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DESCRIPTION

Technical Field

[0001] The present disclosure relates to an isolated anti-FcRn antibody, which is an antibody binding to FcRn (stands for neonatal Fc receptor, also called FcRP, FcRB or Brambell receptor) that is a receptor with a high affinity for IgG or a fragment thereof, a method of preparing thereof, a composition for treating autoimmune disease, which comprises the antibody, and the antibody for use in a method of treating and diagnosing autoimmune diseases using the antibody. The FcRn-specific antibody according to the present disclosure binds to FcRn non-competitively with IgG to reduce serum pathogenic auto-antibody levels, and thus can be used for the treatment of autoimmune diseases.

Background Art

[0002] Antibodies are immunological proteins that bind to a specific antigen. In most animals, including humans and mice, antibodies are constructed from paired heavy and light polypeptide chains and each chain is made up of two distinct regions, referred to as the variable and constant regions. The light and heavy chain variable regions show significant sequence diversity between antibodies, and are responsible for binding the target antigen. The constant regions show less sequence diversity, and are responsible for binding a number of natural proteins to elicit important biochemical events.

[0003] Under normal conditions, the half-life of most IgG excluding IgG3 isotype in serum is about 22-23 days in humans, which is a prolonged period relative to the serum half-life of other plasma proteins. With respect to this prolonged serum half-life of IgG, IgG that entered cells by endocytosis can strongly bind to neonatal Fc receptor (FcRn, a kind of Fc gamma receptor) in endosomes at a pH of 6.0 to avoid the degradative lysosomal pathway. When the IgG-FcRn complex cycles to the plasma membrane, IgG dissociates rapidly from FcRn in the bloodstream at slightly basic pH (~7.4). By this receptor-mediated recycling mechanism, FcRn effectively rescues the IgG from degradation in lysosomes, thereby prolonging the half-life of IgG (Roopenian et al. J. Immunol. 170:3528, 2003).

[0004] FcRn was identified in the neonatal rat gut, where it functions to mediate the absorption of IgG antibody from the mother's milk and facilitates its transport to the circulatory system. FcRn has also been isolated from human placenta, where it mediates absorption and transport of maternal IgG to the fetal circulation. In adults, FcRn is expressed in a number of tissues, including epithelial tissues of the lung, intestine, kidney, as well as nasal, vaginal, and biliary tree surfaces.

[0005] FcRn is a non-covalent heterodimer that typically resides in the endosomes of

endothelial and epithelial cells. FcRn is a membrane bound receptor having three heavy chain alpha domains (α1, α2 and α3) and a single soluble light chain β2-microglobulin (β2m) domain. Structurally, it belongs to a family of major histocompatibility complex class 1 molecules that have β2m as a common light chain. The FcRn chain has a molecular weight of about 46 kD and is composed of an ectodomain containing the α1, α2, and α3 heavy chain domains and a β2m light chain domain and having a single sugar chain, a single-pass transmembrane, and a relatively short cytoplasmic tail.

[0006] In order to study the contributions of FcRn to IgG homeostasis, mice have been engineered so that at least part of the genes encoding β2m and FcRn heavy chains have been "knocked out" so that these proteins are not expressed. In these mice, the serum half-life and concentrations of IgG were dramatically reduced, suggesting an FcRn-dependent mechanism for IgG homeostasis. It has also been suggested that anti-human FcRn antibodies may be generated in these FcRn knockout mice and that these antibodies may prevent the binding of IgG to FcRn. The inhibition of IgG binding to FcRn negatively alters IgG serum half-life by preventing IgG recycling, so that autoimmune diseases caused by auto-antibodies can be treated. This possibility was shown in a mouse model of autoimmune cutaneous bullous diseases (Li et al. J. Clin. Invest. 115:3440, 2005). Accordingly, agents that block or antagonize the binding of IgG to FcRn may be used in a method for treating or preventing autoimmune and inflammatory diseases, which are mediated by IgG.

