CLAIMS

1. A method for increasing a proportion of an IgG where one IgG-binding IgBP, per IgG, is bound, in an IgG reacted with IgG-binding IgBP, the method comprising:

contacting an IgG reacted with IgG-binding IgBP, with a carrier to which Carrier-binding IgBP is bound, the IgBP being the same as or different from the IgG-binding IgBP, to thereby bind the IgG reacted with IgG-binding IgBP, to the carrier;

removing the IgG not bound to the carrier; and

recovering the IgG bound to the carrier, wherein

the IgBP is a peptide to be specifically bound to an Fc region of the IgG.

2. The method according to claim 1, wherein the Carrier-binding IgBP is the following peptide (i) or (ii):

(i) a peptide represented by the following formula (I):

NH_2-(Linker)-($X^1{}_{1\text{-}3}$)-C-(X^2)-(X^3)-(X^4)-(X^5)-G-(X^6)-L-(X^7)-W-C-($X^8{}_{1\text{-}3}$) … (I)

in the formula (I), (Linker) represents a linker, one to three X^1(s), X^2, X^3, X^4, X^5, X^6, X^7, and one to three X^8(s) each mutually independently represent the same or different amino acid residue,

each X^1, X^2, X^3, and each X^8 mutually independently represent any amino acid residues that are the same or different and are other than C,

X^4 is H, R, S, or D,

X^5 is one amino acid residue selected from K, C, D, E, R, V, F, L, 2-aminosuberic acid, Dpr, Orn, AcOrn, AcDab, Dab, Nle, Nva, Tle, Ala(t-Bu), and Cha,

X^6 is E, N, R, or D, and

X^7 is I or V; or

(ii) a peptide represented by the following formula (II), or a peptide containing an amino acid sequence of (II), where one or several amino acids are each added, deleted,

and/or substituted at a position other than X^9 to X^{13}:

$X^9{}_{1\text{-}2}$NMQX^{10}QRRFYEALHDPNLNEEQRNAX^{11}IX^{12}SIRDDX^{13}-(Linker 2)-$CONH_2$ (SEQ ID No. 60) … (II)

in the formula (II), (Linker 2) represents a linker, $X^9{}_{1\text{-}2}$ is selected from the group consisting of GF, AF, VF, LF, IF, MF, PF, FF, WF, KF, Orn-F, CF, DF, EF, βAla-F, 2-aminosuberic acid-F, Dpr-F, and NH_2-$(PEG)_n$-CO (n=1 to 50)-F, F, K, Orn, C, D, E, 2-aminosuberic acid residue, and Dpr,

X^{10} is C or Q,

X^{11} and X^{12} are each independently selected from the group consisting of R, H, D, E, S, T, N, Q, Y, and C, and

X^{13} is C or P.

3. The method according to claim 1, wherein the IgG-binding IgBP is the following peptide (iii) or (iv):

(iii) a peptide represented by the following formula (I') or (I''):

Z-[(Linker 3)-($X^1{}_{1\text{-}3}$)-C-(X^2)-(X^3)-(X^4)-(X^5)-G-(X^6)-L-(X^7)-W-C-($X^8{}_{1\text{-}3}$)] … (I')

[($X^1{}_{1\text{-}3}$)-C-(X^2)-(X^3)-(X^4)-(X^5)-G-(X^6)-L-(X^7)-W-C-($X^8{}_{1\text{-}3}$)-(Linker 3)]-Z ... (I'')

in the formula (I') and the formula (I''),

Z represents a functional group,

(Linker 3) represents a linker,

one to three X^1(s), X^2, X^3, X^4, X^5, X^6, X^7, and one to three X^8(s) each mutually independently represent the same or different amino acid residue,

each X^1, X^2, X^3, and each X^8 mutually independently represent any amino acid residues that are the same or different and are other than C,

X^4 is H, R, S, or D,

X^5 is one amino acid residue selected from K, C, D, E, R, V, F, L, 2-aminosuberic acid, Dpr, Orn, AcOrn, AcDab, Dab, Nle, Nva, Tle, Ala(t-Bu), and Cha,

