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(71) Applicant(s)
Board of Regents, The University of Texas System

(72) Inventor(s)
RAJ, Ganesh;AHN, Jung-mo;VADLAMUDI, Ratna K.

(74) Agent / Attorney
FPA Patent Attorneys Pty Ltd, Level 19, South Tower 80 Collins Street, Melbourne, VIC, 3000, AU

(56) Related Art
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(71) Applicant: **BOARD OF REGENTS, THE UNIVERSITY OF TEXAS SYSTEM** [US/US]; 210 West 7th St., Austin, TX 78701 (US).

(72) Inventors: **RAJ, Ganesh**; C/o UT Southwestern Medical Center, Department Of Urology, 5323 Harry Hines Blvd., Dallas, TX 75390 (US). **AHN, Jung-mo**; C/o UT Dallas, Chemistry And Biochemistry, MS BSB 11.538, 800 W. Campbell RD, Richardson, TX 75080-3021 (US). **VADLAMUDI, Ratna, K.**; C/o UT Dallas, Chemistry And Biochemistry, MS BSB 11.538, 800 W. Campbell RD, Richardson, TX 75080-3021 (US).

(74) Agent: **HIGHLANDER, Steven, L.**; Parker Highlander PLLC, 1120 So. Capital Of Texas Highway, Bldg. One, Suite 200, Austin, TX 78746 (US).

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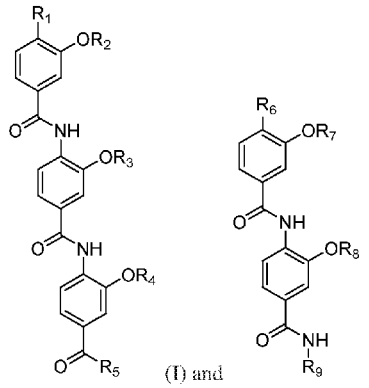
(54) Title: OLIGO-BENZAMIDE ANALOGS AND THEIR USE IN CANCER TREATMENT

(57) Abstract: The present disclosure compounds of the formulae: (I) and (II) wherein the variables are defined herein, as well as pharmaceutical compositions thereof. The present disclosure also provides methods for the use of said compounds and/or pharmaceutical compositions, such as in the treatment of cancer.



(I) and (II).

WO 2020/117715 A1

DESCRIPTION

OLIGO-BENZAMIDE ANALOGS AND THEIR USE IN CANCER TREATMENT

PRIORITY CLAIM

This application claims benefit of priority to U.S. Provisional Application Serial No. 62/774,671, filed December 3, 2018, the entire contents of which are hereby incorporated by reference.

FEDERAL FUNDING STATEMENT

This invention was made with government support under Grant No. 1R01 CA223828-01 awarded by the National Institutes of Health. The government has certain rights in the invention.

BACKGROUND

I. Field of the Invention

The present disclosure relates in general to the field of peptidomimetics and specifically to compositions of matter and methods of their use in medical indications, such as cancer.

II. Description of Related Art

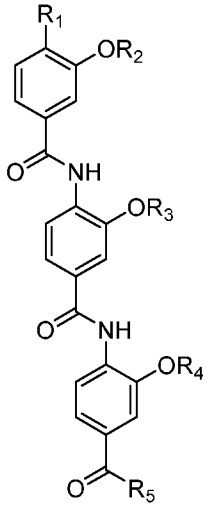
Peptidomimetics (also known as peptide mimetics) are small organic molecules that do not possess the peptide backbone structure, however, still retain a capability to interact with the same target protein by arranging essential functional groups (*i.e.*, pharmacophores) in a required three-dimensional pattern complimentary to a binding pocket in the protein. Since peptides and proteins adopt and utilize secondary structures (*e.g.*, α-helix, β-sheet, and reverse turns) to make their global shapes and to recognize their binding partners, rational design of secondary structure mimetics is an important strategy in developing small molecule modulators for protein complex formation, compared to conventional high-throughput screening of a chemical library.

These compounds are known to bind to hormone receptors in cancer cells and are useful in treating these indications. Therefore, there remains a need to develop new and useful compounds which are useful in the treatment of cancers through the modulation of hormone receptors.

SUMMARY

The present disclosure provides oligo-benzamide peptidomimetic compounds for use in the treatment and/or prevention of cancer. These small molecules include α-helix mimetics that represent helical segments in the target molecules. The oligo-benzamide peptidomimetic compounds modulate protein-protein, protein-peptide, or protein-drug interaction to exert a variety of physiological consequences. The oligo-benzamide peptidomimetic compounds also cause significant endoplasmic reticulum stress in cancer cells and may effectively shut down *de novo* protein synthesis, leading to cell death.

In one aspect, the present disclosure provides compounds of the formula:



(I),

wherein:

R_1 is halo, $-NO_2$, $alkyl_{(C\leq12)}$, substituted $alkyl_{(C\leq12)}$, $amido_{(C\leq12)}$, substituted $amido_{(C\leq12)}$, or $-NHC(O)CH(R_{1a})NH_2$, wherein:

R_{1a} is $aralkyl_{(C\leq18)}$, substituted $aralkyl_{(C\leq18)}$, or the side chain of a canonical amino acid;

R_2, R_3, and R_4 are each independently $alkyl_{(C\leq12)}$, substituted $alkyl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, or substituted $aralkyl_{(C\leq18)}$; and

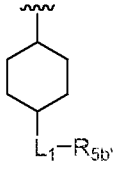
R_5 is $-OR_{5a}$ or $-NHR_{5b}$, wherein:

R_{5a} is $alkyl_{(C\leq12)}$ or substituted $alkyl_{(C\leq12)}$;

R_{5b} is hydrogen; or

cycloalkyl$_{(C\leq12)}$, aryl$_{(C\leq12)}$, aralkyl$_{(C\leq18)}$, heteroaryl$_{(C\leq12)}$, heteroaralkyl$_{(C\leq18)}$, or a substituted version of any of these groups; or

a group of the formula:



wherein:

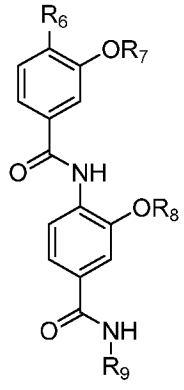
L_1 is $-CO_2-$ or $-C(O)NR_{L1}-$, wherein:

R_{L1} hydrogen, alkyl$_{(C\leq12)}$, or substituted alkyl$_{(C\leq12)}$;

$R_{5b'}$ is aryl$_{(C\leq12)}$, aralkyl$_{(C\leq18)}$, heteroaryl$_{(C\leq12)}$, heteroaralkyl$_{(C\leq18)}$, or a substituted version of any of these groups;

provided R_1 is halo when R_{5b} is hydrogen and provided R_3 is not alkyl$_{(C\leq12)}$ when R_{5a} is methyl; or

compounds of the formula:



(II),

wherein:

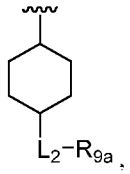
R_6 is halo, $-NO_2$, alkyl$_{(C\leq12)}$, substituted alkyl$_{(C\leq12)}$, amido$_{(C\leq12)}$, substituted amido$_{(C\leq12)}$, or $-NHC(O)CH(R_{6a})NH_2$, wherein:

R_{6a} is aralkyl$_{(C\leq18)}$, substituted aralkyl$_{(C\leq18)}$, or the side chain of a canonical amino acid;

R_7 and R_8 are each independently $alkyl_{(C\leq12)}$, $-alkanediyl_{(C\leq12)}-cycloalkyl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, or a substituted version of any of these groups; and

R_9 is $cycloalkyl_{(C\leq12)}$, $aryl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, $heteroaryl_{(C\leq12)}$, $heteroaralkyl_{(C\leq18)}$, or a substituted version of any of these groups; or

a group of the formula:



wherein:

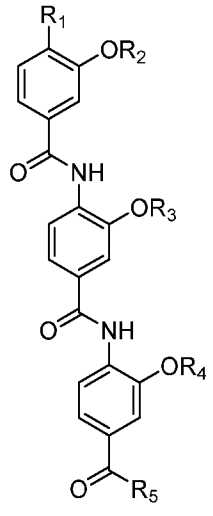
L_2 is $-CO_2-$ or $-C(O)NR_{L2}-$, wherein:

R_{L2} hydrogen, $alkyl_{(C\leq12)}$, or substituted $alkyl_{(C\leq12)}$;

R_{9a} is $aryl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, $heteroaryl_{(C\leq12)}$, $heteroaralkyl_{(C\leq18)}$, or a substituted version of any of these groups;

or a pharmaceutically acceptable salt of either of these formulae.

In some embodiments, the compounds are of formula (I). In further embodiments, the compounds are further defined as:



(I),

wherein:

R_1 is halo, $-NO_2$, $alkyl_{(C\leq12)}$, substituted $alkyl_{(C\leq12)}$, $amido_{(C\leq12)}$, substituted $amido_{(C\leq12)}$, or $-NHC(O)CH(R_{1a})NH_2$, wherein:

R_{1a} is aralkyl$_{(C\leq 18)}$, substituted aralkyl$_{(C\leq 18)}$, or the side chain of a canonical amino acid;

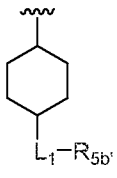
R_2, R_3, and R_4 are each independently alkyl$_{(C\leq 12)}$, substituted alkyl$_{(C\leq 12)}$, aralkyl$_{(C\leq 18)}$, or substituted aralkyl$_{(C\leq 18)}$; and

R_5 is $-OR_{5a}$ or $-NHR_{5b}$, wherein:

R_{5a} is alkyl$_{(C\leq 12)}$ or substituted alkyl$_{(C\leq 12)}$;

R_{5b} is cycloalkyl$_{(C\leq 12)}$, aryl$_{(C\leq 12)}$, aralkyl$_{(C\leq 18)}$, heteroaryl$_{(C\leq 12)}$, heteroaralkyl$_{(C\leq 18)}$, or a substituted version of any of these groups; or

a group of the formula:



wherein:

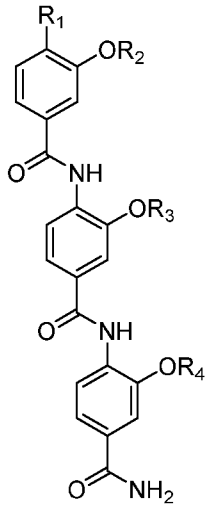
L_1 is $-CO_2-$ or $-C(O)NR_{L1}-$, wherein:

R_{L1} hydrogen, alkyl$_{(C\leq 12)}$, or substituted alkyl$_{(C\leq 12)}$;

$R_{5b'}$ is aryl$_{(C\leq 12)}$, aralkyl$_{(C\leq 18)}$, heteroaryl$_{(C\leq 12)}$, heteroaralkyl$_{(C\leq 18)}$, or a substituted version of any of these groups;

or a pharmaceutically acceptable salt thereof.

In some embodiments, the compounds are further defined as:



(III),

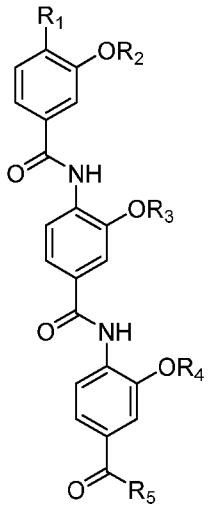
wherein:

R_1 is halo; and

R_2, R_3, and R_4 are each independently $alkyl_{(C\leq12)}$, substituted $alkyl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, or substituted $aralkyl_{(C\leq18)}$;

or a pharmaceutically acceptable salt thereof.

In some embodiments, the compounds are further defined as:



(IV),

wherein:

R_1 is halo, $-NO_2$, $alkyl_{(C\leq12)}$, substituted $alkyl_{(C\leq12)}$, $amido_{(C\leq12)}$, substituted $amido_{(C\leq12)}$, or $-NHC(O)CH(R_{1a})NH_2$, wherein:

R_{1a} is $aralkyl_{(C\leq18)}$, substituted $aralkyl_{(C\leq18)}$, or the side chain of a canonical amino acid;

R_2, R_3, and R_4 are each independently $alkyl_{(C\leq12)}$, substituted $alkyl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, or substituted $aralkyl_{(C\leq18)}$; and

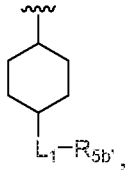
R_5 is $-OR_{5a}$ or $-NHR_{5b}$, wherein:

R_{5a} is $alkyl_{(C2\text{-}12)}$ or substituted $alkyl_{(C\leq12)}$;

R_{5b} is hydrogen; or

$cycloalkyl_{(C\leq12)}$, $aryl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, $heteroaryl_{(C\leq12)}$, $heteroaralkyl_{(C\leq18)}$, or a substituted version of any of these groups; or

a group of the formula:



wherein:

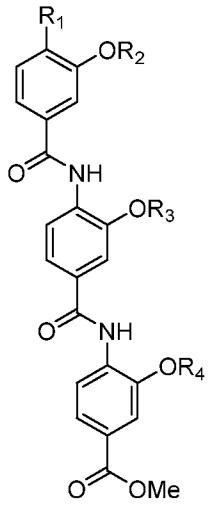
L_1 is $-CO_2-$ or $-C(O)NR_{L1}-$, wherein:

R_{L1} hydrogen, $alkyl_{(C\leq12)}$, or substituted $alkyl_{(C\leq12)}$;

$R_{5b'}$ is $aryl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, $heteroaryl_{(C\leq12)}$, $heteroaralkyl_{(C\leq18)}$, or a substituted version of any of these groups;

or a pharmaceutically acceptable salt thereof.

In some embodiments, the compounds are further defined as:



(V),

wherein:

R_1 is halo, $-NO_2$, $alkyl_{(C\leq12)}$, substituted $alkyl_{(C\leq12)}$, $amido_{(C\leq12)}$, substituted $amido_{(C\leq12)}$, or $-NHC(O)CH(R_{1a})NH_2$, wherein:

R_{1a} is $aralkyl_{(C\leq18)}$, substituted $aralkyl_{(C\leq18)}$, or the side chain of a canonical amino acid;

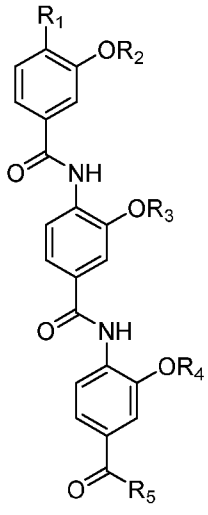
R_2 and R_4 are each independently $alkyl_{(C\leq12)}$, substituted $alkyl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, or substituted $aralkyl_{(C\leq18)}$; and

R_3 is substituted $alkyl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, or substituted $aralkyl_{(C\leq18)}$;

or a pharmaceutically acceptable salt thereof.

In some embodiments, R_{5b} is hydrogen. In some embodiments, R_{5a} is methyl.

In some embodiments, the compounds are further defined as:



(VI),

wherein:

R_1 is halo, $-NO_2$, $alkyl_{(C\leq12)}$, substituted $alkyl_{(C\leq12)}$, $amido_{(C\leq12)}$, substituted $amido_{(C\leq12)}$, or $-NHC(O)CH(R_{1a})NH_2$, wherein:

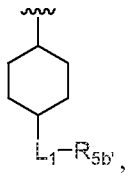
R_{1a} is $aralkyl_{(C\leq18)}$, substituted $aralkyl_{(C\leq18)}$, or the side chain of a canonical amino acid;

R_2, R_3, and R_4 are each independently $alkyl_{(C\leq12)}$, substituted $alkyl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, or substituted $aralkyl_{(C\leq18)}$; and

R_5 is $-NHR_{5b}$, wherein:

R_{5b} is $cycloalkyl_{(C\leq12)}$, $aryl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, $heteroaryl_{(C\leq12)}$, $heteroaralkyl_{(C\leq18)}$, or a substituted version of any of these groups; or

a group of the formula:



wherein:

L_1 is $-CO_2-$ or $-C(O)NR_{L1}-$, wherein:

R_{L1} hydrogen, $alkyl_{(C\leq12)}$, or substituted $alkyl_{(C\leq12)}$;

$R_{5b'}$ is $aryl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, $heteroaryl_{(C\leq12)}$, $heteroaralkyl_{(C\leq18)}$, or a substituted version of any of these groups;

or a pharmaceutically acceptable salt thereof.

In some embodiments, R_2 is $aralkyl_{(C\leq18)}$ or substituted $aralkyl_{(C\leq18)}$. In further embodiments, R_2 is substituted $aralkyl_{(C\leq18)}$, such as 4-hydroxyphenethyl. In other embodiments, R_2 is $alkyl_{(C\leq12)}$ or substituted $alkyl_{(C\leq12)}$. In further embodiments, R_2 is substituted $alkyl_{(C\leq12)}$, such as 1-hydroxyethyl. In some embodiments, R_4 is $aralkyl_{(C\leq18)}$ or substituted $aralkyl_{(C\leq18)}$. In further embodiments, R_4 is $aralkyl_{(C\leq18)}$, such as benzyl. In other embodiments, R_4 is $alkyl_{(C\leq12)}$ or substituted $alkyl_{(C\leq12)}$. In further embodiments, R_4 is $alkyl_{(C\leq12)}$, such as *n*-butyl or *i*-butyl. In some embodiments, R_3 is $aralkyl_{(C\leq18)}$ or substituted $aralkyl_{(C\leq18)}$. In further embodiments, R_3 is $aralkyl_{(C\leq18)}$, such as 2-(naphthalen-2-yl)ethyl. In other embodiments, R_3 is $alkyl_{(C\leq12)}$ or substituted $alkyl_{(C\leq12)}$. In further embodiments, R_3 is $alkyl_{(C\leq12)}$, such as methyl or *i*-butyl.

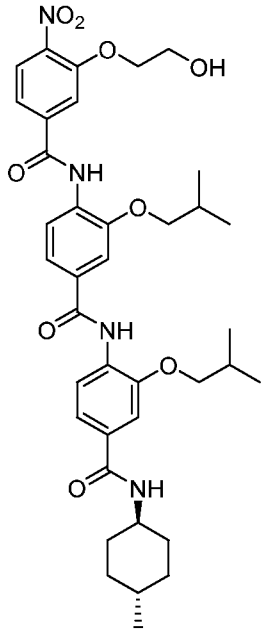
In some embodiments, R_{5b} is $aralkyl_{(C\leq18)}$ or substituted $aralkyl_{(C\leq18)}$. In further embodiments, R_{5b} is $aralkyl_{(C\leq18)}$, such as (naphthalen-2-yl)methyl. In other embodiments, R_{5b} is $heteroaryl_{(C\leq12)}$ or substituted $heteroaryl_{(C\leq12)}$. In further embodiments, R_{5b} is $heteroaryl_{(C\leq12)}$, such as 1*H*-imidazol-2-yl. In still other embodiments, R_{5b} is $cycloalkyl_{(C\leq12)}$ or substituted $cycloalkyl_{(C\leq12)}$. In further embodiments, R_{5b} is $cycloalkyl_{(C\leq12)}$, such as 4-methylcyclohexyl. In some embodiments, L_1 is $-C(O)NR_{L1}-$. In some embodiments, R_{L1} is hydrogen. In some embodiments, $R_{5b'}$ is $heteroaryl_{(C\leq12)}$ or substituted $heteroaryl_{(C\leq12)}$. In further embodiments, $R_{5b'}$ is $heteroaryl_{(C\leq12)}$, such as quinolin-3-yl or 1*H*-indazol-7-yl.

In some embodiments, R_1 is $-NO_2$. In other embodiments, R_1 is $alkyl_{(C\leq12)}$ or substituted $alkyl_{(C\leq12)}$. In further embodiments, R_1 is $alkyl_{(C\leq12)}$, such as methyl. In still other embodiments, R_1 is halo, such as fluoro or iodo. In yet other embodiments, R_1 is $amido_{(C\leq12)}$ or substituted $amido_{(C\leq12)}$. In further embodiments, R_1 is substituted $amido_{(C\leq12)}$, such as 3-aminopropanamido. In some embodiments, R_{1a} is $aralkyl_{(C\leq18)}$ or substituted $aralkyl_{(C\leq18)}$. In further embodiments, R_{1a} is $aralkyl_{(C\leq18)}$, such as benzyl.

In other embodiments, the compounds are of formula (II). In some embodiments, R_7 is $alkyl_{(C\leq12)}$ or substituted $alkyl_{(C\leq12)}$. In further embodiments, R_7 is substituted $alkyl_{(C\leq12)}$, such as 1-hydroxyethyl. In some embodiments, R_8 is $-alkanediyl_{(C\leq12)}-cycloalkyl_{(C\leq12)}$ or substituted $-alkanediyl_{(C\leq12)}-cycloalkyl_{(C\leq12)}$. In further embodiments, R_8 is

–alkanediyl$_{(C\leq12)}$–cycloalkyl$_{(C\leq12)}$, such as (cyclohexyl)methyl. In some embodiments, R_9 is aralkyl$_{(C\leq18)}$ or substituted aralkyl$_{(C\leq18)}$. In further embodiments, R_9 is aralkyl$_{(C\leq18)}$, such as 2-(naphthalen-2-yl)ethyl. In some embodiments, R_6 is amido$_{(C\leq12)}$ or substituted amido$_{(C\leq12)}$. In further embodiments, R_6 is substituted amido$_{(C\leq12)}$, such as 3-aminopropanamido.

In some embodiments, the compound is further defined as: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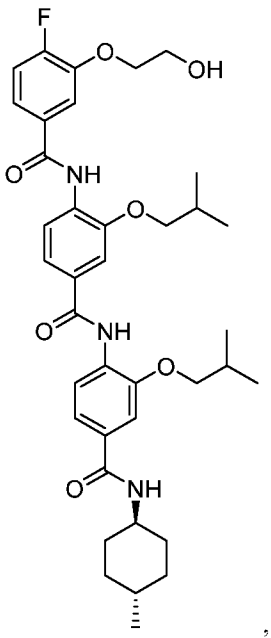
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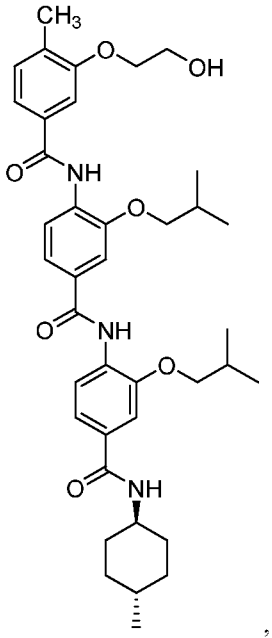
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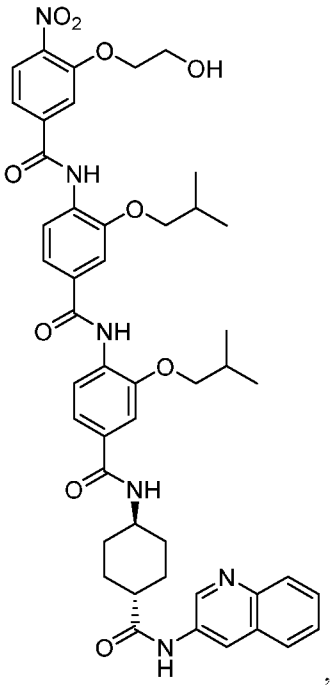
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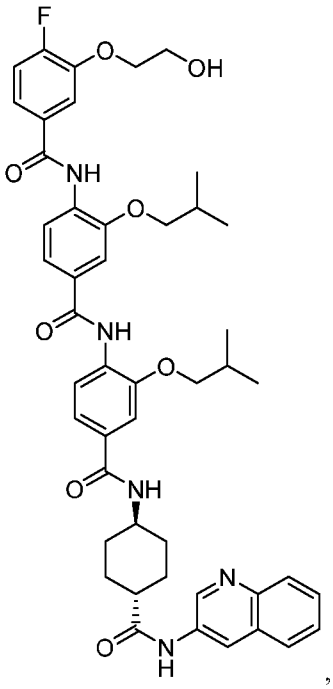
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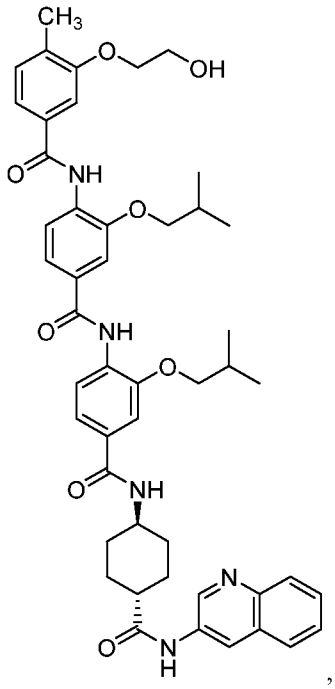
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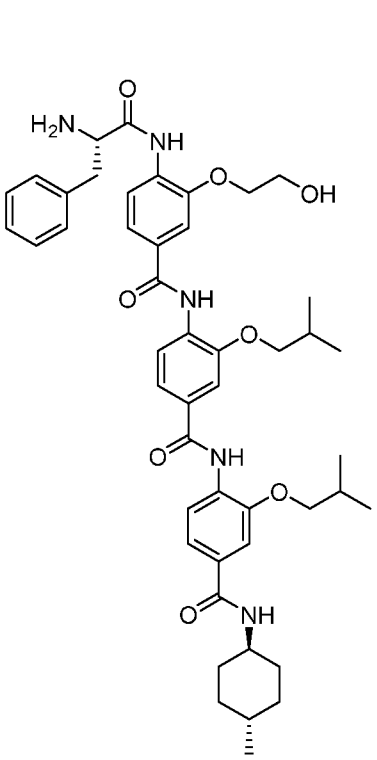

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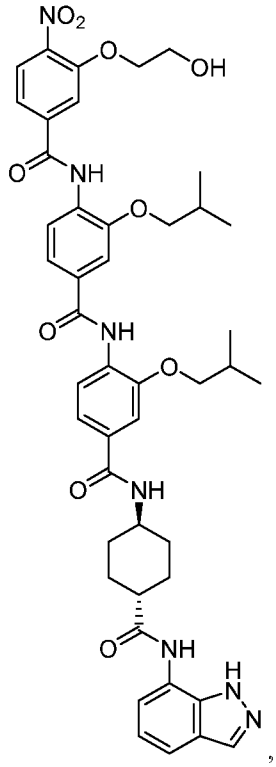

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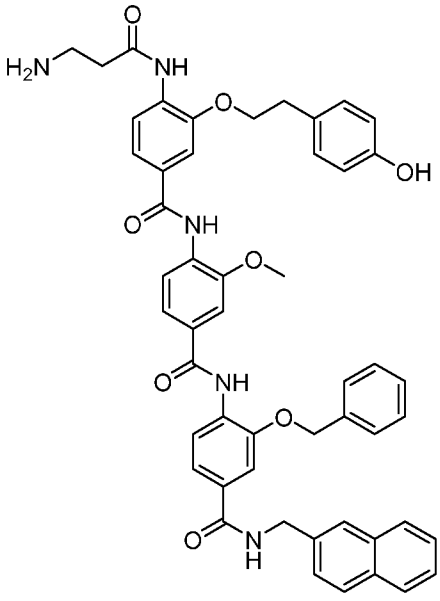

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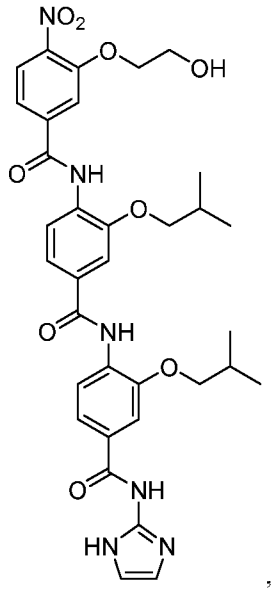

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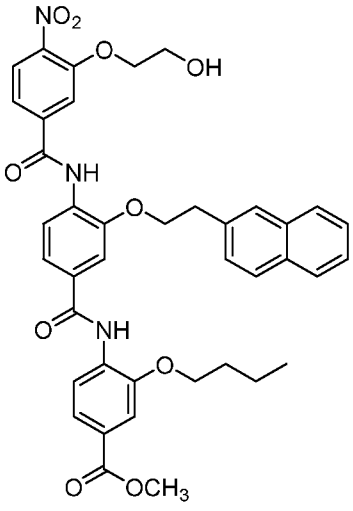

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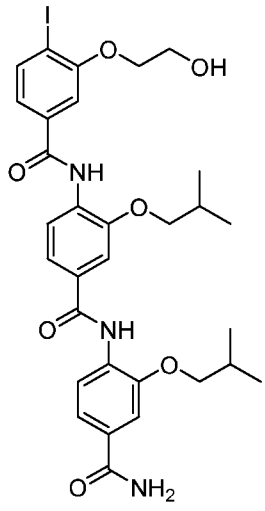

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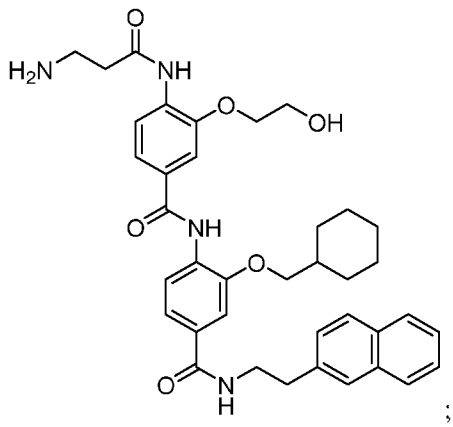
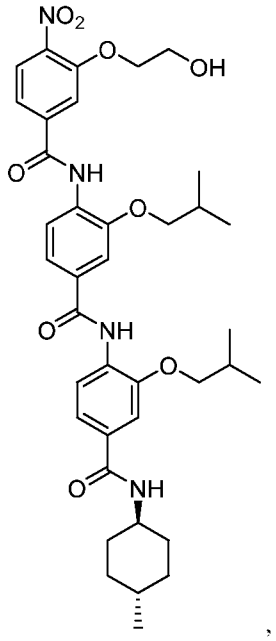


;

or a pharmaceutically acceptable salt thereof.

In some embodiments, the compound is further defined as: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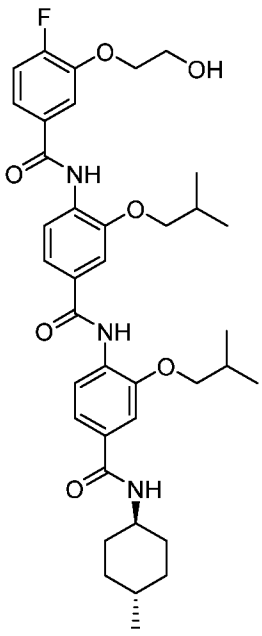
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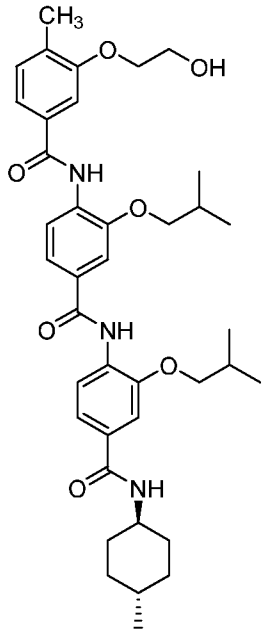
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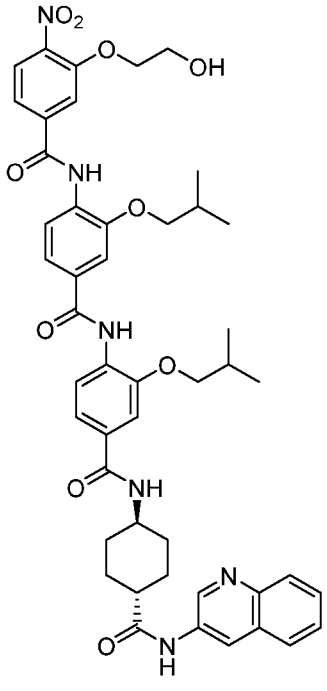
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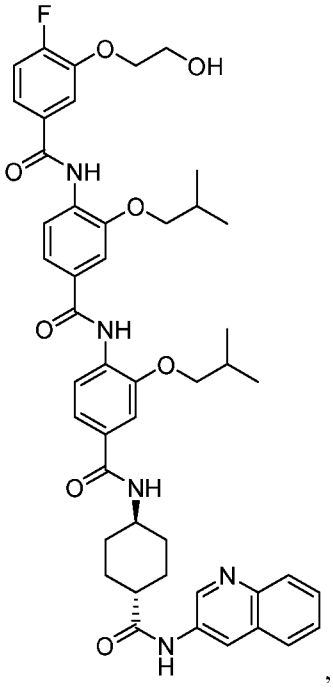
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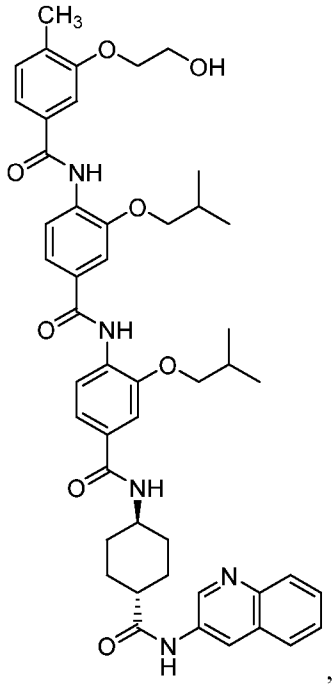
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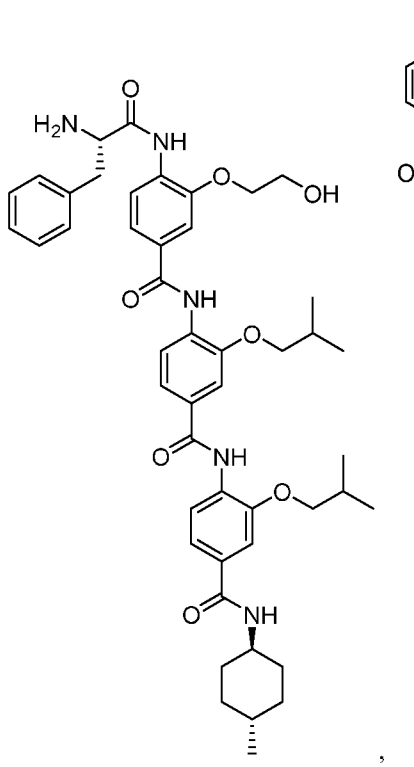
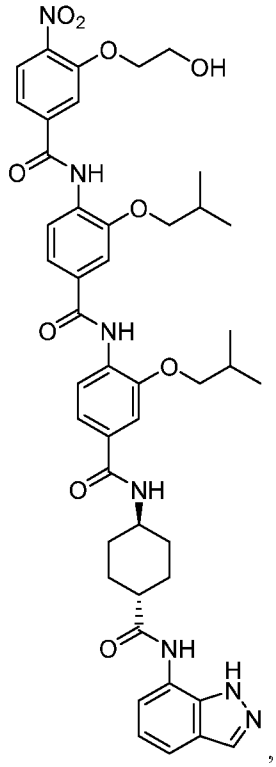
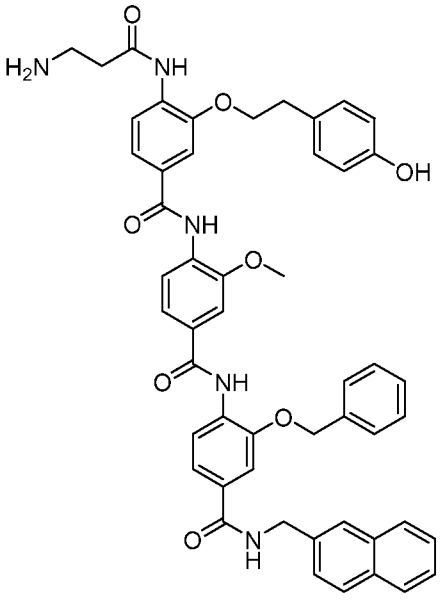
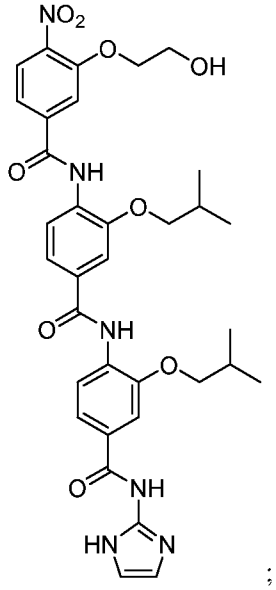
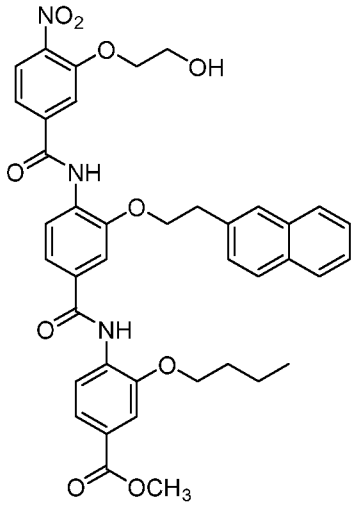





or a pharmaceutically acceptable salt thereof.

