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(71) Demandeur/Applicant:
ASTELLAS PHARMA INC., JP

(72) Inventeurs/Inventors:
SATO, MASAHIRO, JP;
TOYONAGA, HANAE, JP;
OSAKI, FUMIO, JP;
EGUCHI, TOMOHIRO, JP

(74) Agent: GOWLING WLG (CANADA) LLP

(54) Titre : ANTICORPS ANTI-CD73 HUMAIN
(54) Title: ANTI-HUMAN CD73 ANTIBODY

(57) **Abrégé/Abstract:**

[Problem] To provide an anti-human CD73 antibody which is potentiated compared with the conventional antibodies and has an ability to recover a suppressed function of a human T cell which is suppressed in an AMP-dependent manner. [Solution] Provided is an anti-human CD73 antibody containing: a heavy-chain variable region which contains CDR1 comprising an amino acid sequence composed of amino acid residues lying between position-31 to position-35 in SEQ ID NO: 2, CDR2 comprising an amino acid sequence composed of amino acid residues lying between position-50 to position-66 in SEQ ID NO: 2 and CDR3 comprising an amino acid sequence composed of amino acid residues lying between position-99 to position-112 in SEQ ID NO: 2; and a light-chain variable region which contains CDR1 comprising an amino acid sequence composed of amino acid residues lying between position-24 to position-34 in SEQ ID NO: 4, CDR2 comprising an amino acid sequence composed of amino acid residues lying between position-50 to position-56 in SEQ ID NO: 4, and CDR3 comprising an amino acid sequence composed of amino acid residues lying between position-89 to position-98 in SEQ ID NO: 4.

Abstract

[Abstract]

[Problem] Provided is an anti-human CD73 antibody which is enhanced as compared
5 to the antibody in the prior art and has an ability of recovering AMP-dependently
suppressed T cell functions.

[Means for Solution] Provided is an anti-human CD73 antibody comprising a heavy
chain variable region comprising CDR1 consisting of the amino acid sequence of amino
acid numbers 31 to 35 of SEQ ID NO: 2, CDR2 consisting of the amino acid sequence of
10 amino acid numbers 50 to 66 of SEQ ID NO: 2, and CDR3 consisting of the amino acid
sequence of amino acid numbers 99 to 112 of SEQ ID NO: 2, and a light chain variable
region comprising CDR1 consisting of the amino acid sequence of amino acid numbers 24
to 34 of SEQ ID NO: 4, CDR2 consisting of the amino acid sequence of amino acid
numbers 50 to 56 of SEQ ID NO: 4, and CDR3 consisting of the amino acid sequence of
15 amino acid numbers 89 to 98 of SEQ ID NO: 4.

[Selected Figure] Nil

DESCRIPTION

Title of Invention: ANTI-HUMAN CD73 ANTIBODY

5 Technical Field

[0001]

The present invention relates to an anti-human CD73 antibody which is useful as an active ingredient of a pharmaceutical composition.

10 Background Art

[0002]

CD73 (Ecto-5'-nucleotidase) is an enzyme which catalyzes the decomposition of AMP (adenosine monophosphate) into adenosine. CD73 is a GPI anchor-type protein, present on a cell membrane surface as a dimer, and is expressed in various tissues such as lymphocytic cells, endothelial cells, the large intestine, the brain, the kidney, the liver, the lungs, the heart, and the like. In addition, it has been reported that CD73 is cut from a cell membrane surface of a lymphocytic cell and is present as soluble CD73, and the soluble CD73 also has an enzymatic activity of decomposing AMP. Since adenosine which is produced by the decomposition of AMP suppresses functions of immune system cells such as T cells, CD73 plays an important role in adjusting immune response (Arterioscler Thromb Vasc Biol., Vol. 28, p. 18-26, 2008) (Trends Mol Med., Vol. 19, p. 355-367, 2013) (Eur J Immunol., Vol. 45, p. 562-573, 2015).

[0003]

As for the relation to a disease state, it has been confirmed that CD73 is expressed at a colon cancer cell line (Mediators Inflamm., Article ID 879895, 2014). In addition, it has been reported that in a colon cancer patient, expression of CD73 is increased in cancer tissues than in normal tissues, and a patient with high CD73 expression has a lower overall survival rate than a patient with low CD73 expression (J Surg Oncol., Vol. 106, p. 130-137, 2012).

30 [0004]

With regard to other kinds of cancers, it has been confirmed that CD73 is expressed in cell lines of adrenal cancer, breast cancer, malignant melanoma, glioblastoma multiforme, ovarian cancer, medulloblastoma, and bladder cancer, and CD73 activity is increased in breast cancer, stomach cancer, pancreatic cancer, chronic myeloid leukemia, cutaneous T-cell lymphoma, and glioblastoma (Pharmacol Ther., Vol. 87, p. 161-173, 2000) (Biomed Res Int., Article ID 460654, 2014). In addition, it has been reported that expression of CD73 is increased in head and neck cancer and thyroid cancer, or expression

of CD73 accelerates proliferation of cancer cells in prostate cancer (Trends Mol Med., Vol. 19, p. 355-367, 2013).

[0005]

Inhibition of the enzymatic activity of CD73 which decomposes AMP is associated with activation of anti-tumor immunity by recovering suppressed functions of immune system cells such as a T cell, and thus CD73 is studied as a treatment target for cancer. In addition, it has been known that an anti-CD73 antibody having such an enzyme inhibitory activity shows an anti-tumor activity in animal models (Non-Patent Document 1).

[0006]

A plurality of studies is carried out regarding an antibody which inhibits an enzymatic activity of human CD73 (Patent Document 1, Patent Document 2, Patent Document 3, and Non-Patent Document 1). MEDI9447 reported in Patent Document 1 and Non-Patent Document 1 has characteristics of showing bell-shaped inhibition against soluble CD73. Although a phase I trial has been started on MEDI9447 with solid-type cancers being adapted cancers, the clinical treatment effect has yet to be confirmed, even including antibodies reported in Patent Document 2 and Patent Document 3.

[0007]

A fused form of an antibody or an antigen-binding fragment thereof and a cytokine, which is called immunocytokine, is known, and a plurality of studies is carried out on the purpose of activating anti-tumor immunity (Curr Opinion in Immunol., Vol. 40, p. 96-102, 2016).

[0008]

As examples of cytokine which has a possibility of activating anti-tumor immunity, studies on IL-7 and IL-21 are carried out, but it is reported that IL-7 and IL-21 have a possibility of showing toxicity when high doses of IL-7 and IL-21 are administered to a human (Clin Cancer Res., Vol. 16, p. 727-735, 2010) (Clin Cancer Res., Vol. 13, p. 3630-3636, 2007).

Related Art

Patent Document

[0009]

[Patent Document 1] WO 2016/075176

[Patent Document 2] WO 2016/055609

[Patent Document 3] WO 2016/081748

Non-Patent Document

[0010]

[Non-Patent Document 1] "mAbs" (USA), 8 (3); 454-467, 2016

Disclosure of Invention

Problems to Be Solved by the Invention

[0011]

An object of the present invention is to provide an anti-human CD73 antibody.

5

Means for Solving the Problems

[0012]

As a result of performing intensive creative research on preparation of an anti-human CD73 antibody by the present inventors, an anti-human CD73 antibody CDS-1 that comprises a heavy chain variable region comprising CDR1 consisting of the amino acid sequence of amino acid numbers 31 to 35 of SEQ ID NO: 2, CDR2 consisting of the amino acid sequence of amino acid numbers 50 to 66 of SEQ ID NO: 2, and CDR3 consisting of the amino acid sequence of amino acid numbers 99 to 112 of SEQ ID NO: 2, and a light chain variable region comprising CDR1 consisting of the amino acid sequence of amino acid numbers 24 to 34 of SEQ ID NO: 4, CDR2 consisting of the amino acid sequence of amino acid numbers 50 to 56 of SEQ ID NO: 4, and CDR3 consisting of the amino acid sequence of amino acid numbers 89 to 98 of SEQ ID NO: 4 (Example 1) was prepared, and it was found that the antibody binds to human CD73 (Example 2), inhibits an enzymatic activity of human CD73 (Examples 3 and 4), and recovers AMP-dependently suppressed human T cell functions (Example 5). As a result, the above-described anti-human CD73 antibody of the present invention is provided, thereby completing the present invention.

15

20

[0013]

That is, the present invention relates to the following [1] to [31].

[1]

25

An anti-human CD73 antibody or an antigen-binding fragment thereof comprising: a heavy chain variable region comprising CDR1 consisting of the amino acid sequence of amino acid numbers 31 to 35 of SEQ ID NO: 2, CDR2 consisting of the amino acid sequence of amino acid numbers of 50 to 66 of SEQ ID NO: 2, and CDR3 consisting of the amino acid sequence of amino acid numbers of 99 to 112 of SEQ ID NO: 2; and a light chain variable region comprising CDR1 consisting of the amino acid sequence of amino acid numbers of 24 to 34 of SEQ ID NO: 4, CDR2 consisting of the amino acid sequence of amino acid numbers of 50 to 56 of SEQ ID NO: 4, and CDR3 consisting of the amino acid sequence of amino acid numbers of 89 to 98 of SEQ ID NO: 4.

30

35

[2]

The anti-human CD73 antibody or the antigen-binding fragment thereof described in [1], comprising a heavy chain variable region consisting of the amino acid sequence of amino acid numbers of 1 to 123 of SEQ ID NO: 2, and a light chain variable region

consisting of the amino acid sequence of amino acid numbers of 1 to 109 of SEQ ID NO: 4.

[3]

5 The anti-human CD73 antibody described in [1] or [2], selected from the group consisting of the following (a) and (b):

(a) an anti-human CD73 antibody comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 4; and

10 (b) an anti-human CD73 antibody which is derived from posttranslational modification of the anti-human CD73 antibody of (a).

[4]

The anti-human CD73 antibody described in [3], selected from the group consisting of the following (a) and (b):

15 (a) an anti-human CD73 antibody comprising the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and the light chain consisting of the amino acid sequence shown by SEQ ID NO: 4; and

(b) an anti-human CD73 antibody comprising a heavy chain consisting of the amino acid sequence of amino acid numbers of 1 to 452 of SEQ ID NO: 2 and the light chain consisting of the amino acid sequence shown by SEQ ID NO: 4.

20 [5]

The anti-human CD73 antibody described in [4], comprising the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2, and the light chain consisting of the amino acid sequence shown by SEQ ID NO: 4.

[6]

25 The anti-human CD73 antibody described in [4], comprising the heavy chain consisting of the amino acid sequence of amino acid numbers of 1 to 452 of SEQ ID NO: 2, and the light chain consists of the amino acid sequence shown by SEQ ID NO: 4.

[7]

30 A fused form in which the anti-human CD73 antibody or the antigen-binding fragment thereof described in any one of [1] to [6] is fused with another peptide or protein.

[8]

A modified form in which the anti-human CD73 antibody or the antigen-binding fragment thereof described in any one of [1] to [6] binds to a modifying agent.

[9]

35 The fused form described in [7], selected from the group consisting of the following (a) to (e):

(a) a fused form comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 7 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 4;

5 (b) a fused form comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 10 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 4;

(c) a fused form comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 13;

10 (d) a fused form comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 15; and

(e) a fused form which is derived from posttranslational modifications of the fused forms of (a) to (d).

15 [10]

A polynucleotide selected from the group consisting of the following (a) and (b):

(a) a polynucleotide comprising a sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof described in [2]; and

20 (b) a polynucleotide comprising a sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof described in [2].

[11]

The polynucleotide described in [10], selected from the group consisting of the following (a) and (b):

25 (a) a polynucleotide comprising a sequence encoding a heavy chain of the antibody described in [5]; and

(b) a polynucleotide comprising a sequence encoding a light chain of the antibody described in [5].

[12]

30 The polynucleotide described in [11], selected from the group consisting of the following (a) and (b):

(a) a polynucleotide comprising a sequence encoding a heavy chain of the fused form described in [9]; and

(b) a polynucleotide comprising a sequence encoding a light chain of the fused form described in [9].

35 [13]

An expression vector comprising the following (a) and/or (b):

(a) a polynucleotide comprising a sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof described in [2]; and

(b) a polynucleotide comprising a sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof described in [2].

[14]

The expression vector described in [13], comprising the following (a) and/or (b):

5 (a) a polynucleotide comprising a sequence encoding a heavy chain of the antibody described in [5]; and

(b) a polynucleotide comprising a sequence encoding a light chain of the antibody described in [5].

[15]

10 The expression vector described in [14], comprising the following (a) and/or (b):

(a) a polynucleotide comprising a sequence encoding a heavy chain of the fused form described in [9]; and

(b) a polynucleotide comprising a sequence encoding a light chain of the fused form described in [9].

15 [16]

A host cell selected from the group consisting of the following (a) to (d):

(a) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof described in [2];

20 (b) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof described in [2];

(c) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof described in [2] and a polynucleotide comprising a sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof described in [2]; and

25 (d) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof described in [2] and an expression vector comprising a polynucleotide comprising a sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof described in [2].