X^6 is E, N, R, or D, and

X^7 is I or V; or

(iv) a peptide containing an amino acid sequence represented by the following formula (II'), or a peptide containing an amino acid sequence of (II'), where one or several amino acids are each added, deleted, and/or substituted at a position other than X^9 to X^{14}:

$X^9{}_{1\text{-}2}NMQX^{10}QX^{14}RFYEALHDPNLNEEQRNAX^{11}IX^{12}SIRDDX^{13}$-(Linker 2)-$NH_2$ (SEQ ID No. 61) … (II')

in the formula (II'), (Linker 2) represents a linker, $X^9{}_{1\text{-}2}$ is selected from the group consisting of GF, AF, VF, LF, IF, MF, PF, FF, WF, KF, Orn-F, CF, DF, EF, βAla-F, 2-aminosuberic acid-F, Dpr-F, and NH_2-$(PEG)_n$-CO (n=1 to 50)-F, F, K, Orn, C, D, E, a 2-aminosuberic acid residue, Dpr, and Acetyl-K,

X^{10} is C or Q,

X^{11} and X^{12} are each independently selected from the group consisting of R, H, D, E, S, T, N, Q, Y, C, and K(Z),

X^{13} is C or P, or absent,

X^{14} is R, C, or K(Z), and

Z is a functional group, and

the functional group is maleimide, thiol or protected thiol, alcohol, acrylate, acrylamide, amine or protected amine, carboxylic acid or protected carboxylic acid, azide, alkynes including cycloalkyne, 1,3-dienes including cyclopentadiene and furan, alpha-halocarbonyl, N-hydroxysuccinimidyl, N-hydroxysulfosuccinimidyl, nitrophenyl ester, carbonate, dibenzocyclooctyne, tetrazine, methyltetrazine, or trans-cyclooctene.

4. The method according to any one of claims 1 to 3, wherein the carrier is a column.

5. The method according to any one of claims 1 to 4, wherein a proportion of an IgG where one IgBP is bound to one IgG, relative to the entire IgG, in an IgG composition is 55% or more.

6. A method for preparing an IgG composition comprising an IgBP-bound IgG where only one IgG affinity peptide for IgG binding (IgG-binding IgBP) is bound to one IgG, more than an IgBP-bound IgG where two IgG-binding IgBPs are bound to one IgG, the method comprising:

reacting an IgG with a carrier to which an IgG affinity peptide for carrier binding (Carrier-binding IgBP) is bound, to thereby obtain an IgG-bound carrier;

reacting an IgG in the IgG-bound carrier obtained, with IgG-binding IgBP, to thereby obtain a bound product of the IgG-binding IgBP and the IgG; and

cutting a bond between the Carrier-binding IgBP and the IgG to recover the bound product of the IgG-binding IgBP and the IgG from the carrier,

wherein IgBP is a peptide to be specifically bound to an Fc region of the IgG, and

the IgG-binding IgBP and the Carrier-binding IgBP are optionally the same or different.

7. The method according to claim 6, wherein the Carrier-binding IgBP is the following peptide (i) or (ii):

(i) a peptide represented by the following formula (I):

NH_2-(Linker)-($X^1{}_{1\text{-}3}$)-C-(X^2)-(X^3)-(X^4)-(X^5)-G-(X^6)-L-(X^7)-W-C-($X^8{}_{1\text{-}3}$) … (I)

in the formula (I), (Linker) represents a linker, one to three X^1(s), X^2, X^3, X^4, X^5, X^6, X^7, and one to three X^8(s) each mutually independently represent the same or different amino acid residue,

each X^1, X^2, X^3, and each X^8 mutually independently represent any amino acid residues that are the same or different and are other than C,

X^4 is H, R, S, or D,

X^5 is one amino acid residue selected from K, C, D, E, R, V, F, L, 2-aminosuberic acid, Dpr, Orn, AcOrn, AcDab, Dab, Nle, Nva, Tle, Ala(t-Bu), and Cha,