In some embodiments, the compound is further defined as:



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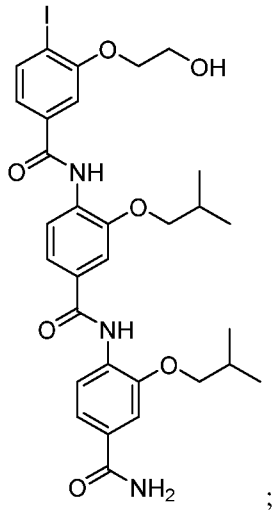
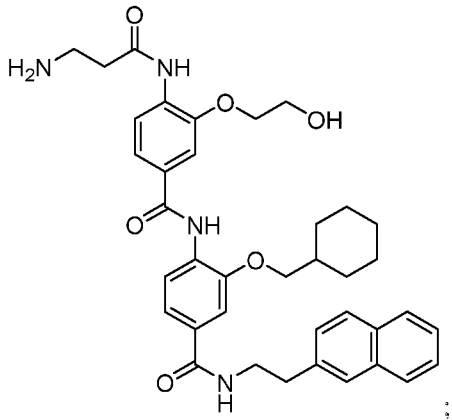


;

or a pharmaceutically acceptable salt thereof.

In some embodiments, the compound is further defined as:



;

or a pharmaceutically acceptable salt thereof.

In another aspect, the present disclosure provides pharmaceutical compositions comprising:

a) a compound disclosed herein; and

b) an excipient and/or a pharmaceutically acceptable carrier.

In some embodiments, the composition is formulated for administration: orally, intraadiposally, intraarterially, intraarticularly, intracranially, intradermally, intralesionally, intramuscularly, intranasally, intraocularly, intrapericardially, intraperitoneally, intrapleurally, intraprostatically, intrarectally, intrathecally, intratracheally, intratumorally,

intraumbilically, intravaginally, intravenously, intravesicularlly, intravitreally, liposomally, locally, mucosally, parenterally, rectally, subconjunctival, subcutaneously, sublingually, topically, transbuccally, transdermally, vaginally, in crèmes, in lipid compositions, via a catheter, via a lavage, via continuous infusion, via infusion, via inhalation, via injection, via local delivery, or via localized perfusion. In further embodiments, the composition is formulated for administration: orally, intraarterially, intratumorally, intravenously, locally, subcutaneously, topically, intraperitoneally, or via injection.

In still another aspect, the present disclosure provides methods of treating a disease or disorder in a patient in need thereof comprising administering to the patient a therapeutically effective amount of a compound or composition disclosed herein. In some embodiments, the patient is a mammal, such as a human. In some embodiments, the disease or disorder is cancer. In some embodiments, the cancer is a therapy resistant cancer. In some embodiments, the cancer is breast cancer, ovarian cancer, pancreatic cancer, or brain cancer. In further embodiments, the cancer is breast cancer, such as triple negative breast cancer. In other embodiments, the cancer is ovarian cancer. In still other embodiments, the cancer is pancreatic cancer. In yet other embodiments, the cancer is brain cancer, such as glioblastoma. In some embodiments, the cancer is an estrogen receptor-positive cancer. In other embodiments, the cancer is an estrogen receptor-negative cancer.

In some embodiments, administering comprises intravenous, intra-arterial, intra-tumoral, subcutaneous, topical or intraperitoneal administration. In some embodiments, administering comprises local, regional, systemic, or continual administration. In some embodiments, the methods further comprise providing to said subject a second anti-cancer therapy. In some embodiments, said second anti-cancer therapy is surgery, chemotherapy, radiotherapy, hormonal therapy, toxin therapy, immunotherapy, and cryotherapy. In some embodiments, said second anti-cancer therapy is provided prior to administering said compound. In other embodiments, said second anti-cancer therapy is provided after administering said compound. In still other embodiments, said second anti-cancer therapy is provided at the same time as said compound.

In some embodiments, said compound is administered daily. In some embodiments, said compound is administered daily for 7 days, 2 weeks, 3 weeks, 4 weeks, one month, 6 weeks, 8 weeks, two months, 12 weeks, or 3 months. In further embodiments, said compound is administered weekly. In some embodiments, said compound is administered weekly for 2 weeks, 3 weeks, 4 weeks, 6 weeks, 8 weeks, 10 weeks, or 12 weeks. In some

embodiments, the compound or composition is administered in an amount sufficient to induce endoplasmic reticulum stress and/or shut down protein synthesis. In some embodiments, said compound acts via inducing endoplasmic reticulum stress within hours of administration and subsequently shuts down protein synthesis. In some embodiments, the level of basal endoplasmic reticulum stress or the compensatory unfolded protein response within a cell dictates the response to the drug.

The use of the word "a" or "an" when used in conjunction with the term "comprising" in the claims and/or the specification may mean "one," but it is also consistent with the meaning of "one or more," "at least one," and "one or more than one."

The term "or combinations thereof" as used herein refers to all permutations and combinations of the listed items preceding the term. For example, "A, B, C, or combinations thereof" is intended to include at least one of: A, B, C, AB, AC, BC, or ABC, and if order is important in a particular context, also BA, CA, CB, CBA, BCA, ACB, BAC, or CAB. The skilled artisan will understand that typically there is no limit on the number of items or terms in any combination, unless otherwise apparent from the context.

As used in this specification and claim(s), the words "comprising" (and any form of comprising, such as "comprise" and "comprises"), "having" (and any form of having, such as "have" and "has"), "including" (and any form of including, such as "includes" and "include") or "containing" (and any form of containing, such as "contains" and "contain") are inclusive or open-ended and do not exclude additional, unrecited elements or method steps.

Other objects, features and advantages of the present disclosure will become apparent from the following detailed description. It should be understood, however, that the detailed description and the specific examples, while indicating specific embodiments of the disclosure, are given by way of illustration only, since various changes and modifications within the spirit and scope of the disclosure will become apparent to those skilled in the art from this detailed description. Note that simply because a particular compound is ascribed to one particular generic formula doesn't mean that it cannot also belong to another generic formula.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the features and advantages of the present disclosure, reference is now made to the detailed description of the disclosure along with the accompanying figures and in which:

FIG. 1 shows primary TK41 (*i.e.*, ERX-41) structure and low energy helical conformation.

FIGS. 2A-2C show the potency of TK41 (IC_{50} from 50-500 nM) on estrogen receptor-positive (FIG. 2A), estrogen receptor-negative (FIG. 2B) and therapy resistant ERMT (FIG. 2C) cells determined by MTT assay.

FIGS. 3A-3C show TK41 (*i.e.*, ERX-41) docked on TLX (MacroModel and AutoDock; FIG. 3A). Interaction with purified TLX protein was analyzed, following incubation with biotinylated-ERX-41, using avidin bead pull down (FIG. 3B). FIG. 3C shows GST-TLX was incubated with TNBC cellular lysates in the presence or absence of TK41 (1 μM) and TLX interaction with PELP1 was analyzed by GST pull down followed by westerns.

FIGS. 4A-4C show the effect of TK41 on estrogen receptor-positive (ER+ve) tumor growth. ZR75 (ER+ve; n = 18) xenografts were established in nude mice and treated with either vehicle (circle markers) or 10 mg/kg/day TK41 (square markers) administered as an oral gavage in Captisol®. Effect on tumor volume is shown in FIG. 4A. Effect on tumor weight is shown in FIG. 4B. Comparison of mice body weights is shown in bar graphs (FIG. 4C). * $p<0.05$; **** $p<0.001$.

FIGS. 5A-5C show the effect of TK41 on triple negative breast cancer xenograft tumors. MDA-MB-231 (TNBC; n = 10) xenografts were established in nude mice and treated with either vehicle (circle markers) or 10 mg/kg/day TK41 (square markers) administered as an oral gavage in Captisol®. Comparison of mice body weights is shown in bar graphs (FIG. 5A). Effect on tumor weight is shown in FIG. 5B. Effect on tumor volume is shown in FIG. 5C. Photographs of individual tumors at necropsy supports the effect of TK41 on TNBC. * $p<0.05$; **** $p<0.001$.

FIG. 6 shows the effect of ERX-41 (TK41) on proliferation of primary patient derived TNBC *ex vivo* culture tissues, as measured by ki67 staining. Cumulative series of n = 11 experiments is shown.

FIGS. 7A-7C show effect of TK41 in triple negative breast cancer in patient derived xenografts. TNBC patient derived xenografts (n = 6) were established in nude mice and treated with vehicle (circle markers) or 10 mg/kg/day/oral ERX-41 (*i.e.*, TK41; square markers). Tumor volume (FIG. 7A), distribution of tumor weights at necropsy (FIG. 7B), and mice body weights (bar graph; FIG. 7C) support that ERX-41 has activity against TNBC PDX tumors. * $p<0.05$; **** $p<0.001$.

FIGS. 8A & 8B show the effect of TK41 (*i.e.*, ERX-41) on therapy resistant cancer cells. ERMT (therapy resistant) xenografts (n = 8) were established in nude mice and treated with vehicle (circle markers) or 10 mg/kg/day/oral ERX-41 (square markers). Tumor volume (FIG. 8A) and mice body weights (bar graph; FIG. 8B) support that ERX-41 has activity against ERMT tumors. * $p<0.05$; ** $p<0.01$.

FIG. 9 shows structure activity relationship between TK11 (*i.e.*, ERX-11; Raj et al., 2017), TK41, TK207, TK203, TK208, and YL144. Replacement of the R_5 amino group of TK11 with a substituted amino groups significantly increased activity against estrogen receptor-positive and estrogen receptor-negative cells lines.

FIGS. 10A & 10B show effects of TK208 against cancer cells. FIG. 10A shows the effect of TK208 against a variety of TNBC cell lines. FIG. 10B shows the effect of TK208 against a variety of ovarian cancer cell lines.

FIGS. 11A & 11B show the comparison of cytotoxic effects of TK208 in BT549 NR1H4 knockout cells versus the parental cell. FIG. 11A shows the results of the cell viability assay. FIG. 11B shows the results of the caspase assay, demonstrating the effect of TK208 on apoptosis.

FIGS. 12A-12D show the effect of TK208 against ovarian cancer cell lines ES2 (FIGS. 12A & 12B) and SKOV3 (FIGS. 12C & 12D). FIGS. 12A & 12C show TK208 promotes apoptosis both ovarian cancer cells. FIGS. 12B & 12D show TK208 reduces cell viability in both cancer cell lines.

FIG. 13 shows TK208 reduces colony formation of ES2 and SKOV3 ovarian cancer cells.

FIG. 14 shows TK208 reduces invasion of ES2 and SKOV3 ovarian cancer cells.

FIG. 15 shows TK208 promotes growth arrest of ES2 and SKOV3 ovarian cancer cells in S phase.

FIG. 16 shows the effect of YL144 on breast cancer cells from various cell lines.

FIG. 17 shows the effect of YL144 on BT549/NR targeted knockout cells.

FIG. 18 shows the effect of YL144 on cell viability of VDR-CRISPR knockout cells.

FIG. 19 shows structure activity relationship between TK11 (Raj et al., 2017), TK41, TK208, TK231, YL144, TK227, YL1113, and TK245.

FIG. 20 shows TK245 has high specificity for estrogen receptor-positive cells.

FIG. 21 shows the effect of TK308 on various cancer cell lines.

FIG. 22 shows the effect of TK309 on various cancer cell lines.

FIG. 23 shows the effect of TK315 on various cancer cell lines.

FIG. 24 shows the effect of TK314 on various cancer cell lines. TK314 exhibits unique activity against ovarian cancer cells with significantly less activity against breast cancer cells.

FIG. 25 shows the ability of TK41 to induce endoplasmic reticulum stress in TNBC MD-MBA-231 cells using electron microscopy. TK41 does not induce endoplasmic reticulum stress in HMEC cells (bottom panel)

FIG. 26 shows the ability of TK41 to induce endoplasmic reticulum stress in MD-MBA-231 cell using western blots. TK41 does not induce endoplasmic reticulum stress in HMEC cells.

FIG. 27 shows the ability of TK41 to shut down *de novo* protein synthesis. TK-41 decreases global new protein synthesis at 4 h and 16 h in 3 TNBC cells as shown by western blots for puromycin labeled nascent proteins. Total protein is shown on right with coomassie blue staining.

FIG. 28 shows that the basal level of expression of endoplasmic reticulum stress and unfolded protein response correlates with TK41 activity.

FIG. 29 shows the ability of TK41 to induce endoplasmic reticulum stress in pancreatic cancer MiaPaca cells using electron microscopy. TK41 does not induce endoplasmic reticulum stress in HMEC cells.

FIG. 30 shows the schematic that explains the mechansism of action of TK41 via targeting either ER or TLX and inducing Endoplasmic reticulum stress, subsequent apoptosis and blocking autophagic fusion.

FIGS. 31A-D show that oral administration of TK315 (ERX-315) decreased the growth and tumor weight of BC xenografts genetically engineered by CRISPR to express the Y537S ERa mutant in the ZR75 (FIGS. 31A-B) and MCF7 cells (FIGS. 31C-D). No change in body weight was noted.

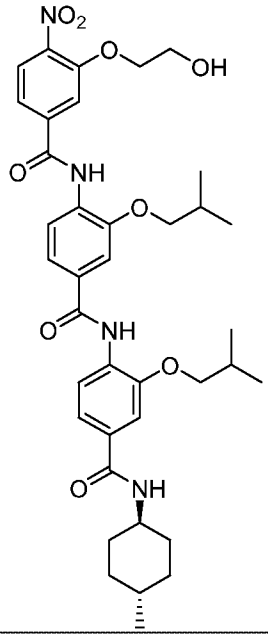
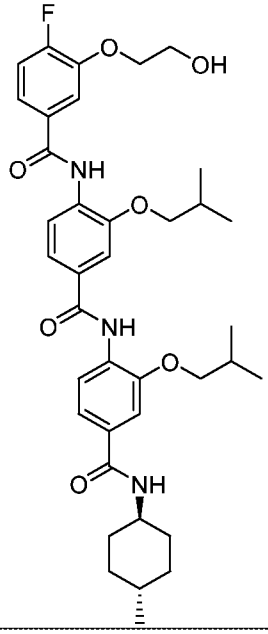
FIGS. 32A-C show established breast PDX tumors treated either with vehicle (circles) or ERX-41 (squares). Tumor volume is graphed (left), distribution of tumor weights at necropsy (middle panel). * $p<0.05$; **** $p<0.001$.

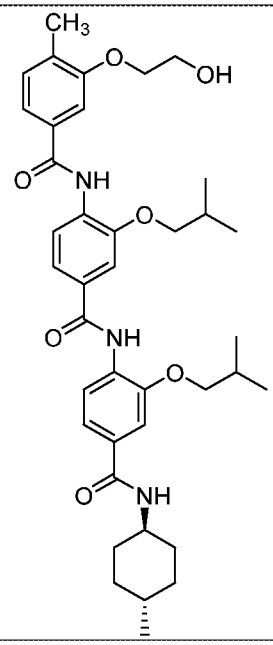
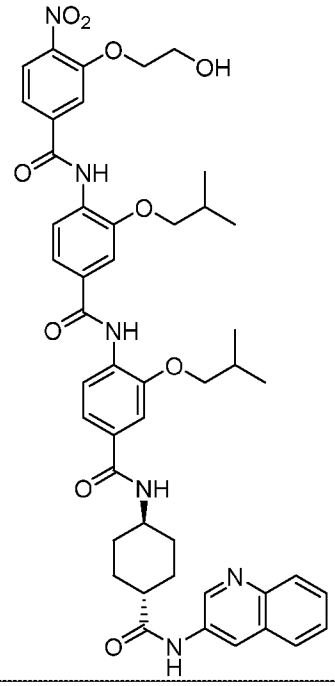
FIGS. 33A-H. FIGS. 33A-D show ovarian cancer xenografts (ES2) treated with vehicle or TK208 (ERX-208). Tumor volume (FIG. 33A), body weight (FIG. 33B) distribution of tumor weights at necropsy (FIG. 33C) and nodules (FIG. 33D) were graphed. FIGS. 33E-H show ovarian PDX tumors were treated with vehicle or TK208 (ERX-208). Tumor volume (FIG. 33E), distribution of tumor weights at necropsy (FIG. 33F) and tumor images (FIG. 33G) and body weight (FIG. 33H) were graphed.

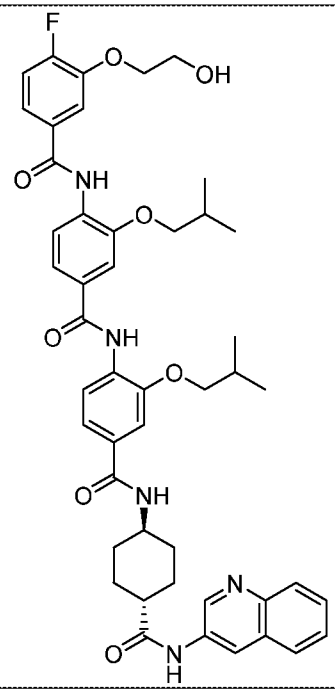
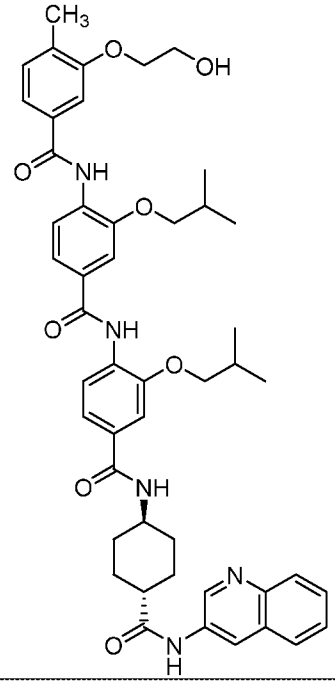
DETAILED DESCRIPTION

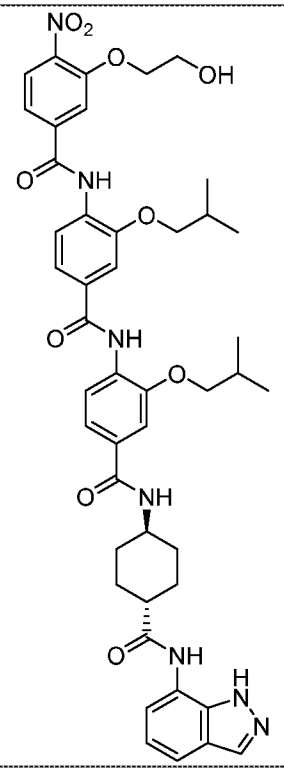
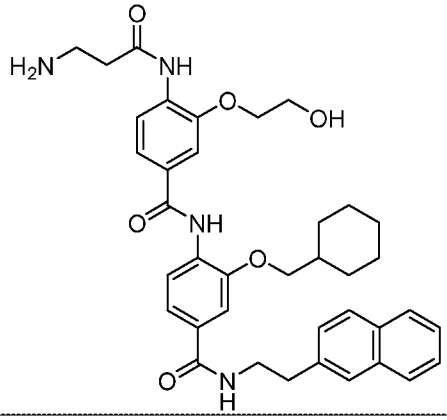
The present disclosure relates oligo-benzamides which are modified with a cyclohexylamide group at the southern terminus of the compound. These compounds have been shown to binding to the hormone receptors in one or more cancer cells such as breast cancer. These compounds may show one or more preferential properties relative to those known in the art, such as improved efficiacy. These and other details are described below.

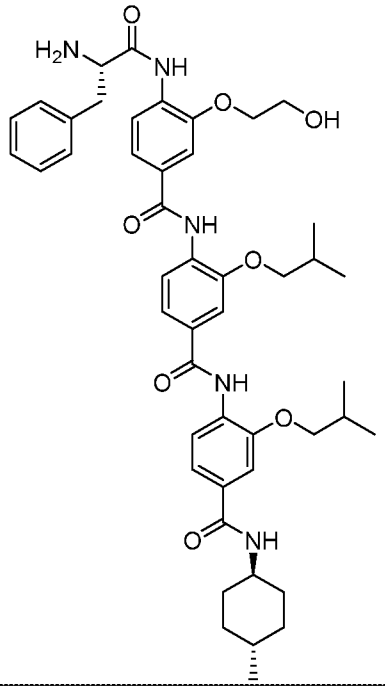
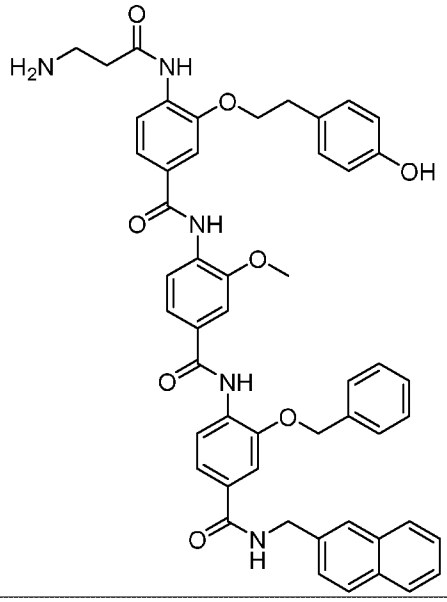
I. Compounds of the Present Disclosure

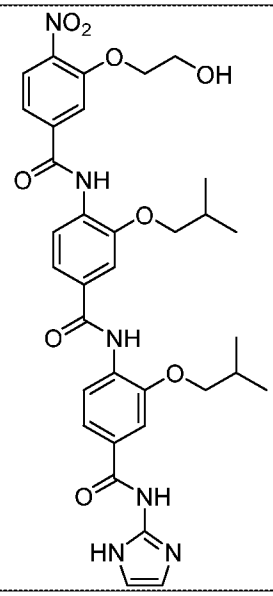
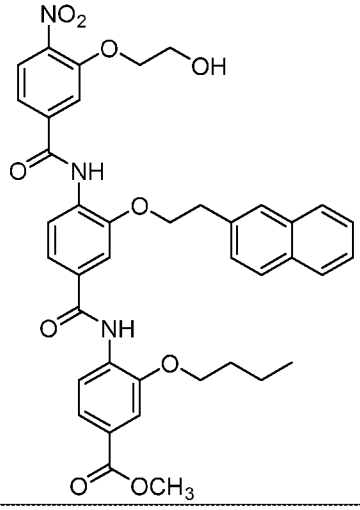
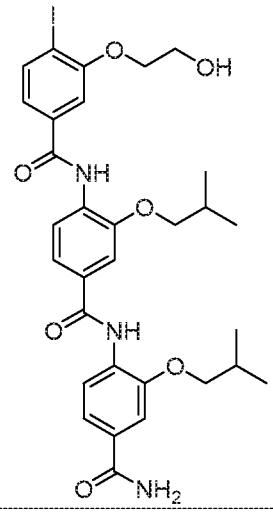
Compound ID	Structure
TK41 (ERX-41)	
TK314	

TK308	
TK208	

TK315	
TK309	

TK207	
TK245	

TK227	
TK296	

YL144	
YL1113	
YL1116	

The compounds of the present disclosure are shown, for example, above, in the summary section, and in the claims below. They may be made using the synthetic methods outlined in the Examples section. These methods can be further modified and optimized using the principles and techniques of organic chemistry as applied by a person skilled in the art. Such principles and techniques are taught, for example, in Smith, *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure,* (2013), which is incorporated by reference herein. In addition, the synthetic methods may be further modified and optimized for preparative, pilot- or large-scale production, either batch or continuous, using the principles and techniques of process chemistry as applied by a person skilled in the art. Such principles and techniques are taught, for example, in Anderson, *Practical Process Research & Development – A Guide for Organic Chemists* (2012), which is incorporated by reference herein.

All the compounds of the present disclosure may in some embodiments be used for the prevention and treatment of one or more diseases or disorders discussed herein or otherwise. In some embodiments, one or more of the compounds characterized or exemplified herein as an intermediate, a metabolite, and/or prodrug, may nevertheless also be useful for the prevention and treatment of one or more diseases or disorders. As such unless explicitly stated to the contrary, all the compounds of the present disclosure are deemed "active compounds" and "therapeutic compounds" that are contemplated for use as active pharmaceutical ingredients (APIs). Actual suitability for human or veterinary use is typically determined using a combination of clinical trial protocols and regulatory procedures, such as those administered by the Food and Drug Administration (FDA). In the United States, the FDA is responsible for protecting the public health by assuring the safety, effectiveness, quality, and security of human and veterinary drugs, vaccines and other biological products, and medical devices.

In some embodiments, the compounds of the present disclosure have the advantage that they may be more efficacious than, be less toxic than, be longer acting than, be more potent than, produce fewer side effects than, be more easily absorbed than, more metabolically stable than, more lipophilic than, more hydrophilic than, and/or have a better pharmacokinetic profile (*e.g.*, higher oral bioavailability and/or lower clearance) than, and/or have other useful pharmacological, physical, or chemical properties over, compounds known in the prior art, whether for use in the indications stated herein or otherwise.

Compounds of the present disclosure may contain one or more asymmetrically-substituted carbon or nitrogen atom and may be isolated in optically active or racemic form.

Thus, all chiral, diastereomeric, racemic form, epimeric form, and all geometric isomeric forms of a chemical formula are intended, unless the specific stereochemistry or isomeric form is specifically indicated. Compounds may occur as racemates and racemic mixtures, single enantiomers, diastereomeric mixtures and individual diastereomers. In some embodiments, a single diastereomer is obtained. The chiral centers of the compounds of the present disclosure can have the *S* or the *R* configuration. In some embodiments, the present compounds may contain two or more atoms which have a defined stereochemical orientation.

Chemical formulas used to represent compounds of the present disclosure will typically only show one of possibly several different tautomers. For example, many types of ketone groups are known to exist in equilibrium with corresponding enol groups. Similarly, many types of imine groups exist in equilibrium with enamine groups. Regardless of which tautomer is depicted for a given compound, and regardless of which one is most prevalent, all tautomers of a given chemical formula are intended.

In addition, atoms making up the compounds of the present disclosure are intended to include all isotopic forms of such atoms. Isotopes, as used herein, include those atoms having the same atomic number but different mass numbers. By way of general example and without limitation, isotopes of hydrogen include tritium and deuterium, isotopes of fluorine include ^{18}F, and isotopes of carbon include ^{13}C and ^{14}C.

In some embodiments, compounds of the present disclosure function as prodrugs or can be derivatized to function as prodrugs. Since prodrugs are known to enhance numerous desirable qualities of pharmaceuticals (*e.g.*, solubility, bioavailability, manufacturing, *etc.*), the compounds employed in some methods of the disclosure may, if desired, be delivered in prodrug form. Thus, the disclosure contemplates prodrugs of compounds of the present disclosure as well as methods of delivering prodrugs. Prodrugs of the compounds employed in the disclosure may be prepared by modifying functional groups present in the compound in such a way that the modifications are cleaved, either in routine manipulation or *in vivo*, to the parent compound. Accordingly, prodrugs include, for example, compounds described herein in which a hydroxy, amino, or carboxy group is bonded to any group that, when the prodrug is administered to a patient, cleaves to form a hydroxy, amino, or carboxylic acid, respectively.

In some embodiments, compounds of the present disclosure exist in salt or non-salt form. With regard to the salt form(s), in some embodiments the particular anion or cation forming a part of any salt form of a compound provided herein is not critical, so long as the salt, as a whole, is pharmacologically acceptable. Additional examples of pharmaceutically

acceptable salts and their methods of preparation and use are presented in *Handbook of Pharmaceutical Salts: Properties, and Use* (2002), which is incorporated herein by reference.

It will be appreciated that many organic compounds can form complexes with solvents in which they are reacted or from which they are precipitated or crystallized. These complexes are known as "solvates." Where the solvent is water, the complex is known as a "hydrate." It will also be appreciated that many organic compounds can exist in more than one solid form, including crystalline and amorphous forms. All solid forms of the compounds provided herein, including any solvates thereof are within the scope of the present disclosure.

II. Chemical Definitions

When used in the context of a chemical group: "hydrogen" means –H; "hydroxy" means –OH; "oxo" means =O; "carbonyl" means –C(=O)–; "carboxy" means –C(=O)OH (also written as –COOH or $-CO_2H$); "halo" means independently –F, –Cl, –Br or –I; "amino" means $-NH_2$; "hydroxyamino" means –NHOH; "nitro" means $-NO_2$; imino means =NH; "cyano" means –CN; "isocyanyl" means –N=C=O; "azido" means $-N_3$; in a monovalent context "phosphate" means $-OP(O)(OH)_2$ or a deprotonated form thereof; in a divalent context "phosphate" means $-OP(O)(OH)O-$ or a deprotonated form thereof; "mercapto" means –SH; and "thio" means =S; "sulfonyl" means $-S(O)_2-$; and "sulfinyl" means –S(O)–.

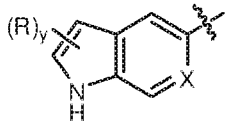
In the context of chemical formulas, the symbol "–" means a single bond, "=" means a double bond, and "≡" means triple bond. The symbol "----" represents an optional bond, which if present is either single or double. The symbol "≡≡≡≡" represents a single bond or a double bond. Thus, the formula  covers, for example,  ,  ,  ,  and  . And it is understood that no one such ring atom forms part of more than one double bond. Furthermore, it is noted that the covalent bond symbol "–", when connecting one or two stereogenic atoms, does not indicate any preferred stereochemistry. Instead, it covers all stereoisomers as well as mixtures thereof. The symbol "  ", when drawn perpendicularly across a bond (*e.g.*,  for methyl) indicates a point of attachment of the group. It is noted that the point of attachment is typically only identified in this manner for larger groups in order to assist the reader in unambiguously identifying a point of attachment. The symbol "" means a single bond where the group attached to the thick end of the wedge is "out of

the page." The symbol "▪▪▪▪" means a single bond where the group attached to the thick end of the wedge is "into the page". The symbol "〰" means a single bond where the geometry around a double bond (*e.g.*, either *E* or *Z*) is undefined. Both options, as well as combinations thereof are therefore intended. Any undefined valency on an atom of a structure shown in this application implicitly represents a hydrogen atom bonded to that atom. A bold dot on a carbon atom indicates that the hydrogen attached to that carbon is oriented out of the plane of the paper.

