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YAN SHI ET AL: "One-Bead-Two-Compound Thioether Bridged Macrocyclic [gamma]-AApeptide Screening Library against EphA2", JOURNAL OF MEDICINAL CHEMISTRY, vol. 60, no. 22, 14 November 2017 (2017-11-14), pages 9290-9298, XP055564691, US ISSN: 0022-2623, DOI: 10.1021/acs.jmedchem.7b01280
BAINAN WU ET AL: "Design and Characterization of Novel EphA2 Agonists for Targeted Delivery of Chemotherapy to Cancer Cells", CHEMISTRY AND BIOLOGY, vol. 22, no. 7, 1 July 2015 (2015-07-01), pages 876-887, XP055564697, GB ISSN: 1074-5521, DOI: 10.1016/j.chembiol.2015.06.011
SHIYU CHEN ET AL: "Peptide Ligands Stabilized by Small Molecules", ANGEWANDTE CHEMIE INTERNATIONAL EDITION, vol. 53, no. 6, 3 February 2014 (2014-02-03), pages 1602-1606, XP055356354, DE ISSN: 1433-7851, DOI: 10.1002/anie.201309459
HEINIS CHRISTIAN ET AL: "Phage-encoded combinatorial chemical libraries based on bicyclic peptides", NATURE CHEMICAL BIOLOGY, NATURE PUBLISHING GROUP, BASINGSTOKE, vol. 5, no. 7, 31 May 2009 (2009-05-31), pages 502-507, XP002588858, ISSN: 1552-4450, DOI: 10.1038/NCHEMBIO.184
Gavin Bennett: "Abstract 5855: Bicycle Drug Conjugates targeting EphA2 for the treatment of solid tumors: Discovery and selection of BT5528 | Cancer Research", , 14 April 2018 (2018-04-14), XP055564144, Retrieved

Fortsættes ...

from the Internet: URL:http://cancerres.aacrjournals.org/content/78/13_Supplement/5855 [retrieved on 2019-03-04]

SAYANTAN MITRA ET AL: "Structure-Activity Relationship Analysis of Peptides Targeting the EphA2 Receptor", *BIOCHEMISTRY*, vol. 49, no. 31, 10 August 2010 (2010-08-10), pages 6687-6695, XP055564687, ISSN: 0006-2960, DOI: 10.1021/bi1006223

DESCRIPTION

Description

FIELD OF THE INVENTION

[0001] The present invention relates to polypeptides which are covalently bound to non-aromatic molecular scaffolds such that two or more peptide loops are subtended between attachment points to the scaffold. In particular, the invention describes peptides which are high affinity binders of the Eph receptor tyrosine kinase A2 (EphA2). The invention also includes drug conjugates comprising said peptides, conjugated to one or more effector and/or functional groups, to pharmaceutical compositions comprising said peptide ligands and drug conjugates and to the use of said peptide ligands and drug conjugates in preventing, suppressing or treating a disease or disorder characterised by overexpression of EphA2 in diseased tissue (such as a tumour).

BACKGROUND OF THE INVENTION

[0002] Cyclic peptides are able to bind with high affinity and target specificity to protein targets and hence are an attractive molecule class for the development of therapeutics. In fact, several cyclic peptides are already successfully used in the clinic, as for example the antibacterial peptide vancomycin, the immunosuppressant drug cyclosporine or the anti-cancer drug octreotide (Driggers et al. (2008), Nat Rev Drug Discov 7 (7), 608-24). Good binding properties result from a relatively large interaction surface formed between the peptide and the target as well as the reduced conformational flexibility of the cyclic structures. Typically, macrocycles bind to surfaces of several hundred square angstrom, as for example the cyclic peptide CXCR4 antagonist CVX15 (400 Å²; Wu et al. (2007), Science 330, 1066-71), a cyclic peptide with the Arg-Gly-Asp motif binding to integrin αVβ3 (355 Å²) (Xiong et al. (2002), Science 296 (5565), 151-5) or the cyclic peptide inhibitor upain-1 binding to urokinase-type plasminogen activator (603 Å²; Zhao et al. (2007), J Struct Biol 160 (1), 1-10).

[0003] Due to their cyclic configuration, peptide macrocycles are less flexible than linear peptides, leading to a smaller loss of entropy upon binding to targets and resulting in a higher binding affinity. The reduced flexibility also leads to locking target-specific conformations, increasing binding specificity compared to linear peptides. This effect has been exemplified by a potent and selective inhibitor of matrix metalloproteinase 8, (MMP-8) which lost its selectivity over other MMPs when its ring was opened (Cherney et al. (1998), J Med Chem 41 (11), 1749-51). The favorable binding properties achieved through macrocyclization are even more

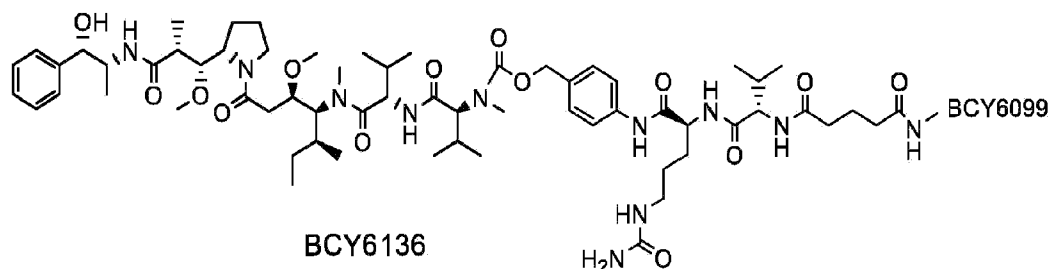
pronounced in multicyclic peptides having more than one peptide ring as for example in vancomycin, nisin and actinomycin.

[0004] Different research teams have previously tethered polypeptides with cysteine residues to a synthetic molecular structure (Kemp and McNamara (1985), J. Org. Chem; Timmerman et al. (2005), ChemBioChem). Meloen and co-workers had used tris(bromomethyl)benzene and related molecules for rapid and quantitative cyclisation of multiple peptide loops onto synthetic scaffolds for structural mimicry of protein surfaces (Timmerman et al. (2005), ChemBioChem). Methods for the generation of candidate drug compounds wherein said compounds are generated by linking cysteine containing polypeptides to a molecular scaffold as for example TATA (1,1',1''-(1,3,5-triazinane-1,3,5-triyl)triprop-2-en-1-one, Heinis et al. Angew Chem, Int Ed. 2014; 53:1602-1606).

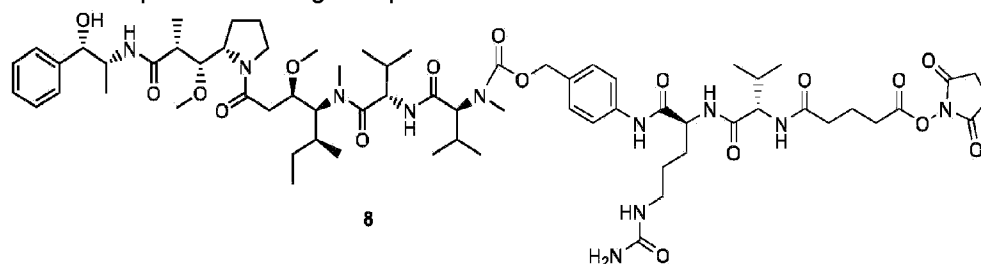
[0005] Phage display-based combinatorial approaches have been developed to generate and screen large libraries of bicyclic peptides to targets of interest (Heinis et al. (2009), Nat Chem Biol 5 (7), 502-7 and WO 2009/098450). Briefly, combinatorial libraries of linear peptides containing three cysteine residues and two regions of six random amino acids (Cys-(Xaa)₆-Cys-(Xaa)₆-Cys) were displayed on phage and cyclised by covalently linking the cysteine side chains to a small molecule scaffold. YAN SHI ET AL: "One-Bead-Two-Compound Thioether Bridged Macrocyclic [gamma]-AApeptide Screening Library against EphA2", JOURNAL OF MEDICINAL CHEMISTRY, vol. 60, no. 22, 14 November 2017 (2017-11-14), pages 9290-9298 discloses a peptide ligand specific for EphA2 that is cyclic. The synthesis is disclosed in figure 1 on page 9291.

SUMMARY OF THE INVENTION

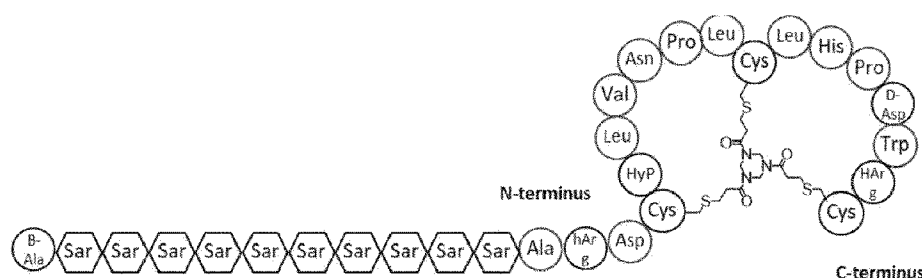
[0006] According to a first aspect of the invention, there is provided a process for preparing BCY6136:



which comprises reacting compound 8:



with compound BCY6099:



BCY6099

wherein Sar is sarcosine, HArg is homoarginine and HyP is hydroxyproline.

[0007] In one embodiment, said reaction is conducted in the presence of DIEA and DMA.

BRIEF DESCRIPTION OF THE FIGURE

[0008] **Figure 1:** General schematic demonstrating the concept of preparing Bicycle drug conjugates (BDCs).