X^6 is E, N, R, or D, and

X^7 is I or V; or

(ii) a peptide represented by the following formula (II), or a peptide containing an amino acid sequence of (II), where one or several amino acids are each added, deleted, and/or substituted at a position other than X^9 to X^{13}:

$X^9{}_{1\text{-}2}$NMQX^{10}QRRFYEALHDPNLNEEQRNAX^{11}IX^{12}SIRDDX^{13}-(Linker 2)-$CONH_2$ (SEQ ID No. 60) … (II)

in the formula (II), (Linker 2) represents a linker, $X^9{}_{1\text{-}2}$ is selected from the group consisting of GF, AF, VF, LF, IF, MF, PF, FF, WF, KF, Orn-F, CF, DF, EF, βAla-F, 2-aminosuberic acid-F, Dpr-F, and NH_2-$(PEG)_n$-CO (n=1 to 50)-F, F, K, Orn, C, D, E, 2-aminosuberic acid residue, and Dpr,

X^{10} is C or Q,

X^{11} and X^{12} are each independently selected from the group consisting of R, H, D, E, S, T, N, Q, Y, and C, and

X^{13} is C or P.

8. The method according to claim 6 or 7, wherein the IgG-binding IgBP is the following peptide (iii) or (iv):

(iii) a peptide represented by the following formula (I') or (I''):

Z-[(Linker 3)-($X^1{}_{1\text{-}3}$)-C-(X^2)-(X^3)-(X^4)-(X^5)-G-(X^6)-L-(X^7)-W-C-($X^8{}_{1\text{-}3}$)] … (I')

[($X^1{}_{1\text{-}3}$)-C-(X^2)-(X^3)-(X^4)-(X^5)-G-(X^6)-L-(X^7)-W-C-($X^8{}_{1\text{-}3}$)-(Linker 3)]-Z … (I'')

in the formula (I') and the formula (I''),

Z represents a functional group,

(Linker 3) represents a linker,

one to three X^1(s), X^2, X^3, X^4, X^5, X^6, X^7, and one to three X^8(s) each mutually independently represent the same or different amino acid residue,

each X^1, X^2, X^3, and each X^8 mutually independently represent any amino acid residues that are the same or different and are other than C,

X^4 is H, R, S, or D,

X^5 is one amino acid residue selected from K, C, D, E, R, V, F, L, 2-aminosuberic acid, Dpr, Orn, AcOrn, AcDab, Dab, Nle, Nva, Tle, Ala(t-Bu), and Cha,

X^6 is E, N, R, or D, and

X^7 is I or V; or

(iv) a peptide containing an amino acid sequence represented by the following formula (II'), or a peptide containing an amino acid sequence of (II'), where one or several amino acids are each added, deleted, and/or substituted at a position other than X^9 to X^{14}:

$X^9{}_{1\text{-}2}$NMQX^{10}QX^{14}RFYEALHDPNLNEEQRNAX^{11}IX^{12}SIRDDX^{13}-(Linker 2)-NH_2 (SEQ ID No. 61) … (II')

in the formula (II'), (Linker 2) represents a linker, $X^9{}_{1\text{-}2}$ is selected from the group consisting of GF, AF, VF, LF, IF, MF, PF, FF, WF, KF, Orn-F, CF, DF, EF, βAla-F, 2-aminosuberic acid-F, Dpr-F, and NH_2-$(PEG)_n$-CO (n=1 to 50)-F, F, K, Orn, C, D, E, a 2-aminosuberic acid residue, Dpr, and Acetyl-K,

X^{10} is C or Q,

X^{11} and X^{12} are each independently selected from the group consisting of R, H, D, E, S, T, N, Q, Y, C, and K(Z),

X^{13} is C or P, or absent,

X^{14} is R, C, or K(Z), and

Z is a functional group, and

the functional group is maleimide, thiol or protected thiol, alcohol, acrylate, acrylamide, amine or protected amine, carboxylic acid or protected carboxylic acid,

azide, alkynes including cycloalkyne, 1,3-dienes including cyclopentadiene and furan, alpha-halocarbonyl, N-hydroxysuccinimidyl, N-hydroxysulfosuccinimidyl, nitrophenyl ester, carbonate, dibenzocyclooctyne, tetrazine, methyltetrazine, or trans-cyclooctene.