When a variable is depicted as a "floating group" on a ring system, for example, the group "R" in the formula:

,

then the variable may replace any hydrogen atom attached to any of the ring atoms, including a depicted, implied, or expressly defined hydrogen, so long as a stable structure is formed. When a variable is depicted as a "floating group" on a fused ring system, as for example the group "R" in the formula:



,

then the variable may replace any hydrogen attached to any of the ring atoms of either of the fused rings unless specified otherwise. Replaceable hydrogens include depicted hydrogens (*e.g.*, the hydrogen attached to the nitrogen in the formula above), implied hydrogens (*e.g.*, a hydrogen of the formula above that is not shown but understood to be present), expressly defined hydrogens, and optional hydrogens whose presence depends on the identity of a ring atom (*e.g.*, a hydrogen attached to group X, when X equals –CH–), so long as a stable structure is formed. In the example depicted, R may reside on either the 5-membered or the 6-membered ring of the fused ring system. In the formula above, the subscript letter "y" immediately following the R enclosed in parentheses, represents a numeric variable. Unless specified otherwise, this variable can be 0, 1, 2, or any integer greater than 2, only limited by the maximum number of replaceable hydrogen atoms of the ring or ring system.

For the chemical groups and compound classes, the number of carbon atoms in the group or class is as indicated as follows: "Cn" or "C=n" defines the exact number (n) of carbon atoms in the group/class. "C≤n" defines the maximum number (n) of carbon atoms

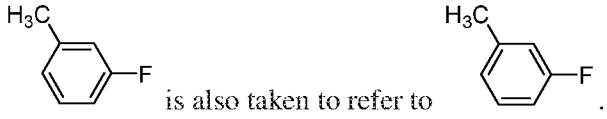
that can be in the group/class, with the minimum number as small as possible for the group/class in question. For example, it is understood that the minimum number of carbon atoms in the groups "alkyl$_{(C\leq 8)}$", "cycloalkanediyl$_{(C\leq 8)}$", "heteroaryl$_{(C\leq 8)}$", and "acyl$_{(C\leq 8)}$" is one, the minimum number of carbon atoms in the groups "alkenyl$_{(C\leq 8)}$", "alkynyl$_{(C\leq 8)}$", and "heterocycloalkyl$_{(C\leq 8)}$" is two, the minimum number of carbon atoms in the group "cycloalkyl$_{(C\leq 8)}$" is three, and the minimum number of carbon atoms in the groups "aryl$_{(C\leq 8)}$" and "arenediyl$_{(C\leq 8)}$" is six. "Cn-n'" defines both the minimum (n) and maximum number (n') of carbon atoms in the group. Thus, "alkyl$_{(C2\text{-}10)}$" designates those alkyl groups having from 2 to 10 carbon atoms. These carbon number indicators may precede or follow the chemical groups or class it modifies and it may or may not be enclosed in parenthesis, without signifying any change in meaning. Thus, the terms "C5 olefin", "C5-olefin", "olefin$_{(C5)}$", and "olefin$_{C5}$" are all synonymous. Except as noted below, every carbon atom is counted to determine whether the group or compound falls with the specified number of carbon atoms. For example, the group dihexylamino is an example of a dialkylamino$_{(C=12)}$ group; however, it is not an example of a dialkylamino$_{(C=6)}$ group. Likewise, phenylethyl is an example of an aralkyl$_{(C=8)}$ group. When any of the chemical groups or compound classes defined herein is modified by the term "substituted", any carbon atom in the moiety replacing the hydrogen atom is not counted. Thus methoxyhexyl, which has a total of seven carbon atoms, is an example of a substituted alkyl$_{(C1\text{-}6)}$. Unless specified otherwise, any chemical group or compound class listed in a claim set without a carbon atom limit has a carbon atom limit of less than or equal to twelve.

The term "saturated" when used to modify a compound or chemical group means the compound or chemical group has no carbon-carbon double and no carbon-carbon triple bonds, except as noted below. When the term is used to modify an atom, it means that the atom is not part of any double or triple bond. In the case of substituted versions of saturated groups, one or more carbon oxygen double bond or a carbon nitrogen double bond may be present. And when such a bond is present, then carbon-carbon double bonds that may occur as part of keto-enol tautomerism or imine/enamine tautomerism are not precluded. When the term "saturated" is used to modify a solution of a substance, it means that no more of that substance can dissolve in that solution.

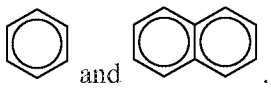
The term "aliphatic" signifies that the compound or chemical group so modified is an acyclic or cyclic, but non-aromatic compound or group. In aliphatic compounds/groups, the carbon atoms can be joined together in straight chains, branched chains, or non-aromatic

rings (alicyclic). Aliphatic compounds/groups can be saturated, that is joined by single carbon-carbon bonds (alkanes/alkyl), or unsaturated, with one or more carbon-carbon double bonds (alkenes/alkenyl) or with one or more carbon-carbon triple bonds (alkynes/alkynyl).

The term "aromatic" signifies that the compound or chemical group so modified has a planar unsaturated ring of atoms with $4n$ +2 electrons in a fully conjugated cyclic π system. An aromatic compound or chemical group may be depicted as a single resonance structure; however, depiction of one resonance structure is taken to also refer to any other resonance structure. For example:

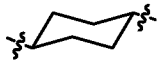


Aromatic compounds may also be depicted using a circle to represent the delocalized nature of the electrons in the fully conjugated cyclic π system, two non-limiting examples of which are shown below:

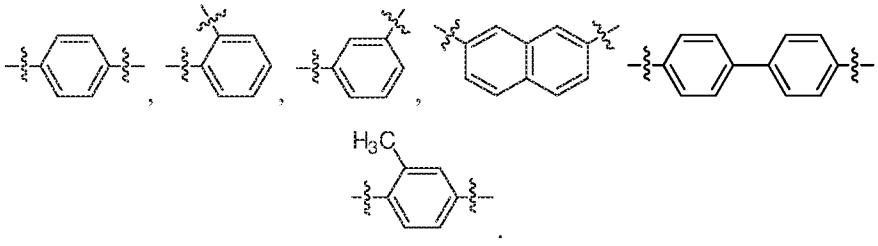


The term "alkyl" refers to a monovalent saturated aliphatic group with a carbon atom as the point of attachment, a linear or branched acyclic structure, and no atoms other than carbon and hydrogen. The groups $-CH_3$ (Me), $-CH_2CH_3$ (Et), $-CH_2CH_2CH_3$ (*n*-Pr or propyl), $-CH(CH_3)_2$ (*i*-Pr, ^{i}Pr or isopropyl), $-CH_2CH_2CH_2CH_3$ (*n*-Bu), $-CH(CH_3)CH_2CH_3$ (*sec*-butyl), $-CH_2CH(CH_3)_2$ (isobutyl), $-C(CH_3)_3$ (*tert*-butyl, *t*-butyl, *t*-Bu or ^{t}Bu), and $-CH_2C(CH_3)_3$ (*neo*-pentyl) are non-limiting examples of alkyl groups. The term "alkanediyl" refers to a divalent saturated aliphatic group, with one or two saturated carbon atom(s) as the point(s) of attachment, a linear or branched acyclic structure, no carbon-carbon double or triple bonds, and no atoms other than carbon and hydrogen. The groups $-CH_2-$ (methylene), $-CH_2CH_2-$, $-CH_2C(CH_3)_2CH_2-$, and $-CH_2CH_2CH_2-$ are non-limiting examples of alkanediyl groups. The term "alkylidene" refers to the divalent group $=CRR'$ in which R and R′ are independently hydrogen or alkyl. Non-limiting examples of alkylidene groups include: $=CH_2$, $=CH(CH_2CH_3)$, and $=C(CH_3)_2$. An "alkane" refers to the class of compounds having the formula H–R, wherein R is alkyl as this term is defined above.

The term "cycloalkyl" refers to a monovalent saturated aliphatic group with a carbon atom as the point of attachment, said carbon atom forming part of one or more non-aromatic ring structures, no carbon-carbon double or triple bonds, and no atoms other than carbon and hydrogen. Non-limiting examples include: $-CH(CH_2)_2$ (cyclopropyl), cyclobutyl,

cyclopentyl, or cyclohexyl (Cy). As used herein, the term does not preclude the presence of one or more alkyl groups (carbon number limitation permitting) attached to a carbon atom of the non-aromatic ring structure. The term "cycloalkanediyl" refers to a divalent saturated aliphatic group with two carbon atoms as points of attachment, no carbon-carbon double or triple bonds, and no atoms other than carbon and hydrogen. The group  is a non-limiting example of cycloalkanediyl group. A "cycloalkane" refers to the class of compounds having the formula H–R, wherein R is cycloalkyl as this term is defined above.

The term "aryl" refers to a monovalent unsaturated aromatic group with an aromatic carbon atom as the point of attachment, said carbon atom forming part of a one or more aromatic ring structures, each with six ring atoms that are all carbon, and wherein the group consists of no atoms other than carbon and hydrogen. If more than one ring is present, the rings may be fused or unfused. Unfused rings are connected with a covalent bond. As used herein, the term aryl does not preclude the presence of one or more alkyl groups (carbon number limitation permitting) attached to the first aromatic ring or any additional aromatic ring present. Non-limiting examples of aryl groups include phenyl (Ph), methylphenyl, (dimethyl)phenyl, $-C_6H_4CH_2CH_3$ (ethylphenyl), naphthyl, and a monovalent group derived from biphenyl (*e.g.*, 4-phenylphenyl). The term "arenediyl" refers to a divalent aromatic group with two aromatic carbon atoms as points of attachment, said carbon atoms forming part of one or more six-membered aromatic ring structures, each with six ring atoms that are all carbon, and wherein the divalent group consists of no atoms other than carbon and hydrogen. As used herein, the term arenediyl does not preclude the presence of one or more alkyl groups (carbon number limitation permitting) attached to the first aromatic ring or any additional aromatic ring present. If more than one ring is present, the rings may be fused or unfused. Unfused rings are connected with a covalent bond. Non-limiting examples of arenediyl groups include:



An "arene" refers to the class of compounds having the formula H–R, wherein R is aryl as that term is defined above. Benzene and toluene are non-limiting examples of arenes.

The term "aralkyl" refers to the monovalent group –alkanediyl–aryl, in which the terms alkanediyl and aryl are each used in a manner consistent with the definitions provided above. Non-limiting examples are: phenylmethyl (benzyl, Bn) and 2-phenyl-ethyl.

The term "heteroaryl" refers to a monovalent aromatic group with an aromatic carbon atom or nitrogen atom as the point of attachment, said carbon atom or nitrogen atom forming part of one or more aromatic ring structures, each with three to eight ring atoms, wherein at least one of the ring atoms of the aromatic ring structure(s) is nitrogen, oxygen or sulfur, and wherein the heteroaryl group consists of no atoms other than carbon, hydrogen, aromatic nitrogen, aromatic oxygen and aromatic sulfur. If more than one ring is present, the rings are fused; however, the term heteroaryl does not preclude the presence of one or more alkyl or aryl groups (carbon number limitation permitting) attached to one or more ring atoms. Non-limiting examples of heteroaryl groups include benzoxazolyl, benzimidazolyl, furanyl, imidazolyl (Im), indolyl, indazolyl (Im), isoxazolyl, methylpyridinyl, oxazolyl, oxadiazolyl, phenylpyridinyl, pyridinyl (pyridyl), pyrrolyl, pyrimidinyl, pyrazinyl, quinolyl, quinazolyl, quinoxalinyl, triazinyl, tetrazolyl, thiazolyl, thienyl, and triazolyl. The term "*N*-heteroaryl" refers to a heteroaryl group with a nitrogen atom as the point of attachment. A "heteroarene" refers to the class of compounds having the formula H–R, wherein R is heteroaryl. Pyridine and quinoline are non-limiting examples of heteroarenes.

The term "heteroaralkyl" refers to the monovalent group –alkanediyl–heteroaryl, in which the terms alkanediyl and heteroaryl are each used in a manner consistent with the definitions provided above. Non-limiting examples are: pyridinylmethyl and 2-quinolinyl-ethyl.

The term "acyl" refers to the group –C(O)R, in which R is a hydrogen, alkyl, cycloalkyl, or aryl as those terms are defined above. The groups, –CHO, $-C(O)CH_3$ (acetyl, Ac), $-C(O)CH_2CH_3$, $-C(O)CH(CH_3)_2$, $-C(O)CH(CH_2)_2$, $-C(O)C_6H_5$, and $-C(O)C_6H_4CH_3$ are non-limiting examples of acyl groups. A "thioacyl" is defined in an analogous manner, except that the oxygen atom of the group –C(O)R has been replaced with a sulfur atom, –C(S)R. The term "aldehyde" corresponds to an alkyl group, as defined above, attached to a –CHO group.

The term "alkylamino" refers to the group –NHR, in which R is an alkyl, as that term is defined above. Non-limiting examples include: $-NHCH_3$ and $-NHCH_2CH_3$. The term "dialkylamino" refers to the group –NRR′, in which R and R′ can be the same or different alkyl groups. Non-limiting examples of dialkylamino groups include: $-N(CH_3)_2$ and $-N(CH_3)(CH_2CH_3)$. The terms "cycloalkylamino", "alkenylamino", "alkynylamino",

"arylamino", "aralkylamino", "heteroarylamino", "heterocycloalkylamino", and "alkoxyamino" when used without the "substituted" modifier, refers to groups, defined as –NHR, in which R is cycloalkyl, alkenyl, alkynyl, aryl, aralkyl, heteroaryl, heterocycloalkyl, and alkoxy, respectively. A non-limiting example of an arylamino group is $-NHC_6H_5$. The terms "dicycloalkylamino", "dialkenylamino", "dialkynylamino", "diarylamino", "diaralkylamino", "diheteroarylamino", "diheterocycloalkylamino", and "dialkoxyamino", refers to groups, defined as –NRR′, in which R and R′ are both cycloalkyl, alkenyl, alkynyl, aryl, aralkyl, heteroaryl, heterocycloalkyl, and alkoxy, respectively. Similarly, the term alkyl(cycloalkyl)amino refers to a group defined as –NRR′, in which R is alkyl and R′ is cycloalkyl. The term "amido" (acylamino), when used without the "substituted" modifier, refers to the group –NHR, in which R is acyl, as that term is defined above. A non-limiting example of an amido group is $-NHC(O)CH_3$.

When a chemical group is used with the "substituted" modifier, one or more hydrogen atom has been replaced, independently at each instance, by –OH, –F, –Cl, –Br, –I, $-NH_2$, $-NO_2$, $-CO_2H$, $-CO_2CH_3$, –CN, –SH, $-OCH_3$, $-OCH_2CH_3$, $-C(O)CH_3$, $-NHCH_3$, $-NHCH_2CH_3$, $-N(CH_3)_2$, $-C(O)NH_2$, $-C(O)NHCH_3$, $-C(O)N(CH_3)_2$, $-OC(O)CH_3$, $-NHC(O)CH_3$, $-S(O)_2OH$, or $-S(O)_2NH_2$. For example, the following groups are non-limiting examples of substituted alkyl groups: $-CH_2OH$, $-CH_2Cl$, $-CF_3$, $-CH_2CN$, $-CH_2C(O)OH$, $-CH_2C(O)OCH_3$, $-CH_2C(O)NH_2$, $-CH_2C(O)CH_3$, $-CH_2OCH_3$, $-CH_2OC(O)CH_3$, $-CH_2NH_2$, $-CH_2N(CH_3)_2$, and $-CH_2CH_2Cl$. The term "haloalkyl" is a subset of substituted alkyl, in which the hydrogen atom replacement is limited to halo (*i.e.* –F, –Cl, –Br, or –I) such that no other atoms aside from carbon, hydrogen and halogen are present. The group, $-CH_2Cl$ is a non-limiting example of a haloalkyl. The term "fluoroalkyl" is a subset of substituted alkyl, in which the hydrogen atom replacement is limited to fluoro such that no other atoms aside from carbon, hydrogen and fluorine are present. The groups $-CH_2F$, $-CF_3$, and $-CH_2CF_3$ are non-limiting examples of fluoroalkyl groups. Non-limiting examples of substituted aralkyls are: (3-chlorophenyl)-methyl, and 2-chloro-2-phenyl-eth-1-yl. The groups, $-C(O)CH_2CF_3$, $-CO_2H$ (carboxyl), $-CO_2CH_3$ (methylcarboxyl), $-CO_2CH_2CH_3$, $-C(O)NH_2$ (carbamoyl), and $-CON(CH_3)_2$, are non-limiting examples of substituted acyl groups. The groups $-NHC(O)OCH_3$ and $-NHC(O)NHCH_3$ are non-limiting examples of substituted amido groups.

The use of the word "a" or "an," when used in conjunction with the term "comprising" in the claims and/or the specification may mean "one," but it is also consistent with the meaning of "one or more," "at least one," and "one or more than one."

Throughout this application, the term "about" is used to indicate that a value includes the inherent variation of error for the device, the method being employed to determine the value, or the variation that exists among the study subjects or patients.

An "active ingredient" (AI) or active pharmaceutical ingredient (API) (also referred to as an active compound, active substance, active agent, pharmaceutical agent, agent, biologically active molecule, or a therapeutic compound) is the ingredient in a pharmaceutical drug that is biologically active.

The terms "comprise," "have" and "include" are open-ended linking verbs. Any forms or tenses of one or more of these verbs, such as "comprises," "comprising," "has," "having," "includes" and "including," are also open-ended. For example, any method that "comprises," "has" or "includes" one or more steps is not limited to possessing only those one or more steps and also covers other unlisted steps.

The term "effective," as that term is used in the specification and/or claims, means adequate to accomplish a desired, expected, or intended result. "Effective amount," "Therapeutically effective amount" or "pharmaceutically effective amount" when used in the context of treating a patient or subject with a compound means that amount of the compound which, when administered to a subject or patient, is sufficient to effect such treatment or prevention of the disease as those terms are defined below.

An "excipient" is a pharmaceutically acceptable substance formulated along with the active ingredient(s) of a medication, pharmaceutical composition, formulation, or drug delivery system. Excipients may be used, for example, to stabilize the composition, to bulk up the composition (thus often referred to as "bulking agents," "fillers," or "diluents" when used for this purpose), or to confer a therapeutic enhancement on the active ingredient in the final dosage form, such as facilitating drug absorption, reducing viscosity, or enhancing solubility. Excipients include pharmaceutically acceptable versions of antiadherents, binders, coatings, colors, disintegrants, flavors, glidants, lubricants, preservatives, sorbents, sweeteners, and vehicles. The main excipient that serves as a medium for conveying the active ingredient is usually called the vehicle. Excipients may also be used in the manufacturing process, for example, to aid in the handling of the active substance, such as by facilitating powder flowability or non-stick properties, in addition to aiding *in vitro* stability such as prevention of denaturation or aggregation over the expected shelf life. The suitability of an excipient will typically vary depending on the route of administration, the dosage form, the active ingredient, as well as other factors.

The term "hydrate" when used as a modifier to a compound means that the compound has less than one (*e.g.*, hemihydrate), one (*e.g.*, monohydrate), or more than one (*e.g.*, dihydrate) water molecules associated with each compound molecule, such as in solid forms of the compound.

As used herein, the term "IC_{50}" refers to an inhibitory dose which is 50% of the maximum response obtained. This quantitative measure indicates how much of a particular drug or other substance (inhibitor) is needed to inhibit a given biological, biochemical or chemical process (or component of a process, *i.e.* an enzyme, cell, cell receptor or microorganism) by half.

An "isomer" of a first compound is a separate compound in which each molecule contains the same constituent atoms as the first compound, but where the configuration of those atoms in three dimensions differs.

As used herein, the term "patient" or "subject" refers to a living mammalian organism, such as a human, monkey, cow, sheep, goat, dog, cat, mouse, rat, guinea pig, or transgenic species thereof. In certain embodiments, the patient or subject is a primate. Non-limiting examples of human patients are adults, juveniles, infants and fetuses.

As generally used herein "pharmaceutically acceptable" refers to those compounds, materials, compositions, and/or dosage forms which are, within the scope of sound medical judgment, suitable for use in contact with the tissues, organs, and/or bodily fluids of human beings and animals without excessive toxicity, irritation, allergic response, or other problems or complications commensurate with a reasonable benefit/risk ratio.

"Pharmaceutically acceptable salts" means salts of compounds disclosed herein which are pharmaceutically acceptable, as defined above, and which possess the desired pharmacological activity. Such salts include acid addition salts formed with inorganic acids such as hydrochloric acid, hydrobromic acid, sulfuric acid, nitric acid, phosphoric acid, and the like; or with organic acids such as 1,2-ethanedisulfonic acid, 2-hydroxyethanesulfonic acid, 2-naphthalenesulfonic acid, 3-phenylpropionic acid, 4,4′-methylenebis(3-hydroxy-2-ene-1-carboxylic acid), 4-methylbicyclo[2.2.2]oct-2-ene-1-carboxylic acid, acetic acid, aliphatic mono- and dicarboxylic acids, aliphatic sulfuric acids, aromatic sulfuric acids, benzenesulfonic acid, benzoic acid, camphorsulfonic acid, carbonic acid, cinnamic acid, citric acid, cyclopentanepropionic acid, ethanesulfonic acid, fumaric acid, glucoheptonic acid, gluconic acid, glutamic acid, glycolic acid, heptanoic acid, hexanoic acid, hydroxynaphthoic acid, lactic acid, laurylsulfuric acid, maleic acid, malic acid, malonic acid, mandelic acid, methanesulfonic acid, muconic acid, *o*-(4-hydroxybenzoyl)benzoic acid,

oxalic acid, *p*-chlorobenzenesulfonic acid, phenyl-substituted alkanoic acids, propionic acid, *p*-toluenesulfonic acid, pyruvic acid, salicylic acid, stearic acid, succinic acid, tartaric acid, tertiarybutylacetic acid, trimethylacetic acid, and the like. Pharmaceutically acceptable salts also include base addition salts which may be formed when acidic protons present are capable of reacting with inorganic or organic bases. Acceptable inorganic bases include sodium hydroxide, sodium carbonate, potassium hydroxide, aluminum hydroxide and calcium hydroxide. Acceptable organic bases include ethanolamine, diethanolamine, triethanolamine, tromethamine, *N*-methylglucamine and the like. It should be recognized that the particular anion or cation forming a part of any salt of this disclosure is not critical, so long as the salt, as a whole, is pharmacologically acceptable. Additional examples of pharmaceutically acceptable salts and their methods of preparation and use are presented in *Handbook of Pharmaceutical Salts: Properties, and Use* (P. H. Stahl & C. G. Wermuth eds., Verlag Helvetica Chimica Acta, 2002).

A "pharmaceutically acceptable carrier," "drug carrier," or simply "carrier" is a pharmaceutically acceptable substance formulated along with the active ingredient medication that is involved in carrying, delivering and/or transporting a chemical agent. Drug carriers may be used to improve the delivery and the effectiveness of drugs, including for example, controlled-release technology to modulate drug bioavailability, decrease drug metabolism, and/or reduce drug toxicity. Some drug carriers may increase the effectiveness of drug delivery to the specific target sites. Examples of carriers include: liposomes, microspheres (*e.g.*, made of poly(lactic-co-glycolic) acid), albumin microspheres, synthetic polymers, nanofibers, protein-DNA complexes, protein conjugates, erythrocytes, virosomes, and dendrimers.

A "pharmaceutical drug" (also referred to as a pharmaceutical, pharmaceutical preparation, pharmaceutical composition, pharmaceutical formulation, pharmaceutical product, medicinal product, medicine, medication, medicament, or simply a drug, agent, or preparation) is a composition used to diagnose, cure, treat, or prevent disease, which comprises an active pharmaceutical ingredient (API) (defined above) and optionally contains one or more inactive ingredients, which are also referred to as excipients (defined above).

"Prevention" or "preventing" includes: (1) inhibiting the onset of a disease in a subject or patient which may be at risk and/or predisposed to the disease but does not yet experience or display any or all of the pathology or symptomatology of the disease, and/or (2) slowing the onset of the pathology or symptomatology of a disease in a subject or patient

which may be at risk and/or predisposed to the disease but does not yet experience or display any or all of the pathology or symptomatology of the disease.

"Prodrug" means a compound that is convertible *in vivo* metabolically into an inhibitor according to the present disclosure. The prodrug itself may or may not also have activity with respect to a given target protein. For example, a compound comprising a hydroxy group may be administered as an ester that is converted by hydrolysis *in vivo* to the hydroxy compound. Non-limiting examples of suitable esters that may be converted *in vivo* into hydroxy compounds include acetates, citrates, lactates, phosphates, tartrates, malonates, oxalates, salicylates, propionates, succinates, fumarates, maleates, methylene-bis-β-hydroxynaphthoate, gentisates, isethionates, di-*p*-toluoyltartrates, methanesulfonates, ethanesulfonates, benzenesulfonates, *p*-toluenesulfonates, cyclohexylsulfamates, quinates, and esters of amino acids. Similarly, a compound comprising an amine group may be administered as an amide that is converted by hydrolysis *in vivo* to the amine compound.

A "stereoisomer" or "optical isomer" is an isomer of a given compound in which the same atoms are bonded to the same other atoms, but where the configuration of those atoms in three dimensions differs. "Enantiomers" are stereoisomers of a given compound that are mirror images of each other, like left and right hands. "Diastereomers" are stereoisomers of a given compound that are not enantiomers. Chiral molecules contain a chiral center, also referred to as a stereocenter or stereogenic center, which is any point, though not necessarily an atom, in a molecule bearing groups such that an interchanging of any two groups leads to a stereoisomer. In organic compounds, the chiral center is typically a carbon, phosphorus or sulfur atom, though it is also possible for other atoms to be stereocenters in organic and inorganic compounds. A molecule can have multiple stereocenters, giving it many stereoisomers. In compounds whose stereoisomerism is due to tetrahedral stereogenic centers (*e.g.*, tetrahedral carbon), the total number of hypothetically possible stereoisomers will not exceed 2^n, where n is the number of tetrahedral stereocenters. Molecules with symmetry frequently have fewer than the maximum possible number of stereoisomers. A 50:50 mixture of enantiomers is referred to as a racemic mixture. Alternatively, a mixture of enantiomers can be enantiomerically enriched so that one enantiomer is present in an amount greater than 50%. Typically, enantiomers and/or diastereomers can be resolved or separated using techniques known in the art. It is contemplated that that for any stereocenter or axis of chirality for which stereochemistry has not been defined, that stereocenter or axis of chirality can be present in its *R* form, *S* form, or as a mixture of the *R* and *S* forms, including racemic

and non-racemic mixtures. As used herein, the phrase "substantially free from other stereoisomers" means that the composition contains ≤ 15%, more preferably ≤ 10%, even more preferably ≤ 5%, or most preferably ≤ 1% of another stereoisomer(s).

"Treatment" or "treating" includes (1) inhibiting a disease in a subject or patient experiencing or displaying the pathology or symptomatology of the disease (*e.g.*, arresting further development of the pathology and/or symptomatology), (2) ameliorating a disease in a subject or patient that is experiencing or displaying the pathology or symptomatology of the disease (*e.g.*, reversing the pathology and/or symptomatology), and/or (3) effecting any measurable decrease in a disease or symptom thereof in a subject or patient that is experiencing or displaying the pathology or symptomatology of the disease.

The term "unit dose" refers to a formulation of the compound or composition such that the formulation is prepared in a manner sufficient to provide a single therapeutically effective dose of the active ingredient to a patient in a single administration. Such unit dose formulations that may be used include but are not limited to a single tablet, capsule, or other oral formulations, or a single vial with a syringeable liquid or other injectable formulations.

The above definitions supersede any conflicting definition in any reference that is incorporated by reference herein. The fact that certain terms are defined, however, should not be considered as indicative that any term that is undefined is indefinite. Rather, all terms used are believed to describe the disclosure in terms such that one of ordinary skill can appreciate the scope and practice the present disclosure.

III. Oligo-Benzamides and Methods of Synthesis

The present disclosure provides synthetic molecules which present the essential functionalities of corresponding peptide ligands in the proper three dimensional orientation that enables specific protein interactions, leading to either stimulation or inhibition of protein-mediated functions.

Peptidomimetics (also known as peptide mimetics) are small organic compounds which lack the peptide backbone of native peptides. Despite this modification, they still retain an ability to interact with corresponding receptors or enzymes by presenting essential chemical functionalities (*i.e.*, pharmacophores) in characteristic three-dimensional patterns which are complimentary to the target proteins (Marshall, 1993; Ahn *et al.*, 2002). Thereby, peptidomimetics potentially combine the advantages of peptides (*e.g.*, high efficacy and selectivity, low side effects) and small organic molecules (*e.g.*, high enzymatic stability and oral bioavailability).

To mimic α-helices, the present disclosure provides an oligo-benzamide scaffold that is rigid in structure and place and orient substituents as an α-helix does. Substitution on the rigid tris-benzamide, for instance, allowed easy placement of three functional groups (R_{2-4}) corresponding to the side chains of amino acids found at the *i*, *i+4*, and *i+7* positions of an ideal α-helix. Furthermore, the present inventors have developed a facile synthetic route to prepare a number of tris-benzamides to represent α-helical segments of target proteins. U.S. Patent Publication 2009/0012141, incorporated herein by reference, discloses a variety of oligo-benzamide compounds and methods of synthesis therefor.

More specifically, the present disclosure provides an oligo-benzamide peptidomimetic compound as illustrated includes 2 or 3 optionally substituted benzamides – so called "bis" and "tris" benzamides. In addition, linkages between the optionally substituted benzamides may be varied as necessary including ester, thioester, thioamide, trans-ethylene, ethyl, methyloxy, methylamino, hydroxyethyl, carbamate, urea, imide, hydrozido, aminoxy, or other linkages known to the skilled artisan. And, the oligo-benzamide peptidomimetic compound may be attached to amino acids, oligopeptides, optionally substituted alkyl, or other structures known to the skilled artisan.

The substitution on the substituted benzamide is generally on a benzene ring and may be on the 2, 3, 4, 5, or 6 position of each of the benzene rings. The substitutions may be at the same position on each of the benzamide rings but may also be at different positions on each of the benzene rings. For example, the substitution is connected to the benzamide ring by a chemical linkage including ether, thioether, amine, amide, carbamate, urea, and carbon-carbon (single-, double-, and triple-) bonds, and the substitution comprises optionally substituted alkyl groups, lower alkyl groups, alkoxy groups, alkoxyalkyl groups, hydroxy groups, hydroxyalkyl groups, alkenyl groups, amino groups, imino groups, nitrate groups, alkylamino groups, nitroso groups, aryl groups, biaryl groups, bridged aryl groups, fused aryl groups, alkylaryl groups, arylalkyl groups, arylalkoxy groups, arylalkylamino groups, cycloalkyl groups, bridged cycloalkyl groups, cycloalkoxy groups, cycloalkyl-alkyl groups, arylthio groups, alkylthio groups, alkylsulfinyl groups, alkylsulfonyl groups, arylsulfonyl groups, arylsulfinyl groups, caboxamido groups, carbamoyl groups, carboxyl groups, carbonyl groups, alkoxycarbonyl groups, halogen groups, haloalkyl groups, haloalkoxy groups, heteroayl, heterocyclic ring, arylheterocyclic ring, heterocyclic compounds, amido, imido, guanidino, hydrazido, aminoxy, alkoxyamino, alkylamido, carboxylic ester groups, thioethers groups, carboxylic acids, phosphoryl groups or combination thereof.

The present disclosure also provides an oligo-benzamide peptidomimetic compound that includes at least two optionally substituted benzamides, with each of the substituted benzamides having one substitution on a benzene ring. The substitutions are individually attached to the benzene rings of the oligo-benzamide peptidomimetic compound by a chemical linkage including ether, thioether, amine, amide, carbamate, urea, and carbon-carbon (single-, double-, and triple-) bonds. The substitutions generally include optionally substituted alkyl groups, lower alkyl groups, alkoxy groups, alkoxyalkyl groups, hydroxy groups, hydroxyalkyl groups, alkenyl groups, amino groups, imino groups, nitrate groups, alkylamino groups, nitroso groups, aryl groups, biaryl groups, bridged aryl groups, fused aryl groups, alkylaryl groups, arylalkyl groups, arylalkoxy groups, arylalkylamino groups, cycloalkyl groups, bridged cycloalkyl groups, cycloalkoxy groups, cycloalkyl-alkyl groups, arylthio groups, alkylthio groups, alkylsulfinyl groups, alkylsulfonyl groups, arylsulfonyl groups, arylsulfinyl groups, caboxamido groups, carbamoyl groups, carboxyl groups, carbonyl groups, alkoxycarbonyl groups, halogen groups, haloalkyl groups, haloalkoxy groups, heteroayl, heterocyclic ring, arylheterocyclic ring, heterocyclic compounds, amido, imido, guanidino, hydrazido, aminoxy, alkoxyamino, alkylamido, carboxylic ester groups, thioethers groups, carboxylic acids, phosphoryl groups or combination thereof.

U.S. Patent Publication 2009/0012141 provides synthesis schemes to prepare α-helix mimetic compounds of the present disclosure, for example, in FIG. 2 therein. A specific example in that document provides fifteen α-helix mimetic compounds made starting with a 4-amino-3-hydroxybenzoic acid compound 7, which was converted to an *N*-Ac protected methyl ester compound 8. Various alkyl groups were introduced to the hydroxyl group using a variety of alkyl halides and a base (*e.g.*, NaOH) known to the skilled artisan. After the alkylation reaction, the methyl ester compound 9 was hydrolyzed using a base (like LiOH), and methyl 4-amino-3-hydroxybenzoate compound 10 was coupled to the free benzoic acid using a coupling reagent (like BOP), resulting in a benzamide compound 11 containing one alkyl group corresponding to the *i* position of a helix. These steps were repeated to synthesize oligo-benzamide compounds. Those of skill in the art would understand the broader applicability of such methods in the synthesis of other compounds such as those disclosed herein.