[17]

35 The host cell described in [16], selected from the group consisting of the following (a) to (d):

(a) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain of the antibody described in [5];

(b) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a light chain of the antibody described in [5];

(c) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain of the antibody described in [5] and a
5 polynucleotide comprising a sequence encoding a light chain of the antibody described in [5]; and

(d) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain of the antibody described in [5] and an expression vector comprising a polynucleotide comprising a sequence encoding a light
10 chain of the antibody described in [5].
[18]

The host cell described in [17], selected from the group consisting of the following (a) to (d):

(a) a host cell transformed with an expression vector comprising a polynucleotide
15 comprising a sequence encoding a heavy chain of the fused form described in [9];

(b) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a light chain of the fused form described in [9];

(c) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain of the fused form described in [9] and a
20 polynucleotide comprising a sequence encoding a light chain of the fused form described in [9]; and

(d) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain of the fused form described in [9] and an expression vector comprising a polynucleotide comprising a sequence encoding a light
25 chain of the fused form described in [9].
[19]

A method for producing an anti-human CD73 antibody, an antigen-binding fragment thereof, and a fused form of any one thereof, the method comprising:

culturing a host cell selected from the group consisting of the following (a) to (c)
30 to express an anti-human CD73 antibody, an antigen-binding fragment thereof, and a fused form of any one thereof:

(a) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof described in [2] and a polynucleotide comprising a base
35 sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof described in [2];

(b) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain variable region of the antibody or the

antigen-binding fragment thereof described in [2] and an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof described in [2]; and

- (c) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof described in [2] and a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof described in [2].

[20]

A method for producing an anti-human CD73 antibody or a fused form thereof, comprising:

culturing a host cell selected from the group consisting of the following (a) to (c) to express an anti-human CD73 antibody or a fused form thereof:

- (a) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the antibody described in [5] and a polynucleotide comprising a base sequence encoding a light chain of the antibody described in [5];

- (b) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the antibody described in [5] and an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain of the antibody described in [5]; and

- (c) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the antibody described in [5] and a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain of the antibody described in [5].

[21]

A method for producing a fused form of an anti-human CD73 antibody comprising:

- culturing a host cell selected from the group consisting of the following (a) to (c) to express a fused form of an anti-human CD73 antibody:

- (a) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the fused form described in [9] and a polynucleotide comprising a base sequence encoding a light chain of the fused form described in [9];

- (b) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the fused form described in [9] and

an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain of the fused form described in [9]; and

(c) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the fused form described in [9] and
5 a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain of the fused form described in [9].

[22]

A pharmaceutical composition comprising the anti-human CD73 antibody described in [3], and a pharmaceutically acceptable excipient.

10 [23]

The pharmaceutical composition described in [22], which is a pharmaceutical composition for preventing or treating cancer.

[24]

A method for preventing or treating cancer, comprising administering a
15 therapeutically effective amount of the anti-human CD73 antibody described in [3].

[25]

The anti-human CD73 antibody described in [3], which is for use in preventing or treating cancer.

[26]

20 Use of the anti-human CD73 antibody described in [3] for the manufacture of a pharmaceutical composition for preventing or treating cancer.

[27]

A pharmaceutical composition comprising the fused form described in [9], and a pharmaceutically acceptable excipient.

25 [28]

The pharmaceutical composition described in [27], which is a pharmaceutical composition for preventing or treating cancer.

[29]

A method for preventing or treating cancer, comprising administering a
30 therapeutically effective amount of the fused form described in [9].

[30]

The fused form described in [9] for use in preventing or treating cancer.

[31]

35 Use of the fused form described in [9] for the manufacture of a pharmaceutical composition for preventing or treating cancer.

Effects of the Invention

[0014]

The anti-human CD73 antibody of the present invention has an activity of inhibiting human CD73 enzymatic activity and can be used as an agent for preventing or treating cancer.

5 Brief Description of the Drawings

[0015]

[Fig. 1] Fig. 1 is a view illustrating enzyme inhibitory activity of CDS-1, MEDI9447, 6E1, and CD73.4IgG2CS-IgG1.1f to human CD73 protein.

[Fig. 2] Fig. 2 is a view illustrating recovery of human T cell functions due to
10 CDS-1, MEDI9447, 6E1, and CD73.4IgG2CS-IgG1.1f, using a production amount of IFN γ from human T cells as an index.

[Fig. 3] Fig. 3 is a view illustrating recovery of human T cell functions due to CDS-1, MEDI9447, 6E1, and CD73.4IgG2CS-IgG1.1f, using proliferation of human T
15 cells as an index.

Embodiments for Carrying Out the Invention

[0016]

Hereinafter, the present invention will be described in detail.

[0017]

20 There are five classes of IgG, IgM, IgA, IgD, and IgE in an antibody. The basic structure of an antibody molecule is configured of heavy chains having a molecular weight of 50000 to 70000 and light chains having a molecular weight of 20000 to 30000 in each of the classes in common. Heavy chain usually consists of a polypeptide chain comprising approximately 440 amino acids, has a distinctive structure for each of the
25 classes, and is referred to as Ig γ , Ig μ , Ig α , Ig δ , and Ig ϵ corresponding to IgG, IgM, IgA, IgD, and IgE, respectively. Further, four subclasses of IgG1, IgG2, IgG3, and IgG4 are present in IgG, and the heavy chains respectively corresponding thereto are referred to as Ig γ 1, Ig γ 2, Ig γ 3, and Ig γ 4. Light chain usually consists of a polypeptide chain comprising 220 amino acids, two types of which, type L and type K are known, and are referred to as
30 Ig λ and Ig κ . In a peptide configuration of the basic structure of antibody molecules, two homologous heavy chains and two homologous light chains are bound by disulfide bonds (S-S bond) and non-covalent bonds, and the molecular weight thereof is 150000 to 190000. Two kinds of light chains can be paired with any heavy chain. The respective antibody molecules typically consist of two identical light chains and two identical heavy chains.

35 [0018]

With regard to intrachain S-S bonds, four of the S-S bonds are present in the heavy chain (five in μ and ϵ chains) and two of them are present in the light chain; one loop is formed per 100 to 110 amino acid residues, and this steric structure is similar among the

loops and are referred to as a structural unit or a domain. The domain located at the amino terminal side (N terminal side) in both of the heavy chain and the light chain, whose amino acid sequence is not constant even in a case of a sample from the same class (sub class) of the same kind of animal is referred to as a variable region, and respective domains are referred to as a heavy chain variable region (or VH) and a light chain variable region (or VL). The amino acid sequence of the carboxy terminal side (C terminal side) from the variable region is nearly constant in each class or subclass and is referred to as a constant region. Respective domains of the constant region are represented as CH1, CH2, CH3, or CL in order from the variable region side, respectively.

10 [0019]

An antigenic binding site of an antibody is configured of VH and VL, and the binding specificity depends on the amino acid sequence of this site. On the other hand, biological activities such as binding to complements and various effector cells reflect differences in the constant region structures among each class Ig. It is understood that the variability of variable regions of the light chains and the heavy chains is mostly limited to three small hypervariable regions present in both chains and these regions are referred to as complementarity determining regions (CDR: CDR1, CDR2, and CDR3 from the N terminal side). The remaining portion of the variable region is referred to as a framework region (FR) and is relatively constant.

20 [0020]

Various antigen-binding fragments comprising VH and VL of an antibody also have antigen-binding activities, and representative examples of such an antigen-binding fragment include a single chain variable region fragment (scFv), Fab, Fab', and F(ab')₂. Fab is a monovalent antibody fragment which is configured of a light chain and a heavy chain fragment comprising VH, a CH1 domain, and a portion of a hinge region. Fab' is a monovalent antibody fragment which is configured of a light chain and a heavy chain fragment comprising VH, a CH1 domain, and a portion of a hinge region, and the portion of the hinge region includes cysteine residues configuring the S-S bond between heavy chains. F(ab')₂ fragment is a divalent antibody fragment in which two Fab' fragments are bound by an S-S bond between heavy chains in the hinge region. In addition, scFv is a monovalent antibody fragment which is configured of VH and VL connected to each other via a linker.

[0021]

With the designation of the Kabat numbering or the EU index (Kabat et al. Sequences of Proteins of Immunological Interest, Fifth Edition, NIH Publication No. 91-3242, 1991), the amino acid residue number of the antibody used in the present specification can be defined according to the numbering system.

[0022]

<Anti-Human CD73 Antibody of the Present Invention>

The anti-human CD73 antibody of the present invention includes an anti-human CD73 antibody or an antigen-binding fragment thereof having the following characteristics.

- 5 An anti-human CD73 antibody or an antigen-binding fragment thereof comprising a heavy chain variable region comprising CDR1 consisting of the amino acid sequence of amino acid numbers 31 to 35 of SEQ ID NO: 2, CDR2 consisting of the amino acid sequence of amino acid numbers 50 to 66 of SEQ ID NO: 2, and CDR3 consisting of the amino acid sequence of amino acid numbers 99 to 112 of SEQ ID NO: 2 and a light chain variable region comprising CDR1 consisting of the amino acid sequence of amino acid numbers 24 to 34 of SEQ ID NO: 4, CDR2 consisting of the amino acid sequence of amino acid numbers 50 to 56 of SEQ ID NO: 4, and CDR3 consisting of the amino acid sequence of amino acid numbers 89 to 98 of SEQ ID NO: 4.

[0023]

- 15 In one embodiment, the anti-human CD73 antibody of the present invention includes the following anti-human CD73 antibody or the antigen-binding fragment thereof:
 an anti-human CD73 antibody or an antigen-binding fragment thereof comprising a heavy chain variable region consisting of the amino acid sequence of amino acid numbers 1 to 123 of SEQ ID NO: 2 and a light chain variable region consisting of the amino acid sequence of amino acid numbers 1 to 109 of SEQ ID NO: 4.

[0024]

- As the heavy chain constant region of the anti-human CD73 antibody of the present invention, any constant region of Ig γ , Ig μ , Ig α , Ig δ , or Ig ϵ can be selected. For example, Ig γ can be selected from Ig γ 1, Ig γ 2, Ig γ 3, or Ig γ 4. As one embodiment, the heavy chain constant region is an Ig γ 1 constant region. For example, the heavy chain constant region is a human Ig γ 1 constant region.

[0025]

- The heavy chain constant region of the anti-human CD73 antibody of the present invention may have mutations for the purpose of degrading an antibody-dependent cellular cytotoxicity activity or a complement-dependent cytotoxicity activity of an antibody. L234A is a substitution of leucine at the amino acid 234 position with alanine in the human Ig γ 1 constant region according to the EU index. L235A is a substitution of leucine at the amino acid 235 position with alanine in the human Ig γ 1 constant region according to the EU index. P331S is a substitution of proline at the amino acid 331 position with serine in the human Ig γ 1 constant region according to the EU index. Examples of the human Ig γ 1 constant region having amino mutations of L234A, L235A, and P331S include a human Ig γ 1 constant region consisting of the amino acid sequence of amino acid numbers 124 to 453 of SEQ ID NO: 2. It is known that the mutations degrade the antibody-dependent

cellular cytotoxicity activity or the complement-dependent cytotoxicity activity of an antibody (Mol Immunol., Vol. 29, p. 633-639, 1992) (J Immunol., Vol. 164, p. 4178-4184, 2000).

[0026]

5 As the light chain constant region of the anti-human CD73 antibody of the present invention, any constant region of Ig λ or Ig κ can be selected. As one embodiment, the light chain constant region is a Ig κ constant region. For example, the light chain constant region is a human Ig κ constant region. Examples of the human Ig κ constant region include a human Ig κ constant region consisting of the amino acid sequence of amino acid
10 numbers 110 to 215 of SEQ ID NO: 4.

[0027]

In one embodiment, the anti-human CD73 antibody of the present invention is an antigen-binding fragment which is scFv, Fab, Fab', or F(ab')₂.

[0028]

15 In one embodiment, the anti-human CD73 antibody of the present invention is an anti-human CD73 antibody comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 4.

[0029]

20 It is known that when an antibody is expressed in cells, the antibody is modified after translation. Examples of the posttranslational modification include cleavage of lysine at the C terminal of the heavy chain by a carboxypeptidase; modification of glutamine or glutamic acid at the N terminal of the heavy chain and the light chain to pyroglutamic acid by pyroglutamylation; glycosylation; oxidation; deamidation; and
25 glycation, and it is known that such posttranslational modifications occur in various antibodies (Journal of Pharmaceutical Sciences, Vol. 97, p. 2426-2447, 2008).

[0030]

The anti-human CD73 antibody of the present invention includes an anti-human CD73 antibody which is an antibody derived from posttranslational modification or an
30 antigen-binding fragment thereof. The antibody which is derived from posttranslational modification includes an antibody comprising polypeptide consisting of the amino acid sequence of the antibody derived from posttranslational modification. Examples of the anti-human CD73 antibody of the present invention which is an antibody derived from posttranslational modification include anti-human CD73 antibodies which have undergone
35 pyroglutamylation at the N terminal of the heavy chain variable region and/or deletion of lysine at the C terminal of the heavy chain. It is known in the field that such posttranslational modification due to pyroglutamylation at the N terminal and deletion of lysine at the C terminal does not have any influence on the activity of the antibody

(Analytical Biochemistry, Vol. 348, p. 24-39, 2006).

[0031]

In one embodiment, the anti-human CD73 antibody of the present invention which is derived from posttranslational modification is the following anti-human CD73 antibody:

5 an anti-human CD73 antibody comprising a heavy chain consisting of the amino acid sequence of amino acid numbers 1 to 452 of SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 4.

