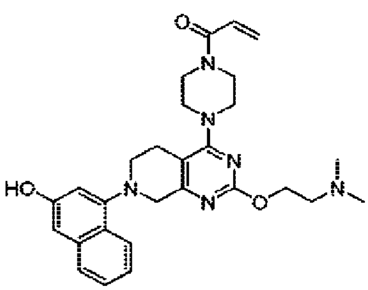
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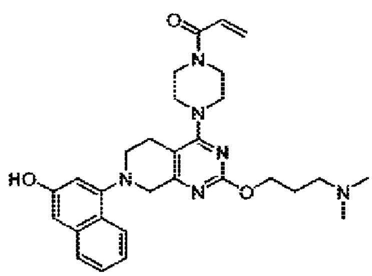
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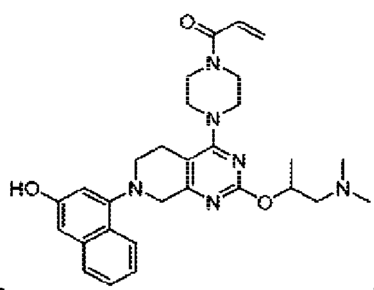
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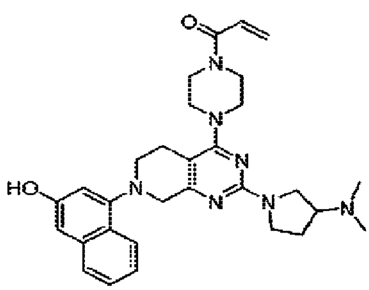
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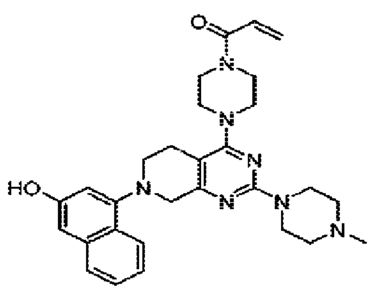
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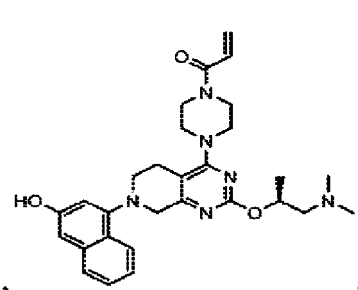
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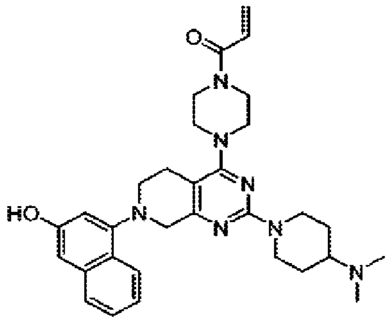
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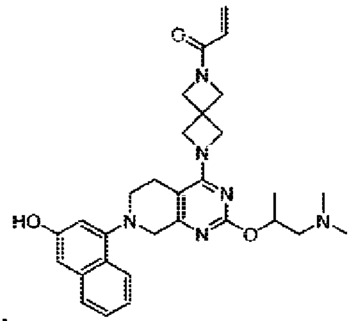
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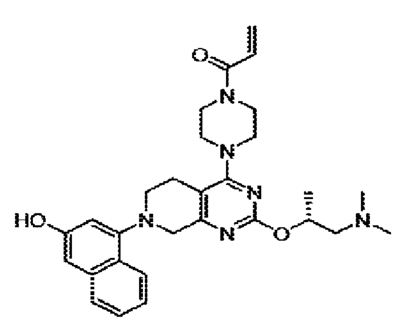
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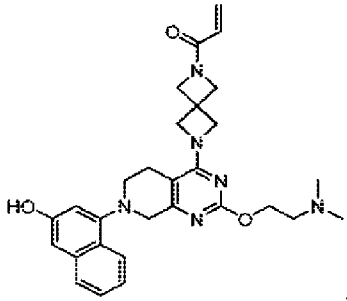
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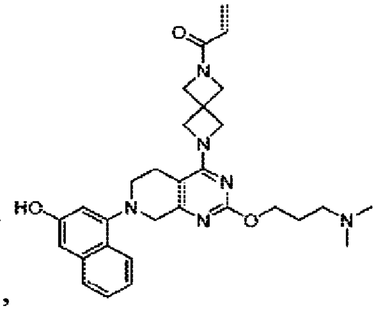
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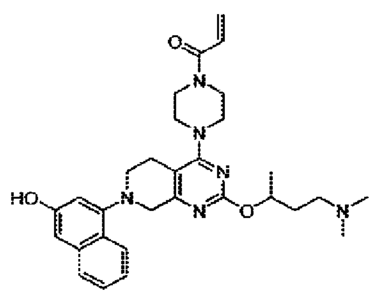
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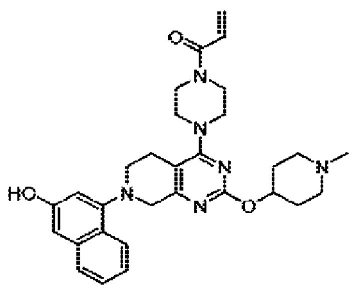
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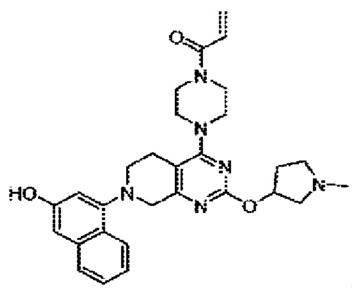
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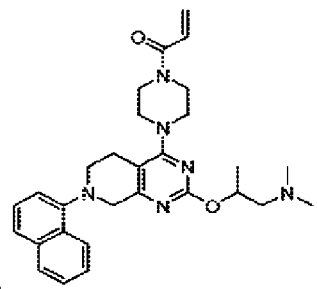
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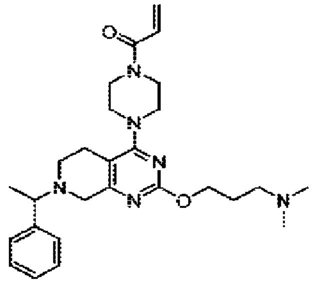
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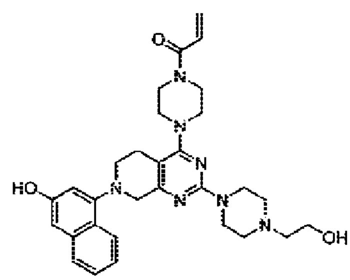
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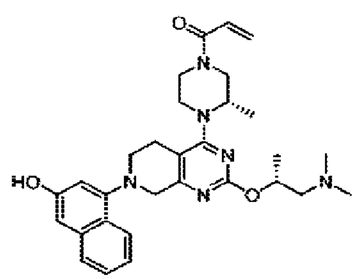
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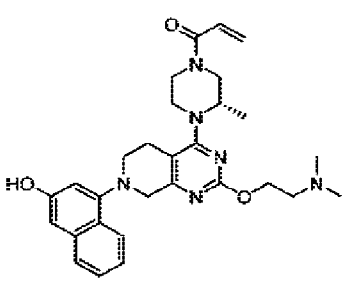
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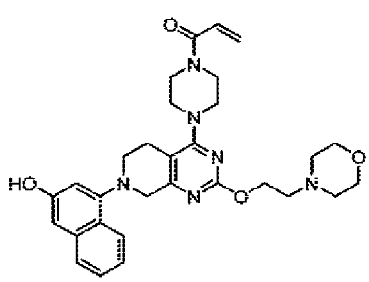
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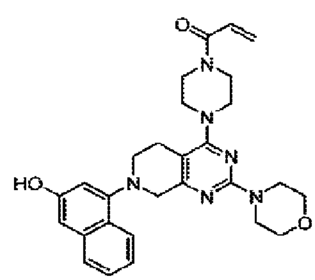
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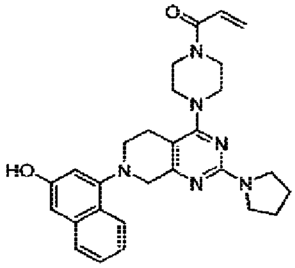
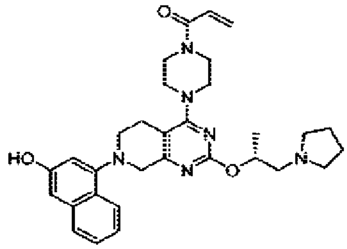
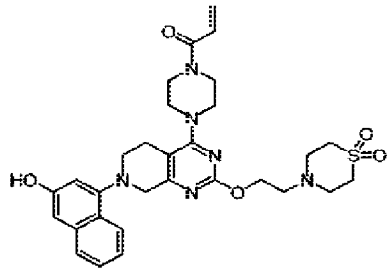
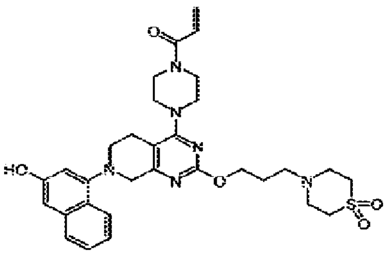
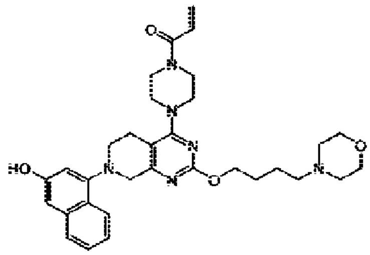
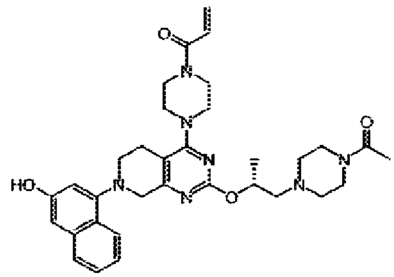
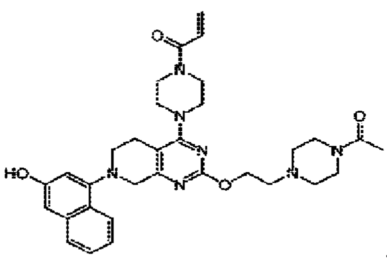
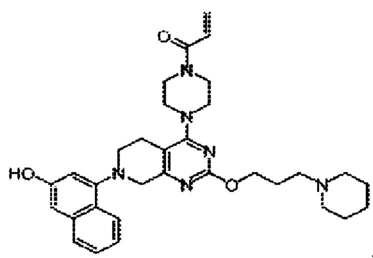
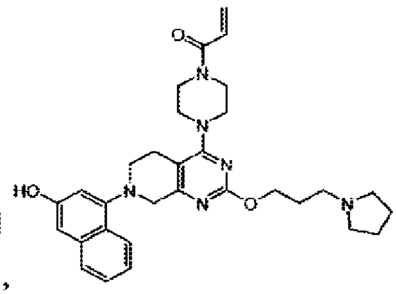
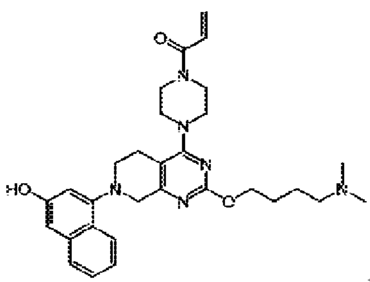
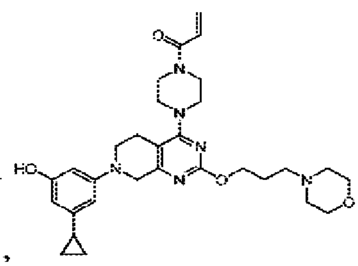
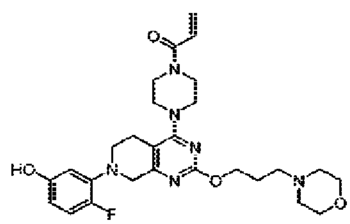
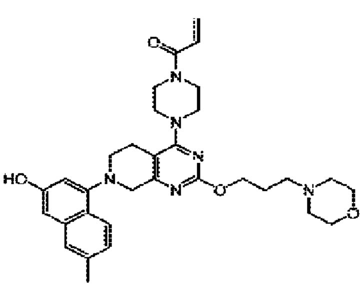
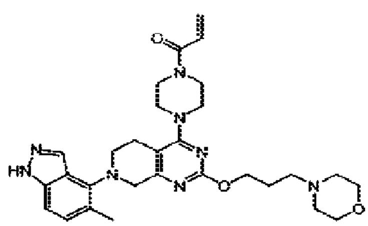
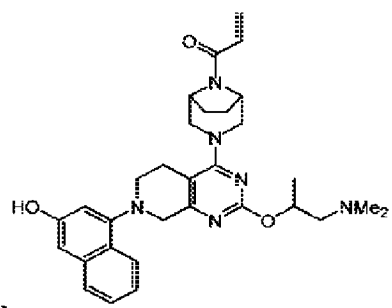
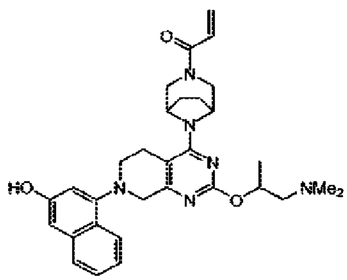
,
,
,

,
,
,

,
,
,

,
,
,

,
,
,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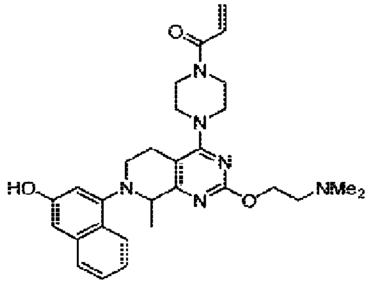
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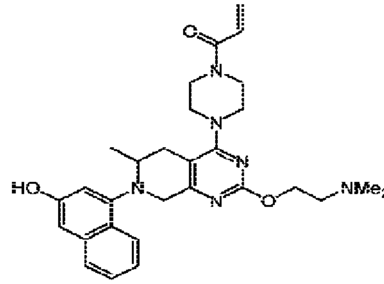
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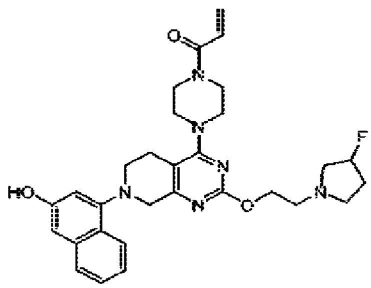
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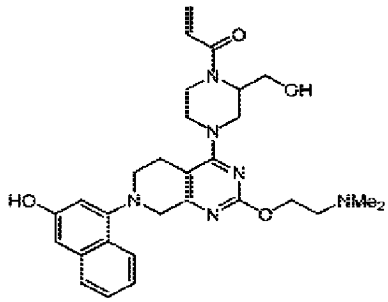
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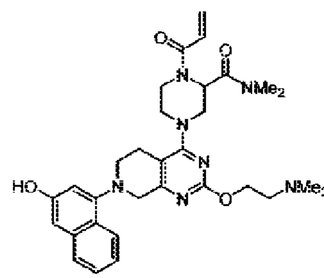
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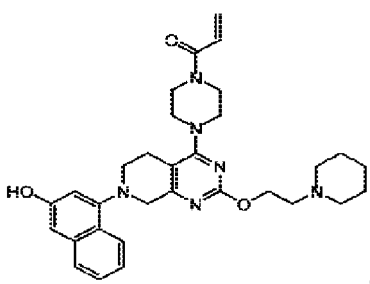
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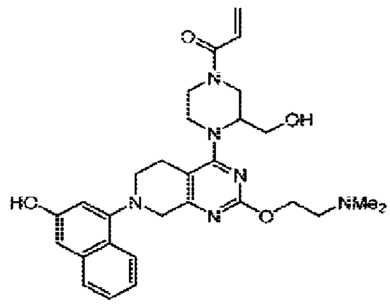
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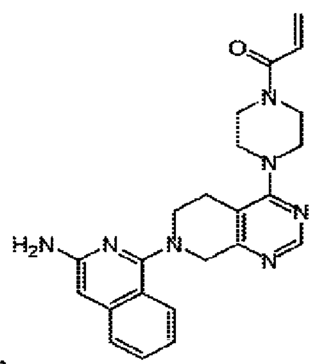
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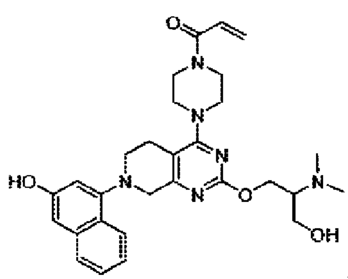
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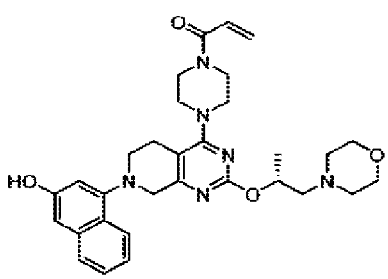
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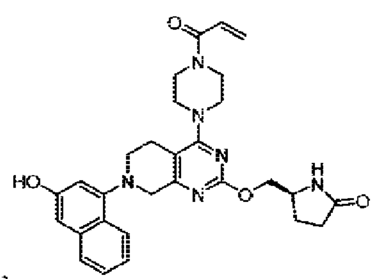
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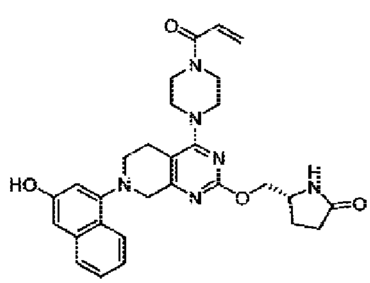
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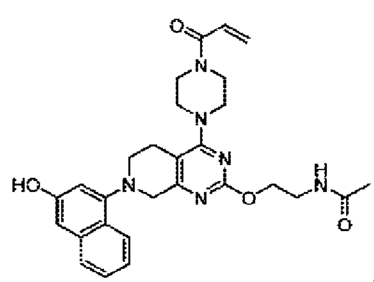
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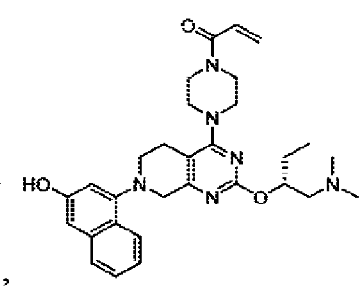
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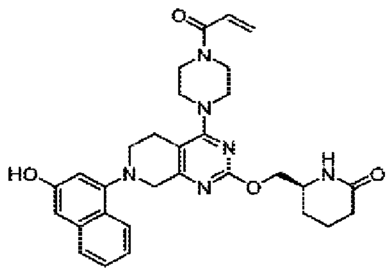
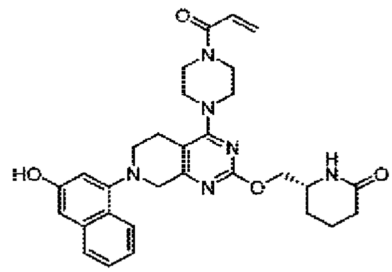
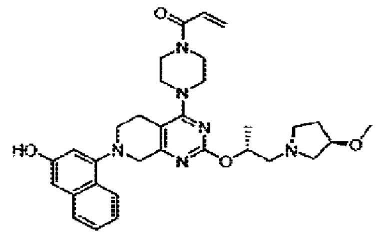
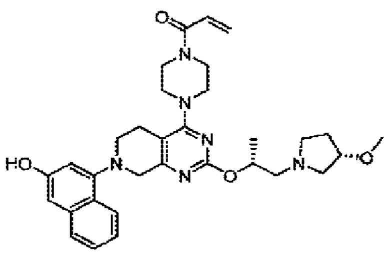
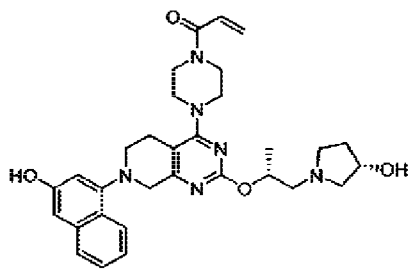
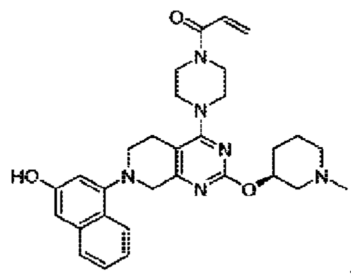
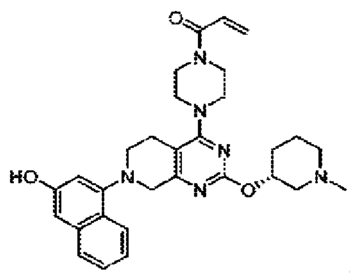
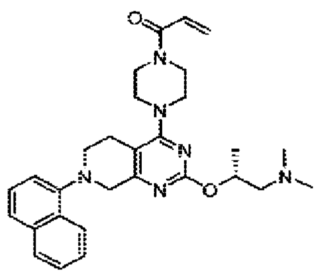
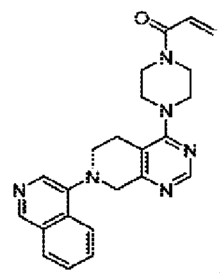
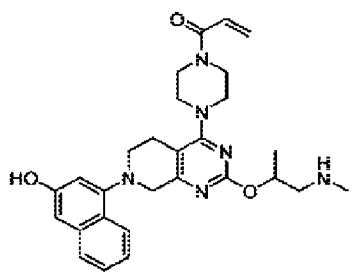
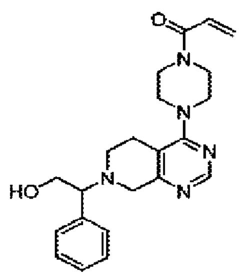
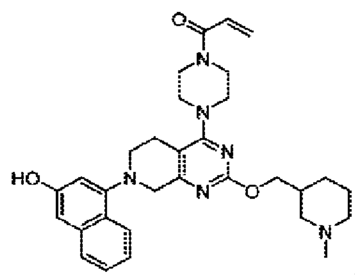
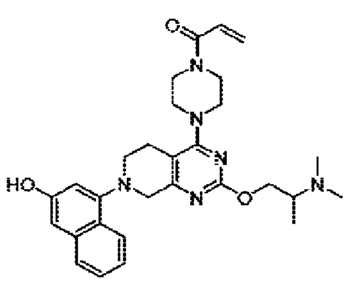
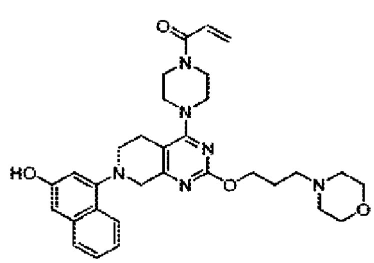
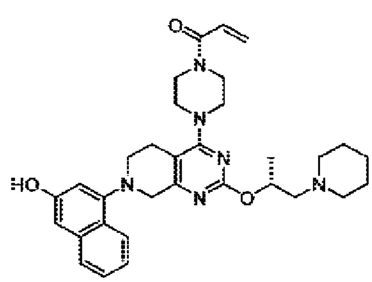
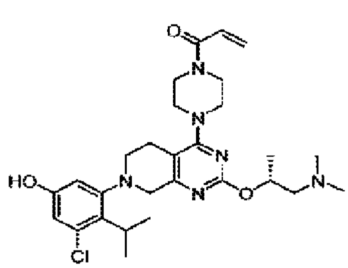
,
,
,
,
,
,
,
,
,
,
,
,
,
,
,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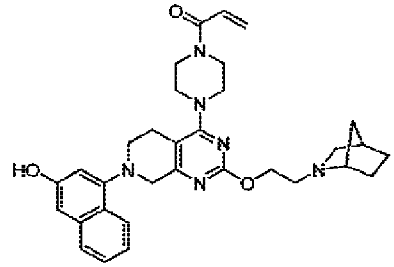
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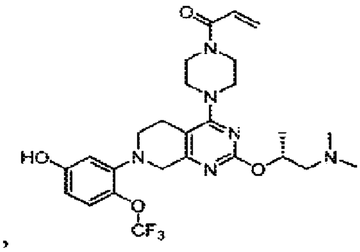
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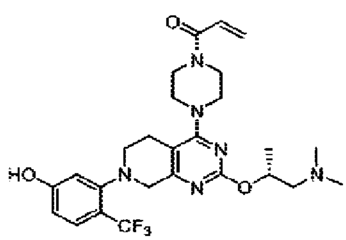
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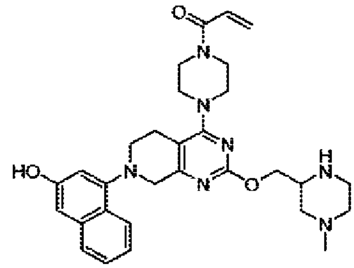
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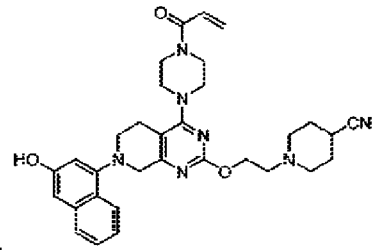
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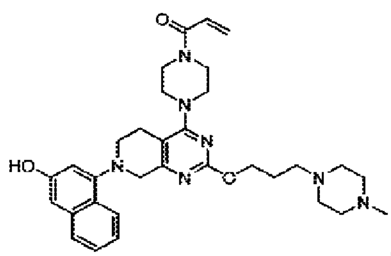
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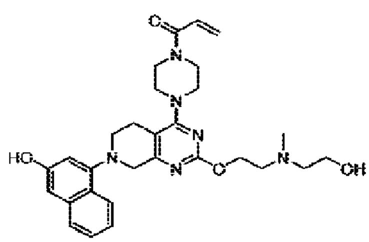
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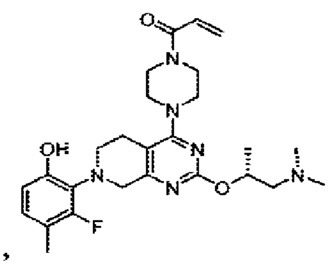
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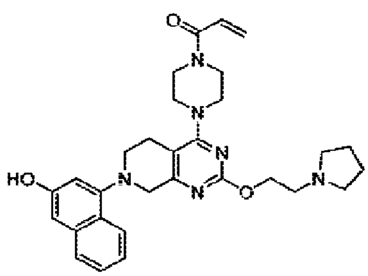
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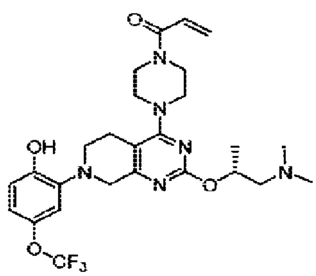
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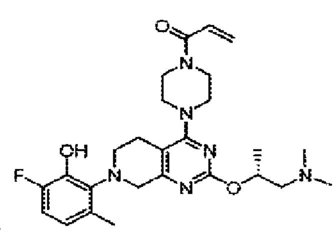
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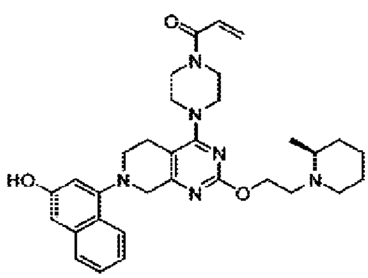
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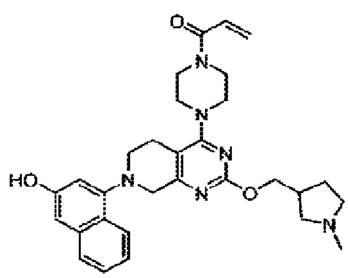
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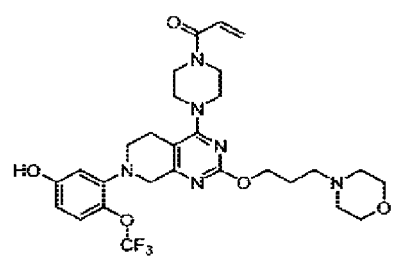
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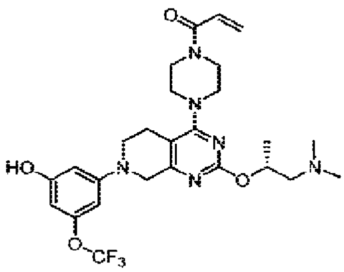
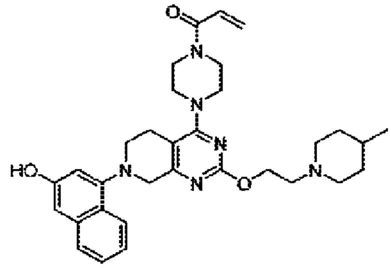
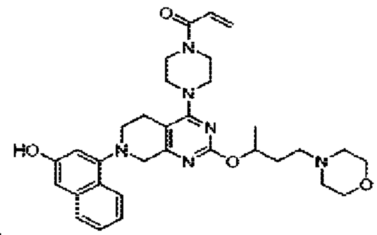
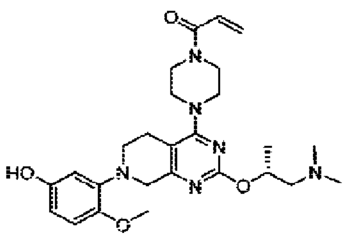
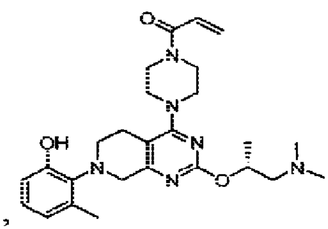
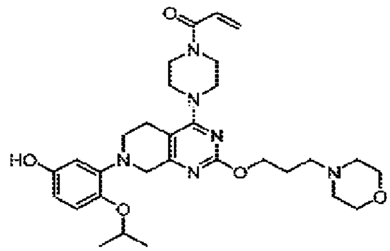
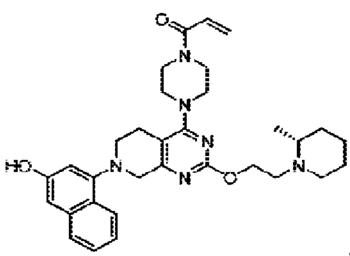
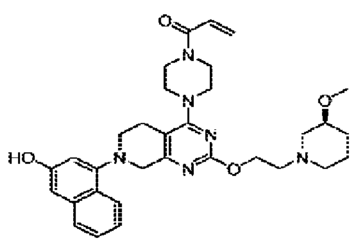
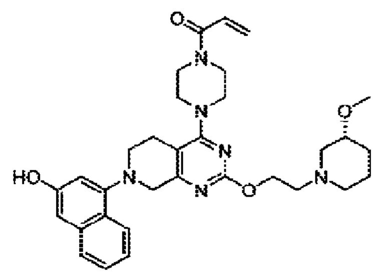
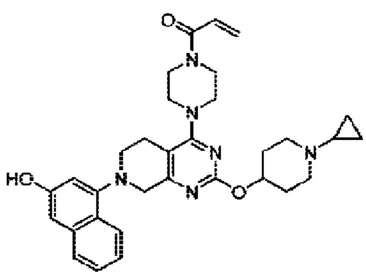
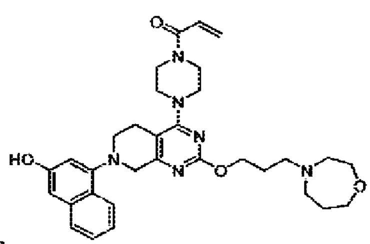
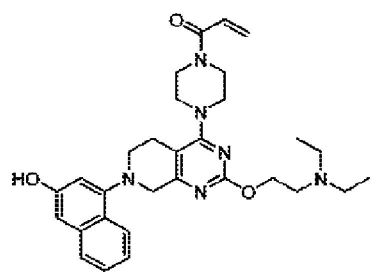
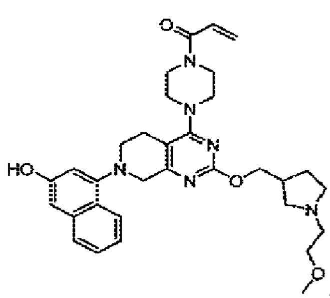
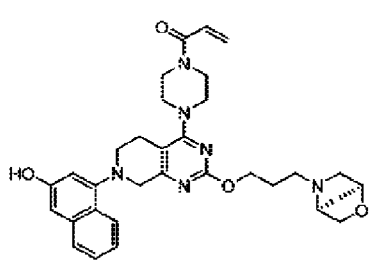
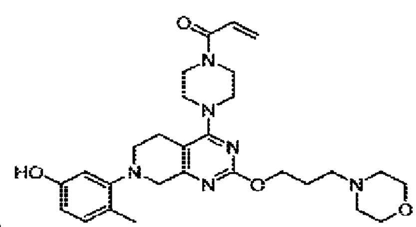
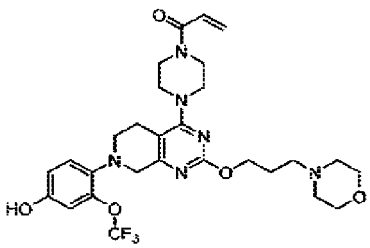
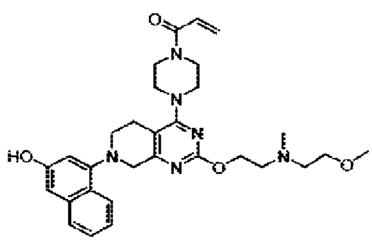
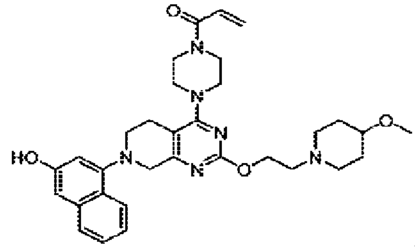
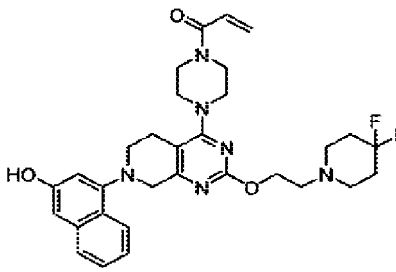
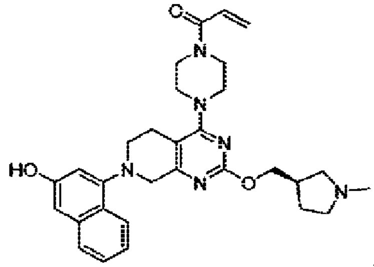
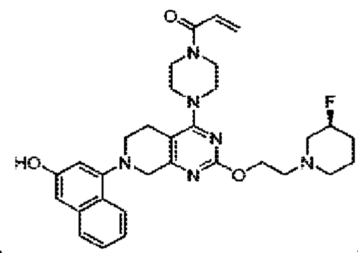
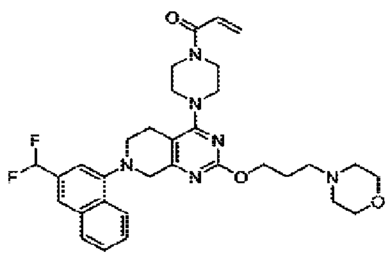
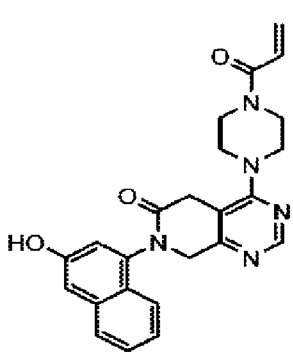
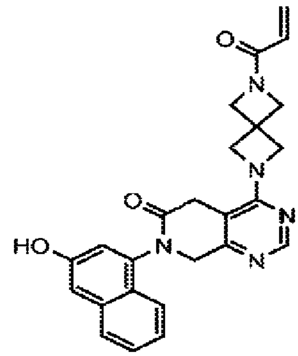
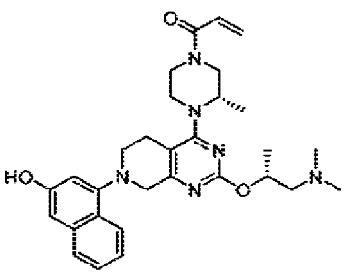
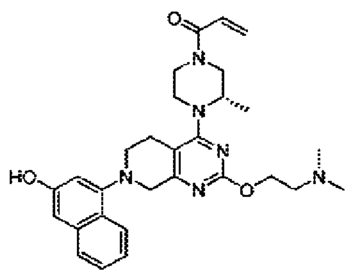
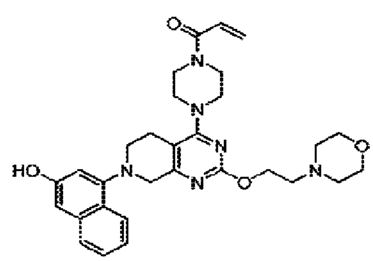
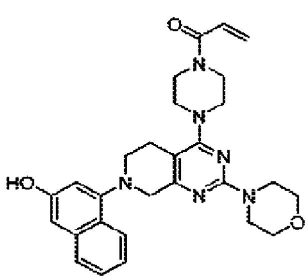
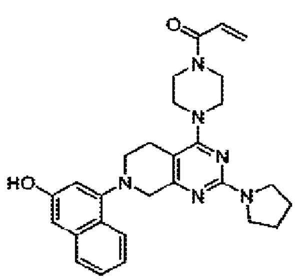
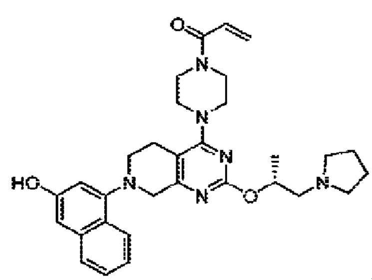
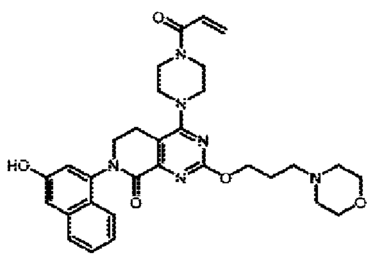
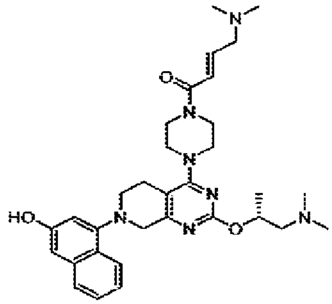
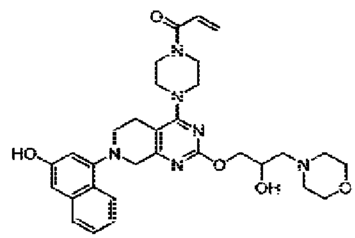
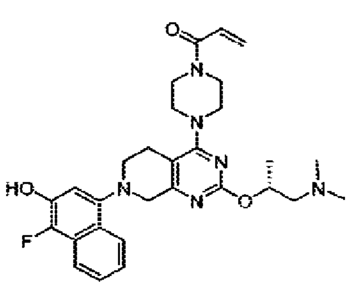
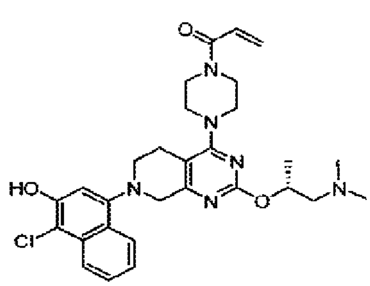
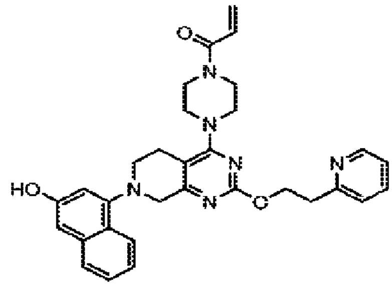
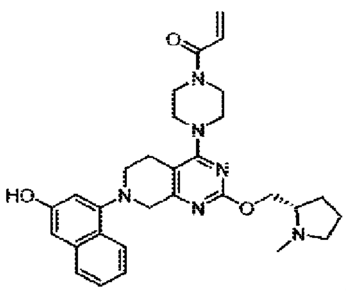
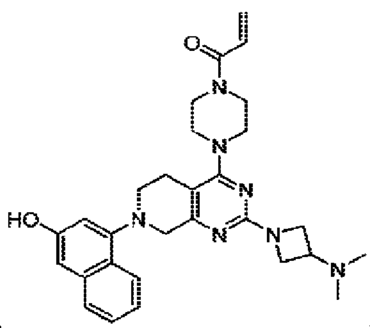
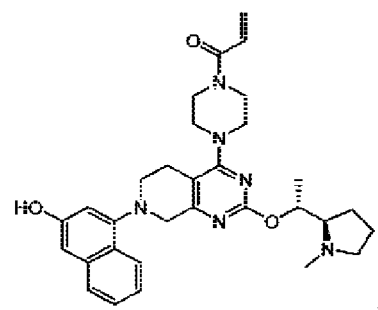
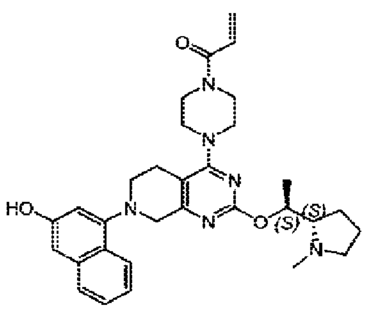
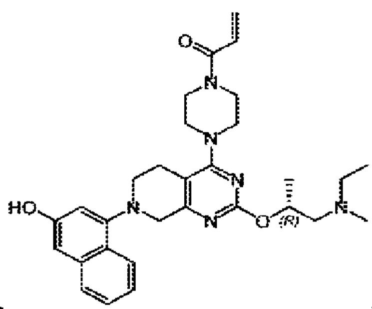
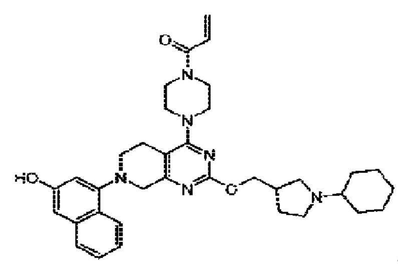
,
,
,
,
,
,
,
,
,
,
,
,
,
,
,