Additional peptidomimetics as well as methods for their manufacture are disclosed in Raj *et al.*, 2017, which is incorporated herein by reference. One of skill in the art appreciates

that the synthetic methods discosed in Raj *et al.*, 2017 may be employed to contruct the compounds of the present disclosure.

IV. Pharmaceutical Formulations and Methods of Treatment

A. Formulations

In another aspect, for administration to a patient in need of such treatment, pharmaceutical formulations (also referred to as a pharmaceutical preparations, pharmaceutical compositions, pharmaceutical products, medicinal products, medicines, medications, or medicaments) comprise a therapeutically effective amount of a compound disclosed herein formulated with one or more excipients and/or drug carriers appropriate to the indicated route of administration. In some embodiments, the compounds disclosed herein are formulated in a manner amenable for the treatment of human and/or veterinary patients. In some embodiments, formulation comprises admixing or combining one or more of the compounds disclosed herein with one or more of the following excipients: lactose, sucrose, starch powder, cellulose esters of alkanoic acids, cellulose alkyl esters, talc, stearic acid, magnesium stearate, magnesium oxide, sodium and calcium salts of phosphoric and sulfuric acids, gelatin, acacia, sodium alginate, polyvinylpyrrolidone, and/or polyvinyl alcohol. In some embodiments, *e.g.*, for oral administration, the pharmaceutical formulation may be tableted or encapsulated. In some embodiments, the compounds may be dissolved or slurried in water, polyethylene glycol, propylene glycol, ethanol, corn oil, cottonseed oil, peanut oil, sesame oil, benzyl alcohol, sodium chloride, and/or various buffers. In some embodiments, the pharmaceutical formulations may be subjected to pharmaceutical operations, such as sterilization, and/or may contain drug carriers and/or excipients such as preservatives, stabilizers, wetting agents, emulsifiers, encapsulating agents such as lipids, dendrimers, polymers, proteins such as albumin, nucleic acids, and buffers.

Pharmaceutical formulations may be administered by a variety of methods, *e.g.*, orally or by injection (*e.g.* subcutaneous, intravenous, and intraperitoneal). Depending on the route of administration, the compounds disclosed herein may be coated in a material to protect the compound from the action of acids and other natural conditions which may inactivate the compound. To administer the active compound by other than parenteral administration, it may be necessary to coat the compound with, or co-administer the compound with, a material to prevent its inactivation. In some embodiments, the active compound may be administered to a patient in an appropriate carrier, for example, liposomes, or a diluent. Pharmaceutically

acceptable diluents include saline and aqueous buffer solutions. Liposomes include water-in-oil-in-water CGF emulsions as well as conventional liposomes.

The compounds disclosed herein may also be administered parenterally, intraperitoneally, intraspinally, or intracerebrally. Dispersions can be prepared in glycerol, liquid polyethylene glycols, and mixtures thereof and in oils. Under ordinary conditions of storage and use, these preparations may contain a preservative to prevent the growth of microorganisms.

Pharmaceutical compositions suitable for injectable use include sterile aqueous solutions (where water soluble) or dispersions and sterile powders for the extemporaneous preparation of sterile injectable solutions or dispersion. The carrier can be a solvent or dispersion medium containing, for example, water, ethanol, polyol (such as, glycerol, propylene glycol, and liquid polyethylene glycol, and the like), suitable mixtures thereof, and vegetable oils. The proper fluidity can be maintained, for example, by the use of a coating such as lecithin, by the maintenance of the required particle size in the case of dispersion and by the use of surfactants. Prevention of the action of microorganisms can be achieved by various antibacterial and antifungal agents, for example, parabens, chlorobutanol, phenol, ascorbic acid, thimerosal, and the like. In many cases, it will be preferable to include isotonic agents, for example, sugars, sodium chloride, or polyalcohols such as mannitol and sorbitol, in the composition. Prolonged absorption of the injectable compositions can be brought about by including in the composition an agent which delays absorption, for example, aluminum monostearate or gelatin.

The compounds disclosed herein can be administered orally, for example, with an inert diluent or an assimilable edible carrier. The compounds and other ingredients may also be enclosed in a hard or soft-shell gelatin capsule, compressed into tablets, or incorporated directly into the patient's diet. For oral therapeutic administration, the compounds disclosed herein may be incorporated with excipients and used in the form of ingestible tablets, buccal tablets, troches, capsules, elixirs, suspensions, syrups, wafers, and the like. The percentage of the therapeutic compound in the compositions and preparations may, of course, be varied. The amount of the therapeutic compound in such pharmaceutical formulations is such that a suitable dosage will be obtained.

The therapeutic compound may also be administered topically to the skin, eye, ear, or mucosal membranes. Administration of the therapeutic compound topically may include

formulations of the compounds as a topical solution, lotion, cream, ointment, gel, foam, transdermal patch, or tincture. When the therapeutic compound is formulated for topical administration, the compound may be combined with one or more agents that increase the permeability of the compound through the tissue to which it is administered. In other embodiments, it is contemplated that the topical administration is administered to the eye. Such administration may be applied to the surface of the cornea, conjunctiva, or sclera. Without wishing to be bound by any theory, it is believed that administration to the surface of the eye allows the therapeutic compound to reach the posterior portion of the eye. Ophthalmic topical administration can be formulated as a solution, suspension, ointment, gel, or emulsion. Finally, topical administration may also include administration to the mucosa membranes such as the inside of the mouth. Such administration can be directly to a particular location within the mucosal membrane such as a tooth, a sore, or an ulcer. Alternatively, if local delivery to the lungs is desired the therapeutic compound may be administered by inhalation in a dry-powder or aerosol formulation.

In some embodiments, it may be advantageous to formulate parenteral compositions in dosage unit form for ease of administration and uniformity of dosage. Dosage unit form as used herein refers to physically discrete units suited as unitary dosages for the patients to be treated; each unit containing a predetermined quantity of therapeutic compound calculated to produce the desired therapeutic effect in association with the required pharmaceutical carrier. In some embodiments, the specification for the dosage unit forms of the disclosure are dictated by and directly dependent on (a) the unique characteristics of the therapeutic compound and the particular therapeutic effect to be achieved, and (b) the limitations inherent in the art of compounding such a therapeutic compound for the treatment of a selected condition in a patient. In some embodiments, active compounds are administered at a therapeutically effective dosage sufficient to treat a condition associated with a condition in a patient. For example, the efficacy of a compound can be evaluated in an animal model system that may be predictive of efficacy in treating the disease in a human or another animal.

In some embodiments, the effective dose range for the therapeutic compound can be extrapolated from effective doses determined in animal studies for a variety of different animals. In some embodiments, the human equivalent dose (HED) in mg/kg can be calculated in accordance with the following formula (see, *e.g.*, Reagan-Shaw *et al.*, *FASEB J.*, 22(3):659-661, 2008, which is incorporated herein by reference):

$$\text{HED (mg/kg)} = \text{Animal dose (mg/kg)} \times (\text{Animal } K_m/\text{Human } K_m)$$

Use of the K_m factors in conversion results in HED values based on body surface area (BSA) rather than only on body mass. K_m values for humans and various animals are well known. For example, the K_m for an average 60 kg human (with a BSA of 1.6 m^2) is 37, whereas a 20 kg child (BSA 0.8 m^2) would have a K_m of 25. K_m for some relevant animal models are also well known, including: mice K_m of 3 (given a weight of 0.02 kg and BSA of 0.007); hamster K_m of 5 (given a weight of 0.08 kg and BSA of 0.02); rat K_m of 6 (given a weight of 0.15 kg and BSA of 0.025) and monkey K_m of 12 (given a weight of 3 kg and BSA of 0.24).

Precise amounts of the therapeutic composition depend on the judgment of the practitioner and are specific to each individual. Nonetheless, a calculated HED dose provides a general guide. Other factors affecting the dose include the physical and clinical state of the patient, the route of administration, the intended goal of treatment and the potency, stability and toxicity of the particular therapeutic formulation.

The actual dosage amount of a compound of the present disclosure or composition comprising a compound of the present disclosure administered to a patient may be determined by physical and physiological factors such as type of animal treated, age, sex, body weight, severity of condition, the type of disease being treated, previous or concurrent therapeutic interventions, idiopathy of the patient and on the route of administration. These factors may be determined by a skilled artisan. The practitioner responsible for administration will typically determine the concentration of active ingredient(s) in a composition and appropriate dose(s) for the individual patient. The dosage may be adjusted by the individual physician in the event of any complication.

In some embodiments, the therapeutically effective amount typically will vary from about 0.001 mg/kg to about 1000 mg/kg, from about 0.01 mg/kg to about 750 mg/kg, from about 100 mg/kg to about 500 mg/kg, from about 1 mg/kg to about 250 mg/kg, from about 10 mg/kg to about 150 mg/kg in one or more dose administrations daily, for one or several days (depending of course of the mode of administration and the factors discussed above). Other suitable dose ranges include 1 mg to 10,000 mg per day, 100 mg to 10,000 mg per day, 500 mg to 10,000 mg per day, and 500 mg to 1,000 mg per day. In some embodiments, the amount is less than 10,000 mg per day with a range of 750 mg to 9,000 mg per day.

In some embodiments, the amount of the active compound in the pharmaceutical formulation is from about 2 to about 75 weight percent. In some of these embodiments, the amount if from about 25 to about 60 weight percent.

Single or multiple doses of the agents are contemplated. Desired time intervals for delivery of multiple doses can be determined by one of ordinary skill in the art employing no more than routine experimentation. As an example, patients may be administered two doses daily at approximately 12-hour intervals. In some embodiments, the agent is administered once a day.

The agent(s) may be administered on a routine schedule. As used herein a routine schedule refers to a predetermined designated period of time. The routine schedule may encompass periods of time which are identical, or which differ in length, as long as the schedule is predetermined. For instance, the routine schedule may involve administration twice a day, every day, every two days, every three days, every four days, every five days, every six days, a weekly basis, a monthly basis or any set number of days or weeks there-between. Alternatively, the predetermined routine schedule may involve administration on a twice daily basis for the first week, followed by a daily basis for several months, etc. In other embodiments, the disclosure provides that the agent(s) may be taken orally and that the timing of which is or is not dependent upon food intake. Thus, for example, the agent can be taken every morning and/or every evening, regardless of when the patient has eaten or will eat.

B. Breast Cancer

Breast cancer refers to cancers originating from breast tissue, most commonly from the inner lining of milk ducts or the lobules that supply the ducts with milk. Cancers originating from ducts are known as ductal carcinomas; those originating from lobules are known as lobular carcinomas. There are many different types of breast cancer, with different stages (spread), aggressiveness, and genetic makeup; survival varies greatly depending on those factors. Computerized models are available to predict survival. With best treatment and dependent on staging, 10-year disease-free survival varies from 98% to 10%. Treatment includes surgery, drugs (hormonal therapy and chemotherapy), and radiation.

Worldwide, breast cancer comprises 10.4% of all cancer incidence among women, making it the second most common type of non-skin cancer (after lung cancer) and the fifth

most common cause of cancer death. In 2004, breast cancer caused 519,000 deaths worldwide (7% of cancer deaths; almost 1% of all deaths). Breast cancer is about 100 times more common in women than in men, although males tend to have poorer outcomes due to delays in diagnosis.

Some breast cancers require the hormones estrogen and progesterone to grow, and have receptors for those hormones. After surgery those cancers are treated with drugs that interfere with those hormones, usually tamoxifen, and with drugs that shut off the production of estrogen in the ovaries or elsewhere; this may damage the ovaries and end fertility. After surgery, low-risk, hormone-sensitive breast cancers may be treated with hormone therapy and radiation alone. Breast cancers without hormone receptors, or which have spread to the lymph nodes in the armpits, or which express certain genetic characteristics, are higher-risk, and are treated more aggressively. One standard regimen, popular in the U.S., is cyclophosphamide plus doxorubicin (Adriamycin), known as CA; these drugs damage DNA in the cancer, but also in fast-growing normal cells where they cause serious side effects. Sometimes a taxane drug, such as docetaxel, is added, and the regime is then known as CAT; taxane attacks the microtubules in cancer cells. An equivalent treatment, popular in Europe, is cyclophosphamide, methotrexate, and fluorouracil (CMF). Monoclonal antibodies, such as trastuzumab (Herceptin), are used for cancer cells that have the HER2 mutation. Radiation is usually added to the surgical bed to control cancer cells that were missed by the surgery, which usually extends survival, although radiation exposure to the heart may cause damage and heart failure in the following years.

While screening techniques (which are further discussed below) are useful in determining the possibility of cancer, a further testing is necessary to confirm whether a lump detected on screening is cancer, as opposed to a benign alternative such as a simple cyst.

In a clinical setting, breast cancer is commonly diagnosed using a "triple test" of clinical breast examination (breast examination by a trained medical practitioner), mammography, and fine needle aspiration cytology. Both mammography and clinical breast exam, also used for screening, can indicate an approximate likelihood that a lump is cancer, and may also identify any other lesions. Fine Needle Aspiration and Cytology (FNAC), which may be done in a doctor's office using local anaesthetic if required, involves attempting to extract a small portion of fluid from the lump. Clear fluid makes the lump highly unlikely to be cancerous, but bloody fluid may be sent off for inspection under a

microscope for cancerous cells. Together, these three tools can be used to diagnose breast cancer with a good degree of accuracy.

Other options for biopsy include core biopsy, where a section of the breast lump is removed, and an excisional biopsy, where the entire lump is removed.

In addition vacuum-assisted breast biopsy (VAB) may help diagnose breast cancer among patients with a mammographically detected breast in women according to a systematic review. In this study, summary estimates for vacuum assisted breast biopsy in diagnosis of breast cancer were as follows sensitivity was 98.1% with 95% CI = 0.972-0.987 and specificity was 100% with 95% CI = 0.997-0.999; however, underestimate rates of atypical ductal hyperplasia (ADH) and ductal carcinoma *in situ* (DCIS) were 20.9% with 95% CI =0.177-0.245 and 11.2% with 95% CI = 0.098-0.128 respectively.

Breast cancer screening refers to testing otherwise-healthy women for breast cancer in an attempt to achieve an earlier diagnosis. The assumption is that early detection will improve outcomes. A number of screening tests have been employed including: clinical and self breast exams, mammography, genetic screening, ultrasound, and magnetic resonance imaging.

A clinical or self breast exam involves feeling the breast for lumps or other abnormalities. Research evidence does not support the effectiveness of either type of breast exam, because by the time a lump is large enough to be found it is likely to have been growing for several years and will soon be large enough to be found without an exam. Mammographic screening for breast cancer uses x-rays to examine the breast for any uncharacteristic masses or lumps. In women at high risk, such as those with a strong family history of cancer, mammography screening is recommended at an earlier age and additional testing may include genetic screening that tests for the BRCA genes and / or magnetic resonance imaging.

Breast cancer is sometimes treated first with surgery, and then with chemotherapy, radiation, or both. Treatments are given with increasing aggressiveness according to the prognosis and risk of recurrence. Stage 1 cancers (and DCIS) have an excellent prognosis and are generally treated with lumpectomy with or without chemotherapy or radiation. Although the aggressive HER2+ cancers should also be treated with the trastuzumab (Herceptin) regime. Stage 2 and 3 cancers with a progressively poorer prognosis and greater risk of

recurrence are generally treated with surgery (lumpectomy or mastectomy with or without lymph node removal), radiation (sometimes) and chemotherapy (plus trastuzumab for HER2+ cancers). Stage 4, metastatic cancer, (*i.e.*, spread to distant sites) is not curable and is managed by various combinations of all treatments from surgery, radiation, chemotherapy and targeted therapies. These treatments increase the median survival time of stage 4 breast cancer by about 6 months.

C. Ovarian Cancer

Ovarian cancer is a cancerous growth arising from different parts of the ovary. Most (>90%) ovarian cancers are classified as "epithelial" and were believed to arise from the surface (epithelium) of the ovary. However, recent evidence suggests that the Fallopian tube could also be the source of some ovarian cancers. Since the ovaries and tubes are closely related to each other, it is hypothesized that these cells can mimic ovarian cancer. Other types arise from the egg cells (germ cell tumor) or supporting cells (sex cord/stromal).

In 2004, in the United States, 25,580 new cases were diagnosed and 16,090 women died of ovarian cancer. The risk increases with age and decreases with pregnancy. Lifetime risk is about 1.6%, but women with affected first-degree relatives have a 5% risk. Women with a mutated BRCA1 or BRCA2 gene carry a risk between 25% and 60% depending on the specific mutation. Ovarian cancer is the fifth leading cause of death from cancer in women and the leading cause of death from gynecological cancer.

Ovarian cancer causes non-specific symptoms. Early diagnosis would result in better survival, on the assumption that stage I and II cancers progress to stage III and IV cancers (but this has not been proven). Most women with ovarian cancer report one or more symptoms such as abdominal pain or discomfort, an abdominal mass, bloating, back pain, urinary urgency, constipation, tiredness and a range of other non-specific symptoms, as well as more specific symptoms such as pelvic pain, abnormal vaginal bleeding or involuntary weight loss. There can be a build-up of fluid (ascites) in the abdominal cavity.

Diagnosis of ovarian cancer starts with a physical examination (including a pelvic examination), a blood test (for CA-125 and sometimes other markers), and transvaginal ultrasound. The diagnosis must be confirmed with surgery to inspect the abdominal cavity, take biopsies (tissue samples for microscopic analysis) and look for cancer cells in the

abdominal fluid. Treatment usually involves chemotherapy and surgery, and sometimes radiotherapy.

In most cases, the cause of ovarian cancer remains unknown. Older women, and in those who have a first or second degree relative with the disease, have an increased risk. Hereditary forms of ovarian cancer can be caused by mutations in specific genes (most notably BRCA1 and BRCA2, but also in genes for hereditary nonpolyposis colorectal cancer). Infertile women and those with a condition called endometriosis, those who have never been pregnant and those who use postmenopausal estrogen replacement therapy are at increased risk. Use of combined oral contraceptive pills is a protective factor. The risk is also lower in women who have had their uterine tubes blocked surgically (tubal ligation).

Ovarian cancer is classified according to the histology of the tumor, obtained in a pathology report. Histology dictates many aspects of clinical treatment, management, and prognosis. Surface epithelial-stromal tumour, also known as ovarian epithelial carcinoma, is the most common type of ovarian cancer. It includes serous tumour, endometrioid tumor and mucinous cystadenocarcinoma. Sex cord-stromal tumor, including estrogen-producing granulosa cell tumor and virilizing Sertoli-Leydig cell tumor or arrhenoblastoma, accounts for 8% of ovarian cancers. Germ cell tumor accounts for approximately 30% of ovarian tumors but only 5% of ovarian cancers, because most germ cell tumors are teratomas and most teratomas are benign (see Teratoma). Germ cell tumor tends to occur in young women and girls. The prognosis depends on the specific histology of germ cell tumor, but overall is favorable. Mixed tumors, containing elements of more than one of the above classes of tumor histology.

Ovarian cancer can also be a secondary cancer, the result of metastasis from a primary cancer elsewhere in the body. Seven percent of ovarian cancers are due to metastases while the rest are primary cancers. Common primary cancers are breast cancer and gastrointestinal cancer (a common mistake is to name all peritoneal metastases from any gastrointestinal cancer as Krukenberg cancer, but this is only the case if it originates from primary gastric cancer). Surface epithelial-stromal tumor can originate in the peritoneum (the lining of the abdominal cavity), in which case the ovarian cancer is secondary to primary peritoneal cancer, but treatment is basically the same as for primary surface epithelial-stromal tumor involving the peritoneum.

Ovarian cancer staging is by the FIGO staging system and uses information obtained after surgery, which can include a total abdominal hysterectomy, removal of (usually) both ovaries and fallopian tubes, (usually) the omentum, and pelvic (peritoneal) washings for cytopathology. The AJCC stage is the same as the FIGO stage. The AJCC staging system describes the extent of the primary Tumor (T), the absence or presence of metastasis to nearby lymph Nodes (N), and the absence or presence of distant Metastasis (M).

The AJCC/TNM staging system includes three categories for ovarian cancer, T, N and M. The T category contains three other subcategories, T1, T2 and T3, each of them being classified according to the place where the tumor has developed (in one or both ovaries, inside or outside the ovary). The T1 category of ovarian cancer describes ovarian tumors that are confined to the ovaries, and which may affect one or both of them. The sub-subcategory T1a is used to stage cancer that is found in only one ovary, which has left the capsule intact and which cannot be found in the fluid taken from the pelvis. Cancer that has not affected the capsule, is confined to the inside of the ovaries and cannot be found in the fluid taken from the pelvis but has affected both ovaries is staged as T1b. T1c category describes a type of tumor that can affect one or both ovaries, and which has grown through the capsule of an ovary or it is present in the fluid taken from the pelvis. T2 is a more advanced stage of cancer. In this case, the tumor has grown in one or both ovaries and is spread to the uterus, fallopian tubes or other pelvic tissues. Stage T2a is used to describe a cancerous tumor that has spread to the uterus or the fallopian tubes (or both) but which is not present in the fluid taken from the pelvis. Stages T2b and T2c indicate cancer that metastasized to other pelvic tissues than the uterus and fallopian tubes and which cannot be seen in the fluid taken from the pelvis, respectively tumors that spread to any of the pelvic tissues (including uterus and fallopian tubes) but which can also be found in the fluid taken from the pelvis. T3 is the stage used to describe cancer that has spread to the peritoneum. This stage provides information on the size of the metastatic tumors (tumors that are located in other areas of the body, but are caused by ovarian cancer). These tumors can be very small, visible only under the microscope (T3a), visible but not larger than 2 centimeters (T3b) and bigger than 2 centimeters (T3c).

This staging system also uses N categories to describe cancers that have or not spread to nearby lymph nodes. There are only two N categories, N0 which indicates that the cancerous tumors have not affected the lymph nodes, and N1 which indicates the involvement of lymph nodes close to the tumor. The M categories in the AJCC/TNM staging

system provide information on whether the ovarian cancer has metastasized to distant organs such as liver or lungs. M0 indicates that the cancer did not spread to distant organs and M1 category is used for cancer that has spread to other organs of the body. The AJCC/TNM staging system also contains a Tx and a Nx sub-category which indicates that the extent of the tumor cannot be described because of insufficient data, respectively the involvement of the lymph nodes cannot be described because of the same reason.

Ovarian cancer, as well as any other type of cancer, is also graded, apart from staged. The histologic grade of a tumor measures how abnormal or malignant its cells look under the microscope. There are four grades indicating the likelihood of the cancer to spread and the higher the grade, the more likely for this to occur. Grade 0 is used to describe non-invasive tumors. Grade 0 cancers are also referred to as borderline tumors. Grade 1 tumors have cells that are well differentiated (look very similar to the normal tissue) and are the ones with the best prognosis. Grade 2 tumors are also called moderately well differentiated and they are made up by cells that resemble the normal tissue. Grade 3 tumors have the worst prognosis and their cells are abnormal, referred to as poorly differentiated.

The signs and symptoms of ovarian cancer are most of the times absent, but when they exist they are nonspecific. In most cases, the symptoms persist for several months until the patient is diagnosed.

A prospective case-control study of 1,709 women visiting primary care clinics found that the combination of bloating, increased abdominal size, and urinary symptoms was found in 43% of those with ovarian cancer but in only 8% of those presenting to primary care clinics.

The exact cause is usually unknown. The risk of developing ovarian cancer appears to be affected by several factors. The more children a woman has, the lower her risk of ovarian cancer. Early age at first pregnancy, older age of final pregnancy and the use of low dose hormonal contraception have also been shown to have a protective effect. Ovarian cancer is reduced in women after tubal ligation.

The relationship between use of oral contraceptives and ovarian cancer was shown in a summary of results of 45 case-control and prospective studies. Cumulatively these studies show a protective effect for ovarian cancers. Women who used oral contraceptives for 10 years had about a 60% reduction in risk of ovarian cancer. (risk ratio .42 with statistical

significant confidence intervals given the large study size, not unexpected). This means that if 250 women took oral contraceptives for 10 years, 1 ovarian cancer would be prevented. This is by far the largest epidemiological study to date on this subject (45 studies, over 20,000 women with ovarian cancer and about 80,000 controls).

The link to the use of fertility medication, such as Clomiphene citrate, has been controversial. An analysis in 1991 raised the possibility that use of drugs may increase the risk of ovarian cancer. Several cohort studies and case-control studies have been conducted since then without demonstrating conclusive evidence for such a link. It will remain a complex topic to study as the infertile population differs in parity from the "normal" population.

There is good evidence that in some women genetic factors are important. Carriers of certain mutations of the BRCA1 or the BRCA2 gene are notably at risk. The BRCA1 and BRCA2 genes account for 5%-13% of ovarian cancersand certain populations (e.g. Ashkenazi Jewish women) are at a higher risk of both breast cancer and ovarian cancer, often at an earlier age than the general population. Patients with a personal history of breast cancer or a family history of breast and/or ovarian cancer, especially if diagnosed at a young age, may have an elevated risk.

A strong family history of uterine cancer, colon cancer, or other gastrointestinal cancers may indicate the presence of a syndrome known as hereditary nonpolyposis colorectal cancer (HNPCC, also known as Lynch syndrome), which confers a higher risk for developing ovarian cancer. Patients with strong genetic risk for ovarian cancer may consider the use of prophylactic, i.e. preventative, oophorectomy after completion of childbearing. Australia being member of International Cancer Genome Consortium is leading efforts to map ovarian cancer's complete genome.

Ovarian cancer at its early stages(I/II) is difficult to diagnose until it spreads and advances to later stages (III/IV). This is because most symptoms are non-specific and thus of little use in diagnosis.

When an ovarian malignancy is included in the list of diagnostic possibilities, a limited number of laboratory tests are indicated. A complete blood count (CBC) and serum electrolyte test should be obtained in all patients.

The serum BHCG level should be measured in any female in whom pregnancy is a possibility. In addition, serum alpha-fetoprotein (AFP) and lactate dehydrogenase (LDH) should be measured in young girls and adolescents with suspected ovarian tumors because the younger the patient, the greater the likelihood of a malignant germ cell tumor.

A blood test called CA-125 is useful in differential diagnosis and in follow up of the disease, but it by itself has not been shown to be an effective method to screen for early-stage ovarian cancer due to its unacceptable low sensitivity and specificity. However, this is the only widely-used marker currently available.

Current research is looking at ways to combine tumor markers proteomics along with other indicators of disease (*i.e.*, radiology and/or symptoms) to improve accuracy. The challenge in such an approach is that the very low population prevalence of ovarian cancer means that even testing with very high sensitivity and specificity will still lead to a number of false positive results (*i.e.*, performing surgical procedures in which cancer is not found intra-operatively). However, the contributions of proteomics are still in the early stages and require further refining. Current studies on proteomics mark the beginning of a paradigm shift towards individually tailored therapy.

A pelvic examination and imaging including CT scan and trans-vaginal ultrasound are essential. Physical examination may reveal increased abdominal girth and/or ascites (fluid within the abdominal cavity). Pelvic examination may reveal an ovarian or abdominal mass. The pelvic examination can include a rectovaginal component for better palpation of the ovaries. For very young patients, magnetic resonance imaging may be preferred to rectal and vaginal examination.

To definitively diagnose ovarian cancer, a surgical procedure to take a look into the abdomen is required. This can be an open procedure (laparotomy, incision through the abdominal wall) or keyhole surgery (laparoscopy). During this procedure, suspicious areas will be removed and sent for microscopic analysis. Fluid from the abdominal cavity can also be analysed for cancerous cells. If there is cancer, this procedure can also determine its spread (which is a form of tumor staging).

Women who have had children are less likely to develop ovarian cancer than women who have not, and breastfeeding may also reduce the risk of certain types of ovarian cancer. Tubal ligation and hysterectomy reduce the risk and removal of both tubes and ovaries

(bilateral salpingo-oophorectomy) dramatically reduces the risk of not only ovarian cancer but breast cancer also. The use of oral contraceptives (birth control pills) for five years or more decreases the risk of ovarian cancer in later life by 50%.

Tubal ligation is believed to decrease the chance of developing ovarian cancer by up to 67% while a hysterectomy may reduce the risk of getting ovarian cancer by about one-third. Moreover, according to some studies, analgesics such as acetaminophen and aspirin seem to reduce one's risks of developing ovarian cancer. Yet, the information is not consistent and more research needs to be carried on this matter.

Routine screening of women for ovarian cancer is not recommended by any professional society - this includes the U.S. Preventive Services Task Force, the American Cancer Society, the American College of Obstetricians and Gynecologists, and the National Comprehensive Cancer Network. This is because no trial has shown improved survival for women undergoing screening. Screening for any type of cancer must be accurate and reliable - it needs to accurately detect the disease and it must not give false positive results in people who do not have cancer. As yet there is no technique for ovarian screening that has been shown to fulfil these criteria. However, in some countries such as the UK, women who are likely to have an increased risk of ovarian cancer (for example if they have a family history of the disease) can be offered individual screening through their doctors, although this will not necessarily detect the disease at an early stage.

Researchers are assessing different ways to screen for ovarian cancer. Screening tests that could potentially be used alone or in combination for routine screening include the CA-125 marker and transvaginal ultrasound. Doctors can measure the levels of the CA-125 protein in a woman's blood - high levels could be a sign of ovarian cancer, but this is not always the case. And not all women with ovarian cancer have high CA-125 levels. Transvaginal ultrasound involves using an ultrasound probe to scan the ovaries from inside the vagina, giving a clearer image than scanning the abdomen. The UK Collaborative Trial of Ovarian Cancer Screening is testing a screening technique that combines CA-125 blood tests with transvaginal ultrasound.

The purpose of screening is to diagnose ovarian cancer at an early stage, when it is more likely to be treated successfully. However, the development of the disease is not fully understood, and it has been argued that early-stage cancers may not always develop into late-stage disease. With any screening technique there are risks and benefits that need to be

carefully considered, and health authorities need to assess these before introducing any ovarian cancer screening programs.

The goal of ovarian cancer screening is to detect the disease at stage I. Several large studies are ongoing, but none have identified an effective technique. In 2009, however, early results from the UK Collaborative Trial of Ovarian Cancer Screening (UKCTOCS) showed that a technique combining annual CA-125 tests with ultrasound imaging did help to detect the disease at an early stage. However, it is not yet clear if this approach could actually help to save lives - the full results of the trial will be published in 2015.

Surgical treatment may be sufficient for malignant tumors that are well-differentiated and confined to the ovary. Addition of chemotherapy may be required for more aggressive tumors that are confined to the ovary. For patients with advanced disease a combination of surgical reduction with a combination chemotherapy regimen is standard. Borderline tumors, even following spread outside of the ovary, are managed well with surgery, and chemotherapy is not seen as useful.

Surgery is the preferred treatment and is frequently necessary to obtain a tissue specimen for differential diagnosis via its histology. Surgery performed by a specialist in gynecologic oncology usually results in an improved result. Improved survival is attributed to more accurate staging of the disease and a higher rate of aggressive surgical excision of tumor in the abdomen by gynecologic oncologists as opposed to general gynecologists and general surgeons.

The type of surgery depends upon how widespread the cancer is when diagnosed (the cancer stage), as well as the presumed type and grade of cancer. The surgeon may remove one (unilateral oophorectomy) or both ovaries (bilateral oophorectomy), the fallopian tubes (salpingectomy), and the uterus (hysterectomy). For some very early tumors (stage 1, low grade or low-risk disease), only the involved ovary and fallopian tube will be removed (called a "unilateral salpingo-oophorectomy," USO), especially in young females who wish to preserve their fertility.

In advanced malignancy, where complete resection is not feasible, as much tumor as possible is removed (debulking surgery). In cases where this type of surgery is successful (*i.e.*, < 1 cm in diameter of tumor is left behind ["optimal debulking"]), the prognosis is improved compared to patients where large tumor masses (> 1 cm in diameter) are left

behind. Minimally invasive surgical techniques may facilitate the safe removal of very large (greater than 10 cm) tumors with fewer complications of surgery.

Chemotherapy has been a general standard of care for ovarian cancer for decades, although with highly variable protocols. Chemotherapy is used after surgery to treat any residual disease, if appropriate. This depends on the histology of the tumor; some kinds of tumor (particularly teratoma) are not sensitive to chemotherapy. In some cases, there may be reason to perform chemotherapy first, followed by surgery.

For patients with stage IIIC epithelial ovarian adenocarcinomas who have undergone successful optimal debulking, a recent clinical trial demonstrated that median survival time is significantly longer for patient receiving intraperitoneal (IP) chemotherapy. Patients in this clinical trial reported less compliance with IP chemotherapy and fewer than half of the patients received all six cycles of IP chemotherapy. Despite this high "drop-out" rate, the group as a whole (including the patients that didn't complete IP chemotherapy treatment) survived longer on average than patients who received intravenous chemotherapy alone.

Some specialists believe the toxicities and other complications of IP chemotherapy will be unnecessary with improved IV chemotherapy drugs currently being developed.

Although IP chemotherapy has been recommended as a standard of care for the first-line treatment of ovarian cancer, the basis for this recommendation has been challenged.

Radiation therapy is not effective for advanced stages because when vital organs are in the radiation field, a high dose cannot be safely delivered. Radiation therapy is then commonly avoided in such stages as the vital organs may not be able to withstand the problems associated with these ovarian cancer treatments.

Ovarian cancer usually has a poor prognosis. It is disproportionately deadly because it lacks any clear early detection or screening test, meaning that most cases are not diagnosed until they have reached advanced stages. More than 60% of women presenting with this cancer already have stage III or stage IV cancer, when it has already spread beyond the ovaries. Ovarian cancers shed cells into the naturally occurring fluid within the abdominal cavity. These cells can then implant on other abdominal (peritoneal) structures, included the uterus, urinary bladder, bowel and the lining of the bowel wall omentum forming new tumor growths before cancer is even suspected.