[0032]

10 In the present specification, the “anti-human CD73 antibody” means an antibody binding to human CD73. Whether the “anti-human CD73 antibody” binds to human CD73 is confirmed by using a known binding activity measurement method. Examples of the binding activity measurement method include a method of Enzyme-Linked ImmunoSorbent Assay (ELISA) and the like. In a case of using the ELISA, for example, a human CD73 protein (for example, BPS Bioscience Inc., 71184) is immobilized on an
15 ELISA plate and a test antibody is added thereto to be reacted. After the reaction, a secondary antibody such as an anti-IgG antibody, labeled with an enzyme such as horseradish peroxidase (HRP) or the like, is reacted. After the reaction, washing is performed, and then it is possible to confirm whether the test body binds to the human CD73 by identifying binding of the secondary antibody through activity measurement
20 using a reagent detecting the activity (for example, in a case of HRP labeling, TMB + substrate-chromogen (Dako Ltd.)). As a specific measurement method, the method described in Example 2 below can be used.

[0033]

25 The anti-human CD73 antibody of the present invention includes, in addition to binding to human CD73, an antibody binding to CD73 derived from other animals (for example, monkey CD73), as long as the antibody binds to human CD73.

[0034]

30 As a method for evaluating the activity of the anti-human CD73 antibody of the present invention, the enzyme inhibitory activity of human CD73 may be evaluated. As the methods for evaluating such activity, the methods described in Examples 3 and 4 below can be used, for example. The anti-human CD73 antibody of the present invention includes an antibody which binds to human CD73 and has an enzyme inhibitory activity of human CD73.

[0035]

35 In addition, as a method for evaluating the activity of the anti-human CD73 antibody of the present invention, the activity of recovering AMP-dependently suppressed human T cell functions may be evaluated. As a method for evaluating such activity, it is possible to use the method as disclosed in Example 5 which will be described later. The

anti-human CD73 antibody of the present invention includes an antibody which binds to human CD73 and has an activity of recovering AMP-dependently suppressed human T cell functions.

[0036]

5 The anti-human CD73 antibody of the present invention can be easily prepared by a person skilled in the art using a known method in the field, based on sequence information on VH and VL of the present invention, which is disclosed in the present specification. The anti-human CD73 antibody of the present invention is not particularly limited, and can be produced according to the method described in the section of <Method
10 for Producing the Anti-Human CD73 Antibody of the Present Invention or the Fused Form of the Present Invention, and the Anti-Human CD73 Antibody or the Fused Form thereof that can be Produced by the Method> described below.

[0037]

The anti-human CD73 antibody of the present invention is further purified as
15 needed, formulated according to a conventional method, and can be used for the prevention or the treatment of cancer. Cancers which are targets for the prevention or the treatment in the present invention are not particularly limited, but examples of the cancers include lung cancer, large intestine cancer, adrenocortical cancer, breast cancer, malignant melanoma, glioblastoma, ovarian cancer, medulloblastoma, bladder cancer, stomach
20 cancer, pancreatic cancer, chronic myeloid leukemia, cutaneous T-cell lymphoma, glioblastoma, head and neck cancer, thyroid cancer, or prostate cancer.

[0038]

<Fused Form and Modified Form of the Present Invention>

Any person skilled in the art can prepare a fused form in which the anti-human
25 CD73 antibody or the antigen-binding fragment thereof of the present invention is fused with another peptide or protein, or also can prepare a modified form to which a modifying agent binds by using the anti-human CD73 antibody of the present invention. The fused form and the modified form of the present invention include a fused form in which the anti-human CD73 antibody or the antigen-binding fragment thereof of the present
30 invention is fused with another peptide or protein or a modified form to which a modifying agent binds, as long as the fused form or the modified form binds to human CD73. Other peptides or proteins used for the fusion is not particularly limited, and examples thereof include human serum albumin, various tag peptides, artificial helix motif peptide, maltose-binding proteins, glutathione S transferase, various toxins, cytokine, chemokine, other
35 peptides or proteins capable of promoting multimerization, and the like. The modifying agent used for the modification is not particularly limited, and examples thereof include polyethylene glycol, sugar chains, phospholipids, liposomes, low-molecular compounds, and the like. The fusion or modification may be direct fusion or modification, and may

be fusion or modification via an arbitrary linker. The fused form of the present invention includes a fused form in which the anti-human CD73 antibody or the antigen-binding fragment thereof of the present invention is fused with a cytokine. The cytokine used in the fused form of the present invention is not limited to a cytokine present in nature, and
5 may be a variant having the function. In one embodiment, a cytokine included in the fused form of the present invention is interleukin-7 (IL-7), interleukin 21 (IL-21), or a variant therefrom. In addition, a cytokine used in the fused form of the present invention may be a variant obtained by degrading a biological activity of IL-7 or IL-21.

[0039]

10 In the fused form of the present invention, the heavy chain includes a heavy chain of an antibody comprised in the fused form and another peptide or protein with which the heavy chain is fused. In the fused form of the present invention, the light chain includes a light chain of an antibody comprised in the fused form and another peptide or protein with which the light chain is fused.

15 [0040]

IL-7 is a cytokine which functions as a ligand with respect to an IL-7 receptor. It has been reported that IL-7 contributes to survival, proliferation, and differentiation of T cells, B cells, or the like (Curr Drug Targets., Vol. 7, p. 1571-1582, 2006). In the present invention, IL-7 includes IL-7 present in nature and a variant having the function. In one
20 embodiment, IL-7 is human IL-7. In the present invention, human IL-7 includes human IL-7 present in nature and a variant having the function. In one embodiment, human IL-7 is selected from the group consisting of the following (1) to (3): (1) a polypeptide comprising the amino acid sequence shown by Accession No. NP_000871.1 and having the function of human IL-7, (2) a polypeptide consisting of the amino acid sequence in
25 which 1 to 10 amino acids are deleted, substituted, inserted, and/or added and having the function of human IL-7, in the amino acid sequence shown by Accession No. NP_000871.1, and (3) a polypeptide comprising the amino acid sequence having equal to or greater than 90% identity to the amino acid sequence shown by Accession No. NP_000871.1 and having the function of human IL-7. In one embodiment, human IL-7
30 used in the present invention is a polypeptide consisting of the amino acid sequence shown by Accession No. NP_000871.1. Here, the function of human IL-7 is to perform actions for survival, proliferation, and differentiation of various human immune cells.

[0041]

IL-21 is a cytokine which functions as a ligand with respect to an IL-21 receptor.
35 It has been reported that IL-21 contributes to survival, proliferation, and differentiation of T cells, B cells, or the like (Cancer Lett., Vol. 358, p. 107-114, 2015). In the present invention, IL-21 includes IL-21 present in nature and a variant having the function. In one embodiment, IL-21 is human IL-21. In the present invention, human IL-21 includes

human IL-21 present in nature and a variant having the function. In one embodiment, human IL-21 is selected from the group consisting of the following (1) to (3): (1) a polypeptide comprising the amino acid sequence shown by Accession No. NP_068575.1 and having the function of human IL-21, (2) a polypeptide consisting of the amino acid sequence in which 1 to 10 amino acids are deleted, substituted, inserted, and/or added and having the function of human IL-21, in the amino acid sequence shown by Accession No. NP_068575.1, and (3) a polypeptide comprising the amino acid sequence having equal to or greater than 90% identity to the amino acid sequence shown by Accession No. NP_068575.1 and having the function of human IL-21. In one embodiment, human IL-21 used in the present invention is a polypeptide consisting of the amino acid sequence shown by Accession No. NP_068575.1. Here, the function of human IL-21 is to perform actions for survival, proliferation, and differentiation of various human immune cells.

[0042]

The fused form of the present invention also includes a fused form which is derived from posttranslational modification. Examples of posttranslational modification include various posttranslational modifications described in <Anti-Human CD73 Antibody of the Present Invention>.

[0043]

In one embodiment, the fused form of the present invention is a fused form selected from the group consisting of the following (a) to (e):

(a) a fused form comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 7 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 4;

(b) a fused form comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 10 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 4;

(c) a fused form comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 13;

(d) a fused form comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 15; and

(e) a fused form which is derived from posttranslational modification of the fused form of (a) to (d).

[0044]

In one embodiment, the fused form of the present invention which is a fused form derived from posttranslational modification is the following fused form:

a fused form comprising a heavy chain consisting of the amino acid sequence of

amino acid numbers 1 to 452 of SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 13.

[0045]

5 In one embodiment, the fused form of the present invention which is a fused form derived from posttranslational modification is the following fused form:

a fused form comprising a heavy chain consisting of the amino acid sequence of amino acid numbers 1 to 452 of SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 15.

[0046]

10 <Polynucleotide of the Present Invention>

The polynucleotide of the present invention includes a polynucleotide comprising a base sequence encoding VH of the anti-human CD73 antibody of the present invention and a polynucleotide comprising a base sequence encoding VL of the anti-human CD73 antibody of the present invention.

15 [0047]

In one embodiment, the polynucleotide comprising a base sequence encoding VH of the anti-human CD73 antibody of the present invention is a polynucleotide comprising a base sequence encoding VH consisting of the amino acid sequence of amino acid numbers 1 to 123 of SEQ ID NO: 2.

20 [0048]

Examples of the polynucleotide comprising a base sequence encoding VH consisting of the amino acid sequence of amino acid numbers 1 to 123 of SEQ ID NO: 2 include a polynucleotide comprising a base sequence of base sequence numbers 1 to 369 of SEQ ID NO: 1.

25 [0049]

In one embodiment, the polynucleotide comprising a base sequence encoding VL of the anti-human CD73 antibody of the present invention is a polynucleotide comprising a base sequence encoding VL consisting of the amino acid sequence of amino acid numbers 1 to 109 of SEQ ID NO: 4.

30 [0050]

Examples of the polynucleotide comprising a base sequence encoding VL consisting of the amino acid sequence of amino acid numbers 1 to 109 of SEQ ID NO: 4 include a polynucleotide comprising a base sequence of base sequence numbers 1 to 327 of SEQ ID NO: 3.

35 [0051]

The polynucleotide of the present invention includes a polynucleotide comprising a base sequence encoding a heavy chain of the anti-human CD73 antibody of the present invention and a polynucleotide comprising a base sequence encoding a light chain of the

anti-human CD73 antibody of the present invention.

[0052]

In one embodiment, the polynucleotide comprising a base sequence encoding the heavy chain of the anti-human CD73 antibody of the present invention is a polynucleotide comprising a base sequence encoding the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2.

[0053]

Examples of the polynucleotide comprising a base sequence encoding the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 include a polynucleotide comprising a base sequence shown by SEQ ID NO: 1 or 11.

[0054]

In one embodiment, the polynucleotide comprising a base sequence encoding the light chain of the anti-human CD73 antibody of the present invention is a polynucleotide comprising a base sequence encoding the light chain consisting of the amino acid sequence shown by SEQ ID NO: 4.

[0055]

Examples of the polynucleotide comprising a base sequence encoding the light chain consisting of the amino acid sequence shown by SEQ ID NO: 4 include a polynucleotide comprising a base sequence shown by SEQ ID NO: 3 or 8.

[0056]

The polynucleotide of the present invention includes a polynucleotide comprising a base sequence encoding a heavy chain of the fused form of the present invention and a polynucleotide comprising a base sequence encoding a light chain of the fused form of the present invention.

[0057]

In one embodiment, the polynucleotide comprising a base sequence encoding the heavy chain of the fused form of the present invention is a polynucleotide comprising a base sequence encoding the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 7.

[0058]

Examples of the polynucleotide comprising a base sequence encoding the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 7 include a polynucleotide comprising a base sequence shown by SEQ ID NO: 5 or 6.

[0059]

In one embodiment, the polynucleotide comprising a base sequence encoding the light chain of the fused form of the present invention is a polynucleotide comprising a base sequence encoding the light chain consisting of the amino acid sequence shown by SEQ ID NO: 4.

[0060]

Examples of the polynucleotide comprising a base sequence encoding the light chain consisting of the amino acid sequence shown by SEQ ID NO: 4 include a polynucleotide comprising a base sequence shown by SEQ ID NO: 3 or 8.

5 [0061]

In one embodiment, the polynucleotide comprising a base sequence encoding the heavy chain of the fused form of the present invention is a polynucleotide comprising a base sequence encoding the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 10.

10 [0062]

Examples of the polynucleotide comprising a base sequence encoding the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 10 include a polynucleotide comprising a base sequence shown by SEQ ID NO: 9 or 16.

[0063]

15 In one embodiment, the polynucleotide comprising a base sequence encoding the heavy chain of the fused form of the present invention is a polynucleotide comprising a base sequence encoding the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2.

[0064]

20 Examples of the polynucleotide comprising a base sequence encoding the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 include a polynucleotide comprising a base sequence shown by SEQ ID NO: 1 or 11.

[0065]

25 In one embodiment, the polynucleotide comprising a base sequence encoding the light chain of the fused form of the present invention is a polynucleotide comprising a base sequence encoding the light chain consisting of the amino acid sequence shown by SEQ ID NO: 13.

[0066]

30 Examples of the polynucleotide comprising a base sequence encoding the light chain consisting of the amino acid sequence shown by SEQ ID NO: 13 include a polynucleotide comprising a base sequence shown by SEQ ID NO: 12.

[0067]

35 In one embodiment, the polynucleotide comprising a base sequence encoding the light chain of the fused form of the present invention is a polynucleotide comprising a base sequence encoding the light chain consisting of the amino acid sequence shown by SEQ ID NO: 15.

[0068]

Examples of the polynucleotide comprising a base sequence encoding the light

chain consisting of the amino acid sequence shown by SEQ ID NO: 15 include a polynucleotide comprising a base sequence shown by SEQ ID NO: 14.