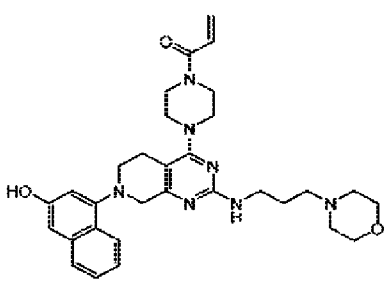
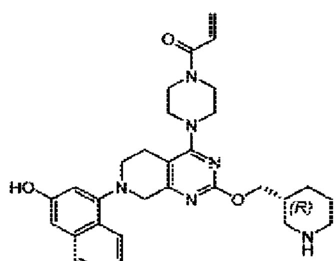
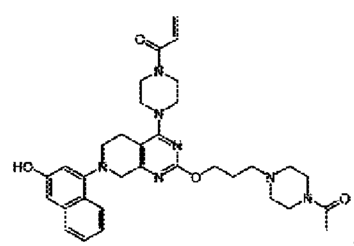
,
,
,
,
,
,
,
,
,
,
,
,
,
,
,

,
,
,

,
,
,

,
,
,

,
,
,

,
,
,

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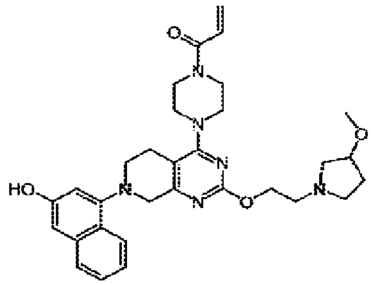
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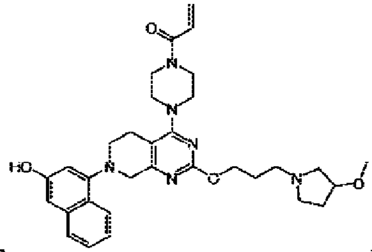
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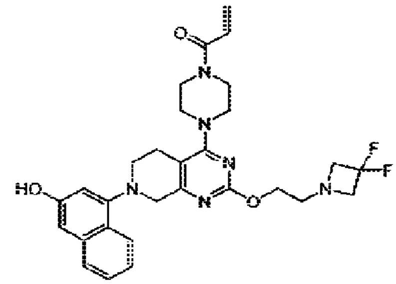
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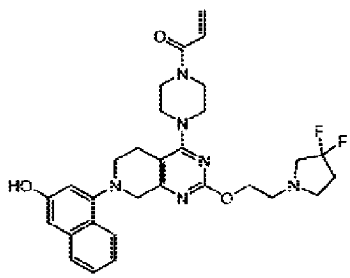
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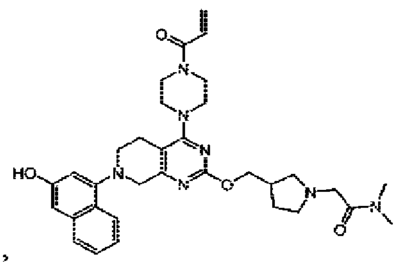
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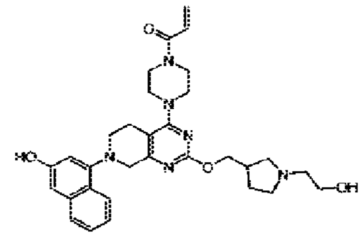
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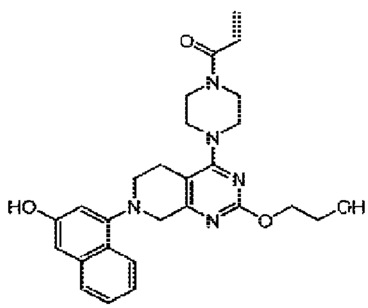
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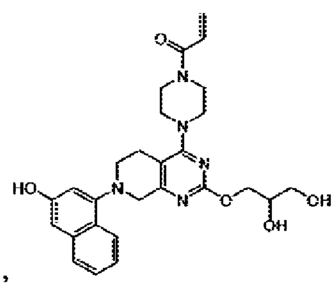
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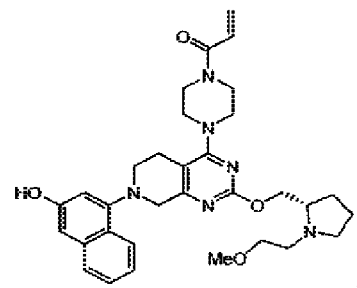
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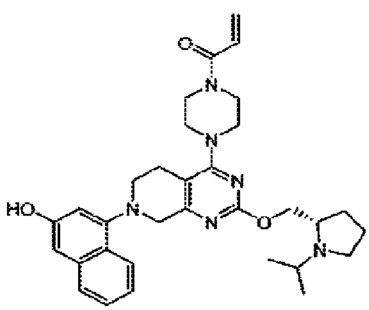
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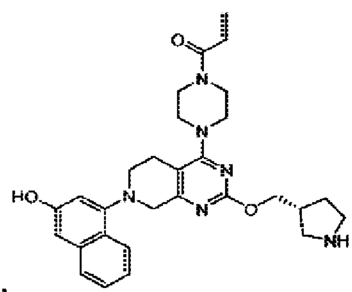
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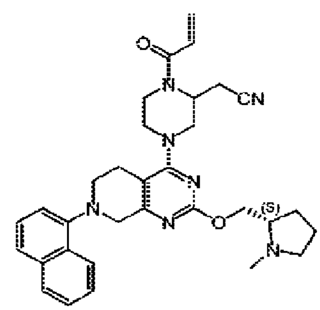
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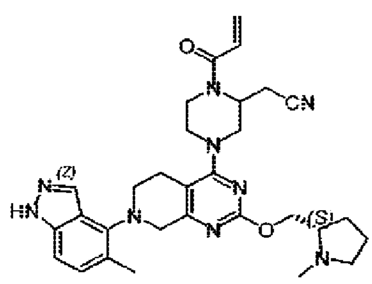
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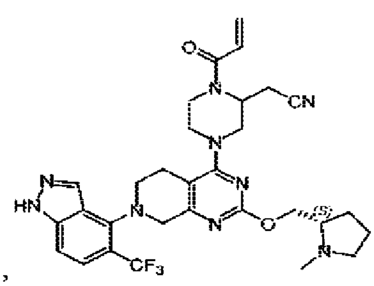
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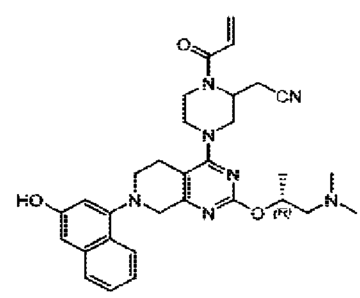
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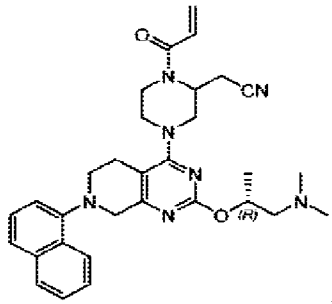
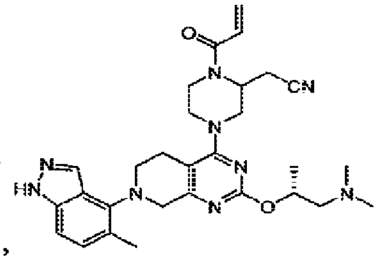
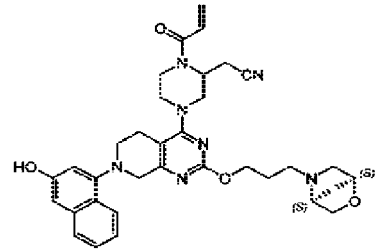
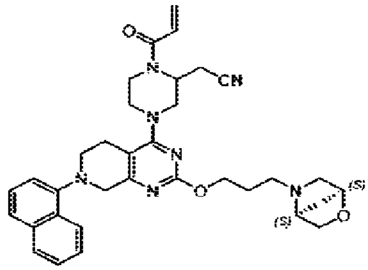
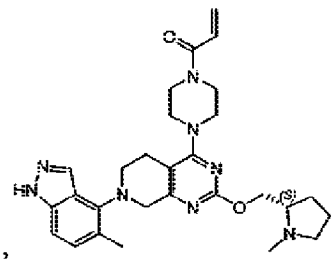
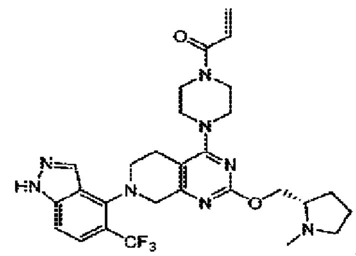
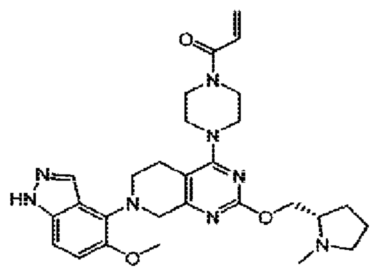
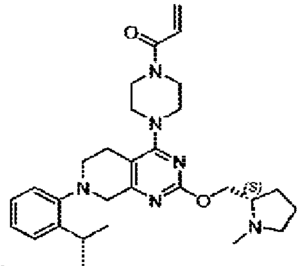
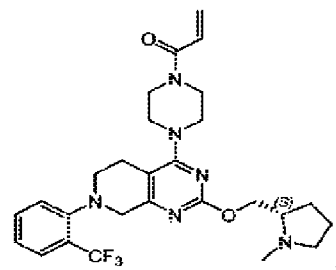
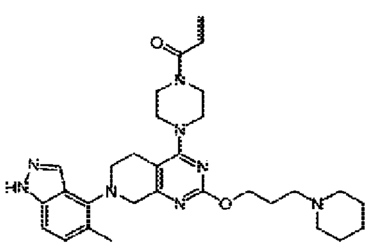
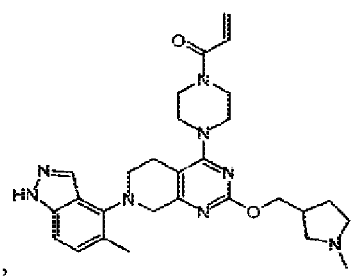
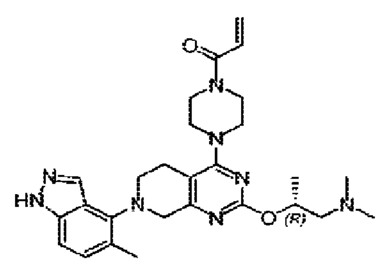
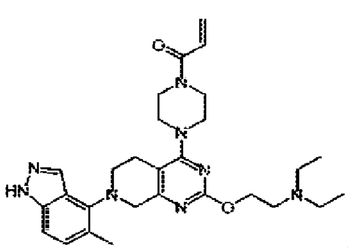
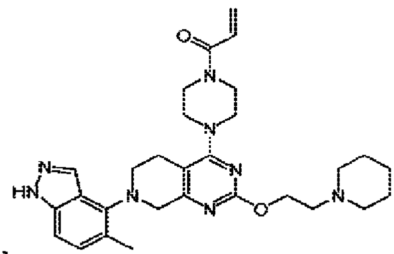
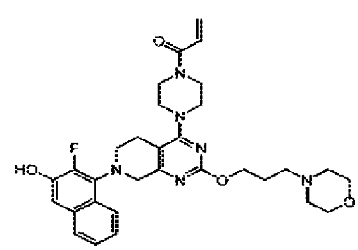
,
,
,

,
,
,

,
,
,

,
,
,

,
,
,

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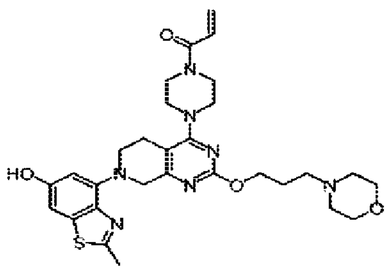
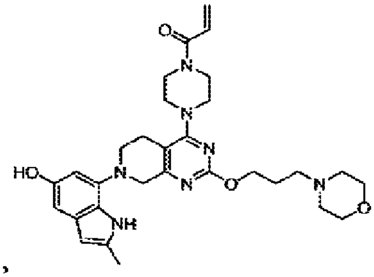
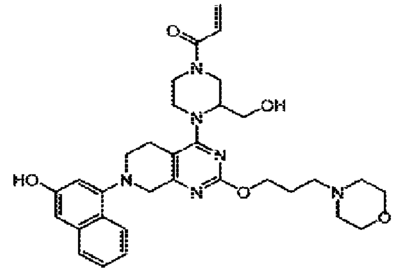
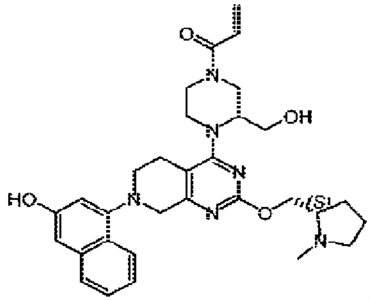
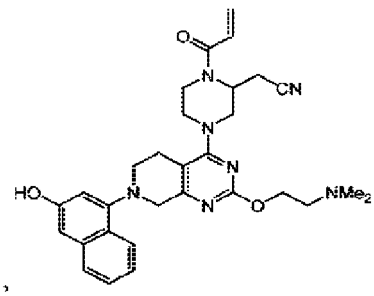
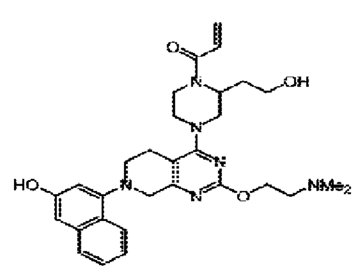
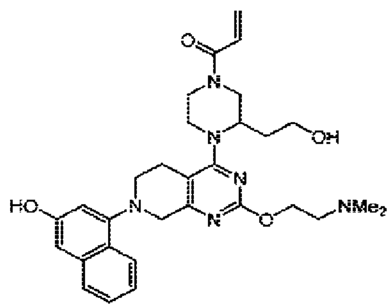
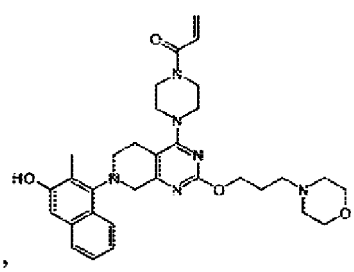
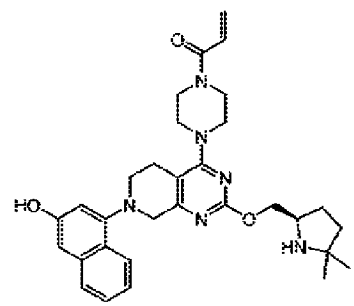
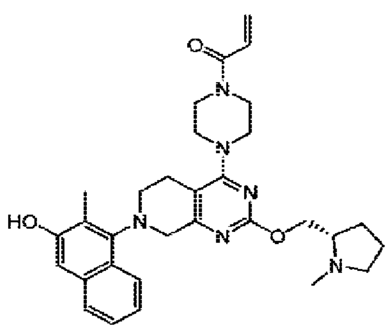
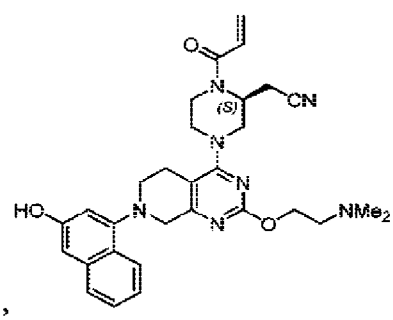
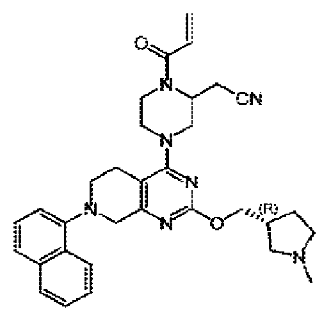
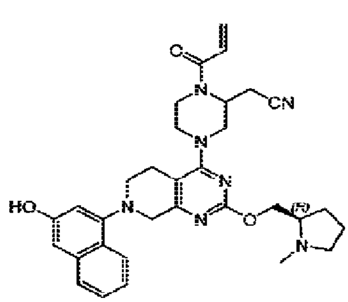
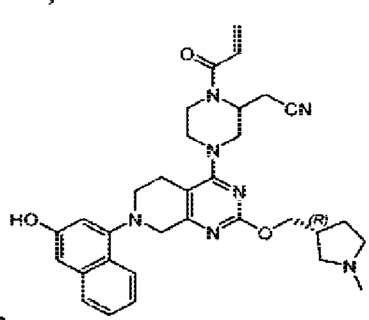
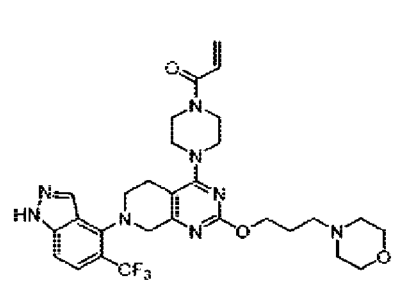
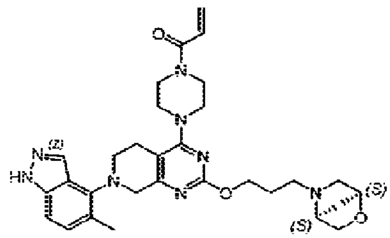
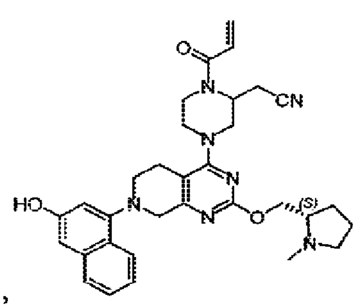
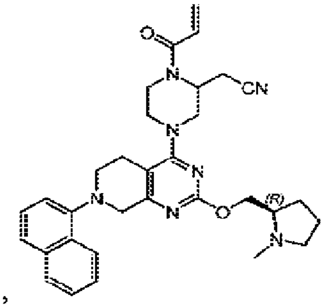
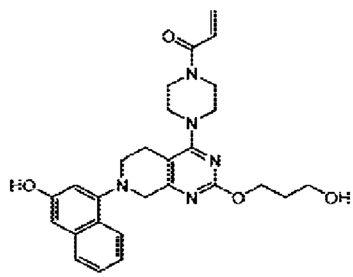
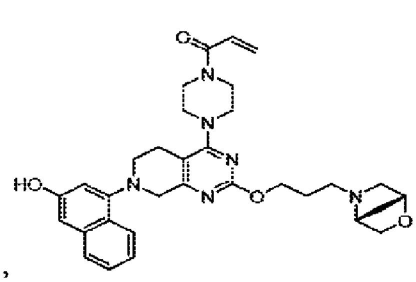
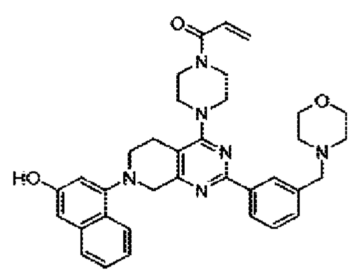
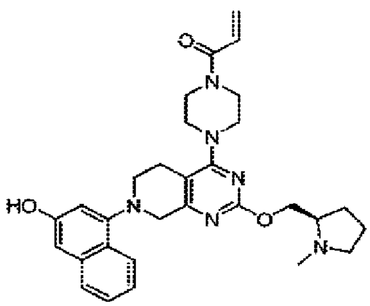
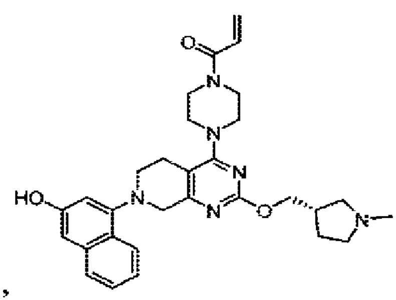
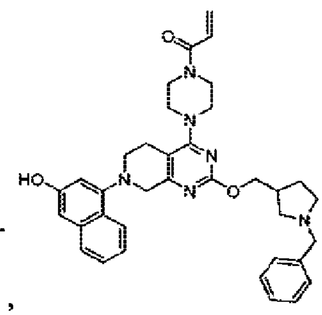
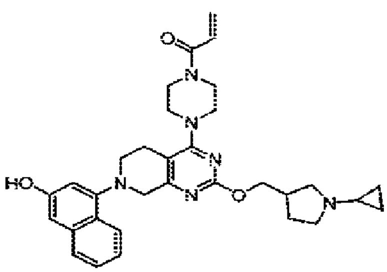
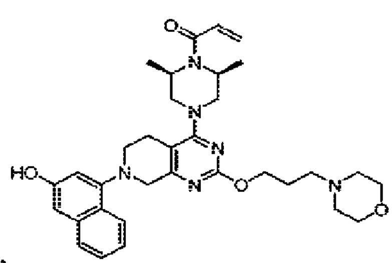
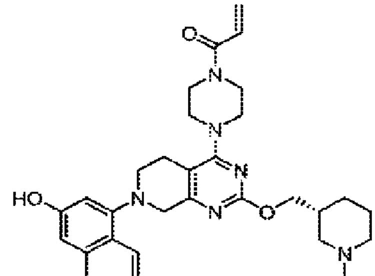
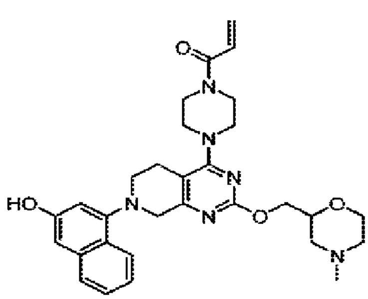
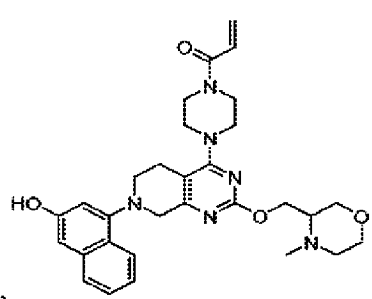
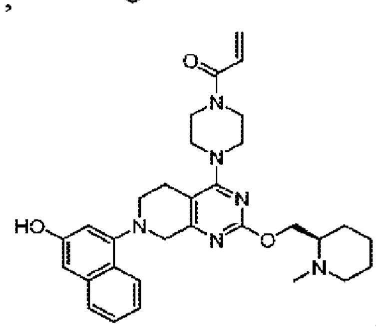
,
,
,
,
,
,
,
,
,
,
,
,
,
,
,

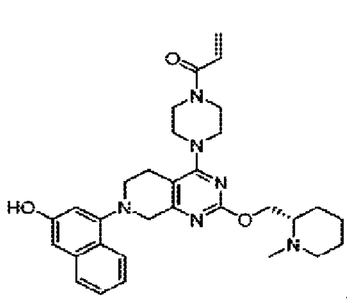
, , ,

, , ,

, , ,

, , ,

, , ,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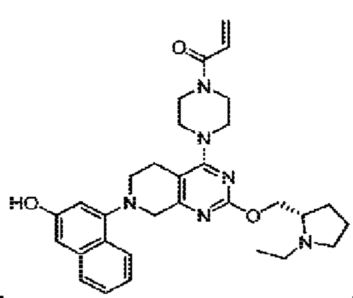
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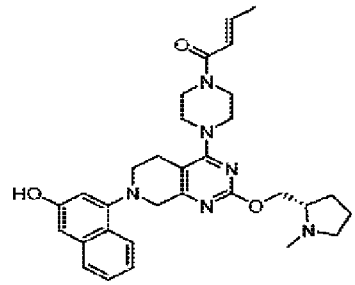
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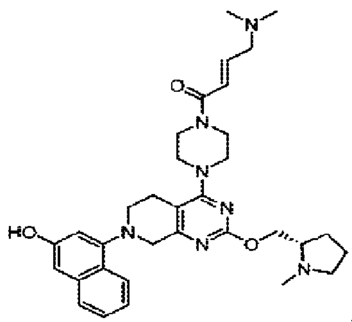
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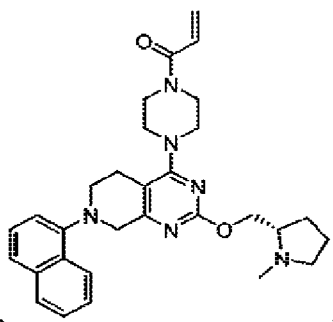
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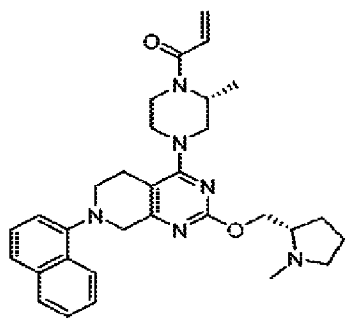
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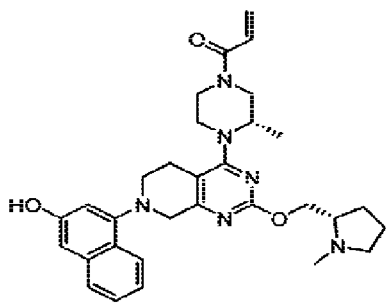
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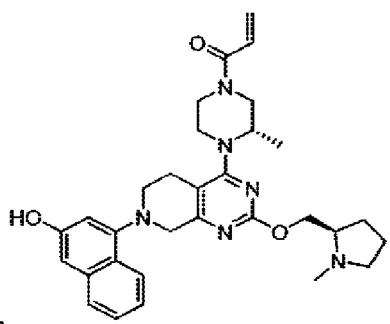
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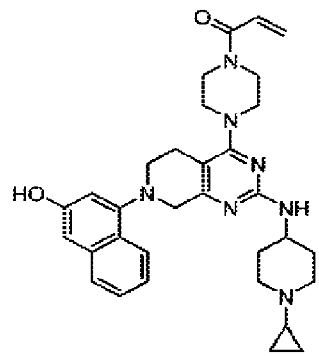
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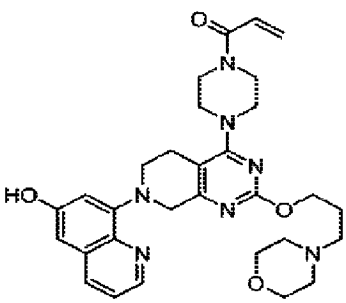
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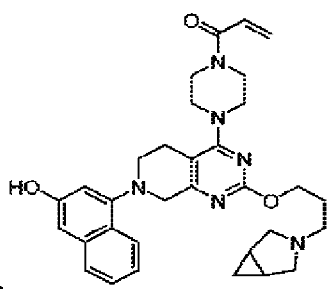
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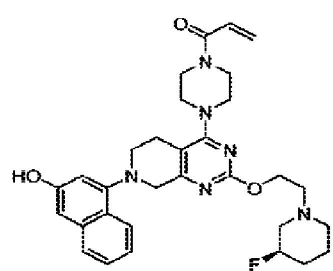
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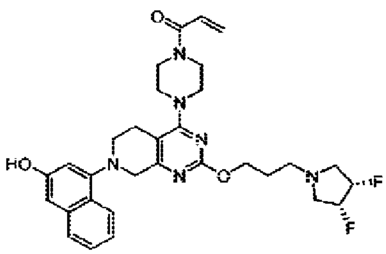
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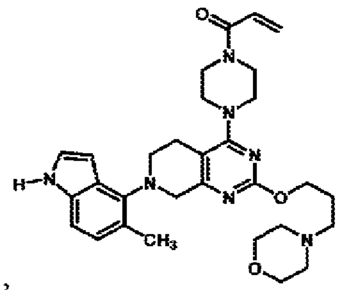
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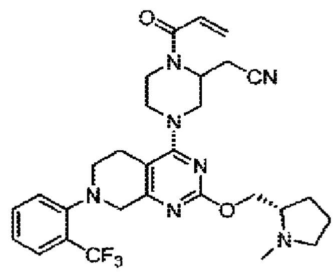
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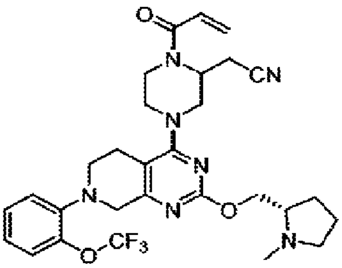
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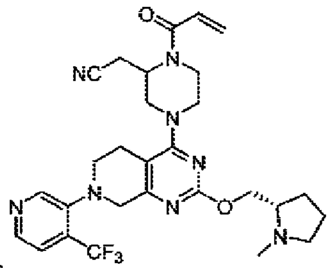
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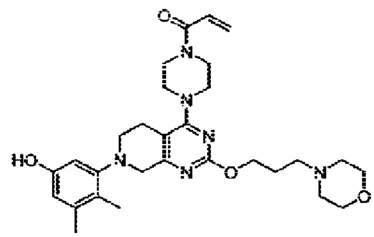
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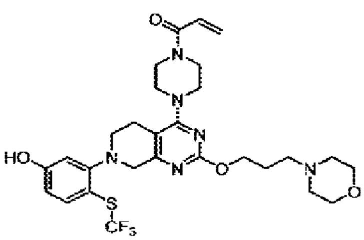
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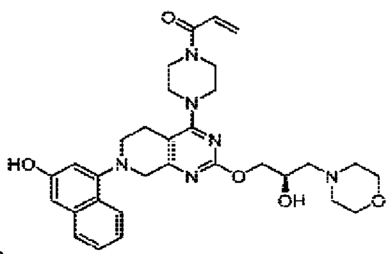
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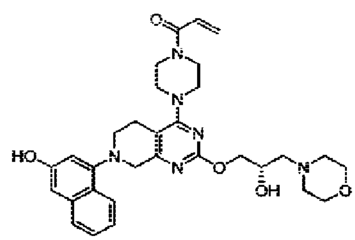
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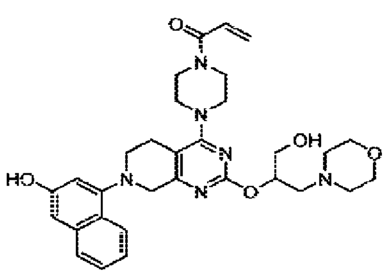
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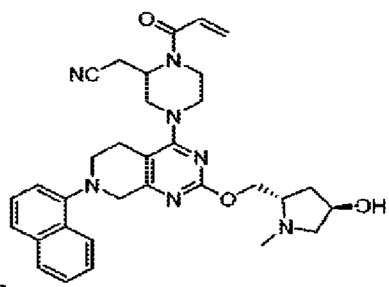
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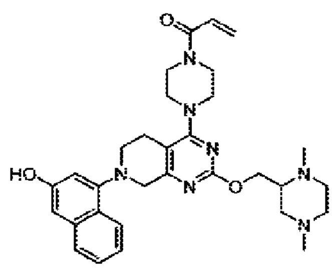
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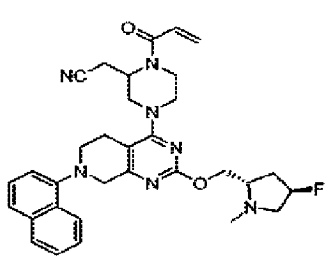
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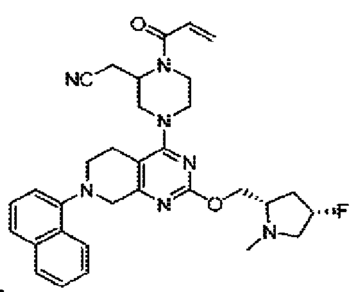
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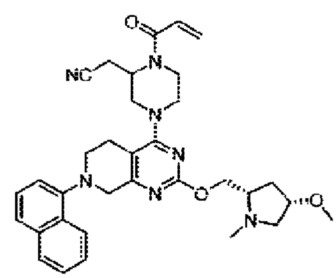
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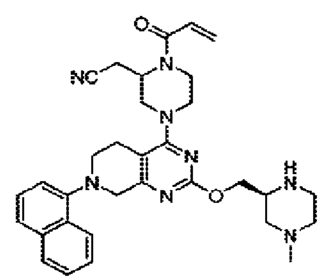
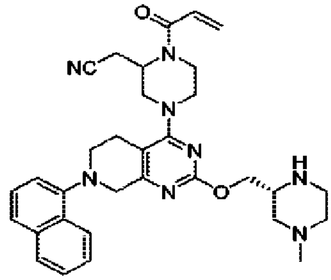
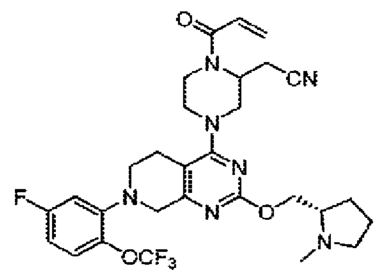
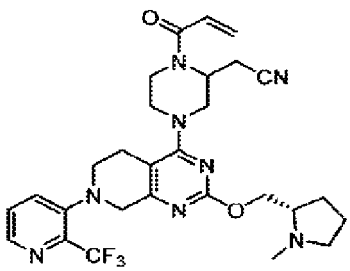
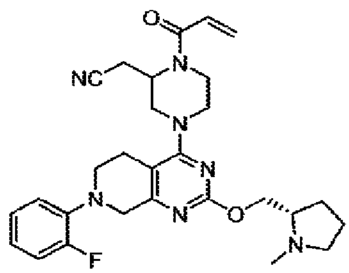
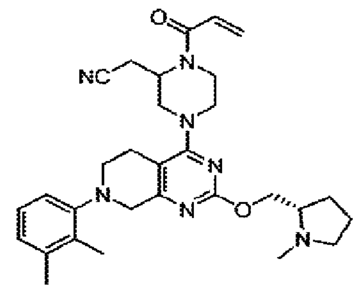
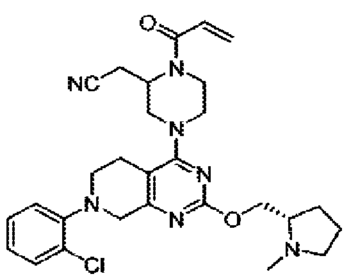
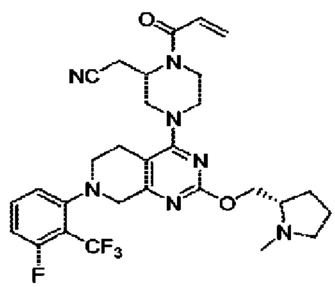
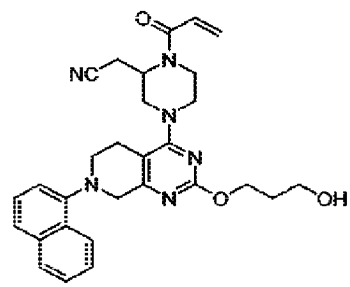
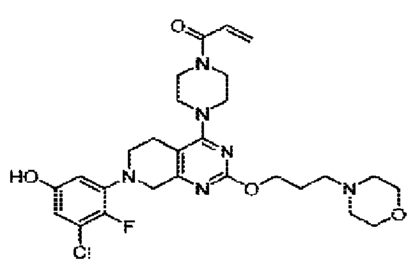
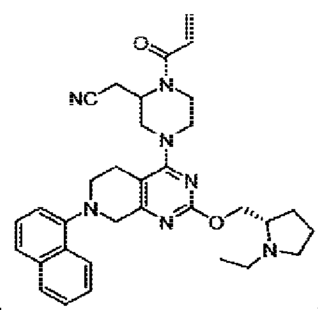
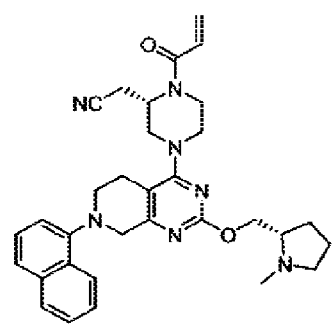
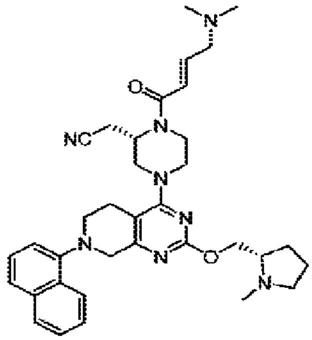
 ,  ,  ,