The five-year survival rate for all stages of ovarian cancer is 45.5%. For cases where a diagnosis is made early in the disease, when the cancer is still confined to the primary site, the five-year survival rate is 92.7%.

D. Brain Cancer

A brain tumor is an intracranial solid neoplasm, a tumor (defined as an abnormal growth of cells) within the brain or the central spinal canal. Brain tumors include all tumors inside the cranium or in the central spinal canal. They are created by an abnormal and uncontrolled cell division, normally either in the brain itself (neurons, glial cells (astrocytes, oligodendrocytes, ependymal cells, myelin-producing Schwann cells), lymphatic tissue, blood vessels), in the cranial nerves, in the brain envelopes (meninges), skull, pituitary and pineal gland, or spread from cancers primarily located in other organs (metastatic tumors).

Any brain tumor is inherently serious and life-threatening because of its invasive and infiltrative character in the limited space of the intracranial cavity. However, brain tumors (even malignant ones) are not invariably fatal. Brain tumors or intracranial neoplasms can be cancerous (malignant) or non-cancerous (benign); however, the definitions of malignant or benign neoplasms differs from those commonly used in other types of cancerous or non-cancerous neoplasms in the body. Its threat level depends on the combination of factors like the type of tumor, its location, its size and its state of development. Because the brain is well protected by the skull, the early detection of a brain tumor only occurs when diagnostic tools are directed at the intracranial cavity. Usually detection occurs in advanced stages when the presence of the tumor has caused unexplained symptoms.

Primary (true) brain tumors are commonly located in the posterior cranial fossa in children and in the anterior two-thirds of the cerebral hemispheres in adults, although they can affect any part of the brain.

The prognosis of brain cancer varies based on the type of cancer. Medulloblastoma has a good prognosis with chemotherapy, radiotherapy, and surgical resection while glioblastoma multiforme has a median survival of only 12 months even with aggressive chemoradiotherapy and surgery. Brainstem gliomas have the poorest prognosis of any form of brain cancer, with most patients dying within one year, even with therapy that typically consists of radiation to the tumor along with corticosteroids. However, one type of brainstem

glioma, a focal seems open to exceptional prognosis and long-term survival has frequently been reported.

Glioblastoma multiforme is the deadliest and most common form of malignant brain tumor. Even when aggressive multimodality therapy consisting of radiotherapy, chemotherapy, and surgical excision is used, median survival is only 12--17 months. Standard therapy for glioblastoma multiforme consists of maximal surgical resection of the tumor, followed by radiotherapy between two and four weeks after the surgical procedure to remove the cancer. This is followed by chemotherapy. Most patients with glioblastoma take a corticosteroid, typically dexamethasone, during their illness to palliate symptoms. Experimental treatments include gamma-knife radiosurgery, boron neutron capture therapy and gene transfer.

Oligodendroglioma is an incurable but slowly progressive malignant brain tumor. They can be treated with surgical resection, chemotherapy, and/or radiotherapy. For suspected low-grade oligodendrogliomas in select patients, some neuro-oncologists opt for a course of watchful waiting, with only symptomatic therapy. Tumors with the 1p/19q co-deletion have been found to be especially chemosensitive, and one source reports oligodendrogliomas to be among the most chemosensitive of human solid malignancies. A median survival of up to 16.7 years has been reported for low grade oligodendrogliomas.

Although there is no specific or singular clinical symptom or sign for any brain tumors, the presence of a combination of symptoms and the lack of corresponding clinical indications of infections or other causes can be an indicator to redirect diagnostic investigation towards the possibility of an intracranial neoplasm.

The diagnosis will often start with an interrogation of the patient to get a clear view of his medical antecedents, and his current symptoms. Clinical and laboratory investigations will serve to exclude infections as the cause of the symptoms. Examinations in this stage may include ophtamological, otolaryngological (or ENT) and/or electrophysiological exams. The use of electroencephalography (EEG) often plays a role in the diagnosis of brain tumors.

Swelling, or obstruction of the passage of cerebrospinal fluid (CSF) from the brain may cause (early) signs of increased intracranial pressure which translates clinically into headaches, vomiting, or an altered state of consciousness, and in children changes to the

diameter of the skull and bulging of the fontanelles. More complex symptoms such as endocrine dysfunctions should alarm doctors not to exclude brain tumors.

A bilateral temporal visual field defect (due to compression of the optic chiasm) or dilatation of the pupil, and the occurrence of either slowly evolving or the sudden onset of focal neurologic symptoms, such as cognitive and behavioral impairment (including impaired judgment, memory loss, lack of recognition, spatial orientation disorders), personality or emotional changes, hemiparesis, hypoesthesia, aphasia, ataxia, visual field impairment, impaired sense of smell, impaired hearing, facial paralysis, double vision, or more severe symptoms such as tremors, paralysis on one side of the body hemiplegia, or (epileptic) seizures in a patient with a negative history for epilepsy, should raise the possibility of a brain tumor.

Imaging plays a central role in the diagnosis of brain tumors. Early imaging methods - invasive and sometimes dangerous - such as pneumoencephalography and cerebral angiography, have been abandoned in recent times in favor of non-invasive, high-resolution techniques, such as computed tomography (CT)-scans and especially magnetic resonance imaging (MRI). Neoplasms will often show as differently colored masses (also referred to as processes) in CT or MRI results.

Benign brain tumors often show up as hypodense (darker than brain tissue) mass lesions on cranial CT-scans. On MRI, they appear either hypo- (darker than brain tissue) or isointense (same intensity as brain tissue) on T1-weighted scans, or hyperintense (brighter than brain tissue) on T2-weighted MRI, although the appearance is variable.

Contrast agent uptake, sometimes in characteristic patterns, can be demonstrated on either CT or MRI-scans in most malignant primary and metastatic brain tumors. Perifocal edema, or pressure-areas, or where the brain tissue has been compressed by an invasive process also appears hyperintense on T2-weighted MRI might indicate the presence a diffuse neoplasm (unclear outline). This is because these tumors disrupt the normal functioning of the blood-brain barrier and lead to an increase in its permeability. Howeve,r it is not possible to diagnose high versus low grade gliomas based on enhancement pattern alone.

Glioblastoma multiforme and anaplastic astrocytoma have been associated with the genetic acute hepatic porphyrias (PCT, AIP, HCP and VP), including positive testing associated with drug refractory seizures. Unexplained complications associated with drug

treatments with these tumors should alert physicians to an undiagnosed neurological porphyria.

The definitive diagnosis of brain tumor can only be confirmed by histological examination of tumor tissue samples obtained either by means of brain biopsy or open surgery. The histological examination is essential for determining the appropriate treatment and the correct prognosis. This examination, performed by a pathologist, typically has three stages: interoperative examination of fresh tissue, preliminary microscopic examination of prepared tissues, and followup examination of prepared tissues after immunohistochemical staining or genetic analysis.

When a brain tumor is diagnosed, a medical team will be formed to assess the treatment options presented by the leading surgeon to the patient and his/her family. Given the location of primary solid neoplasms of the brain in most cases a "do-nothing" option is usually not presented. Neurosurgeons take the time to observe the evolution of the neoplasm before proposing a management plan to the patient and his/her relatives. These various types of treatment are available depending on neoplasm type and location and may be combined to give the best chances of survival: surgery: complete or partial ressection of the tumor with the objective of removing as many tumor cells as possible; radiotherapy; and chemotherapy, with the aim of killing as many as possible of cancerous cells left behind after surgery and of putting remaining tumor cells into a nondividing, sleeping state for as long as possible.

Survival rates in primary brain tumors depend on the type of tumor, age, functional status of the patient, the extent of surgical tumor removal and other factors specific to each case.

The primary and most desired course of action described in medical literature is surgical removal (resection) via craniotomy. Minimally invasive techniques are being studied but are far from being common practice. The prime remediating objective of surgery is to remove as many tumor cells as possible, with complete removal being the best outcome and cytoreduction ("debulking") of the tumor otherwise. In some cases access to the tumor is impossible and impedes or prohibits surgery.

Many meningiomas, with the exception of some tumors located at the skull base, can be successfully removed surgically. Most pituitary adenomas can be removed surgically, often using a minimally invasive approach through the nasal cavity and skull base (trans-

nasal, trans-sphenoidal approach). Large pituitary adenomas require a craniotomy (opening of the skull) for their removal. Radiotherapy, including stereotactic approaches, is reserved for inoperable cases.

Several current research studies aim to improve the surgical removal of brain tumors by labeling tumor cells with a chemical (5-aminolevulinic acid) that causes them to fluoresce. Post-operative radiotherapy and chemotherapy are integral parts of the therapeutic standard for malignant tumors. Radiotherapy may also be administered in cases of "low-grade" gliomas, when a significant tumor burden reduction could not be achieved surgically.

Any person undergoing brain surgery may suffer from epileptic seizures. Seizures can vary from absences to severe tonic-clonic attacks. Medication is prescribed and administered to minimize or eliminate the occurrence of seizures.

Multiple metastatic tumors are generally treated with radiotherapy and chemotherapy rather than surgery. the prognosis in such cases is determined by the primary tumor, but is generally poor.

The goal of radiation therapy is to selectively kill tumor cells while leaving normal brain tissue unharmed. In standard external beam radiation therapy, multiple treatments of standard-dose "fractions" of radiation are applied to the brain. This process is repeated for a total of 10 to 30 treatments, depending on the type of tumor. This additional treatment provides some patients with improved outcomes and longer survival rates.

Radiosurgery is a treatment method that uses computerized calculations to focus radiation at the site of the tumor while minimizing the radiation dose to the surrounding brain. Radiosurgery may be an adjunct to other treatments, or it may represent the primary treatment technique for some tumors.

Radiotherapy may be used following, or in some cases in place of, resection of the tumor. Forms of radiotherapy used for brain cancer include external beam radiation therapy, brachytherapy, and in more difficult cases, stereotactic radiosurgery, such as Gamma knife, Cyberknife or Novalis Tx radiosurgery.

Radiotherapy is the most common treatment for secondary brain tumors. The amount of radiotherapy depends on the size of the area of the brain affected by cancer. Conventional external beam 'whole brain radiotherapy treatment' (WBRT) or 'whole brain irradiation' may

be suggested if there is a risk that other secondary tumors will develop in the future. Stereotactic radiotherapy is usually recommended in cases involving fewer than three small secondary brain tumors.

Patients undergoing chemotherapy are administered drugs designed to kill tumor cells. Although chemotherapy may improve overall survival in patients with the most malignant primary brain tumors, it does so in only about 20 percent of patients. Chemotherapy is often used in young children instead of radiation, as radiation may have negative effects on the developing brain. The decision to prescribe this treatment is based on a patient's overall health, type of tumor, and extent of the cancer. The toxicity and many side effects of the drugs, and the uncertain outcome of chemotherapy in brain tumors puts this treatment further down the line of treatment options with surgery and radiation therapy preferred.

A shunt is used not as a cure but to relieve symptoms by reducing hydrocephalus caused by blockage of cerebrospinal fluid.

Researchers are presently investigating a number of promising new treatments including gene therapy, highly focused radiation therapy, immunotherapy and novel chemotherapies. A variety of new treatments are being made available on an investigational basis at centers specializing in brain tumor therapies.

V. Examples

The following examples are included to demonstrate preferred embodiments of the disclosure. It should be appreciated by those of skill in the art that the techniques disclosed in the examples which follow represent techniques discovered by the inventor to function well in the practice of the disclosure, and thus can be considered to constitute preferred modes for its practice. However, those of skill in the art should, in light of the present disclosure, appreciate that many changes can be made in the specific embodiments which are disclosed and still obtain a like or similar result without departing from the spirit and scope of the disclosure.

Example 1 – Results

The present oligo-benzamide analogs are extremely potent and effective on various cancer cells including breast cancer, ovarian cancer, and pancreatic cancer. These compounds have a unique mode of action compared to existing therapeutic treatments to these diseases.

The compounds are very potent with IC_{50} values of 10-50 nM for growth inhibition. TK41 is a tris-benzamide analog and it inhibits nuclear receptor (NR) interaction with its coregulator proteins in cancer cells with high potency (IC_{50} is approximately 100 nM; FIGS. 1-4). This compound was found to be very effective on endocrine therapy resistant breast cancer cells that are difficult to be treated by currently available endocrine and chemotherapy (FIG. 2 and FIG. 8).

While TK41 was initially designed to target the estrogen receptor, it was found to also exhibit activity in triple negative breast cancer cells that are estrogen-receptor negative (FIG. 2 and FIGS. 5-7). This result was unexpected based on the performance of earlier benzamide compounds (see FIG. 9 for structure activity table). Indeed, TK41 shows remarkably strong growth inhibition of triple-negative breast cancer cells (TNBC) with the IC_{50} values below 100 nM. TNBC is difficult to be treated and currently there are no good drugs available in the market. Animal studies with TK41 not only showed outstanding tumor growth inhibition but also showed no apparent side effects or toxicity. TK41 is orally available and an excellent therapeutic candidate for a broad range of breast cancers.

In addition, another tris-benzmaide compound TK208 was synthesized and tested against breast cancer and ovarian cancer cell lines (FIGS. 10-15). TK208 showed remarkably high potency in growth inhibition of TNBC and ovarian cancer cells with IC_{50} values from 10-100 nM. Additional tris-benzamide analogs, TK314 (FIG. 24) and TK315 (FIG. 23), were also prepared and exhibit even more potent activity against ovarian cancer cells and breast cancer cells, respectively, with IC_{50} values of from 10-50 nM. These compounds (*e.g.*, TK41, TK208, TK308 (FIG. 21), TK309 (FIG. 22), TK314, TK315) are extremely potent compounds that inhibit tumor growth and kill breast and ovarian cancer cells and as such, they are superb therapeutic candidates for such diseases.

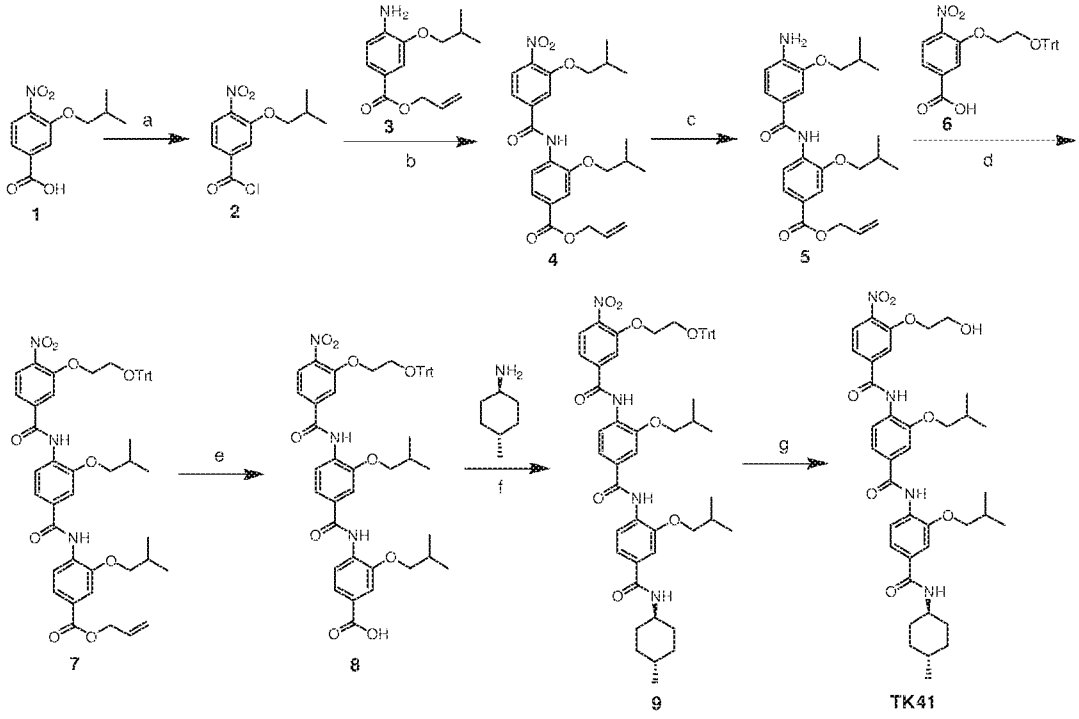
Tris-benzamide YL144 was also synthesized and was found to inhibit vitamin D receptor (VDR) with high potency and may be a useful therapeutic candidate for pancreatic cancer (FIGS. 16-18). Bis-benzamide TK245 is a unique compound showing strong growth inhibition of estrogen receptor-positive breast cancer (FIG. 19 and FIG. 20).

TK41 was also shown to induce endoplasmic reticulum stress in TNBC MD-MBA-231 cells but does not induce endoplasmic reticulum stress in HMEC cells (FIG. 25 and FIG. 26). TK41 shuts down *de novo* protein synthesis in TNBC cells (FIG. 27). The basal level of expression of endoplasmic reticulum stress and unfolded protein response correlates with TK41 activity (FIG. 28). Modulation of the level of these stress proteins affects the activity of TK41. Thus, the basal level of expression of endoplasmic reticulum

stress and unfolded protein response proteins may serve as a biomarker to predict response to TK41. Endoplasmic reticulum stress was also induced in pancreatic cancer MiaPaca cells upon exposure to TK41 but does not induce endoplasmic reticulum stress in HMEC cells (FIG. 29). Without wishing to be bound by any particular theory, the mechanism of action of TK41 may operate comprise targeting either ER or TLX and inducing endoplasmic reticulum stress, subsequent apoptosis, and blocking autophagic fusion (FIG. 30).

In summary, many oligo-benzamide analogs were developed and showed remarkably strong therapeutic potentials in treating breast cancer, ovarian cancer, and pancreatic cancer. Their mode of action and efficacy are unmatched by drugs currently available, and as such these are highly promising therapeutic candidates.

Example 2 – Synthetic Methods



Scheme 1. Synthetic route to TK41.

Reagents and conditions: (a) $(COCl)_2$, cat. DMF, DCM, rt, 2 h; (b) DIEA, DCM, rt, 24 h; (c) $SnCl_2$, DMF, rt, 12 h; (d) HATU, DIEA, DMF, rt, 24 h; (e) $Pd(PPh_3)_4$, $PhSiH_3$, THF, rt, 1 h; (f) HATU, DIEA, DMF, rt, 24 h; (g) conc. HCl, rt, 24 h.

Compound 4: A 250 mL round-bottomed flask was charged with compound **1** (5.45g, 22.8 mmol), DCM (100 mL), oxalyl chloride (2.6 mL, 30.1 mmol) and 2 drops of DMF. The reaction mixture was stirred at room temperature for 2 h and then concentrated

under reduced pressure. The resulting compound **2** was dissolved in DCM (20 mL) and slowly added to a solution of compound **3** (3.8 g, 15.2 mmol), DIEA (5.3 mL, 30.4 mmol) and DCM (100 mL). The reaction mixture was stirred at room temperature for 24 h, and then was washed with 1 N HCl (50 mL), saturated $NaHCO_3$ (50 mL) and brine (50 mL). The organic layer was dried over Na_2SO_4, filtered, and concentrated under reduced pressure to yield the crude product. Purification by crystallization from EtOAc/hexanes (1:4) gave compound **4** as a light yellow solid (5.1 g, 71 %).

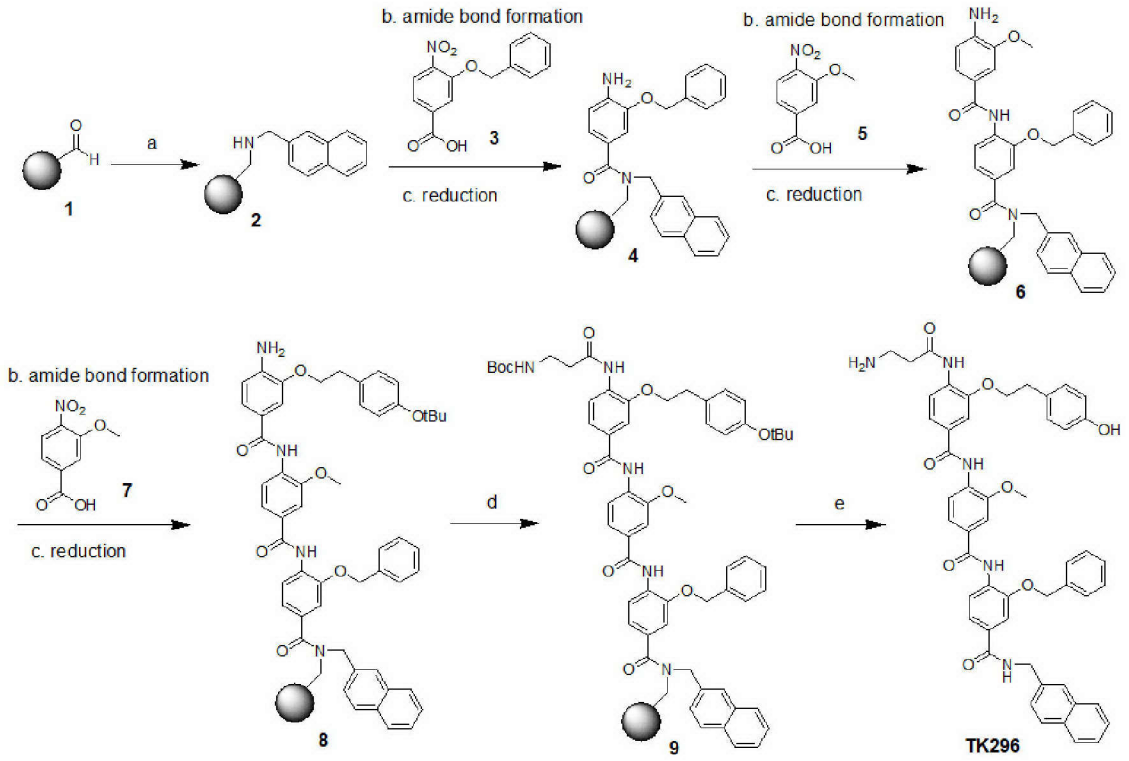
Compound 5: A 250 mL round-bottomed flask was charged with compound **4** (4.7 g, 10.0 mmol), DMF (100 mL), and $SnCl_2{\cdot}2H_2O$ (6.8 g, 30.0 mmol). The reaction mixture was stirred at room temperature for 12 h and then diluted with EtOAc (200 mL) and 1 N HCl (200 mL). The organic layer was separated and washed with 1 N HCl (100 mL) and brine (100 mL). The organic layer was dried over Na_2SO_4, filtered, and concentrated under reduced pressure to yield the crude product. Purification by flash chromatography (hexanes/EtOAc 4:1) gave the compound **5** as a light yellow solid (3.6 g, 82%).

Compound 7: A 250 mL round-bottomed flask was charged with compound **5** (3.6 g, 8.2 mmol), compound **6** (6.2 g, 13.2 mmol), HATU (6.7 g, 17.6 mmol), DMF (100 mL), and DIEA (4.6 mL, 26.4 mmol). The reaction mixture was stirred at room temperature for 24 h and then diluted with EtOAc (300 mL) and 0.5 N HCl (200 mL). The organic layer was separated and washed with 0.5 N HCl (100 mL) and brine (100 mL). The organic layer was concentrated under reduced pressure to yield the crude product. Purification by crystallization from EtOAc gave compound **7** as a light yellow solid (5.6 g, 77 %).

Compound 8: A 250 mL round-bottomed flask was charged with compound **7** (5.3 g, 5.9 mmol) and THF (100 mL). Then, $Pd(PPh_3)_4$ (0.69 g, 0.60 mmol) and $PhSiH_3$ (1.5 mL, 12.2 mmol) were added to the reaction mixture. The reaction mixture was stirred at room temperature for 1 h. The resulting solid was filtered, washed with ether and dried *in vacuo* to give compound **8** as a white sold (4.9 g, 97%).

Compound 9: A 100 mL round-bottomed flask was charged with compound **8** (2.7 g, 3.2 mmol), HATU (1.4 g, 3.7 mmol), DMF (30 mL), trans-4-methylcyclohexylamine (0.73 g, 6.4 mmol), and DIEA (1.2 mL, 6.9 mmol). The reaction mixture was stirred at room temperature for 24 h and then diluted with EtOAc (100 mL) and 0.5 N HCl (50 mL). The organic layer was separated and washed with 0.5 N HCl (50 mL) and brine (50 mL). The resulting solid was filtered, washed with EtOAc and dried *in vacuo* to give compound **9** as a white sold (1.75 g). The product was used in the next reaction without further purification.

TK41: A 500 mL round-bottomed flask was charged with compound **9** (1.75 g), THF (300 mL) and conc. HCl (30 mL). The reaction mixture was stirred at room temperature for 24 h and then concentrated under reduced pressure. The resulting solid was filtered, washed with MeOH and dried *in vacuo* to give **TK11-41** as a light yellow solid (1.3 g, 57% over 2 reaction steps).



Scheme 2. Synthetic route to TK296.

Reagents and conditions: (a)), naphthalene-2-methaneamine hydrochloride, $NaBH_3CN$, 1% AcOH/DMF, rt, 24 h; (b) PyBroP, DIEA, DCM, rt, 24 h; (c) $Na_2S_2O_4$, 1,1'-di-n-octyl-4,4'-bipyridinium dibromide, K_2CO_3, H_2O/THF, rt, 24 h; (d) Boc-β-Ala-OH, DIC, DMF/DCM, rt, 24 h; (e) TFA, rt, 1 h.

Compound 1: AM PS resin (0.42 mmol/g, 3.0 g, 1.26 mmol) was swollen in DMF for 12 h and washed with DMF (3 × 1 min). A solution of BAL linker (676 mg, 2.52 mmol), PyBOP (1.44 g, 2.77 mmol) and DIEA (0.97 mL, 5.6 mmol) in DMF (25 mL) was added to the resin, shaken at room temperature for 24 h, and washed with DMF (3 × 1 min). The completion of the coupling reaction was confirmed by a negative Kaiser ninhydrin test.

Compound 2: A mixture of compound **1** (0.25 g, 0.11 mmol), naphthalene-2-methaneamine hydrochloride (85 mg, 0.44 mmol), $NaBH_3CN$ (29 mg, 0.44 mmol) in 1%

AcOH/DMF (5 mL) was shaken at room temperature for 24 h, and washed with DMF (3 × 1 min). The reaction was monitored using a positive chloranil test.

Compound 4:

1. Amide-bond formation: A solution of compound **3** (90 mg, 0.33 mmol), PyBroP (154 mg, 0.33 mmol) and DIEA (0.11 mL, 0.66 mmol) in DCM (6 mL) was shaken at room temperature for 1 h, and added to the compound **2**. The reaction mixture was shaken at room temperature for 24 h, and washed with DMF (3 × 1 min). The completion of the reaction was confirmed by a negative chloranil test.

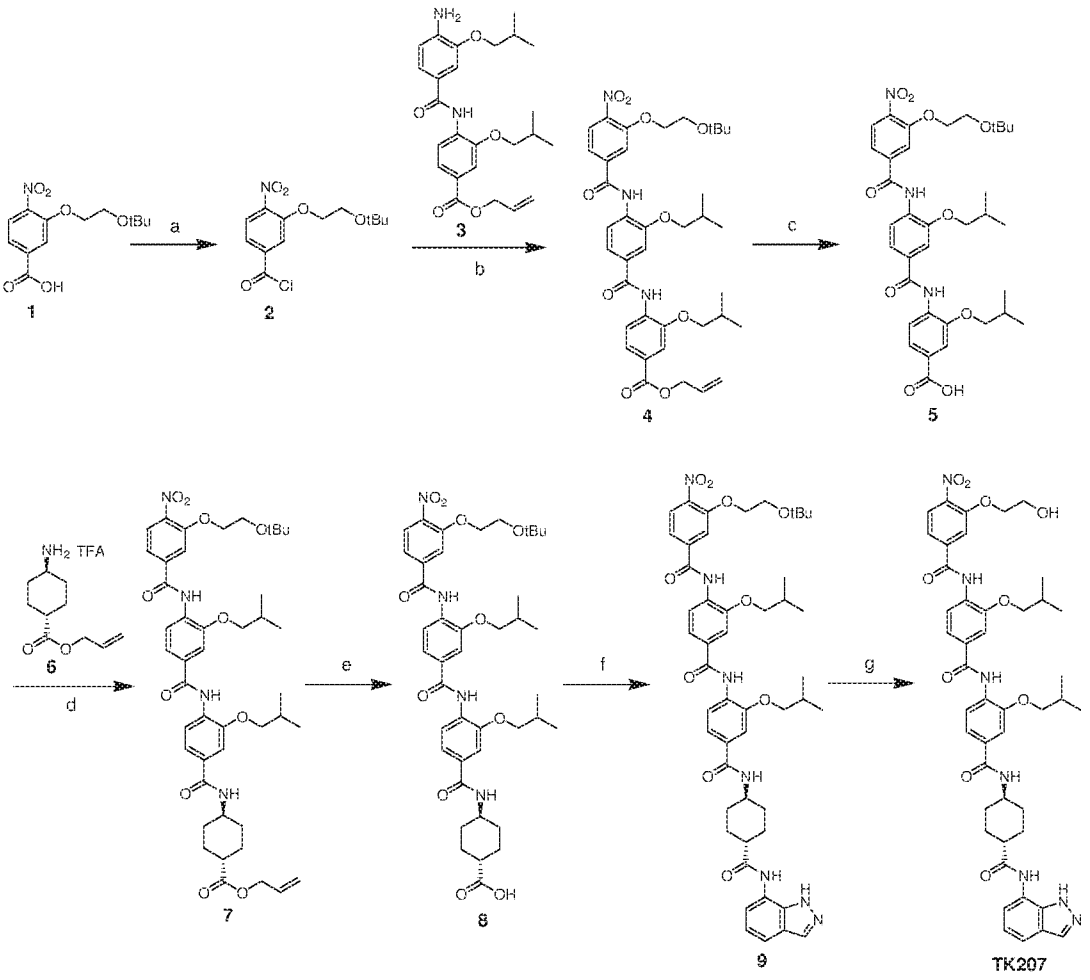
2. Reduction: A mixture of the resulting resin, $Na_2S_2O_4$ (113 mg, 0.55 mmol), 1,1'-di-n-octyl-4,4'-bipyridinium dibromide (6 mg, 0.01 mmol), K_2CO_3 (30 mg, 0.22 mmol) in 20% H_2O/THF (8 mL) was shaken at room temperature for 24 h, and washed with H_2O (3 × 1 min), 20% 1N HCl (aq)/THF (3 × 1 min), 20% H_2O/THF (3 × 1 min), DMF (3 × 1 min) to give compound **4**.

Compound 6: This compound was prepared from compound **5** by using the same procedure as that for compound **4**.

Compound 8: This compound was prepared from compound **7** by using the same procedure as that for compound **4**.

Compound 9: A solution of Boc-β-Ala-OH (378 mg, 2.0 mmol), DIC (0.15 mL, 1.0 mmol) in 20% DMF/DCM (6 mL) was shaken at room temperature for 1 h, and added to the compound **6**. The reaction mixture was shaken at room temperature for 24 h, and washed with DMF (3 × 1 min).

TK296: A mixture of compound **9** in 5% H_2O/TFA (5 mL) was shaken at room temperature for 2 h, and then the TFA solution was filtered, and the resin was washed with TFA (2 mL) and DCM (2 mL). The combined TFA solution was concentrated with a gentle stream of nitrogen, and a white solid was precipitated by adding cold diethyl ether (5 mL). The white solid was washed with ether and dried *in vacuo* to give TK296 (30 mg, 28%)



Scheme 3. Synthetic route to TK207.

Reagents and conditions: (a) $(COCl)_2$, cat. DMF, DCM, rt, 2 h; (b) DIEA, DCM, rt, 24 h; (c) $Pd(PPh_3)_4$, $PhSiH_3$, THF, rt, 1 h; (d) PyBOP, DIEA, DMF, rt, 24 h; (e) $Pd(PPh_3)_4$, $PhSiH_3$, THF, rt, 1 h; (f) 7-amino-1H-indazole, HATU, DIEA, DMF, rt, 24 h; (g) TFA, rt, 1 h.

Compound 4: A 250 mL round-bottomed flask was charged with compound **1** (1.91 g, 6.75 mmol), DCM (50 mL), oxalyl chloride (1.2 mL, 13.5 mmol) and 2 drops of DMF. The reaction mixture was stirred at room temperature for 2 h and then concentrated under reduced pressure. The resulting compound **2** was dissolved in DCM (20 mL) and slowly added to a solution of compound **3** (2.0 g, 4.5 mmol), DIEA (1.6 mL, 9.0 mmol) and DCM (50 mL). The reaction mixture was stirred at room temperature for 24 h, and then was washed with 1 N HCl (50 mL), saturated $NaHCO_3$ (50 mL) and brine (50 mL). The organic layer was concentrated under reduced pressure to yield the crude product. Purification by crystallization from EtOAc/hexanes (1:2) gave compound **4** as a light yellow solid (2.7 g, 85 %).

