

2016/177802. These molecules are antibody-lipocalin mutein fusion polypeptides, meaning that a lipocalin mutein with binding specificity for CD137 is fused to an anti-Her2 antibody.

Lipocalin muteins (anticalins) are non-antibody scaffolds and the conversion of such modalities into differentiated drugs has been challenging (Vazquez-Lombardi et al. 2015, Drug Discovery

5 Today 20, 1271-1283). Compared to antibodies challenges could arise in view of different serum half-life, tissue penetration and immunogenicity. Thus, there is still a need for drug candidates with improved properties that are based on antibody technology or human-like proteins.

SUMMARY

10 The new antigen binding molecules of the present disclosure combine an anti-Her2 antigen binding domain with a moiety that is capable of forming a costimulatory 4-1BBL trimer and that is sufficiently stable to be pharmaceutically useful. Surprisingly, antigen binding molecules of the disclosure provide a trimeric and thus biologically active human 4-1BB ligand, although one of the trimerizing 4-1BBL ectodomains is located on another polypeptide than the other two 4-1BBL ectodomains of the molecule. Targeted by the anti-Her2 antigen binding domain the

15 antigen binding molecules of the present disclosure have an increased activity on the tumor site, comprise the natural human 4-1BB ligand and should thus impose less safety issues compared to conventional 4-1BB agonistic antibodies or more artificial fusion proteins.

The disclosure provides a 4-1BBL trimer-containing antigen binding molecule comprising

(a) an antigen binding domain capable of specific binding to Her2,

20 (b) a first and a second polypeptide that are linked to each other by a disulfide bond, wherein the antigen binding molecule is characterized in that the first polypeptide comprises two ectodomains of 4-1BBL or a fragment thereof that are connected to each other by a peptide linker and in that the second polypeptide comprises one ectodomain of 4-1BBL or a fragment thereof, and

25 (c) an Fc domain composed of a first and a second subunit capable of stable association.

In one aspect, the disclosure provides a 4-1BBL trimer-containing antigen binding molecule comprising

(a) a Fab molecule capable of specific binding to Her2 comprising

a VH domain comprising an amino acid sequence of SEQ ID NO:19 and a VL domain

30 comprising an amino acid sequence of SEQ ID NO:20, or

a VH domain comprising an amino acid sequence of SEQ ID NO:27 and a VL domain comprising an amino acid sequence of SEQ ID NO:28, or

a VH domain comprising an amino acid sequence of SEQ ID NO:35 and a VL domain comprising an amino acid sequence of SEQ ID NO:36,

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(b) a first and a second polypeptide that are linked to each other by a disulfide bond, wherein the antigen binding molecule is characterized in that the first polypeptide contains a CH1 or CL domain and the second polypeptide contains a CL or CH1 domain, respectively, wherein the second polypeptide is linked to the first polypeptide by a disulfide bond between the CH1 and CL domain, and wherein the first polypeptide comprises two ectodomains of 4-1BBL comprising the amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO: 2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO: 6, SEQ ID NO:7 and SEQ ID NO:8 that are connected to each other and to the CH1 or CL domain by a peptide linker and wherein the second polypeptide comprises one ectodomain of said 4-1BBL comprising the amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO: 2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO: 6, SEQ ID NO:7 and SEQ ID NO:8 connected via a peptide linker to the CL or CH1 domain of said polypeptide, and

(c) an Fc domain composed of a first and a second subunit capable of stable association, wherein the Fc domain is an IgG1 Fc domain comprising the amino acid substitutions L234A, L235A and P329G (numbering according to Kabat EU index).

In a particular example, the disclosure provides a 4-1BBL trimer-containing antigen binding molecule, wherein the ectodomain of 4-1BBL or a fragment thereof comprises the amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO: 2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO: 6, SEQ ID NO:7 and SEQ ID NO:8, particularly the amino acid sequence of SEQ ID NO:1 or SEQ ID NO:5.

In a further example, the disclosure provides a 4-1BBL trimer-containing antigen binding molecule, comprising

(a) an antigen binding domain capable of specific binding to Her2,

(b) a first and a second polypeptide that are linked to each other by a disulfide bond,

sequence of SEQ ID NO:38, or

(b) a first heavy chain comprising the amino acid sequence of SEQ ID NO:47, a first light chain comprising the amino acid sequence of SEQ ID NO:48, a second heavy chain comprising the amino acid sequence of SEQ ID NO:37 and a second light chain comprising the amino acid

5 sequence of SEQ ID NO:38, or

(c) a first heavy chain comprising the amino acid sequence of SEQ ID NO:49, a first light chain comprising the amino acid sequence of SEQ ID NO:50, a second heavy chain comprising the amino acid sequence of SEQ ID NO:37 and a second light chain comprising the amino acid sequence of SEQ ID NO:38.