9. The method according to any one of claims 6 to 8, wherein the carrier is a column.

10. The method according to claim 9, wherein the reacting an IgG with a carrier to which Carrier-binding IgBP is bound, to thereby obtain an IgG-bound carrier, is performed by injecting an IgG to a column to which Carrier-binding IgBP is bound, and the reacting the IgG bound to the carrier, with IgG-binding IgBP, to thereby obtain a bound product of the IgG-binding IgBP and the IgG is performed by injecting IgG-binding IgBP, to a column to which an IgG is bound.

11. The method according to claim 10, wherein a proportion of an IgG where one IgBP is bound to one IgG obtained, relative to a total amount of the IgG injected, is 55% or more.

12. The method according to any one of claims 6 to 11, wherein a proportion of an IgG where one IgBP is bound to one IgG, relative to the entire IgG, in the bound product of the IgG-binding IgBP and the IgG, obtained, is 55% or more.

13. A method for preparing an IgG composition comprising an IgG (functional group-bound IgG) where a functional group is bound to only one of two Fc chains present in one IgG and where no IgBP is bound, more than an IgG where functional groups are bound to two Fc chains present in one IgG, the method comprising:

(i) reacting an IgG with a carrier to which an IgG affinity peptide for carrier

binding (Carrier-binding IgBP) is bound, to thereby obtain an IgG-bound carrier;

(ii) reacting an IgG affinity peptide for IgG binding (CCB-IgBP) to which a crosslinking agent is bound via a cleavable linker, with an IgG in the IgG-bound carrier obtained, to thereby obtain a bound product of CCB-IgBP and the IgG;

(iii) reacting and then covalently binding the crosslinking agent and the IgG;

(iv) cleaving the cleavable linker to cut a bond between the crosslinking agent and IgG-binding IgBP;

(v) dissociating IgG-binding IgBP, from the IgG, to thereby obtain a functional group-bound IgG bound to the carrier, and free IgG-binding IgBP; and

(vi) recovering the functional group-bound IgG from the carrier, wherein

IgBP is a peptide to be specifically bound to an Fc region of the IgG,

the IgG-binding IgBP and the Carrier-binding IgBP are optionally the same or different,

a group containing a functional group is optionally present between the cleavable linker and the crosslinking agent,

the functional group contained in the functional group-bound IgG is a functional group present between the cleavable linker and the crosslinking agent, or a group generated by linker cleavage, and

the functional group is maleimide, thiol or protected thiol, alcohol, acrylate, acrylamide, amine or protected amine, carboxylic acid or protected carboxylic acid, azide, alkynes including cycloalkyne, 1,3-dienes including cyclopentadiene and furan, alpha-halocarbonyl, N-hydroxysuccinimidyl, N-hydroxysulfosuccinimidyl, nitrophenyl ester, carbonate, dibenzocyclooctyne, tetrazine, methyltetrazine, or trans-cyclooctene.

14. A method for preparing an IgG composition comprising an IgG (functional molecule-bound IgG) where a functional molecule is bound to only one of two Fc chains present in one IgG and where no IgBP is bound, more than an IgG where functional

molecules are bound to two Fc chains present in one IgG, the method comprising:

(i) reacting an IgG with a carrier to which an IgG affinity peptide for carrier binding (Carrier-binding IgBP) is bound, to thereby obtain an IgG-bound carrier;

(ii) reacting an IgG affinity peptide for IgG binding (CCB-IgBP) to which a crosslinking agent is bound via a cleavable linker, with an IgG in the IgG-bound carrier obtained, to thereby obtain a bound product of CCB-IgBP and the IgG;

(iii) reacting and then covalently binding the crosslinking agent and the IgG;