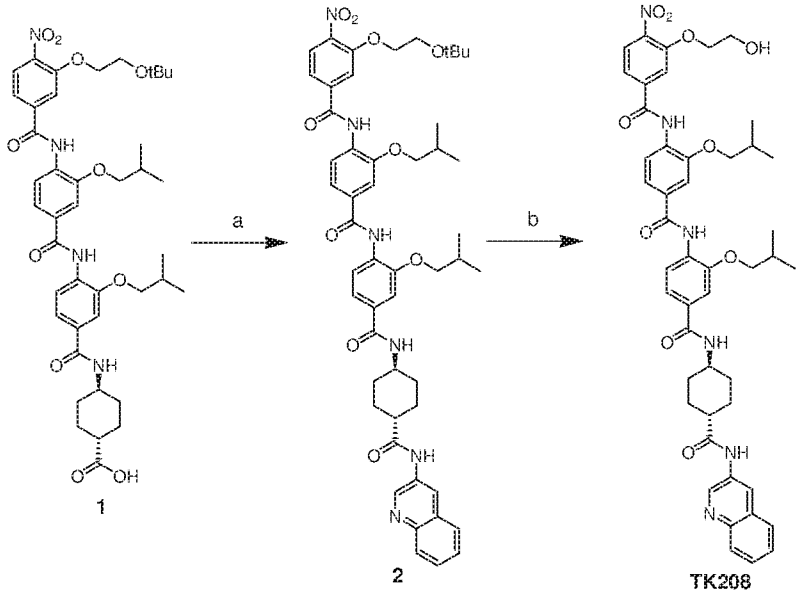
Compound 5: A 250 mL round-bottomed flask was charged with compound **4** (2.7 g, 3.83 mmol) and THF (100 mL). Then, $Pd(PPh_3)_4$ (0.59 g, 0.51 mmol) and $PhSiH_3$ (0.95 mL, 7.7 mmol) were added to the reaction mixture. The reaction mixture was stirred at room temperature for 1 h and then concentrated under reduced pressure. The resulting solid was washed with ether and dried *in vacuo* to give compound **5** as a light yellow sold (2.5 g, 98%).

Compound 7: A 100 mL round-bottomed flask was charged with compound **5** (0.60 g, 0.90 mmol), PyBOP (0.56 g, 1.1 mmol), DMF (30 mL), and DIEA (0.93 mL, 5.3 mmol), and the mixture was stirred at room temperature for 1 h. Compound **6** (0.80 g, 2.70 mmol) was then added to the reaction mixture and the resulting mixture was stirred at room temperature for 24 h. The reaction mixture was diluted with EtOAc (100 mL) and 1 N HCl (50 mL). The organic layer was separated and washed with 1 N HCl (50 mL) and brine (50 mL). The organic layer was concentrated under reduced pressure to yield the crude product. Purification by crystallization from EtOAc gave compound **7** as a light yellow solid (0.51 g, 68 %).

Compound 8: A 250 mL round-bottomed flask was charged with compound **7** (0.49 g, 0.59 mmol) and THF (100 mL). Then, $Pd(PPh_3)_4$ (0.14 g, 0.12 mmol) and $PhSiH_3$ (0.30 mL, 0.24 mmol) were added to the reaction mixture. The reaction mixture was stirred at room temperature for 1 h and then concentrated under reduced pressure. The resulting solid was washed with ether and dried *in vacuo* to give compound **8** as a yellow sold (0.38 g, 81%).

TK207: A solution of compound **8** (40 mg, 0.051 mmol), HATU (25 mg, 0.066 mmol), and DIEA (27µL, 0.16 mmol) in DMF (3 mL) was stirred at room temperature for 1 h. 7-Amino-1H-indazole (20 mg, 0.15 mmol) was then added to the reaction mixture and the resulting mixture was stirred at room temperature for 24 h. The reaction mixture was diluted with EtOAc (30 mL) and 1 N HCl (20 mL). The organic layer was separated and washed with 1 N HCl (20 mL) and brine (20 mL). The organic layer was concentrated under reduced pressure to yield the crude product. Purification by crystallization from EtOAc gave compound **9** as a yellow solid.

A solution of compound **9** in TFA (3 mL) was stirred at room temperature for 1 h and then concentrated under reduced pressure. The resulting solid was washed with ether and dried *in vacuo* to give **TK207** as a yellow solid (16 mg, 37% over 2 reaction steps).

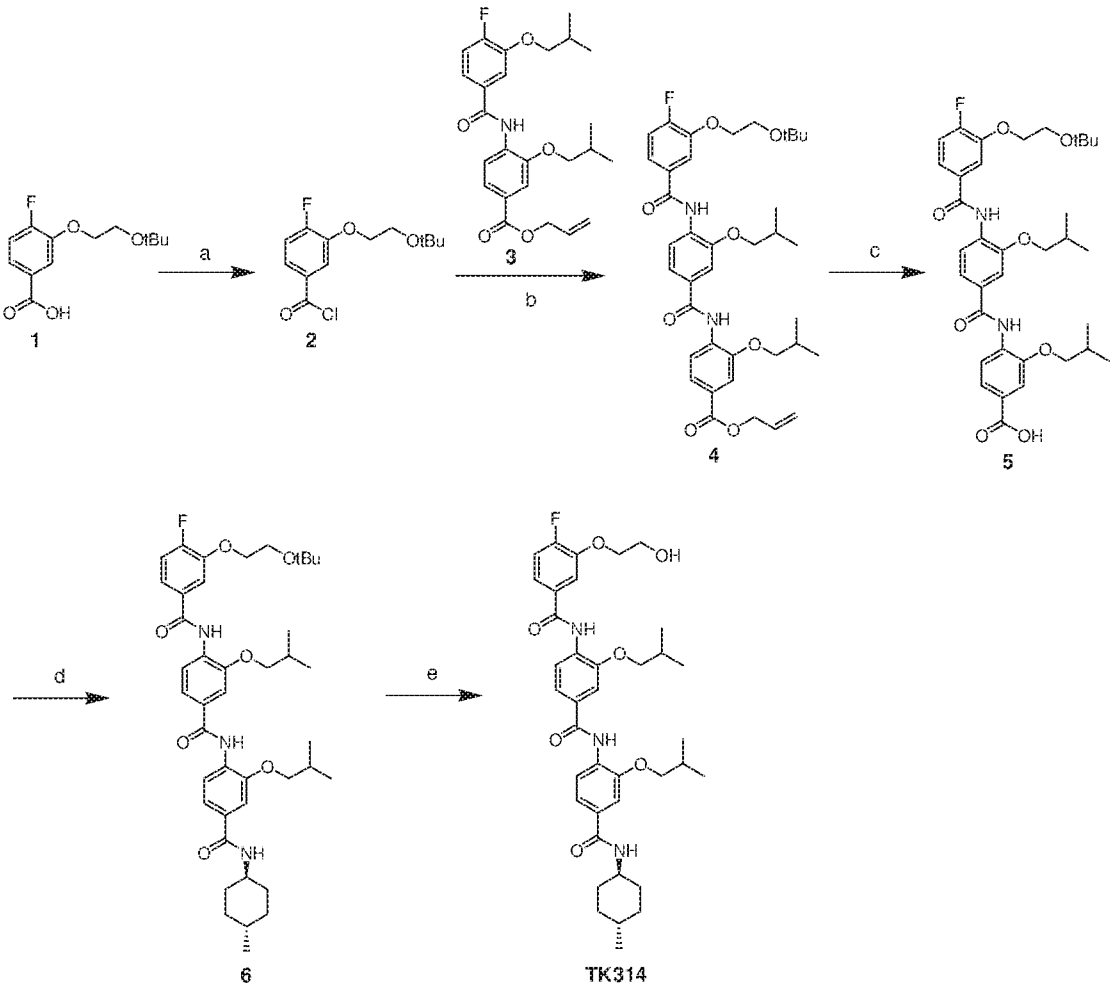


Scheme 4. Synthetic route to TK208.

Reagents and conditions: (a) 3-aminoquinoline, HATU, DIEA, DMF, rt, 24 h; (b) TFA, rt, 1 h.

Compound 2: A solution of compound **1** (2.6 g, 3.3 mmol), HATU (1.5 g, 3.9 mmol), and DIEA (1.1 mL, 6.3 mmol) in DMF (50 mL) was stirred at room temperature for 1 h. 3-Aminoquinoline (1.4 g, 9.7 mmol) was then added to the reaction mixture and the resulting mixture was stirred at room temperature for 24 h. The reaction mixture was diluted with EtOAc (100 mL) and 1 N HCl (50 mL). The organic layer was separated and washed with 1 N HCl (50 mL) and brine (50 mL). The organic layer was concentrated under reduced pressure to yield the crude product. Purification by crystallization from EtOAc gave compound **2** as a yellow solid (2.6 g, 86%).

TK208: A solution of compound **9** (1.2 g, 1.31 mmol) in TFA (30 mL) was stirred at room temperature for 1 h and then concentrated under reduced pressure. The resulting solid was washed with ether and dried *in vacuo* to give **TK208** as a yellow solid (0.67 g, 60%).



Scheme 5. Synthetic route to TK314.

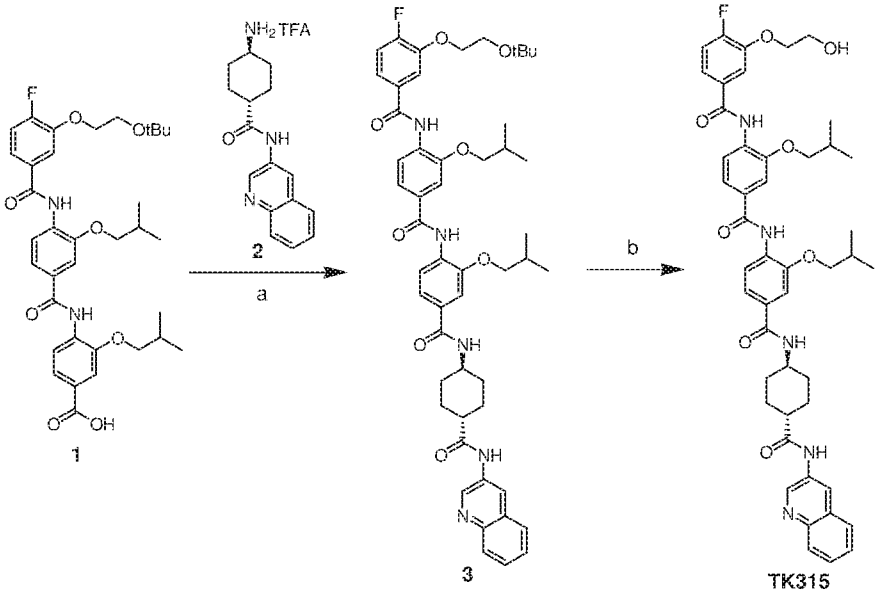
Reagents and conditions: (a) $(COCl)_2$, cat. DMF, DCM, rt, 2 h; (b) DIEA, DCM, rt, 24 h; (c) $Pd(PPh_3)_4$, $PhSiH_3$, THF, rt, 1 h; (d) trans-4-methylcyclohexylamine, HATU, DIEA, DMF, rt, 24 h; (e) TFA, rt, 1 h.

Compound 4: A solution of compound **1** (0.62 g, 2.4 mmol), oxalyl chloride (0.41 mL, 4.7 mmol) and 2 drops of DMF in DCM (30 mL) was stirred at room temperature for 2 h, and then concentrated under reduced pressure. The resulting compound **2** was dissolved in DCM (10 mL) and slowly added to a solution of compound **3** (0.70 g, 1.6 mmol), DIEA (0.55 mL, 3.2 mmol) and DCM (30 mL). The reaction mixture was stirred at room temperature for 24 h, and then was washed with 1 N HCl (50 mL), saturated $NaHCO_3$ (50 mL) and brine (50 mL). The organic layer was concentrated under reduced pressure to yield the crude product. Purification by crystallization from EtOAc/hexanes (1:2) gave compound **4** as a yellow solid (0.46 g, 42 %).

Compound 5: A solution of compound **4** (0.40 g, 0.59 mmol), $Pd(PPh_3)_4$ (69 mg, 0.06 mmol) and $PhSiH_3$ (0.15 mL, 1.2 mmol) in THF (30 mL) was stirred at room temperature for 2 h, and then concentrated under reduced pressure. The resulting solid was washed with ether and dried *in vacuo* to give compound **5** as a yellow sold (0.37 g, 98%).

TK314: A solution of compound **5** (50 mg, 0.078 mmol), HATU (39 mg, 0.10 mmol), DIEA (41 µL, 0.24 mmol) in DMF (4 mL) was stirred at room temperature for 1 h, and then trans-4-methylcyclohexylamine (45 mg, 0.40 mmol) was added to the reaction mixture. The resulting mixture was stirred at room temperature for 24 h and then diluted with EtOAc (20 mL) and 1 N HCl (10 mL). The organic layer was separated, washed with 1 N HCl (10 mL) and brine (10 mL), and concentrated under reduced pressure. The resulting solid was washed with EtOAc and dried *in vacuo* to give compound **6** as a yellow sold.

A solution of compound **6** in TFA (3 mL) was stirred at room temperature for 1 h and then concentrated under reduced pressure. The resulting solid was washed with ether and dried *in vacuo* to give **TK314** as a yellow solid (42 mg, 79% over 2 reaction steps).



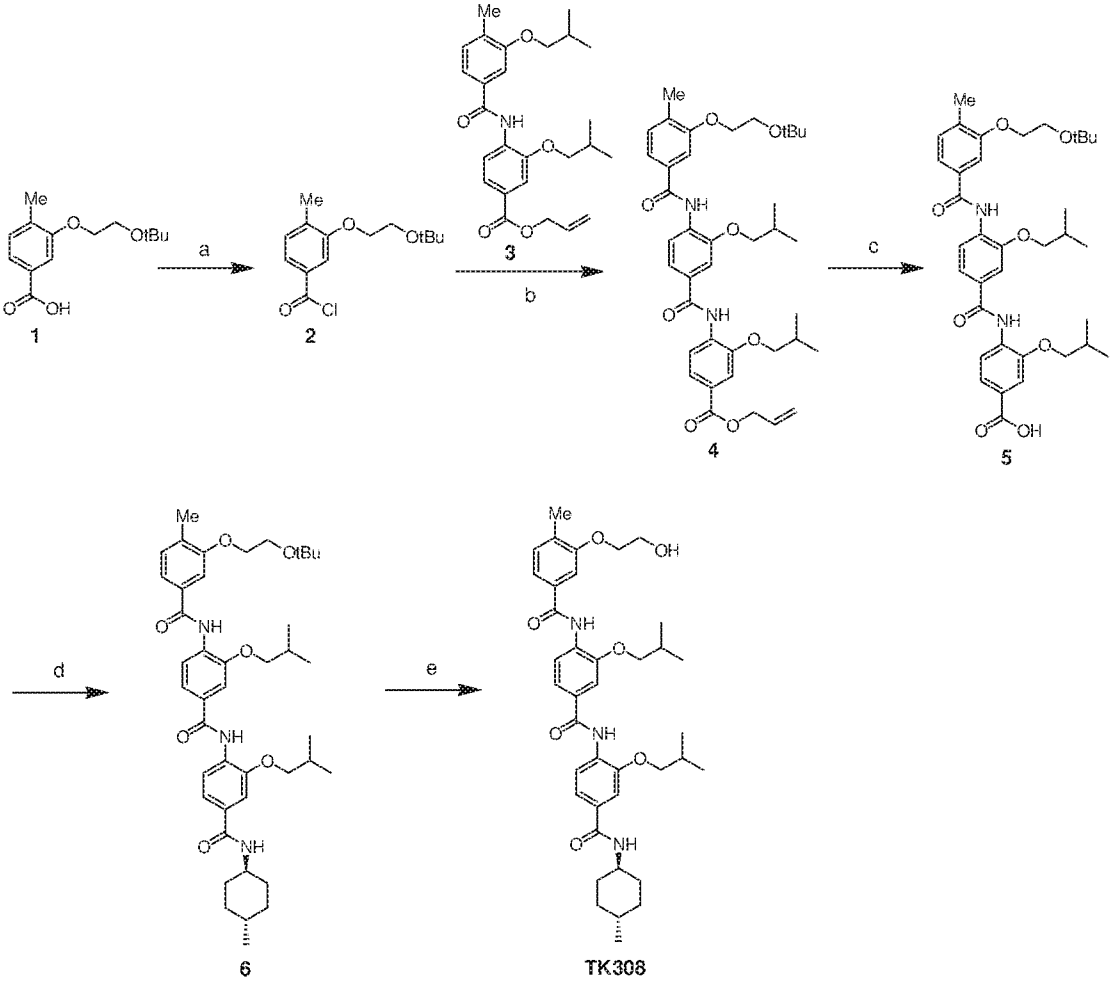
Scheme 6. Synthetic route ot TK315.

Reagents and conditions: (a) HATU, DIEA, DMF, rt, 24 h; (b) TFA, rt, 1 h.

TK315: A solution of compound **1** (50 mg, 0.078 mmol), HATU (39 mg, 0.10 mmol), DIEA (41 µL, 0.24 mmol) in DMF (4 mL) was stirred at room temperature for 1 h, and then compound **2** (91 mg, 0.24 mmol) was added to the reaction mixture. The resulting mixture was stirred at room temperature for 24 h and then diluted with EtOAc (20 mL) and 1 N HCl (10 mL). The organic layer was separated, washed with 1 N HCl (10 mL) and brine

(10 mL), and concentrated under reduced pressure. The resulting solid was washed with EtOAc and dried *in vacuo* to give compound **3** as a yellow sold.

A solution of compound **3** in TFA (3 mL) was stirred at room temperature for 1 h and then concentrated under reduced pressure. The resulting solid was washed with ether and dried *in vacuo* to give **TK315** as a yellow solid (51 mg, 78% over 2 reaction steps).



Scheme 7. Synthetic route to TK308.

Reagents and conditions: (a) $(COCl)_2$, cat. DMF, DCM, rt, 2 h; (b) DIEA, DCM, rt, 24 h; (c) $Pd(PPh_3)_4$, $PhSiH_3$, THF, rt, 1 h; (d) trans-4-methylcyclohexylamine, HATU, DIEA, DMF, rt, 24 h; (e) TFA, rt, 1 h.

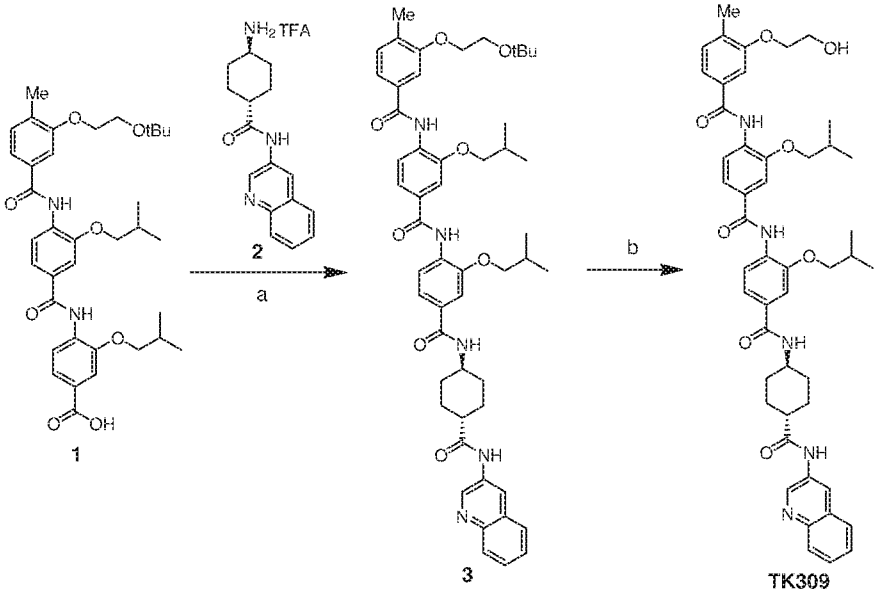
Compound 4: A solution of compound **1** (1.1 g, 4.4 mmol), oxalyl chloride (0.78 mL, 9.0 mmol) and 2 drops of DMF in DCM (30 mL) was stirred at room temperature for 2 h, and then concentrated under reduced pressure. The resulting compound **2** was dissolved in DCM (10 mL) and slowly added to a solution of compound **3** (1.3 g, 3.0 mmol), DIEA (1.0 mL, 5.7 mmol) and DCM (30 mL). The reaction mixture was stirred at room temperature for

24 h, and then was washed with 1 N HCl (50 mL), saturated $NaHCO_3$ (50 mL) and brine (50 mL). The organic layer was concentrated under reduced pressure to yield the crude product. Purification by crystallization from EtOAc/hexanes (1:2) gave compound **4** as a yellow solid (0.74 g, 37 %).

Compound 5: A solution of compound **4** (0.70 g, 1.04 mmol), $Pd(PPh_3)_4$ (0.12 g, 0.10 mmol) and $PhSiH_3$ (0.26 mL, 2.1 mmol) in THF (30 mL) was stirred at room temperature for 2 h, and then concentrated under reduced pressure. The resulting solid was washed with ether and dried *in vacuo* to give compound **5** as a yellow sold (0.57 g, 86%).

TK308: A solution of compound **5** (50 mg, 0.079 mmol), HATU (39 mg, 0.10 mmol), DIEA (41 µL, 0.24 mmol) in DMF (4 mL) was stirred at room temperature for 1 h, and then trans-4-methylcyclohexylamine (45 mg, 0.40 mmol) was added to the reaction mixture. The resulting mixture was stirred at room temperature for 24 h and then diluted with EtOAc (20 mL) and 1 N HCl (10 mL). The organic layer was separated, washed with 1 N HCl (10 mL) and brine (10 mL), and concentrated under reduced pressure. The resulting solid was washed with EtOAc and dried *in vacuo* to give compound **6** as a yellow sold.

A solution of compound **6** in TFA (3 mL) was stirred at room temperature for 1 h and then concentrated under reduced pressure. The resulting solid was washed with ether and dried *in vacuo* to give **TK308** as a yellow solid (40 mg, 75% over 2 reaction steps).

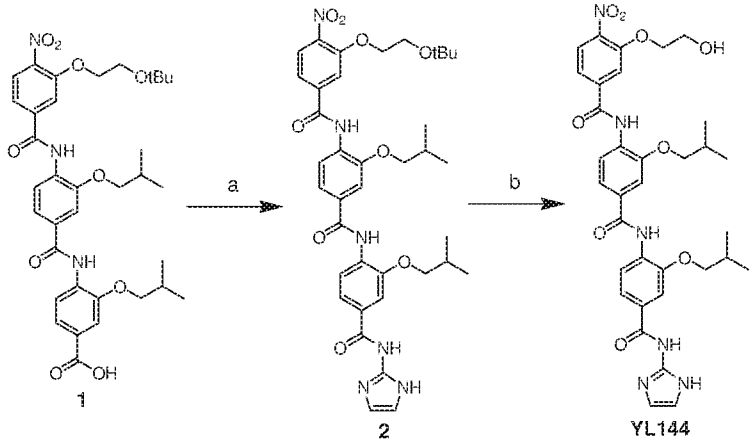


Scheme 8. Synthetic route to TK309.

Reagents and conditions: (a) HATU, DIEA, DMF, rt, 24 h; (b) TFA, rt, 1 h.

TK309: A solution of compound **1** (50 mg, 0.079 mmol), HATU (39 mg, 0.10 mmol), DIEA (41 µL, 0.24 mmol) in DMF (4 mL) was stirred at room temperature for 1 h, and then compound **2** (91 mg, 0.24 mmol) was added to the reaction mixture. The resulting mixture was stirred at room temperature for 24 h and then diluted with EtOAc (20 mL) and 1 N HCl (10 mL). The organic layer was separated, washed with 1 N HCl (10 mL) and brine (10 mL), and concentrated under reduced pressure. The resulting solid was washed with EtOAc and dried *in vacuo* to give compound **3** as a yellow sold.

A solution of compound **3** in TFA (3 mL) was stirred at room temperature for 1 h and then concentrated under reduced pressure. The resulting solid was washed with ether and dried *in vacuo* to give **TK309** as a yellow solid (55 mg, 84% over 2 reaction steps).



Scheme 9. Synthetic route to YL144.

Reagents and conditions: (a) 2-aminoimidazole sulfate, HATU, DIEA, DMF, rt, 24 h; (b) TFA, rt, 1 h.

YL144: A mixture of compound **1** (0.20 g, 0.30 mmol), 2-aminoimidazole sulfate (79 mg, 0.60 mmol) and DIEA (0.42 mL, 2.4 mmol) in DMF (20 mL) was stirred at 60 °C for 1 h. HATU (0.15 g, 0.39 mmol) was then added to the reaction mixture and the resulting mixture was stirred at 60 °C for 24 h. The reaction mixture was cooled to room temperature and diluted with EtOAc (50 mL) and 1 N HCl (30 mL). The organic layer was separated and washed with 1 N HCl (30 mL) and brine (30 mL). The organic layer was concentrated under reduced pressure to yield the crude product. Purification by crystallization from EtOAc gave compound **2** as a yellow solid.

A solution of compound **2** in TFA (5 mL) was stirred at room temperature for 1 h and then concentrated under reduced pressure. The resulting solid was washed with ether and dried *in vacuo* to give **YL144** as a yellow solid (0.12 g, 52%).

Example 3 – Oligo Benzamide Analogs and Their Use in Cancer Treatment - OTC Ref.: HSC-1542

The inventors have conducted several studies at UTHSCSA using preclinical murine Xenograft and Patient derived xenografts (PDX) examining the efficacy of new compounds TK41 (ERX-41), TK208 (ERX-208) and TK315 (ERX-315). The results are given below.

Oral administration of TK315 (ERX-315) in captisol formulation showed potent activity against both MCF7-MT *ESR1* ZR-75 and ZR75-MT Y537S ERα expressing therapy resistant BC xenograft models but no effect on mouse liver or body weight (FIGS. 31A-C). Histologic evaluation of the tumors showed dramatically decreased Ki67 proliferation indices in these tumors. Importantly, the lack of immune antibody infiltrates in the spleen, lymph nodes, kidney, or liver of the syngeneic D2A1 tumors with treated with ERX-315 suggested that ERX-315 is potent, not immunogenic and can be safely administered orally.

PDX models recapitulate the structural complexity and individual heterogeneity of human BC (primary tumor samples), therefore, studies with these models will establish an incontrovertible basis for clinical translation. Three different TNBC PDX tumors were established in NSG mice by transplanting PDX tumor pieces into the mammary fat fad using established protocol in the inventors' lab. Results showed that TK41 (ERX-41) treatment significantly decreased the growth of all the three TNBC PDX tumors tested (FIGS. 32A-C).

The inventors have tested the *in vivo* activity of TK208 (ERX-208) using both ovarian xenograft and PDX models. Results showed that TK208 (ERX-208) has good efficacy in reducing the ovarian tumor volume with no effect on mouse body weight, suggesting lack of toxicity (FIGS. 33A-H).

* * * * * * * * * * * * * * * * *

All of the compositions and/or methods disclosed and claimed herein can be made and executed without undue experimentation in light of the present disclosure. While the compositions and methods of this disclosure have been described in terms of preferred embodiments, it will be apparent to those of skill in the art that variations may be applied to the compositions and/or methods and in the steps or in the sequence of steps of the method described herein without departing from the concept, spirit and scope of the disclosure. All such similar substitutes and modifications apparent to those skilled in the art are deemed to be within the spirit, scope and concept of the disclosure as defined by the appended claims.

REFERENCES

The following references, to the extent that they provide exemplary procedural or other details supplementary to those set forth herein, are specifically incorporated herein by reference.

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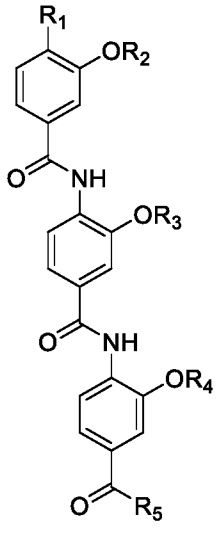
Reference to any prior art in the specification is not an acknowledgement or suggestion that this prior art forms part of the common general knowledge in any jurisdiction or that this prior art could reasonably be expected to be combined with any other piece of prior art by a skilled person in the art.

By way of clarification and for avoidance of doubt, as used herein and except where the context requires otherwise, the term "comprise" and variations of the term, such as "comprising", "comprises" and "comprised", are not intended to exclude further additions, components, integers or steps.

2019393770 15 Jan 2025

CLAIMS

1. A compound of the formula:



(I),

wherein:

R_1 is halo, $-NO_2$, $alkyl_{(C\leq12)}$, substituted $alkyl_{(C\leq12)}$, $amido_{(C\leq12)}$, substituted $amido_{(C\leq12)}$, or $-NHC(O)CH(R_{1a})NH_2$, wherein:

R_{1a} is $aralkyl_{(C\leq18)}$, substituted $aralkyl_{(C\leq18)}$, or the side chain of a canonical amino acid;

R_2 is $aralkyl_{(C\leq18)}$, substituted $aralkyl_{(C\leq18)}$, $alkyl_{(C\leq12)}$ or substituted $alkyl_{(C\leq12)}$;

R_3 is $aralkyl_{(C\leq18)}$, substituted $aralkyl_{(C\leq18)}$, $alkyl_{(C\leq12)}$ or substituted $alkyl_{(C\leq12)}$;

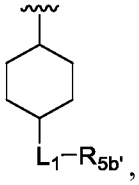
R_4 is $alkyl_{(C\leq12)}$ or substituted $alkyl_{(C\leq12)}$;

R_5 is $-NHR_{5b}$, wherein:

R_{5b} is

cycloalkyl$_{(C\leq12)}$, heteroaryl$_{(C\leq12)}$, heteroaralkyl$_{(C\leq18)}$, or a substituted version of any of these groups; or

a group of the formula:



wherein:

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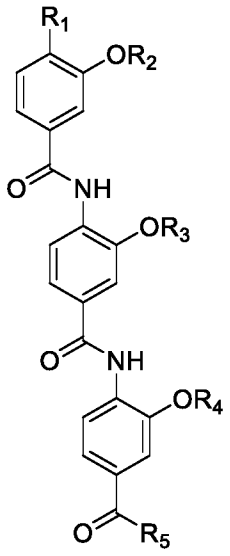
L_1 is $-C(O)NR_{L1}-$, wherein:

R_{L1} is hydrogen, $alkyl_{(C\leq12)}$, or substituted $alkyl_{(C\leq12)}$;

$R_{5b'}$ is $aryl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, $heteroaryl_{(C\leq12)}$, $heteroaralkyl_{(C\leq18)}$, or a substituted version of any of these groups;

or a pharmaceutically acceptable salt of either of these formulae.

2. The compound of claim 1, wherein the compound is further defined as:



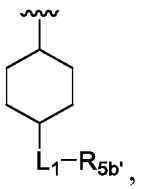
(I),

wherein:

R_5 is $-NHR_{5b}$, wherein:

R_{5b} is

a group of the formula:



,

wherein:

L_1 is $-C(O)NR_{L1}-$, wherein:

R_{L1} is hydrogen, $alkyl_{(C\leq12)}$, or substituted $alkyl_{(C\leq12)}$;

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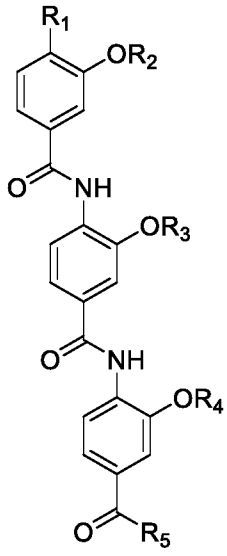
$R_{5b'}$ is $aryl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, $heteroaryl_{(C\leq12)}$, $heteroaralkyl_{(C\leq18)}$, or a substituted version of any of these groups;

or a pharmaceutically acceptable salt thereof.

3. The compound of claim 1, wherein the compound is further defined as:



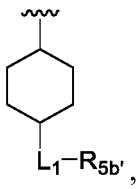
(IV),

wherein:

R_5 is $-NHR_{5b}$, wherein:

R_{5b} is

a group of the formula:



wherein:

L_1 is or $-C(O)NR_{L1}-$, wherein:

R_{L1} is hydrogen;

$R_{5b'}$ is $aryl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, $heteroaryl_{(C\leq12)}$, $heteroaralkyl_{(C\leq18)}$, or a substituted version of any of these groups;

or a pharmaceutically acceptable salt thereof.

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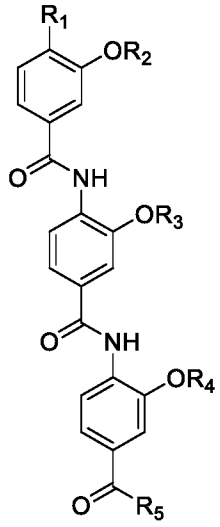
4. The compound according to any one of claims 1-3, wherein the compound is further defined as:



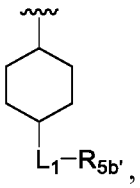
(VI),

wherein:

R_5 is $-NHR_{5b}$, wherein:

R_{5b} is

a group of the formula:



wherein:

L_1 is $-C(O)NR_{L1}-$, wherein:

R_{L1} is hydrogen, $alkyl_{(C\leq12)}$, or substituted $alkyl_{(C\leq12)}$;

$R_{5b'}$ is $aryl_{(C\leq12)}$, $aralkyl_{(C\leq18)}$, $heteroaryl_{(C\leq12)}$, or a substituted version of any of these groups;

or a pharmaceutically acceptable salt thereof.

5. The compound according to any one of claims 1-4, wherein R_2 is $aralkyl_{(C\leq18)}$ or substituted $aralkyl_{(C\leq18)}$.

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6. The compound according to any one of claims 1-4, wherein R_2 is alkyl$_{(C\leq12)}$ or substituted alkyl$_{(C\leq12)}$.

7. The compound according to any one of claims 1-4 and 6, wherein R_2 is 1-hydroxyethyl.

8. The compound according to any one of claims 1-7, wherein R_4 is alkyl$_{(C\leq12)}$.

9. The compound according to any one of claims 1-8, wherein R_4 is *i*-butyl.

10. The compound according to any one of claims 1-9, wherein R_3 is alkyl$_{(C\leq12)}$ or substituted alkyl$_{(C\leq12)}$.

11. The compound according to any one of claims 1-10, wherein R_3 is *i*-butyl.

12. The compound according to any one of claims 1-11, wherein R_{5b} is heteroaryl$_{(C\leq12)}$ or substituted heteroaryl$_{(C\leq12)}$.