 ,  ,  ,

 ,  ,  ,

 ,  ,  ,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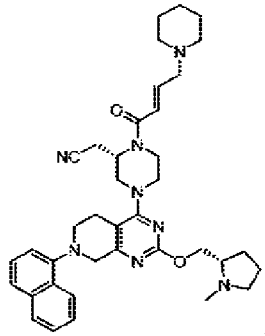
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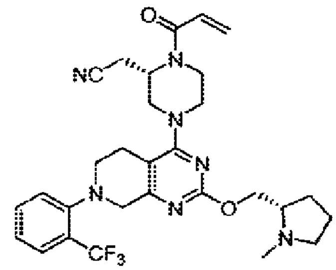
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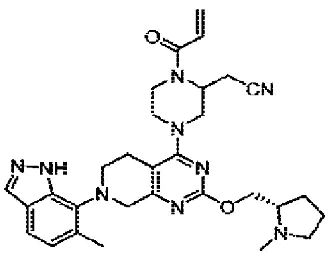
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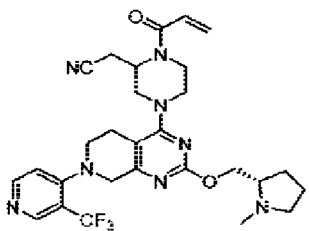
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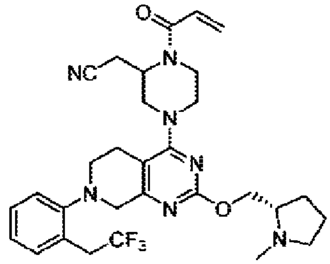
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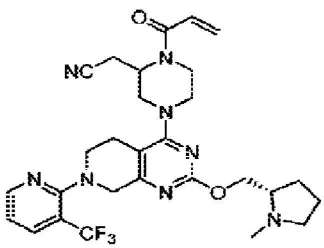
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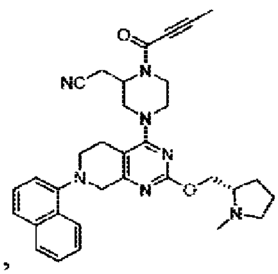
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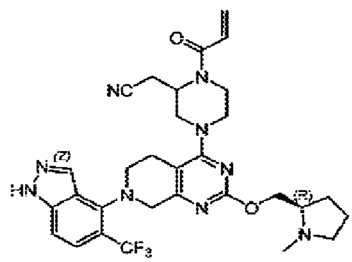
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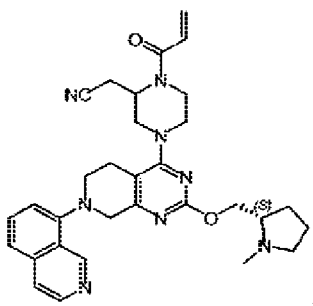
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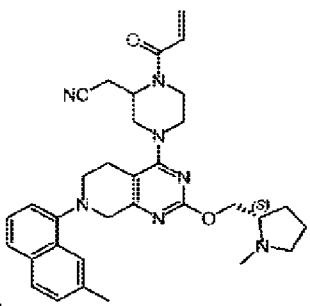
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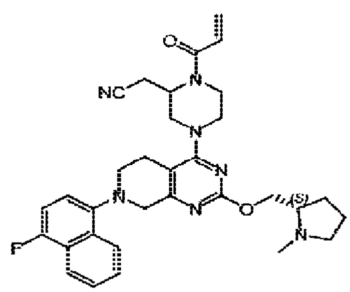
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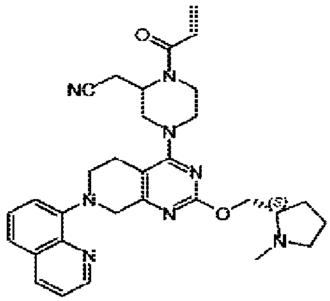
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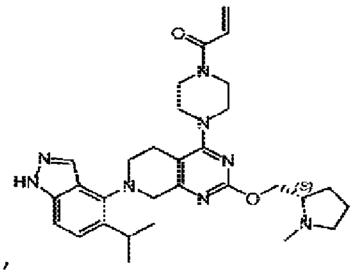
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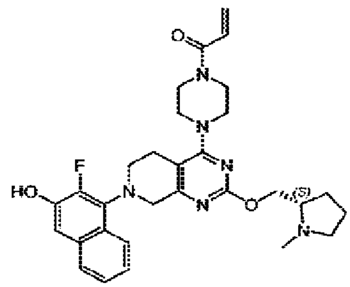
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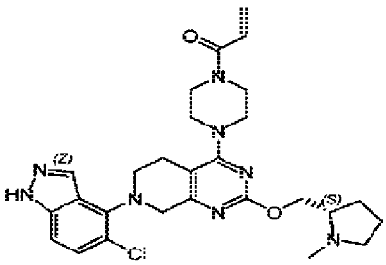
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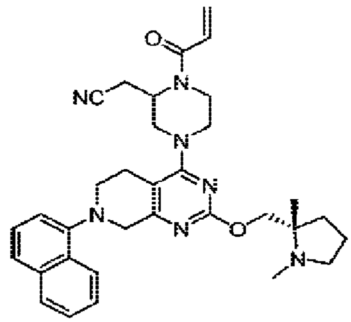
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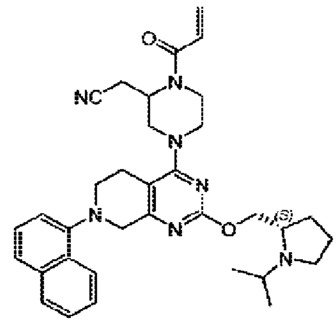
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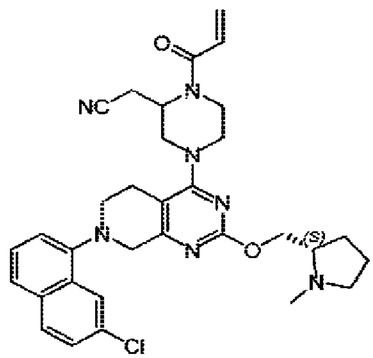
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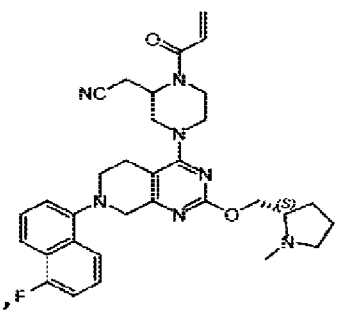
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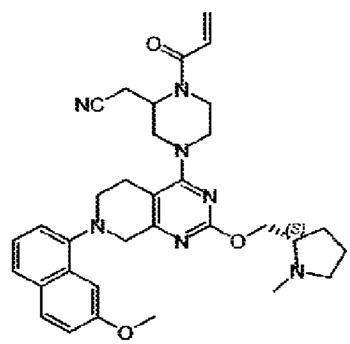
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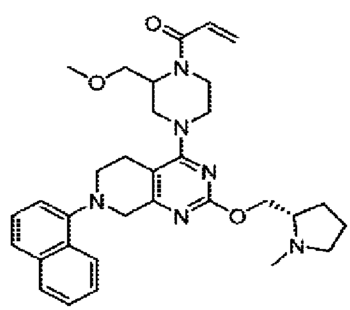
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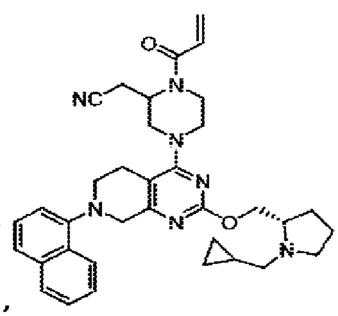
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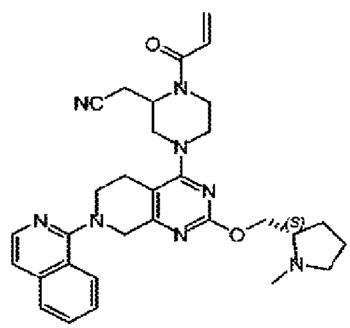
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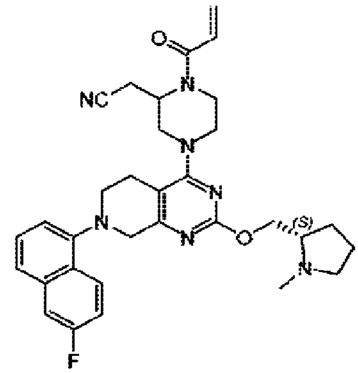
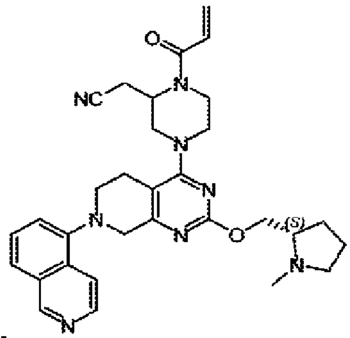
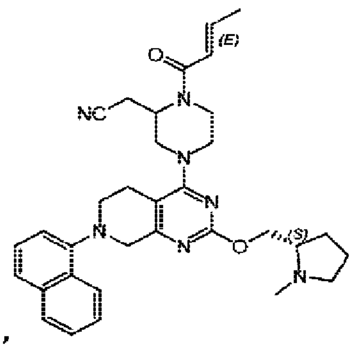
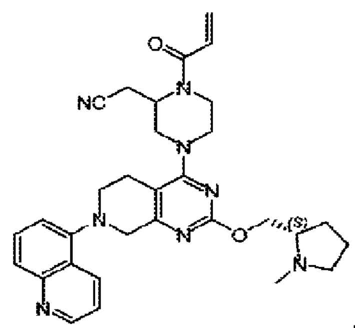
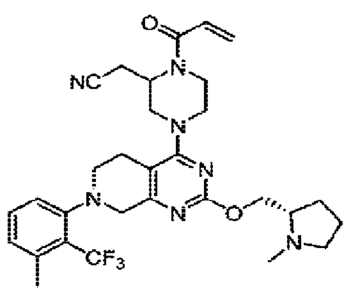
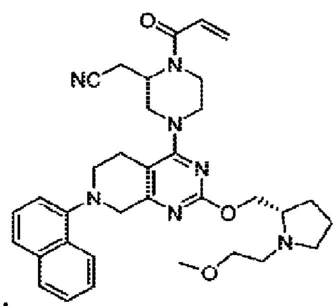
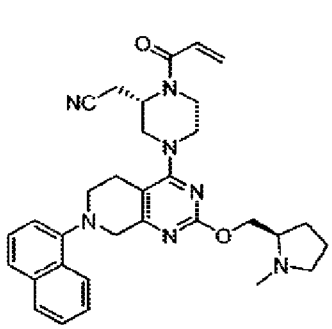
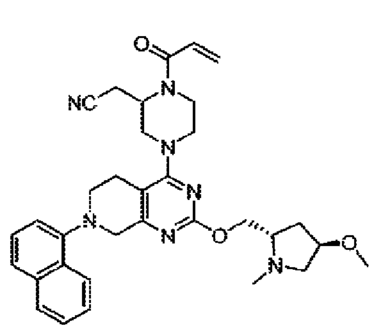
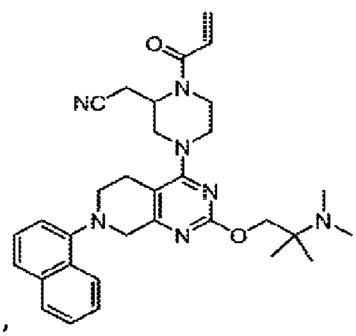
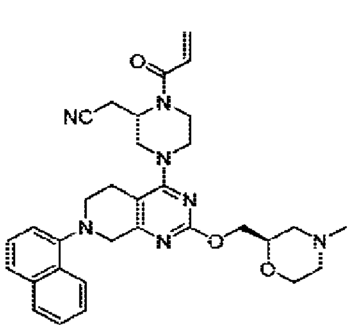
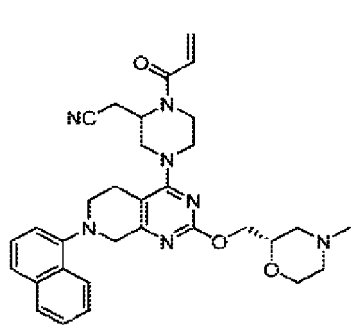
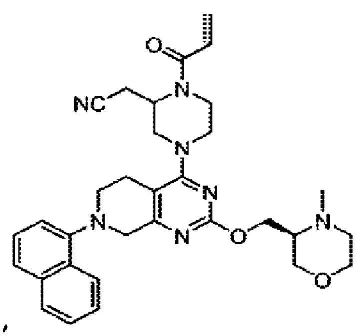
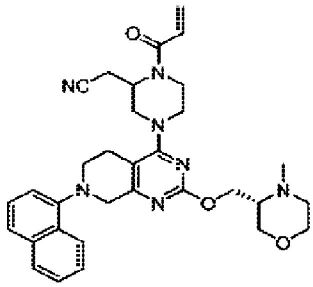
,
,
,
,
,
,
,
,
,
,
,
,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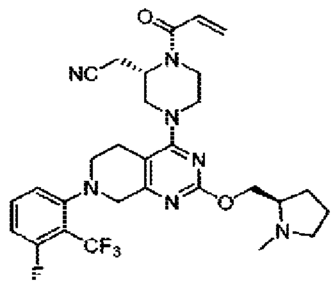
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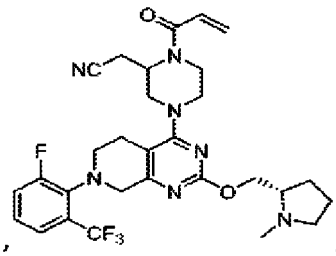
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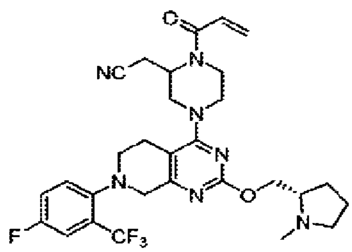
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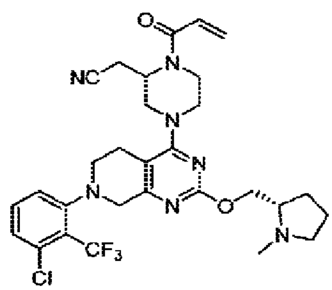
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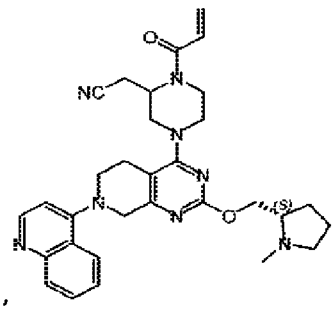
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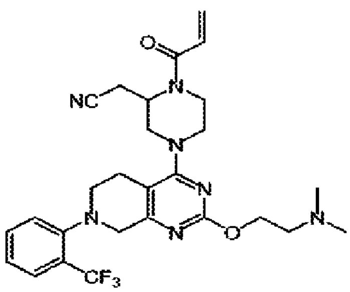
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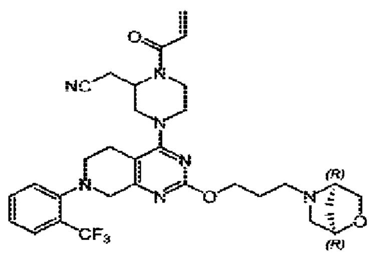
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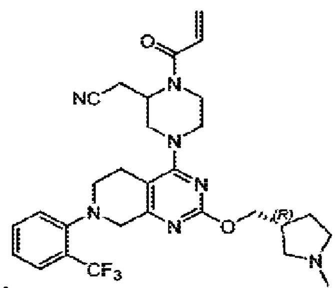
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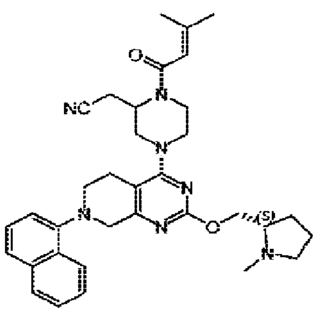
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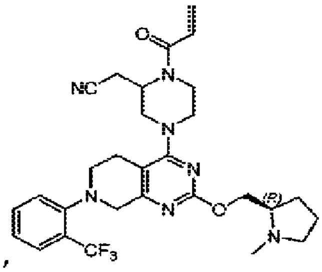
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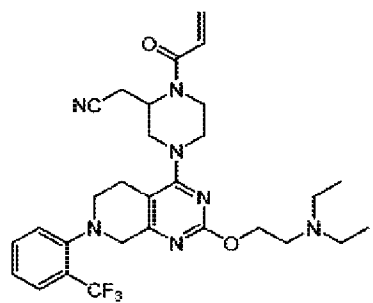
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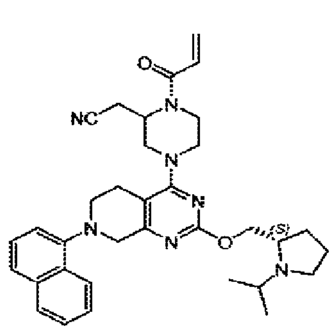
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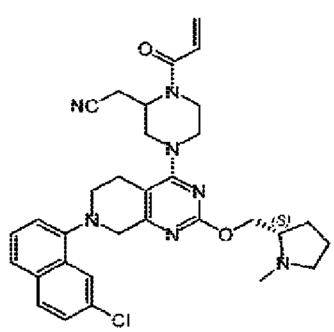
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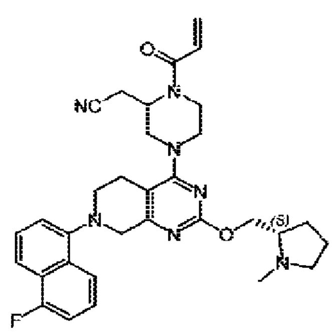
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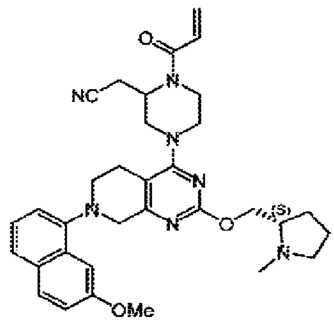
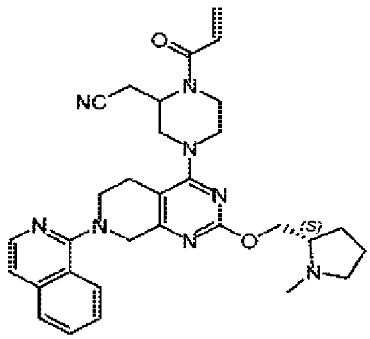
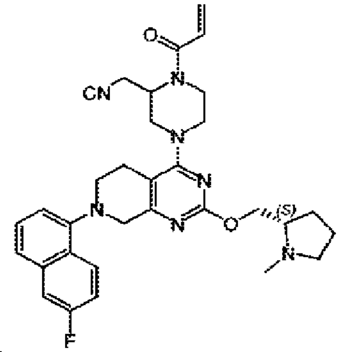
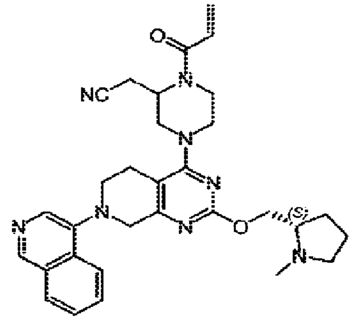
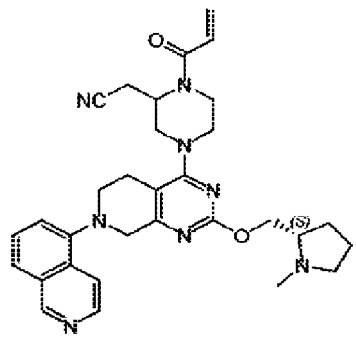
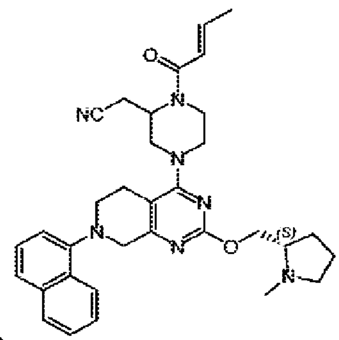
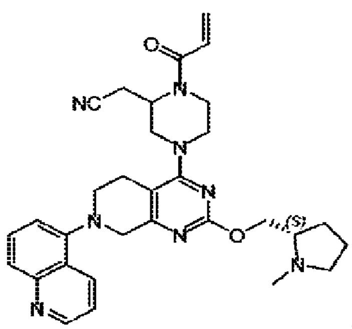
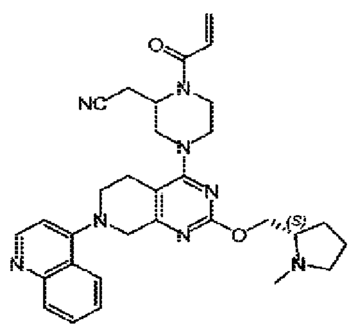
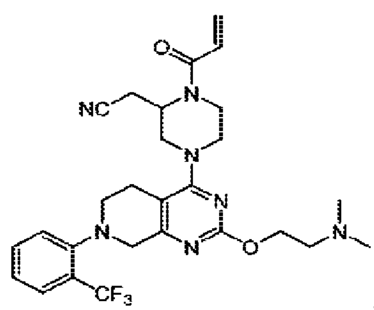
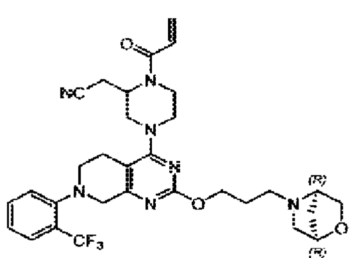
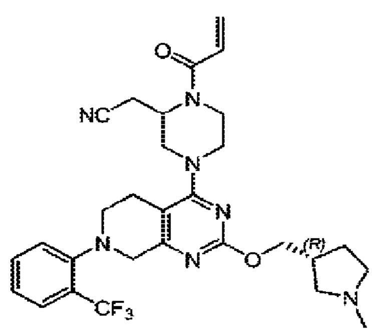
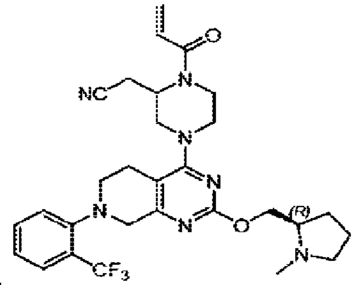
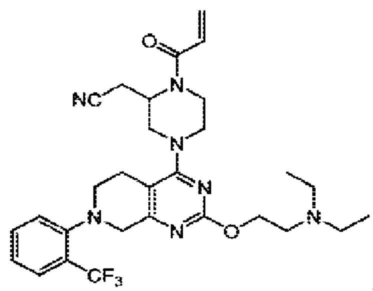
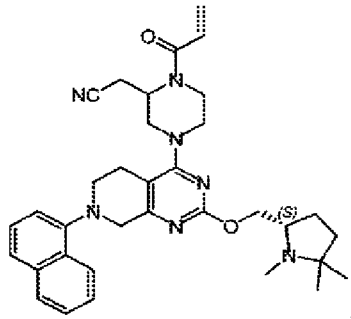
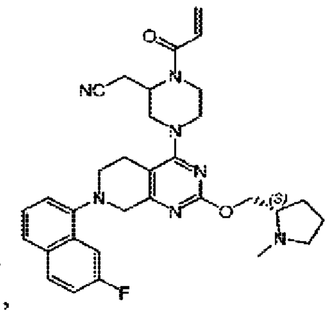
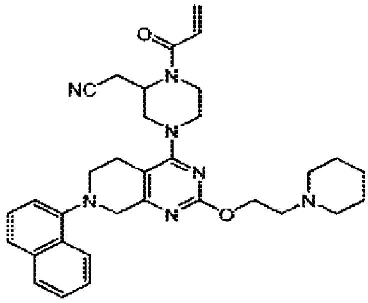
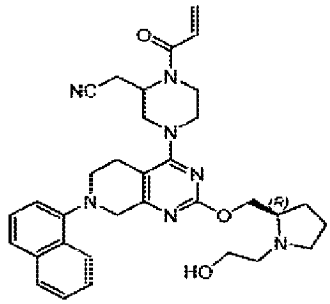
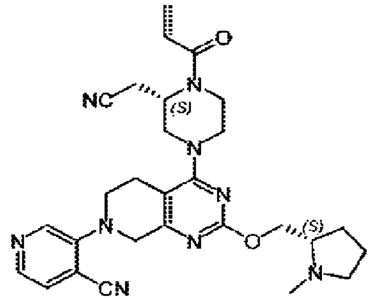
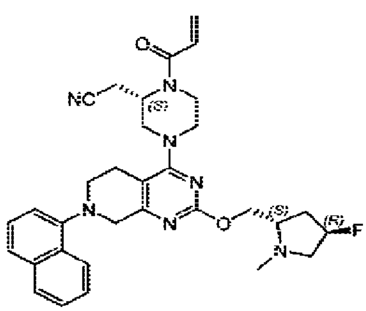
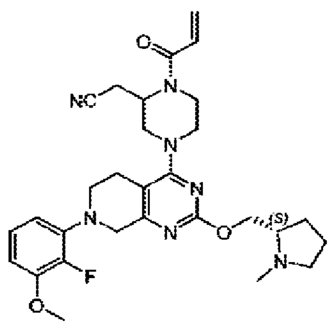
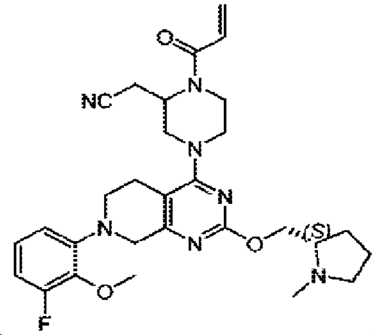
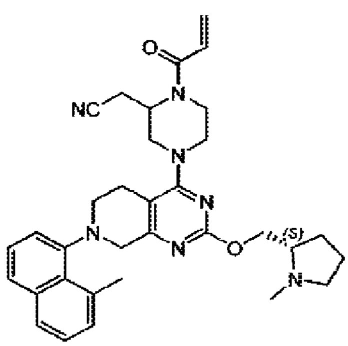
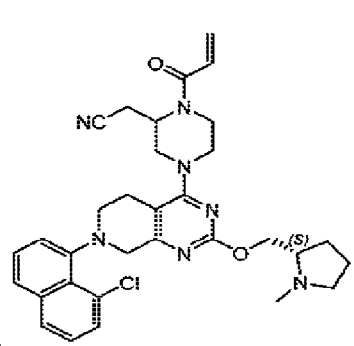
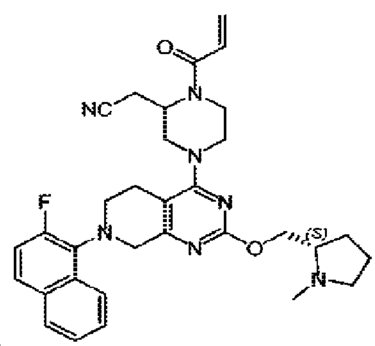
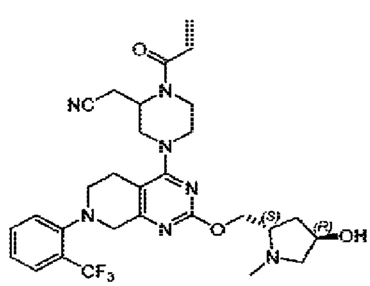
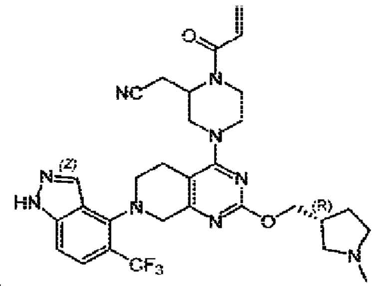
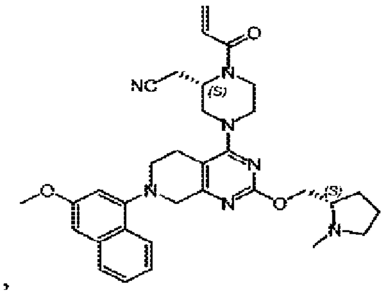
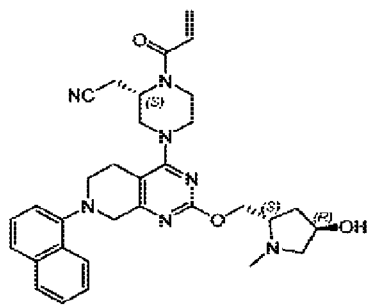
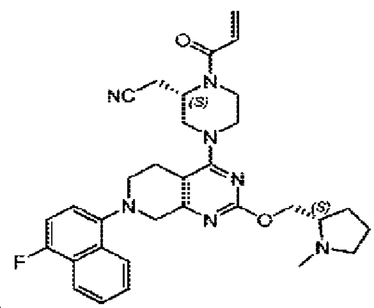
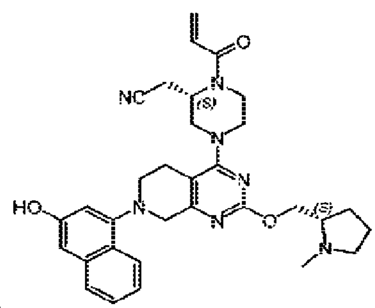
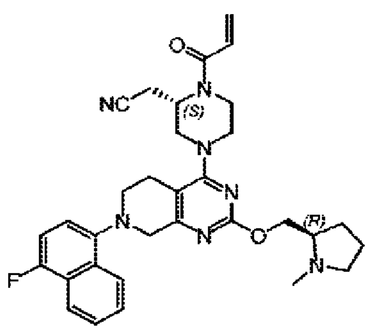
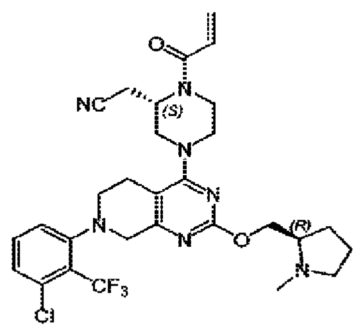
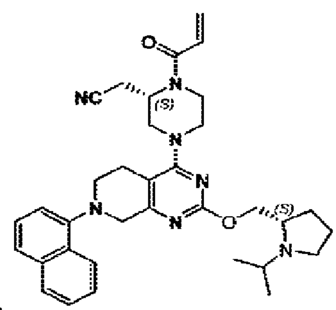
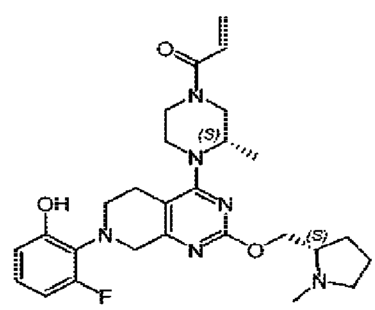
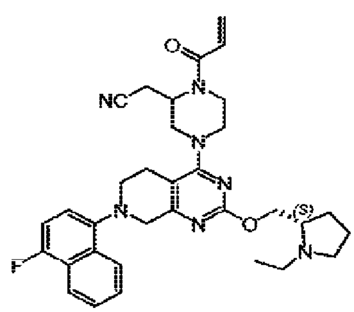
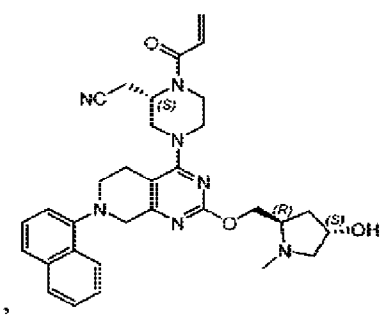
,
,
,
,
,
,
,
,
,
,
,
,

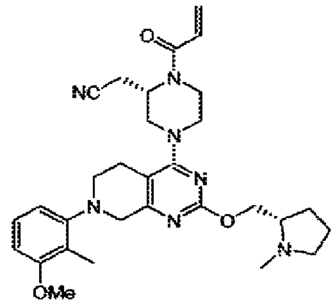
 ,
 ,
 ,

 ,
 ,
 ,

 ,
 ,
 ,

 ,
 ,
 ,

 ,
 ,
 ,
 ,
 ,
 ,
 ,
 ,
 ,
 ,
 ,
 ,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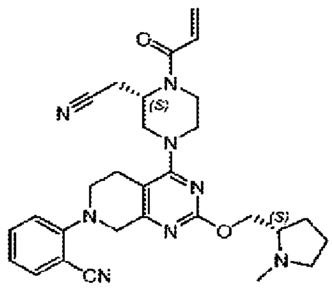
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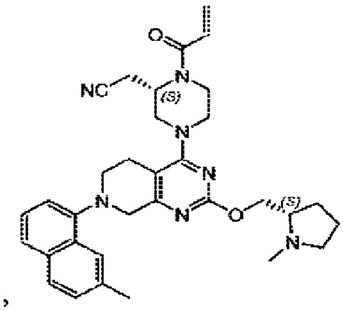
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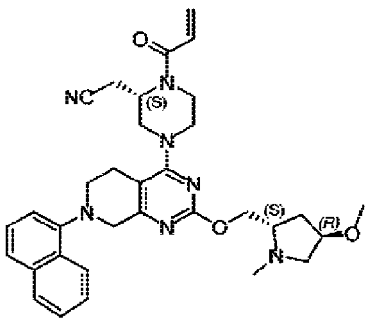
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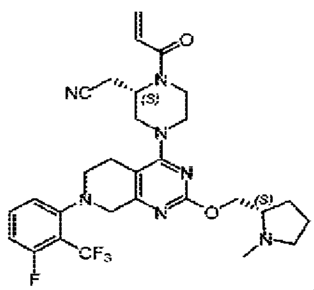
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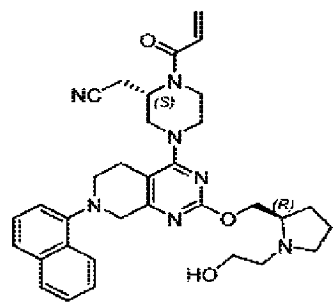
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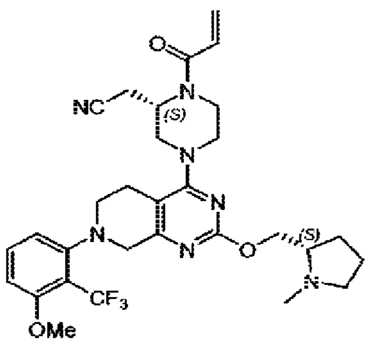
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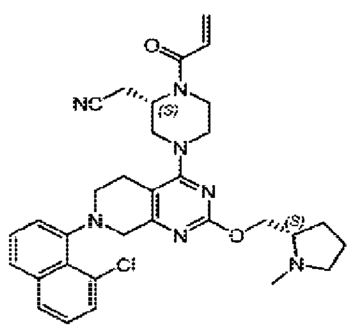
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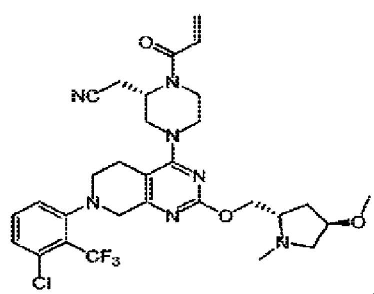
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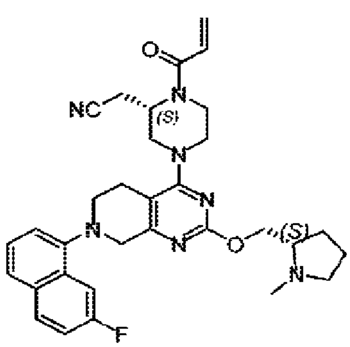
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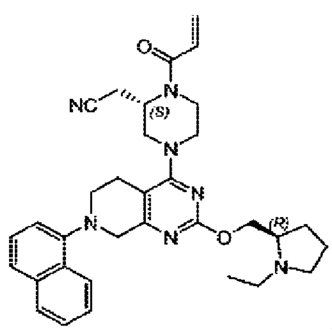
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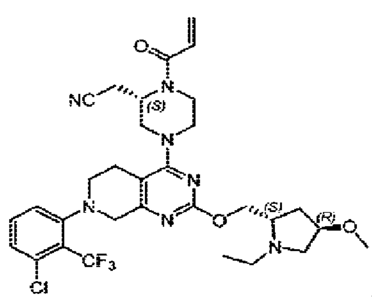
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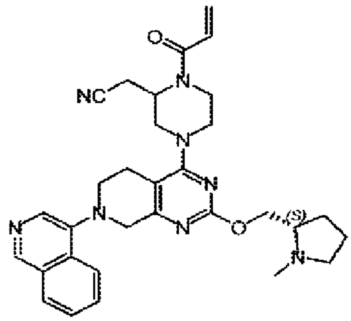
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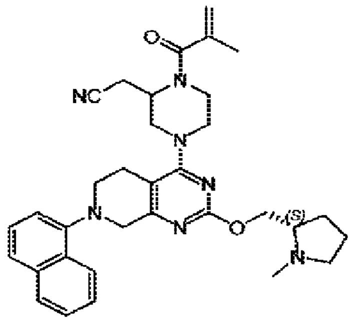
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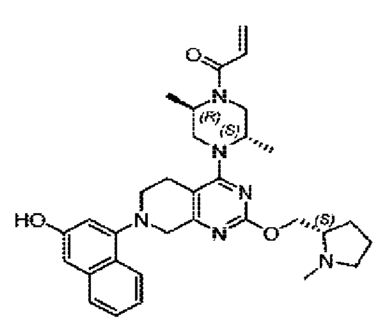
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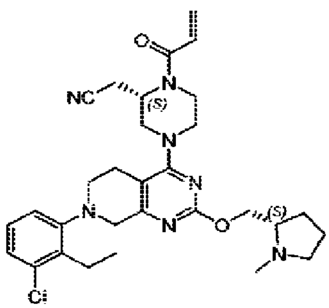
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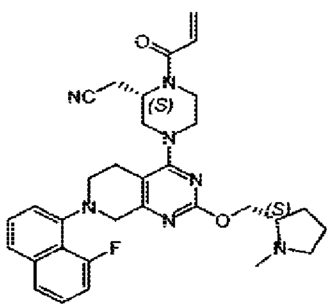
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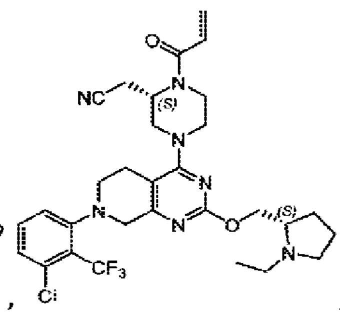
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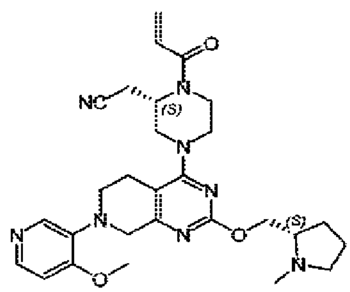
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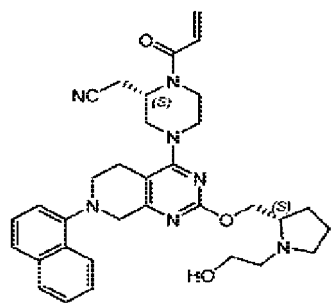
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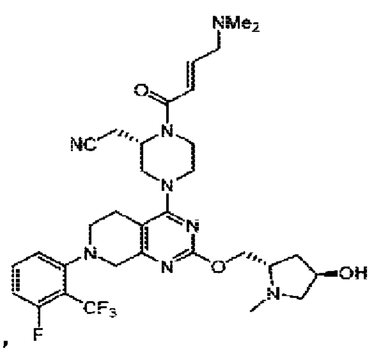
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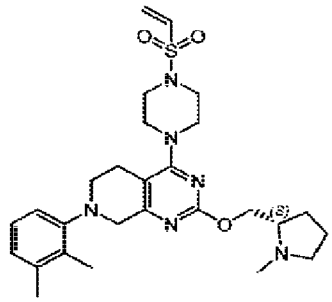
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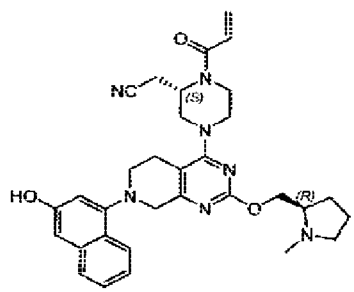
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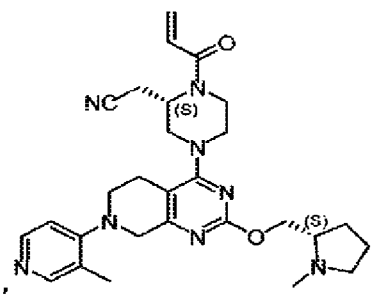
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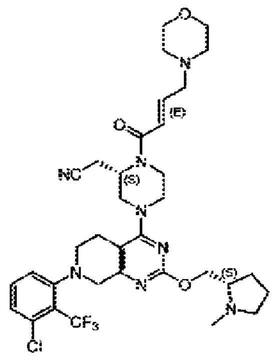
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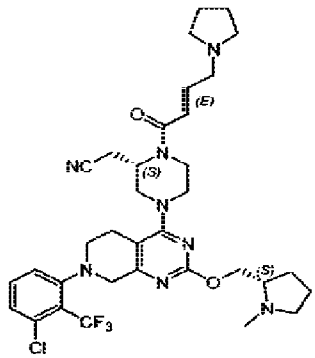
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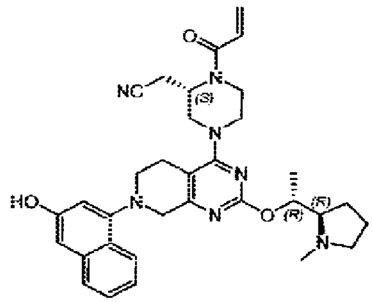
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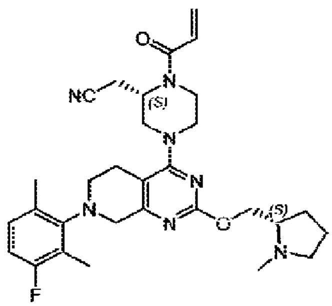
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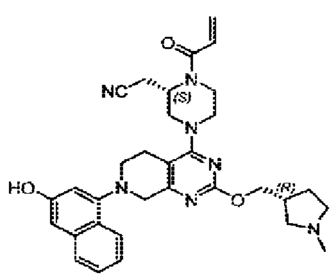
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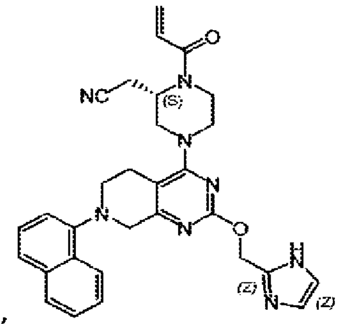
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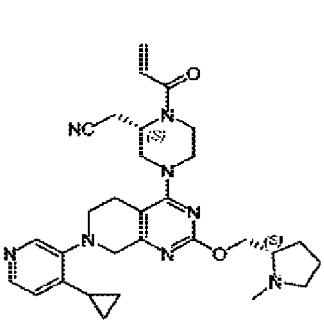
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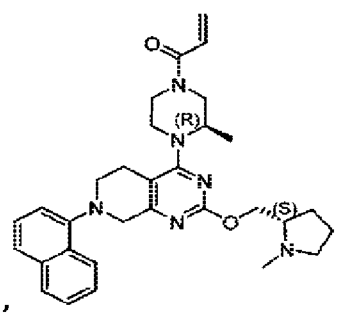
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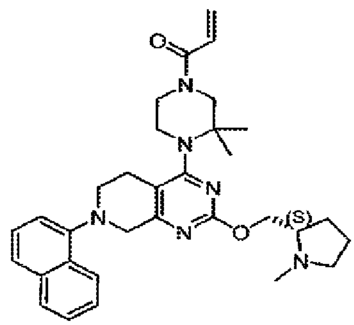
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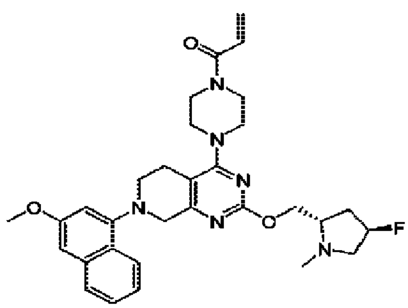
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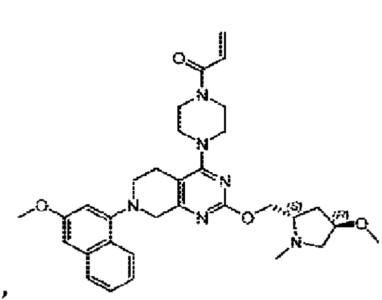
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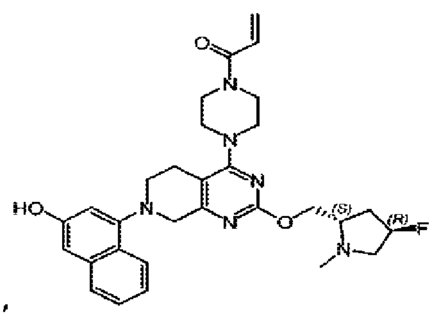
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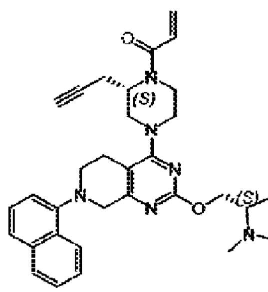
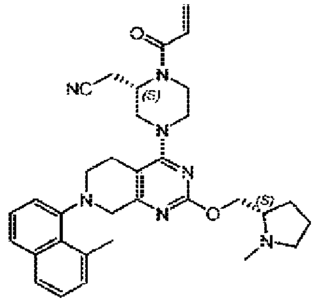
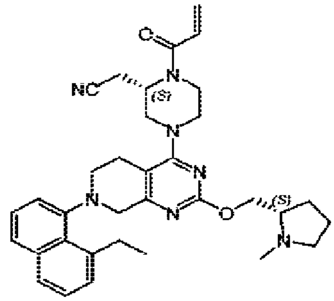
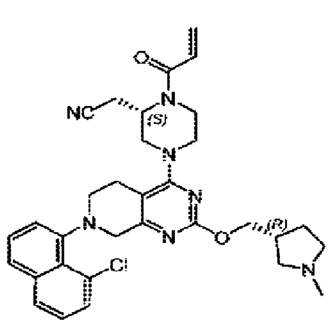
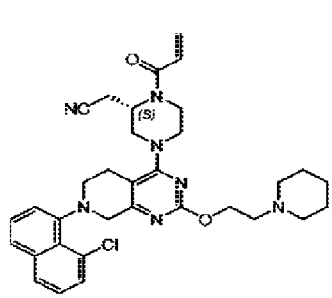
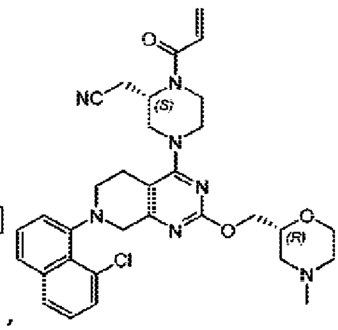
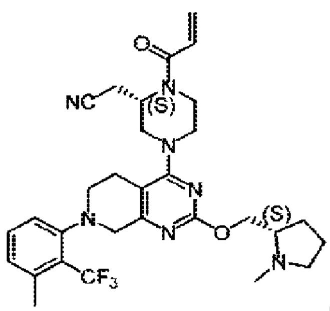
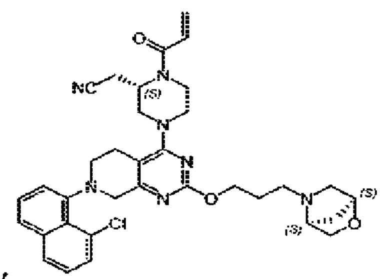
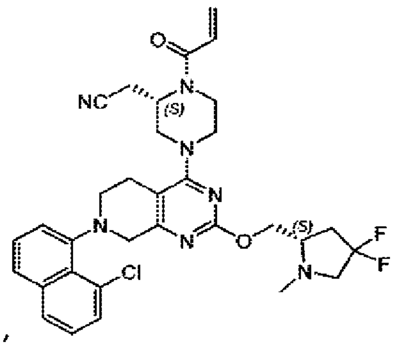
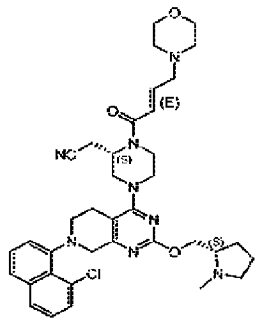
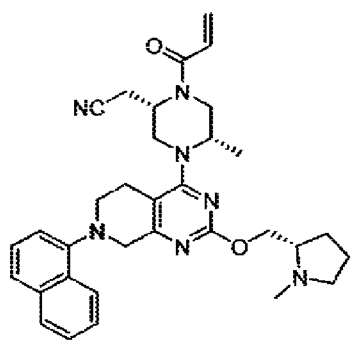
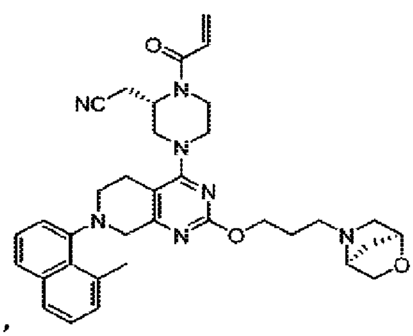
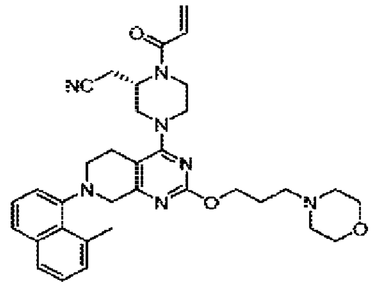
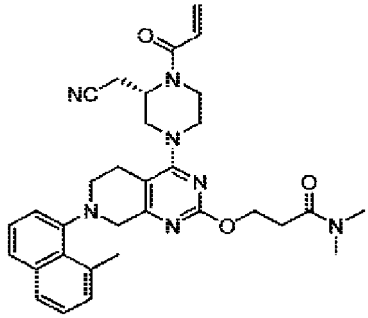
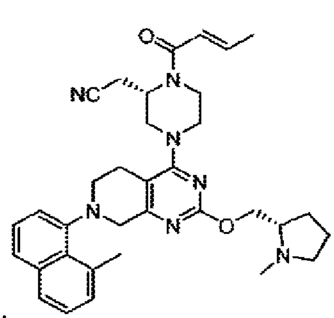
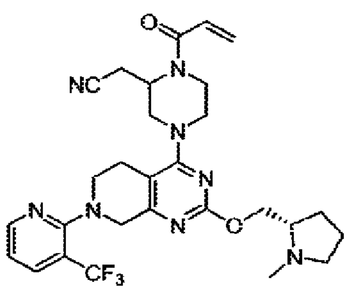
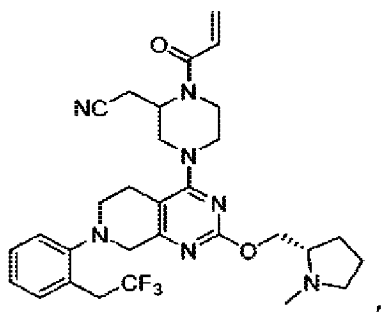
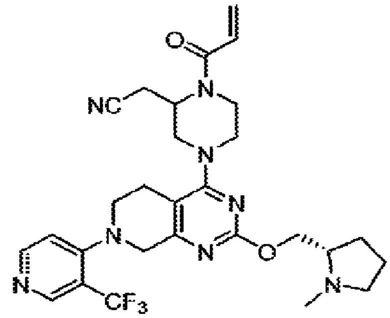
 ,
 ,
 ,