[0069]

5 The polynucleotide of the present invention can be easily prepared by a person skilled in the art using a known method in the field based on the base sequence. For example, the polynucleotide of the present invention can be synthesized using a known gene synthesis method in the field. As the gene synthesis method, various methods such as a synthesis method of antibody genes described in WO90/07861 known by a person skilled in the art can be used.

10 [0070]

<Expression Vector of the Present Invention>

An expression vector of the present invention includes an expression vector comprising a polynucleotide comprising a base sequence encoding VH of the anti-human CD73 antibody of the present invention, an expression vector comprising a polynucleotide
15 comprising a base sequence encoding VL of the anti-human CD73 antibody of the present invention, and an expression vector comprising a polynucleotide comprising a base sequence encoding VH of the anti-human CD73 antibody of the present invention and a polynucleotide comprising a base sequence encoding VL of the antibody.

[0071]

20 An expression vector of the present invention includes an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the anti-human CD73 antibody of the present invention, an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain of the anti-human CD73 antibody of the present invention, and an expression vector comprising a polynucleotide
25 comprising a base sequence encoding the heavy chain of the anti-human CD73 antibody of the present invention and a polynucleotide comprising a base sequence encoding the light chain of the antibody.

[0072]

An expression vector of the present invention includes an expression vector
30 comprising a polynucleotide comprising a base sequence encoding a heavy chain of the fused form of the present invention, an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain of the fused form of the present invention, and an expression vector comprising a polynucleotide comprising a base sequence encoding the heavy chain of the fused form and a polynucleotide comprising a
35 base sequence encoding the light chain of the fused form.

[0073]

The expression vectors used to express the polynucleotide of the present invention are not particularly limited as long as a polynucleotide comprising the base sequence

encoding the heavy chain of the anti-human CD73 antibody or the fused form of the present invention and/or a polynucleotide comprising the base sequence encoding the light chain of the anti-human CD73 antibody or the fused form of the present invention can be expressed in various host cells of eukaryotic cells (for example, animal cells, insect cells, plant cells, and yeast) and/or prokaryotic cells (for example, *Escherichia coli*), and the polypeptides encoded by these can be produced. Examples of the expression vector include plasmid vectors, viral vectors (for example, adenovirus or retrovirus), and the like. In one embodiment, pEE6.4 or pEE12.4 (Lonza Biologics, Inc.) can be used as an expression vector.

10 [0074]

The expression vector of the present invention may include a promoter that is operably linked to the polynucleotide of the present invention. Examples of the promoter for expressing the polynucleotide of the invention with animal cells include a virus-derived promoter such as CMV, RSV, or SV40, an actin promoter, an EF (elongation factor) 1 α promoter, and a heat shock promoter. Examples of promoters for expressing the polynucleotide of the invention by bacteria (for example, *Escherichia*) include a trp promoter, a lac promoter, λ PL promoter, and tac promoter. Further, examples of promoters for expressing the polynucleotide of the invention by yeast include a GAL1 promoter, a GAL10 promoter, a PH05 promoter, a PGK promoter, a GAP promoter, and an ADH promoter.

20 [0075]

In the case of using an animal cell, an insect cell, or yeast as the host cell, the expression vector of the present invention may include initiation codon and termination codon. In this case, the expression vector of the present invention may comprise an enhancer sequence, an untranslated region on the 5' side and the 3' side of genes encoding the antibody of the present invention or the heavy chain or the light chain, a secretory signal sequence, a splicing junction, a polyadenylation site, or a replicable unit. When *Escherichia coli* is used as the host cell, the expression vector of the present invention may comprise an initiation codon, a termination codon, a terminator region, and a replicable unit. In this case, the expression vector of the present invention may comprise a selection marker (for example, tetracycline resistant genes, ampicillin resistant genes, kanamycin resistant genes, neomycin resistant genes, or dihydrofolate reductase genes) which is generally used according to the purpose.

30 [0076]

35 <Transformed Host Cell of the Present Invention>

The transformed host cell of the present invention includes a host cell transformed with the expression vector of the present invention, which is selected from the group consisting of the following (a) to (d):

(a) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding VH of the anti-human CD73 antibody of the present invention;

5 (b) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding VL of the anti-human CD73 antibody of the present invention;

(c) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding VH of the anti-human CD73 antibody of the present invention and a polynucleotide comprising a base sequence encoding VL of the antibody;
10 and

(d) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding VH of the anti-human CD73 antibody of the present invention and an expression vector comprising a polynucleotide comprising a base sequence encoding VL of the antibody.

15 [0077]

The transformed host cell of the present invention includes a host cell transformed with the expression vector of the present invention, which is selected from the group consisting of the following (a) to (d):

(a) a host cell transformed with an expression vector comprising a polynucleotide
20 comprising a base sequence encoding the heavy chain of the anti-human CD73 antibody of the present invention;

(b) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the light chain of the anti-human CD73 antibody of the present invention;

25 (c) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the heavy chain of the anti-human CD73 antibody of the present invention and a polynucleotide comprising a base sequence encoding the light chain of the anti-human CD73 antibody of the present invention; and

(d) a host cell transformed with an expression vector comprising a polynucleotide
30 comprising a base sequence encoding the heavy chain of the anti-human CD73 antibody of the present invention and an expression vector comprising a polynucleotide comprising a base sequence encoding the light chain of the antibody.

[0078]

The transformed host cell of the present invention includes a host cell transformed
35 with the expression vector of the present invention, which is selected from the group consisting of the following (a) to (d):

(a) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the heavy chain of the fused form of the present

invention;

(b) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the light chain of the fused form of the present invention;

5 (c) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the heavy chain of the fused form of the present invention and a polynucleotide comprising a base sequence encoding the light chain of the fused form; and

(d) a host cell transformed with an expression vector comprising a polynucleotide
10 comprising a base sequence encoding the heavy chain of the fused form of the present invention and an expression vector comprising a polynucleotide comprising a base sequence encoding the light chain of the fused form.

[0079]

Examples of the transformed host cell of the present invention include a host cell
15 transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the heavy chain of the anti-human CD73 antibody of the present invention and a polynucleotide comprising a base sequence encoding the light chain of the antibody, and a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the heavy chain of the anti-human
20 CD73 antibody of the present invention and an expression vector comprising a polynucleotide comprising a base sequence encoding the light chain of the antibody.

[0080]

The transformed host cell is not particularly limited as long as the host cell is appropriate for the expression vector being used, transformed with the expression vector,
25 and can express the antibody or the fused form. Examples of the transformed host cell include various cells such as natural cells or artificially established cells which are generally used in the field of the present invention (for example, animal cells (for example, CHO-K1SV cells), insect cells (for example, Sf9), bacteria (for example, Escherichia), yeast (for example, Saccharomyces or Pichia) or the like). In one embodiment, cell lines
30 such as CHO-K1SV cells, CHO-DG 44 cells, HEK293 cells, NS0 cells, or the like can be used as a transformed host cell.

[0081]

A method of transforming the host cell is not particularly limited, and, for example, a calcium phosphate method or an electroporation method can be used.

35 [0082]

< Method for Producing the Anti-Human CD73 Antibody of the Present Invention or the Fused Form of the Present Invention, and the Anti-Human CD73 Antibody or the Fused Form thereof that can be Produced by the Method >

The method for producing the anti-human CD73 antibody of the present invention or the fused form of the present invention includes a method for producing an anti-human CD73 antibody, an antigen-binding fragment thereof, or a fused form of any one thereof by culturing host cell(s) selected from the group consisting of the following (a) to (c) to

5 express the anti-human CD73 antibody, the antigen-binding fragment thereof, or the fused form of any one thereof:

(a) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding VH of the anti-human CD73 antibody of the present invention and a polynucleotide comprising a base sequence encoding VL of the antibody;

10 (b) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding VH of the anti-human CD73 antibody of the present invention and an expression vector comprising a polynucleotide comprising a base sequence encoding VL of the antibody; and

(c) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding VH of the anti-human CD73 antibody of the present invention and a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding VL of the antibody.

[0083]

The method for producing the anti-human CD73 antibody of the present invention or the fused form of the present invention includes a method for producing an anti-human CD73 antibody or a fused form thereof by culturing host cell(s) selected from the group consisting of the following (a) to (c) to express the anti-human CD73 antibody or the fused form of thereof:

20 (a) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the heavy chain of the anti-human CD73 antibody of the present invention and a polynucleotide comprising a base sequence encoding the light chain of the antibody;

(b) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the heavy chain of the anti-human CD73 antibody of the present invention and an expression vector comprising a polynucleotide comprising a base sequence encoding the light chain of the antibody; and

30 (c) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the heavy chain of the anti-human CD73 antibody of the present invention and a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the light chain of the antibody.

[0084]

The method for producing the fused form of the present invention includes a method for producing a fused form of the anti-human CD73 antibody by culturing host

cell(s) selected from the group consisting of the following (a) to (c) to express the fused form of the anti-human CD73 antibody:

(a) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the heavy chain of the fused form of the present invention and a polynucleotide comprising a base sequence encoding the light chain of the fused form;

(b) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the heavy chain of the fused form of the present invention and an expression vector comprising a polynucleotide comprising a base sequence encoding the light chain of the fused form; and

(c) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the heavy chain of the fused form of the present invention and a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding the light chain of the fused form.

[0085]

The method for producing the anti-human CD73 antibody of the present invention or the fused form of the present invention is not particularly limited as long as it comprises a step of culturing the transformed host cells of the present invention to express the anti-human CD73 antibody, the antigen-binding fragment, or the fused form of any one thereof. Examples of the host cells used in the method include the transformed host cells of the present invention as described above.

[0086]

The transformed host cell can be cultured by known methods. Culture conditions, for example, the temperature, pH of culture medium, and the culture time are appropriately selected. In a case where the host cell is an animal cell, examples of the culture medium include MEM culture medium supplemented with approximately 5% to 20% of fetal bovine serum (Science, Vol. 130, p. 432-437, 1959), DMEM culture medium (Virology, Vol. 8, p. 396, 1959), RPMI1640 culture medium (J. Am. Med. Assoc., Vol. 199, p. 519, 1967), and a 199 culture medium (Exp. Biol. Med., Vol. 73, p. 1-8, 1950). The pH of the culture medium is preferably approximately 6 to 8, and the culture is generally carried out at approximately 30°C to 40°C for approximately 15 hours to 336 hours while air ventilating and stirring if necessary. In a case where the host cell is an insect cell, as the culture medium, for example, Grace's culture medium (Proc Natl Acad Sci USA., Vol. 82, p. 8404, 1985) supplemented with fetal bovine serum can be used. The pH of the culture medium is approximately 5 to 8, for example, and the culture is generally carried out at approximately 20°C to 40°C for approximately 15 hours to 100 hours while air ventilating and stirring if necessary. In a case where the host cell is Escherichia coli or yeast, as the culture medium, for example, liquid culture medium supplemented with a

source of nutrients is appropriate. The nutrient culture medium includes a carbon source, an inorganic nitrogen source, or an organic nitrogen source necessary for the growth of the transformed host cell. Examples of the carbon source include glucose, dextran, soluble starch, and sucrose and examples of the inorganic nitrogen source or the organic nitrogen source include ammonium salts, nitrate salts, amino acids, corn steep liquor, peptone, casein, meat extract, soybean meal, and potato extract. Other nutrients (for example, inorganic salts (for example, calcium chloride, sodium dihydrogen phosphate, and magnesium chloride), vitamins), and antibiotics (for example, tetracycline, neomycin, ampicillin, and kanamycin) may be included as desired. The pH of the culture medium is approximately 5 to 8, for example. In a case where the host cell is *Escherichia coli*, examples of the culture medium include LB culture medium and M9 culture medium (Molecular Cloning, Cold Spring Harbor Laboratory, Vol. 3, A2.2). The culture is generally carried out at approximately 14°C to 43°C for approximately 3 hours to 24 hours while air ventilating and stirring if necessary. In a case where the host cell is yeast, as the culture medium, for example, Burkholder minimal medium (Proc Natl Acad Sci USA., Vol. 77, p. 4505, 1980) can be used. The culture is generally carried out at approximately 20°C to 35°C for approximately 14 hours to 144 hours while air ventilating and stirring if necessary. By carrying out the culture in the above-described manner, it is possible to express the anti-human CD73 antibody of the present invention.

[0087]

The method for producing the anti-human CD73 antibody of the present invention or the fused form of the present invention may further include recovering, isolating, or purifying the anti-human CD73 antibody, the antigen-binding fragment thereof, or the fused form of any one thereof, in addition to culturing the transformed host cell of the present invention to express the anti-human CD73 antibody, the antigen-binding fragment thereof, or the fused form of any one thereof. Examples of the isolation or purification method include methods using solubility such as salting-out and the solvent precipitation method, methods using the difference in molecular weight such as dialysis, ultrafiltration, and gel filtration, methods using an electric charge such as ion exchange chromatography and hydroxylapatite chromatography, methods using specific affinity such as affinity chromatography, methods using the difference in hydrophobicity such as reverse phase high performance liquid chromatography, and methods using the difference in the isoelectric point such as isoelectric focusing phoresis. In one embodiment, the antibody accumulated in a culture supernatant can be purified by various chromatographies, for example, column chromatography using Protein A column or Protein G column.

[0088]

The anti-human CD73 antibody of the present invention or the fused form of the present invention also includes an anti-human CD73 antibody and an antigen-binding

fragment thereof, or a fused form of any one thereof produced by the method for producing the anti-human CD73 antibody of the present invention or the fused form of the present invention.