[0007] "Autoimmune diseases" cover diseases that occur when the body's immune system attacks its own normal tissues, organs or other in vivo components due to immune system abnormalities whose cause cannot be found. These autoimmune diseases are systemic diseases that can occur in almost all parts of the body, including the nervous system, the gastrointestinal system, the endocrine system, the skin, the skeletal system, and the vascular tissue. It is known that autoimmune diseases affect about 5-8% of the world population, but the reported prevalence of autoimmune diseases is lower than the actual level due to limitations in the understanding of autoimmune diseases and a method for diagnosing these diseases.

[0008] The causes of autoimmune diseases have been studied for a long period of time in terms of genetic, environmental and immunological factors, but have not yet been clearly identified. Many recent studies revealed that a number of autoimmune diseases are caused by IgG-type autoantibodies. In fact, the relation between the presence or absence of disease-specific autoantibodies and the treatment of autoimmune diseases has been widely identified from studies on the disease and the treatment of autoimmune diseases. Thus, the presence of disease-specific autoantibodies and the pathological role thereof in a large number of autoimmune diseases have been identified, and when the autoantibodies of interest are removed from blood, an effect of quickly treating diseases can be obtained.

[0009] Autoimmune diseases and alloimmune diseases are mediated by pathogenic antibodies, and typical examples thereof include immune neutropenia, Guillain-Barré syndrome, epilepsy, autoimmune encephalitis, Isaac's syndrome, nevus syndrome, pemphigus vulgaris, Pemphigus foliaceus, Bullous pemphigoid, epidermolysis bullosa acquisita,

pemphigoid gestationis, mucous membrane pemphigoid, antiphospholipid syndrome, autoimmune anemia, autoimmune Grave's disease, Goodpasture's syndrome, myasthenia gravis, multiple sclerosis, rheumatoid arthritis, lupus, idiopathic Thrombocytopenic Purpura(ITP), lupus nephritis or membranous nephropathy, or the like.

[0010] For example, it is known that, in case of myasthenia gravis (MG), acetylcholine receptor (AChR) located at the neuromuscular junction of voluntary muscles is destroyed or blocked by autoantibodies against the receptor to impair the function of voluntary muscles. Also, it is known that when such autoantibodies are reduced, the function of muscles is restored.

[0011] As to the case of ITP, ITP is a disease caused by the destruction of peripheral platelets due to the generation of auto-antibodies that bind to a specific platelet membrane glycoprotein. Anti-platelet antibodies opsonize platelets and result in rapid platelet destruction by reticular cells (e.g., macrophages).

[0012] In general, attempts to treat ITP include suppressing the immune system, and consequently causing an increase in platelet levels. ITP affects women more frequently than men, and is more common in children than adults. The incidence is 1 out of 10,000 people. Chronic ITP is one of the major blood disorders in both adults and children. It is a source of significant hospitalization and treatment cost at specialized hematological departments in the US and around the world. Each year there are approximately 20,000 new cases in the US, and the cost for ITP care and special therapy is extremely high. Most children with ITP have a very low platelet count that causes sudden bleeding, with typical symptoms including bruises, small red dots on the skin, nosebleeds and bleeding gums. Although children can sometimes recover with no treatment, many doctors recommend careful observation and mitigation of bleeding and treatment with intravenous infusions of gamma globulin.

[0013] It is known that the important pathogenesis of Lupus nephritis, a kind of autoimmune disease, is that an increased immune complex, which could be occurred due to the inappropriate overproduction of auto-antibodies such as anti-nuclear antibodies, is accumulated in the systemic organs to cause inflammatory responses. About 40-70% of Lupus patients have renal involvement, and about 30% of the patients develop Lupus nephritis, which is known as a bad prognostic factor in Lupus patients. Although methods of treating Lupus nephritis using immunosuppressive agents have been attempted, it was reported that remission was not induced in about 22% of Lupus nephritis patients even when immunosuppressive agents were used. Also, it was reported that, even when remission was induced, 10-65% of patients relapsed into Lupus nephritis when the use of immunosuppressive agents was reduced. Ultimately, 5-10% of patients with serious Lupus nephritis (WHO class III and IV) die after 10 years, and 5-15% of the patients lead to end-stage renal stage. Thus, appropriate treatment of Lupus nephritis has not yet been reported.