DETAILED DESCRIPTION OF THE INVENTION

[0009] The invention is defined by the claims. Any subject-matter falling outside the scope of the claims is provided for information purposes only.

[0010] The present invention relates to a process for preparing BCY6136 as defined in the claims.

[0011] Disclosed herein is a peptide ligand specific for EphA2 comprising a polypeptide comprising at least three cysteine residues, separated by at least two loop sequences, and a non-aromatic molecular scaffold which forms covalent bonds with the cysteine residues of the polypeptide such that at least two polypeptide loops are formed on the molecular scaffold, wherein the peptide ligand comprises the amino acid sequence:

$C_i(\text{HyP})\text{LVNPLC}_{ii}\text{LHP}(\text{D-Asp})\text{W}(\text{HArg})\text{C}_{iii}$ (SEQ ID NO: 1);

wherein HyP is hydroxyproline, HArg is homoarginine and C_i , C_{ii} and C_{iii} represent first, second and third cysteine residues, respectively or a pharmaceutically acceptable salt thereof.

[0012] Also disclosed herein is a drug conjugate comprising a peptide ligand as defined herein conjugated to one or more effector and/or functional groups.

[0013] Also disclosed herein is a pharmaceutical composition comprising a peptide ligand or a drug conjugate as defined herein in combination with one or more pharmaceutically acceptable excipients.

[0014] Also disclosed herein is a peptide ligand or drug conjugate as defined herein for use in preventing, suppressing or treating a disease or disorder characterised by overexpression of EphA2 in diseased tissue (such as a tumour).

[0015] Peptide ligand BCY6099 comprises the amino acid sequence:

(β -Ala)-Sar₁₀-A(HArg)D-C_i(HyP)LVNPLC_{ii}LHP(D-Asp)W(HArg)C_{iii} (SEQ ID NO: 2) (BCY6099); wherein Sar is sarcosine, HArg is homoarginine and HyP is hydroxyproline and wherein the molecular scaffold is 1,1',1''-(1,3,5-triazinane-1,3,5-triyl)triprop-2-en-1-one (TATA).

[0016] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by those of ordinary skill in the art, such as in the arts of peptide chemistry, cell culture and phage display, nucleic acid chemistry and biochemistry. Standard techniques are used for molecular biology, genetic and biochemical methods (see Sambrook et al., Molecular Cloning: A Laboratory Manual, 3rd ed., 2001, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY; Ausubel et al., Short Protocols in Molecular Biology (1999) 4th ed., John Wiley & Sons, Inc.).

Nomenclature

Numbering

[0017] When referring to amino acid residue positions within the peptides of the invention, cysteine residues (C_i, C_{ii} and C_{iii}) are omitted from the numbering as they are invariant, therefore, the numbering of amino acid residues within the peptides of the invention is referred to as below:

-C_i-HyP₁-L₂-V₃-N₄-P₅-L₆-C_{ii}-L₇-H₈-P₉-(D-Asp)₁₀-W₁₁-(HArg)₁₂-C_{iii}- (SEQ ID NO: 1).

[0018] For the purpose of this description, all bicyclic peptides are assumed to be cyclised with 1,1',1''-(1,3,5-triazinane-1,3,5-triyl)triprop-2-en-1-one (TATA) yielding a tri-substituted 1,1',1''-(1,3,5-triazinane-1,3,5-triyl)tripropan-1-one structure. Cyclisation with TATA occurs on C_i, C_{ii}, and C_{iii}.

Molecular Format

[0019] N- or C-terminal extensions to the bicycle core sequence are added to the left or right side of the sequence, separated by a hyphen. For example, an N-terminal (β -Ala)-Sar₁₀-Ala tail would be denoted as:

(β -Ala)-Sar₁₀-A-(SEQ ID NO: X).

Inversed Peptide Sequences

[0020] In light of the disclosure in Nair et al (2003) J Immunol 170(3), 1362-1373, it is envisaged that the peptide sequences disclosed herein would also find utility in their retro-inverso form. For example, the sequence is reversed (i.e. N-terminus becomes C-terminus and *vice versa*) and their stereochemistry is likewise also reversed (i.e. D-amino acids become L-amino acids and *vice versa*).

Peptide Ligands

[0021] A peptide ligand, as referred to herein, refers to a peptide, peptidic or peptidomimetic covalently bound to a molecular scaffold. Typically, such peptides, peptidics or peptidomimetics comprise a peptide having natural or non-natural amino acids, two or more reactive groups (i.e. cysteine residues) which are capable of forming covalent bonds to the scaffold, and a sequence subtended between said reactive groups which is referred to as the loop sequence, since it forms a loop when the peptide, peptidic or peptidomimetic is bound to the scaffold. In the present case, the peptides, peptidics or peptidomimetics comprise at least three cysteine residues (referred to herein as C_i, C_{ii} and C_{iii}), and form at least two loops on the scaffold.

Advantages of the Peptide Ligands

[0022] Certain bicyclic peptides of the present invention have a number of advantageous properties which enable them to be considered as suitable drug-like molecules for injection, inhalation, nasal, ocular, oral or topical administration. Such advantageous properties include:

- Species cross-reactivity. This is a typical requirement for preclinical pharmacodynamics and pharmacokinetic evaluation;
- Protease stability. Bicyclic peptide ligands should in most circumstances demonstrate stability to plasma proteases, epithelial ("membrane-anchored") proteases, gastric and intestinal proteases, lung surface proteases, intracellular proteases and the like. Protease stability should be maintained between different species such that a bicyclic peptide lead candidate can be developed in animal models as well as administered with confidence to humans;
- Desirable solubility profile. This is a function of the proportion of charged and hydrophilic versus hydrophobic residues and intra/inter-molecular H-bonding, which is important for formulation and absorption purposes;
- An optimal plasma half-life in the circulation. Depending upon the clinical indication and treatment regimen, it may be required to develop a bicyclic peptide with short or prolonged *in vivo* exposure times for the management of either chronic or acute disease states. The optimal exposure time will be governed by the requirement for sustained

exposure (for maximal therapeutic efficiency) versus the requirement for short exposure times to minimise toxicological effects arising from sustained exposure to the agent.

- **Selectivity.** Certain peptide ligands of the invention demonstrate good selectivity over other Eph receptor tyrosine kinases, such as EphA1, EphA3, EphA4, EphA5, EphA6, EphA7, EphB1, factor XIIA, carbonic anhydrase 9 and CD38. It should also be noted that selected peptide ligands of the invention exhibit cross reactivity with other species (eg mouse and rat) to permit testing in animal models (Tables 3, 7-8, 10 and 12); and
- **Safety.** Bleeding events have been reported in pre-clinical *in vivo* models and clinical trials with EphA2 Antibody Drug Conjugates. For example, a phase 1, open-label study with MEDI-547 was halted due to bleeding and coagulation events that occurred in 5 of 6 patients (Annunziata *et al*, Invest New Drugs (2013) 31:77-84). The bleeding events observed in patients were consistent with effects on the coagulation system observed in rat and monkey pre-clinical studies: increased activated partial thromboplastin time and increased fibrinogen/fibrin degradation product (Annunziata *et al* IBID). Overt bleeding events were reportedly seen in toxicology studies in monkeys (Annunziata *et al*, IBID). Taken together these results imply that MEDI-547 causes Disseminated Intravascular Coagulation (DIC) in both preclinical species and patients. The BDCs reported here have short *in vivo* half lives (< 30 minutes) and are therefore intrinsically less likely to give rise to DIC in patients.

Pharmaceutically Acceptable Salts

[0023] It will be appreciated that references herein to peptide ligands include the salt forms of said ligands.

[0024] The salts of the present invention can be synthesized from the parent compound that contains a basic or acidic moiety by conventional chemical methods such as methods described in *Pharmaceutical Salts: Properties, Selection, and Use*, P. Heinrich Stahl (Editor), Camille G. Vermuth (Editor), ISBN: 3-90639-026-8, Hardcover, 388 pages, August 2002. Generally, such salts can be prepared by reacting the free acid or base forms of these compounds with the appropriate base or acid in water or in an organic solvent, or in a mixture of the two.

[0025] Acid addition salts (mono- or di-salts) may be formed with a wide variety of acids, both inorganic and organic. Examples of acid addition salts include mono- or di-salts formed with an acid selected from the group consisting of acetic, 2,2-dichloroacetic, adipic, alginic, ascorbic (e.g. L-ascorbic), L-aspartic, benzenesulfonic, benzoic, 4-acetamidobenzoic, butanoic, (+) camphoric, camphor-sulfonic, (+)-(1S)-camphor-10-sulfonic, capric, caproic, caprylic, cinnamic, citric, cyclamic, dodecylsulfuric, ethane-1,2-disulfonic, ethanesulfonic, 2-hydroxyethanesulfonic, formic, fumaric, galactaric, gentisic, glucoheptonic, D-gluconic, glucuronic (e.g. D-glucuronic), glutamic (e.g. L-glutamic), a-oxoglutaric, glycolic, hippuric, hydrohalic acids (e.g. hydrobromic,

hydrochloric, hydriodic, isethionic, lactic (e.g. (+)-L-lactic, (±)-DL-lactic), lactobionic, maleic, malic, (-)-L-malic, malonic, (±)-DL-mandelic, methanesulfonic, naphthalene-2-sulfonic, naphthalene-1,5-disulfonic, 1-hydroxy-2-naphthoic, nicotinic, nitric, oleic, orotic, oxalic, palmitic, pantoic, phosphoric, propionic, pyruvic, L-pyroglutamic, salicylic, 4-amino-salicylic, sebacic, stearic, succinic, sulfuric, tannic, (+)-L-tartaric, thiocyanic, p-toluenesulfonic, undecylenic and valeric acids, as well as acylated amino acids and cation exchange resins.