(iv) cleaving the cleavable linker to cut a bond between the crosslinking agent and IgG-binding IgBP;

(v) dissociating IgG-binding IgBP, from the IgG, to thereby obtain a functional group-bound IgG bound to the carrier, and free IgG-binding IgBP;

(vi) binding a functional molecule to the functional group of the functional group-bound IgG to thereby obtain a functional molecule-bound IgG; and

(vii) recovering the functional molecule-bound IgG from the carrier, wherein

IgBP is a peptide to be specifically bound to an Fc region of the IgG,

the IgG-binding IgBP and the Carrier-binding IgBP are optionally the same or different,

a group containing a functional group is optionally present between the cleavable linker and the crosslinking agent,

the functional group contained in the functional group-bound IgG is a functional group present between the cleavable linker and the crosslinking agent, or a group generated by linker cleavage, and

the functional group is maleimide, thiol or protected thiol, alcohol, acrylate, acrylamide, amine or protected amine, carboxylic acid or protected carboxylic acid, azide, alkynes including cycloalkyne, 1,3-dienes including cyclopentadiene and furan, alpha-halocarbonyl, N-hydroxysuccinimidyl, N-hydroxysulfosuccinimidyl, nitrophenyl ester, carbonate, dibenzocyclooctyne, tetrazine, methyltetrazine, or trans-cyclooctene.

15. A method for preparing an IgG composition comprising a functional molecule-bound IgG where a functional molecule is bound to only one of two Fc chains present in one IgG and where no IgBP is bound, more than an IgG where functional molecules are bound to two Fc chains present in one IgG, the method comprising:

(i) reacting an IgG with a carrier to which an IgG affinity peptide for carrier binding (Carrier-binding IgBP) is bound, to thereby obtain an IgG-bound carrier;

(ii) reacting an IgG affinity peptide for IgG binding (CCB-IgBP) to which a crosslinking agent is bound via a cleavable linker, with an IgG in the IgG-bound carrier obtained, to thereby obtain a bound product of CCB-IgBP and the IgG;

(iii) reacting and then covalently binding the crosslinking agent and the IgG;

(iv) cleaving the cleavable linker to cut a bond between the crosslinking agent and IgG-binding IgBP;

(v) dissociating IgG-binding IgBP, from the IgG, to thereby obtain a functional molecule-bound IgG bound to the carrier via Carrier-binding IgBP, and free IgG-binding IgBP; and

(vi) recovering the functional molecule-bound IgG from the carrier, wherein

IgBP is a peptide to be specifically bound to an Fc region of the IgG,

the IgG-binding IgBP and the Carrier-binding IgBP are optionally the same or different, and

a functional molecule is bound between the cleavable linker and the crosslinking agent.

16. The method according to any one of claims 13 to 15, wherein the carrier is a column.

17. The method according to claim 13 or 14, wherein the method further

comprises, after the cleaving the cleavable linker to cut a bond between the crosslinking agent and the IgG affinity peptide for IgG binding (IgG-binding IgBP) and before the cutting a bond between the Carrier-binding IgBP and the IgG to recover a functional group-bound IgG from the carrier, binding another functional molecule to the functional group.

18. An IgG composition, wherein any one proportion of the following (a) to (c) is higher than such any one proportion obtained in synthesis in a test tube according to a CCAP method:

(a) a proportion of an IgG to which only one IgG affinity peptide (IgBP) to be specifically bound to an Fc region of IgG is bound, relative to the entire IgG;

(b) a proportion of a functional group-bound IgG where a functional group is bound to only one of two Fc chains present in one IgG, relative to the entire IgG; or

(c) a proportion of a functional group-bound IgG where another functional molecule is bound to only one of two Fc chains present in one IgG, relative to the entire IgG, and

the functional group is maleimide, thiol or protected thiol, alcohol, acrylate, acrylamide, amine or protected amine, carboxylic acid or protected carboxylic acid, azide, alkynes including cycloalkyne, 1,3-dienes including cyclopentadiene and furan, alpha-halocarbonyl, N-hydroxysuccinimidyl, N-hydroxysulfosuccinimidyl, nitrophenyl ester, carbonate, dibenzocyclooctyne, tetrazine, methyltetrazine, or trans-cyclooctene.