[0014] Thus, the use of antibodies having a new mechanism that treat autoimmune diseases by clearing pathogenic autoantibodies is expected to have therapeutic effects against pathogenic IgG-mediated autoimmune diseases such as pemphigus vulgaris, neuromyelitis

optica and myasthenia gravis, as well as immune complex-mediated glomerular diseases such as Lupus nephritis or membraneous nephropathy.

[0015] Methods of treating autoimmune diseases by intravenous administration of IgG (IVIG) in large amounts have been widely used (Arnson Autoimmunity 42:553, 2009). IVIG effects are explained by various mechanisms, but are also explained by the mechanism that increases the clearance of pathogenic antibodies by competition with endogenous IgG for FcRn. Intravenous administration of human immunoglobulin (IVIG) in large amounts has been shown to increase platelet counts in children afflicted with immune ITP, and IVIG has shown to be beneficial as a treatment for several other autoimmune conditions. Many studies have investigated the mechanisms by which IVIG achieves effects in the treatment of autoimmune diseases. With regard to ITP, early investigations led to the conclusion that IVIG effects are mainly due to blockade of the Fc receptors responsible for phagocytosis of antibody-opsonized platelets. Subsequent studies showed that Fc-depleted IVIG preparations provided increases in platelet counts in some patients with ITP, and recently it was reported that IVIG effects are due to stimulation of FcγRIIb expression on macrophage cells, leading to inhibition of platelet phagocytosis.

[0016] However, such IVIG treatments have substantial side effects and are very costly to administer. Further, other therapies used for the treatment of autoimmune/alloimmune conditions other than IVIG include polyclonal anti-D immunoglobulin, corticosteroids, immuno-suppressants (including chemotherapeutics), cytokines, plasmapheresis, extracorporeal antibody adsorption (e.g., using Prosorba columns), surgical interventions such as splenectomy, and others. However, like IVIG, these therapies are also complicated by incomplete efficacy and high cost. Also, very high doses of IVIG are required to produce substantial increases in the clearance of pathogenic antibody due to the putative mechanism of IVIG inhibition of FcRn binding with pathogenic antibody (i.e., competitive inhibition) and due to the fact that IgG shows very low affinity for FcRn at physiologic pH (i.e., pH 7.2-7.4), and the typical clinical dose of IVIG is about 2 g/kg.

[0017] The use of an inhibitor that competitively inhibits the binding of IgG to FcRn to treat autoimmune diseases is a promising therapeutic method. However, owing to the high affinity of endogenous IgG for FcRn and to the high concentrations of endogenous IgG in blood, it is likely that competitive inhibition of FcRn would require very high doses, and thus have the same limitations similar to those of the current IVIG treatment.

[0018] Accordingly, although the anti-FcRn antibody is disclosed in WO2006/118772, WO2007/087289, WO2009/131702, WO2012/167039, and KR 2013 0071961, there is an urgent need for the development of an improved human antibody that has a high affinity for FcRn, and thus can remove pathogenic antibody even at low doses and reduce immunogenicity.

Disclosure of Invention Technical Problem

[0019] The invention is set out in the appended claims. Any references in the description to methods of treatment refer to the compounds, pharmaceutical compositions and medicaments of the present invention for use in a method for treatment of the human (or animal) body by therapy (or for diagnosis).

[0020] The present inventors have made extensive efforts to solve the above-described problems and to provide a medicament for effectively and fundamentally treating autoimmune disease including ITP, and finally provide an antibody that has a high affinity for FcRn or a fragment thereof and a method of preparing the same. The antibody binding to FcRn or a fragment thereof, binds specifically to the FcRn chain in a pH-independent manner and interferes non-competitively with the binding of Fc of antibody to FcRn, to treat autoimmune disease by reducing autologous antibody in vivo, which could be a cause of autoimmune disease.