[0026] One particular group of salts consists of salts formed from acetic, hydrochloric, hydriodic, phosphoric, nitric, sulfuric, citric, lactic, succinic, maleic, malic, isethionic, fumaric, benzenesulfonic, toluenesulfonic, sulfuric, methanesulfonic (mesylate), ethanesulfonic, naphthalenesulfonic, valeric, propanoic, butanoic, malonic, glucuronic and lactobionic acids. One particular salt is the hydrochloride salt. Another particular salt is the acetate salt.

[0027] If the compound is anionic, or has a functional group which may be anionic (e.g., -COOH may be -COO^-), then a salt may be formed with an organic or inorganic base, generating a suitable cation. Examples of suitable inorganic cations include, but are not limited to, alkali metal ions such as Li^+ , Na^+ and K^+ , alkaline earth metal cations such as Ca^{2+} and Mg^{2+} , and other cations such as Al^{3+} or Zn^{2+} . Examples of suitable organic cations include, but are not limited to, ammonium ion (i.e., NH_4^+) and substituted ammonium ions (e.g., NH_3R^+ , NH_2R_2^+ , NHR_3^+ , NR_4^+). Examples of some suitable substituted ammonium ions are those derived from: methylamine, ethylamine, diethylamine, propylamine, dicyclohexylamine, triethylamine, butylamine, ethylenediamine, ethanolamine, diethanolamine, piperazine, benzylamine, phenylbenzylamine, choline, meglumine, and tromethamine, as well as amino acids, such as lysine and arginine. An example of a common quaternary ammonium ion is $\text{N}(\text{CH}_3)_4^+$.

[0028] Where the peptides of the invention contain an amine function, these may form quaternary ammonium salts, for example by reaction with an alkylating agent according to methods well known to the skilled person. Such quaternary ammonium compounds are within the scope of the peptides of the invention.

Isotopic variations

[0029] The present invention includes all pharmaceutically acceptable (radio)isotope-labeled peptide ligands of the invention, wherein one or more atoms are replaced by atoms having the same atomic number, but an atomic mass or mass number different from the atomic mass or mass number usually found in nature, and peptide ligands of the invention, wherein metal chelating groups are attached (termed "effector") that are capable of holding relevant (radio)isotopes, and peptide ligands of the invention, wherein certain functional groups are covalently replaced with relevant (radio)isotopes or isotopically labelled functional groups.

[0030] Examples of isotopes suitable for inclusion in the peptide ligands of the invention comprise isotopes of hydrogen, such as ^2H (D) and ^3H (T), carbon, such as ^{11}C , ^{13}C and ^{14}C , chlorine, such as ^{36}Cl , fluorine, such as ^{18}F , iodine, such as ^{123}I , ^{125}I and ^{131}I , nitrogen, such as ^{13}N and ^{15}N , oxygen, such as ^{15}O , ^{17}O and ^{18}O , phosphorus, such as ^{32}P , sulfur, such as ^{35}S , copper, such as ^{64}Cu , gallium, such as ^{67}Ga or ^{68}Ga , yttrium, such as ^{90}Y and lutetium, such as ^{177}Lu , and Bismuth, such as ^{213}Bi .

[0031] Certain isotopically-labelled peptide ligands of the invention, for example, those incorporating a radioactive isotope, are useful in drug and/or substrate tissue distribution studies, and to clinically assess the presence and/or absence of the EphA2 target on diseased tissues. The peptide ligands of the invention can further have valuable diagnostic properties in that they can be used for detecting or identifying the formation of a complex between a labelled compound and other molecules, peptides, proteins, enzymes or receptors. The detecting or identifying methods can use compounds that are labelled with labelling agents such as radioisotopes, enzymes, fluorescent substances, luminous substances (for example, luminol, luminol derivatives, luciferin, aequorin and luciferase), etc. The radioactive isotopes tritium, *i.e.* ^3H (T), and carbon-14, *i.e.* ^{14}C , are particularly useful for this purpose in view of their ease of incorporation and ready means of detection.

[0032] Substitution with heavier isotopes such as deuterium, *i.e.* ^2H (D), may afford certain therapeutic advantages resulting from greater metabolic stability, for example, increased *in vivo* half-life or reduced dosage requirements, and hence may be preferred in some circumstances.

[0033] Substitution with positron emitting isotopes, such as ^{11}C , ^{18}F , ^{15}O and ^{13}N , can be useful in Positron Emission Topography (PET) studies for examining target occupancy.

[0034] Isotopically-labeled compounds of peptide ligands of the invention can generally be prepared by conventional techniques known to those skilled in the art or by processes analogous to those described in the accompanying Examples using an appropriate isotopically-labeled reagent in place of the non-labeled reagent previously employed.

Non-Aromatic Molecular scaffold

[0035] References herein to the term "non-aromatic molecular scaffold" refer to any molecular scaffold as defined herein which does not contain an aromatic (*i.e.* unsaturated) carbocyclic or heterocyclic ring system.

[0036] Suitable examples of non-aromatic molecular scaffolds are described in Heinis et al (2014) *Angewandte Chemie, International Edition* 53(6) 1602-1606.

[0037] As noted in the foregoing documents, the molecular scaffold may be a small molecule, such as a small organic molecule.

[0038] In one embodiment the molecular scaffold may be a macromolecule. In one embodiment the molecular scaffold is a macromolecule composed of amino acids, nucleotides or carbohydrates.

[0039] In one embodiment the molecular scaffold comprises reactive groups that are capable of reacting with functional group(s) of the polypeptide to form covalent bonds.

[0040] The molecular scaffold may comprise chemical groups which form the linkage with a peptide, such as amines, thiols, alcohols, ketones, aldehydes, nitriles, carboxylic acids, esters, alkenes, alkynes, azides, anhydrides, succinimides, maleimides, alkyl halides and acyl halides.

[0041] An example of an α unsaturated carbonyl containing compound is 1,1',1''-(1,3,5-triazinane-1,3,5-triyl)triprop-2-en-1-one (TATA) (Angewandte Chemie, International Edition (2014), 53(6), 1602-1606).

Effector and Functional Groups

[0042] According to a further aspect of the disclosure, there is provided a drug conjugate comprising a peptide ligand as defined herein conjugated to one or more effector and/or functional groups.

[0043] Effector and/or functional groups can be attached, for example, to the N and/or C termini of the polypeptide, to an amino acid within the polypeptide, or to the molecular scaffold.

[0044] Appropriate effector groups include antibodies and parts or fragments thereof. For instance, an effector group can include an antibody light chain constant region (CL), an antibody CH1 heavy chain domain, an antibody CH2 heavy chain domain, an antibody CH3 heavy chain domain, or any combination thereof, in addition to the one or more constant region domains. An effector group may also comprise a hinge region of an antibody (such a region normally being found between the CH1 and CH2 domains of an IgG molecule).

[0045] An effector group disclosed herein is an Fc region of an IgG molecule. Advantageously, a peptide ligand-effector group according to the present disclosure comprises or consists of a peptide ligand Fc fusion having a $t_{1/2}$ half-life of a day or more, two days or more, 3 days or more, 4 days or more, 5 days or more, 6 days or more or 7 days or more. Most advantageously, the peptide ligand disclosed herein comprises or consists of a peptide ligand Fc fusion having a $t_{1/2}$ half-life of a day or more.

[0046] Functional groups include, in general, binding groups, drugs, reactive groups for the attachment of other entities, functional groups which aid uptake of the macrocyclic peptides

into cells, and the like.

[0047] The ability of peptides to penetrate into cells will allow peptides against intracellular targets to be effective. Targets that can be accessed by peptides with the ability to penetrate into cells include transcription factors, intracellular signalling molecules such as tyrosine kinases and molecules involved in the apoptotic pathway. Functional groups which enable the penetration of cells include peptides or chemical groups which have been added either to the peptide or the molecular scaffold. Peptides such as those derived from such as VP22, HIV-Tat, a homeobox protein of *Drosophila* (Antennapedia), e.g. as described in Chen and Harrison, *Biochemical Society Transactions* (2007) Volume 35, part 4, p821; Gupta et al. in *Advanced Drug Discovery Reviews* (2004) Volume 57 9637. Examples of short peptides which have been shown to be efficient at translocation through plasma membranes include the 16 amino acid penetratin peptide from *Drosophila* Antennapedia protein (Derossi et al (1994) *J Biol. Chem.* Volume 269 p10444), the 18 amino acid 'model amphipathic peptide' (Oehlke et al (1998) *Biochim Biophys Acts* Volume 1414 p127) and arginine rich regions of the HIV TAT protein. Non peptidic approaches include the use of small molecule mimics or SMOCs that can be easily attached to biomolecules (Okuyama et al (2007) *Nature Methods* Volume 4 p153). Other chemical strategies to add guanidinium groups to molecules also enhance cell penetration (Elson-Scwab et al (2007) *J Biol Chem* Volume 282 p13585). Small molecular weight molecules such as steroids may be added to the molecular scaffold to enhance uptake into cells.

[0048] One class of functional groups which may be attached to peptide ligands includes antibodies and binding fragments thereof, such as Fab, Fv or single domain fragments. In particular, antibodies which bind to proteins capable of increasing the half-life of the peptide ligand *in vivo* may be used.