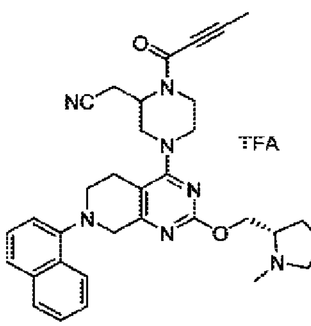
 ,
 ,
 ,

 ,
 ,
 ,

 ,
 ,
 ,

,
,
,

,
,
,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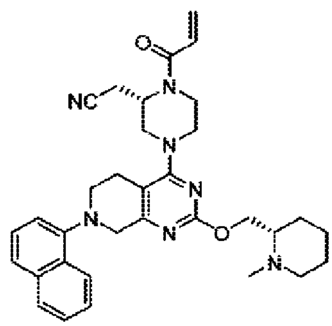
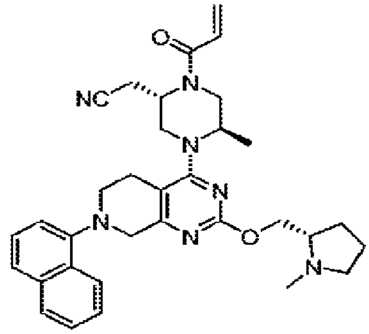
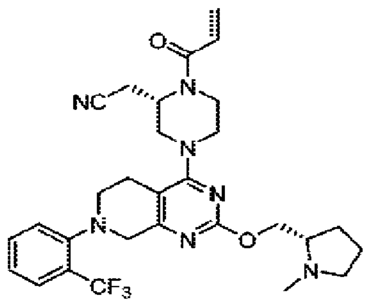
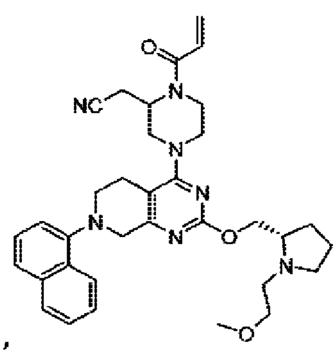
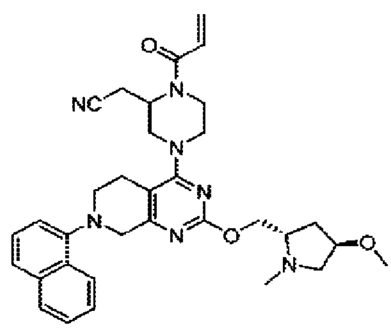
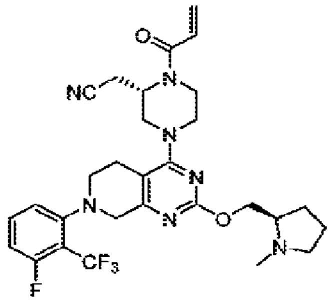
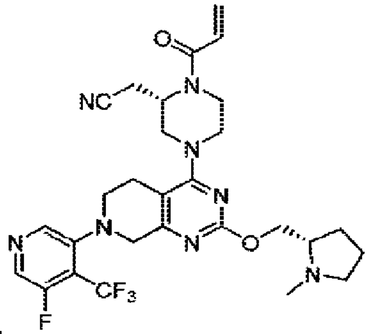
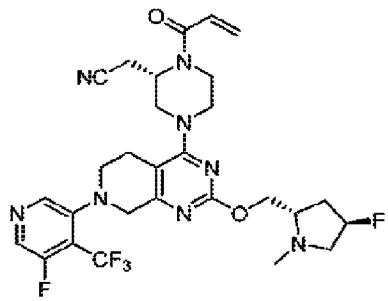
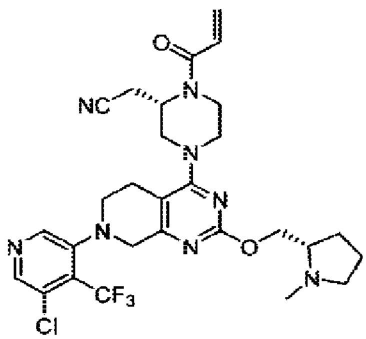
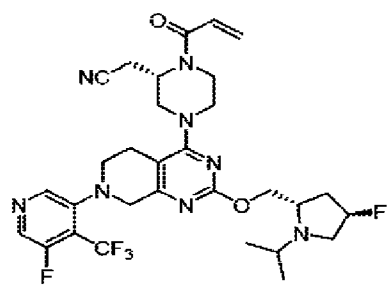
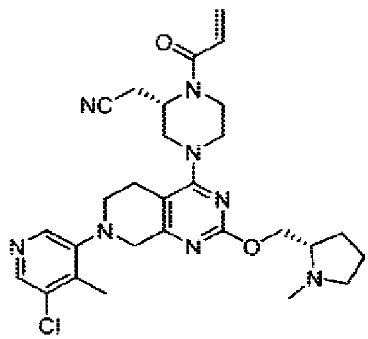
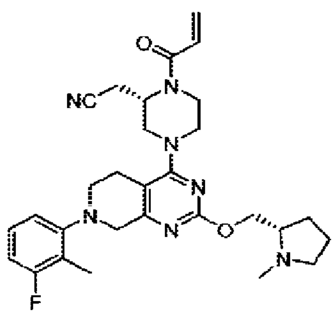
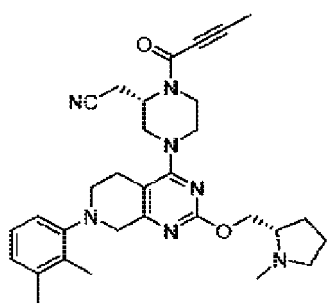
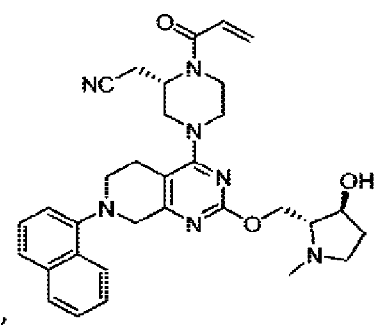
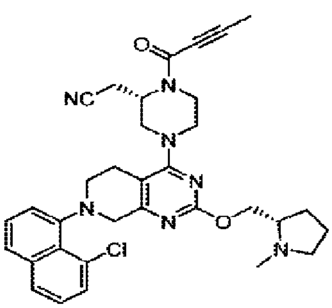
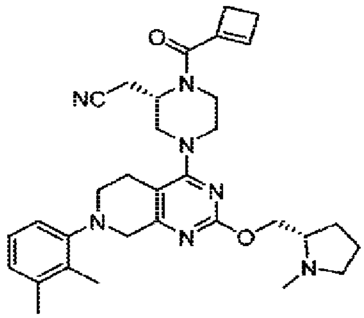
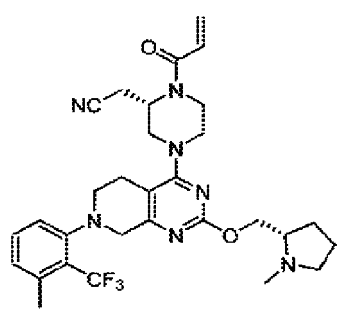
,
,

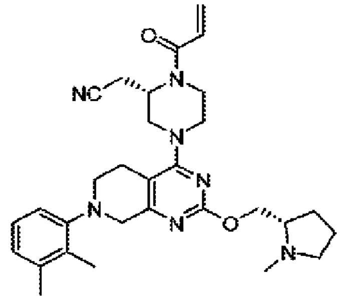
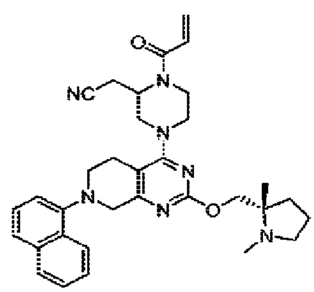
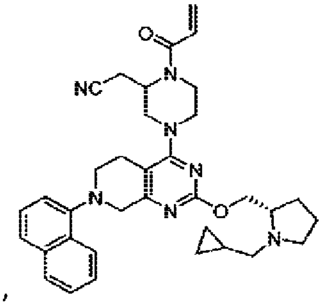
,
,
,

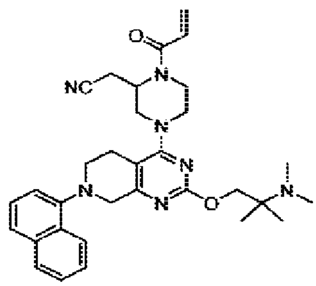
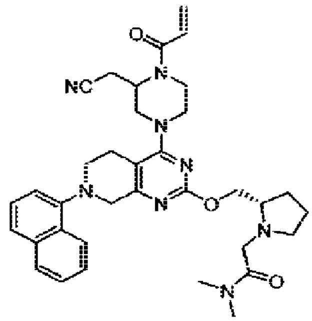
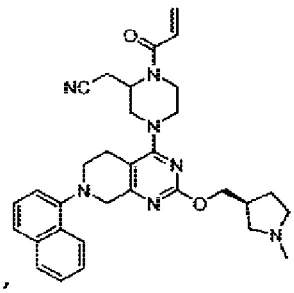
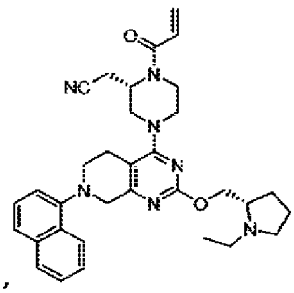
,
,
,

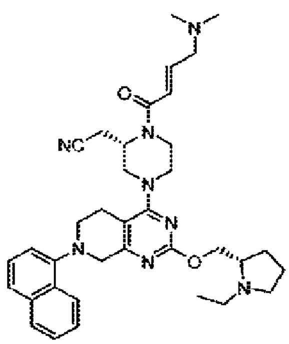
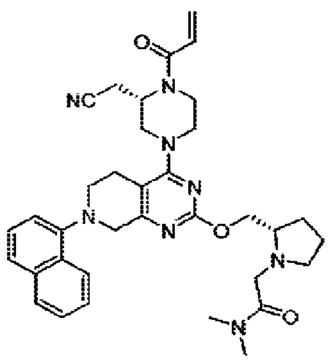
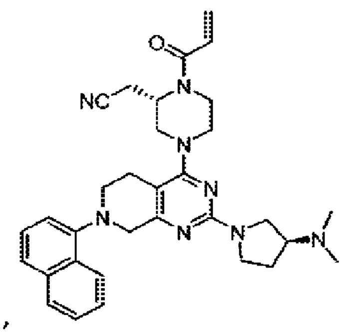
,
,
,

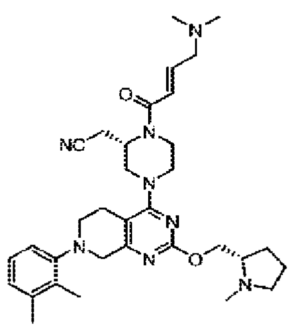
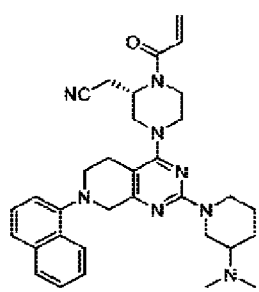
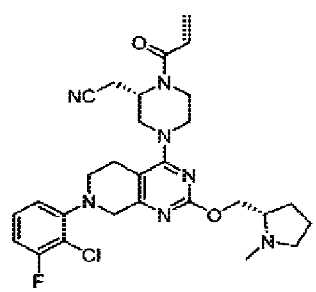
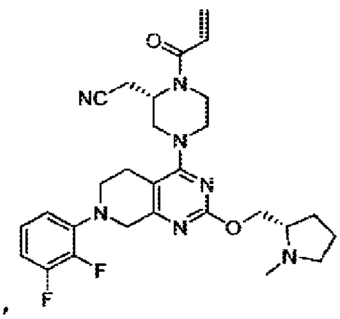
,
,
,

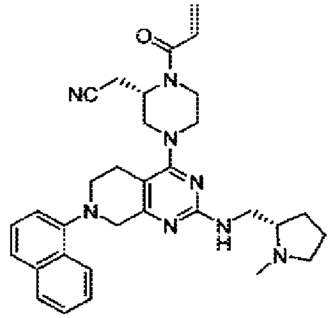
,
,
,

,
,
,

,
,
,
,

,
,
,

,
,
,
,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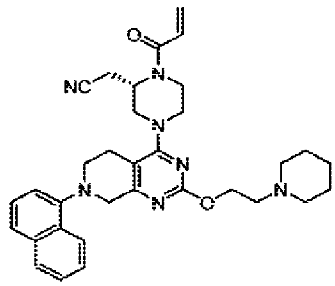
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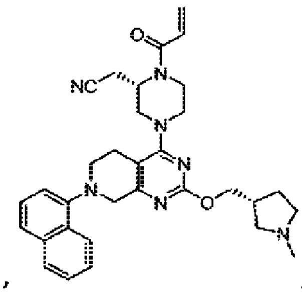
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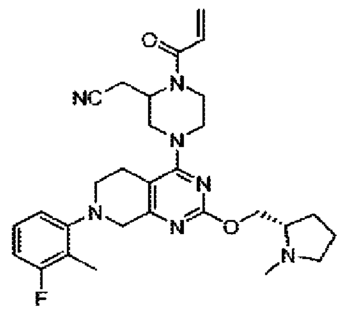
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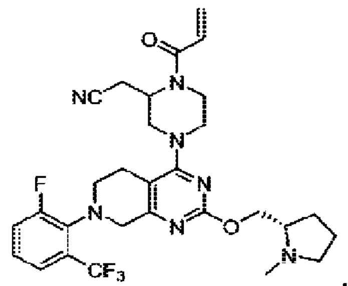
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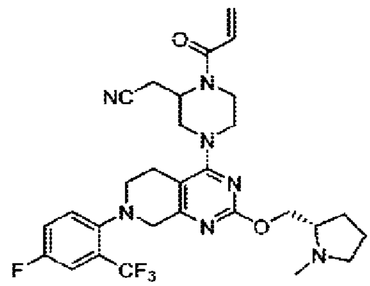
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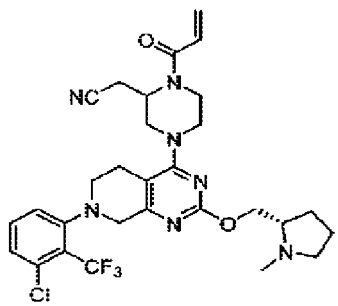
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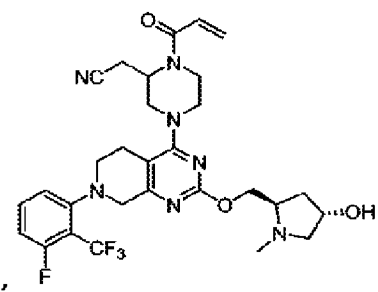
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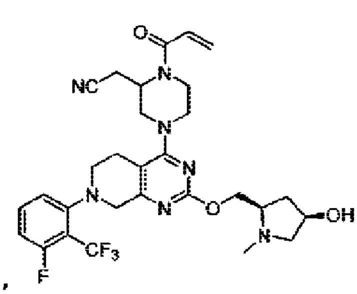
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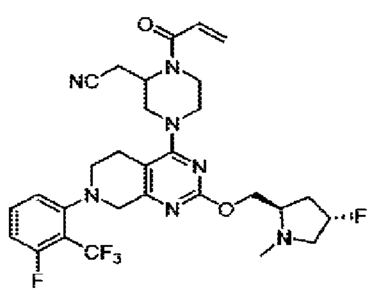
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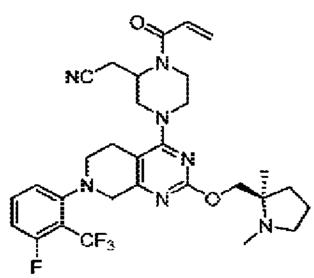
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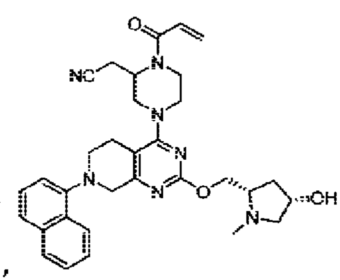
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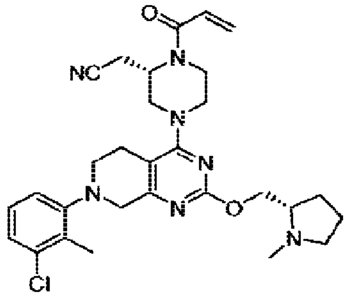
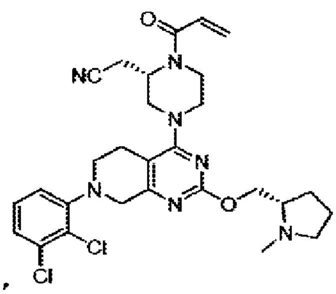
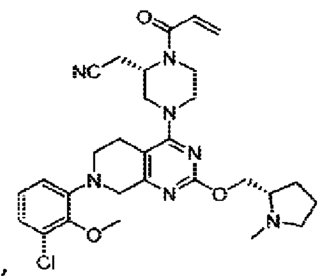
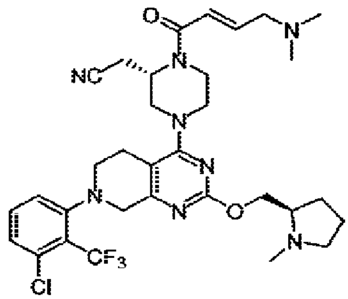
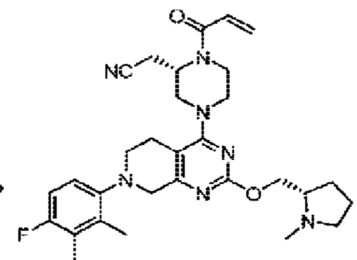
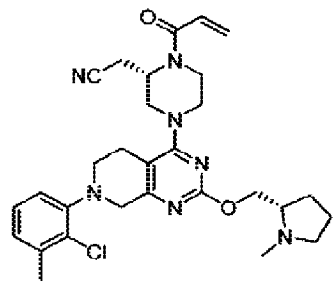
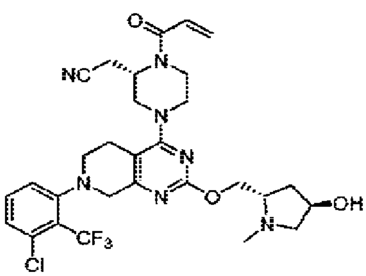
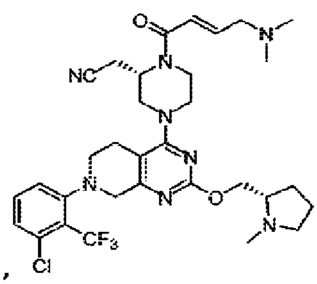
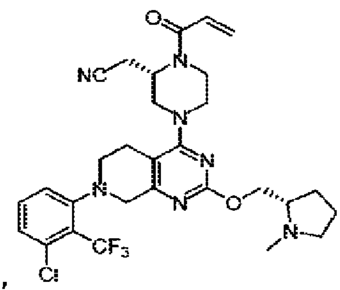
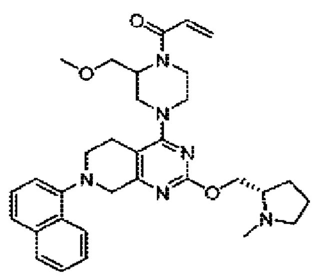
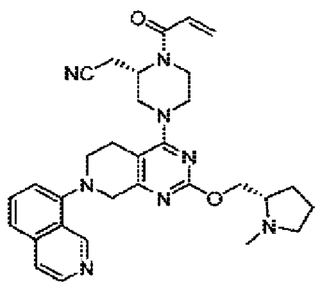
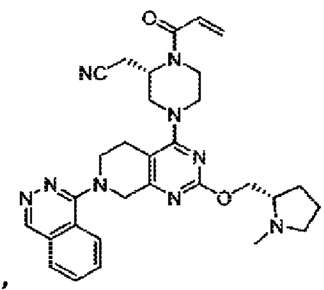
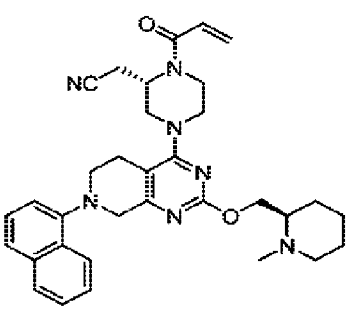
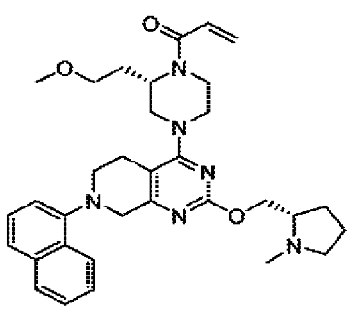
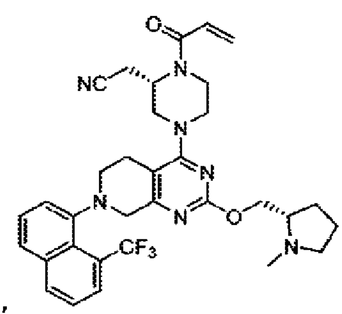
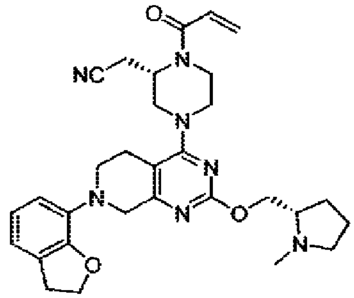
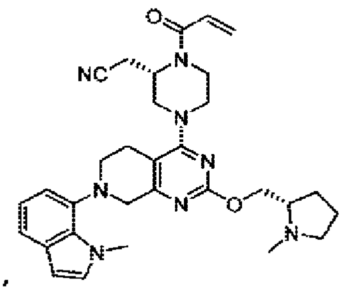
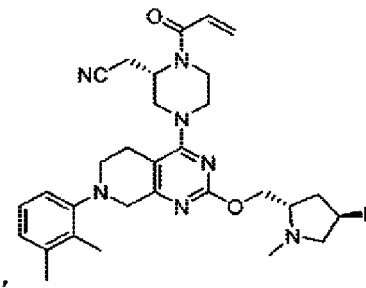
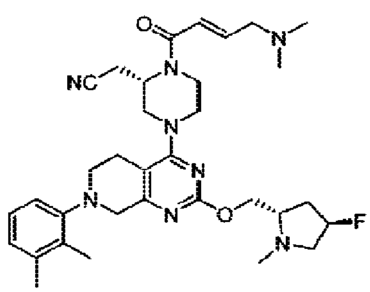
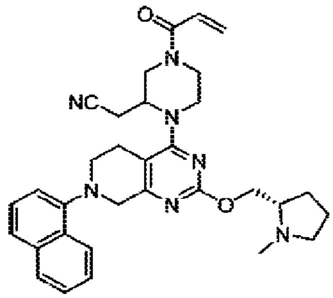
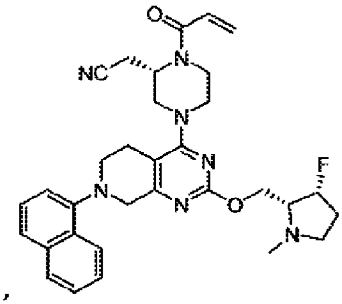
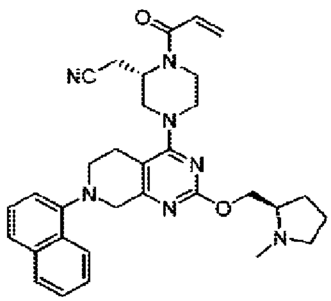
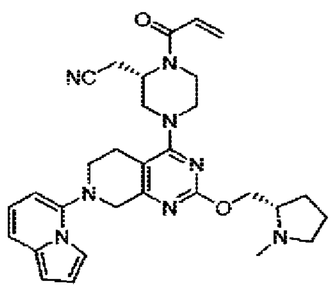
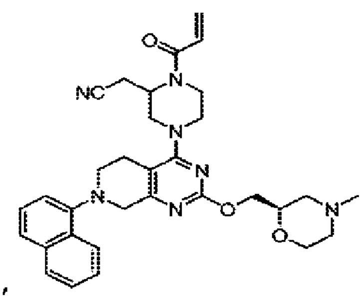
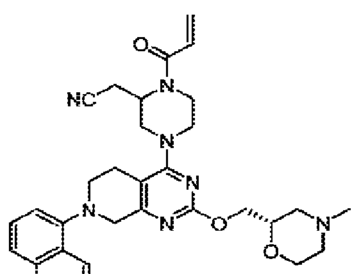
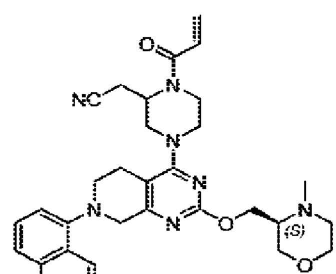
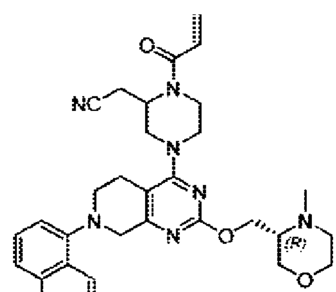
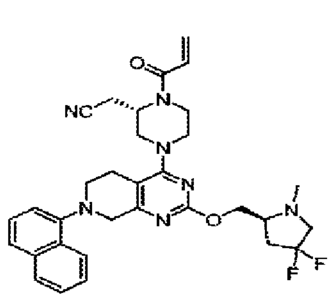
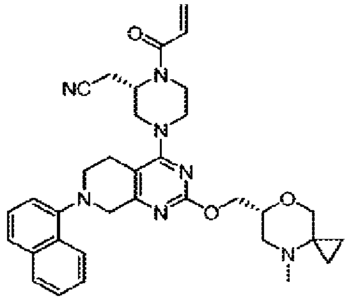
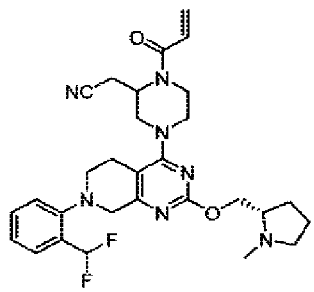
,
,
,
,
,
,
,
,
,
,
,
,
,
,
,

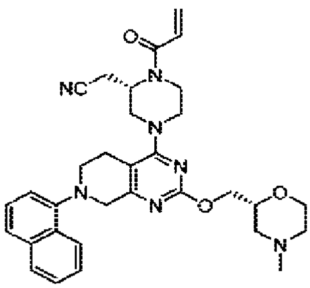
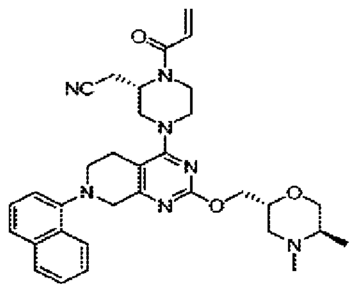
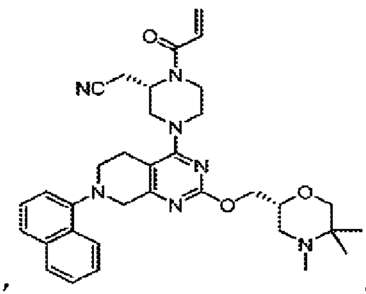
,
,
,

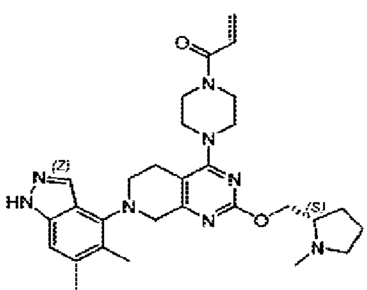
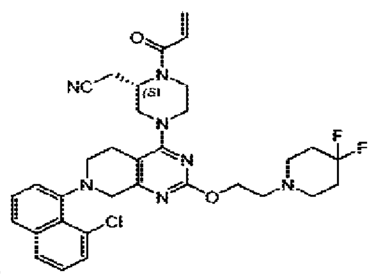
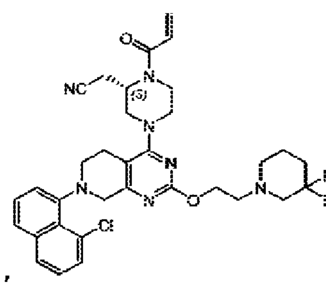
,
,
,

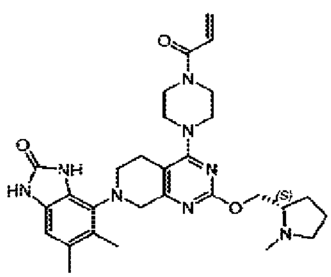
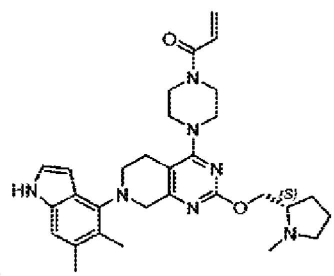
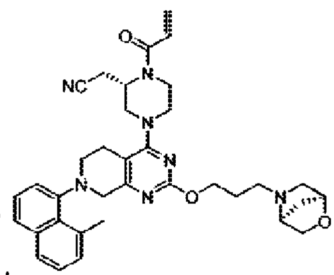
,
,
,

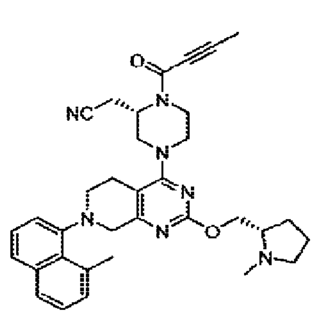
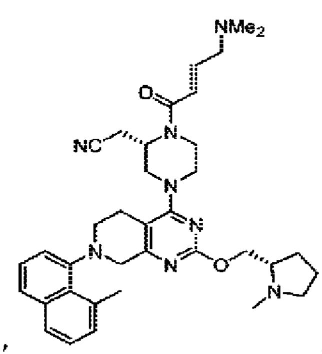
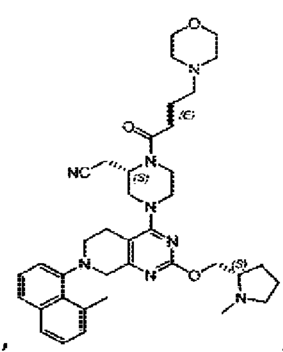
,
,
,