[0021] It is an object of the present disclosure to provide a pharmaceutical composition for treating autoimmune diseases, comprising the antibody binding to FcRn, wherein the autoimmune disease is immune neutropenia, Guillain-Barré syndrome, epilepsy, autoimmune encephalitis, Isaac's syndrome, nevus syndrome, pemphigus vulgaris, Pemphigus foliaceus, Bullous pemphigoid, epidermolysis bullosa acquisita, pemphigoid gestationis, mucous membrane pemphigoid, antiphospholipid syndrome, autoimmune anemia, autoimmune Grave's disease, Goodpasture's syndrome, myasthenia gravis, multiple sclerosis, rheumatoid arthritis, lupus, idiopathic thrombocytopenic purpura, lupus nephritis or membranous nephropathy, or the like.

Technical Solution

[0022] To achieve the above objects, the present disclosure provides an isolated anti-FcRn antibody or an antigen-binding fragment thereof, comprising a heavy chain variable region comprising CDR1 comprising an amino acid sequence of SEQ ID No: 27, CDR2 comprising an amino acid sequence of SEQ ID No: 28 and CDR3 comprising an amino acid sequence of SEQ ID No: 29, and a light chain variable region comprising CDR1 comprising an amino acid sequence of SEQ ID No: 30, CDR2 comprising an amino acid sequence of SEQ ID No: 31 and CDR3 comprising an amino acid sequence of SEQ ID No: 32;
wherein said antibody or antigen-binding fragment comprises either:

1. (i) a heavy chain variable region comprising an amino acid sequence of SEQ ID No: 4 and a light chain variable region comprising an amino acid sequence of SEQ ID No: 14; or
2. (ii) a heavy chain variable region comprising an amino acid sequence of SEQ ID No: 6 and a light chain variable region comprising an amino acid sequence of SEQ ID No: 16.

[0023] Further, the present disclosure provides polynucleotide encoding the anti-FcRn antibody or a fragment thereof.

[0024] Further, the present disclosure provides polynucleotide encoding an anti-FcRn antibody comprising one or more sequence selected from the group consisting of SEQ ID Nos: 3, 5, 13 and 15.

[0025] Further, the present disclosure provides a recombinant expression vector comprising the polynucleotide, host cell, which is transected with the recombinant expression vector. The present disclosure additionally provides a method of preparing an antibody binding specifically to FcRn or a fragment thereof comprising: culturing the host cell and producing the antibody therefrom; and isolating and purifying the produced antibody to recover the anti-FcRn antibody.

[0026] Further, the present disclosure provides a pharmaceutical composition comprising the anti-FcRn antibody or a fragment thereof, and one or more pharmaceutically acceptable carrier.

[0027] Further, the present disclosure provides a pharmaceutical composition for use in a method of treating a patient suffering from an autoimmune disease, comprising administering the composition to said patient.

[0028] Further, the present disclosure provides a composition comprising the antibody labelled with a detection label.

[0029] Further, the present disclosure provides a method of detecting FcRn in vitro comprising using the anti-FcRn antibody or a fragment thereof, and provides the antibody or fragment thereof for use in an in vivo method of detecting FcRn.

Advantageous Effects

[0030] The inventive antibody or a fragment thereof specific for FcRn that is a receptor having a high affinity for IgG has high affinity and specificity, causes little or no immunogenicity-related problems, and binds to FcRn non-competitively with IgG or the like to reduce serum auto-antibody levels. By virtue of such properties, the antibody or a fragment thereof is useful for the treatment and diagnosis of autoimmune diseases.

Brief Description of Drawings

[0031] Antibodies HL161A, HL161C and HL161D are not according to the invention.

FIG. 1 shows the results of analyzing the expression of antibodies in CHO-S cells and

analyzing HL161A, HL161B, HL161C and HL161D antibody proteins, obtained by protein A purification, on SDS-PAGE gel under a reduced or non-reduced condition. It was shown that, under a non-reduced condition, each of the HL161 antibodies had a whole human IgG1 type structure having a size of about 160 kDa, and under a reduced condition, the heavy chain had a size of about 55 kDa, and the light chain had a size of about 25 kDa, suggesting that the antibody was composed of typical antibody subunits. In FIG. 1, lane 1 represents a molecular weight (M.W.) marker, lane 2 represents 2 μg non-reduced (*NEM-treated) antibody, and lane 3 represents 2 μg reduced antibody.