[0049] A peptide ligand-effector group disclosed herein has a $t_{1/2}$ half-life selected from the group consisting of: 12 hours or more, 24 hours or more, 2 days or more, 3 days or more, 4 days or more, 5 days or more, 6 days or more, 7 days or more, 8 days or more, 9 days or more, 10 days or more, 11 days or more, 12 days or more, 13 days or more, 14 days or more, 15 days or more or 20 days or more. Advantageously a peptide ligand-effector group or composition disclosed herein will have a $t_{1/2}$ range 12 to 60 hours. For example, it will have a $t_{1/2}$ half-life of a day or more or it will be in the range 12 to 26 hours.

[0050] The functional group of the disclosure is selected from a metal chelator, which is suitable for complexing metal radioisotopes of medicinal relevance.

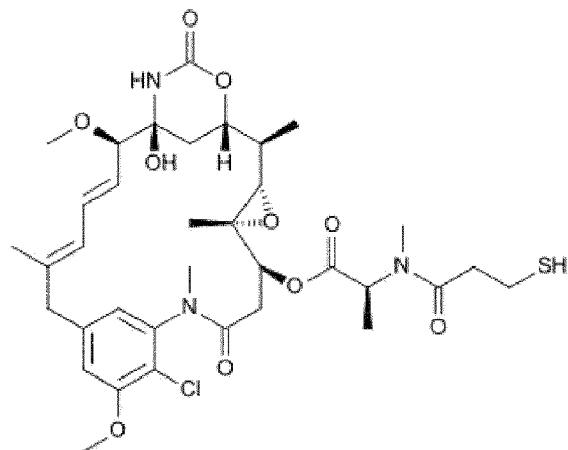
[0051] Possible effector groups also include enzymes, for instance such as carboxypeptidase G2 for use in enzyme/prodrug therapy, where the peptide ligand replaces antibodies in ADEPT.

[0052] The functional group may be selected from a drug, such as a cytotoxic agent for cancer therapy. Suitable examples include: alkylating agents such as cisplatin and carboplatin, as well as oxaliplatin, mechlorethamine, cyclophosphamide, chlorambucil, ifosfamide; Antimetabolites

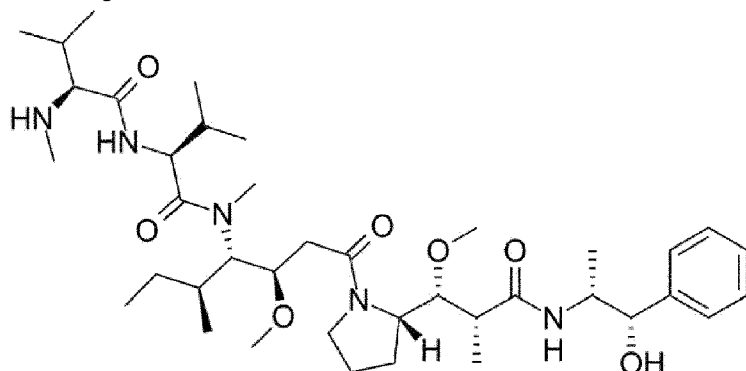
including purine analogs azathioprine and mercaptopurine or pyrimidine analogs; plant alkaloids and terpenoids including vinca alkaloids such as Vincristine, Vinblastine, Vinorelbine and Vindesine; Podophyllotoxin and its derivatives etoposide and teniposide; Taxanes, including paclitaxel, originally known as Taxol; topoisomerase inhibitors including camptothecins: irinotecan and topotecan, and type II inhibitors including amsacrine, etoposide, etoposide phosphate, and teniposide. Further agents can include antitumour antibiotics which include the immunosuppressant dactinomycin (which is used in kidney transplantations), doxorubicin, epirubicin, bleomycin, calicheamycins, and others.

[0053] The cytotoxic agent may be selected from maytansinoids (such as DM1) or monomethyl auristatins (such as MMAE).

[0054] DM1 is a cytotoxic agent which is a thiol-containing derivative of maytansine and has the following structure:



[0055] Monomethyl auristatin E (MMAE) is a synthetic antineoplastic agent and has the following structure:



[0056] The cytotoxic agent may be linked to the bicyclic peptide by a cleavable bond, such as a disulphide bond or a protease sensitive bond. The groups adjacent to the disulphide bond may be modified to control the hindrance of the disulphide bond, and by this the rate of cleavage and concomitant release of cytotoxic agent.

[0057] Published work established the potential for modifying the susceptibility of the disulphide bond to reduction by introducing steric hindrance on either side of the disulphide bond (Kellogg et al (2011) *Bioconjugate Chemistry*, 22, 717). A greater degree of steric hindrance reduces the rate of reduction by intracellular glutathione and also extracellular (systemic) reducing agents, consequentially reducing the ease by which toxin is released, both inside and outside the cell. Thus, selection of the optimum in disulphide stability in the circulation (which minimises undesirable side effects of the toxin) versus efficient release in the intracellular milieu (which maximises the therapeutic effect) can be achieved by careful selection of the degree of hindrance on either side of the disulphide bond.

[0058] The hindrance on either side of the disulphide bond is modulated through introducing one or more methyl groups on either the targeting entity (here, the bicyclic peptide) or toxin side of the molecular construct.

[0059] The drug conjugate may additionally comprise a linker between said peptide ligand and said cytotoxic agents.

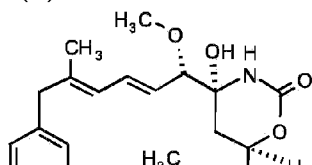
[0060] The cytotoxic agent and linker may be selected from any combinations of those described in WO 2016/067035.

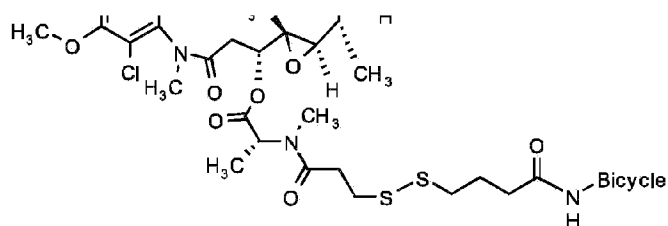
[0061] The cytotoxic agent may be MMAE.

[0062] The linker between said cytotoxic agent and said bicyclic peptide may comprise one or more amino acid residues. Thus, the cytotoxic agent may be MMAE and the linker is selected from: -Val-Cit-, -Trp-Cit-, -Val-Lys-, -D-Trp-Cit-, -Ala-Ala-Asn-, D-Ala-Phe-Lys- or -Glu-Pro-Cit-Gly-hPhe-Tyr-Leu- (SEQ ID NO: 3). The cytotoxic agent may be MMAE and the linker is selected from: -Val-Cit-, -Trp-Cit-, -Val-Lys- or -D-Trp-Cit-. The cytotoxic agent may be MMAE and the linker is -Val-Cit- or -Val-Lys-. The cytotoxic agent may be MMAE and the linker is -Val-Cit-.

[0063] The linker between said cytotoxic agent may comprise a disulfide bond, such as a cleavable disulfide bond. Thus, the cytotoxic agent may be DM1 and the linker is selected from: -S-S-, -SS(SO₃H)-, -SS-(Me)-, -(Me)-SS-(Me)-, -SS-(Me)₂- or -SS-(Me)-SO₃H-. The cytotoxic agent may be DM1 and the linker comprises an -S-S- moiety, such as (N-succinimidyl 3-(2-pyridyldithio)propionate (SPDB), or an -SS(SO₃H)- moiety, such as SO₃H-SPDB. The cytotoxic agent may be DM1 and the linker comprises an -S-S- moiety, such as -S-S- or -S-S-(SO₃H)-.

[0064] The cytotoxic agent may be DM1 and the drug conjugate comprises a compound of formula (A):

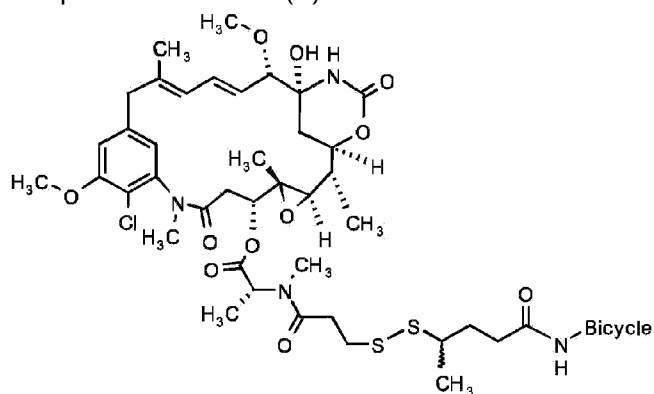




(A)

wherein said bicycle is BCY6099 as defined herein.