10 According to another aspect of the disclosure, there is provided an isolated nucleic acid molecule encoding a 4-1BBL trimer-containing antigen binding molecule as defined herein before. There is provided a vector, particularly an expression vector, comprising the isolated nucleic acid molecule of the disclosure. According to another aspect of the disclosure, there is provided an expression vector comprising the isolated nucleic acid molecule of the disclosure.

15 According to another aspect of the disclosure, there is provided a host cell comprising the isolated nucleic acid or the vector of the disclosure. In some examples the host cell is an eukaryotic cell, particularly a mammalian cell.

There is also provided a method for producing the 4-1BBL trimer-containing antigen binding molecule of the disclosure, comprising culturing the host cell of the disclosure under
20 conditions suitable for expression of the 4-1BBL trimer-containing antigen binding molecule, and isolating the 4-1BBL trimer-containing antigen binding molecule. In another aspect, there is provided a method of producing the 4-1BBL trimer-containing antigen binding molecule of the disclosure, comprising culturing the host cell of the disclosure under conditions suitable for expression of the 4-1BBL trimer-containing antigen binding molecule. In another aspect, there is
25 provide a 4-1BBL trimer-containing antigen binding molecule produced by the method of the disclosure.

In another aspect, there is provided a pharmaceutical composition comprising the 4-1BBL trimer-containing antigen binding molecule of the disclosure and at least one pharmaceutically acceptable excipient. In another example, a pharmaceutical composition is provided comprising
30 the 4-1BBL trimer-containing antigen binding molecule of the disclosure and at least one pharmaceutically acceptable excipient, further comprising an additional therapeutic agent, e.g. a chemotherapeutic agent and/ or other agents for use in cancer immunotherapy. In a further example, provided is a pharmaceutical composition further comprising a T-cell activating anti-CD3 bispecific antibody, in particular an anti-Her2/anti-CD3 bispecific antibody.

of the disclosure, for use in the treatment of cancer. In another example, provided is the 4-1BBL trimer-containing antigen binding molecule of the disclosure, or the pharmaceutical composition of the disclosure, for use in up-regulating or prolonging cytotoxic T cell activity. In another aspect, there is provided the 4-1BBL trimer-containing antigen binding molecule of the disclosure for use in the treatment of Her2-positive cancer.

In another example, provided is the 4-1BBL trimer-containing antigen binding molecule of the disclosure, or the pharmaceutical composition of the disclosure, for use in the treatment of cancer, wherein the the 4-1BBL trimer-containing antigen binding molecule is used in combination with another therapeutic agent, in particular a T-cell activating anti-CD3 bispecific antibody. In one example, the T-cell activating anti-CD3 bispecific antibody is administered concurrently with, prior to, or subsequently to the 4-1BBL trimer-containing antigen binding molecule.

In another aspect, there is provided the 4-1BBL trimer-containing antigen binding molecule of the disclosure for use in the treatment of Her2-positive cancer, wherein the 4-1BBL trimer-containing antigen binding molecule is used in combination with a T-cell activating anti-CD3 bispecific antibody and wherein the T-cell activating anti-CD3 bispecific antibody is to be administered concurrently with, prior to, or subsequently to the 4-1BBL trimer-containing antigen binding molecule.

Also provided is the use of the 4-1BBL trimer-containing antigen binding molecule of the disclosure for the manufacture of a medicament for the treatment of a disease in an individual in need thereof, in particular for the manufacture of a medicament for the treatment of cancer, as well as a method of treating a disease in an individual, comprising administering to said individual a therapeutically effective amount of a composition comprising the 4-1BBL trimer-containing antigen binding molecule as disclosed herein in a pharmaceutically acceptable form. In a specific example, the disease is cancer. In another aspect, there is provided use of the 4-1BBL trimer-containing antigen binding molecule of the disclosure in the manufacture of a medicament for the treatment of Her2-positive cancer. Further provided is the use of the 4-1BBL trimer-containing antigen binding molecule of the disclosure for the manufacture of a medicament for the treatment of cancer, wherein the 4-1BBL trimer-containing antigen binding molecule is used in combination with a T-cell activating anti-CD3 bispecific antibody, in particular an anti-Her2/anti-CD3 antibody. In another aspect, there is provided use of the 4-1BBL trimer-containing antigen binding molecule of the disclosure in the manufacture of a medicament for the treatment of Her2-positive cancer, wherein the 4-1BBL trimer-containing antigen binding molecule is used in combination with with a T-cell activating anti-CD3 bispecific antibody.