FIG. 2 shows the results of analysis performed using a SPR system in order to determine the kinetic dissociation (KD) of four kinds of anti-FcRn antibodies (HL161A, HL161B, HL161C and HL161D) that bind to FcRn. The results in FIG. 2 were obtained by analyzing the interaction between human FcRn and the HL161A, HL161B, HL161C or HL161D antibody at pH 6.0 and pH 7.4 using a Proteon GLC chip and a Proteon XPR36 (Bio-Rad) system:

FIG. 2a shows the results of analyzing the interaction between human FcRn and the HL161A antibody at pH 6.0.

FIG. 2b shows the results of analyzing the interaction between human FcRn and the HL161A antibody at pH 7.4.

FIG. 2c shows the results of analyzing the interaction between human FcRn and the HL161B antibody at pH 6.0.

FIG. 2d shows the results of analyzing the interaction between human FcRn and the HL161B antibody at pH 7.4.

FIG. 2e shows the results of analyzing the interaction between human FcRn and the HL161C antibody at pH 6.0.

FIG. 2f shows the results of analyzing the interaction between human FcRn and the HL161C antibody at pH 7.4.

FIG. 2g shows the results of analyzing the interaction between human FcRn and the HL161D antibody at pH 6.0.

FIG. 2h shows the results of analyzing the interaction between human FcRn and the HL161D antibody at pH 7.4.

FIG. 3 shows the ability of two selected antibodies to bind to the cell surface, and shows the results obtained by treating human FcRn-overexpressing HEK293 cells with selected HL161A and HL161B antibodies binding to human FcRn present on the cell surface and analyzing the antibodies binding to cell surface at pH 6.0 and pH 7.4. The binding of each of the HL161A and HL161B antibodies to human FcRn was expressed as an MFI value obtained by performing fluorescent activated cell sorter (FACS) using Alexa488-labelled anti-human goat antibody after treating cells with each antibody at varying pHs.

FIG. 4 shows the results of analyzing the ability to block the binding of human IgG to human

FcRn-expressing cells at pH 6.0, and shows the results of observing whether two selected antibodies binding to cell surface human FcRn can block the binding of human IgG to human FcRn, at the cell level. A profile about the ability to block the binding of Alexa488-labelled human IgG to human FcRn was obtained by diluting each of HL161A and HL161B antibodies, confirmed to bind to human FcRn-overexpressing HEK293 cells, serially 4-fold from 200 nM.

FIG. 5a and FIG. 5b show the results of analyzing the effects of HL161A and HL161B antibodies, selected from human FcRn-expressing transgenic mouse Tg32 (hFcRn+/+, hβ2m+/+, mFcRn-/-, mβ2m-/-), on the catabolism of hIgG1. At 0 hour, 5 mg/kg of biotin-hIgG and 495 mg/kg of human IgG were intraperitoneally administered to saturate IgG *in vivo.* Regarding drug administration, at 24, 48, 72 and 96 hours after administration of biotin-IgG, IgG1, HL161A, HL161B or PBS was injected intraperitoneally at doses of 5, 10 and 20 mg/kg once a day. Sample collection was performed at 24, 48, 72, 96, 120 and 168 hours after administration of biotin-IgG. At 24, 48, 72 and 96 hours, blood was collected before drug administration, and the remaining amount of biotin-IgG was analyzed by an ELISA method. The results were expressed as the ratio of the remaining amount at each time point to 100% for the remaining amount in the blood sample collected at 24 hours.

FIG. 6 shows the results of analyzing the change in blood level of monkey IgG caused by administration of two antibodies (HL161A and HL161B) to cynomolgus monkeys having a sequence homology of 96% to human FcRn. Each of HL161A and HL161B antibodies was administered intravenously to cynomolgus monkeys at doses of 5 and 20 mg/kg once a day, and as a result, it was shown that monkey IgG decreased up to 70% compared to that at 0 hour, and decreased by about 30% up to day 29.

FIG. 6a shows the serum IgG-reducing effects of HL161A and HL161B antibodies at varying antibody concentrations.