[0089]

5 <Pharmaceutical Composition of the Present Invention>

The pharmaceutical composition of the present invention includes a pharmaceutical composition comprising the anti-human CD73 antibody of the present invention, the antigen-binding fragment thereof, or the fused form of the present invention, and pharmaceutically acceptable excipients. The pharmaceutical composition of the
10 present invention can be prepared by a method being generally used with excipients, that is, excipients for medicine or carriers for medicine being generally used in the field. Examples of dosage forms of the pharmaceutical compositions include parenteral drug such as an injection drug and a drip infusion drug, and these can be administered by intravenous administration, subcutaneous administration, or the like. In drug preparation,
15 excipients, carriers, and additives in accordance with the dosage forms can be used within the pharmaceutically acceptable range.

[0090]

The pharmaceutical composition of the present invention may include plural kinds of anti-human CD73 antibody of the present invention. For example, the present
20 invention also includes a pharmaceutical composition containing an antibody or an antigen-binding fragment thereof which does not undergo deletion of lysine at the C terminal and pyroglutamylation at the N terminal and/or an antibody or an antigen-binding fragment thereof which have undergone deletion of lysine at the C terminal and/or pyroglutamylation at the N terminal.

25 [0091]

The pharmaceutical composition of the present invention may include plural kinds of fused form of the present invention. For example, the pharmaceutical composition of the present invention also includes a pharmaceutical composition containing a fused form which does not undergo deletion of lysine at the C terminal and pyroglutamylation at the N
30 terminal and/or a fused form which has undergone deletion of lysine at the C terminal and/or pyroglutamylation at the N terminal.

[0092]

In one embodiment, the pharmaceutical composition of the present invention contains an anti-human CD73 antibody or an antigen-binding fragment thereof comprising
35 a heavy chain variable region consisting of the amino acid sequence of amino acid numbers 1 to 123 of SEQ ID NO: 2 and a light chain variable region consisting of the amino acid sequence of amino acid numbers 1 to 109 of SEQ ID NO: 4, and an anti-human CD73 antibody or an antigen-binding fragment thereof which is derived from

posttranslational modification of the anti-human CD73 antibody or the antigen-binding fragment thereof.

[0093]

The pharmaceutical composition of the present invention also includes a
5 pharmaceutical composition containing an antibody in which lysine at the C terminal of the heavy chain is deleted, an antibody or an antigen-binding fragment thereof which has undergone pyroglutamylation at the N terminal, an antibody in which lysine at the C terminal of the heavy chain is deleted and which has undergone pyroglutamylation at the N terminal, and/or an antibody or an antigen-binding fragment thereof which has lysine at the
10 C terminal of the heavy chain and does not undergo pyroglutamylation at the N terminal.

[0094]

In one embodiment, the pharmaceutical composition of the present invention is a pharmaceutical composition comprising an anti-human CD73 antibody comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and a light chain
15 consisting of the amino acid sequence shown by SEQ ID NO: 4, an anti-human CD73 antibody comprising a polynucleotide consisting of the amino acid sequence of an antibody derived from posttranslational modification of the anti-human CD73 antibody, and a pharmaceutically acceptable excipient.

[0095]

In one embodiment, the pharmaceutical composition of the present invention is a pharmaceutical composition comprising a fused form of an anti-human CD73 antibody comprising the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 7 and the light chain consisting of the amino acid sequence shown by SEQ ID NO: 4, a fused form comprising a polypeptide consisting of the amino acid sequence of a fused form
25 derived from posttranslational modification of the fused form, and a pharmaceutically acceptable excipient.

[0096]

In one embodiment, the pharmaceutical composition of the present invention is a pharmaceutical composition comprising a fused form of an anti-human CD73 antibody comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 10
30 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 4, a fused form comprising a polypeptide consisting of the amino acid sequence of a fused form derived from posttranslational modification of the fused form, and a pharmaceutically acceptable excipient.

35 [0097]

In one embodiment, the pharmaceutical composition of the present invention is a pharmaceutical composition comprising a fused form of an anti-human CD73 antibody comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2

and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 13, a fused form comprising a polypeptide consisting of the amino acid sequence of a fused form derived from posttranslational modification of the fused form, and a pharmaceutically acceptable excipient.

5 [0098]

In one embodiment, the pharmaceutical composition of the present invention is a pharmaceutical composition comprising a fused form of an anti-human CD73 antibody comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 15, a fused
10 form comprising a polypeptide consisting of the amino acid sequence of a fused form derived from posttranslational modification of the fused form, and a pharmaceutically acceptable excipient.

[0099]

The addition amount of the anti-human CD73 antibody, the fused form, and the
15 modified form of the present invention in formulation varies depending on the degree of a patient's symptoms, the age of a patient, a dosage form of the drug to be used, the binding titer of the antibody, or the like, and for example, an addition amount of approximately 0.001 mg/kg to 100 mg/kg can be used.

[0100]

20 The pharmaceutical composition of the present invention can be used as an agent for treating cancer.

[0101]

The pharmaceutical composition of the present invention includes a pharmaceutical composition for preventing or treating cancer comprising the anti-human
25 CD73 antibody, the fused form, or the modified form of the present invention. Further, the present invention includes a method for treating or preventing cancer comprising administering a therapeutically effective amount of the anti-human CD73 antibody, the fused form, or the modified form of the present invention. Further, the present invention includes the anti-human CD73 antibody, the fused form, and the modified form of the
30 present invention for use in preventing or treating cancer. In addition, the present invention includes use of the anti-human CD73 antibody, the fused form, and the modified form of the present invention for the manufacture of a pharmaceutical composition for preventing or treating cancer. Cancers which are targets for the prevention or the treatment in the present invention are not particularly limited, but examples of the cancers
35 include lung cancer, large intestine cancer, adrenocortical cancer, breast cancer, malignant melanoma, glioblastoma, ovarian cancer, medulloblastoma, bladder cancer, stomach cancer, pancreatic cancer, chronic myeloid leukemia, cutaneous T-cell lymphoma, glioblastoma, head and neck cancer, thyroid cancer, or prostate cancer.

[0102]

For better understanding regarding the present invention, specific examples referred to will be provided, but these are merely examples and the present invention is not limited thereto.

5 [Examples]

[0103]

Unless otherwise noted, the tests are performed according to the known methods. In addition, with regard to parts using commercially available reagents or kits, the tests are performed according to the instructions of the commercially available products.

10 [0104]

[Example 1: Preparation of Anti-Human CD73 Antibody]

An anti-human CD73 antibody was prepared using a human monoclonal antibody developing technology “VelocImmune” (VelocImmune antibody technology; Regeneron Pharmaceuticals, Inc. (US Patent No. 6596541)) mouse. The antibody acquired by the
15 technology is a chimeric antibody of which the variable region is derived from a human and the constant region is derived from a mouse. A VelocImmune mouse was immunized with an adjuvant for causing an immune reaction together with a human CD73 protein. The human CD73 protein was manufactured by the following technique. A base sequence encoding a HisTag sequence ($\text{His} \times 6$) and a termination codon was added to the
20 3' terminal of a base sequence of base numbers 1 to 1641 of a human CD73 gene (ORIGENE Technologies, Inc., RC209568) by a gene engineering technique using a gene introduced to a vector for mammalian cell expression as an expression vector. The expression vector was transfected to an Expi293F™ cell (Thermo Fisher Scientific Inc.) and a fusion protein of human CD73 and HisTag (human CD73-His protein) was purified
25 from recovered supernatant. The purified human CD73-His protein was immunized into the mouse several times, and then hybridoma was prepared according to the conventional method. Using the antibody purified with hybridoma supernatant, a hybridoma clone producing an antibody having a function of inhibiting human CD73 enzymatic activity was selected. Then, genes encoding a heavy chain and a light chain of an antibody from
30 hybridoma were cloned. As for the gene cloning, according to the conventional method, antibody gene sequences of cDNA prepared by extracted RNA of hybridoma were analyzed and sequence determination was performed. In addition, the amino acid sequence was analyzed, and Kabat et al. database (Kabat et al. Sequences of Proteins of Immunological Interest, Fifth Edition, NIH Publication No. 91-3242, 1991) was referred to
35 so as to determine CDR sequence and FR sequence. In order to improve physical properties and stability, FR of the heavy chain and the light chain of some clones was substituted with FR of the heavy chain and the light chain of other human antibodies, respectively. The VH and the VL of the substituted antibody sequence were respectively

linked to a human Igγ1 constant region (in some clones, human Igγ1 constant region having amino acid mutations of L234A, L235A and P331S) and human Igκ1 constant region by the PCR method, inserted into a GS vector (Lonza Biologics, Inc.) which is a vector for mammalian cell expression, thereby constructing an expression vector.

5 Specifically, genes encoding signal sequences (Protein Eng., Vol. 1, p. 499-505, 1987) and human Igγ1 constant region genes were respectively ligated to the 5' side and the 3' side of the heavy chain variable region genes of the antibody, and then the heavy chain genes were inserted into a GS vector pEE6.4. Further, genes encoding signal sequences (Protein Eng., Vol. 1, p. 499-505, 1987) and the constant region genes of a human κ chain were
10 respectively ligated to the 5' side and the 3' side of the light chain variable region genes, and then the light chain genes were inserted into a GS vector pEE12.4.

[0105]

Using an expression vector comprising the antibody heavy chain and the antibody light chain thereof, a purified antibody was acquired from a transient expression or stable
15 expression line. With regard to the transient expression, specifically, both expression vectors of the above-described antibody heavy chain and antibody light chain were transfected to CHOK1SV cells (Lonza Biologics, Inc.) using MaxCyte STX (trade name) (MaxCyte Inc.), and cultured for about 7 days. The culture supernatants of the transient expression or stable expression were purified using MabSelect SuRe (GE Healthcare Japan
20 Corporation), Vivapure (trade name) Q Maxi H (Sartorius Group), and the like, thereby obtaining purified antibodies.

[0106]

As a result of selecting clones having the function of inhibiting human CD73 enzymatic activity from a number of purified antibodies, it was evident that an anti-human
25 CD73 antibody named CDS-1 has the strongest function of inhibiting enzymatic activity.

[0107]

The base sequence encoding residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering, of the heavy chain of CDS-1 is shown by SEQ ID NO: 1, the amino acid sequence encoded by the base sequence is
30 shown by SEQ ID NO: 2, the base sequence encoding residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering, of the light chain of the antibody is shown by SEQ ID NO: 3, and the amino acid sequence encoded by the base sequence is shown by SEQ ID NO: 4.

[0108]

35 The VH of CDS-1 consists of the amino acid sequence of the amino acid numbers 1 to 123 of SEQ ID NO: 2, CDR1, CDR2, and CDR3 of the heavy chain respectively consist of the amino acid sequences of amino acid numbers 31 to 35, 50 to 66, and 99 to 112 of SEQ ID NO: 2. The VL of the antibody consists of the amino acid sequence of the

amino acid numbers 1 to 109 of SEQ ID NO: 4, and CDR1, CDR2, and CDR3 of the light chain respectively consist of the amino acid sequences of amino acid numbers 24 to 34, 50 to 56, and 89 to 98 of SEQ ID NO: 4.

[0109]

5 A fused form in which human IL-7 is fused to the C terminal side of the heavy chain of CDS-1 was acquired and named CDS-3. The base sequence encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering, and human IL-7 via a linker, of the heavy chain of CDS-3 is shown by SEQ ID NOS: 5 and 6, the amino acid sequence encoded by the base sequence is shown by
10 SEQ ID NO: 7, the base sequence encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering, of the light chain of the fused form is shown by SEQ ID NOS: 3 and 8, the amino acid sequence encoded by the base sequence is shown by SEQ ID NO: 4, and the heavy chain of CDS-3 consists of the amino acid sequences in which the amino acid sequence of human IL-7 consisting of the
15 amino acid sequence of amino acid numbers 464 to 615 of SEQ ID NO: 7 is fused to the C terminal side of the heavy chain of CDS-1 via a linker consisting of the amino acid sequence of amino acid numbers 454 to 463 of SEQ ID NO: 7.

[0110]

A fused form in which human IL-7 variant is fused to the C terminal side of the
20 heavy chain of CDS-1 was acquired and named CDS-6. The base sequence encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering, and human IL-7 variant via a linker, of the heavy chain of CDS-6 is shown by SEQ ID NOS: 9 and 16, the amino acid sequence encoded by the base sequence is shown by SEQ ID NO: 10, the base sequence encoding the residue number 1 of a
25 variable region to the C terminal of a constant region according to Kabat numbering, of the light chain of the fused form is shown by SEQ ID NOS: 3 and 8, and the amino acid sequence encoded by the base sequence is shown by SEQ ID NO: 4, respectively. The heavy chain of CDS-6 consists of the amino acid sequences in which the amino acid sequence of human IL-7 variant consisting of the amino acid sequence of amino acid
30 numbers 464 to 615 of SEQ ID NO: 10 is fused to the C terminal side of the heavy chain of CDS-1 via a linker consisting of the amino acid sequence of amino acid numbers 454 to 463 of SEQ ID NO: 10.

[0111]

A fused form in which human IL-21 is fused to the C terminal side of the light
35 chain of CDS-1 was acquired and named CDS-7. The base sequence encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering, of the heavy chain of CDS-7 is shown by SEQ ID NO: 11, the amino acid sequence encoded by the base sequence is shown by SEQ ID NO: 2, the base

sequence encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering and IL-21 via a linker, of the light chain of the fused form is shown by SEQ ID NO: 12, and the amino acid sequence encoded by the base sequence is shown by SEQ ID NO: 13. The light chain of CDS-7 consists of the amino acid sequences in which the amino acid sequence of human IL-21 consisting of the amino acid sequence of amino acid numbers 226 to 358 of SEQ ID NO: 13 is fused to the C terminal side of the light chain of CDS-1 via a linker consisting of the amino acid sequence of amino acid numbers 216 to 225 of SEQ ID NO: 13.