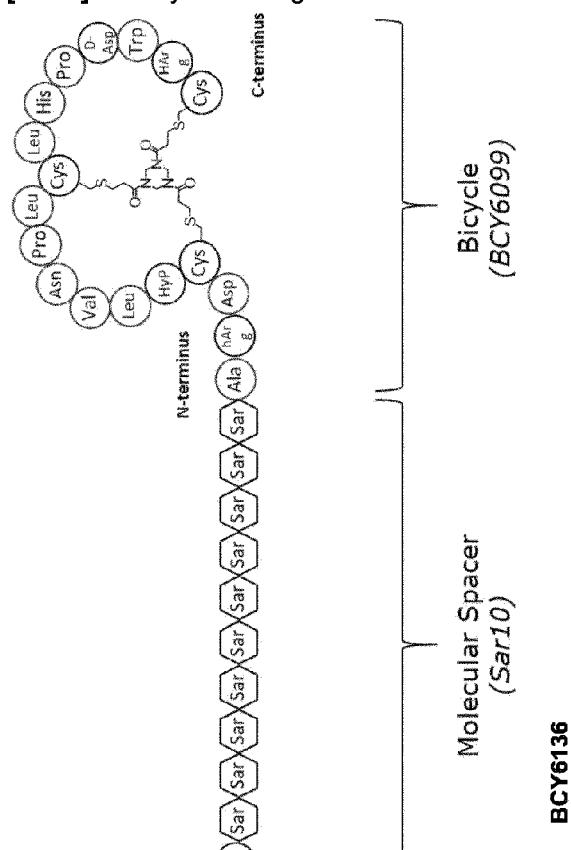
[0065] Alternatively, the cytotoxic agent may be DM1 and the drug conjugate comprises a compound of formula (B):

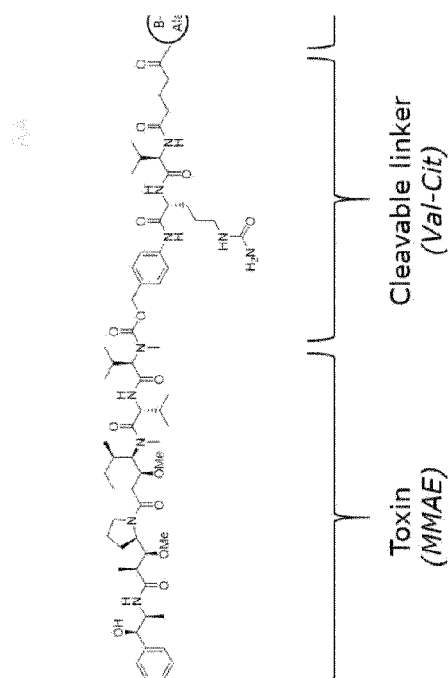


(B)

wherein said bicycle is BCY6099 as defined herein.

[0066] The cytotoxic agent is MMAE and the drug conjugate is BCY6136:





Synthesis

[0067] The peptides of the present invention may be manufactured synthetically by standard techniques followed by reaction with a molecular scaffold *in vitro*. When this is performed, standard chemistry may be used. This enables the rapid large scale preparation of soluble material for further downstream experiments or validation. Such methods could be accomplished using conventional chemistry such as that disclosed in Timmerman *et al* (*supra*).

[0068] Thus, the invention also relates to manufacture of polypeptides or conjugates selected as set out herein, wherein the manufacture comprises optional further steps as explained below. In one embodiment, these steps are carried out on the end product polypeptide/conjugate made by chemical synthesis.

[0069] Optionally amino acid residues in the polypeptide of interest may be substituted when manufacturing a conjugate or complex.

[0070] Peptides can also be extended, to incorporate for example another loop and therefore introduce multiple specificities.

[0071] To extend the peptide, it may simply be extended chemically at its N-terminus or C-terminus or within the loops using orthogonally protected lysines (and analogues) using standard solid phase or solution phase chemistry. Standard (bio)conjugation techniques may be used to introduce an activated or activatable N- or C-terminus. Alternatively additions may be made by fragment condensation or native chemical ligation e.g. as described in (Dawson et al. 1994. Synthesis of Proteins by Native Chemical Ligation. Science 266:776-779), or by

enzymes, for example using subtiligase as described in (Chang et al Proc Natl Acad Sci U S A. 1994 Dec 20; 91(26):12544-8 or in Hikari et al Bioorganic & Medicinal Chemistry Letters Volume 18, Issue 22, 15 November 2008, Pages 6000-6003).

[0072] Alternatively, the peptides may be extended or modified by further conjugation through disulphide bonds. This has the additional advantage of allowing the first and second peptide to dissociate from each other once within the reducing environment of the cell. In this case, the molecular scaffold could be added during the chemical synthesis of the first peptide so as to react with the three cysteine groups; a further cysteine or thiol could then be appended to the N or C-terminus of the first peptide, so that this cysteine or thiol only reacted with a free cysteine or thiol of the second peptide, forming a disulfide-linked bicyclic peptide-peptide conjugate.

[0073] Similar techniques apply equally to the synthesis/coupling of two bicyclic and bispecific macrocycles, potentially creating a tetraspecific molecule.

[0074] Furthermore, addition of other functional groups or effector groups may be accomplished in the same manner, using appropriate chemistry, coupling at the N- or C-termini or via side chains. In one embodiment, the coupling is conducted in such a manner that it does not block the activity of either entity.

Pharmaceutical Compositions

[0075] According to a further aspect of the disclosure, there is provided a pharmaceutical composition comprising a peptide ligand or a drug conjugate as defined herein in combination with one or more pharmaceutically acceptable excipients.

[0076] Generally, the present peptide ligands will be utilised in purified form together with pharmacologically appropriate excipients or carriers. Typically, these excipients or carriers include aqueous or alcoholic/aqueous solutions, emulsions or suspensions, including saline and/or buffered media. Parenteral vehicles include sodium chloride solution, Ringer's dextrose, dextrose and sodium chloride and lactated Ringer's. Suitable physiologically-acceptable adjuvants, if necessary to keep a polypeptide complex in suspension, may be chosen from thickeners such as carboxymethylcellulose, polyvinylpyrrolidone, gelatin and alginates.

[0077] Intravenous vehicles include fluid and nutrient replenishers and electrolyte replenishers, such as those based on Ringer's dextrose. Preservatives and other additives, such as antimicrobials, antioxidants, chelating agents and inert gases, may also be present (Mack (1982) Remington's Pharmaceutical Sciences, 16th Edition).

[0078] The peptide ligands of the present invention may be used as separately administered compositions or in conjunction with other agents. These can include antibodies, antibody fragments and various immunotherapeutic drugs, such as cyclosporine, methotrexate,

adriamycin or cisplatinum and immunotoxins. Pharmaceutical compositions can include "cocktails" of various cytotoxic or other agents in conjunction with the protein ligands of the present invention, or even combinations of selected polypeptides according to the present invention having different specificities, such as polypeptides selected using different target ligands, whether or not they are pooled prior to administration.

[0079] The route of administration of pharmaceutical compositions according to the disclosure may be any of those commonly known to those of ordinary skill in the art. For therapy, the peptide ligands of the invention can be administered to any patient in accordance with standard techniques. The administration can be by any appropriate mode, including parenterally, intravenously, intramuscularly, intraperitoneally, transdermally, via the pulmonary route, or also, appropriately, by direct infusion with a catheter. Preferably, the pharmaceutical compositions according to the disclosure will be administered by inhalation. The dosage and frequency of administration will depend on the age, sex and condition of the patient, concurrent administration of other drugs, counterindications and other parameters to be taken into account by the clinician.

[0080] The peptide ligands of this invention can be lyophilised for storage and reconstituted in a suitable carrier prior to use. This technique has been shown to be effective and art-known lyophilisation and reconstitution techniques can be employed. It will be appreciated by those skilled in the art that lyophilisation and reconstitution can lead to varying degrees of activity loss and that levels may have to be adjusted upward to compensate.

[0081] The compositions containing the present peptide ligands or a cocktail thereof can be administered for prophylactic and/or therapeutic treatments. In certain therapeutic applications, an adequate amount to accomplish at least partial inhibition, suppression, modulation, killing, or some other measurable parameter, of a population of selected cells is defined as a "therapeutically-effective dose". Amounts needed to achieve this dosage will depend upon the severity of the disease and the general state of the patient's own immune system, but generally range from 0.005 to 5.0 mg of selected peptide ligand per kilogram of body weight, with doses of 0.05 to 2.0 mg/kg/dose being more commonly used. For prophylactic applications, compositions containing the present peptide ligands or cocktails thereof may also be administered in similar or slightly lower dosages.

[0082] A composition containing a peptide ligand according to the present invention may be utilised in prophylactic and therapeutic settings to aid in the alteration, inactivation, killing or removal of a select target cell population in a mammal. In addition, the peptide ligands described herein may be used extracorporeally or *in vitro* selectively to kill, deplete or otherwise effectively remove a target cell population from a heterogeneous collection of cells. Blood from a mammal may be combined extracorporeally with the selected peptide ligands whereby the undesired cells are killed or otherwise removed from the blood for return to the mammal in accordance with standard techniques.

Therapeutic Uses

[0083] The bicyclic peptides of the invention have specific utility as EphA2 binding agents.

[0084] Eph receptor tyrosine kinases (Ephs) belong to a large group of receptor tyrosine kinases (RTKs), kinases that phosphorylate proteins on tyrosine residues. Ephs and their membrane bound ephrin ligands (ephrins) control cell positioning and tissue organization (Poliakov et al. (2004) *Dev Cell* 7, 465-80). Functional and biochemical Eph responses occur at higher ligand oligomerization states (Stein et al. (1998) *Genes Dev* 12, 667-678).

[0085] Among other patterning functions, various Ephs and ephrins have been shown to play a role in vascular development. Knockout of EphB4 and ephrin-B2 results in a lack of the ability to remodel capillary beds into blood vessels (Poliakov *et al., supra*) and embryonic lethality. Persistent expression of some Eph receptors and ephrins has also been observed in newly-formed, adult micro-vessels (Brantley-Sieders et al. (2004) *Curr Pharm Des* 10, 3431-42; Adams (2003) *J Anat* 202, 105-12).