19. An IgG composition, wherein any one proportion of the following (a) to (c) is 55% or more:

(a) a proportion of an IgG to which only one IgG affinity peptide (IgBP) to be specifically bound to an Fc region of IgG is bound, in the entire IgG;

(b) a proportion of a functional group-bound IgG where a functional group is

bound to only one of two Fc chains present in one IgG, relative to the entire IgG; or

(c) a proportion of a functional group-bound IgG where another functional molecule is bound to only one of two Fc chains present in one IgG, relative to the entire IgG, and

the functional group is maleimide, thiol or protected thiol, alcohol, acrylate, acrylamide, amine or protected amine, carboxylic acid or protected carboxylic acid, azide, alkynes including cycloalkyne, 1,3-dienes including cyclopentadiene and furan, alpha-halocarbonyl, N-hydroxysuccinimidyl, N-hydroxysulfosuccinimidyl, nitrophenyl ester, carbonate, dibenzocyclooctyne, tetrazine, methyltetrazine, or trans-cyclooctene.

20. The composition according to claim 18 or 19, wherein the IgBP is the following peptide (iii) or (iv) to be specifically bound to an Fc region of IgG, the peptides (iii) and (iv) being the same or different:

(iii) a peptide represented by the following formula (I') or (I''):

Z-[(Linker 3)-(X^1_{1-3})-C-(X^2)-(X^3)-(X^4)-(X^5)-G-(X^6)-L-(X^7)-W-C-(X^8_{1-3})] … (I')

[(X^1_{1-3})-C-(X^2)-(X^3)-(X^4)-(X^5)-G-(X^6)-L-(X^7)-W-C-(X^8_{1-3})-(Linker 3)]-Z … (I'')

in the formula (I') and the formula (I''),

Z represents a functional group,

(Linker 3) represents a linker,

one to three X^1(s), X^2, X^3, X^4, X^5, X^6, X^7, and one to three X^8(s) each mutually independently represent the same or different amino acid residue,

each X^1, X^2, X^3, and each X^8 mutually independently represent any amino acid residues that are the same or different and are other than C,

X^4 is H, R, S, or D,

X^5 is one amino acid residue selected from K, C, D, E, R, V, F, L, 2-aminosuberic acid, Dpr, Orn, AcOrn, AcDab, Dab, Nle, Nva, Tle, Ala(t-Bu), and Cha,

X^6 is E, N, R, or D, and

X^7 is I or V; or

(iv) a peptide containing an amino acid sequence represented by the following formula (II'), or a peptide containing an amino acid sequence of (II'), where one or several amino acids are each added, deleted, and/or substituted at a position other than X^9 to X^{14}:

$X^9{}_{1\text{-}2}NMQX^{10}QX^{14}RFYEALHDPNLNEEQRNAX^{11}IX^{12}SIRDDX^{13}$-(Linker 2)-$NH_2$ (SEQ ID No. 61) … (II')

in the formula (II'), (Linker 2) represents a linker, $X^9{}_{1\text{-}2}$ is selected from the group consisting of GF, AF, VF, LF, IF, MF, PF, FF, WF, KF, Orn-F, CF, DF, EF, βAla-F, 2-aminosuberic acid-F, Dpr-F, and NH_2-$(PEG)_n$-CO (n=1 to 50)-F, F, K, Orn, C, D, E, a 2-aminosuberic acid residue, Dpr, and Acetyl-K,

X^{10} is C or Q,

X^{11} and X^{12} are each independently selected from the group consisting of R, H, D, E, S, T, N, Q, Y, C, and K(Z),

X^{13} is C or P, or absent,

X^{14} is R, C, or K(Z), and

Z is a functional group.

21. The composition according to any one of claims 18 to 20, wherein the composition is a medical or diagnostic composition.