[0112]

A fused form in which human IL-21 variant is fused to the C terminal side of the light chain of CDS-1 was acquired and named CDS-8. The base sequence encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering, of the heavy chain of CDS-8 is shown by SEQ ID NO: 11, the amino acid sequence encoded by the base sequence is shown by SEQ ID NO: 2, the base sequence encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering and IL-21 variant via a linker, of the light chain of the fused form is shown by SEQ ID NO: 14, and the amino acid sequence encoded by the base sequence is shown by SEQ ID NO: 15. The light chain of CDS-8 consists of the amino acid sequences in which the amino acid sequence of human IL-21 variant consisting of the amino acid sequence of amino acid numbers 226 to 358 of SEQ ID NO: 15 is fused to the C terminal side of the light chain of CDS-1 via a linker consisting of the amino acid sequence of amino acid numbers 216 to 225 of SEQ ID NO: 15.

[0113]

Purified CDS-3, CDS-6, CDS-7 and CDS-8 were acquired according to the above-described method.

[0114]

Based on information illustrated in Fig. 1C and Fig. 1D of Patent Document 1, an expression vector expressing an antibody named MEDI9447 was prepared. Based on information shown by SEQ ID NOS: 21 and 22 of Patent Document 2, an expression vector expressing an antibody named 6E1 was prepared. Based on information shown by SEQ ID NOS: 133 and 102 of Patent Document 3, an expression vector expressing an antibody named CD73.4IgG2CS-IgG1.1f was prepared. Genes encoding signal sequences were inserted into these expression vectors according to the conventional method.

[0115]

Purified MEDI9447, CD73.4IgG2CS-IgG1.1f, and 6E1 were acquired according to the conventional method and used for comparison.

[0116]

As a result of analyzing amino acid modification of the purified CDS-1, CDS-7, and CDS-8, deletion of lysine at the C terminal of the heavy chain occurred in most purified antibodies.

[0117]

5 As a result of analyzing amino acid modification of the purified CDS-3, the heavy chain was a sequence corresponding to SEQ ID NO: 7 and the light chain was a sequence corresponding to SEQ ID NO: 4.

[0118]

10 As a result of analyzing amino acid modification of the purified CDS-6, the light chain was a sequence corresponding to SEQ ID NO: 4. Since sugar chains in the heavy chain were not completely cut, the type of amino acid modification cannot be specified.

[0119]

[Example 2: Evaluation of Binding Activity of Anti-Human CD73 Antibody to Human CD73 Protein]

15 In order to evaluate the binding activity of CDS-1, CDS-3, CDS-6, CDS-7, and CDS-8 acquired in Example 1 to human CD73, the ELISA was performed using a human CD73 protein. The human CD73 protein (BPS Bioscience Inc., 71184) diluted in PBS (Life Technologies, Inc.) to have a concentration of 4 µg/mL was added to a MaxiSorp 384-well plate Clear (Thermo Fisher Scientific Inc.) by an amount of 20 µL/well, and then
20 immobilized overnight at a temperature of 4°C. The next day, the resultant was washed with a wash solution (0.05% Tween-20 containing Tris-buffered saline (TBS)) once, Blocking One (Nacalai tesque, Inc.) was added thereto in an amount of 100 µL/well, and the resultant was blocked at room temperature for 30 minutes. The resultant was washed with the wash solution once again, and the purified CDS-1, the purified CDS-3, the
25 purified CDS-6, the purified CDS-7, or the purified CDS-8 prepared in Example 1 was added thereto by an amount of 20 µL/well, respectively. These purified antibodies were diluted using a reaction buffer obtained by mixing the same amount of PBS and Blocking One, and dilution was performed in 12 steps from 10 µg/mL to 56 pg/mL. The resultant was reacted at room temperature for 1 hour, and then washed three times with a wash
30 solution. 20 µL/well of a human IgG-heavy and light chain cross-adsorbed antibody (Bethyl Laboratories Inc., A80-219P) which had been diluted 4000-fold with a reaction buffer was added thereto, and the resultant was reacted at room temperature for 1 hour. The resultant was washed with a wash solution three times, and 20 µL/well of TMB + substrate-chromogen (DAKO Ltd., S1599) was added thereto. After 5 minutes, 20
35 µL/well of 1M sulfuric acid (Wako Pure Chemical Industries, Ltd.) was added thereto and the reaction was stopped. The values of absorbance at 450 nm and 540 nm were measured by Infinite M200 PRO (TECAN Inc.), and EC₅₀ values of CDS-1, CDS-3, CDS-6, CDS-7, and CDS-8 with respect to the human CD73 protein were calculated. In

calculation of the EC₅₀ values, the ordinate represents a difference in the measurement values of absorbance at 450 nm and 540 nm, and the abscissa represents an antibody concentration value. In addition, a measurement value when the measurement value can be determined to reach a convergence value according to the increase in the antibody concentration, from the shape of the sigmoid curve drawn on the graph, was set to 100%, and a measurement value when the measurement value can be determined to reach a convergence value according to the decrease in the antibody concentration therefrom was set to 0%. This assay was independently performed, and the EC₅₀ values were calculated from the 4-parameter logistic curve regression (Table 1).

10 [Table 1]

	EC ₅₀ (ng/mL)	
	First	Second
CDS-1	3.9	8.8
CDS-3	Not performed	20.9
CDS-6	Not performed	19.6
CDS-7	Not performed	20.1
CDS-8	Not performed	23.9

[0120]

As a result, it was evident that CDS-1, CDS-3, CDS-6, CDS-7, and CDS-8 bind to the human CD73 protein.

15 [0121]

[Example 3: Evaluation of Enzyme Inhibitory Activity of Anti-Human CD73 Antibody to Human CD73 Protein]

In order to evaluate inhibition of CDS-1, CDS-3, CDS-6, CDS-7, and CDS-8 acquired in Example 1 against enzymatic activity of human CD73, an enzyme assay was performed using a human CD73 protein. In this example, MEDI9447, CD73.4IgG2CS-IgG1.1f, and 6E1 were used for comparison. 25mM Tris-buffered saline containing 5 mM magnesium chloride was manufactured with hydrochloric acid to have a pH of 7.5, and set as an assay buffer. A human CD73 protein (R&D Systems, Inc., 5795) prepared with an assay buffer such that the final concentration was adjusted to 15 ng/mL, a purified CDS-1, a purified CDS-3, a purified CDS-6, a purified CDS-7, a purified CDS-8, a purified MEDI9447, a purified CD73.4IgG2CS-IgG1.1f, or a purified 6E1 diluted in an assay buffer was added to a 96-well assay plate Clear (Corning, Inc.) by an amount of 20 μL/well, respectively, and the resultant was reacted at room temperature for 30 minutes. These purified antibodies were diluted using an assay buffer, and the dilution was performed in 11 steps such that the final concentration was adjusted to 20 μg/mL to 0.339 ng/mL. AMP (SIGMA-ALDRICH Corporation, A1752-1G) diluted in an assay buffer

was added by an amount of 20 μ L/well such that the final concentration was adjusted to 30 μ M thereto, and the resultant was reacted at room temperature for 45 minutes. 60 μ L/well of acetonitrile was added thereto to stop the reaction, and the adenosine concentration was measured by LC/MS (LC: Shimadzu Corporation SIL-HTc or Waters Corporation Acquity UPLC I-Class, Column: Agilent Technologies, Inc. ZORBAX SB-Aq 1.8 μ m 2.1 $\times$ 30 mm, MS: AB Sciex Ltd. API4000). On the basis of the measured adenosine concentration, inhibition of CDS-1 and the like against enzymatic activity of human CD73 was evaluated based on the measured EC₅₀ values. In calculation of the EC₅₀ values, the ordinate represents a measured adenosine concentration value, and the abscissa represents an antibody concentration value. In addition, an adenosine concentration value when the adenosine concentration value can be determined to reach a convergence value according to the increase in the antibody concentration, from the shape of the sigmoid curve drawn on the graph, was set to 100%, and an adenosine concentration value when the adenosine concentration value can be determined to reach a convergence value according to the decrease in the antibody concentration therefrom was set to 0%. This assay was independently performed, and the EC₅₀ values were calculated from the 4-parameter logistic curve regression (Table 2). As reported in Non-Patent Document 1, MEDI9447 was characterized to have a property of showing bell-shaped inhibition (Fig. 1). In addition, the convergence value of CD73.4IgG2CS-IgG1.1f was higher than the convergence value of the adenosine concentration value according to the increase in the antibody concentration of CDS-1.

[Table 2]

	EC ₅₀ (ng/mL)	
	Frist	Second
CDS-1	16.8	9.2
CDS-3	Not performed	19.4
CDS-6	Not performed	20.4
CDS-7	Not performed	17.5
CDS-8	Not performed	21.1

[0122]

As a result, it was evident that CDS-1, CDS-3, CDS-6, CDS-7, and CDS-8 inhibit enzymatic activity of human CD73 proteins.

[0123]

[Example 4: Evaluation of Enzyme Inhibitory Activity of Anti-Human CD73 Antibody in Human CD73 Expression Cells]

In order to evaluate inhibition of CDS-1, CDS-3, CDS-6, CDS-7, and CDS-8 acquired in Example 1 against the enzymatic activity of human CD73, an enzyme assay

was performed using a cancer cell line NCI-H1373 (ATCC: CRL-5866) endogenously expressing human CD73. NCI-H1373 cells were suspended in PBS (Life Technologies, Inc.), and added to a 96-well V-bottom plate (Sumitomo Bakelite Co., Ltd.) by an amount of 30 μ L/well such that the final cell concentration was adjusted to 4×10^4 cells/well.

- 5 Immediately thereafter, a purified CDS-1, a purified CDS-3, a purified CDS-6, a purified CDS-7, or a purified CDS-8 was respectively added by an amount of 10 μ L/well. These purified antibodies were diluted using PBS, and the dilution was performed in 11 steps such that the final concentration was adjusted to 50.0 μ g/mL to 0.847 ng/mL. After being reacted at room temperature for 30 minutes, AMP (SIGMA-ALDRICH Corporation,
- 10 A1752-1G) was added by an amount of 10 μ L/well such that the final concentration was adjusted to 180 μ M. After being reacted at room temperature for 30 minutes, the plate was centrifuged at a temperature of 4°C at $340 \times g$. 15 μ L/well of supernatant was transferred from the centrifuged plate to the newly prepared 96-well V-bottom plate (Sumitomo Bakelite Co., Ltd.) by, and 15 μ L/well of acetonitrile was added thereto. The
- 15 adenosine concentration was measured by LC/MS (described in Example 3), and the inhibition of CDS-1, CDS-3, CDS-6, CDS-7, and CDS-8 against the enzymatic activity of human CD73 based on the measured EC_{50} values. This assay was independently performed, and the EC_{50} values were calculated by the measurement method described in Example 3 (Table 3).

20 [Table 3]

	EC_{50} (ng/mL)	
	First	Second
CDS-1	785	579
CDS-3	Not performed	455
CDS-6	Not performed	678
CDS-7	Not performed	712
CDS-8	Not performed	750

[0124]

As a result, it was evident that CDS-1, CDS-3, CDS-6, CDS-7, and CDS-8 inhibit enzymatic activity of human CD73 in NCI-H1373 cells.