13. The compound according to any one of claims 1-12, wherein R_{5b} is heteroaryl$_{(C\leq12)}$.

14. The compound according to any one of claims 1-11, wherein R_{5b} is cycloalkyl$_{(C\leq12)}$ or substituted cycloalkyl$_{(C\leq12)}$.

15. The compound according to any one of claims 1-11, wherein $R_{5b'}$ is heteroaryl$_{(C\leq12)}$ or substituted heteroaryl$_{(C\leq12)}$.

16. The compound according to any one of claims 1-11, wherein $R_{5b'}$ is heteroaryl$_{(C\leq12)}$.

17. The compound according to any one of claims 1-11, wherein $R_{5b'}$ is quinolin-3-yl.

18. The compound according to any one of claims 1-17, wherein R_1 is $-NO_2$.

19. The compound according to any one of claims 1-17, wherein R_1 is alkyl$_{(C\leq12)}$ or substituted alkyl$_{(C\leq12)}$.

20. The compound according to any one of claims 1-17, wherein R_1 is halo.

21. The compound according to any one of claims 1-17 or 20, wherein R_1 is fluoro.

22. The compound according to any one of claims 1-17, wherein R_1 is amido$_{(C\leq12)}$ or substituted amido$_{(C\leq12)}$.

24. The compound according to any one of claims 1-17, wherein R_{1a} is aralkyl$_{(C\leq18)}$ or substituted aralkyl$_{(C\leq18)}$.

25. The compound according to claim 1, wherein the compound is further defined as:

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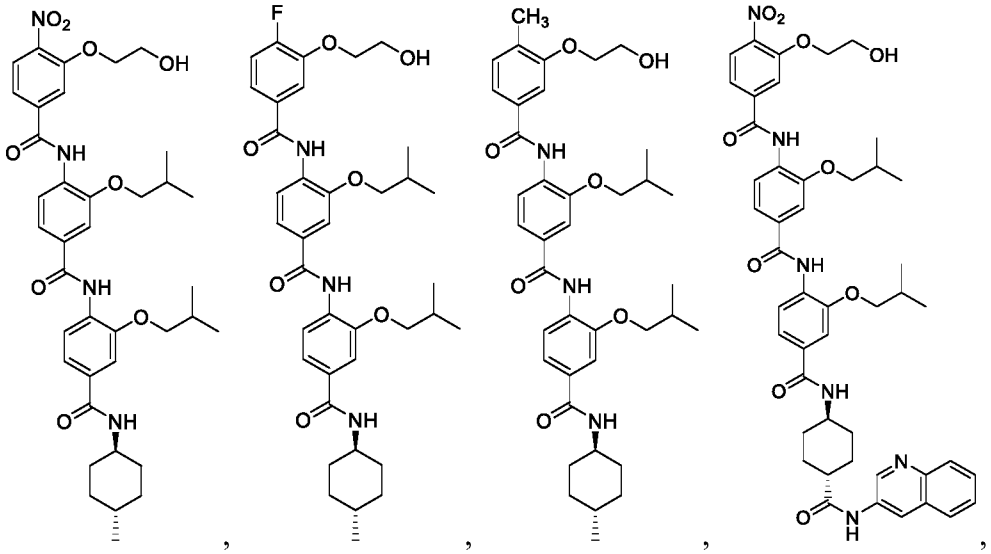
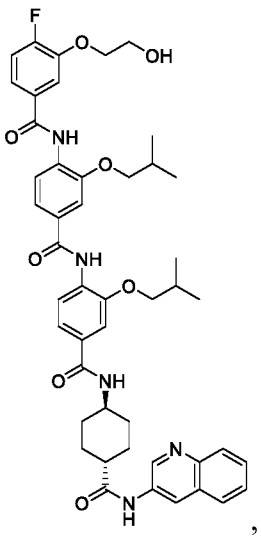
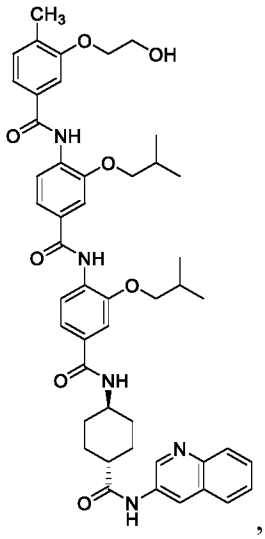
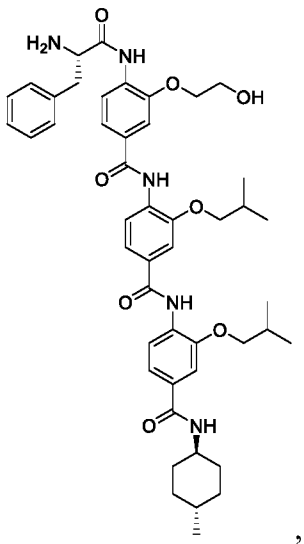
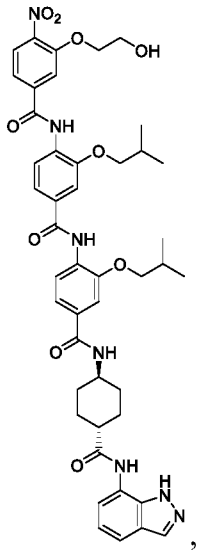
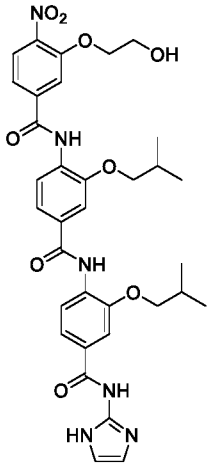

,

,

,

,

,

,

,

,

;

or a pharmaceutically acceptable salt thereof.

26. The compound according to claim 1, wherein the compound is further defined as:

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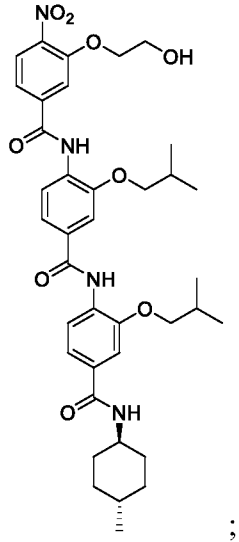
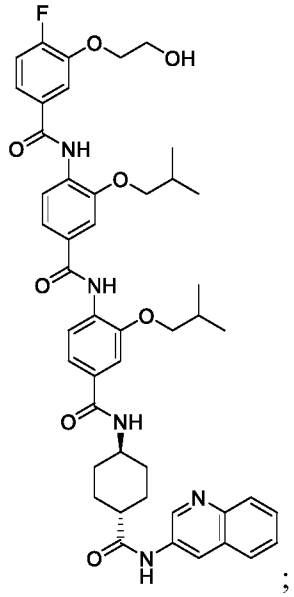


;

or a pharmaceutically acceptable salt thereof.

27. The compound according to claim 1, wherein the compound is further defined as:



;

or a pharmaceutically acceptable salt thereof.

28. The compound according to claim 1, wherein the compound is further defined as:

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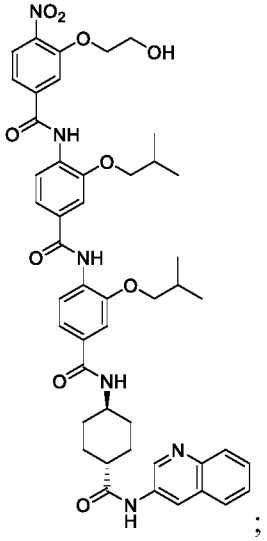


;

or a pharmaceutically acceptable salt thereof.

29. A pharmaceutical composition comprising:

a) a compound according to any one of claims 1-28; and

b) an excipient and/or a pharmaceutically acceptable carrier.

30. A method of treating a disease or disorder in a patient in need thereof comprising administering to the patient a therapeutically effective amount of a compound or composition according to any one of claims 1-28, wherein the disease or disorder is breast cancer or ovarian cancer.

31. Use of a compound or composition according to any one of claims 1-28 in the preparation of a medicament for treating a disease or disorder in a patient in need thereof, wherein the disease or disorder is breast cancer or ovarian cancer.

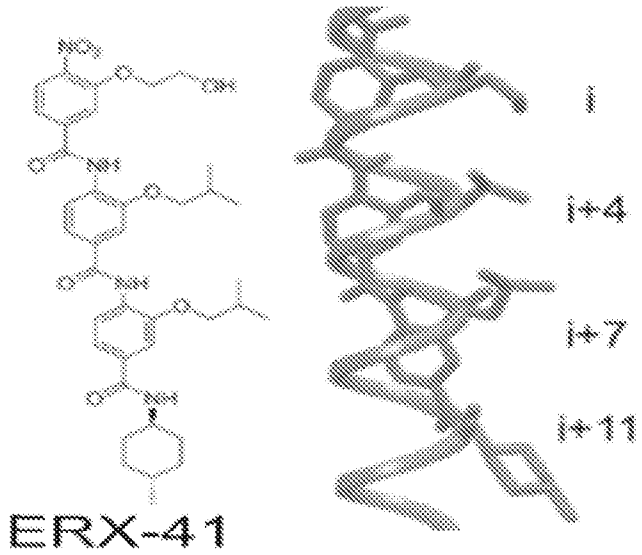
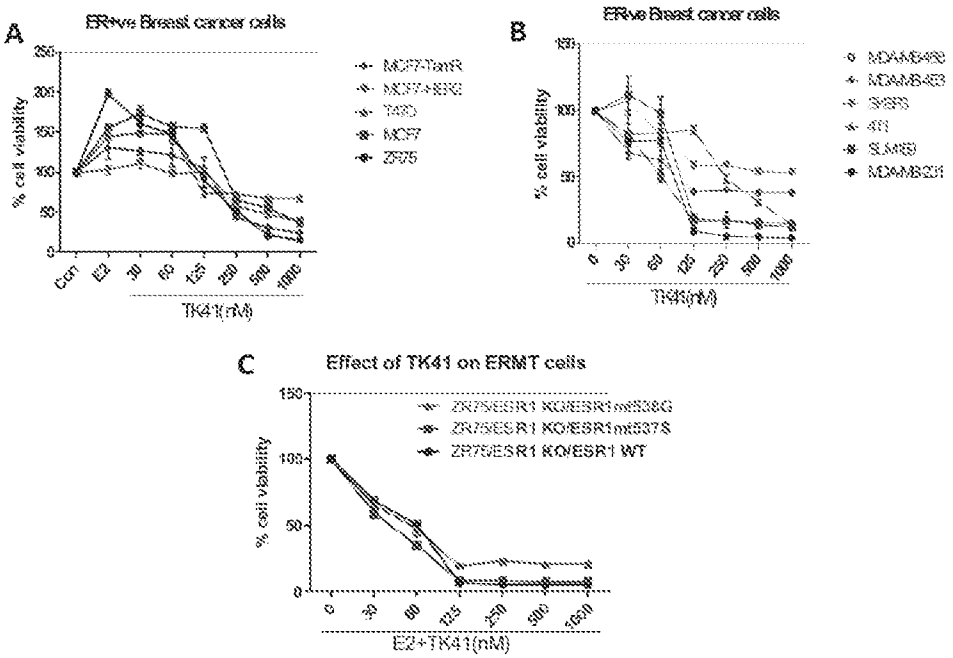
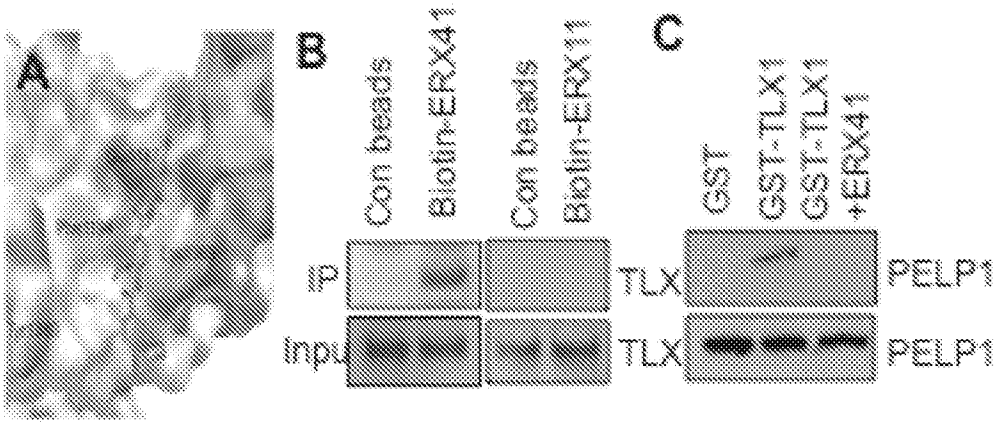


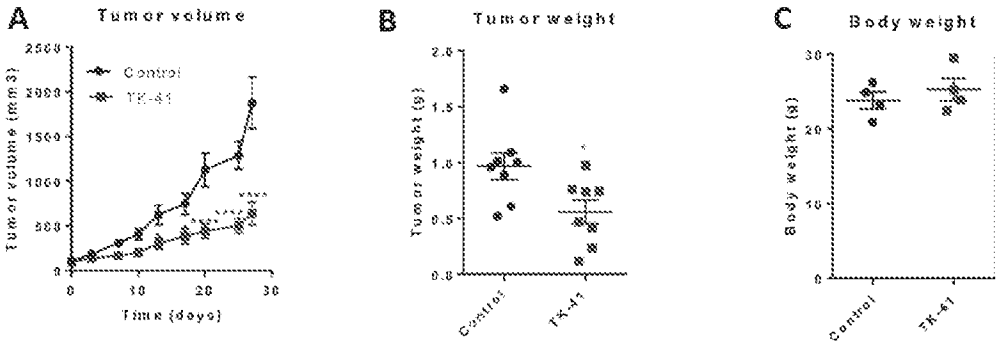
FIG. 1



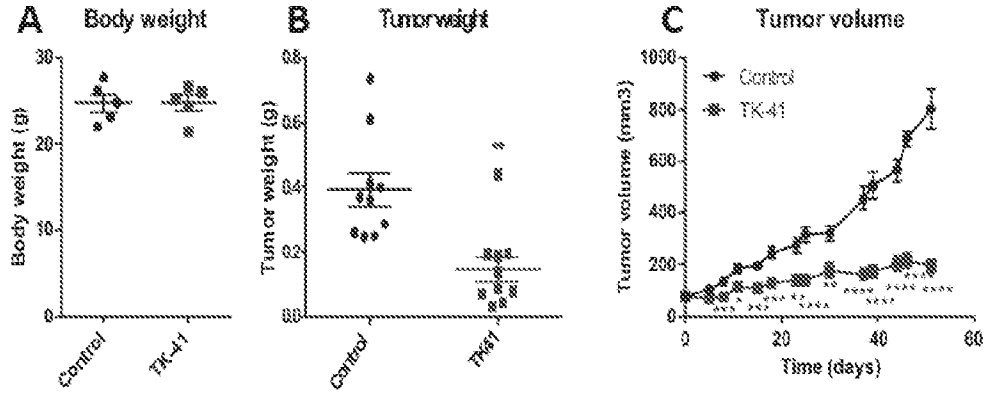
FIGS. 2A-2C



FIGS. 3A-3C



FIGS. 4A-4C



FIGS. 5A-5C

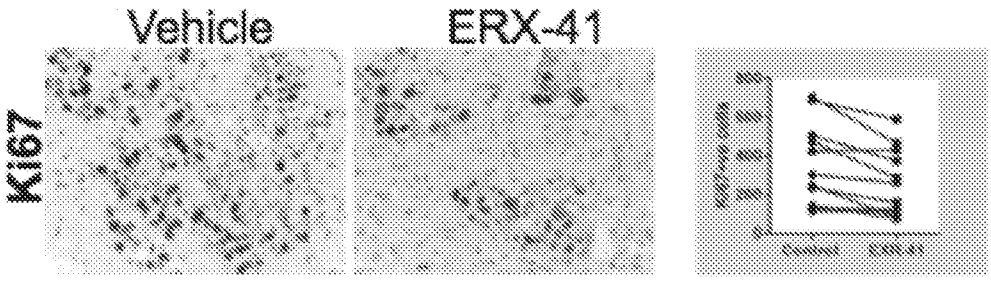
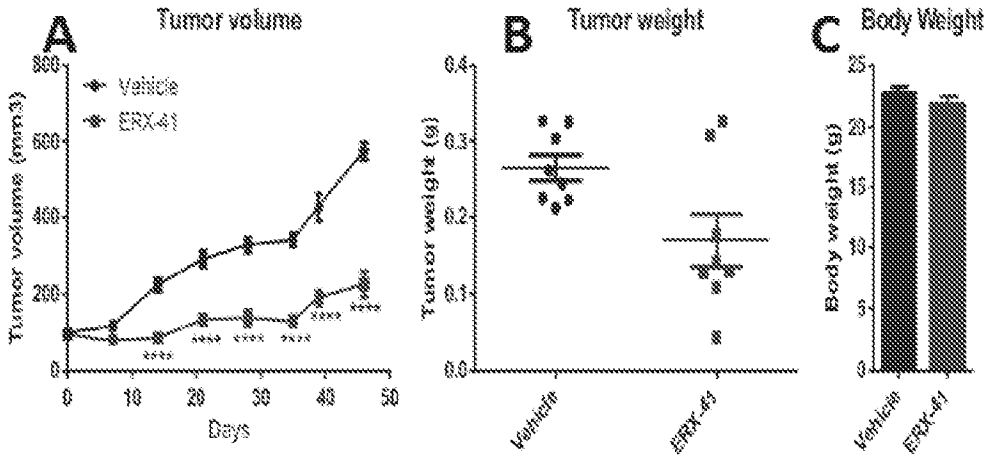
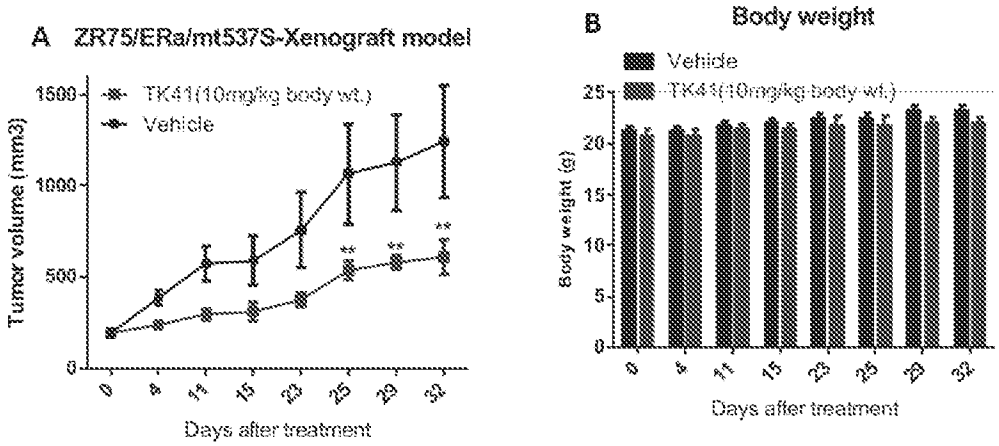


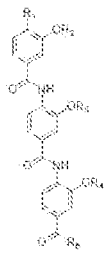
FIG. 6

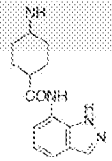
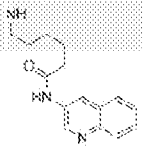
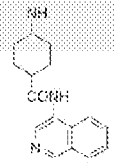


FIGS. 7A-7C



FIGS. 8A & 8B

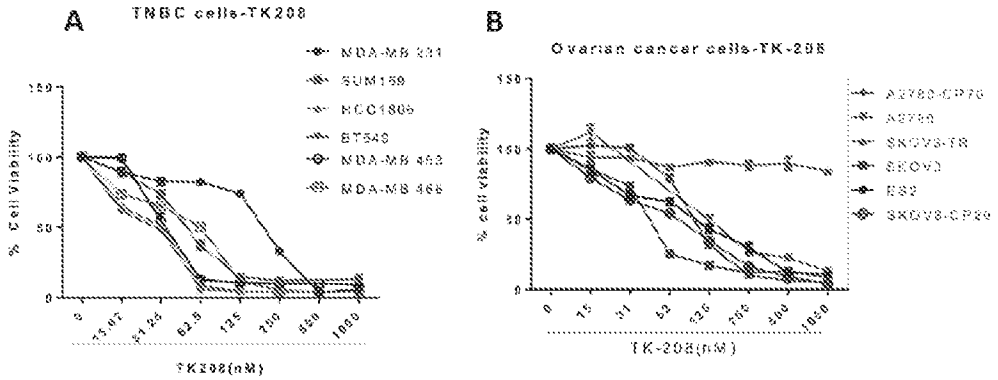


	TK11	TK41	TK207	TK203	TK208	YL144
	NO2	NO2	NO2	NO2	NO2	NO2
	iBu	iBu	iBu	iBu	iBu	iBu
	iBu	iBu	iBu	iBu	iBu	iBu
	NH2					

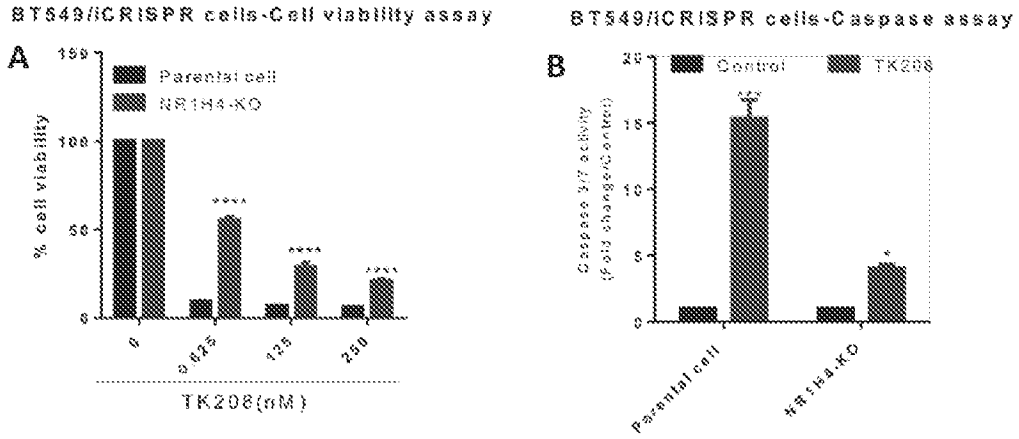
ER+	ZR75	500	125	100	No effect	100	500
	MCF7	350	100	100	No effect	100	No effect
ER-	MDA-MB-231	1000	100	100	No effect	100	125
	SUM159	-	100	-	-	-	-
	BT549	No effect	100	100	-	100	-

Inhibitory activities in MTT assays, IC_{50}(nM)

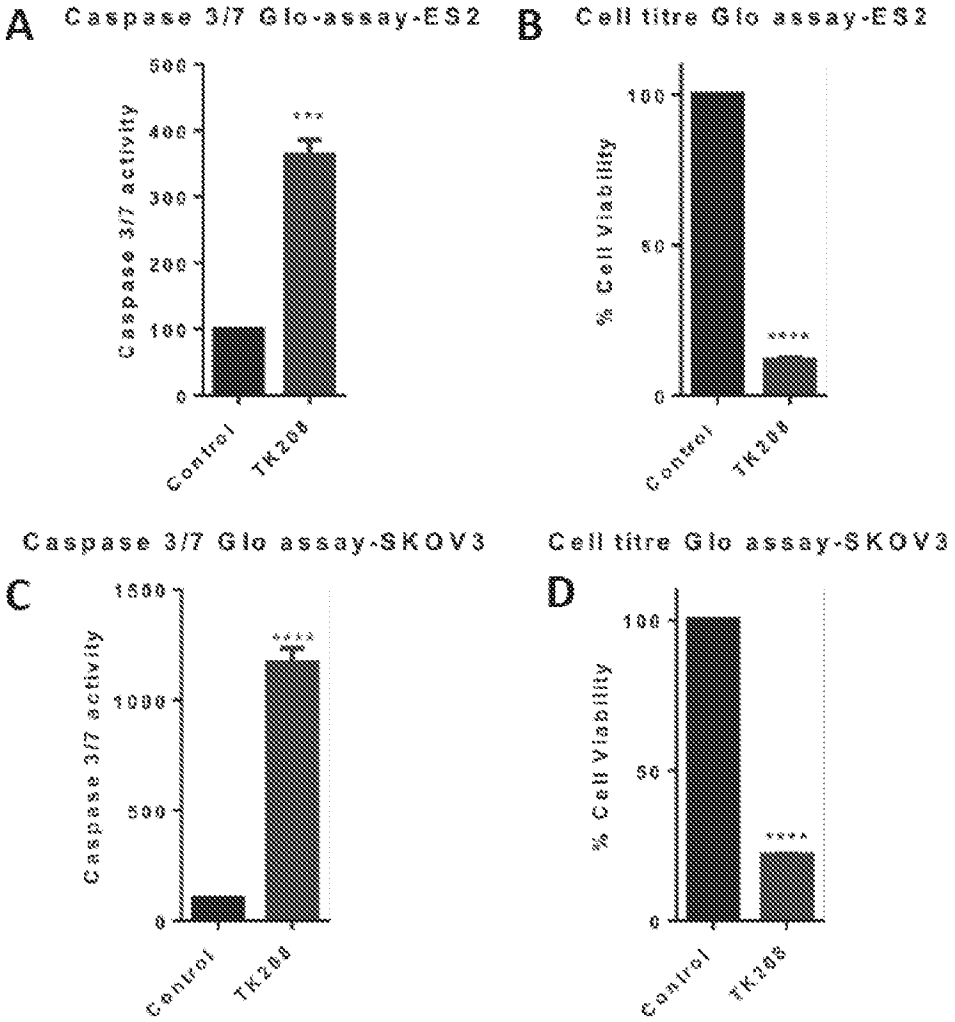
FIG. 9



FIGS. 10A & 10B



FIGS. 11A & 11B



FIGS. 12A-12D

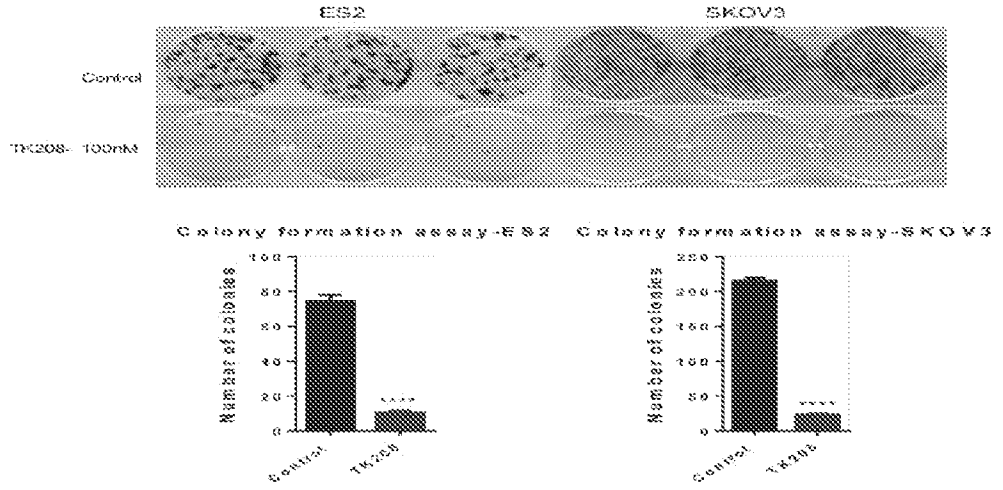

ES2
SKOV3
Control
TK208- 100nM
Colony formation assay-ES2
Colony formation assay-SKOV3
Number of colonies
Control
TK208

FIG. 13

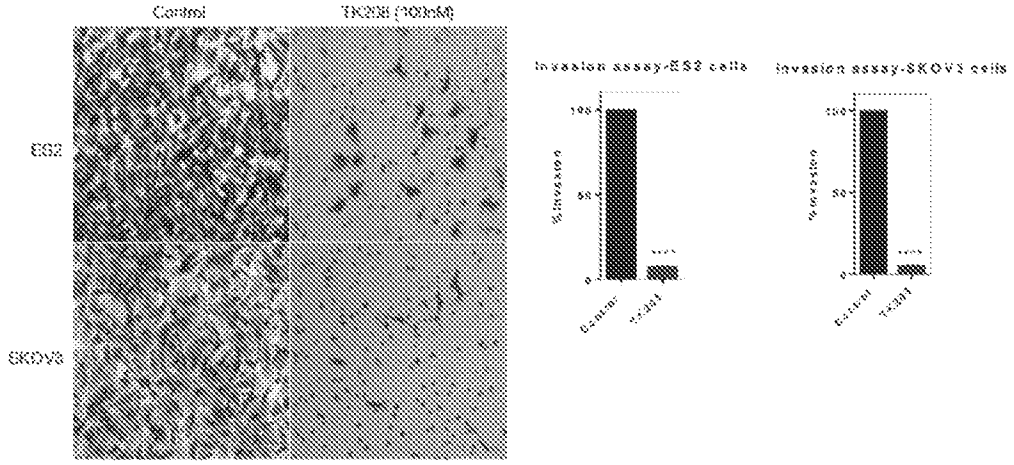

Control
TK208 (100nM)
ES2
SKOV3
Invasion assay-ES2 cells
Invasion assay-SKOV3 cells
% invasion
Control
TK208

FIG. 14

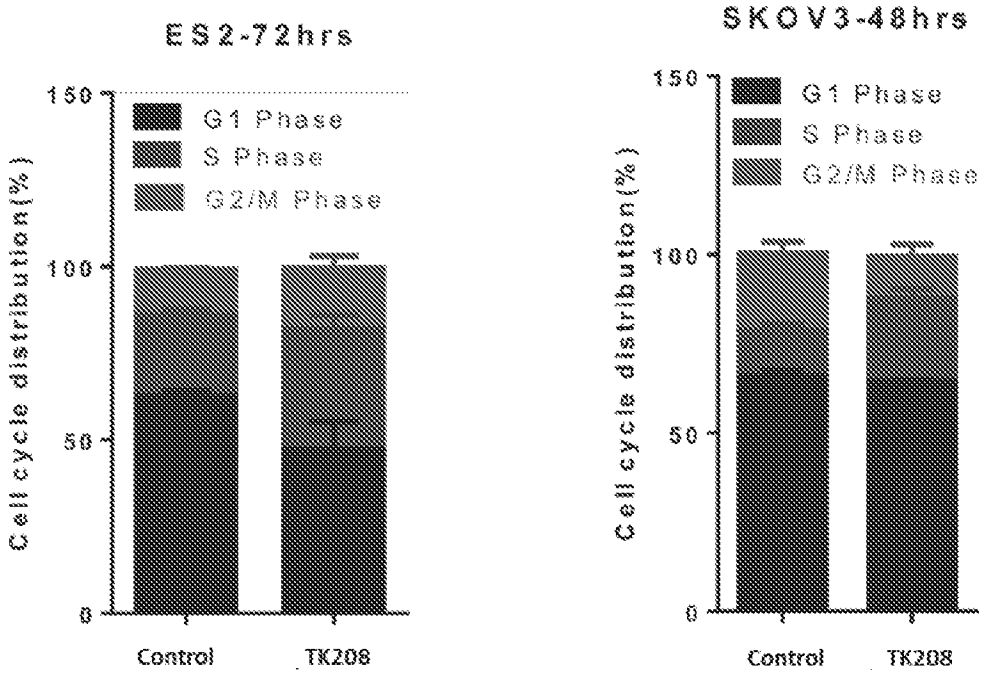

ES2-72hrs
Cell cycle distribution(%)
150
100
50
0
G1 Phase
S Phase
G2/M Phase
Control
TK208
SKOV3-48hrs
Cell cycle distribution(%)
150
100
50
0
G1 Phase
S Phase
G2/M Phase
Control
TK208

FIG. 15

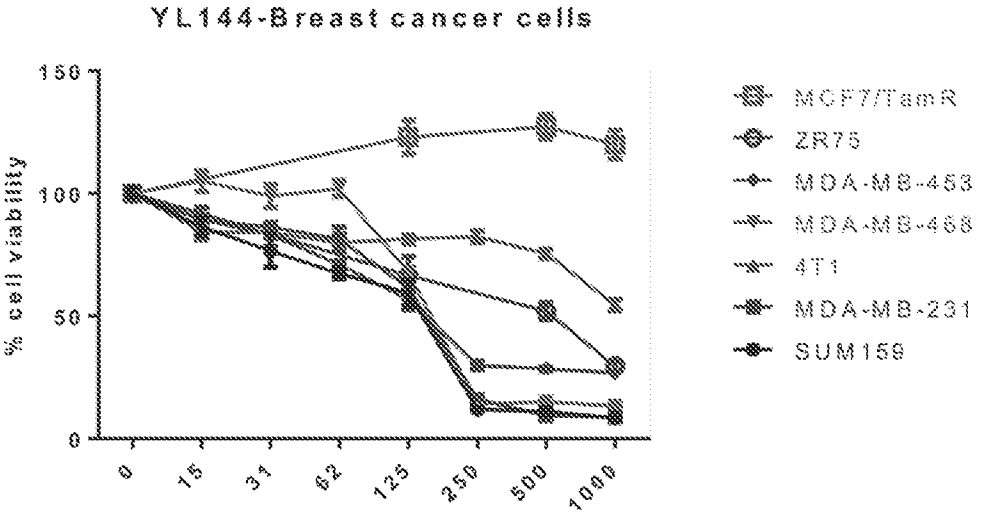

YL144-Breast cancer cells
% cell viability
150
100
50
0
0
15
31
62
125
250
500
1000
MCF7/TamR
ZR75
MDA-MB-453
MDA-MB-468
4T1
MDA-MB-231
SUM159