Furthermore, provided is a method for treating an individual having cancer comprising administering to the subject an effective amount of the 4-1BBL trimer-containing antigen binding molecule of the disclosure, or a pharmaceutical composition thereof, and an effective
5 amount of a T-cell activating anti-CD3 bispecific antibody, in particular an anti-Her2/anti-CD3 antibody. Also provided is a method of up-regulating or prolonging cytotoxic T cell activity in an individual having cancer, comprising administering to the individual an effective amount of the 4-1BBL trimer-containing antigen binding molecule of the disclosure, or the pharmaceutical composition of the disclosure. In any of the above examples the individual is preferably a
10 mammal, particularly a human.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows the components for the assembly of the monovalent Her2-targeting split trimeric 4-1BB ligand Fc fusion antigen binding molecules. **Fig. 1A** shows the dimeric 4-1BB ligand that is fused at the C-terminus to a human IgG1-CL domain with mutations E123R and
15 Q124K (charged variant) and **Fig. 1B** shows the monomeric 4-1BB ligand fused at its C-terminus to a human IgG1-CH1 domain with mutations K147E and K213E (charged variant).

Claims

1. A 4-1BBL trimer-containing antigen binding molecule comprising
(a) a Fab molecule capable of specific binding to Her2 comprising
5 a VH domain comprising an amino acid sequence of SEQ ID NO:19 and a VL domain comprising an amino acid sequence of SEQ ID NO:20, or
a VH domain comprising an amino acid sequence of SEQ ID NO:27 and a VL domain comprising an amino acid sequence of SEQ ID NO:28, or
10 a VH domain comprising an amino acid sequence of SEQ ID NO:35 and a VL domain comprising an amino acid sequence of SEQ ID NO:36,
(b) a first and a second polypeptide that are linked to each other by a disulfide bond, wherein the antigen binding molecule is characterized in that the first polypeptide contains a CH1 or CL domain and the second polypeptide contains a CL or CH1 domain, respectively, wherein the second polypeptide is linked to the first polypeptide by a disulfide bond
15 between the CH1 and CL domain, and wherein the first polypeptide comprises two ectodomains of 4-1BBL comprising the amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO: 2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO: 6, SEQ ID NO:7 and SEQ ID NO:8 that are connected to each other and to the CH1 or CL domain by a peptide linker and wherein the second polypeptide comprises one
20 ectodomain of said 4-1BBL comprising the amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO: 2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO: 6, SEQ ID NO:7 and SEQ ID NO:8 connected via a peptide linker to the CL or CH1 domain of said polypeptide, and
(c) an Fc domain composed of a first and a second subunit capable of stable association,
25 wherein the Fc domain is an IgG1 Fc domain comprising the amino acid substitutions L234A, L235A and P329G (numbering according to Kabat EU index).
2. The 4-1BBL trimer-containing antigen binding molecule of claim 1, wherein the ectodomain of 4-1BBL comprises the amino acid sequence of SEQ ID NO:1 or SEQ ID NO:5.
3. The 4-1BBL trimer-containing antigen binding molecule of claim 1 or 2, wherein the Fc
30 domain comprises knob-into-hole modifications promoting association of the first and the second subunit of the Fc domain.
4. The 4-1BBL trimer-containing antigen binding molecule of any one of claims 1 to 3, wherein the antigen binding molecule comprises
(i) a first heavy chain comprising the VH domain comprising the amino acid sequence of
35 SEQ ID NO:19 and a first light chain comprising the VL domain comprising the amino acid

sequence of SEQ ID NO:20 or

a first heavy chain comprising the VH domain comprising the amino acid sequence of SEQ ID NO:27 and a first light chain comprising the VL domain comprising the amino acid sequence of SEQ ID NO:28, or

5 a first heavy chain comprising the VH domain comprising the amino acid sequence of SEQ ID NO:35 and a first light chain comprising the VL domain comprising the amino acid sequence of SEQ ID NO:36,

(ii) a second heavy chain comprising the amino acid sequence selected from the group consisting of SEQ ID NO:37, SEQ ID NO:39, SEQ ID NO:41 and SEQ ID NO:43, and

10 (iii) a second light chain comprising the amino acid sequence selected from the group consisting of SEQ ID NO:38, SEQ ID NO:40, SEQ ID NO:42 and SEQ ID NO:44.