25 [0125]

[Example 5: Evaluation of Effect of Anti-Human CD73 Antibody on Recovery of AMP-Dependently Suppressed Human T Cell Functions]

In order to evaluate the effect of CDS-1 acquired in Example 1 on recovery of AMP-dependently suppressed human T cell functions, an assay was performed using

30 human T cell expressing human CD73. In this assay, it is possible to evaluate an antibody which activates anti-tumor immunity by recovering functions of immune cells suppressed

by AMP using recovery of human T cell functions as an index. In this example, MEDI9447, CD73.4IgG2CS-IgG1.1f, and 6E1 were used for comparison. A human T cell was isolated from a human peripheral blood mononuclear cell (AllCells, LLC) using Pan T Cell Isolation Kit (Miltenyi Biotec Ltd., 130-096-535), suspended on a

5 TexMACS™ culture medium (Miltenyi Biotec Ltd., 130-097-196), and added to a 96-well flat bottom plate (AGC TECHNO GLASS Co., Ltd.) by an amount of 50 μ L/well such that the final cell density was adjusted to 1×10^5 cells/well. Immediately thereafter, a purified CDS-1, a purified MEDI9447, a purified 6E1, or a purified CD73.4IgG2CS-IgG1.1f was respectively added thereto by an amount of 25 μ L/well. These purified antibodies were

10 diluted using the TexMACS™ culture medium, and the dilution was performed in 12 steps such that the final concentration was adjusted to 15 μ g/mL to 0.05 ng/mL. Further, AMP (SIGMA-ALDRICH Corporation) was added by an amount of 50 μ L/well such that the final concentration was adjusted to 250 μ M. Immediately thereafter, Dynabeads Human T-Activator CD3/CD28 (Thermo Fisher Scientific Inc., 11131D) was added thereto by an

15 amount of 50 μ L/well such that the final concentration was adjusted to 1×10^5 dynabeads/well. Then, a TexMACS™ culture medium was added such that a reaction solution of each well was 200 μ L, and cultured in a 5% CO₂ incubator at a temperature of 37°C for 3 days. 100 μ L of cultured supernatant after 3 days was collected, and the interferon gamma (IFN γ) concentration in the supernatant was measured based on the

20 protocol of AlphaLISA (trade name) IFN γ Immunoassay Kit (PerkinElmer Inc., AL217C). In addition, in order to analyze proliferation of human T cells, 20 μ L/well of CellTiter-Blue Reagent was added to the above-described plate from which 100 μ L of supernatant had been removed, based on the protocol of CellTiter-Blue (trade name) Cell Viability Assay (Promega K.K., G8081). After 4 hours, fluorescence (excitation wavelength of 560

25 nm/fluorescence wavelength of 590 nm) of each well was measured using EnVision™ (PerkinElmer Inc.). The effect of CDS-1 on recovery of AMP-dependently suppressed human T cell functions was evaluated based on the calculated EC₅₀ values using the IFN γ concentration and proliferation of human T cells as an index. In calculation of the EC₅₀ values, the ordinate represents an IFN γ concentration value or fluorescence value

30 calculated from the measurement value, and the abscissa represents an antibody concentration value. In addition, a measurement value when the IFN γ concentration value can be determined to reach a convergence value according to the increase in the antibody concentration, from the shape of the sigmoid curve drawn on the graph, was set to 100%, and a measurement value when the IFN γ concentration value or fluorescence value

35 can be determined to reach a convergence value according to the decrease in the antibody concentration therefrom was set to 0%. The EC₅₀ values were calculated from the 4-parameter logistic curve regression using the IFN γ concentration value and proliferation of human T cells as an index (Table 4). Among the compared subjects, the convergence

value of CD73.4IgG2CS-IgG1.1f was lower than the convergence value of the IFN γ concentration value and the proliferation value of human T cells according to the increase in the antibody concentration of CDS-1, and MEDI9447 did not show a sigmoid curve, the EC50 values of MEDI9447 and CD73.4IgG2CS-IgG1.1f which can be compared with those of CDS-1 could not be calculated (Fig. 2 and Fig. 3).

[Table 4]

	EC ₅₀ (ng/mL)	
	IFN γ	Proliferation of T cells
CDS-1	5.8	23.2
6E1	131.6	357.3

[0126]

As a result, it was evident that CDS-1 has a stronger function of recovering AMP-dependently suppressed T cell functions than that of any one of antibodies of MEDI9447, 6E1, CD73.4IgG2CS-IgG1.1f, thereby activating anti-tumor immunity.

[0127]

[Example 6: Evaluation of Effect of CDS-3 and CDS-6 on Biological Activity of IL-7]

In order to evaluate the effect of CDS-3 and CDS-6 acquired in Example 1 on the biological activity of IL-7, an assay was performed using a 2E8 cell line (ATCC:TIB-239) showing a dose-dependent cell proliferation activity due to the addition of human IL-7. In this example, Human IgG1 Isotype Control (EnzoLife Sciences Inc., ALX-804-133-C100) was used as a negative control. As a culture medium, Iscove's Modified Dulbecco's Medium (SIGMA-ALDRICH Corporation, I3390) containing L-glutamine solution (SIGMA-ALDRICH Corporation), 2-mercaptoethanol (Thermo Fisher Scientific Inc.), and inactivated 20% fetal bovine serum (HyClone Inc.) was used. A purified CDS-3, a purified CDS-6, or recombinant human IL-7 (Peprotech Inc., 200-07) was respectively added to a 384-well flat bottom plate (Thermo Fisher Scientific Inc.) by an amount of 10 μ L/well. The purified CDS-3, the purified CDS-6, and the recombinant human IL-7 were diluted using a culture medium, the molecular weight of the purified CDS-3 and the purified CDS-6 was 180000, and the dilution was performed in 11 steps such that the final concentration was adjusted to 100 nM to 0.001 nM. A 2E8 cell was suspended in a culture medium, and added by an amount of 40 μ L/well such that the final cell density was adjusted to 2×10^4 cells/well. Immediately thereafter, the resultant was cultured in a 5% CO₂ incubator at a temperature of 37°C for 3 days. In order to analyze cell proliferation after 3 days, 50 μ L/well of CellTiter-Glo Reagent was added to the above-described plate based on the protocol of CellTiter-Glo (trade name) Luminescent Cell Viability Assay (Promega K.K., G7573), and luminescent intensity of each well was measured using

ARVO-HTS (PerkinElmer Inc.) On the basis of the measured luminescent intensity, the cell proliferation activity of the purified CDS-3, the purified CDS-6, and the recombinant human IL-7 were evaluated based on the calculated EC₅₀ values. In calculation of the EC₅₀ values, the ordinate represents luminescent intensity, and the abscissa represents a drug concentration value. In addition, a luminescent intensity value of 100 nM recombinant human IL-7 was set to 100%, and a luminescent intensity value of the negative control was set to 0% to draw a sigmoid curve. The EC₅₀ values of the purified CDS-3, the purified CDS-6, and the recombinant human IL-7 calculated from the 4-parameter logistic curve regression were 0.050 nM, 1.8 nM, and 0.051 nM.

[0128]

As a result, it was evident that CDS-3 and CDS-6 have an effect on the biological activity of IL-7. In addition, it was evident that the effect of CDS-6 on biological activity of IL-7 is lower than that of CDS-3.

[0129]

[Example 7: Evaluation of Effect of CDS-7 and CDS-8 on Biological Activity of IL-21]

In order to evaluate the effect of CDS-7 and CDS-8 acquired in Example 1 on the biological activity of IL-21, an assay was performed using a human cell line Ramos (ATCC: CRL-1596) in which STAT3 phosphorylation is human IL-21 concentration-dependently induced. A Ramos cell was sowed in a dish using an RPMI culture medium (SIGMA-ALDRICH Corporation, R8758), and cultured in a 5% CO₂ incubator at a temperature of 37°C for 16 hours. After being collected, the Ramos cell was suspended in the above-described culture medium and sowed in a 96-well plate (Nippon Genetics Co., Ltd., 35800) by an amount of 45 µL/well such that the final cell density was adjusted to 2 × 10⁵ cells, and a purified CDS-7, a purified CDS-8, or recombinant human IL-21 (Peprotech Inc., 200-21) was respectively added thereto by an amount of 5 µL/well to be reacted. The purified CDS-7, the purified CDS-8, or the recombinant human IL-21 was diluted using PBS (Life Technologies, Inc.), the molecular weight of the purified CDS-7 and the purified CDS-8 was 180000, and the dilution was performed in 11 steps such that the final concentration was adjusted to 1200 nM to 0.02 nM, or performed in 10 steps such that the final concentration was adjusted to 400 nM to 0.02 nM. After being reacted at a temperature of 37°C for 30 minutes, the entire amount was transferred to a 96-well round bottom plate (Corning Inc., 351177) to which 200 µL/well of Fix Buffer I (BD Biosciences, Inc., 557870) had been added in advance, and reacted at a temperature of 37°C for 10 minutes to fix the cells. After washing was performed with a dyeing buffer, 200 µL/well of Perm Buffer III (BD Biosciences, Inc., 558050) was added thereto, reacted on ice for 30 minutes for permeabilization. As the dyeing buffer, Stain Buffer (FBS) (BD Biosciences, Inc., 554656) was used. The resultant was washed with the above-described

dyeing buffer and suspended, phosphorylated STAT3 was dyed using PE Mouse Anti-Stat3 (pY705) (BD Biosciences, Inc., 562072), and then fluorescence intensity of the cell was measured using FACSArray™ (BD Biosciences, Inc.). As the fluorescence intensity, a Geometric MFI value was used. On the basis of the measured fluorescence intensity, EC₅₀ values of the purified CDS-7, the purified CDS-8, and the recombinant human IL-21 were measured, and the STAT3 phosphorylation-induced activity was evaluated. In calculation of the EC₅₀ values, the ordinate represents measured fluorescence intensity, and the abscissa represents a drug concentration value. In addition, a fluorescence intensity value that can be determined to reach a convergence value according to the increase in the drug concentration, from the shape of the sigmoid curve drawn on the graph, was set to 100%, and a fluorescence intensity value that can be determined to reach a convergence value according to the decrease in the drug concentration therefrom was set to 0%. The EC₅₀ values of the purified CDS-7, the purified CDS-8, and the recombinant human IL-21 calculated from the 4-parameter logistic curve regression were 1.3 nM, 28.3 nM, and 8.0 nM.

[0130]

As a result, it was evident that CDS-7 and CDS-8 have an effect on the biological activity of IL-21. In addition, it was evident that the effect of CDS-8 on the biological activity of IL-21 is lower than that of CDS-7.

Industrial Applicability

[0131]

The anti-human CD73 antibody and fused form of the present invention is expected to be useful for preventing or treating cancer. In addition, the method for producing a polynucleotide, an expression vector, a transformed host cell, or an antibody of the present invention is useful for producing the anti-human CD73 antibody and fused form.

[Sequence List Free Text]

[0132]

In the number heading <223> of the following sequence list, description of "Artificial Sequence" is made. Specifically, the base sequences shown by SEQ ID NOS: 1 and 3 of the sequence list are respectively the base sequences encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering, of the heavy chain and the light chain of the CDS-1, the amino acid sequences shown by SEQ ID NOS: 2 and 4 of the sequence list are respectively the amino acid sequences of the heavy chain and the light chain encoded by SEQ ID NOS: 1 and 3, the base sequence shown by SEQ ID NO: 5 or 6 of the sequence list is the base sequence encoding the residue number 1 of a variable region to the C terminal of a constant region

according to Kabat numbering and human IL-7 via a linker, of the heavy chain of CDS-3, and the amino acid sequence shown by SEQ ID NO: 7 of the sequence list is the amino acid sequence of the heavy chain encoded by SEQ ID NO: 5 or 6. The base sequence shown by SEQ ID NO: 8 is the base sequence encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering, of the light chain of CDS-3. The base sequence shown by SEQ ID NO: 9 or 16 of the sequence list is the base sequence encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering and a human IL-7 variant, of the heavy chain of CDS-6, the amino acid sequence shown by SEQ ID NO: 10 of the sequence list is the amino acid sequence of the heavy chain encoded by SEQ ID NO: 9 or 16. The base sequence shown by SEQ ID NO: 11 of the sequence list is the base sequence encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering, of the heavy chain of CDS-7. The base sequence shown by SEQ ID NO: 12 of the sequence list is the base sequence encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering and human IL-21 via a linker, of the light chain of CDS-7, and the amino acid sequence shown by SEQ ID NO: 13 of the sequence list is the amino acid sequence of the light chain encoded by SEQ ID NO: 12. The base sequence shown by SEQ ID NO: 14 of the sequence list is the base sequence encoding the residue number 1 of a variable region to the C terminal of a constant region according to Kabat numbering and a human IL-21 variant via a linker, of the light chain of CDS-8, and the amino acid sequence shown by SEQ ID NO: 15 of the sequence list is the amino acid sequence of the light chain encoded by SEQ ID NO: 14.

Claims

[Claim 1] An anti-human CD73 antibody or an antigen-binding fragment thereof comprising:

- 5 a heavy chain variable region comprising CDR1 consisting of the amino acid sequence of amino acid numbers 31 to 35 of SEQ ID NO: 2, CDR2 consisting of the amino acid sequence of amino acid numbers of 50 to 66 of SEQ ID NO: 2, and CDR3 consisting of the amino acid sequence of amino acid numbers of 99 to 112 of SEQ ID NO: 2; and
- 10 a light chain variable region comprising CDR1 consisting of the amino acid sequence of amino acid numbers of 24 to 34 of SEQ ID NO: 4, CDR2 consisting of the amino acid sequence of amino acid numbers of 50 to 56 of SEQ ID NO: 4, and CDR3 consisting of the amino acid sequence of amino acid numbers of 89 to 98 of SEQ ID NO: 4.

[Claim 2] The anti-human CD73 antibody or the antigen-binding fragment thereof according to Claim 1, comprising a heavy chain variable region consisting of the amino acid sequence of amino acid numbers of 1 to 123 of SEQ ID NO: 2, and a light chain variable region consisting of the amino acid sequence of amino acid numbers of 1 to 109 of SEQ ID NO: 4.

[Claim 3] The anti-human CD73 antibody according to Claim 1 or 2, selected from the group consisting of the following (a) and (b):

- (a) an anti-human CD73 antibody comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 4; and
- 25 (b) an anti-human CD73 antibody which is derived from posttranslational modification of the anti-human CD73 antibody of (a).

[Claim 4] The anti-human CD73 antibody according to Claim 3, selected from the group consisting of the following (a) and (b):

- (a) an anti-human CD73 antibody comprising the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and the light chain consisting of the amino acid sequence shown by SEQ ID NO: 4; and
- 30 (b) an anti-human CD73 antibody comprising a heavy chain consisting of the amino acid sequence of amino acid numbers of 1 to 452 of SEQ ID NO: 2 and the light chain consisting of the amino acid sequence shown by SEQ ID NO: 4.

[Claim 5] The anti-human CD73 antibody according to Claim 4, comprising the heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2, and the light chain consisting of the amino acid sequence shown by SEQ ID NO: 4.

[Claim 6] The anti-human CD73 antibody according to Claim 4, comprising the heavy chain consisting of the amino acid sequence of amino acid numbers of 1 to 452 of

SEQ ID NO: 2, and the light chain consists of the amino acid sequence shown by SEQ ID NO: 4.