[0086] The de-regulated re-emergence of some ephrins and their receptors in adults also has been observed to contribute to tumor invasion, metastasis and neo-angiogenesis (Nakamoto et al. (2002) *Microsc Res Tech* 59, 58-67; Brantley-Sieders *et al., supra*). Furthermore, some Eph family members have been found to be over-expressed on tumor cells from a variety of human tumors (Brantley-Sieders *et al., supra*); Marme (2002) *Ann Hematol* 81 Suppl 2, S66; Booth et al. (2002) *Nat Med* 8, 1360-1).

[0087] EPH receptor A2 (ephrin type-A receptor 2) is a protein that in humans is encoded by the *EPHA2* gene.

[0088] EphA2 is upregulated in multiple cancers in man, often correlating with disease progression, metastasis and poor prognosis e.g.: breast (Zelinski et al (2001) *Cancer Res.* 61, 2301-2306; Zhuang et al (2010) *Cancer Res.* 70, 299-308; Brantley-Sieders et al (2011) *PLoS One* 6, e24426), lung (Brannan et al (2009) *Cancer Prev Res (Phila)* 2, 1039-1049; Kinch et al (2003) *Clin Cancer Res.* 9, 613-618; Guo et al (2013) *J Thorac Oncol.* 8, 301-308), gastric (Nakamura et al (2005) *Cancer Sci.* 96, 42-47; Yuan et al (2009) *Dig Dis Sci* 54, 2410-2417), pancreatic (Mudali et al (2006) *Clin Exp Metastasis* 23, 357-365), prostate (Walker-Daniels et al (1999) *Prostate* 41, 275-280), liver (Yang et al (2009) *Hepatol Res.* 39, 1169-1177) and glioblastoma (Wykosky et al (2005) *Mol Cancer Res.* 3, 541-551; Li et al (2010) *Tumour Biol.* 31, 477-488).

[0089] The full role of EphA2 in cancer progression is still not defined although there is evidence for interaction at numerous stages of cancer progression including tumour cell growth, survival, invasion and angiogenesis. Downregulation of EphA2 expression suppresses tumour cancer cell propagation (Binda et al (2012) *Cancer Cell* 22, 765-780), whilst EphA2 blockade inhibits VEGF induced cell migration (Hess et al (2001) *Cancer Res.* 61, 3250-3255), sprouting and angiogenesis (Cheng et al (2002) *Mol Cancer Res.* 1, 2-11; Lin et al (2007)

Cancer 109, 332-40) and metastatic progression (Brantley-Sieders et al (2005) FASEB J. 19, 1884-1886).

[0090] An antibody drug conjugate to EphA2 has been shown to significantly diminish tumour growth in rat and mouse xenograft models (Jackson et al (2008) Cancer Research 68, 9367-9374) and a similar approach has been tried in man although treatment had to be discontinued for treatment related adverse events (Annunziata et al (2013) Invest New drugs 31, 77-84).

[0091] Polypeptide ligands selected according to the method of the present invention may be employed in *in vivo* therapeutic and prophylactic applications, *in vitro* and *in vivo* diagnostic applications, *in vitro* assay and reagent applications, and the like. Ligands having selected levels of specificity are useful in applications which involve testing in non-human animals, where cross-reactivity is desirable, or in diagnostic applications, where cross-reactivity with homologues or paralogues needs to be carefully controlled. In some applications, such as vaccine applications, the ability to elicit an immune response to predetermined ranges of antigens can be exploited to tailor a vaccine to specific diseases and pathogens.

[0092] Substantially pure peptide ligands of at least 90 to 95% homogeneity are preferred for administration to a mammal, and 98 to 99% or more homogeneity is most preferred for pharmaceutical uses, especially when the mammal is a human. Once purified, partially or to homogeneity as desired, the selected polypeptides may be used diagnostically or therapeutically (including extracorporeally) or in developing and performing assay procedures, immunofluorescent stainings and the like (Lefkovite and Pernis, (1979 and 1981) Immunological Methods, Volumes I and II, Academic Press, NY).

[0093] According to a further aspect of the disclosure, there is provided a peptide ligand or a drug conjugate as defined herein, for use in preventing, suppressing or treating a disease or disorder characterised by overexpression of EphA2 in diseased tissue (such as a tumour).

[0094] According to a further aspect of the disclosure, there is provided a method of preventing, suppressing or treating a disease or disorder characterised by overexpression of EphA2 in diseased tissue (such as a tumour), which comprises administering to a patient in need thereof an effector group and drug conjugate of the peptide ligand as defined herein.

[0095] In one embodiment, the EphA2 is mammalian EphA2. In a further embodiment, the mammalian EphA2 is human EphA2.

[0096] In one embodiment, the disease or disorder characterised by overexpression of EphA2 in diseased tissue is selected from cancer.

[0097] Examples of cancers (and their benign counterparts) which may be treated (or inhibited) include, but are not limited to tumours of epithelial origin (adenomas and carcinomas of various types including adenocarcinomas, squamous carcinomas, transitional cell carcinomas and other carcinomas) such as carcinomas of the bladder and urinary tract,

breast, gastrointestinal tract (including the esophagus, stomach (gastric), small intestine, colon, rectum and anus), liver (hepatocellular carcinoma), gall bladder and biliary system, exocrine pancreas, kidney, lung (for example adenocarcinomas, small cell lung carcinomas, non-small cell lung carcinomas, bronchioalveolar carcinomas and mesotheliomas), head and neck (for example cancers of the tongue, buccal cavity, larynx, pharynx, nasopharynx, tonsil, salivary glands, nasal cavity and paranasal sinuses), ovary, fallopian tubes, peritoneum, vagina, vulva, penis, cervix, myometrium, endometrium, thyroid (for example thyroid follicular carcinoma), adrenal, prostate, skin and adnexae (for example melanoma, basal cell carcinoma, squamous cell carcinoma, keratoacanthoma, dysplastic naevus); haematological malignancies (i.e. leukemias, lymphomas) and premalignant haematological disorders and disorders of borderline malignancy including haematological malignancies and related conditions of lymphoid lineage (for example acute lymphocytic leukemia [ALL], chronic lymphocytic leukemia [CLL], B-cell lymphomas such as diffuse large B-cell lymphoma [DLBCL], follicular lymphoma, Burkitt's lymphoma, mantle cell lymphoma, T-cell lymphomas and leukaemias, natural killer [NK] cell lymphomas, Hodgkin's lymphomas, hairy cell leukaemia, monoclonal gammopathy of uncertain significance, plasmacytoma, multiple myeloma, and post-transplant lymphoproliferative disorders), and haematological malignancies and related conditions of myeloid lineage (for example acute myelogenous leukemia [AML], chronic myelogenous leukemia [CML], chronic myelomonocytic leukemia [CMML], hypereosinophilic syndrome, myeloproliferative disorders such as polycythaemia vera, essential thrombocythaemia and primary myelofibrosis, myeloproliferative syndrome, myelodysplastic syndrome, and promyelocytic leukemia); tumours of mesenchymal origin, for example sarcomas of soft tissue, bone or cartilage such as osteosarcomas, fibrosarcomas, chondrosarcomas, rhabdomyosarcomas, leiomyosarcomas, liposarcomas, angiosarcomas, Kaposi's sarcoma, Ewing's sarcoma, synovial sarcomas, epithelioid sarcomas, gastrointestinal stromal tumours, benign and malignant histiocytomas, and dermatofibrosarcoma protuberans; tumours of the central or peripheral nervous system (for example astrocytomas, gliomas and glioblastomas, meningiomas, ependymomas, pineal tumours and schwannomas); endocrine tumours (for example pituitary tumours, adrenal tumours, islet cell tumours, parathyroid tumours, carcinoid tumours and medullary carcinoma of the thyroid); ocular and adnexal tumours (for example retinoblastoma); germ cell and trophoblastic tumours (for example teratomas, seminomas, dysgerminomas, hydatidiform moles and choriocarcinomas); and paediatric and embryonal tumours (for example medulloblastoma, neuroblastoma, Wilms tumour, and primitive neuroectodermal tumours); or syndromes, congenital or otherwise, which leave the patient susceptible to malignancy (for example Xeroderma Pigmentosum).

[0098] In a further embodiment, the cancer is selected from: breast cancer, lung cancer, gastric cancer, pancreatic cancer, prostate cancer, liver cancer, glioblastoma and angiogenesis.

[0099] In a further embodiment, the cancer is selected from: prostate cancer, lung cancer (such as non-small cell lung carcinomas (NSCLC)), breast cancer (such as triple negative breast cancer), gastric cancer, ovarian cancer, oesophageal cancer, multiple myeloma and fibrosarcoma. In a yet further embodiment, the cancer is prostate cancer. In a yet further

embodiment, the drug conjugate is useful for preventing, suppressing or treating solid tumours such as fibrosarcomas and breast, and non-small cell lung carcinomas. In a yet further embodiment, the cancer is selected from lung cancer, such as non-small cell lung carcinomas (NSCLC). In a further embodiment, the cancer is gastric cancer. In a further embodiment, the cancer is ovarian cancer. In a further embodiment, the cancer is oesophageal cancer. In a further embodiment, the cancer is multiple myeloma. In a further embodiment, the cancer is fibrosarcoma.

[0100] References herein to the term "prevention" involves administration of the protective composition prior to the induction of the disease. "Suppression" refers to administration of the composition after an inductive event, but prior to the clinical appearance of the disease. "Treatment" involves administration of the protective composition after disease symptoms become manifest.

[0101] Animal model systems which can be used to screen the effectiveness of the peptide ligands in protecting against or treating the disease are available. The use of animal model systems is facilitated by the present invention, which allows the development of polypeptide ligands which can cross react with human and animal targets, to allow the use of animal models.