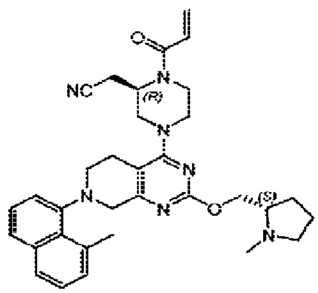
,
,
,

,
,
,

,
,
,

,
,
,

,
,
,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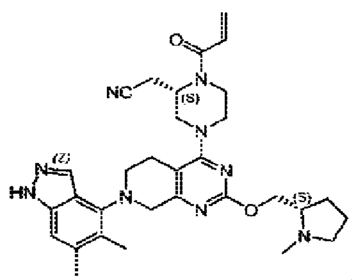
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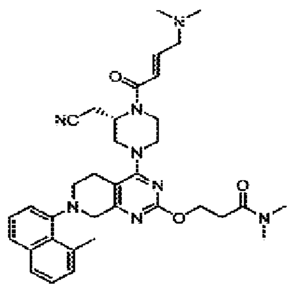
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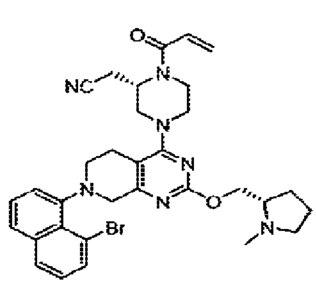
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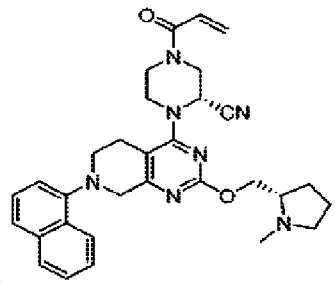
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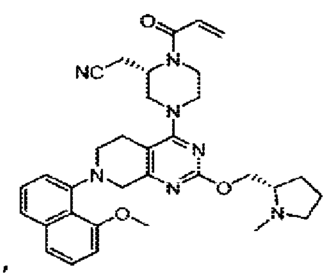
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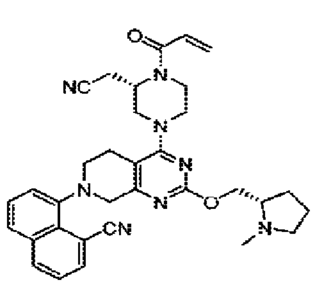
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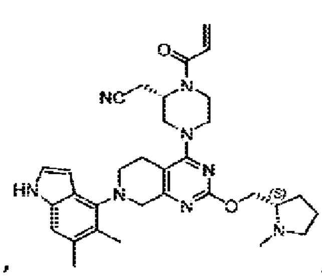
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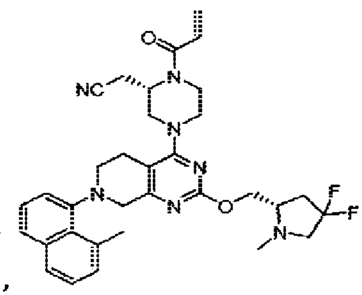
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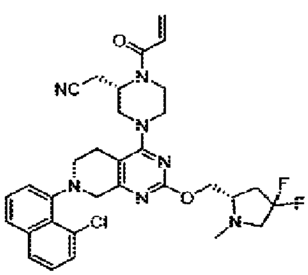
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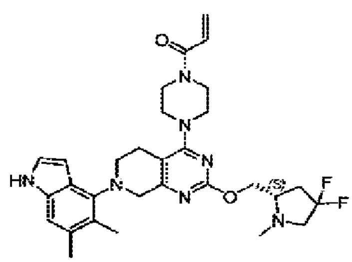
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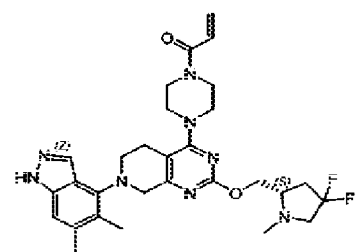
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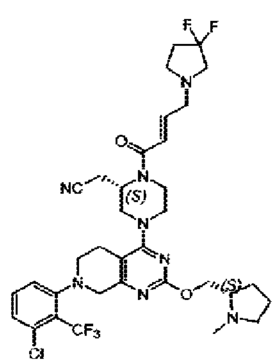
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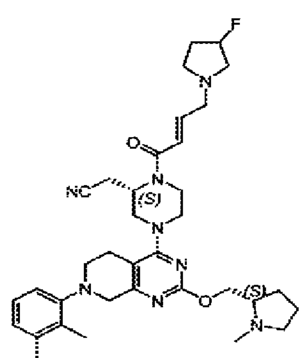
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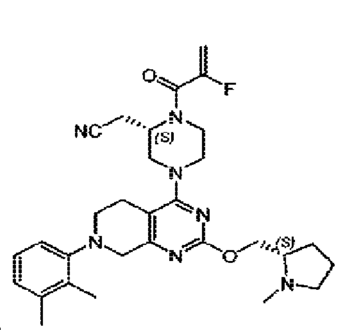
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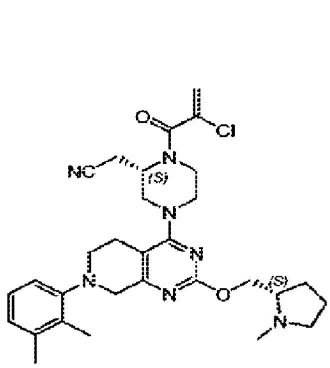
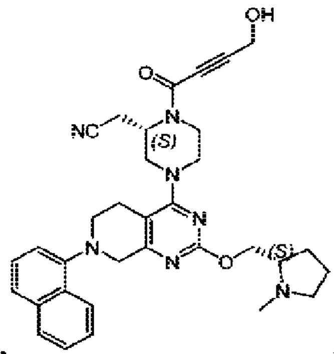
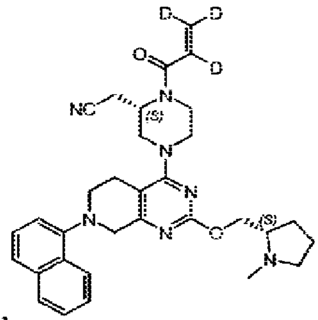
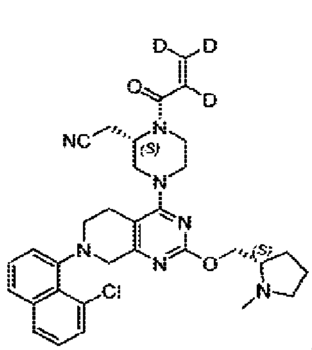
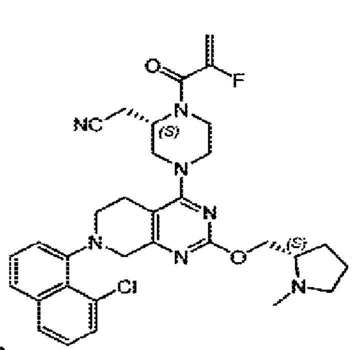
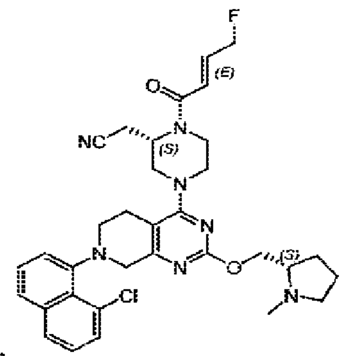
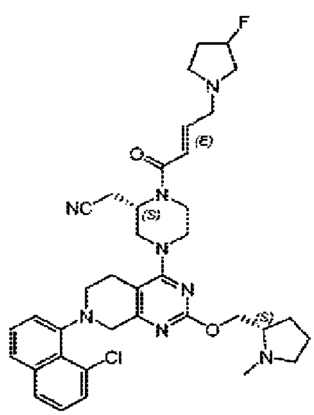
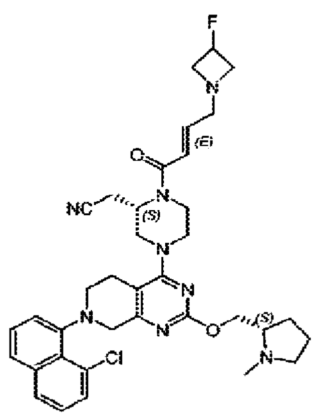
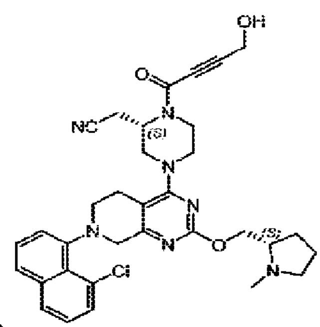
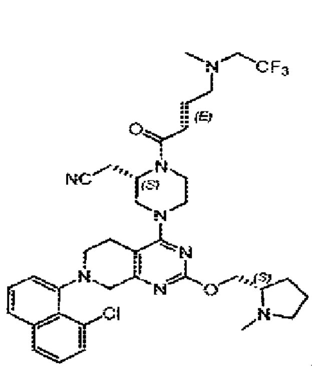
 ,  ,  ,

 ,  ,  ,

 ,  ,  ,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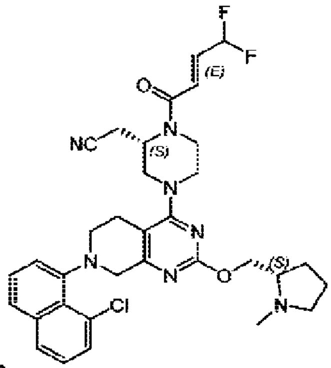
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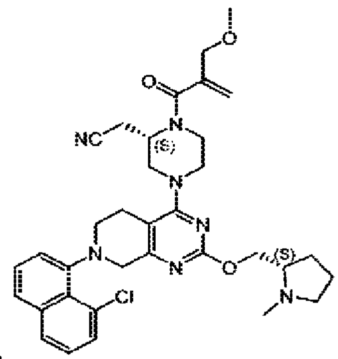
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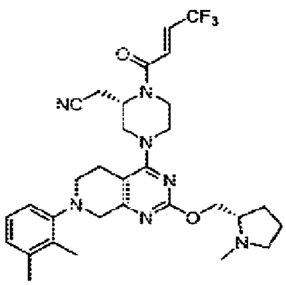
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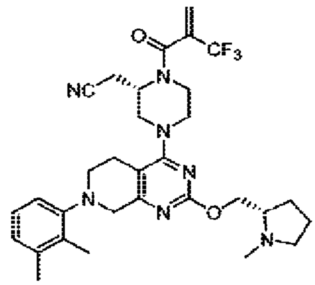
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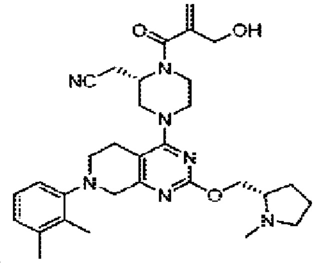
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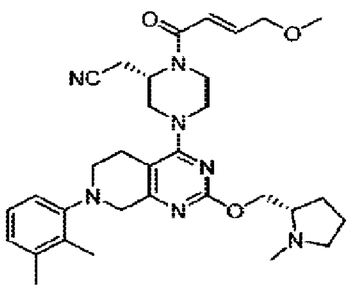
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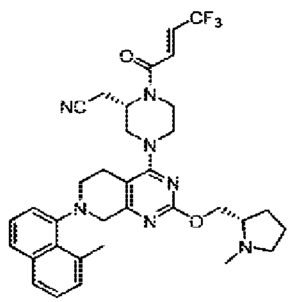
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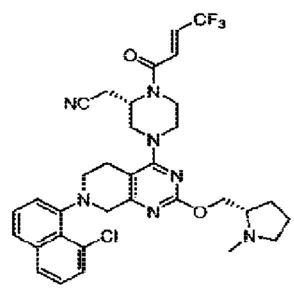
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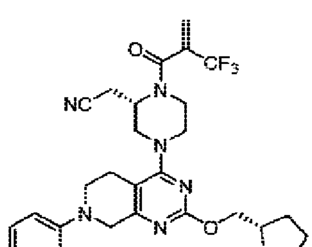
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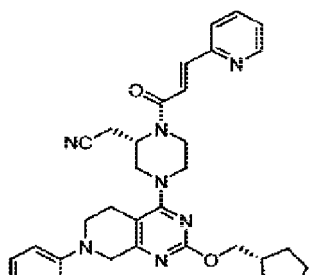
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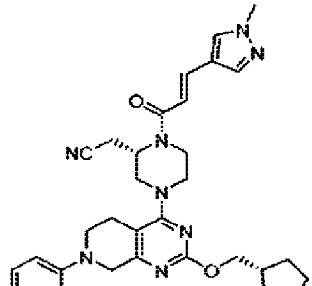
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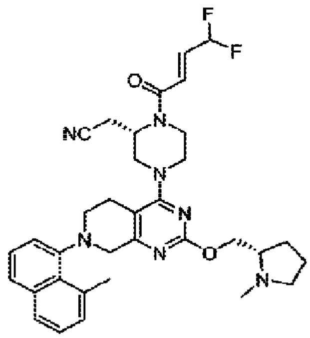
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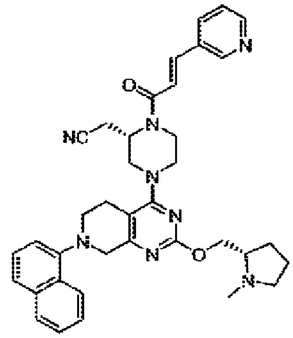
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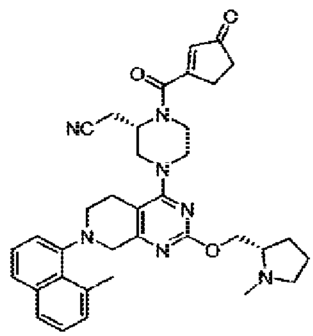
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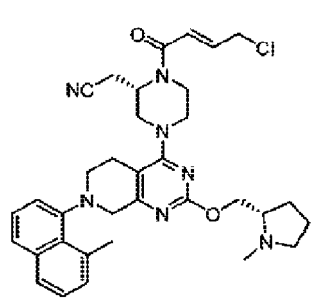
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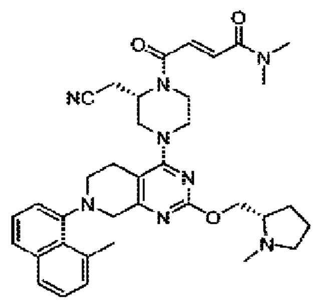
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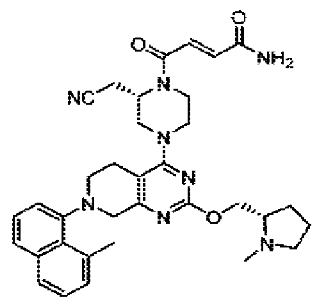
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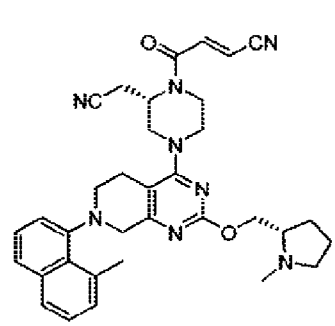
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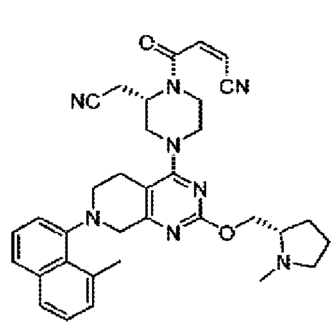
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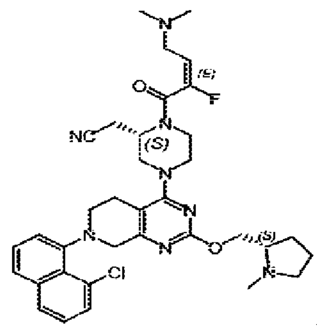
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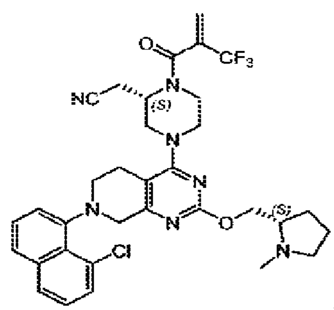
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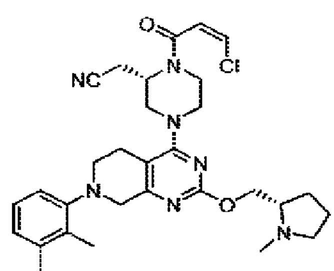
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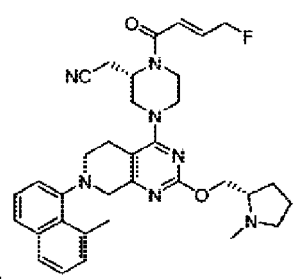
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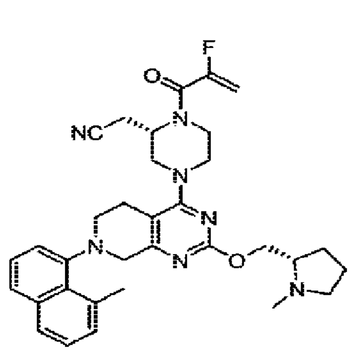
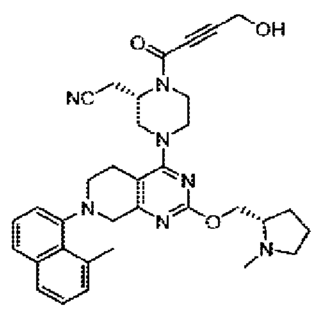
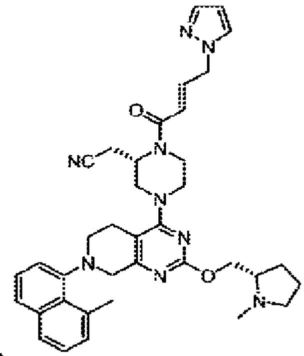
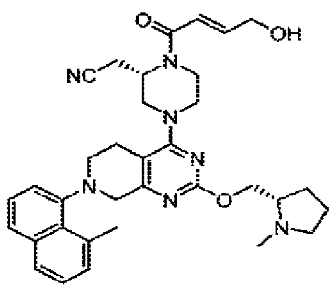
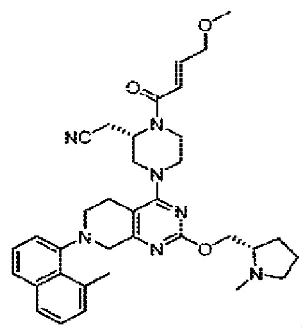
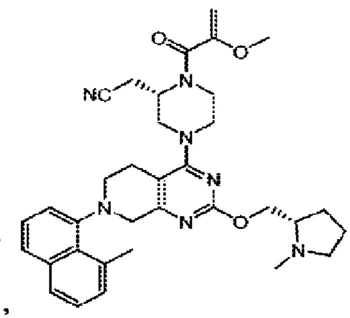
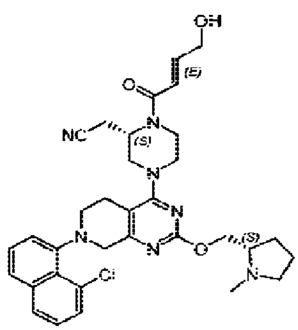
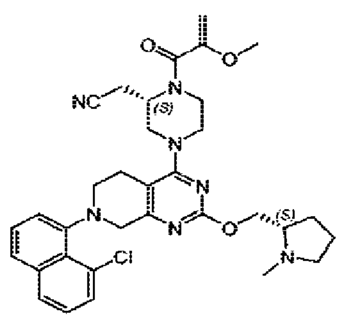
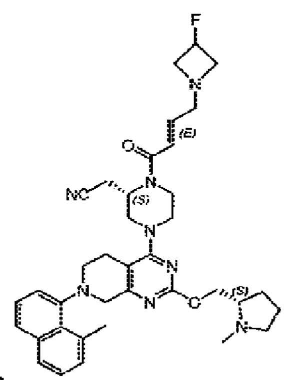
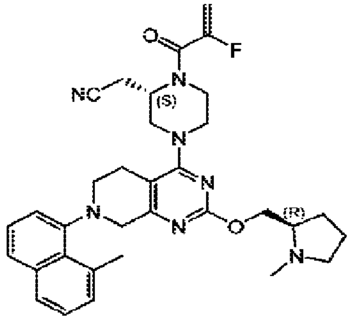
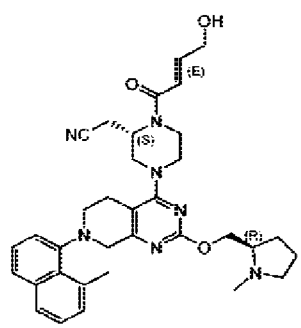
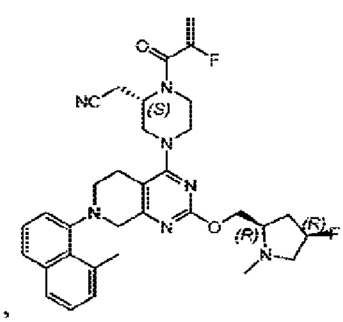
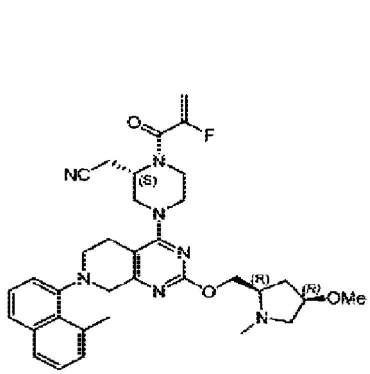
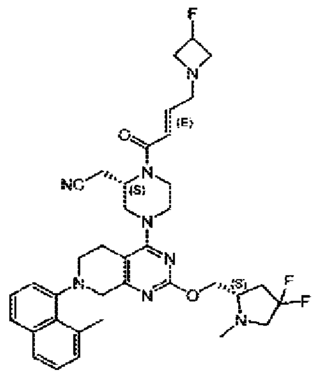
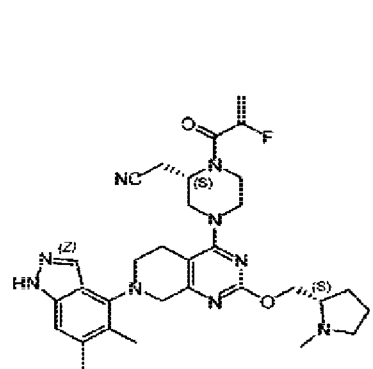
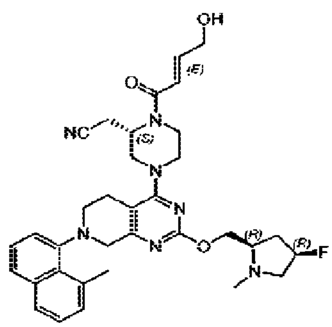
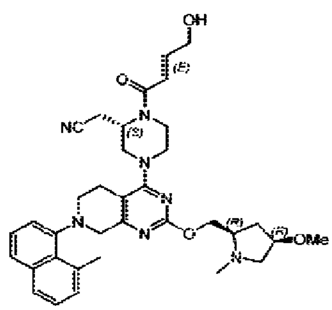
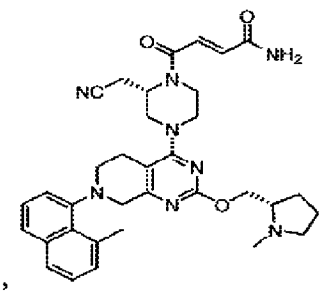
,
,
,

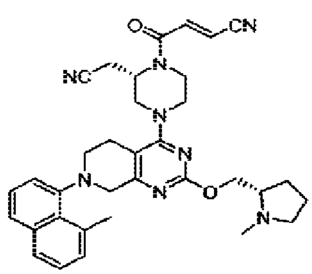
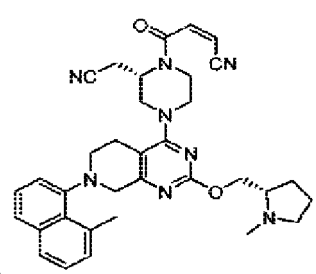
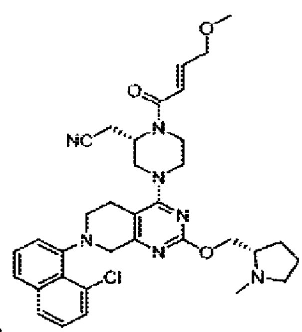
,
,
,

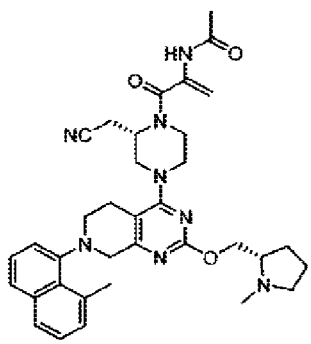
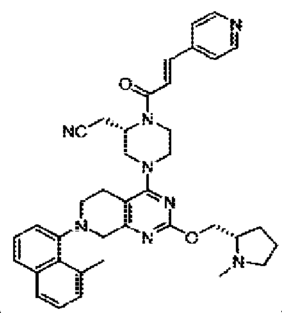
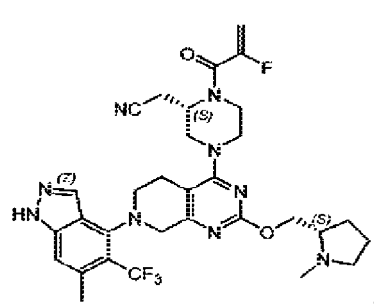
,
,
,

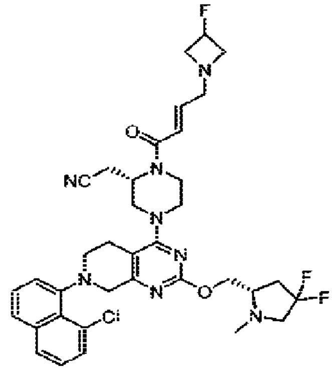
,
,
,

,
,
,

,
,
,

,
,
,

,
,
,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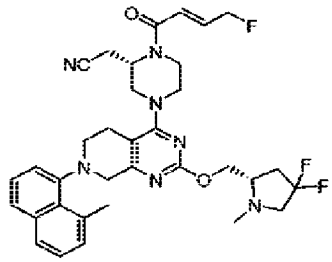
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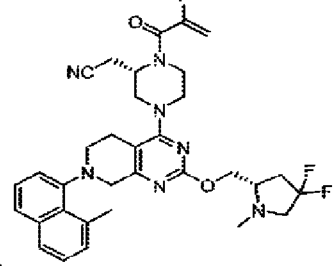
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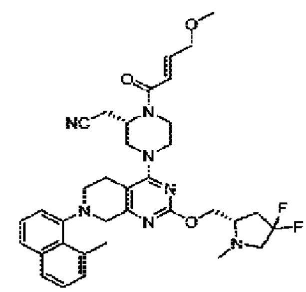
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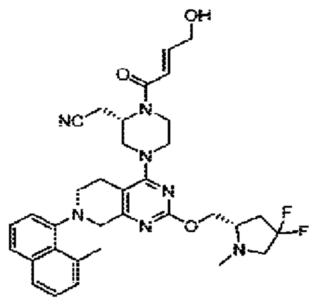
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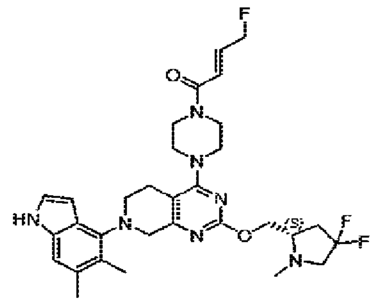
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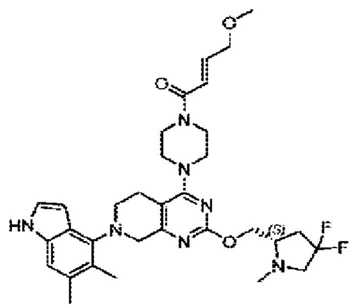
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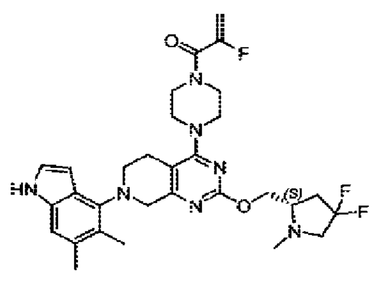
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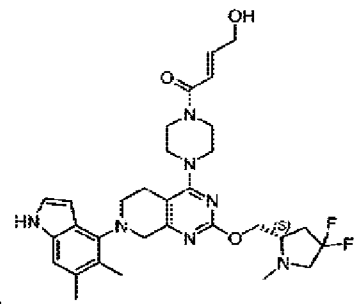
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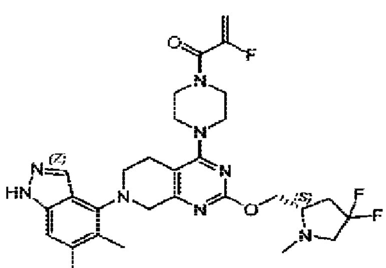
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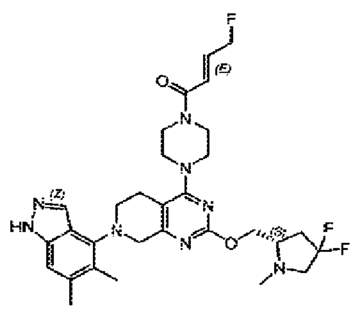
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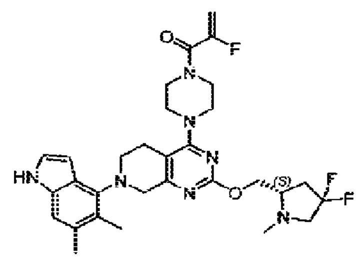
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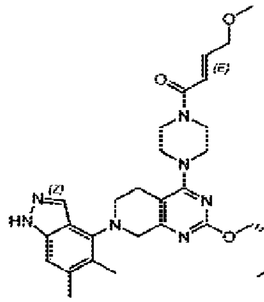
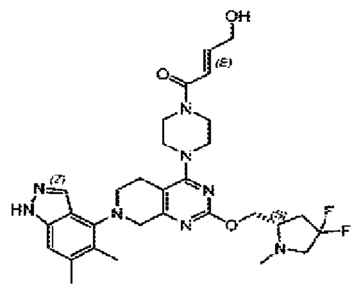
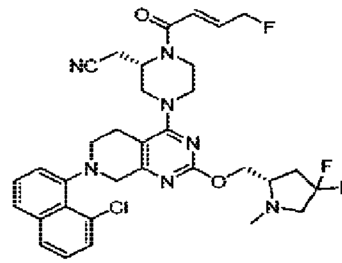
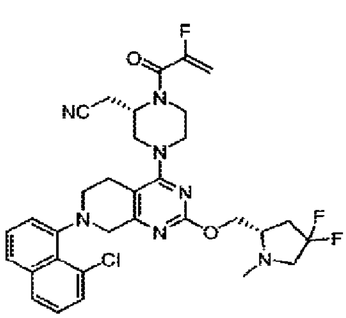
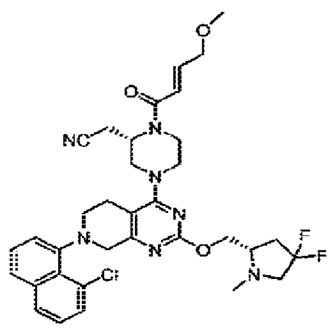
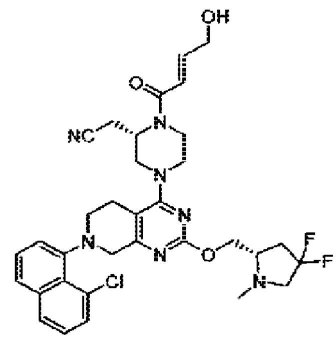
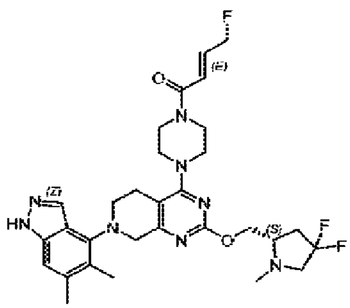
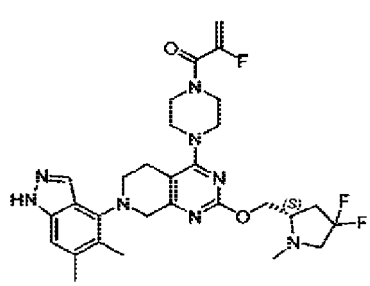
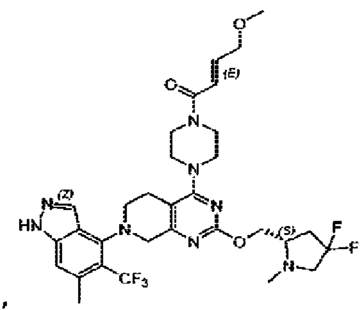
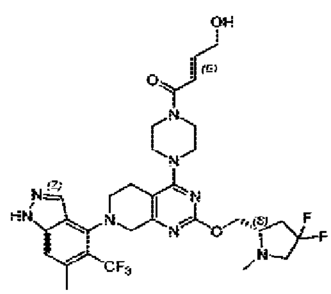
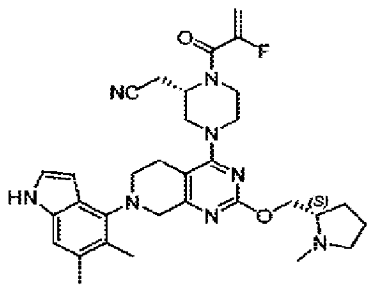
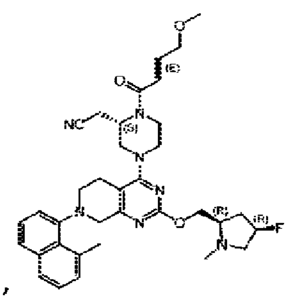
 ,  ,  ,

 ,  ,  ,

 ,  ,  ,

  ,  ,

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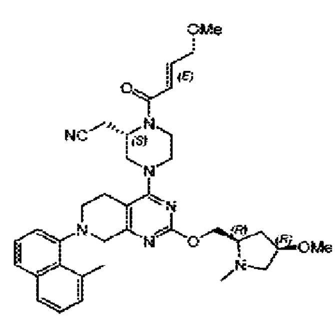
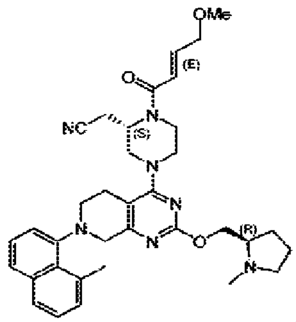
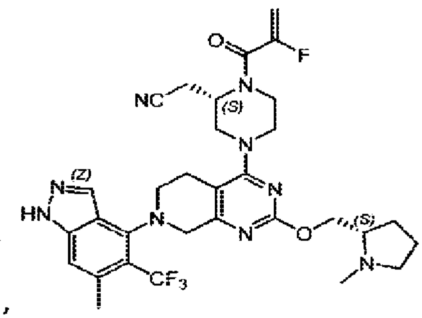
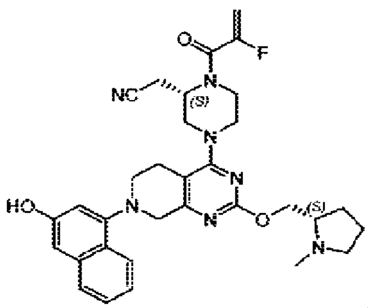
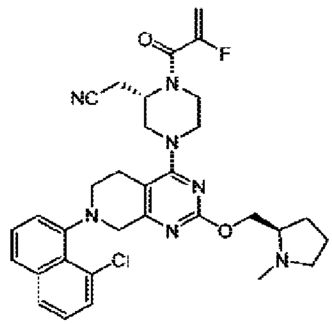
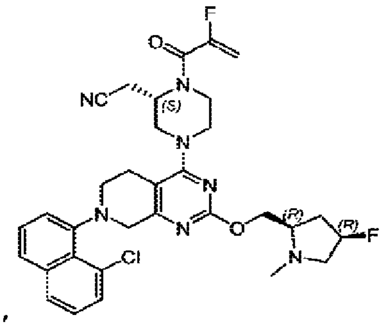
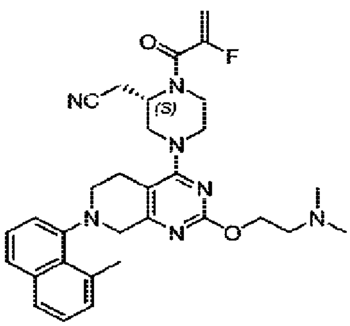
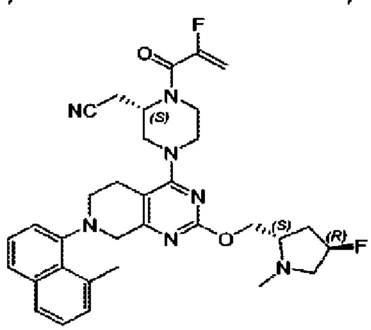
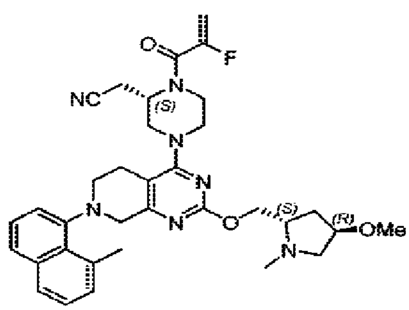
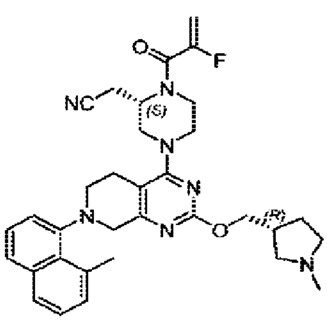
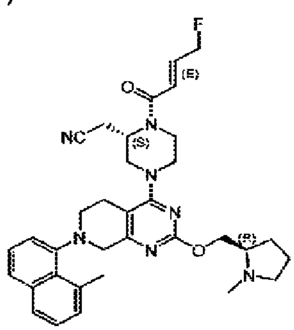
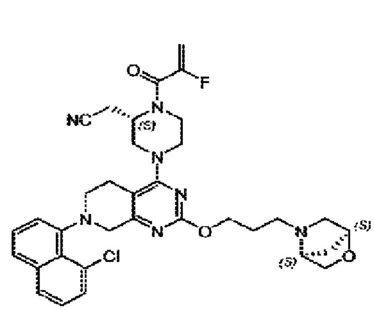
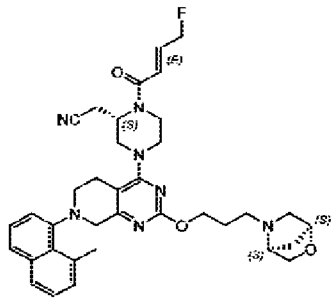
,
,
,