[Claim 7] A fused form in which the anti-human CD73 antibody or the antigen-binding fragment thereof according to any one of Claims 1 to 6 is fused with another peptide or protein.

[Claim 8] A modified form in which the anti-human CD73 antibody or the antigen-binding fragment thereof according to any one of Claims 1 to 6 binds to a modifying agent.

[Claim 9] The fused form according to Claim 7, selected from the group consisting of the following (a) to (e):

(a) a fused form comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 7 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 4;

(b) a fused form comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 10 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 4;

(c) a fused form comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 13;

(d) a fused form comprising a heavy chain consisting of the amino acid sequence shown by SEQ ID NO: 2 and a light chain consisting of the amino acid sequence shown by SEQ ID NO: 15; and

(e) a fused form which is derived from posttranslational modifications of the fused forms of (a) to (d).

[Claim 10] A polynucleotide selected from the group consisting of the following (a) and (b):

(a) a polynucleotide comprising a sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2; and

(b) a polynucleotide comprising a sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2.

[Claim 11] The polynucleotide according to Claim 10, selected from the group consisting of the following (a) and (b):

(a) a polynucleotide comprising a sequence encoding a heavy chain of the antibody according to Claim 5; and

(b) a polynucleotide comprising a sequence encoding a light chain of the antibody according to Claim 5.

[Claim 12] The polynucleotide according to Claim 11, selected from the group consisting of the following (a) and (b):

(a) a polynucleotide comprising a sequence encoding a heavy chain of the fused form according to Claim 9; and

(b) a polynucleotide comprising a sequence encoding a light chain of the fused form according to Claim 9.

5 [Claim 13] An expression vector comprising the following (a) and/or (b):

(a) a polynucleotide comprising a sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2; and

(b) a polynucleotide comprising a sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2.

10 [Claim 14] The expression vector according to Claim 13, comprising the following (a) and/or (b):

(a) a polynucleotide comprising a sequence encoding a heavy chain of the antibody according to Claim 5; and

15 (b) a polynucleotide comprising a sequence encoding a light chain of the antibody according to Claim 5.

[Claim 15] The expression vector according to Claim 14, comprising the following (a) and/or (b):

(a) a polynucleotide comprising a sequence encoding a heavy chain of the fused form according to Claim 9; and

20 (b) a polynucleotide comprising a sequence encoding a light chain of the fused form according to Claim 9.

[Claim 16] A host cell selected from the group consisting of the following (a) to (d):

25 (a) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2;

(b) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2;

30 (c) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2 and a polynucleotide comprising a sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2; and

35 (d) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2 and an expression vector comprising a polynucleotide comprising a sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2.

[Claim 17] The host cell according to Claim 16, selected from the group consisting of the following (a) to (d):

(a) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain of the antibody according to Claim 5;

5 (b) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a light chain of the antibody according to Claim 5;

(c) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain of the antibody according to Claim 5 and a polynucleotide comprising a sequence encoding a light chain of the antibody according to
10 Claim 5; and

(d) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain of the antibody according to Claim 5 and an expression vector comprising a polynucleotide comprising a sequence encoding a light chain of the antibody according to Claim 5.

15 [Claim 18] The host cell according to Claim 17, selected from the group consisting of the following (a) to (d):

(a) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain of the fused form according to Claim 9;

(b) a host cell transformed with an expression vector comprising a polynucleotide
20 comprising a sequence encoding a light chain of the fused form according to Claim 9;

(c) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain of the fused form according to Claim 9 and a polynucleotide comprising a sequence encoding a light chain of the fused form according to Claim 9; and

25 (d) a host cell transformed with an expression vector comprising a polynucleotide comprising a sequence encoding a heavy chain of the fused form according to Claim 9 and an expression vector comprising a polynucleotide comprising a sequence encoding a light chain of the fused form according to Claim 9.

[Claim 19] A method for producing an anti-human CD73 antibody, an antigen-
30 binding fragment thereof, and a fused form of any one thereof, the method comprising:

culturing a host cell selected from the group consisting of the following (a) to (c) to express an anti-human CD73 antibody, an antigen-binding fragment thereof, and a fused form of any one thereof:

(a) a host cell transformed with an expression vector comprising a polynucleotide
35 comprising a base sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2 and a polynucleotide comprising a base sequence encoding a light chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2;

(b) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2 and an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain variable
5 region of the antibody or the antigen-binding fragment thereof according to Claim 2; and

(c) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2 and a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a
10 light chain variable region of the antibody or the antigen-binding fragment thereof according to Claim 2.

[Claim 20] A method for producing an anti-human CD73 antibody or a fused form thereof, comprising:

culturing a host cell selected from the group consisting of the following (a) to (c)
15 to express an anti-human CD73 antibody or a fused form thereof:

(a) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the antibody according to Claim 5 and a polynucleotide comprising a base sequence encoding a light chain of the antibody according to Claim 5;

20 (b) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the antibody according to Claim 5 and an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain of the antibody according to Claim 5; and

(c) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the antibody according to Claim 5
25 and a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain of the antibody according to Claim 5.

[Claim 21] A method for producing a fused form of an anti-human CD73 antibody comprising:

30 culturing a host cell selected from the group consisting of the following (a) to (c) to express a fused form of an anti-human CD73 antibody:

(a) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the fused form according to Claim 9 and a polynucleotide comprising a base sequence encoding a light chain of the fused
35 form according to Claim 9;

(b) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the fused form according to Claim

9 and an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain of the fused form according to Claim 9; and

(c) a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a heavy chain of the fused form according to Claim

5 9 and a host cell transformed with an expression vector comprising a polynucleotide comprising a base sequence encoding a light chain of the fused form according to Claim 9.

[Claim 22] A pharmaceutical composition comprising the anti-human CD73 antibody according to Claim 3, and a pharmaceutically acceptable excipient.

10 [Claim 23] The pharmaceutical composition according to Claim 22, which is a pharmaceutical composition for preventing or treating cancer.

[Claim 24] A method for preventing or treating cancer, comprising administering a therapeutically effective amount of the anti-human CD73 antibody according to Claim 3.

[Claim 25] The anti-human CD73 antibody according to Claim 3, which is for use in preventing or treating cancer.

15 [Claim 26] Use of the anti-human CD73 antibody according to Claim 3 for the manufacture of a pharmaceutical composition for preventing or treating cancer.

[Claim 27] A pharmaceutical composition comprising the fused form according to Claim 9, and a pharmaceutically acceptable excipient.

20 [Claim 28] The pharmaceutical composition according to Claim 27, which is a pharmaceutical composition for preventing or treating cancer.

[Claim 29] A method for preventing or treating cancer, comprising administering a therapeutically effective amount of the fused form according to Claim 9.

[Claim 30] The fused form according to Claim 9 for use in preventing or treating cancer.

25 [Claim 31] Use of the fused form according to Claim 9 for the manufacture of a pharmaceutical composition for preventing or treating cancer.

Fig. 1

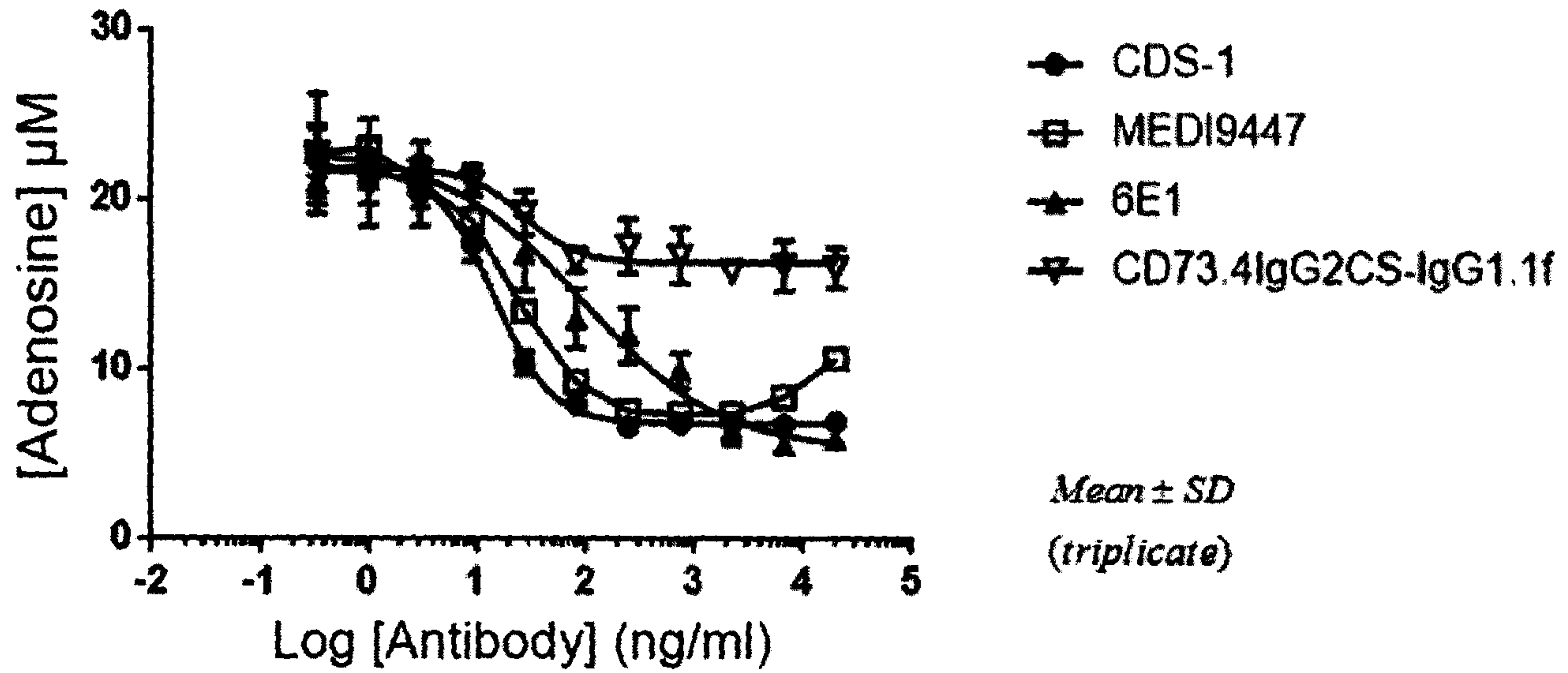


Fig. 2

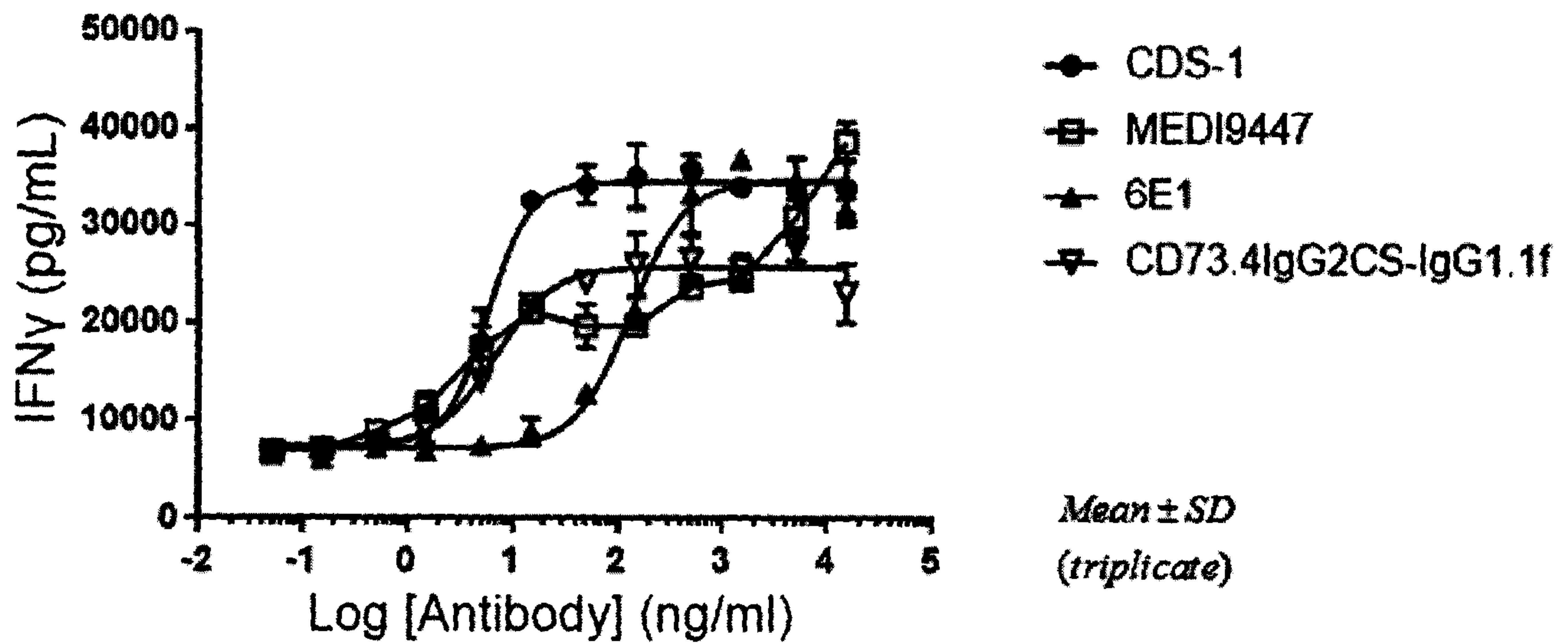


Fig. 3