[0102] In one embodiment, the cancer is selected from those identified herein as having increased CNV of EphA2. In a further embodiment, the cancer is breast cancer.

[0103] The invention is further described below with reference to the following examples.

Examples

[0104]

Abbreviations	Name	Precursor Name	Precursor CAS	Supplier
β -Ala	β -Alanine	Fmoc- β -alanine	35737-10-1	Fluorochem
D-Asp	D-Aspartic acid	Fmoc-D-aspartic acid 4-tert-butyl ester	112883-39-3	Sigma aldrich
FI	5(6)-carboxyfluorescein			Sigma
HArg	HomoArginine	Fmoc-L-HomoArg(Pbf)-OH	401915-53-5	Fluorochem
HyP	Hydroxyproline	Fmoc-Hydroxyproline(tBu)-OH	122996-47-8	Sigma

Abbreviations	Name	Precursor Name	Precursor CAS	Supplier
Sar	Sarcosine, such that Sar _x represents x Sar residues	Fmoc-Sarcosine-OH	77128-70-2	Sigma

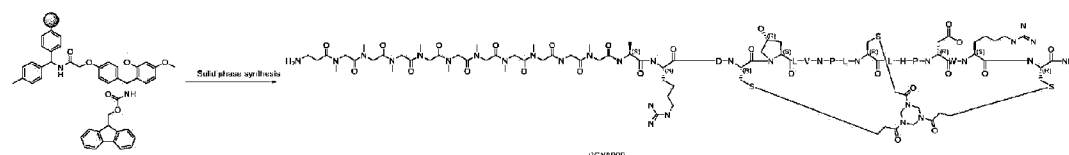
Materials and Methods

Peptide Synthesis

[0105] Peptides were synthesized by solid phase synthesis. Rink Amide MBHA Resin was used. To a mixture containing Rink Amide MBHA (0.4-0.45 mmol/g) and Fmoc-Cys(Trt)-OH (3.0 eq) was added DMF, then DIC (3 eq) and HOAt (3 eq) were added and mixed for 1 hour. 20% piperidine in DMF was used for deblocking. Each subsequent amino acid was coupled with 3 eq using activator reagents, DIC (3.0 eq) and HOAT (3.0 eq) in DMF. The reaction was monitored by ninhydrin color reaction or tetrachlor color reaction. After synthesis completion, the peptide resin was washed with DMF x 3, MeOH x 3, and then dried under N₂ bubbling overnight. The peptide resin was then treated with 92.5% TFA/2.5% TIS/2.5% EDT/2.5% H₂O for 3h. The peptide was precipitated with cold isopropyl ether and centrifuged (3 min at 3000 rpm). The pellet was washed twice with isopropyl ether and the crude peptide was dried under vacuum for 2 hours and then lyophilised. The lyophilised powder was dissolved in of ACN/H₂O (50:50), and a solution of 100 mM TATA in ACN was added, followed by ammonium bicarbonate in H₂O (1M) and the solution mixed for 1 h. Once the cyclisation was complete, the reaction was quenched with 1M aq. Cysteine hydrochloride (10 eq relative to TATA), then mixed and left to stand for an hour. The solution was lyophilised to afford crude product. The crude peptide was purified by Preparative HPLC and lyophilized to give the product

[0106] All amino acids, unless noted otherwise, were used in the L- configurations.

BCY6099



Sequence: (β-Ala)-Sar₁₀-(SEQ ID NO: 2)-CONH₂

[0107] 8.0 g of resin was used to generate 2.1 g BCY6099 (99.2% purity; 16.3% yield) as a

white solid.

BCY6099 Analytical Data	
Mobile Phase:	A: 0.1% TFA in H ₂ O B: 0.1%TFA in ACN
Flow:	1.0ml/min
Column:	Gemini-NX C18 5µm 110A 150*4.6mm
Instrument:	Agilent 1200 HPLC-BE(1-614)
Method:	15-45% B over 20 minutes, then 3 min 95% B
Retention Time:	11.31 min
LCMS (ESI):	m/z 1061.8 [M+3H] ³⁺ , 796.5 [M+4H] ⁴⁺
Peptide mw	3183.68

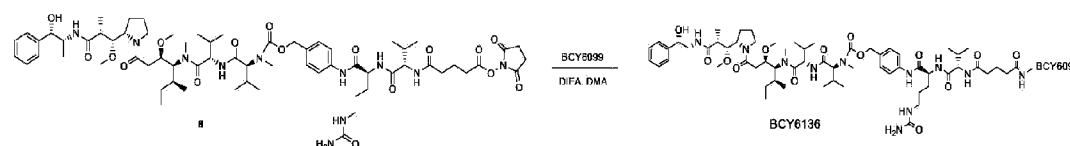
Preparation of Bicyclic Peptide Drug Conjugates

[0108] The general schematic for preparing Bicycle drug conjugates (BDCs) is shown in Figure 1 and Table A describes the component targeting bicycle and linker/toxin within each BDC.

Table A

BDC (BCY Number)	Targetting Bicycle (BCY Number)	Linker/Toxin
6136	6099	ValCit-MMAE

BCY6136



[0109] BCY6099 (71.5 mg, 22.48 µmol) was used as the bicycle reagent. Compound BCY6136 (40.9 mg, 9.05 µmol, 40.27% yield, 97.42% purity) was obtained as a white solid.

BCY6136 Analytical Data	
Mobile Phase:	A: 0.1% TFA in H ₂ O B: 0.1%TFA in ACN
Flow:	1.0ml/min
Column:	Gemini-NX C18 5µm 110A 150*4.6mm
Instrument:	Agilent 1200 HPLC-BE(1-614)
Method:	28-68% B over 30 minutes, then 3 min 95% B
Retention Time:	11.35 min
LCMS (ESI):	m/z 1468.1 [M+3H] ³⁺ , 1101.2 [M+4H] ⁴⁺ , 881.3 [M+5H] ⁵⁺
Peptide mw	4404.2

REFERENCES CITED IN THE DESCRIPTION

Cited references

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- [WO2009098450A \[0005\]](#)
- [WO2016067035A \[0060\]](#)

Non-patent literature cited in the description

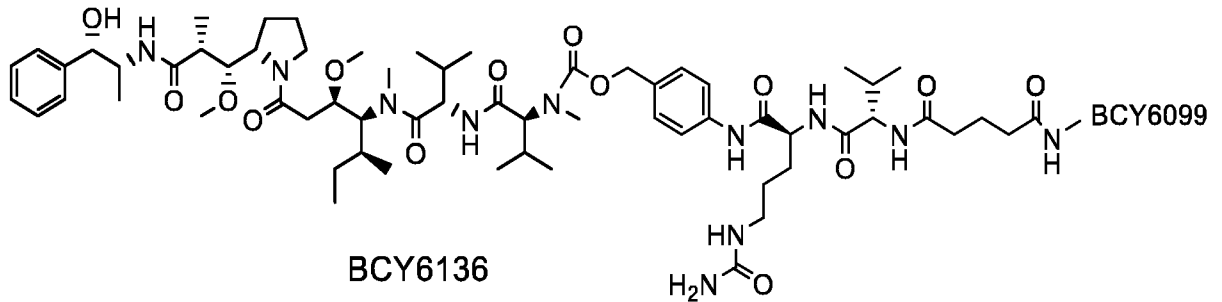
- **DRIGGERS et al.** Nat Rev Drug Discov, 2008, vol. 7, 7608-24 [\[0002\]](#)
- **WU et al.** Science, 2007, vol. 330, 1066-71 [\[0002\]](#)
- **XIONG et al.** Science, 2002, vol. 296, 5565151-5 [\[0002\]](#)
- **ZHAO et al.** J Struct Biol, 2007, vol. 160, 11-10 [\[0002\]](#)
- **CHERNEY et al.** J Med Chem, 1998, vol. 41, 111749-51 [\[0003\]](#)
- **KEMPMCNAMARAJ.** Org. Chem, 1985, [\[0004\]](#)
- **TIMMERMAN et al.** ChemBioChem, 2005, [\[0004\]](#) [\[0004\]](#)
- **HEINIS et al.** Angew Chem, 2014, vol. 53, 1602-1606 [\[0004\]](#)
- **HEINIS et al.** Nat Chem Biol, 2009, vol. 5, 7502-7 [\[0005\]](#)
- **YAN SHI et al.** One-Bead-Two-Compound Thioether Bridged Macrocyclic [gamma]-AApeptide Screening Library against EphA2 JOURNAL OF MEDICINAL CHEMISTRY, 2017, vol. 60, 9290-9298 [\[0005\]](#)
- **SAMBROOK et al.** Molecular Cloning: A Laboratory Manual Cold Spring Harbor Laboratory Press 2001 0000 [\[0016\]](#)
- **AUSUBEL et al.** Short Protocols in Molecular Biology John Wiley & Sons, Inc. 1999 0000 [\[0016\]](#)
- **NAIR et al.** J Immunol, 2003, vol. 170, 31362-1373 [\[0020\]](#)