5. The 4-1BBL trimer-containing antigen binding molecule of any one of claims 1 to 4, wherein the antigen binding molecule comprises

15 (a) a first heavy chain comprising the amino acid sequence of SEQ ID NO:45, a first light chain comprising the amino acid sequence of SEQ ID NO:46, a second heavy chain comprising the amino acid sequence of SEQ ID NO:37 and a second light chain comprising the amino acid sequence of SEQ ID NO:38, or

20 (b) a first heavy chain comprising the amino acid sequence of SEQ ID NO:47, a first light chain comprising the amino acid sequence of SEQ ID NO:48, a second heavy chain comprising the amino acid sequence of SEQ ID NO:37 and a second light chain comprising the amino acid sequence of SEQ ID NO:38, or

25 (c) a first heavy chain comprising the amino acid sequence of SEQ ID NO:49, a first light chain comprising the amino acid sequence of SEQ ID NO:50, a second heavy chain comprising the amino acid sequence of SEQ ID NO:37 and a second light chain comprising the amino acid sequence of SEQ ID NO:38.

6. Isolated nucleic acid molecule encoding the 4-1BBL trimer-containing antigen binding molecule of any one of claims 1 to 5.

7. An expression vector comprising the isolated nucleic acid molecule of claim 6.

8. A host cell comprising the nucleic acid of claim 6 or the expression vector of claim 7.

30 9. A method of producing the 4-1BBL trimer-containing antigen binding molecule of any one of claims 1 to 5, comprising culturing the host cell of claim 8 under conditions suitable for expression of the 4-1BBL trimer-containing antigen binding molecule.

10. The method of claim 9, further comprising recovering the antibody from the host cell.
11. A 4-1BBL trimer-containing antigen binding molecule produced by the method of claim 10.
12. A pharmaceutical composition comprising the 4-1BBL trimer-containing antigen binding molecule of any one of claims 1 to 5 or 11 and at least one pharmaceutically acceptable
5 excipient.
13. The pharmaceutical composition of claim 12, further comprising an additional therapeutic agent.
14. The pharmaceutical composition of claims 12 or 13, further comprising a T-cell activating anti-CD3 bispecific antibody.
- 10 15. The pharmaceutical composition of claim 14, wherein the T-cell activating anti-CD3 bispecific antibody is an anti-Her2/anti-CD3 bispecific antibody.
16. The 4-1BBL trimer-containing antigen binding molecule of any one of claims 1 to 5, or the pharmaceutical composition of any one of claims 12 to 15, for use as a medicament.
17. The 4-1BBL trimer-containing antigen binding molecule of any one of claims 1 to 5 for use
15 in the treatment of Her2-positive cancer.
18. The 4-1BBL trimer-containing antigen binding molecule of any one of claims 1 to 5 for use according to claim 17, wherein the 4-1BBL trimer-containing antigen binding molecule is used in combination with another therapeutic agent.
19. The 4-1BBL trimer-containing antigen binding molecule of any one of claims 1 to 5 for use
20 in the treatment of Her2-positive cancer, wherein the 4-1BBL trimer-containing antigen binding molecule is used in combination with a T-cell activating anti-CD3 bispecific antibody and wherein the T-cell activating anti-CD3 bispecific antibody is to be administered concurrently with, prior to, or subsequently to the 4-1BBL trimer-containing antigen binding molecule.
- 25 20. The 4-1BBL trimer-containing antigen binding molecule of any one of claims 1 to 5 for use according to claim 19, wherein the T-cell activating anti-CD3 bispecific antibody is an anti-Her2/anti-CD3 bispecific antibody.

21. Use of the 4-1BBL trimer-containing antigen binding molecule of any one of claims 1 to 5 in the manufacture of a medicament for the treatment of Her2-positive cancer.
22. Use of the 4-1BBL trimer-containing antigen binding molecule of any one of claims 1 to 5 in the manufacture of a medicament for the treatment of Her2-positive cancer, wherein the 4-
5 1BBL trimer-containing antigen binding molecule is used in combination with with a T-cell activating anti-CD3 bispecific antibody.
23. The use of claim 22, wherein the T-cell activating anti-CD3 bispecific antibody is an anti-Her2/anti-CD3 antibody.