FIG. 16

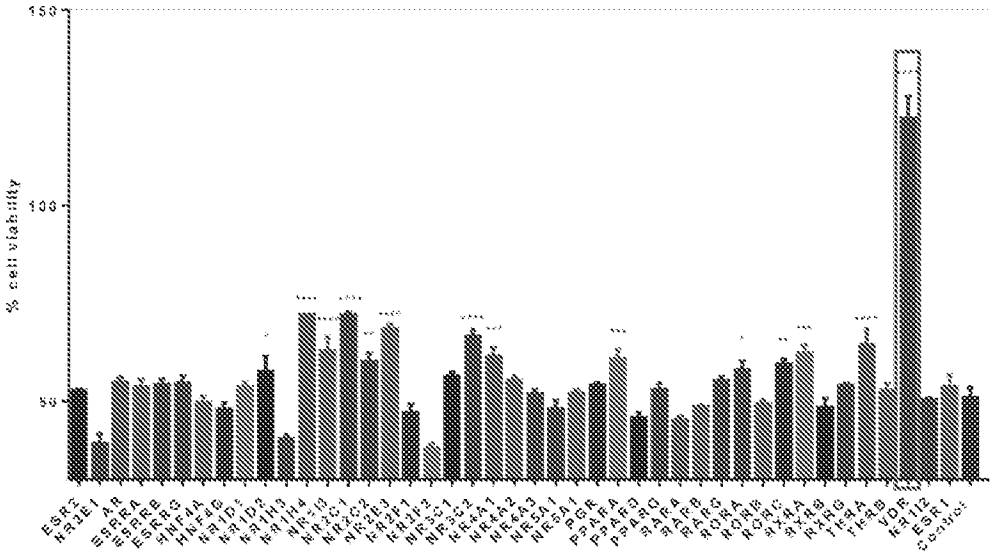

150
100
50
% cell viability
ESRG
NR3E1
AR
ESRRA
ESRRB
ESRRG
HNF4A
HNF4G
NR1D1
NR1D2
RORA
RORB
RORC
NR2C1
NR2C2
NR2E1
NR2F1
NR3C1
NR3C2
NR4A1
NR4A2
NR4A3
NR5A1
PGR
PPARA
PPARD
PPARG
RARA
RARB
RARG
RORA
RORB
RORC
RXRA
RXRB
RXRG
THRA
THRB
VDR
NR1I2
ESR1
Control

FIG. 17

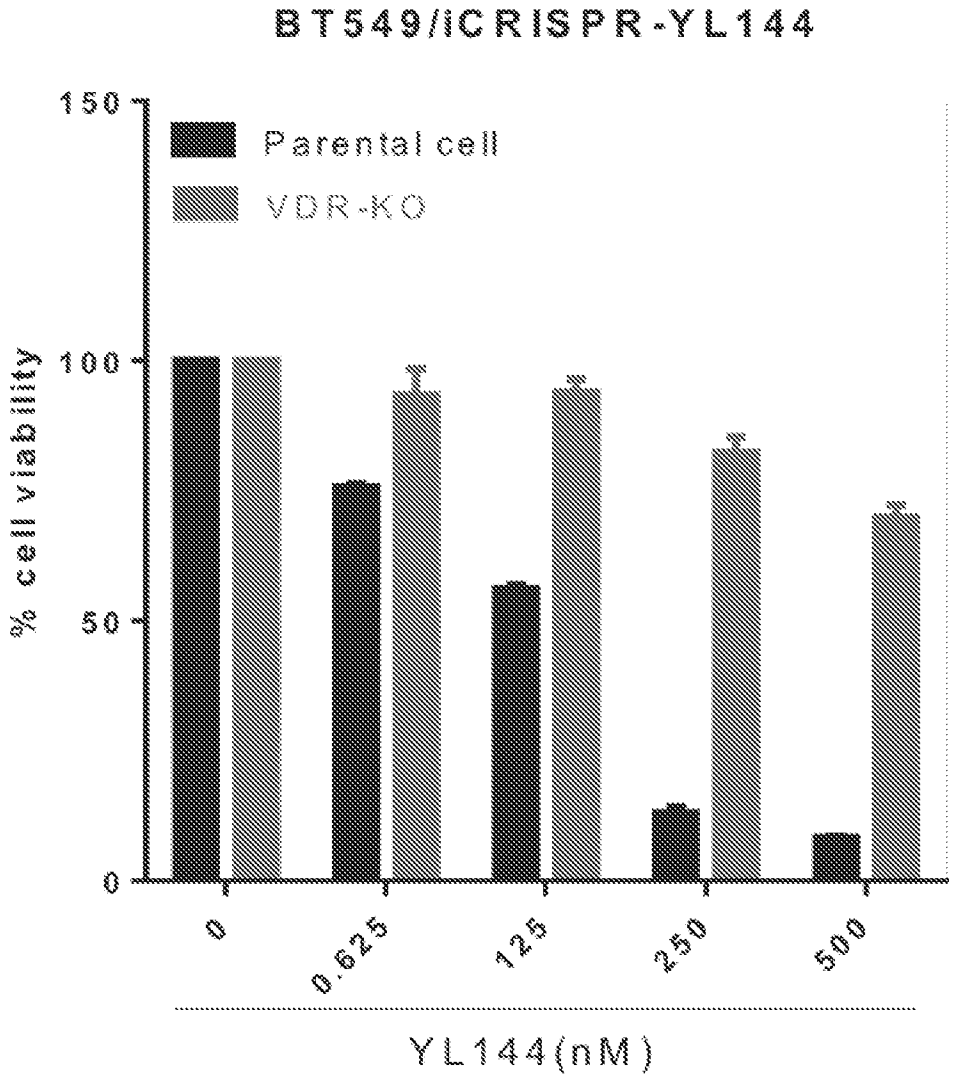
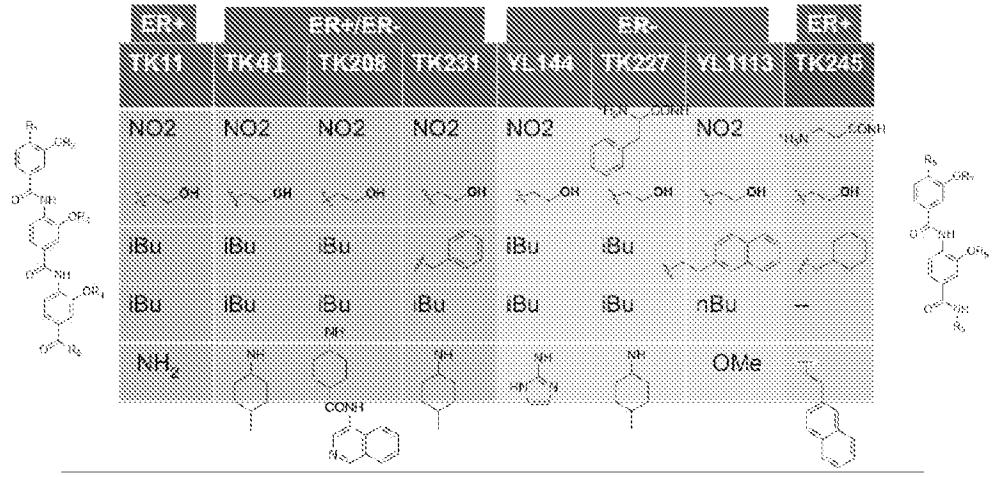

BT549/ICRISPR-YL144
150
100
50
0
% cell viability
Parental cell
VDR-KO
0
0.625
125
250
500
YL144(nM)

FIG. 18



ER+	ZR75	500	125	100	125	500	No effect	No effect	500
	MCF7	350	100	100	125	No effect	No effect	No effect	500
ER-	MDA-MB-231	1000	100	100	125	125	500	125	-
	SUM159	-	100	-	-	-	-	-	No effect

FIG. 19

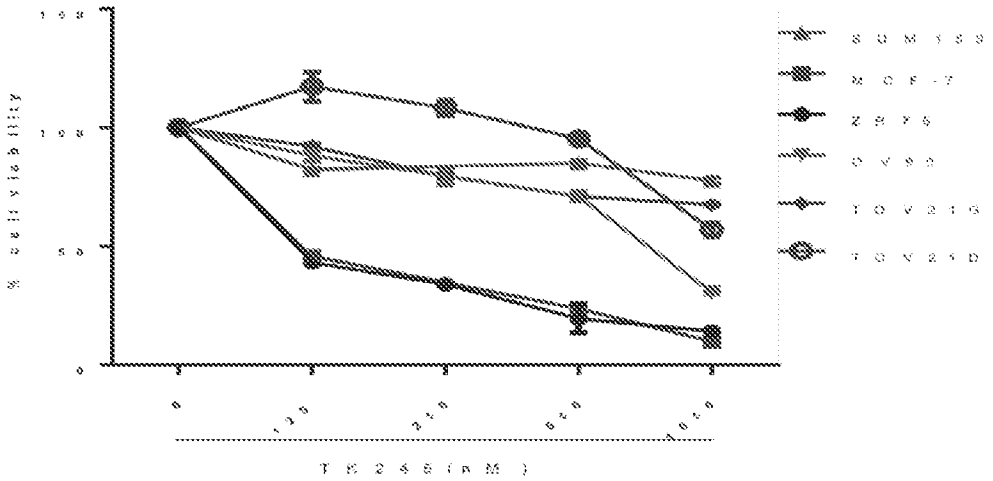


FIG. 20

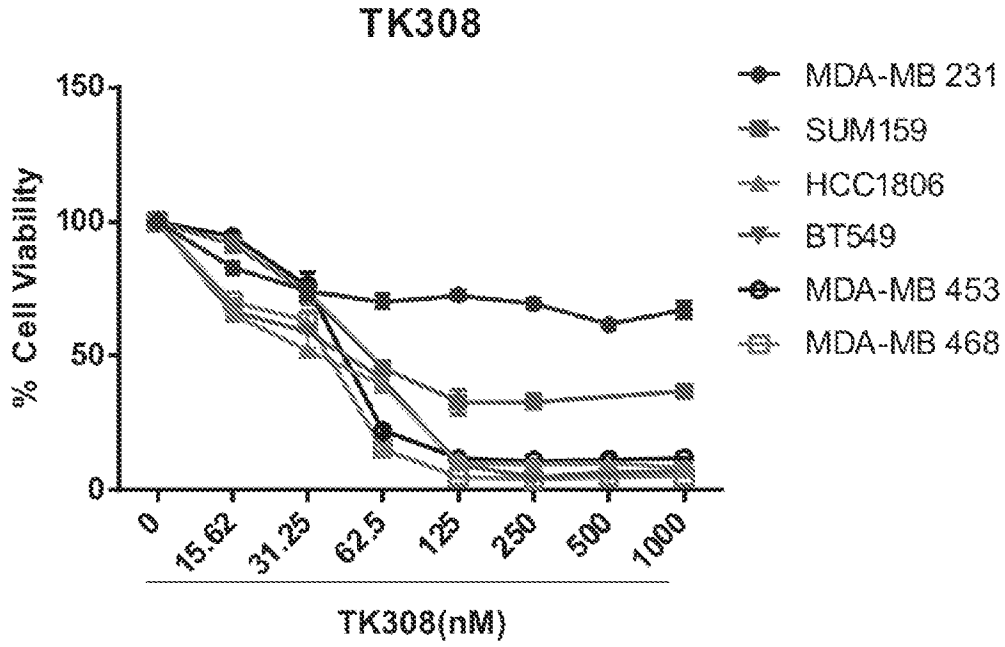

TK308
% Cell Viability
150
100
50
0
0
15.62
31.25
62.5
125
250
500
1000
TK308(nM)
MDA-MB 231
SUM159
HCC1806
BT549
MDA-MB 453
MDA-MB 468

FIG. 21

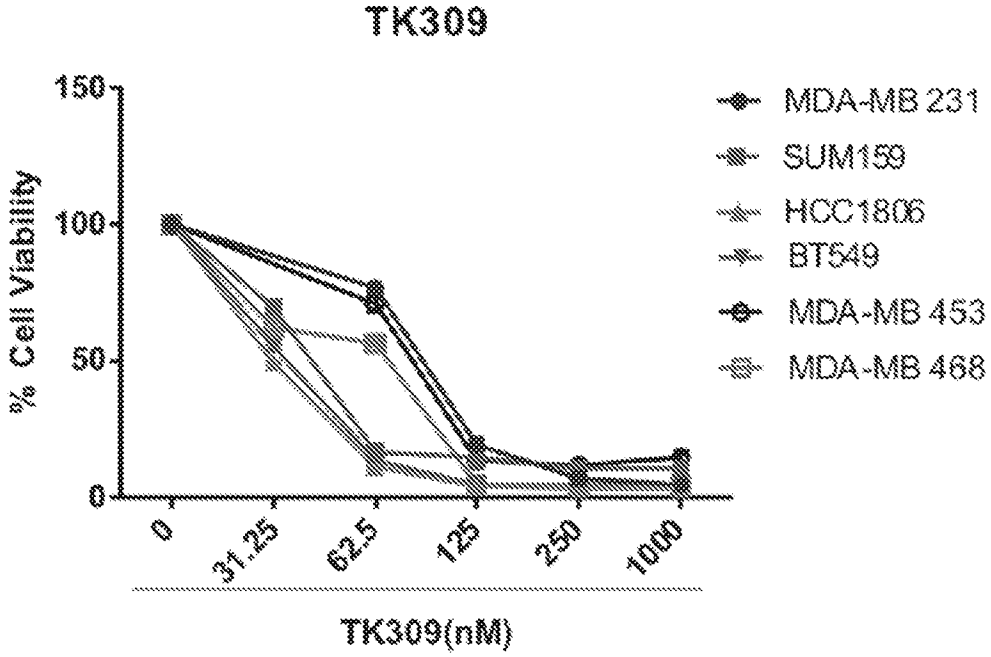

TK309
% Cell Viability
150
100
50
0
0
31.25
62.5
125
250
1000
TK309(nM)
MDA-MB 231
SUM159
HCC1806
BT549
MDA-MB 453
MDA-MB 468

FIG. 22

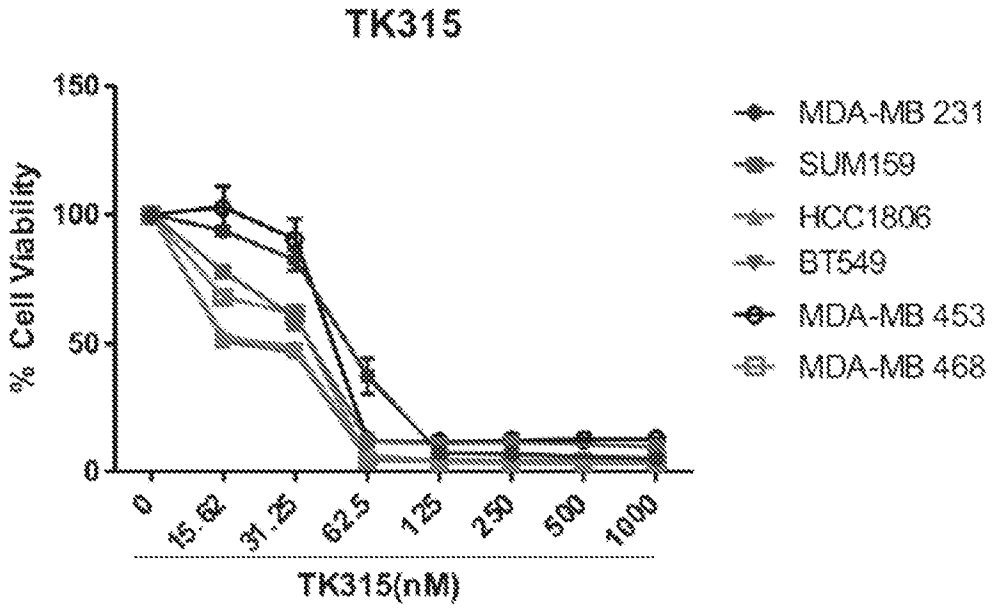

TK315
% Cell Viability
150
100
50
0
0
15.62
31.25
62.5
125
250
500
1000
TK315(nM)
MDA-MB 231
SUM159
HCC1806
BT549
MDA-MB 453
MDA-MB 468

FIG. 23

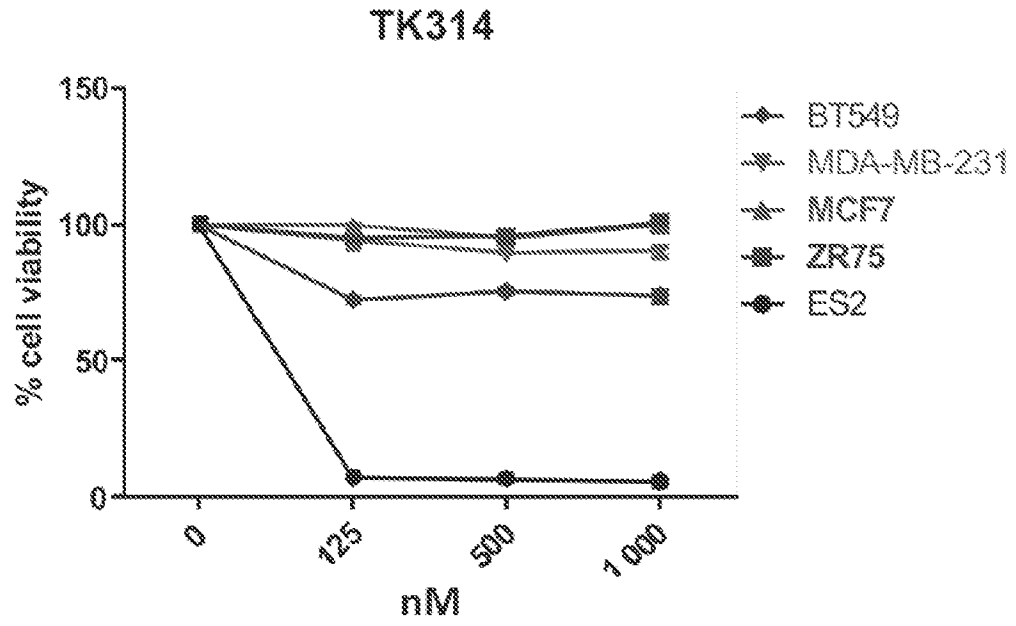

TK314
% cell viability
150
100
50
0
0
125
500
1 000
nM
BT549
MDA-MB-231
MCF7
ZR75
ES2

FIG.24

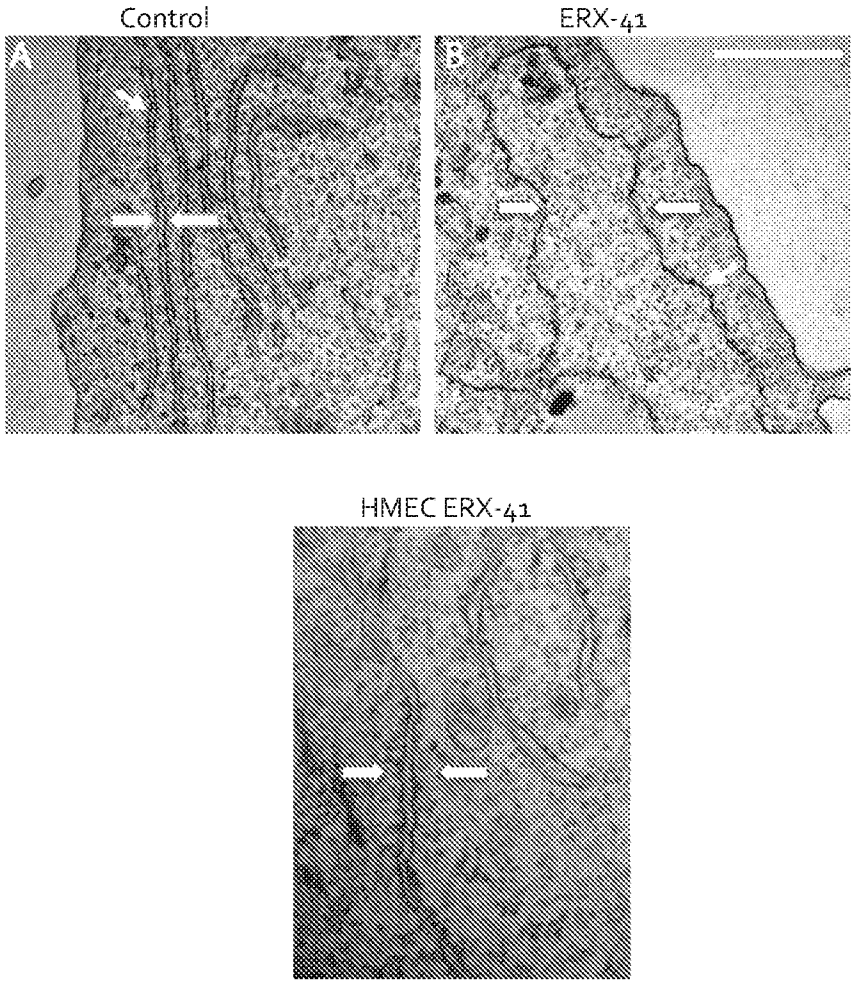

Control
ERX-41
A
B
HMEC ERX-41

FIG.25

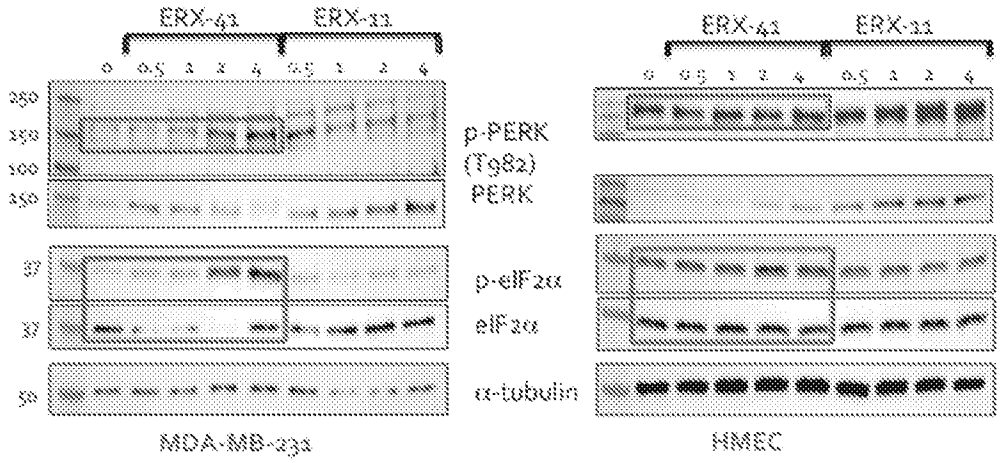

ERX-41
ERX-11
0 0.5 1 2 4 0.5 1 2 4
250
150
100
250
37
37
50
p-PERK
(T982)
PERK
p-eIF2α
eIF2α
α-tubulin
MDA-MB-231
HMEC

FIG.26

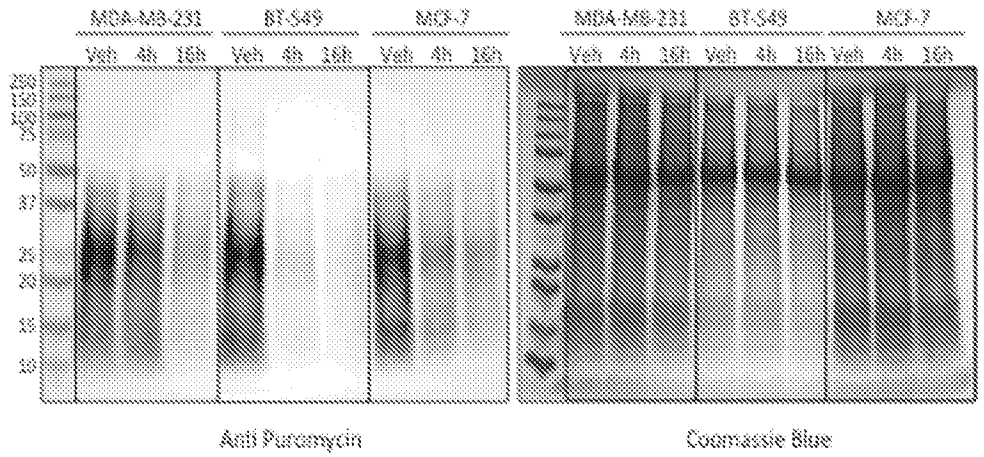

MDA-MB-231
BT-549
MCF-7
Veh
4h
16h
Anti Puromycin
Coomassie Blue

FIG. 27

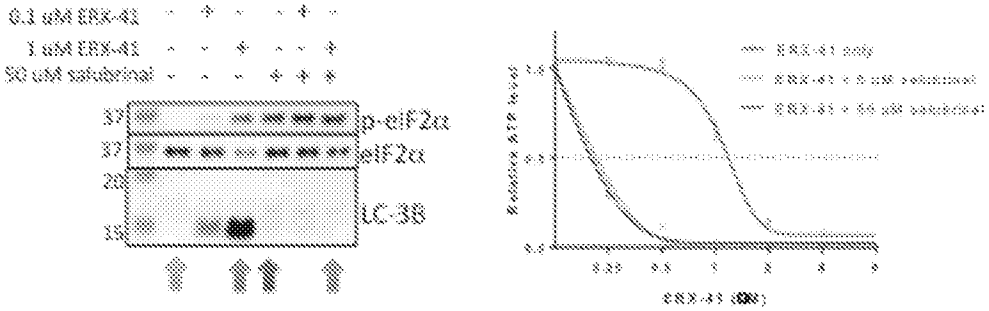

0.3 uM ERX-41
1 uM ERX-41
50 uM salubrinal
p-eIF2α
eIF2α
LC-3B

FIG. 28

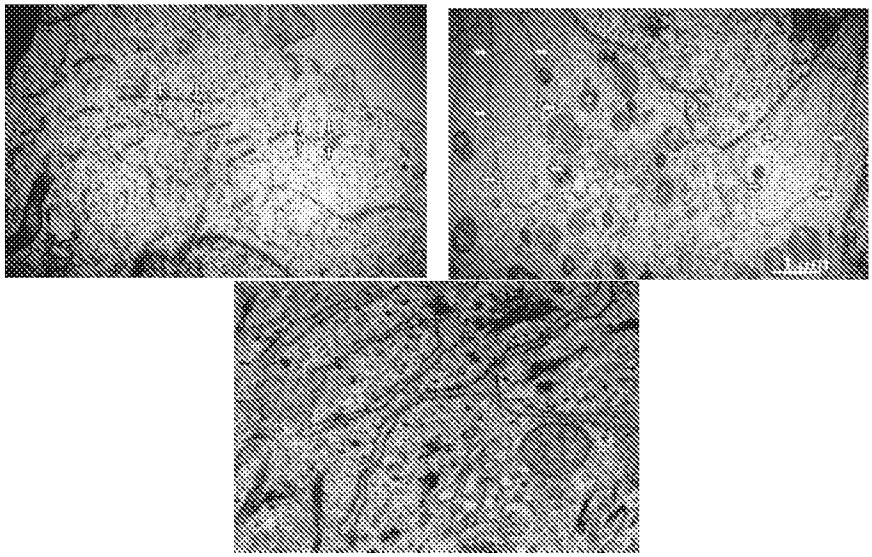


FIG. 29

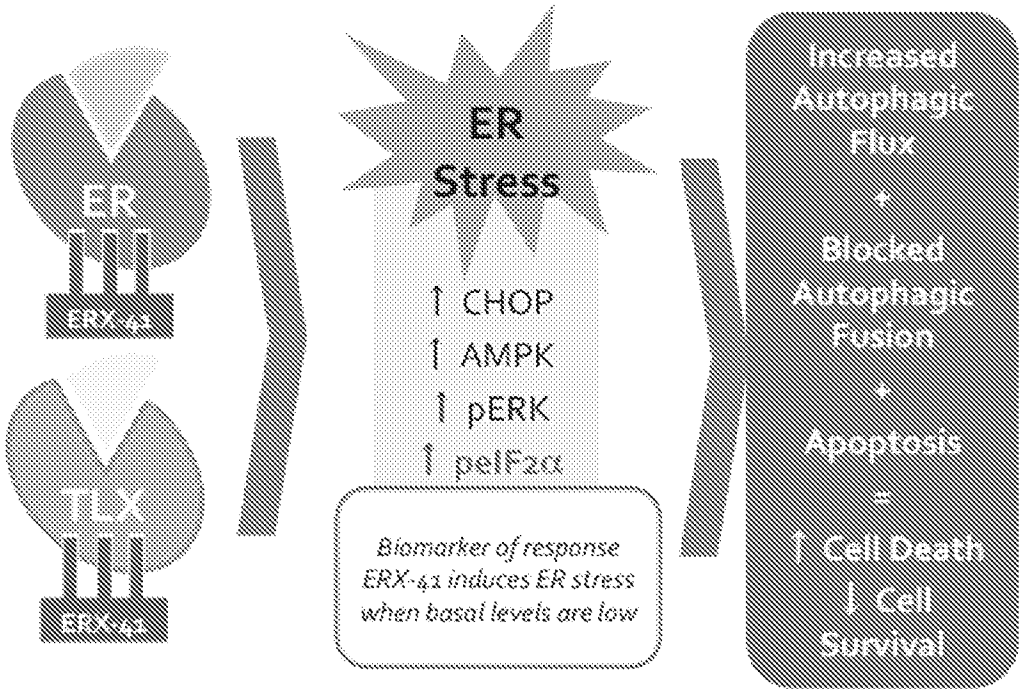
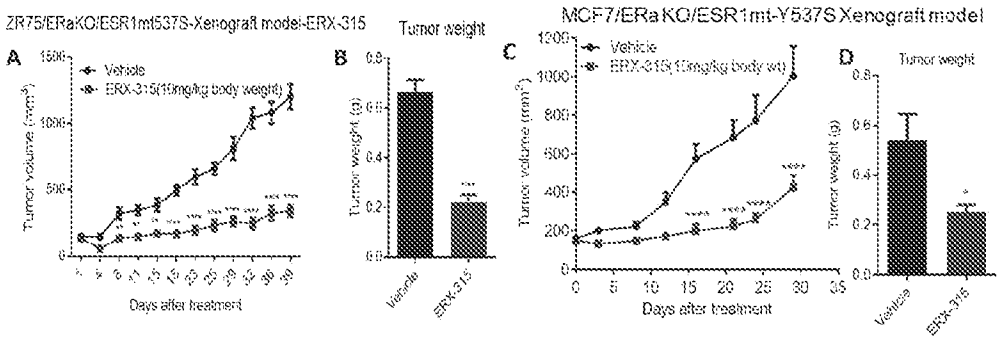
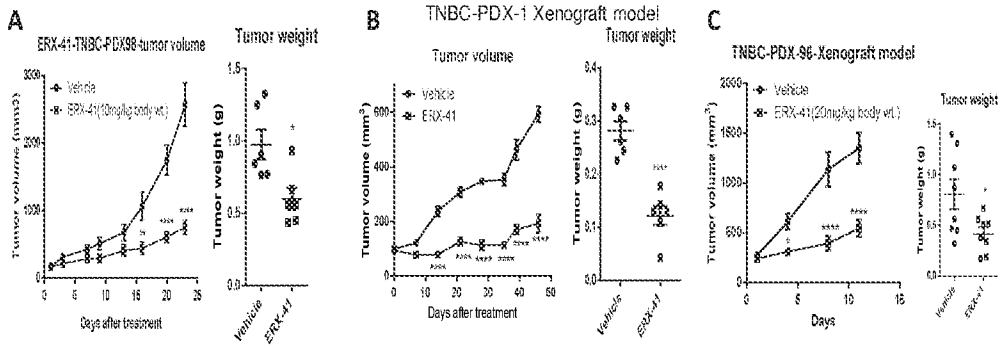

ER
ERX-41
TLX
ERX-41
ER Stress
↑ CHOP
↑ AMPK
↑ pERK
↑ pelF2α
Biomarker of response
ERX-41 induces ER stress
when basal levels are low
Increased Autophagic Flux
+
Blocked Autophagic Fusion
+
Apoptosis
=
↑ Cell Death
↓ Cell Survival

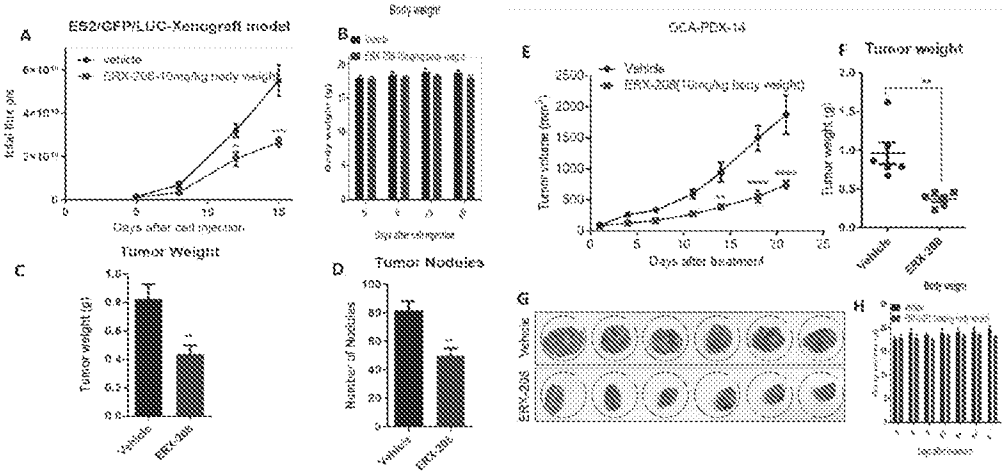
FIG. 30



FIGS. 31A-D



FIGS. 32A-C



FIGS. 33A-H