- **ANNUNZIATA et al.** Invest New Drugs, 2013, vol. 31, 77-84 [0022]
- **Pharmaceutical Salts: Properties, Selection, and Use**, 20020800388- [0024]
- **HEINIS et al.** Angewandte Chemie 20140000 vol. 53, 1602-1606 [0036]
- **Angewandte Chemie** 20140000 vol. 53, 1602-1606 [0041]
- **CHENHARRISON** Biochemical Society Transactions, 2007, vol. 35, 4821- [0047]
- **GUPTA et al.** Advanced Drug Discovery Reviews, 2004, vol. 57, 9637- [0047]
- **DEROSSI et al.** J Biol. Chem., 1994, vol. 269, 10444- [0047]
- **OEHLKE et al.** Biochim Biophys Acts, 1998, vol. 1414, 127- [0047]
- **OKUYAMA et al.** Nature Methods, 2007, vol. 4, 153- [0047]
- **ELSON-SCWAB et al.** J Biol Chem, 2007, vol. 282, 13585- [0047]
- **KELLOGG et al.** Bioconjugate Chemistry, 2011, vol. 22, 717- [0057]
- **DAWSON et al.** Synthesis of Proteins by Native Chemical Ligation Science, 1994, vol. 266, 776-779 [0071]
- **CHANG et al.** Proc Natl Acad Sci U S A., 1994, vol. 91, 2612544-8 [0071]
- **HIKARI et al.** Bioorganic & Medicinal Chemistry Letters, 2008, vol. 18, 226000-6003 [0071]
- **MACK** Remington's Pharmaceutical Sciences 19820000 [0077]
- **POLIAKOV et al.** Dev Cell, 2004, vol. 7, 465-80 [0084]
- **STEIN et al.** Genes Dev, 1998, vol. 12, 667-678 [0084]
- **BRANTLEY-SIEDERS et al.** Curr Pharm Des, 2004, vol. 10, 3431-42 [0085]
- **ADAMS** J Anat, 2003, vol. 202, 105-12 [0085]
- **NAKAMOTO et al.** Microsc Res Tech, 2002, vol. 59, 58-67 [0086]
- **MARME** Ann Hematol, 2002, vol. 81, 2S66- [0086]
- **BOOTH et al.** Nat Med, 2002, vol. 8, 1360-1 [0086]
- **ZELINSKI et al.** Cancer Res., 2001, vol. 61, 2301-2306 [0088]
- **ZHUANG et al.** Cancer Res., 2010, vol. 70, 299-308 [0088]
- **BRANTLEY-SIEDERS et al.** PLoS One, 2011, vol. 6, e24426- [0088]
- **BRANNAN et al.** Cancer Prev Res (Phila), 2009, vol. 2, 1039-1049 [0088]
- **KINCH et al.** Clin Cancer Res., 2003, vol. 9, 613-618 [0088]
- **GUO et al.** J Thorac Oncol., 2013, vol. 8, 301-308 [0088]
- **NAKAMURA et al.** Cancer Sci., 2005, vol. 96, 42-47 [0088]
- **YUAN et al.** Dig Dis Sci, 2009, vol. 54, 2410-2417 [0088]
- **MUDALI et al.** Clin Exp Metastasis, 2006, vol. 23, 357-365 [0088]
- **WALKER-DANIELS et al.** Prostate, 1999, vol. 41, 275-280 [0088]
- **YANG et al.** Hepatol Res., 2009, vol. 39, 1169-1177 [0088]
- **WYKOSKY et al.** Mol Cancer Res., 2005, vol. 3, 541-551 [0088]
- **LI et al.** Tumour Biol., 2010, vol. 31, 477-488 [0088]
- **BINDA et al.** Cancer Cell, 2012, vol. 22, 765-780 [0089]
- **HESS et al.** Cancer Res., 2001, vol. 61, 3250-3255 [0089]
- **CHENG et al.** Mol Cancer Res., 2002, vol. 1, 2-11 [0089]
- **LIN et al.** Cancer, 2007, vol. 109, 332-40 [0089]
- **BRANTLEY-SIEDERS et al.** FASEB J., 2005, vol. 19, 1884-1886 [0089]
- **JACKSON et al.** Cancer Research, 2008, vol. 68, 9367-9374 [0090]
- **ANNUNZIATA et al.** Invest New drugs, 2013, vol. 31, 77-84 [0090]

- LEFKOVITEPERNIS Immunological Methods Academic Press 1979 0000 vol. I-II, [0092]

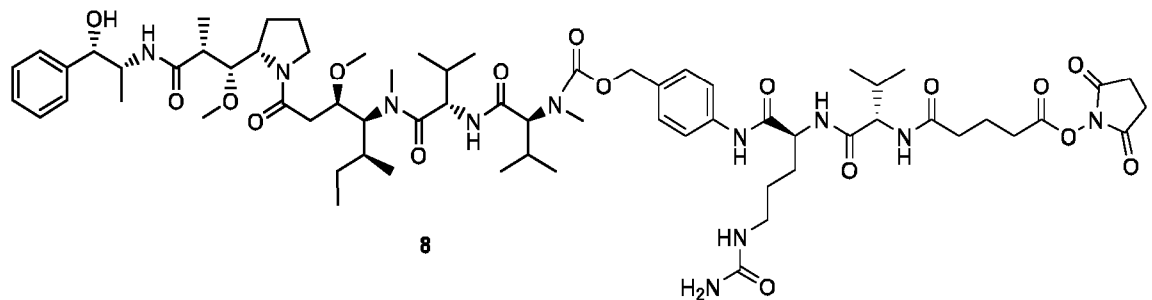
PATENTKRAV

1. Fremgangsmåde til fremstilling af BCY6136:

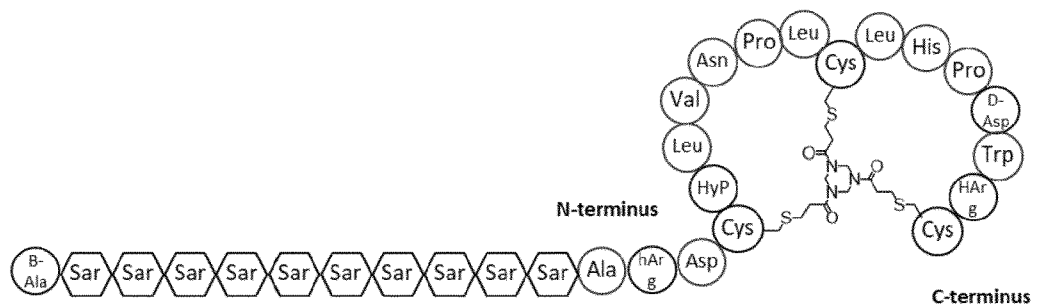


5

der omfatter omsætning af forbindelse 8:



med forbindelsen BCY6099:



10

BCY6099

hvor Sar er sarcosin, HArg er homoarginin og HyP er hydroxyprolin.

2. Fremgangsmåde ifølge krav 1, hvor omsætningen sker i tilstedeværelse af DIEA og DMA.

DRAWINGS

Drawing

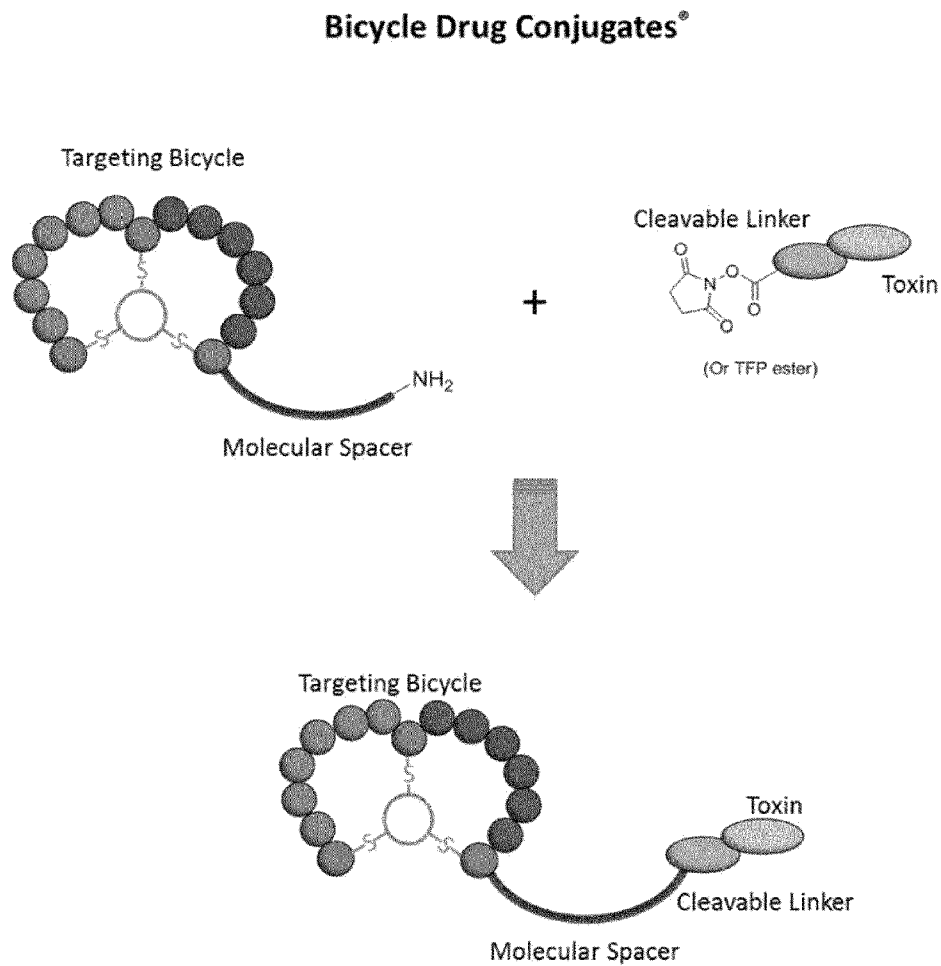


FIGURE 1

SEKVENSLISTE

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