,
,
,

,
,
,

,
,
,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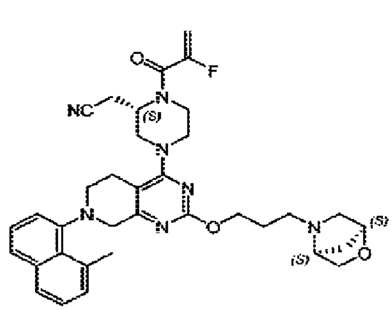
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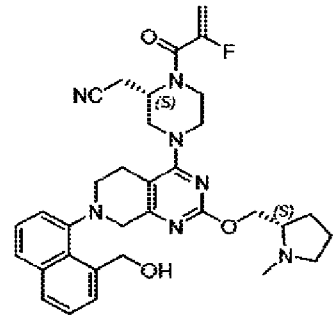
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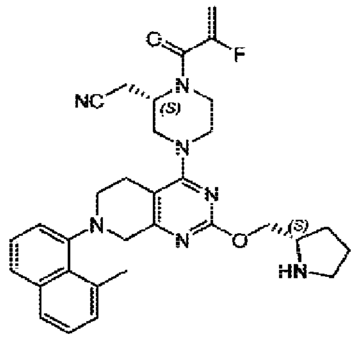
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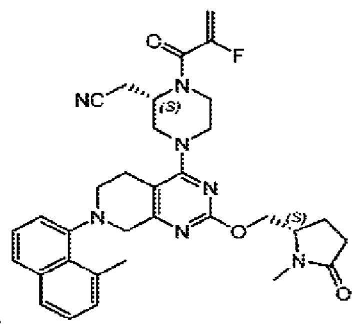
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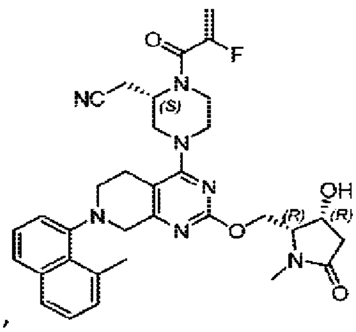
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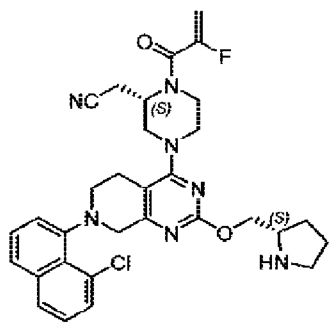
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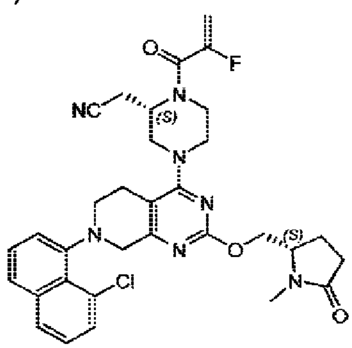
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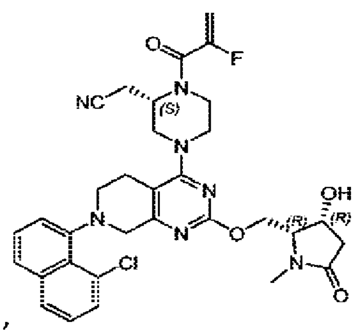
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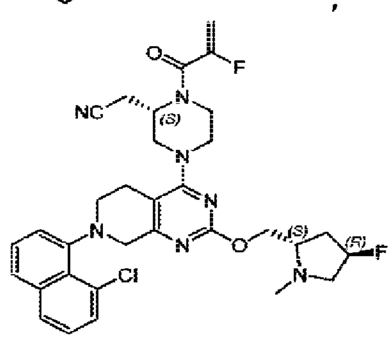
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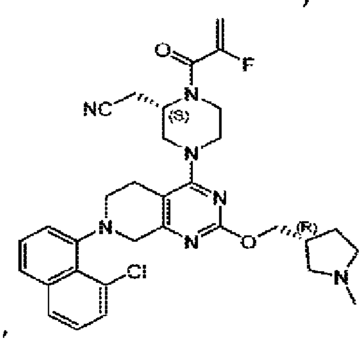
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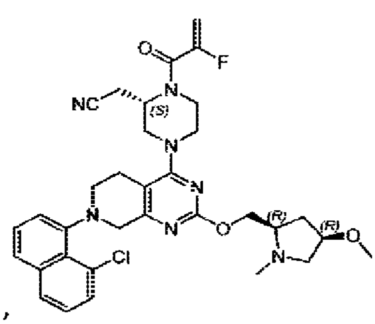
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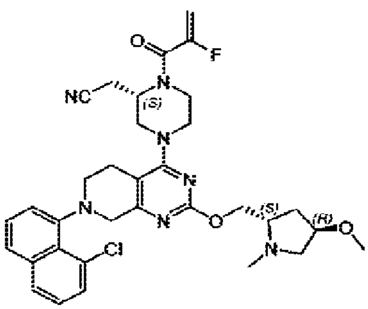
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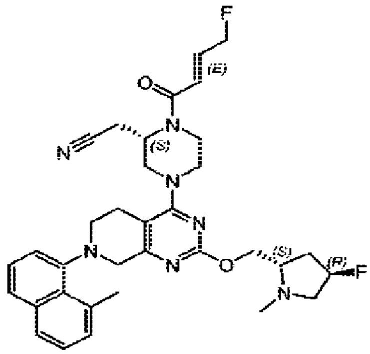
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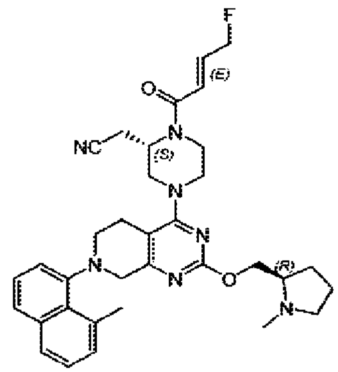
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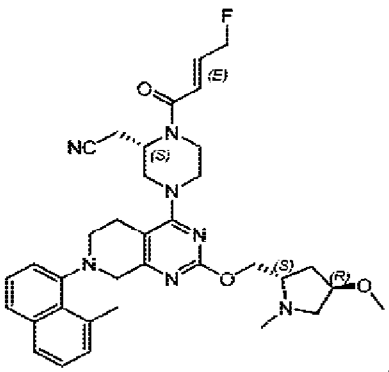
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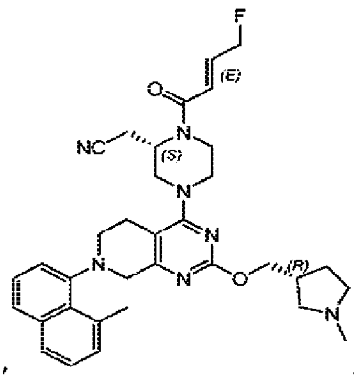
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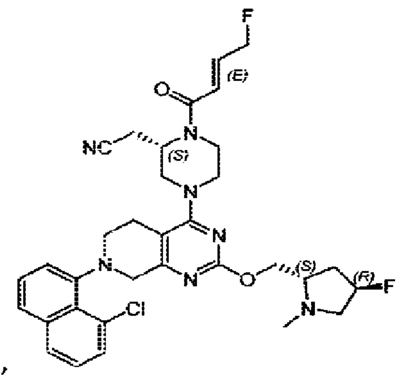
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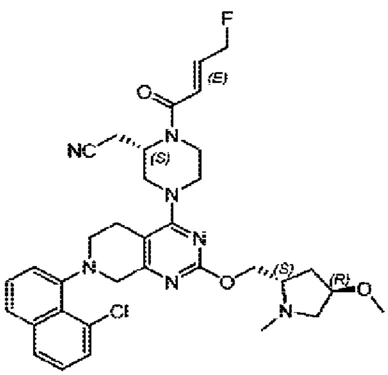
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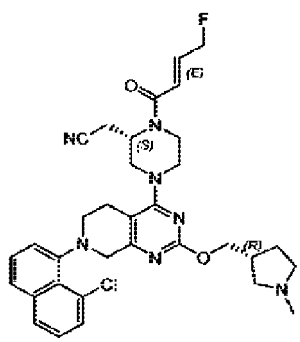
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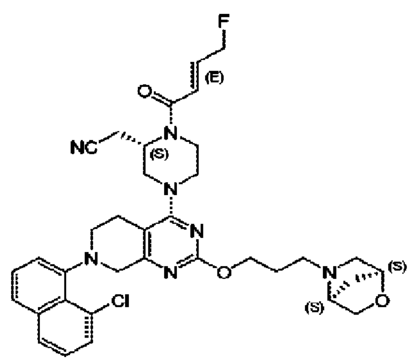
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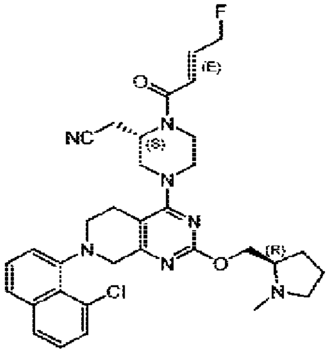
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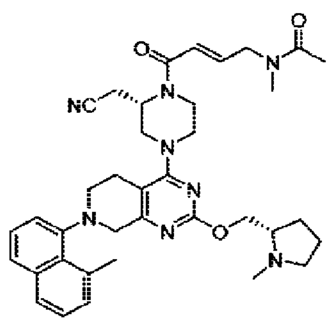
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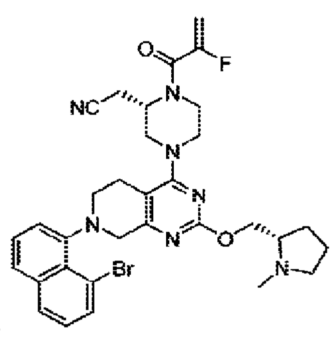
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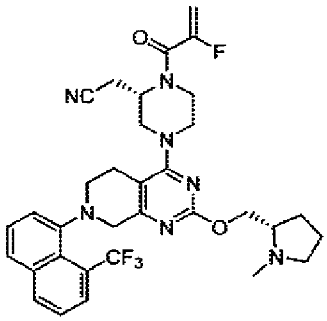
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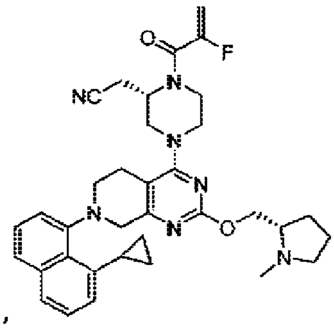
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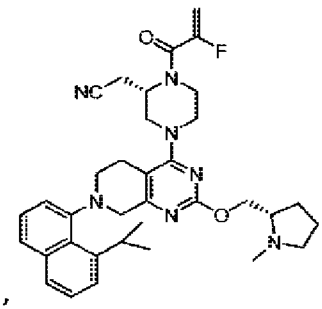
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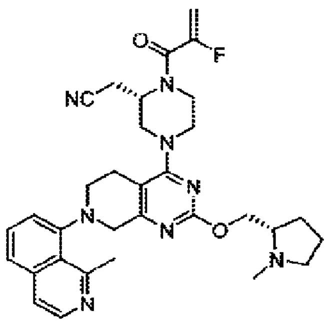
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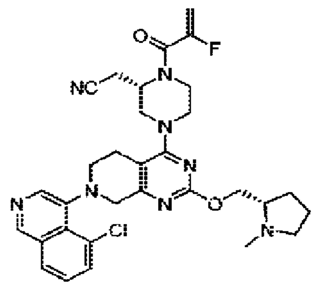
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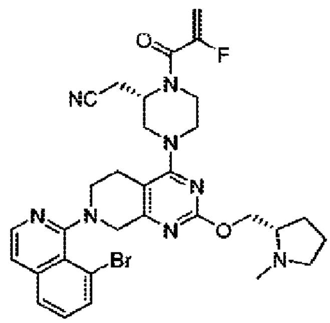
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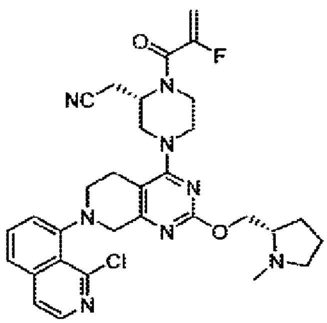
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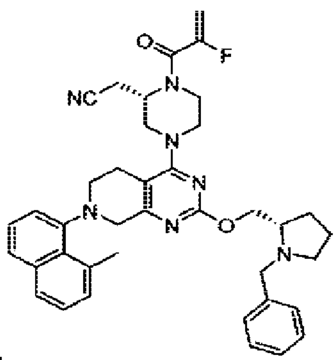
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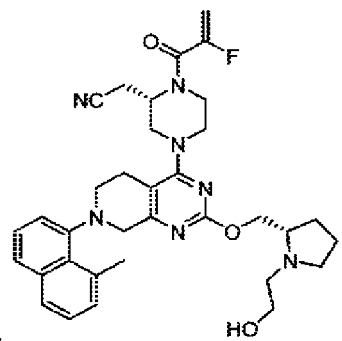
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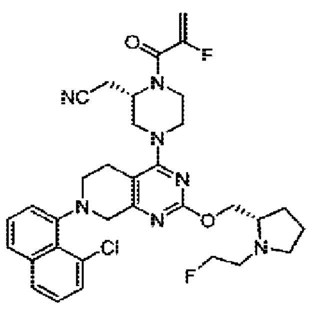
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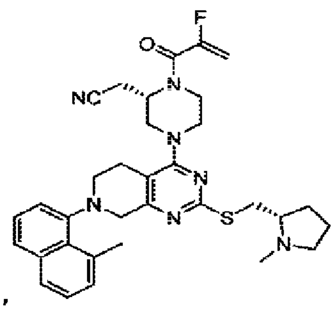
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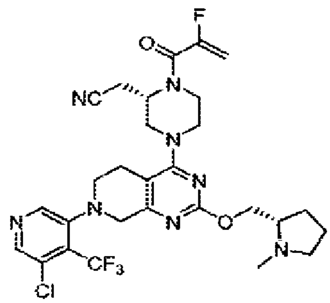
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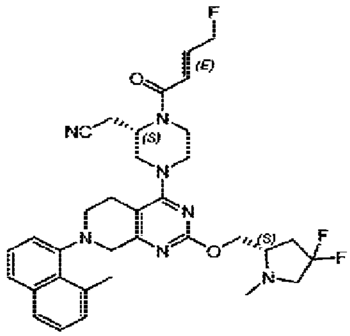
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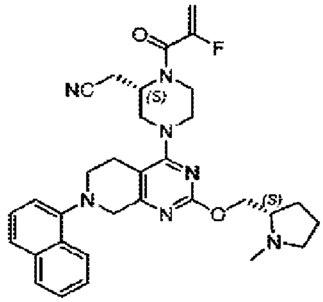
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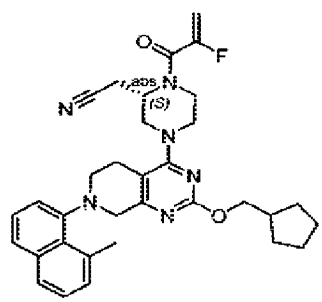
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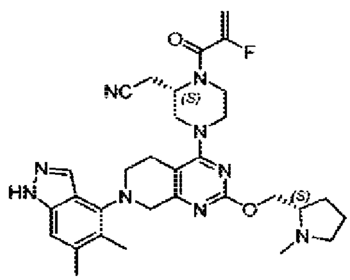
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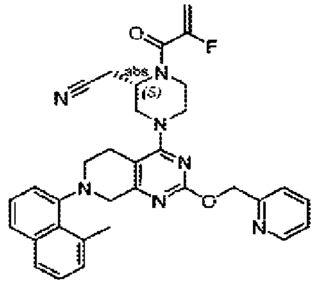
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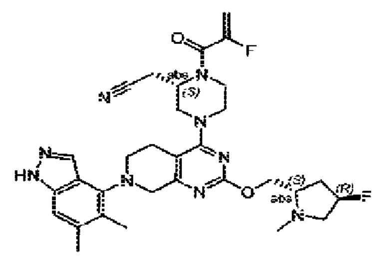
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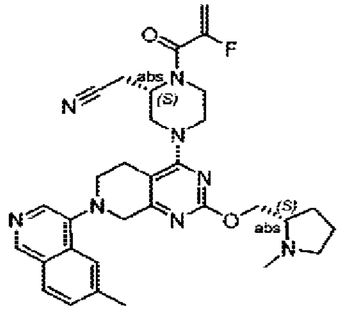
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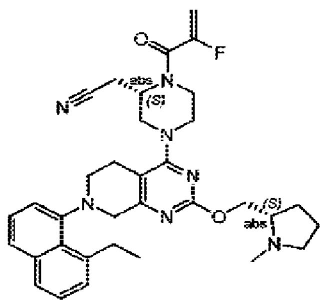
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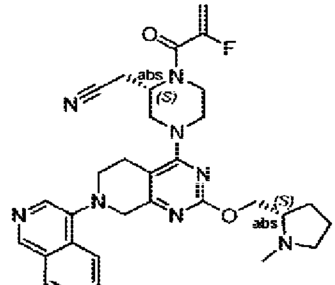
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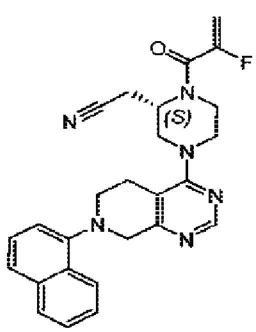
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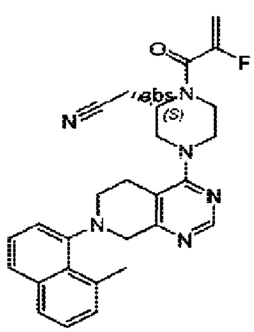
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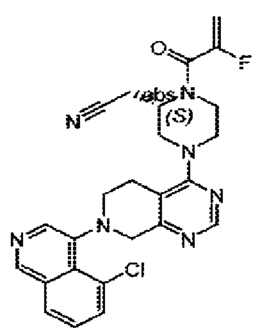
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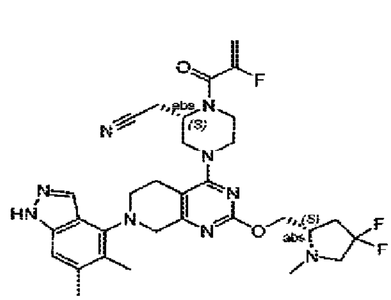
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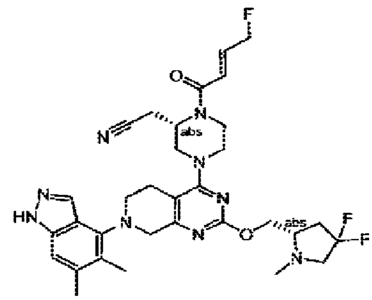
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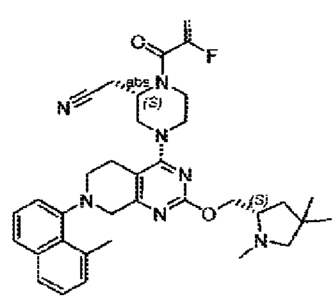
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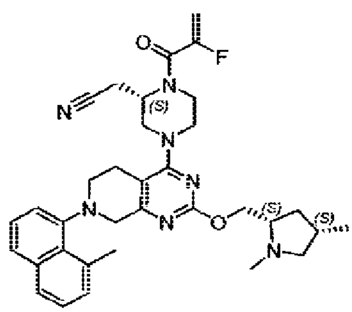
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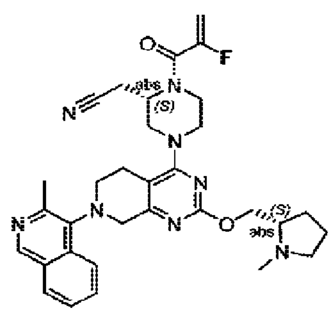
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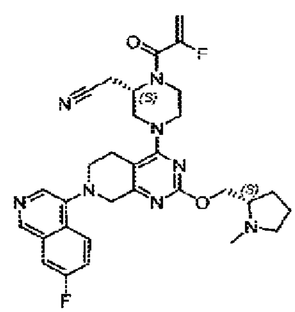
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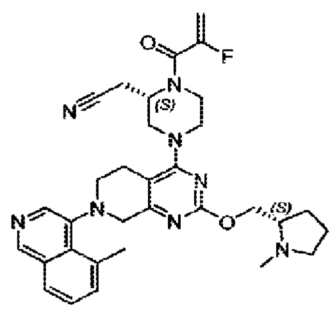
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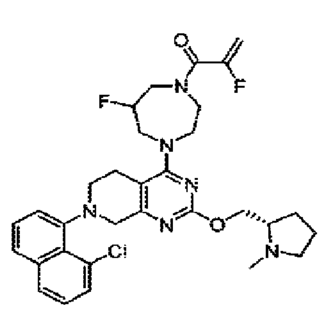
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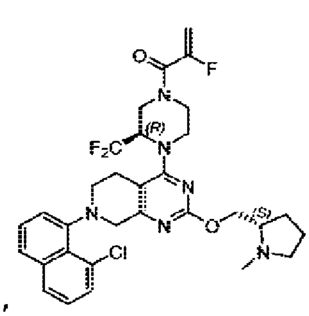
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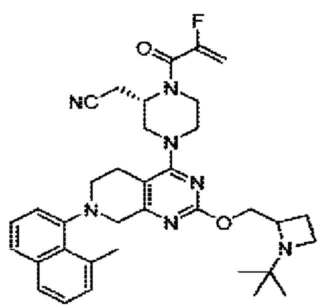
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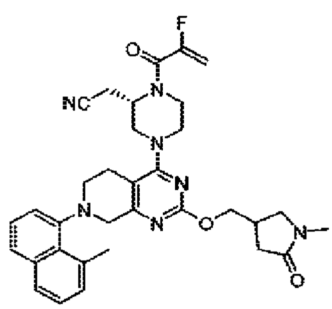
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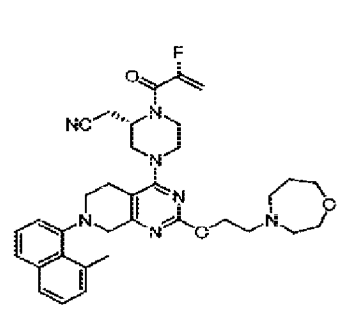
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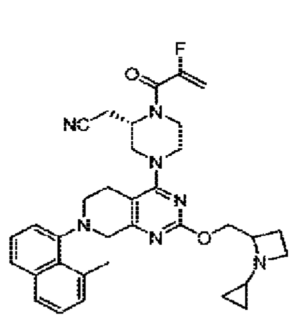
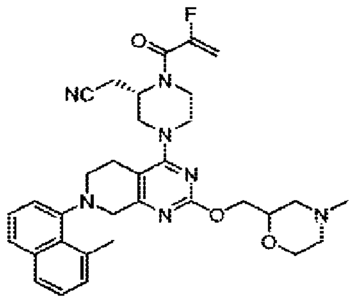
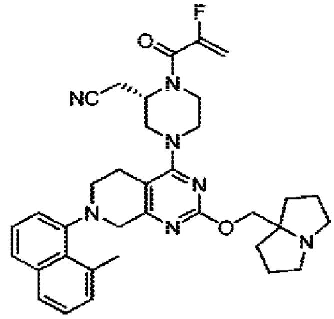
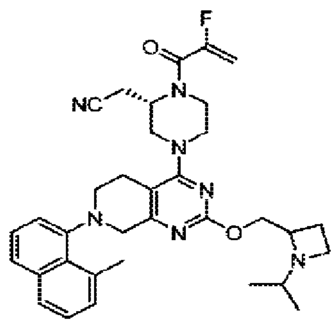
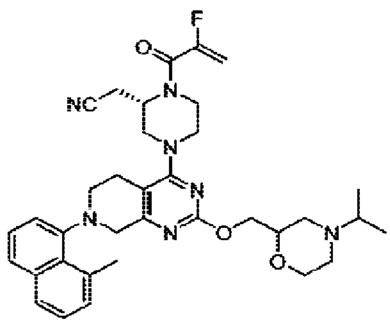
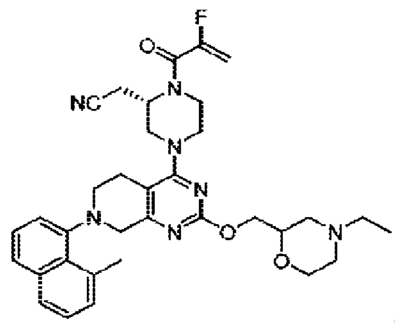
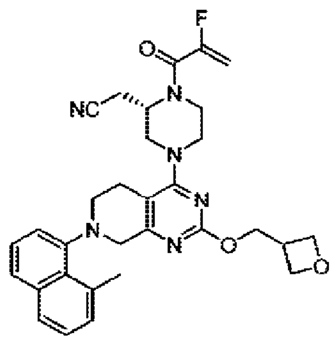
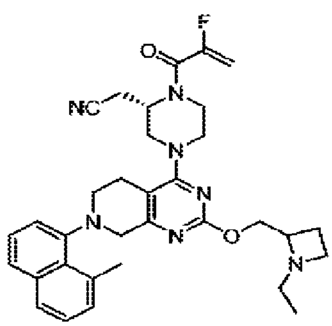
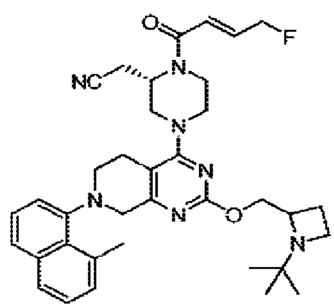
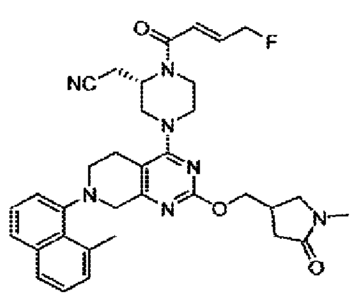
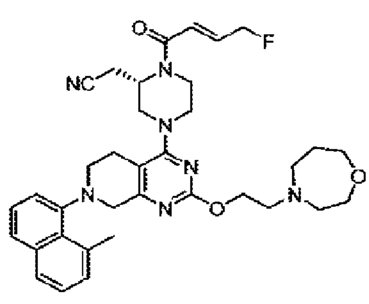
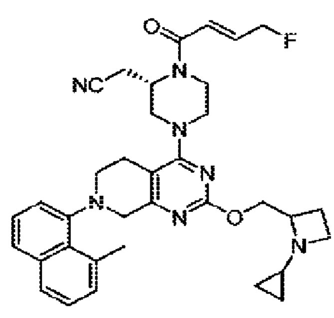
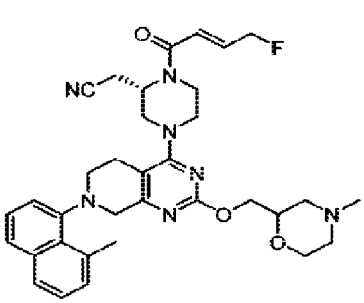
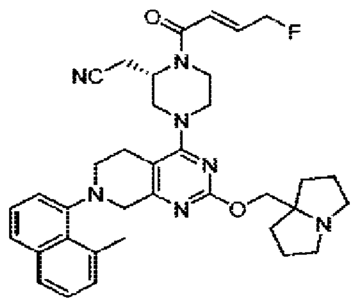
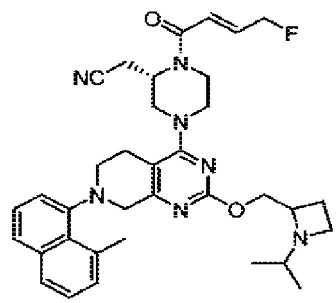
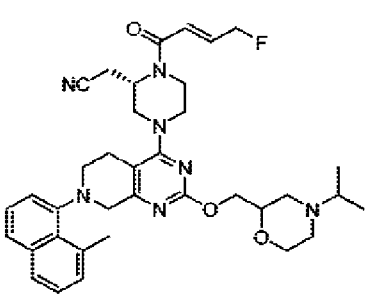
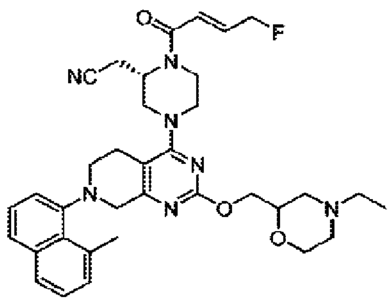
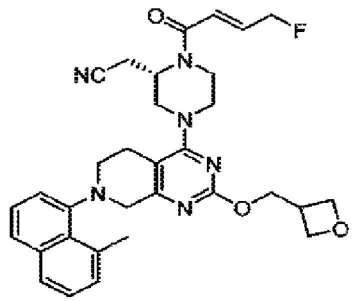
 ,  ,  ,

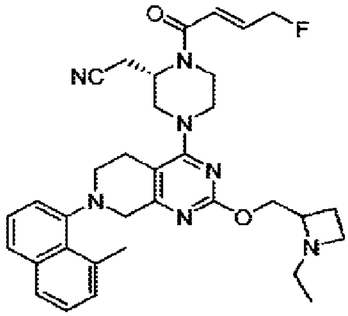
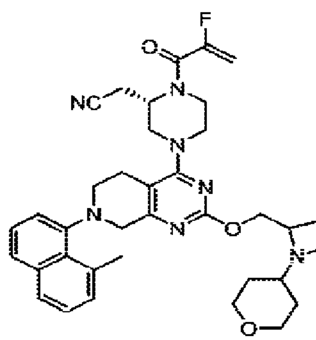
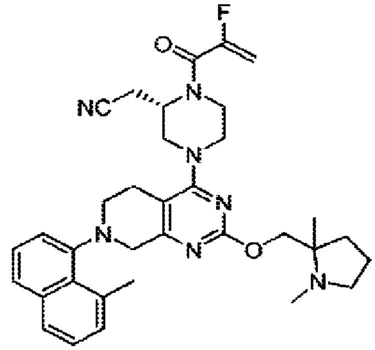
 ,  ,  ,

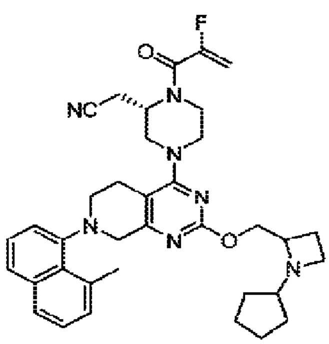
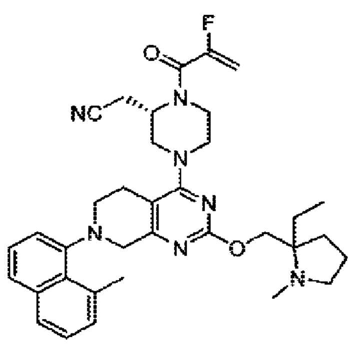
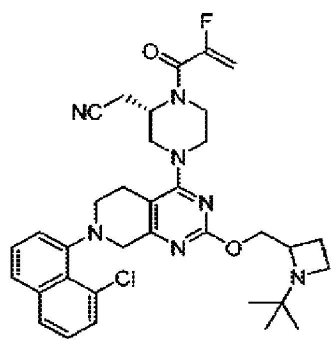
 ,  ,  ,

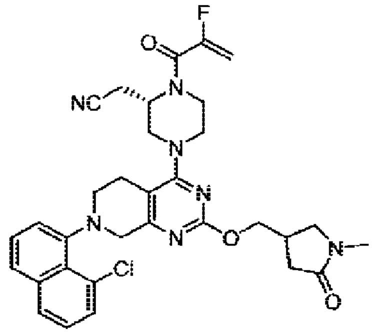
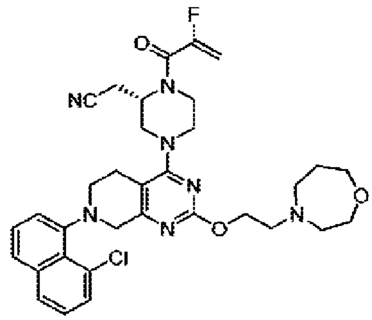
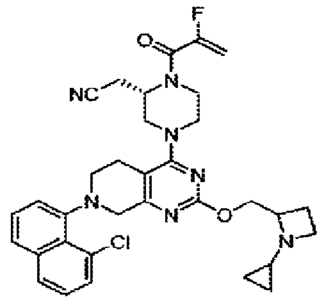
 ,  ,  ,

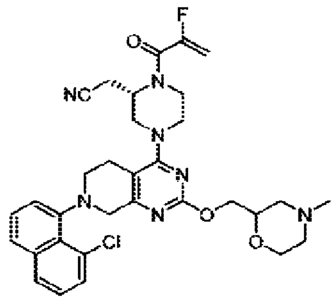
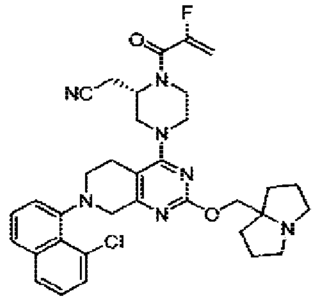
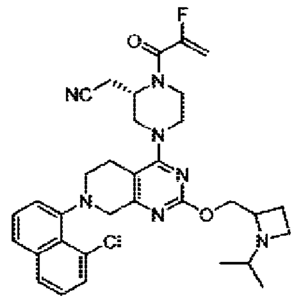
,
,
,

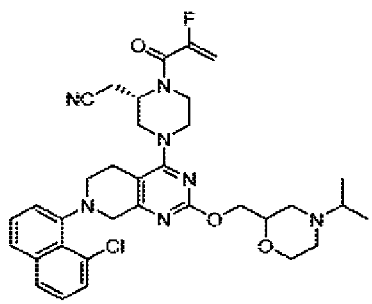
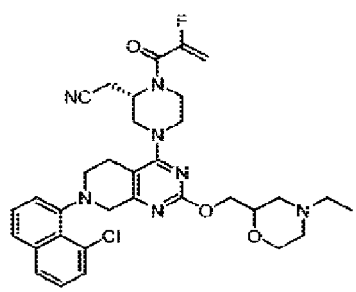
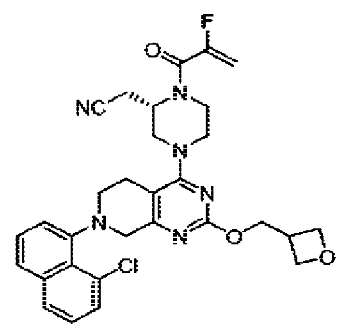
,
,
,

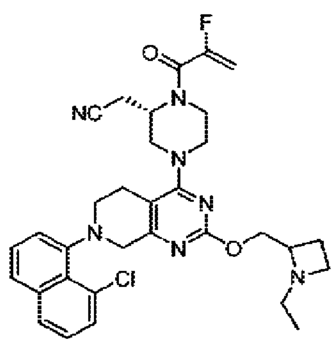
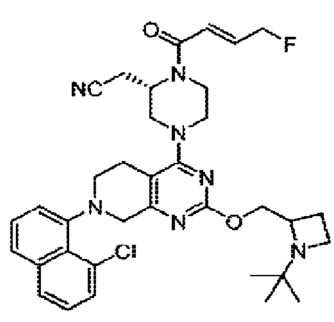
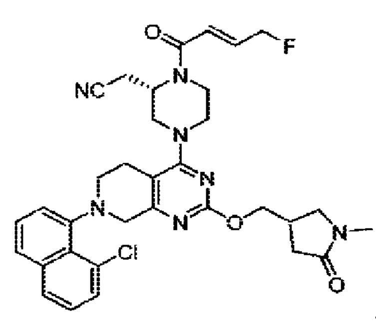
,
,
,

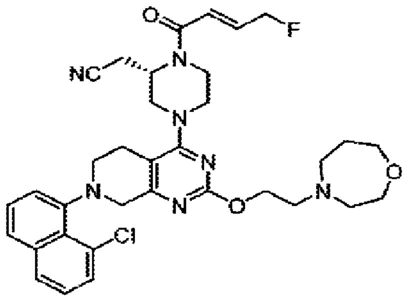
,
,
,

 ,  ,  ,

 ,  ,  ,

 ,  ,  ,

 ,  ,  ,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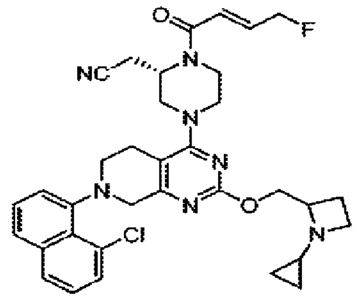
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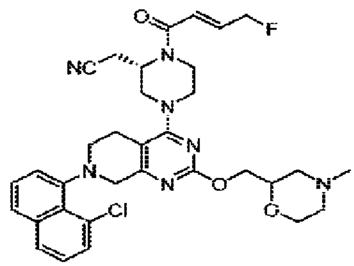
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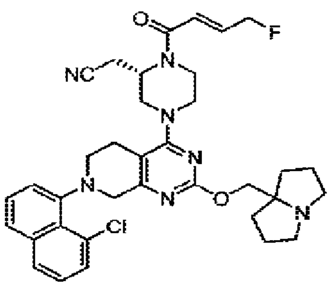
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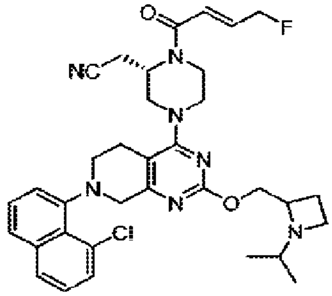
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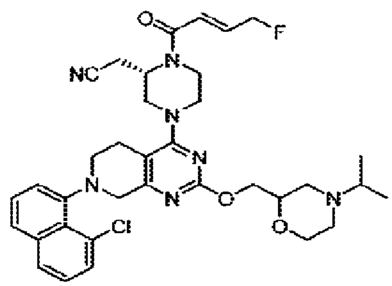
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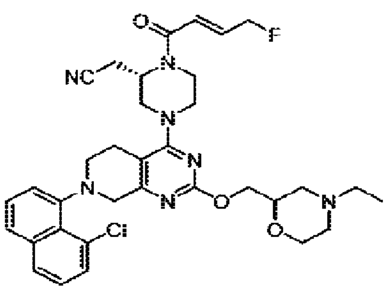
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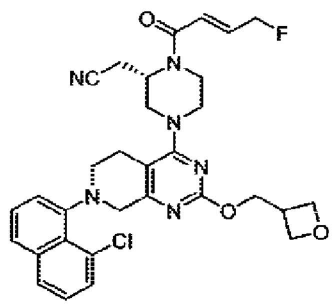
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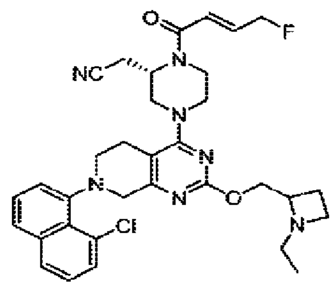
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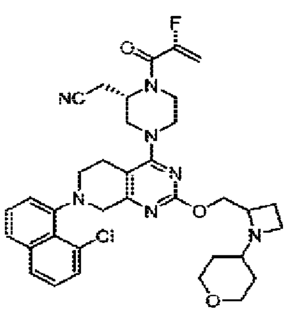
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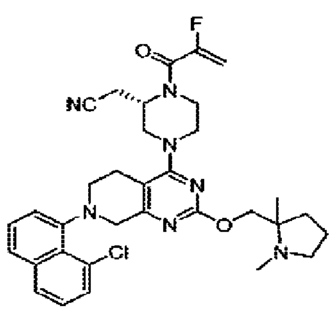
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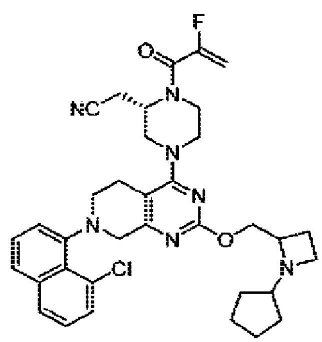
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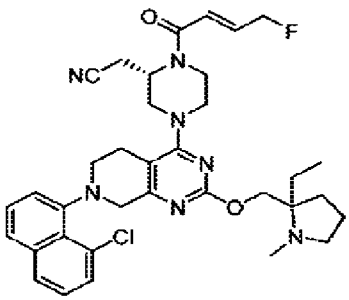
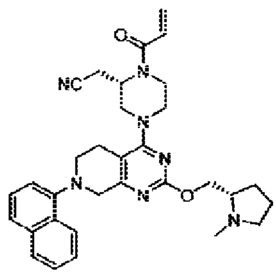
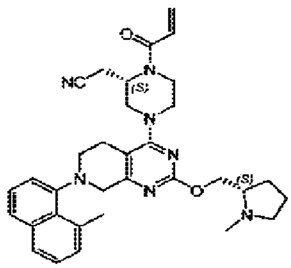
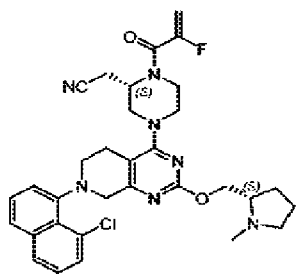
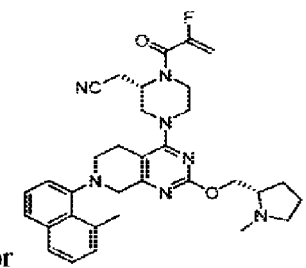
and  ,

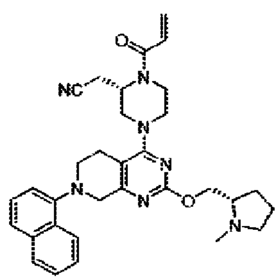
and pharmaceutically acceptable salts thereof.

[0128] In one embodiment, the KRas G12C inhibitor is selected from:

 ,  ,  , or  ,

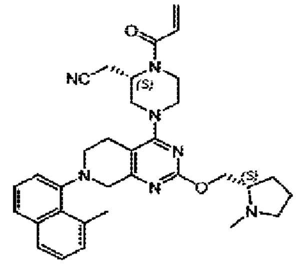
and pharmaceutically acceptable salts thereof.

[0129] In one embodiment, the KRas G12C inhibitor is:



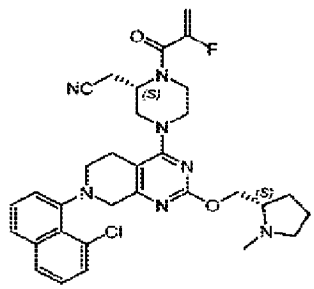
(also referred to as Example 234) or a pharmaceutically acceptable salt thereof.

[0130] In one embodiment, the KRas G12C inhibitor is:



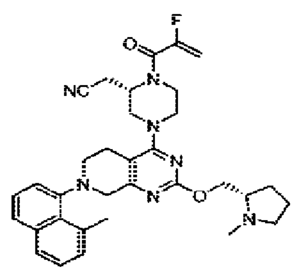
(also referred to as Example 359) or a pharmaceutically acceptable salt thereof.

[0131] In one embodiment, the KRas G12C inhibitor is:



(also referred to as Example 478) or a pharmaceutically acceptable salt thereof.

[0132] In one embodiment, the KRas G12C inhibitor is:



(also referred to as Example 507) or a pharmaceutically acceptable salt thereof.

[0133] The KRas G12C inhibitors used in the methods of the present invention may have one or more chiral center and may be synthesized as stereoisomeric mixtures, isomers of identical constitution that differ in the arrangement of their atoms in space. The compounds may be used as mixtures or the individual components/isomers may be separated using commercially available reagents and conventional methods for isolation of stereoisomers and enantiomers well-known to those skilled in the art, e.g., using CHIRALPAK® (Sigma-Aldrich) or CHIRALCEL® (Diacel Corp) chiral chromatographic HPLC columns according to the manufacturer's instructions. Alternatively, compounds of the present invention may be synthesized using optically pure, chiral reagents and intermediates to prepare individual isomers or enantiomers. Unless otherwise indicated, all chiral (enantiomeric and diastereomeric) and racemic forms are within the scope of the invention. Unless otherwise indicated, whenever the specification, including the claims, refers to compounds of the invention, the term "compound" is to be understood to encompass all chiral (enantiomeric and diastereomeric) and racemic forms.

[0134] In one embodiment, the KRas G12C inhibitor compounds of Formula I, Formula I-A, or Formula I-B used in the methods include trifluoroacetic acid salts of the above compounds.

[0135] Methods for manufacturing the KRas G12C inhibitors disclosed herein are known. For example, commonly owned published international PCT application numbers WO2017201161 and WO2019099524 describe general reaction schemes for preparing compounds of Formula I, Formula I-A, or Formula I-B and also provide detailed synthetic routes for the preparation of each KRas G12C inhibitor disclosed herein.

[0136] The PD-1/PD-L1 inhibitors and the KRas G12C compounds of Formula (I), Formula I-A, or Formula I-B or pharmaceutically acceptable salts thereof may be separately formulated into pharmaceutical compositions.

PHARMACEUTICAL COMPOSITIONS

[0137] In another aspect, the invention provides pharmaceutical compositions comprising a PD-1/PD-L1 inhibitor and pharmaceutical compositions comprising a KRas G12C inhibitor or a pharmaceutically acceptable salt thereof according to the invention, wherein said compositions further comprise a pharmaceutically acceptable carrier, excipient, or diluent, that may be used in the methods disclosed herein. The KRas G12C inhibitor may be independently formulated by any method well known in the art and may be prepared for administration by any route, including, without limitation, parenteral, oral, sublingual, transdermal, topical, intranasal, intratracheal, intravenously or intrarectal. In certain embodiments, the pharmaceutical composition comprising a KRas G12C inhibitor, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, is administered intravenously. In one embodiment, the pharmaceutical composition comprising a KRas G12C inhibitor is administered orally. In one embodiment, the pharmaceutical composition comprising a PD-1/PD-L1 inhibitor is administered parenterally, including via subcutaneous, intracutaneous, intravenous, intramuscular, intraarticular, intraarterial, intrasynovial, intrasternal, intrathecal, intralesional and intracranial injection or infusion techniques. In one embodiment, the pharmaceutical composition comprising a PD-1/PD-L1 inhibitor is administered intravenously.

[0138] The characteristics of the carrier will depend on the route of administration. As used herein, the term "pharmaceutically acceptable" means a non-toxic material that is compatible with a biological system such as a cell, cell culture, tissue, or organism, and that does not interfere with the effectiveness of the biological activity of the active ingredient(s). Thus, compositions may contain, in addition to the inhibitor, diluents, fillers, salts, buffers, stabilizers, solubilizers, and other materials well known in the art. The preparation of pharmaceutically acceptable formulations is described in, e.g., Remington's Pharmaceutical Sciences, 18th Edition, ed. A. Gennaro, Mack Publishing Co., Easton, Pa., 1990.

[0139] As used herein, the term pharmaceutically acceptable salt refers to salts that retain the desired biological activity of the above-identified compounds and exhibit minimal or no undesired toxicological effects. Examples of such salts include, but are not limited to acid addition salts formed with inorganic acids (for example, hydrochloric acid, hydrobromic acid, sulfuric acid, phosphoric acid, nitric acid, and the like), and salts formed with organic acids such as acetic acid, oxalic acid, tartaric acid, succinic acid, malic acid, ascorbic acid, benzoic acid, tannic acid, pamoic acid, alginic acid, polyglutamic acid, naphthalenesulfonic acid, naphthalenedisulfonic acid, and polygalacturonic acid. The compounds can also be administered as pharmaceutically acceptable quaternary salts known by those skilled in the art, which specifically include the quaternary ammonium salt of the formula --NR+Z-, wherein R is hydrogen, alkyl, or benzyl, and Z is a counterion, including chloride, bromide, iodide, --O-alkyl, toluenesulfonate, methylsulfonate, sulfonate, phosphate, or carboxylate (such as benzoate, succinate, acetate, glycolate, maleate, malate, citrate, tartrate, ascorbate, benzoate, cinnamoate, mandeloate, benzyloate, and diphenylacetate).

[0140] The active compound or agent is included in the pharmaceutically acceptable carrier or diluent in an amount sufficient to deliver to a patient a therapeutically effective amount without causing serious toxic effects in the patient treated. In one embodiment, a dose of the active compound for all of the above-mentioned compositions of the KRas G12C inhibitor is in the range from about 0.01 to 300 mg/kg, for example 0.1 to 100 mg/kg per day, and as a further example 0.5 to about 25 mg per kilogram body weight of the recipient per day. The effective dosage range of the pharmaceutically acceptable carrier or diluent can be calculated based on the weight of the parent compound to be delivered. If the derivative exhibits activity in itself, the effective dosage can be estimated as above using the weight of the derivative, or by other means known to those skilled in the art.

[0141] The pharmaceutical compositions comprising a PD-1/PD-L1 inhibitor and the pharmaceutical compositions comprising a KRas G12C inhibitor may be used in any of the methods of use described herein.

CO-ADMINSTRATION

[0142] The components of the pharmaceutical combinations described herein comprising a PD-1/PD-L1 inhibitor and/or a KRas G12C inhibitor or a pharmaceutically acceptable salt thereof, for use in any of the methods herein may be for simultaneous, separate or sequential use. In one embodiment, the PD-1/PD-L1 inhibitor is administered prior to administration of the KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof. In another embodiment, the PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof is administered after administration of the KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof. In another embodiment, the PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, is administered at about the same time as administration of the KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof. In one embodiment, the PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and the KRas G12C inhibitor, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, can be formulated into separate or individual dosage forms which can be co-administered simultaneously or one after the other.

[0143] Separate administration of each inhibitor, at different times and by different routes, in some cases would be advantageous. Thus, the components of the combination, i.e. the KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof and the PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof, need not be necessarily administered at essentially the same time or in any order.

[0144] Oncology drugs are typically administered at the maximum tolerated dose ("MTD"), which is the highest dose of drug that does not cause unacceptable side effects. In one embodiment, the KRas G12C inhibitor, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, and the PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof are each dosed at their respective MTDs. In one embodiment, the KRas G12C inhibitor, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, is dosed at its MTD and the PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof is dosed in an amount less than its MTD. In one embodiment, the KRas G12C inhibitor, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, is dosed at an amount less than its MTD and the PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof is dosed at its MTD. In one embodiment, the KRas G12C inhibitor, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, and the PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof are each dosed at less than their respective MTDs. The administration can be so timed that the peak pharmacokinetic effect of one inhibitor coincides with the peak pharmacokinetic effect of the other.

[0145] In one embodiment, a single dose of KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, is administered per day (i.e., in about 24 hour intervals) (i.e., QD). In another embodiment, two doses of the KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, are administered per day (i.e., BID). In another embodiment, three doses of the KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, are administered per day (i.e., TID). In one of any of said embodiments, the KRAS inhibitor is administered orally.

[0146] Examples of PD-1/PD-L1 inhibitors suitable for the provided compositions and methods include, but are not limited to, PD-1 antibodies, including but not limited to nivolumab (Opdivo®), pembrolizumab (Keytruda®), cemiplimab (Libtayo®) and tislelizumab, and biosimilars thereof., and anti-PD-L1 antibodies including, but not limited to, atezolizumab (Tecentriq®), avelumab (Bavencio®), and durvalumab (Imfinzi®), and biosimilars thereof.

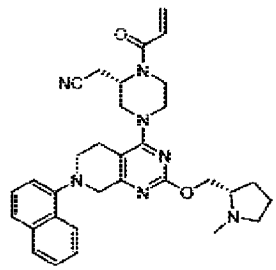
[0147] In one embodiment, a single dose of the PD-1/PD-L1 inhibitor is administered. In one embodiment, the PD-1/PD-L1 inhibitor is administered once every two weeks. In one embodiment, the PD-1/PD-L1 inhibitor is administered once every three weeks. In one embodiment, the PD-1/PD-L1 inhibitor is administered once every four weeks. In one embodiment, the PD-1/PD-L1 inhibitor is nivolumab and is administered once every two weeks. In one embodiment, the PD-1/PD-L1 inhibitor is nivolumab and is administered once every four weeks. In one embodiment, the PD-1/PD-L1 inhibitor is pembrolizumab and is administered once every three weeks. In one embodiment, the PD-1/PD-L1 inhibitor is atezolizumab and is administered once every three weeks. In one embodiment, the PD-1/PD-L1 inhibitor is cemiplimab and is administered once every three weeks. In one embodiment, the PD-1/PD-L1 inhibitor is tislelizumab and is administered once every three weeks. In one embodiment, the PD-1/PD-L1 inhibitor is avelumab and is administered once every two weeks. In one embodiment, the PD-1/PD-L1 inhibitor is durvalumab and is administered once every two weeks. In one of any of said embodiments, the PD-1/PD-L1 inhibitor is administered intravenously.

COMBINATION THERAPIES

[0148] In one aspect of the invention, provided herein are methods of treating cancer in a subject in need thereof, comprising administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof. In one embodiment, the cancer is a KRas G12C-associated cancer. In one embodiment, the KRas G12C-associated cancer is lung cancer. In one embodiment, the KRas G12C-associated cancer is colorectal cancer.

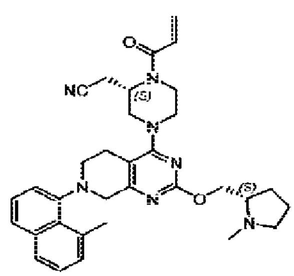
[0149] In one embodiment, the invention provides for methods for inducing a durable complete response in a subject having cancer, comprising administering to the subject a therapeutically effective amount of a combination of a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof and a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof, wherein the subject exhibits a durable complete response.

[0150] In one embodiment, the combination therapy comprises a combination of a compound having the formula:



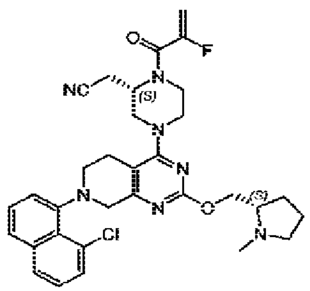
[0151] (also referred to herein as Example No. 234) or a pharmaceutically acceptable salt thereof, and a PD-1/PD-L1 inhibitor. In one embodiment, the PD-1/PD-L1 inhibitor is nivolumab. In one embodiment, the PD-1/PD-L1 inhibitor is pembrolizumab. In one embodiment, the PD-1/PD-L1 inhibitor is cemiplimab. In one embodiment, the PD-1/PD-L1 inhibitor is tislelizumab. In one embodiment, the PD-1/PD-L1 inhibitor is atezolizumab. In one embodiment, the PD-1/PD-L1 inhibitor is avelumab. In one embodiment, the PD-1/PD-L1inhibitor is durvalumab.

[0152] In one embodiment, the combination therapy comprises a combination of a compound having the formula:



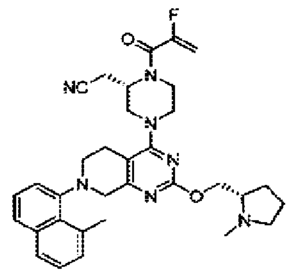
[0153] (also referred to herein as Example No. 359) or a pharmaceutically acceptable salt thereof, and a PD-1/PD-L1 inhibitor. In one embodiment, the PD-1/PD-L1 inhibitor is nivolumab. In one embodiment, the PD-1/PD-L1 inhibitor is pembrolizumab. In one embodiment, the PD-1/PD-L1 inhibitor is cemiplimab. In one embodiment, the PD-1/PD-L1 inhibitor is tislelizumab. In one embodiment, the PD-1/PD-L1 inhibitor is atezolizumab. In one embodiment, the PD-1/PD-L1 inhibitor is avelumab. In one embodiment, the PD-1/PD-L1inhibitor is durvalumab.

[0154] In one embodiment, the combination therapy comprises a combination of a compound having the formula:



[0155] (also referred to herein as Example No. 478) or a pharmaceutically acceptable salt thereof, and a PD-1/PD-L1 inhibitor. In one embodiment, the PD-1/PD-L1 inhibitor is nivolumab. In one embodiment, the PD-1/PD-L1 inhibitor is pembrolizumab. In one embodiment, the PD-1/PD-L1 inhibitor is cemiplimab. In one embodiment, the PD-1/PD-L1 inhibitor is tislelizumab. In one embodiment, the PD-1/PD-L1 inhibitor is atezolizumab. In one embodiment, the PD-1/PD-L1 inhibitor is avelumab. In one embodiment, the PD-1/PD-L1inhibitor is durvalumab.

[0156] In one embodiment, the combination therapy comprises a combination of a compound having the formula:



[0157] (also referred to herein as Example No. 507) or a pharmaceutically acceptable salt thereof, and a PD-1/PD-L1 inhibitor. In one embodiment, the PD-1/PD-L1 inhibitor is nivolumab. In one embodiment, the PD-1/PD-L1 inhibitor is pembrolizumab. In one embodiment, the PD-1/PD-L1 inhibitor is cemiplimab. In one embodiment, the PD-1/PD-L1 inhibitor is tislelizumab. In one embodiment, the PD-1/PD-L1 inhibitor is atezolizumab. In one embodiment, the PD-1/PD-L1 inhibitor is avelumab. In one embodiment, the PD-1/PD-L1inhibitor is durvalumab.

[0158] By negatively modulating the activity of KRas G12C, the methods described herein are designed to inhibit undesired cellular proliferation resulting from enhanced KRas G12C activity that can lead to immune suppression and resistance to PD-1/PD-L1 inhibitors. The degree of covalent modification of KRas G12C may be monitored in vitro using well known methods, including those described in published international PCT application numbers WO2017201161 and WO2019099524. In addition, the inhibitory activity of combination in cells may be monitored, for example, by measuring the inhibition of KRas G12C activity of the amount of phosphorylated ERK to assess the effectiveness of treatment and dosages may be adjusted accordingly by the attending medical practitioner. Methods for determining the expression of PD-1 and PD-L1 are well known and may be used to monitor PD-1 status during treatment.

[0159] The combinations and methods provided herein may be used for the treatment of a KRas G12C-associated cancer in a subject in need thereof, comprising administering to said subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B, or pharmaceutically acceptable salts or pharmaceutical compositions thereof, wherein the PD-1/PD-L1 inhibitor synergistically increases the sensitivity of the KRas G12C-associated cancer to the KRas G12C inhibitor. In one embodiment, the

KRas G12C-associated cancer is lung cancer. In one embodiment, the KRAS G12C-associated cancer is colorectal cancer.

[0160] In one embodiment, the therapeutically effective amount of the combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, results in an increased duration of overall survival ("OS") in subjects relative to treatment with only the KRas G12C inhibitor. In one embodiment, the increased duration of overall survival ("OS") in subjects relative to treatment with KRas G12C inhibitor monotherapy is for the remaining life time of the subject. In one embodiment, the therapeutically effective amount of the combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, results in an increased duration of progression-free survival ("PFS") in subjects relative to treatment with only the KRas G12C inhibitor. In one embodiment, the therapeutically effective amount of the combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, results in increased tumor regression in subjects relative to treatment with only the KRas G12C inhibitor. In one embodiment, the therapeutically effective amount of the combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, results in increased tumor growth inhibition in subjects relative to treatment with only the KRas G12C inhibitor. In one embodiment, the therapeutically effective amount of the combination of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A, or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, results in an improvement in the duration of stable disease in subjects compared to treatment with only the KRas G12C inhibitor. In one embodiment, the KRas G12C inhibitor is a compound selected from compound Nos. 1-678 (as numbered in WO2019099524), or a pharmaceutically acceptable salt thereof (e.g., Example No. 234, 359, 478 or 507 or a pharmaceutically acceptable salt thereof). In one embodiment, the PD-1/PD-L1 inhibitor is selected from nivolumab, pembrolizumab, cemiplimab, tislelizumab, atezolizumab, avelumab, and durvalumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and nivolumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and pembrolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and cemiplimab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and tislelizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and atezolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and avelumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and durvalumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and nivolumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and pembrolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and cemiplimab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and tislelizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and atezolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and avelumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and durvalumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and nivolumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and pembrolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and cemiplimab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and tislelizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and atezolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and avelumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of

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Example No. 478 and durvalumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and nivolumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and pembrolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and cemiplimab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and tislelizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and atezolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and avelumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and durvalumab.

[0161] In another embodiment, the PD-1/PD-L1 inhibitor is administered in combination with the KRas G12C inhibitor once disease progression has been observed for KRas G12C monotherapy, in which the combination therapy results in enhanced clinical benefit for the patient by increasing OS, PFS, tumor regression, tumor growth inhibition or the duration of stable disease in the patient. In one embodiment, the KRas G12C inhibitor is a compound selected from compound Nos. 1-678 (as numbered in WO2019099524), or a pharmaceutically acceptable salt thereof (e.g., Example No. 234, 359, 478 or 507 or a pharmaceutically acceptable salt thereof). In one embodiment, the PD-1/PD-L1 inhibitor is selected from nivolumab, pembrolizumab, cemiplimab, tislelizumab, atezolizumab, avelumab, and durvalumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and nivolumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and pembrolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and cemiplimab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and tislelizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and atezolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and avelumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and durvalumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and nivolumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and pembrolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and cemiplimab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and tislelizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and atezolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and avelumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and durvalumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and nivolumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and pembrolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and cemiplimab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and tislelizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and atezolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and avelumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and durvalumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and nivolumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and pembrolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and cemiplimab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and tislelizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and atezolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and avelumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and durvalumab.

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[0162] The compositions and methods provided herein may be used for the treatment of a wide variety of cancers including tumors such as lung, colorectal, pancreas, prostate, breast, brain, skin, cervical carcinomas, testicular carcinomas, etc. More particularly, cancers that may be treated by the compositions and methods of the invention include, but are not limited to, tumor types such as astrocytic, breast, cervical, colorectal, endometrial, esophageal, gastric, head and neck, hepatocellular, laryngeal, lung, oral, ovarian, prostate and thyroid carcinomas and sarcomas. More specifically, these compounds can be used to treat: Cardiac: sarcoma (angiosarcoma, fibrosarcoma, rhabdomyosarcoma, liposarcoma), myxoma, rhabdomyoma, fibroma, lipoma and teratoma; Lung: bronchogenic carcinoma (squamous cell, undifferentiated small cell, undifferentiated large cell, adenocarcinoma), alveolar (bronchiolar) carcinoma, bronchial adenoma, sarcoma, lymphoma, chondromatous hamartoma, mesothelioma; Gastrointestinal: esophagus (squamous cell carcinoma, adenocarcinoma, leiomyosarcoma, lymphoma), stomach (carcinoma, lymphoma, leiomyosarcoma), pancreas (ductal adenocarcinoma, insulinoma, glucagonoma, gastrinoma, carcinoid tumors, vipoma), small bowel (adenocarcinoma, lymphoma, carcinoid tumors, Kaposi's sarcoma, leiomyoma, hemangioma, lipoma, neurofibroma, fibroma), large bowel (adenocarcinoma, tubular adenoma, villous adenoma, hamartoma, leiomyoma); Genitourinary tract: kidney (adenocarcinoma, Wilm's tumor (nephroblastoma), lymphoma, leukemia), bladder and urethra (squamous cell carcinoma, transitional cell carcinoma, adenocarcinoma), prostate (adenocarcinoma, sarcoma), testis (seminoma, teratoma, embryonal carcinoma, teratocarcinoma, choriocarcinoma, sarcoma, interstitial cell carcinoma, fibroma, fibroadenoma, adenomatoid tumors, lipoma); Liver: hepatoma (hepatocellular carcinoma), cholangiocarcinoma, hepatoblastoma, angiosarcoma, hepatocellular adenoma, hemangioma; Biliary tract: gall bladder carcinoma, ampullary carcinoma, cholangiocarcinoma; Bone: osteogenic sarcoma (osteosarcoma), fibrosarcoma, malignant fibrous histiocytoma, chondrosarcoma, Ewing's sarcoma, malignant lymphoma (reticulum cell sarcoma), multiple myeloma, malignant giant cell tumor chordoma, osteochronfroma (osteocartilaginous exostoses), benign chondroma, chondroblastoma, chondromyxofibroma, osteoid osteoma and giant cell tumors; Nervous system: skull (osteoma, hemangioma, granuloma, xanthoma, osteitis deformans), meninges (meningioma, meningiosarcoma, gliomatosis), brain (astrocytoma, medulloblastoma, glioma, ependymoma, germinoma (pinealoma), glioblastoma multiform, oligodendroglioma, schwannoma, retinoblastoma, congenital tumors), spinal cord neurofibroma, meningioma, glioma, sarcoma); Gynecological: uterus (endometrial carcinoma), cervix (cervical carcinoma, pre-tumor cervical dysplasia), ovaries (ovarian carcinoma (serous cystadenocarcinoma, mucinous cystadenocarcinoma, unclassified carcinoma), granulosa-thecal cell tumors, Sertoli-Leydig cell tumors, dysgerminoma, malignant teratoma), vulva (squamous cell carcinoma, intraepithelial carcinoma, adenocarcinoma, fibrosarcoma, melanoma), vagina (clear cell carcinoma, squamous cell carcinoma, botryoid sarcoma (embryonal rhabdomyosarcoma), fallopian tubes (carcinoma); Hematologic: blood (myeloid leukemia (acute and chronic), acute lymphoblastic leukemia, chronic lymphocytic leukemia, myeloproliferative diseases, multiple myeloma, myelodysplastic syndrome), Hodgkin's disease, non-Hodgkin's lymphoma (malignant lymphoma); Skin: malignant melanoma, basal cell carcinoma, squamous cell carcinoma, Kaposi's sarcoma, moles dysplastic nevi, lipoma, angioma, dermatofibroma, keloids, psoriasis; and Adrenal glands: neuroblastoma. In certain embodiments, the cancer is non-small cell lung cancer. In one embodiment, the KRas G12C-associated cancer is colorectal cancer.

[0163] Also provided herein is a method for treating cancer in a subject in need thereof, the method comprising (a) determining that cancer is associated with a KRas G12C mutation (e.g., a KRas G12C-associated cancer) (e.g., as determined using a regulatory agency-approved, e.g., FDA-approved, assay or kit); and (b) administering to the patient a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor and a KRas G12C inhibitor compound of Formula I, Formula I-A, Formula 1-B, or a pharmaceutically acceptable salt or pharmaceutical composition thereof, wherein the PD-1/PD-L1 inhibitor synergistically increases the sensitivity of the KRas G12C-associated cancer to the KRas G12C inhibitor.

[0164] The combinations and methods provided herein also may be used for the treatment of a KRas G12C-associated cancer in a subject in need thereof, wherein the KRas G12C-associated cancer is resistant to treatment with a PD-1/PD-L1 inhibitor, comprising administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0165] In one embodiment, the combinations and methods provided herein are used for the treatment of a KRas G12C-associated cancer and determined to have previously developed resistance to treatment with a PD-1/PD-L1 inhibitor that include administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0166] Also the combinations and methods provided herein also may be used for suppressing resistance to treatment with a PD-1/PD-L1 inhibitor in a subject having a KRas G12C-associated cancer that include administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0167] In one embodiment, the invention provides methods of treating a subject identified or diagnosed as having a KRAS G12C-associated cancer that include (a) detecting resistance of the KRas G12C-associated cancer in the subject to treatment with a PD-1/PD-L1 inhibitor that was previously administered to the patient; and (b) after (a), administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0168] The combinations and methods provided herein also may be used for the treatment of a subject identified or diagnosed as having a KRas G12C-associated cancer and determined to have previously developed resistance to treatment with a KRAS G12C inhibitor that include administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0169] In one embodiment, the invention provides methods of treating a subject identified or diagnosed as having a KRas G12C-associated cancer, comprising (a) administering a KRAS G12C inhibitor as monotherapy until disease progression, and (b) after (a), administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a KRAS G12C inhibitor of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

[0170] In one embodiment, the KRas G12C inhibitor used for treating the KRas G12C-associated cancers in any of the foregoing methods is a compound selected from compound Nos. 1-678 (as numbered in WO2019099524), or a pharmaceutically acceptable salt thereof (e.g., Example No. 234, 359, 478 or 507 or a pharmaceutically acceptable salt thereof). In one embodiment, the PD-1/PD-L1 inhibitor is selected from nivolumab, pembrolizumab, cemiplimab, tislelizumab, atezolizumab, avelumab, and durvalumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and nivolumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and pembrolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and cemiplimab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and tislelizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and atezolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and avelumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 234 and durvalumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and nivolumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and pembrolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and cemiplimab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and tislelizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and atezolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and avelumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 359 and durvalumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and nivolumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and pembrolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and cemiplimab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and tislelizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and atezolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and avelumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 478 and durvalumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and nivolumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and pembrolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and cemiplimab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and tislelizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and atezolizumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and avelumab. In one embodiment, the therapeutic combination comprises therapeutically effective amounts of Example No. 507 and durvalumab.

[0171] In one embodiment, a compound of Formula I, Formula I-A, Formula 1-B, or a pharmaceutically acceptable salt or pharmaceutical composition thereof is administered as a tablet or capsule. In one embodiment, a tablet or capsule formulation of a compound of Formula I comprises about 10 mg to about 100 mg (e.g., about 10 mg to about 95 mg, about 10 mg to about 90 mg, about 10 mg to about 85 mg, about 10 mg to about 80 mg, about 10 mg to about 75 mg, about 10 mg to about 70 mg, about 10 mg to about 65 mg, about 10 mg to about 60 mg, about 10 mg to about 55 mg, about 10 mg to about 50 mg, about 10 mg to about 45 mg, about 10 mg to about 40 mg, about 10 mg to about 35 mg, about 10 mg to about 30 mg, about 10 mg to about 25 mg, about 10 mg to about 20 mg, about 10 mg to about 15 mg, about 15 mg to about 100 mg, about 15 mg to about 95 mg, about 15 mg to about 90 mg, about 15 mg to about 85 mg, about 15 mg to about 80 mg, about 15 mg to about 75 mg, about 15 mg to about 70 mg, about 15 mg to about 65 mg, about 15 mg to about 60 mg, about 15 mg to about 55 mg, about 15 mg to about 50 mg, about 15 mg to about 45 mg, about 15 mg to about 40 mg, about 15 mg to about 35 mg, about 15 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45 mg, about 50 mg, about 55 mg, about 60 mg, about 65 mg, about 70 mg, about 75 mg, about 80 mg, about 85 mg, about 90 mg, about 95 mg, or about 100 mg) of a compound of Formula Nos. 1-678 (as numbered in WO2019099524), or a pharmaceutically acceptable salt thereof (e.g., Example No. 234, 359, 478 or 507 or a pharmaceutically acceptable salt thereof). In one embodiment, a compound of Formula I is orally administered once a day (QD) on a daily basis during a period of time. In one embodiment, a compound of Formula I is orally administered twice a day (BID) on a daily basis during a period of time. In one embodiment, a compound of Formula I is orally administered in the amount of about 20 mg to about 500 mg (e.g., about 20 mg to about 480 mg, about 20 mg to about 460 mg, about 20 mg to about 440 mg, about 20 mg to about 420 mg, about 20 mg to about 400 mg, about 20 mg to about 380 mg, about 20 mg to about 360 mg, about 20 mg to about 340 mg, about 20 mg to about 320 mg, about 20 mg to about 300 mg, about 20 mg to about 280 mg, about 20 mg to about 260 mg, about 20 mg to about 240 mg, about 20 mg to about 220 mg, about 20 mg to about 200 mg, about 20 mg to about 180 mg, about 20 mg to about 160 mg, about 20 mg to about 140 mg, about 20 mg to about 120 mg, about 20 mg to about 100 mg, about 20 mg to about 80 mg, about 20 mg to about 60 mg, about 20 mg to about 40 mg, about 40 mg to about 500 mg, about 40 mg to about 480 mg, about 40 mg to about 460 mg, about 40 mg to about 440 mg, about 40 mg to about 420 mg, about 40 mg to about 400 mg, about 40 mg to about 380 mg, about 40 mg to 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25, about 50, about 75, about 100, about 150, about 200, about 250, about 300, about 350, about 400, about 450, or about 500 mg), during a period of time.

[0172] In one embodiment, the combination therapy comprises oral administration of a compound of Formula I once or twice a day on a daily basis (during a period of time), e.g., in an amount of about 10 mg to about 400 mg (e.g., about 10 mg to about 380 mg, about 10 mg to about 360 mg, about 10 mg to about 340 mg, about 10 mg to about 320 mg, about 10 mg to about 300 mg, about 10 mg to about 280 mg, about 10 mg to about 260 mg, about 10 mg to about 240 mg, about 10 mg to about 220 mg, about 10 mg to about 200 mg, about 10 mg to about 180 mg, about 10 mg to about 160 mg, about 10 mg to about 140 mg, about 10 mg to about 120 mg, about 10 mg to about 100 mg, about 10 mg to about 80 mg, about 10 mg to about 60 mg, about 10 mg to about 40 mg, about 10 mg to about 20 mg, about 20 mg to about 400 mg, about 20 mg to about 380 mg, about 20 mg to about 360 mg, about 20 mg to about 340 mg, about 20 mg to about 320 mg, about 20 mg to about 300 mg, about 20 mg to about 280 mg, about 20 mg to about 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about 320 mg, about 260 mg to about 300 mg, about 260 mg to about 280 mg, about 280 mg to about 400 mg, about 280 mg to about 380 mg, about 280 mg to about 360 mg, about 280 mg to about 340 mg, about 280 mg to about 320 mg, about 280 mg to about 300 mg, about 300 mg to about 400 mg, about 300 mg to about 380 mg, about 300 mg to about 360 mg, about 300 mg to about 340 mg, about 300 mg to about 320 mg, about 320 mg to about 400 mg, about 320 mg to about 380 mg, about 320 mg to about 360 mg, about 340 mg to about 360 mg, about 340 mg to about 400 mg, about 340 mg to about 380 mg, about 340 mg to about 360 mg, about 360 mg to about 400 mg, about 360 mg to about 380 mg, about 380 mg to about 400 mg, about 100 mg, about 200 mg, about 300 mg, or about 400 mg), and i.v. administration of a PD-1/PD-L1 inhibitor which is administered, for example, once a week, once every two weeks, once every three weeks, or once every four weeks, depending on the dosage. In one embodiment, the KRas G12C inhibitor is orally administered once daily. In one embodiment, the KRas G12C inhibitor is orally administered twice daily.

[0173] In one embodiment, the PD-L1 inhibitor is avelumab or a biosimilar thereof. In one embodiment, avelumab or a biosimilar thereof is administered intravenously in the amount of about 800 mg every 2 weeks (Q2W) or about 10 mg/kg every 2 weeks (Q2W). In one embodiment, avelumab or a biosimilar thereof is administered intravenously over 60 minutes.

[0174] In one embodiment, the PD-L1 inhibitor is atezolizumab or a biosimilar thereof. In one embodiment, atezolizumab or a biosimilar thereof is administered at a dose of 1200 mg intravenously once every 3 weeks (Q3W) or at a dose of 840 mg intravenously two weeks apart. In one embodiment, atezolizumab or a biosimilar thereof is administered intravenously over 60 minutes.

[0175] In one embodiment, the PD-L1 inhibitor is durvalumab or a biosimilar thereof. In one embodiment, durvalumab or a biosimilar thereof is administered at a dose of 10 mg/kg intravenously once every 2 weeks (Q2W). In one embodiment, durvalumab or a biosimilar thereof is administered intravenously over 60 minutes.

[0176] In one embodiment, the PD-1 inhibitor is nivolumab or a biosimilar thereof. In one embodiment, nivolumab or a biosimilar thereof is administered at a dose of 240 mg intravenously once every 2 weeks (Q2W). In one embodiment, nivolumab or a biosimilar thereof is administered at a dose of 480 mg intravenously once every 4 weeks (Q4W). In one embodiment, nivolumab or a biosimilar thereof is administered intravenously over 30 minutes.

[0177] In one embodiment, the PD-1 inhibitor is pembrolizumab or a biosimilar thereof. In one embodiment, pembrolizumab is administered at a dose of 200 mg intravenously once every 3 weeks (Q3W). In one embodiment, pembrolizumab or a biosimilar thereof is administered intravenously over 60 minutes.

[0178] In one embodiment, the PD-1 inhibitor is cemiplimab or a biosimilar thereof. In one embodiment, cemiplimab or a biosimilar thereof is administered at a dose of 350 mg intravenously once every 3 weeks (Q3W). In one embodiment, cemiplimab or a biosimilar thereof is administered intravenously over 30 minutes.

[0179] In one embodiment, the PD-1 inhibitor is tislelizumab or a biosimilar thereof. In one embodiment, tislelizumab or a biosimilar thereof is administered at a dose of 200 mg intravenously once every 3 weeks (Q3W).

[0180] One skilled in the art will recognize that, both in vivo and in vitro trials using suitable, known and generally accepted cell and/or animal models are predictive of the ability of a test compound of the combination or the combination to treat or prevent a given disorder.

[0181] One skilled in the art will further recognize that human clinical trials including first-in-human, dose ranging and efficacy trials, in healthy patients and/or those suffering from a given disorder, may be completed according to methods well known in the clinical and medical arts.

[0182] In some embodiments, the methods provided herein can result in a 1% to 99% (e.g., 1% to 98%, 1% to 95%, 1% to 90%, 1 to 85%, 1 to 80%, 1% to 75%, 1% to 70%, 1% to 65%, 1% to 60%, 1% to 55%, 1% to 50%, 1% to 45%, 1% to 40%, 1% to 35%, 1% to 30%, 1% to 25%, 1% to 20%, 1% to 15%, 1% to 10%, 1% to 5%, 2% to 99%, 2% to 90%, 2% to 85%, 2% to 80%, 2% to 75%, 2% to 70%, 2% to 65%, 2% to 60%, 2% to 55%, 2% to 50%, 2% to 45%, 2% to 40%, 2% to 35%, 2% to 30%, 2% to 25%, 2% to 20%, 2% to 15%, 2% to 10%, 2% to 5%, 4% to 99%, 4% to 95%, 4% to 90%, 4% to 85%, 4% to 80%, 4% to 75%, 4% to 70%, 4% to 65%, 4% to 60%, 4% to 55%, 4% to 50%, 4% to 45%, 4% to 40%, 4% to 35%, 4% to 30%, 4% to 25%, 4% to 20%, 4% to 15%, 4% to 10%, 6% to 99%, 6% to 95%, 6% to 90%, 6% to 85%, 6% to 80%, 6% to 75%, 6% to 70%, 6% to 65%, 6% to 60%, 6% to 55%, 6% to 50%, 6% to 45%, 6% to 40%, 6% to 35%, 6% to 30%, 6% to 25%, 6% to 20%, 6% to 15%, 6% to 10%, 8% to 99%, 8% to 95%, 8% to 90%, 8% to 85%, 8% to 80%, 8% to 75%, 8% 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[0183] The phrase "time of survival" means the length of time between the identification or diagnosis of cancer (e.g., any of the cancers described herein) in a mammal by a medical professional and the time of death of the mammal (caused by the cancer). Methods of increasing the time of survival in a mammal having a cancer are described herein.

[0184] In some embodiments, any of the methods described herein can result in an increase (e.g., a 1% to 400%, 1% to 380%, 1% to 360%, 1% to 340%, 1% to 320%, 1% to 300%, 1% to 280%, 1% to 260%, 1% to 240%, 1% to 220%, 1% to 200%, 1% to 180%, 1% to 160%, 1% to 140%, 1% to 120%, 1% to 100%, 1% to 95%, 1% to 90%, 1% to 85%, 1% to 80%, 1% to 75%, 1% to 70%, 1% to 65%, 1% to 60%, 1% to 55%, 1% to 50%, 1% to 45%, 1% to 40%, 1% to 35%, 1% to 30%, 1% to 25%, 1% to 20%, 1% to 15%, 1% to 10%, 1% to 5%, 5% to 400%, 5% to 380%, 5% to 360%, 5% to 340%, 5% to 320%, 5% to 300%, 5% to 280%, 5% to 260%, 5% to 240%, 5% to 220%, 5% to 200%, 5% to 180%, 5% to 160%, 5% to 140%, 5% to 120%, 5% to 100%, 5% to 90%, 5% to 80%, 5% to 70%, 5% to 60%, 5% to 50%, 5% to 40%, 5% to 30%, 5% to 20%, 5% to 10%, 10% to 400%, 10% to 380%, 10% to 360%, 10% to 340%, 10% to 320%, 10% to 300%, 10% to 280%, 10% to 260%, 10% to 240%, 10% to 220%, 10% to 200%, 10% to 180%, 10% to 160%, 10% to 140%, 10% to 120%, 10% to 100%, 10% to 90%, 10% to 80%, 10% to 70%, 10% to 60%, 10% to 50%, 10% to 40%, 10% to 30%, 10% to 20%, 20% to 400%, 20% to 380%, 20% to 360%, 20% to 340%, 20% to 320%, 20% to 300%, 20% to 280%, 20% to 260%, 20% to 240%, 20% to 220%, 20% to 200%, 20% to 180%, 20% to 160%, 20% to 140%, 20% to 120%, 20% to 100%, 20% to 90%, 20% to 80%, 20% to 70%, 20% to 60%, 20% to

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[0185] In some embodiments of any of the methods described herein, before treatment with the compositions or methods of the invention, the patient was treated with one or more of a chemotherapy, a targeted anticancer agent, radiation therapy, and surgery, and optionally, the prior treatment was unsuccessful; and/or the patient has been administered surgery and optionally, the surgery was unsuccessful; and/or the patient has been treated with a platinum-based chemotherapeutic agent, and optionally, the patient has been previously determined to be non-responsive to treatment with the platinum-based chemotherapeutic agent; and/or the patient has been treated with a kinase inhibitor, and optionally, the prior treatment with the kinase inhibitor was unsuccessful; and/or the patient was treated with one or more other therapeutic agent(s).

KITS

[0186] The present invention also relates to a kit comprising a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof. Also provided is a kit comprising a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof, for use in treating a hematological cancer.

[0187] In a related aspect, the invention provides a kit containing a dose of a PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a dose of a KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof in an amount effective to inhibit proliferation of cancer cells, particularly KRas G12C-expressing cancer cells, in a subject. The kit in some cases includes an insert with instructions for administration of the PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof and a KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof. The insert may provide a user with one set of instructions for using the PD-1/PD-L1 inhibitor or a pharmaceutical composition thereof in combination with a KRas G12C inhibitor compound of Formula (I), Formula I-A or Formula I-B, or a pharmaceutically acceptable salt or a pharmaceutical composition thereof.

EXAMPLE A

Engineering of Colon Cancer Cell Line CT26.WT to Express KRas G12C

[0188] This Example illustrates that the colon cancer cell line CT26.WT (ATCC CRL-2638) was genetically modified to express KRas G12C rending these cells susceptible to target therapy using the KRas G12C inhibitors of the present invention.

[0189] CT26.WT cell line is triallelic for the KRas gene (NCBI Ref: NM_021284) and each allele harbors a mutation at codon 12 that changes a glycine residue (G) to an aspartic acid residue (D). In order to create a CT26.WT cell line derivative harboring a KRas G12C mutation, the G12D codon was changed to a G12C codon using a CRISPR/CAS9 system (Synthego, Redwood City, CA) in the following manner.

[0190] Briefly, a synthetically modified guide RNA (sgRNA) targeting the region near the KRas 12 codon was designed and synthesized based on high specificity and propensity to create double strand breaks when complexed with the CAS9 DNA endonuclease. A single-stranded donor oligonucleotide (ssODN) was designed to enable homologous donor repair at the site of the sgRNA cut site and introduce the desired cysteine codon (GAT; D to TGT: C) at position 12 while also introducing silent mutations to prevent recutting.

[0191] Cas9/sgRNA riboprotein complexes and ssODN were transfected into CT26.WT cells. Single cell CT26.WT clones were isolated and their genotypes were screened by Sanger DNA sequencing to identify homozygous G12C targeted clones.

[0192] One particular clone, KRas G12C CT26.WT E3 clone was selected for further analysis.

EXAMPLE B

Inhibition of KRas G12C-dependent Cell Growth

[0193] This Example illustrates that exemplary compounds of the present invention inhibit the growth of engineered CT26.WT KRas G12C E3 clone that expresses KRas G12C with a greater potency than the parental CT26.WT wild type cell line.

[0194] The cellular inhibition of KRAs G12C by exemplary compounds of the present invention was determined by measuring the amount of intracellular ATP.

[0195] CT26.WT wild type cells and CT26.WT G12C E3 clone expressing KRas G12C were cultured in RPMI medium supplemented with 10% fetal bovine serum and 1% penicillin/1% streptomycin and plated at a density of 1000 cells/90μl/well in 96 well white assay plates. A dose response curve for compounds of the present invention was determined by adding a 10μl aliquot of stock solutions of varying concentrations of compounds to the same medium in each well, over a concentration range of 10μM using 3-fold dilutions to a final concentration of 1.5nM. The plates were incubated at 37^0 C for 3 days and the viability of the cells was measured using a CTG assay kit (Cell Titre Glo; Promega cat.no G7573) on Day 3 in accordance with the manufacturer's instructions.

[0196] The IC_{50} values for each cell line at Day 3 were calculated using Graph pad PRISM software and the results are shown in Table 1.

Table 1

Cell Line	IC50 (nM)
CT26.WT KRas Wild Type	3239
CT26.WT KRas G12C	455.3

[0197] As shown in Table 1, the CT26.WT cell line expressing KRas G12C was about 7-fold more sensitive to inhibition by Example 478 compared to the syngeneic parent wild type KRas cell line thereby demonstrating the enhanced sensitivity and specificity of this cell line to KRas G12C inhibitors of the present invention.

EXAMPLE C

In Vivo Models for Examining KRas G12C inhibitor – Immune Cell Modulation

[0198] This Example illustrates that the in vivo administration of a KRas G12C inhibitor alone or in combination with an anti-PD-1 antibody to CT26.WT KRas G12C E3 clone-bearing animals results in intra-tumoral modulation of key immune cell populations.

[0199] BALBc mice were inoculated in the right hind flank with 1 x 10^6 CT26.WT KRas G12C E3 cells harboring the KRas G12C mutation. When tumor volumes reach between 200 – 400 mm^3 in size (Day 0), the mice were divided into two sets of three groups of 5 mice each. The first group was daily administered vehicle (10% Captisol in 50mM citrate buffer pH 5.0), the second group was administered a 100 mg/kg oral dose of the KRas G12C inhibitor Example 478 daily for four days (Day 4), the third group was administered 10 mg/kg of murine anti-PD-1 antibody IP on Days 1, 4 and 7. and the fourth group was administered a combination of a 100 mg/kg oral dose of the KRas G12C inhibitor Example 478 daily for four days and 10 mg/kg of murine anti-PD-1 antibody IP on Days 1, 4 and 7

[0200] Approximately three hours after the final Day 4 dose, the mice were euthanized and tumor were harvested for FACS analysis (MI Bioresearch, Ann Arbor, MI). Individual tumors were homogenized and live tumor cells were isolated from the homogenized tumors using a 7-AAD Viability dye. Isolated live cells were separated from cell debris by centrifugation, washed, and resuspended in ice cold DPBS medium. An aliquot of 1 x 10^6 cells was transferred to predefined wells in a deep well 96 well plates containing specific fluorescein-tagged antibodies to specific immune cell extracellular and intracellular markers.

[0201] One plate was designed to quantitate the percentage of CD45+CD3+ T-cells including CD4+ and CD8+ T-cells, CD69 & PD-1 expressing CD8+ T-cells, KI-67+ CD8+ T-cells, natural killer (NK) T-cells and regulatory T-cells (T-regs). The percentages of the cells were determined using an Attune NxT Acoustic Focusing Cytometer. The results are shown in Table 2.

Table 2

Immune Cell Populations Post-treatment using a KRas G12C inhibitor or a KRas G12C inhibitor + PD-1/PD-L1 Inhibitor Combination

Treatment	CD45+[#]	% CD3+ T-cells*	% CD4+ T-cells*	% CD8+ T-cells*	% T-Regs	% CD69+ CD8+[ƚ]	% PD-1 CD8+[ƚ]	% KI167 + CD8+ T	% KI167 + CD8+	% NK*	% NK-T*
Vehicle	28.8 ± 6.1	18.5 ± 4.0	6.3 ± 1.9	10.2 ± 2.9	2.8 ± 0.5	3.4 ± 1.4	87.4 ± 8.3	4869 ± 395	3088 ± 943	11.2 ± 3.6	2.3 ± 0.5
Ex 478	57.6 ± 7.0	32.5 ± 5.2	13.5 ± 3.6	15.4 ± 3.6	5.8 ± 0.5	7.2 ± 3.8	83.0 ± 8.3	4061 ± 786	2834± 883	11.6 ± 3.1	5.2 ± 0.6
Anti-PD-1	31.6 ± 5.3	24.6 ± 6.4	6.6 ± 1.1	14.3 ± 4.9	3.6 ± 0.9	2.8 ± 0.4	1.3 ± 0.3	5507 ± 605	4800 ± 770	11.9 ± 2.1	2.2 ± 0.3
Combination	70.0 ± 6.3	34.9 ± 2.3	15.8 ± 1.6	15.3 ± 4.6	8.4 ± 0.8	6.1 ± 1.7	2.0 ± 0.6	4382 ± 699	3878 ± 765	14.6 ± 3.5	6.5 ± 1.3

- percentage of live cells

* remaining values percentage of CD45+ cells

ƚ percentage of CD8+ T-cells

[0202] A second plate was designed to quantitate the percentage of CD45+CD11+ cells including myeloid-derived suppressor cells (G-MDSC and M-MDSC), M1 & M2 macrophages and dendritic cells (DC). The percentages of the cells were determined using an Attune NxT Acoustic Focusing Cytometer. Positive and negative control samples were processed in parallel. The results are shown in Table 3.

Table 3

Immune Cell Populations Post-treatment using a KRas G12C inhibitor or a KRas G12C inhibitor + anti-PD-1/anti-PD-L1 Combination

Treatment	% CD45+[#]	% CD19+*	% CD11b+	% MAC	% M1	% M2	% G-MDSC	% M-MDSC	% DC
Vehicle	30 ± 6.4	2.0 ± 1.3	66 ± 4.5	33 ± 5.5	1.2 ± 0.2	31.9 ± 5.6	4.0 ± 3.8	15.1 ± 1.8	3.4 ± 0.5

Ex 478	61 ± 6.6	3.2 ± 1.7	56 ± 2.8	35 ± 3.8	2.6 ± 0.8	32.3 ± 3.0	1.2 ± 0.4	6.0 ± 1.8	5.5 ± 1.7
Anti-PD-1	35 ± 4.4	1.6 ± 0.6	67 ± 2.6	31 ± 0.9	1.6 ± 0.3	29.7 ± 1.0	2.7 ± 2.1	16.3 ± 0.9	2.4 ± 1.1
Combination	73 ± 6.1	2.1 ± 0.9	56 ± 2.1	31 ± 2.8	3.2 ± 0.5	28.0 ± 2.4	0.8 ± 0.3	7.8 ± 1.1	5.1 ± 1.6

- percentage of live cells

* remaining values percentage of CD45+ cell

[0203] After four days of dosing of Example 478 at 100 mg/kg, numerous differences in the immune cell populations in the tumor microenvironment were observed. For instance, intratumoral CD45+ cells increased as a percentage of live cells. This increase is indicative of an active immune tumor microenvironment (TME), as it is not only a marker for hematopoietic cells, but also an essential regulator of T and B cell antigen receptor-mediated activation (e.g., see Perrick N. CD45. PathologyOutlines.com website. http://www.pathologyoutlines.com/topic/cdmarkerscd45.html). Additional increases were observed in the CD4 and CD4 Helper T cell populations. These immune cell types are paramount in stimulating killer T cells, macrophages and B cells to mount an immune response. The observed increase in CD8 positive immune cells, cytotoxic T cells, leads to effect killing of target cells. In the presence of an antigen, CD8 + T cells progress through 3 phases initiated by proliferation, then contraction and ultimately differentiation to a long-lived memory T cell. This increase in CD8 positive immune cells may also represent an early hallmark for CD8 positive immune cell clonal expansion and thus provide a mechanism for efficient recognition and killing of cancer cells in the present and future (e.g., see Clambey et al., (2005) Immun Rev 205:170-189). Consistent with T cell increases, Example 478 treatment in the tumor caused an increase in CD19 positive cells. This marker, a common B cell marker, represents a cell type that regulates B cell development, activation and differentiation (e.g., see Otero & Ricket (2003) J. Immunol. 171:5921-5930). Thus, this B cell increase is capable of eliciting a high-affinity response to pathogens and may provide the host with protective long-lived humoral immunity.

[0204] Furthermore, M1 macrophages represent the first responders in intracellular pathogens and exhibit a high level of phagocytic activity. The observed increase of M1 provides a rationale for increased proinflammatory cytokine signaling and a hallmark for an acute inflammatory response (Atri et al., (2018) Int J Mol Sci 19:1801). MDSC accumulate significantly during pathologic conditions and have been detected in almost all studied tumor models and tested cancer patients (e.g., see Youn & Gabrilovich (2010) Euro J Immunol 40:2969-2975) These conditions not only cause the expansion MDSC cells, but also may lead to their activation, which in turn up-regulates many intermediates with potential immune suppressive activity, such as ROS, iNOS, COX2, and arginase (Youn & Gabrilovich (2010) Euro J Immunol 40:2969-2975).

[0205] A large majority of the increased CD8+ T-cell population post-treatment with Example 478 single agent expressed PD-1 (83%) and remain susceptible to inhibition by PD-L1 thereby blocking activation of these T-cells; however, after four days of combination therapy, PD-1 surface protein expression in the CD8+ T-cells had been blocked by binding of the PD-1 inhibitor (only 1.2% express PD-1) thereby preventing these T-cells from being suppressed by PD-L1 and allowing for these cells to become activated and to mount an adaptive anti-tumor response resulting in a durable complete response in animal models.

[0206] Collectively, treatment with a KRas G12C inhibitor of the present invention results in the modulation of key immune cell subtypes in the tumor that may contribute to the overall mechanism of tumor reduction in this model. The noteworthy contribution from treatment with a PD-1 inhibitor was the dramatic decrease in PD-1 positive CD8 immune cells in the tumor. This modulation suggests, in an already immunologically hot tumor microenvironment as described with KRas G12C inhibitor treatment alone, decreasing this population of immune cells would lead to additional anti-tumor activity by removing an existing inhibition dictated by the PD-1/PD-L1 axis signaling pathway.

EXAMPLE D

In Vivo Models for Examining KRas G12C inhibitor + PD-1/PD-L1 Inhibitor Combinations

[0207] BALBc mice were inoculated in the right hind flank with 1 x 10^6 CT26.WT KRas G12C E3 cells harboring the KRas G12C mutation, and tumor volumes were measured using a caliper every two – three days and tumor volumes were calculated by the formula: 0.5 x (Length x Width)^2.

[0208] When tumor volumes reached between 200 – 400 mm^3 in size (Study Day 0), the mice were divided into four groups of 5 mice each. The first group was daily administered vehicle (10% Captisol in 50mM citrate buffer pH 5.0) through Study Day 15 and also administered i.p. vehicle (BioXcel diluent) on Study Days 1, 4 and 7. The second group was daily administered a 10 mg/kg i.p. dose of the murine anti-PD-1 antibody (F26, BioXcel) at Days 1, 4 and 7. The third group was administered a 100 mg/kg dose of the KRas G12C inhibitor Example 478 through Study Day 29. The fourth group was daily administered a 100 mg/kg dose of the KRas G12C inhibitor Example 478 through Study Day 29 in combination with a 10 mg/kg i.p. dose of the F26 murine anti-PD-1 antibody at Study Days 1, 4 and 7.

[0209] At Study Day 29, administration of 100 mg/kg dose of the KRas G12C inhibitor Example 478 was stopped in the single agent and combination groups.

[0210] At Study Day 39, four tumor-free mice from the combination group were rechallenged $1x10^6$ CT26.WT KRas G12C E3 cells in the opposite left flank and mice were monitored for tumor growth for a period of twenty four days to determine whether a durable, adaptive immune response was observed.

Table 4

Tumor Volumes (mm^3) of CT26.WT KRas G12C E3 Clone Tumor Bearing Mice Treated with Single Agents and in Combination

Table 4A

Group 1: Vehicle

Study Day	M1	M2	M3	M4	M5
0	132	251	157	339	261
3	306	644	357	520	319
7	713	1164	943	829	630
9	885	1583	1269	1024	591
11	1389	1936	1723	1178	892
14	2034	2633	2394	1541	1501

Table 4B

Group 2: 10 mg/kg i.p. F26 murine anti-PD-1 antibody

Study Day	M1	M2	M3	M4	M5
0	229	312	104	232	273
3	403	484	183	367	469
7	529	522	568	728	779
9	805	840	725	875	1164
11	1073	968	1206	1254	1518
14	1760	1091	1604	1784	2088

Table 4C

Group 3: 100 mg/kg KRas G12C Inhibitor Example 478

Study Day	M1	M2	M3	M4	M5
0	194	314	242	110	268
3	32	173	131	69	130
7	0	4	14	14	4
9	0	0	0	0	0
11	0	0	0	0	0
14	0	0	0	0	0
17	0	0	32	0	0
21	0	63	160	0	0
23	0	198	400	0	0
25	0	360	804	0	106
28	0	501		0	319
30	0			0	496
32	0			0	772
35	0			0	1243
38	0			0	
44	0			32	
46	68			142	
49	259			336	
51	391			349	
53	691			656	
56	1265			1006	
60	1787			1295	
63	2412			2163	

Table 4D

Group 4: 100 mg/kg KRas G12C Inhibitor Example 478

+ 10 mg/kg i.p. F26 murine anti-PD-1 antibody‡

Study Day	M1	M2	M3	M4	M5
0	285	231	98	277	230
3	121	160	14	123	151
7	77	32	0	4	32
9	14	0	0	0	0
11	4	0	0	0	0
14	0	0	0	0	0
17	0	0	0	0	0
21	0	0	0	0	0
23	0	0	0	0	0
25	0	0	0	0	0
28	0	0	0	0	0
30	0	0	0	0	0
32	0	0	0	0	0
35	0	0	0	0	0
38	0	0	0	0	0
44	0R 0L	230	0R 0L	0R 0L	0R 0L
46	0R 0L	313	0R 0L	0R 0L	0R 0L
49	0R 0L	447	0R 0L	0R 0L	0R 0L
51	0R 0L	706	0R 0L	0R 0L	0R 0L
53	0R 0L	825	0R 0L	0R 0L	0R 0L
56	0R 0L	1357	0R 0L	0R 0L	0R 0L
60	0R 0L	1710	0R 0L	0R 0L	0R 0L
63	0R 0L	2262	0R 0L	0R 0L	0R 0L
65	0R 0L		0R 0L	0R 0L	0R 0L
67	0R 0L		0R 0L	0R 0L	0R 0L
70	0R 0L		0R 0L	0R 0L	0R 0L
72	0R 0L		0R 0L	0R 0L	0R 0L
74	0R 0L		0R 0L	0R 0L	0R 0L
77	0R 0L		0R 0L	0R 0L	0R 0L
79	0R 0L		0R 0L	0R 0L	0R 0L
84	0R 0L		0R 0L	0R 0L	0R 0L
86	0R 0L		0R 0L	0R 0L	0R 0L
88	0R 0L		0R 0L	0R 0L	0R 0L
91	0R 0L		0R 0L	0R 0L	0R 0L
93	0R 0L		0R 0L	0R 0L	0R 0L
95	0R 0L		0R 0L	0R 0L	0R 0L
98	0R 0L		0R 0L	0R 0L	0R 0L
100	0R 0L		0R 0L	0R 0L	0R 0L
102	0R 0L		0R 0L	0R 0L	0R 0L
115	0R 0L		0R 0L	0R 0L	0R 0L
120	0R 0L		0R 0L	0R 0L	0R 0L

ǂ "R" refers to the site of the original implantation in the right limb and "L" refers to the site of re-challenge in the left limb

[0211] As shown in Table 4B, the administration of anti-PD-1 F26 antibody as a single agent exhibited only a minimal 19.8 % tumor growth inhibition at Day 14 compared to vehicle-treated mice.

[0212] As shown in Table 4C, the administration of KRas G12C inhibitor Example 478 as a single agent exhibited a robust anti-tumor response with all five treated mice achieving a complete response after nine days of administration (Study Day 9). All five mice remained without a detectable tumor for at least five days; however, eventually tumor growth was detected at the original site of implantation in all five mice mice either while still receiving Example 478 daily (three mice, Study Days 17, 21 & 25) or after administration was stopped at Study Day 29 (two mice, Study Days 44 & 46).

[0213] As shown in Table 4D, the co-administration of the combination of the anti-PD-1 F26 antibody and KRas G12C inhibitor Example 478 similarly exhibited a robust anti-tumor response with all five treated mice (M1-M5) achieving a complete response after fourteen days of administration (Study Day 14). Four of the five mice (M1 & M3-M5) remained without a detectable tumor for at least ninety one days after administration of Example 478 was stopped (Study Day 120). Tumor growth was detected in a single mouse (M2) starting at Study Day 44, fifteen days after administration of Example 478 was stopped.

[0214] Four of the five mice (M1 & M3-M5) remained without a detectable tumor at Study Day 39 and were rechallenged with CT26.WT KRas G12C E3 cells in the opposite left flank. No detectable tumor growth was observed at the original implantation site (R) or at the second reimplantation site (L) whereas, in contrast, implantation of the same cells into naïve mice resulted in tumor formation (data not shown). These results demonstrate that combination treated animals exhibited an anti-tumor immunological memory that resulted in a durable complete response for at least forty nine days demonstrating the superiority of the combination therapy at treating and potentially preventing the re-occurrence of KRas G12C-associated cancers.

[0215] Tables 5A-5D represent a repeat of the study shown in 4A-4D. In the second study the number of treated mice was increased from 5 animals per group to 10 animals per group.

[0216] When tumor volumes reach between 200 – 400 mm^3 in size (Study Day 0), the mice were divided into four groups of 10 mice each. The first group was daily administered vehicle (10% Captisol in 50mM citrate buffer pH 5.0) through Study Day 10 and also administered i.p. vehicle (BioXcel diluent) on Study Days 1, 4 and 7. The second group was daily administered a 10 mg/kg i.p. dose of the murine anti-PD-1 antibody (F26, BioXcel) at Days 1, 4 and 7. The third group was administered a 100 mg/kg dose of the KRas G12C inhibitor Example 478 through Study Day 25. The fourth group was daily administered a 100 mg/kg dose of the KRas G12C inhibitor Example 478 through Study Day 25 in combination with a 10 mg/kg i.p. dose of the F26 murine anti-PD-1 antibody at Study Days 1, 4 and 7.

[0217] At Study Day 25, administration of 100 mg/kg dose of the KRas G12C inhibitor Example 478 was stopped in the single agent and combination groups.

[0218] At Study Day 32, seven tumor-free mice from the combination group were rechallenged $1x10^6$ CT26.WT KRas G12C E3 cells in the opposite left flank and mice were monitored for tumor growth for a period of fifty days to determine whether a durable, adaptive immune response was observed.

Table 5

Tumor Volumes (mm^3) of Repeat of CT26.WT KRas G12C E3 Clone Tumor Bearing Mice Treated with Single Agents and in Combination

Table 5A

Group 1: Vehicle

Study Day	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**
0	203	182	257	200	181	255	222	157	225	332
3	519	355	634	416	486	754	426	310	571	1024
5	780	632	747	953	643	1311	571	516	916	1256
7	1096	981	1172	1303	981	1678	841	857	1452	1617
10	1967	1690	2192	2286	1848	2658	1582	1740	2453	2552

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Table 5B

Group 2: 10 mg/kg i.p. F26 murine anti-PD-1 antibody

Study Day	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
0	198	171	304	206	270	213	186	230	252	165
3	450	224	735	547		515	250	503	618	420
5	545	391	1058	795		929	470	584	778	606
7	796	617	1755	1175		1549	915	937	1033	1304
10	1132	1023	2258	1695		2150	1509	1554	1576	1626

Table 5C

Group 3: 100 mg/kg KRas G12C Inhibitor Example 478ǂ

Study Day	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
0	158	330	221	255	269	229	184	175	206	198
3	32	102	143	133	181	140	63	93	59	32
5	0	0	14	14	63	0	0	4	0	4
7	0	0	4	4	32	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
14	0	4	0	0	0	0	0	0	0	0
17	0	212	0	32	0	0	0	0	0	0
19	51	875	32	371	0	63	0	0	0	0
21	268	1320	139	762	0	274	0	0	0	0
24	877	2470	588	1498	0	291	0	0	0	0
26	1237		923	1699	14		0	0	0	0
28	1371		1056	2035	14		0	0	0	0
31	2334		2113		161		0R 0L	0R 0L	0R 0L	0R 0L
33					289		63R 0L	32R 0L	4R 0L	0R 0L
38					425		318R 0L	124R 0L	63R 0L	0R 0L
40							464R 0L	511R 0L	326R 0L	0R 0L
42							550R 0L	868R 0L	704R 0L	0R 0L
45							1447R 0L	2052R 0L	196R 0L	0R 0L
47							1947R 0L			0R 0L
49										0R 0L
52										0R 0L
56										0R 0L
69										0R 0L
74										0R 0L

ǂ "R" refers to the site of the original implantation in the right flank and "L" refers to the site of re-challenge in the left flank

Table 5D

Group 4: 100 mg/kg KRas G12C Inhibitor Example 478

+ 10 mg/kg i.p. F26 murine anti-PD-1 antibody‡

Study Day	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
0	276	191	245	210	195	168	246	212	166	288
3	32	98	156	140	14	32	116	112	104	135
5	0	32	63	63	0	4	0	77	4	32
7	0	0	32	14	0	0	0	4	4	0
10	0	0	4	0	0	0	0	0	0	0
14	0	0	4	0	0	0	0	0	0	0
17	0	0	4	0	0	0	0	0	0	0
19	0	0	4	0	0	0	0	0	0	0
21	0	14	4	0	0	0	0	0	0	0
24	0	203	97	0	0	0	14	0	0	0
26	0	1006	136	0	0	0	84	0	0	0
28	0	1312	133	0	0	0	164	0	0	0
31	0R 0L	1893	177	0R 0L	0R 0L	0R 0L	312	0R 0L	0R 0L	0R 0L
33	0R 0L	1935	221	0R 0L	0R 0L	0R 0L		0R 0L	0R 0L	0R 0L
38	0R 0L	2332	490	0R 0L	0R 0L	0R 0L		0R 0L	0R 0L	0R 0L
40	0R 0L		507	0R 0L	0R 0L	0R 0L		0R 0L	0R 0L	0R 0L
42	0R 0L		581	0R 0L	0R 0L	0R 0L		0R 0L	0R 0L	0R 0L
45	0R 0L		873	0R 0L	0R 0L	0R 0L		0R 0L	0R 0L	0R 0L
47	0R 0L		923	0R 0L	0R 0L	0R 0L		0R 0L	0R 0L	0R 0L
49	0R 0L		1195	0R 0L	0R 0L	0R 0L		0R 0L	0R 0L	0R 0L
52	0R 0L		1517	0R 0L	32R 0L	0R 0L		0R 0L	0R 0L	0R 0L
54	0R 0L		1577	0R 0L	282R 0L	0R 0L		0R 0L	0R 0L	0R 0L
56	0R 0L		1631	0R 0L	754R 0L	0R 0L		0R 0L	0R 0L	0R 0L
69	0R 0L			0R 0L		0R 0L		0R 0L	0R 0L	0R 0L
75				0R 0L		0R 0L		0R 0L	0R 0L	0R 0L

‡ "R" refers to the site of the original implantation in the right flank and "L" refers to the site of re-challenge in the left flankAs shown in Table 5B, the administration of anti-PD-1 F26 antibody as a single agent exhibited only a minimal 25.6 % tumor growth inhibition at Day 10 compared to vehicle-treated mice.

[0219] As shown in Table 5C, the administration of KRas G12C inhibitor Example 478 as a single agent exhibited a robust anti-tumor response with all ten treated mice achieving a complete response in all mice after ten days of administration (Study Day 10). 9 of the 10 mice remained without a detectable tumor for at least four days after achieving a complete response; however, eventually tumor growth was detected in 6 out of 9 mice at the original site of implantation while still receiving Example 478 daily (five mice, Study Days 14 (M2), 17 (M4) & 19 (M1, M3 & M6)) or after administration was stopped at Study Day 25 (one mouse (M6) Study Day 26). Three mice (M7-M9) remained tumor free for six days after Example 478 daily administration was stopped (Day 31) and one mouse (M10) remained tumor free for at least forty nine days.

[0220] As shown in Table 5D, the co-administration of the combination of the anti-PD-1 F26 antibody and KRas G12C inhibitor Example 478 similarly exhibited a robust anti-tumor response with nine out of ten treated mice achieving a complete response after ten days of administration (Study Day 10). Eight mice remained without a detectable tumor for at least twenty four days after administration of Example 478 was stopped (Study Day 49). Tumor growth was detected in a one of the eight mice (M3) starting at Study Day 52.

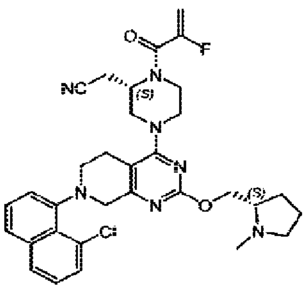
[0221] Seven of the ten mice (M1, M4, M5, M6, M8, M9 and M10) remained without a detectable tumor at Study Day 32 and were rechallenged with CT26.WT KRas G12C E3 cells in the opposite left flank. No detectable tumor growth was observed at the original implantation site (R) or at the second reimplantation site (L) in six out of seven mice whereas, in contrast, implantation of the same cells into naïve mice resulted in tumor formation (data not shown). Tumor formation was detected in a single mouse at the original implantation site at Study Day 52 (M3); however, no tumor formation was detected at the site of rechallenge. These results demonstrate that combination treated animals exhibited an anti-tumor immunological memory that resulted in a durable complete response for at least fifty days demonstrating the superiority of the combination therapy at treating and potentially preventing the re-occurrence of KRas G12C-associated cancers.

[0222] 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

WE CLAIM:

1. A method of treating a KRas G12C-associated cancer in a subject in need thereof, comprising administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor and a compound of formula:



or a pharmaceutically acceptable salt thereof.

2. The method of according to claim 1, wherein the PD-1/PD-L1 inhibitor is a PD-1 inhibitor.

3. The method of claim 2, wherein the PD-1 inhibitor is selected from the group consisting of nivolumab, pembrolizumab, cemiplimab, tislelizumab, and a biosimilar thereof.

4. The method of claim 3, wherein the PD-1 inhibitor is nivolumab or a biosimilar thereof.

5. The method of claim 4, wherein the therapeutically effective amount of nivolumab or biosimilar thereof in the combination is about 240 mg administered every two weeks.

6. The method of claim 4, wherein the therapeutically effective amount of nivolumab, or biosimilar thereof, in the combination is about 480 mg administered every four weeks.

7. The method of claim 3, wherein the PD-1 inhibitor is pembrolizumab or a biosimilar thereof.

8. The method of claim 7, wherein the therapeutically effective amount of pembrolizumab or biosimilar thereof in the combination is about 200 mg administered every three weeks.

9. The method of claim 7, wherein the KRas G12C-associated cancer is non-small cell lung cancer (NSCLC).

10. The method of claim 3, wherein the wherein the PD-1 inhibitor is cemiplimab or a biosimilar thereof.

11. The method of claim 10, wherein the therapeutically effective amount of pembrolizumab or biosimilar thereof in the combination is about 350 mg administered every three weeks.

12. The method of claim 3, wherein the PD-1 inhibitor is tislelizumab or a biosimilar thereof.

13. The method of claim 12, wherein the therapeutically effective amount of tislelizumab, or biosimilar thereof, in the combination is about 200 mg administered every three weeks.

14. The method according to claim 1, wherein the PD-1/PD-L1 inhibitor is a PD-L1 inhibitor.

15. The method of claim 14, wherein the PD-L1 inhibitor is selected from the group consisting of atezolizumab, avelumab, durvalumab, and a biosimilar thereof.

16. The method of claim 15, wherein the PD-L1 inhibitor is atezolizumab or a biosimilar thereof.

17. The method of claim 16, wherein the therapeutically effective amount of atezolizumab or biosimilar thereof in the combination is about 1200 mg administered every three weeks.

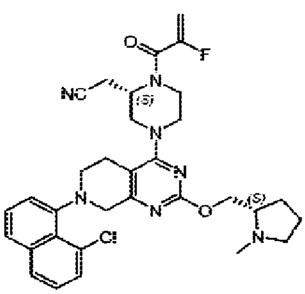
18. The method of claim 15, wherein the PD-L1 inhibitor is avelumab or a biosimilar thereof.

19. The method of claim 18, wherein the therapeutically effective amount of avelumab or biosimilar thereof in the combination is about 10 mg/kg administered every two weeks or 800 mg every two weeks.

20. The method of claim 15, wherein the PD-L1 inhibitor is durvalumab or a biosimilar thereof.

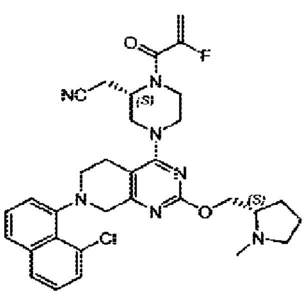
21. The method of claim 20, wherein the therapeutically effective amount of durvalumab or biosimilar thereof in the combination is about 10 mg/kg administered every two weeks.

22. The method according to claim 1, wherein the PD-1/PD-L1 inhibitor and the compound of formula:



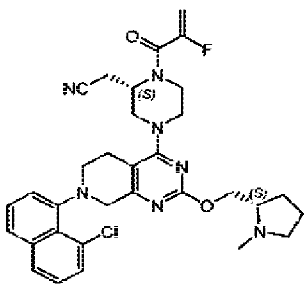
or a pharmaceutically acceptable salt thereof are administered on the same day.

23. The method according to claim 1, wherein the PD-1/PD-L1 inhibitor and the compound of formula:



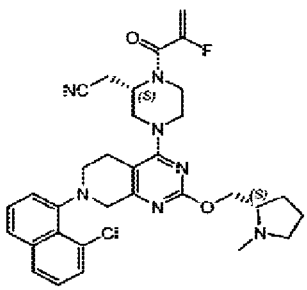
or a pharmaceutically acceptable salt thereof are administered on different days.

24. The method according to claim 1, wherein the compound of formula:



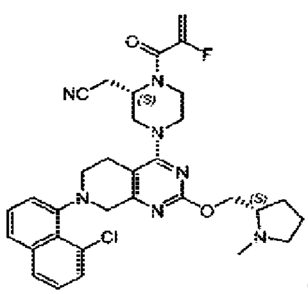
or a pharmaceutically acceptable salt thereof is administered at a maximum tolerated dose.

25. The method according to claim 1, wherein the PD-1/PD-L1 inhibitor and the compound of formula:

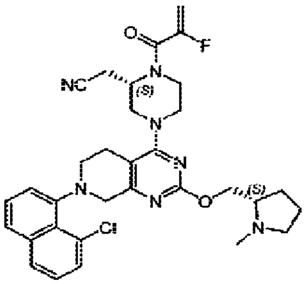


or a pharmaceutically acceptable salt thereof are each administered at a maximum tolerated dose.

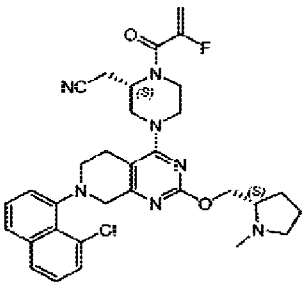
26. The method of according to claim 1, wherein the therapeutically effective amount of the combination of the PD-1/PD-L1 inhibitor and the compound of formula:



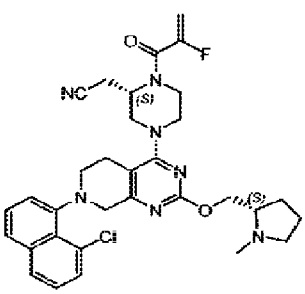
or a pharmaceutically acceptable salt thereof results in an increased duration of overall survival, an increased duration of progression free survival, an increase in tumor growth regression, an increase in tumor growth inhibition or an increased duration of stable disease in the subjects relative to treatment with only the compound of formula:


or a pharmaceutically acceptable salt thereof.

27. The method according to claim 1, wherein the therapeutically effective amount of the combination of the PD-1/PD-L1 inhibitor and the compound of formula:


or a pharmaceutically acceptable salt thereof results in a durable complete response.

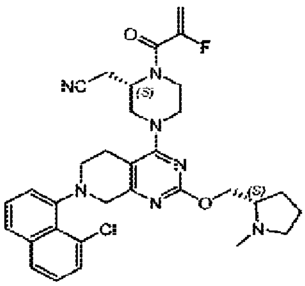
28. A pharmaceutical composition comprising a therapeutically effective amount of a PD-1/PD-L1 inhibitor and a compound of formula:


, or a pharmaceutically acceptable salt thereof,

and a pharmaceutically acceptable excipient.

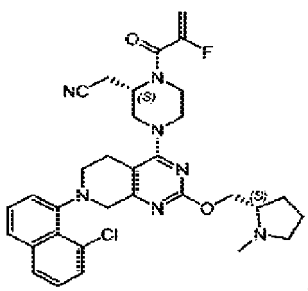
29. The method according to claim 1, wherein the method incudes a durable complete response in the subject having a KRas G12C-associated cancer.

30. A method of treating a KRas G12C-associated cancer in a subject in need thereof, wherein the KRas G12C-associated cancer is resistant to treatment with a PD-1/PD-L1 inhibitor, comprising administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a compound of formula:



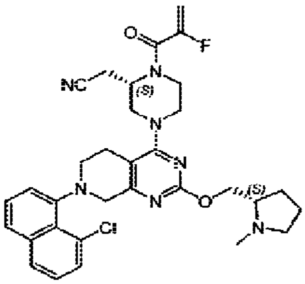
, or a pharmaceutically acceptable salt thereof, or a pharmaceutical composition thereof.

31. A method for treating a KRas G12C-associated cancer and determined to have previously developed resistance to treatment with a PD-1/PD-L1 inhibitor that include administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a compound of formula:



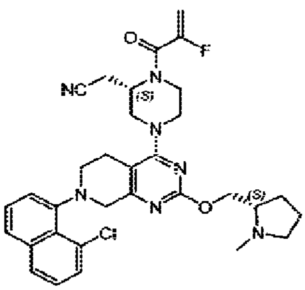
, or a pharmaceutically acceptable salt thereof, or a pharmaceutical composition thereof.

32. A method for suppressing resistance to treatment with a PD-1/PD-L1 inhibitor in a subject having a KRas G12C-associated cancer that include administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a compound of formula:



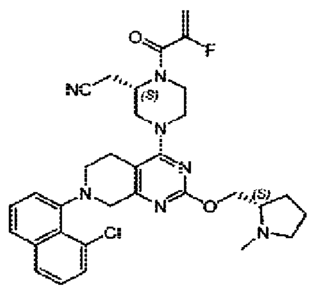
, or a pharmaceutically acceptable salt thereof, or a pharmaceutical composition thereof.

33. A method of treating a subject identified or diagnosed as having a KRAS G12C-associated cancer that include (a) detecting resistance of the KRas G12C-associated cancer in the subject to treatment with a PD-1/PD-L1 inhibitor that was previously administered to the patient; and (b) after (a), administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a compound of formula:



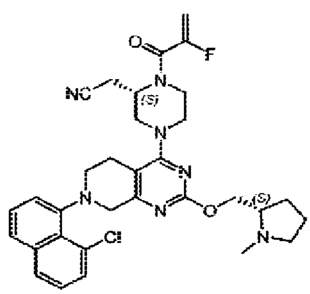
, or a pharmaceutically acceptable salt thereof, or a pharmaceutical composition thereof.

34. A method of treating a subject identified or diagnosed as having a KRas G12C-associated cancer and determined to have previously developed resistance to treatment with a KRAS G12C inhibitor that include administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a compound of formula:



, or a pharmaceutically acceptable salt thereof, or a pharmaceutical composition thereof.

35. A method of treating a subject identified or diagnosed as having a KRas G12C-associated cancer, comprising (a) administering a KRAS G12C inhibitor as monotherapy until disease progression, and (b) after (a), administering to the subject a therapeutically effective amount of a combination of a PD-1/PD-L1 inhibitor, or a pharmaceutical composition thereof, and a compound of formula:



, or a pharmaceutically acceptable salt thereof, or a pharmaceutical composition thereof.

36. The method according to claim 1, wherein the therapeutically effective amount of the KRas G12C inhibitor is between about 0.01 to 100 mg/kg per day.

37. The method of claim 36, wherein the therapeutically effective amount of the KRas G12C inhibitor is between about 0.1 to 50 mg/kg per day.

38. The method according to claim 1, wherein the KRas G12C-associated cancer is selected from the group consisting of Cardiac: sarcoma (angiosarcoma, fibrosarcoma, rhabdomyosarcoma, liposarcoma), myxoma, rhabdomyoma, fibroma, lipoma and teratoma; Lung: bronchogenic carcinoma (squamous cell, undifferentiated small cell, undifferentiated large

cell, adenocarcinoma), alveolar (bronchiolar) carcinoma, bronchial adenoma, sarcoma, lymphoma, chondromatous hamartoma, mesothelioma; Gastrointestinal: esophagus (squamous cell carcinoma, adenocarcinoma, leiomyosarcoma, lymphoma), stomach (carcinoma, lymphoma, leiomyosarcoma), pancreas (ductal adenocarcinoma, insulinoma, glucagonoma, gastrinoma, carcinoid tumors, vipoma), small bowel (adenocarcinoma, lymphoma, carcinoid tumors, Kaposi's sarcoma, leiomyoma, hemangioma, lipoma, neurofibroma, fibroma), large bowel (adenocarcinoma, tubular adenoma, villous adenoma, hamartoma, leiomyoma); Genitourinary tract: kidney (adenocarcinoma, Wilm's tumor (nephroblastoma), lymphoma, leukemia), bladder and urethra (squamous cell carcinoma, transitional cell carcinoma, adenocarcinoma), prostate (adenocarcinoma, sarcoma), testis (seminoma, teratoma, embryonal carcinoma, teratocarcinoma, choriocarcinoma, sarcoma, interstitial cell carcinoma, fibroma, fibroadenoma, adenomatoid tumors, lipoma); Liver: hepatoma (hepatocellular carcinoma), cholangiocarcinoma, hepatoblastoma, angiosarcoma, hepatocellular adenoma, hemangioma; Biliary tract: gall bladder carcinoma, ampullary carcinoma, cholangiocarcinoma; Bone: osteogenic sarcoma (osteosarcoma), fibrosarcoma, malignant fibrous histiocytoma, chondrosarcoma, Ewing's sarcoma, malignant lymphoma (reticulum cell sarcoma), multiple myeloma, malignant giant cell tumor chordoma, osteochronfroma (osteocartilaginous exostoses), benign chondroma, chondroblastoma, chondromyxofibroma, osteoid osteoma and giant cell tumors; Nervous system: skull (osteoma, hemangioma, granuloma, xanthoma, osteitis deformans), meninges (meningioma, meningiosarcoma, gliomatosis), brain (astrocytoma, medulloblastoma, glioma, ependymoma, germinoma (pinealoma), glioblastoma multiform, oligodendroglioma, schwannoma, retinoblastoma, congenital tumors), spinal cord neurofibroma, meningioma, glioma, sarcoma); Gynecological: uterus (endometrial `carcinoma (serous cystadenocarcinoma, mucinous cystadenocarcinoma, unclassified carcinoma), granulosa-thecal cell tumors, Sertoli-Leydig cell tumors, dysgerminoma, malignant teratoma), vulva (squamous cell carcinoma, intraepithelial carcinoma, adenocarcinoma, fibrosarcoma, melanoma), vagina (clear cell carcinoma, squamous cell carcinoma, botryoid sarcoma (embryonal rhabdomyosarcoma), fallopian tubes (carcinoma); Hematologic: blood (myeloid leukemia (acute and chronic), acute lymphoblastic leukemia, chronic lymphocytic leukemia, myeloproliferative diseases, multiple myeloma, myelodysplastic syndrome), Hodgkin's disease, non-Hodgkin's lymphoma (malignant lymphoma); Skin: malignant melanoma, basal cell carcinoma, squamous cell carcinoma, Kaposi's sarcoma, moles dysplastic nevi, lipoma, angioma, dermatofibroma, keloids, psoriasis; and Adrenal glands: neuroblastoma.

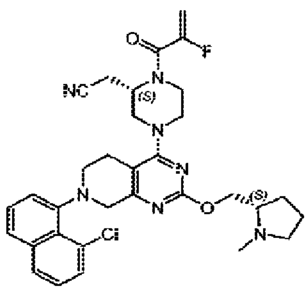
39. The method according to claim 38, wherein the cancer is non-small cell lung cancer.

40. The method according to claim 38, wherein the cancer is colorectal cancer.

41. The method according to claim 38, wherein the cancer is pancreatic cancer.

42. A kit comprising the pharmaceutical composition of claim 27 for treating a KRas G12C cancer in a subject.

43. A kit comprising: a) a pharmaceutical composition comprising a PD-1/PD-L1 inhibitor and b) a pharmaceutical composition comprising a compound of formula:



, or a pharmaceutically acceptable salt thereof,

for treating a KRas G12C cancer in a subject.

44. The kit according to claim 42, further comprising an insert with instructions for administration of the pharmaceutical composition.