FIG. 6b shows the serum IgG-reducing effects of HL161A and HL161B antibodies (concentration: (5 mg/kg) in monkey individuals.

FIG. 6c shows the serum IgG-reducing effects of HL161A and HL161B antibodies (concentration: (20 mg/kg) in monkey individuals.

FIGS. 7a and 7b show the results of analyzing the pharmacokinetic profiles of HL161A and HL161B in an experiment performed using cynomolgus monkeys. It was shown that HL161B had a high half-life AUC and Cmax overall compared to HL161A.

FIGS. 8a to 8c show the results of analyzing the changes in blood levels of monkey IgM, IgA and albumin caused by administration of HL161A and HL161B antibodies in an experiment performed using cynomolgus monkeys. There were slight changes in the blood levels of monkey IgM, IgA and albumin, such changes were within the normal ranges of cynomolgus monkeys, suggesting that such changes resulted from a difference between individuals rather than the influence of the test substances.

FIG. 8a shows a change in the serum IgM level of monkeys.

FIG. 8b shows a change in the serum IgA level of monkeys.

FIG. 8c shows a change in the serum albumin level of monkeys.

Mode for Invention

[0032] To achieve the above objects, the present disclosure provides an antibody, which can bind specifically to FcRn with high affinity in a pH-independent manner and is composed of a human-derived sequence, and thus causes little or no immune response when administered *in vivo.*

[0033] Antibodies according to the present disclosure are binding molecules having specificity for FcRn. The antibodies may include monoclonal antibodies (e.g., full-length antibodies having an immunoglobulin Fc domain), antibody compositions with polyepitopic specificity, bispecific antibodies, diabodies, and single-chain molecules, as well as antibody fragments (e.g., Fab, F(ab')2 and Fv), but are not limited thereto. The antibodies according to the present disclosure may be, for example, monoclonal antibodies against human FcRn.

[0034] Human antibodies can be generated. "Human antibodies" are antibodies that are produced by humans or have amino acid sequences corresponding to antibodies produced using any human antibody production technology. Human antibodies can be produced using various technologies known in the art, including phage display libraries. Human antibodies can be prepared by administering an antigen to a transgenic animal that has been modified to produce such antibodies in response to antigenic challenge, but whose endogenous loci have been disabled, e.g., immunized xenomice. Antibodies according to the present disclosure may be in the form of, for example, human antibodies.

[0035] Native four-chain antibodies are heterotetrameric glycoproteins composed of two identical light (L) chains and two identical heavy (H) chains. Each light chain has a variable domain at one end (V_L) and a constant domain at its other end. Each heavy chain has a variable domain (V_H) at the N-terminus, and has three constant domains (CH) for α and γ chains and four CH domains for μ and ε isotypes.

[0036] The term "variable" refers to the fact that certain portions of the variable domains differ extensively in sequence among antibodies. The V domain mediates antigen binding and defines the specificity of a particular antibody for its particular antigen. However, the variability is concentrated in three segments called hypervariable regions (HVRs) i.e. CDRs both in the light-chain and the heavy chain variable domains. The more highly conserved portions of variable domains are called the framework regions (FR). The light and heavy chain variable domains comprise from N- to C-terminus the domains FR1, CDR1, FR2, CDR2, FR3, CDR3 and FR4.

[0037] In the present disclosure, antibodies having affinity and specificity for human FcRn were obtained using human immunoglobulin transgenic animals. Transgenic animals can be produced by inactivating animal Ig germline genes and transplanting human Ig germline gene loci. The use of transgenic animals has an advantage in that an antibody is naturally optimized by the animal immune system without requiring affinity maturation so that an antibody drug having low immunogenicity and high affinity can be developed within a short time (US20090098134, US20100212035, Menoret et al, Eur J Immunol, 40:2932, 2010).

[0038] In the present disclosure, OmniRat™ (OMT, USA) having technology patented for human immunoglobulin transgenic rats was used. OmniRat™ can efficiently select an antibody having a high affinity for human FcRn, because it has a heavy chain composed of CH2 and CH3 domains that are from rat genes, and V, D and J regions and CH1 domain that are from human genes, and kappa light chain and lamda light chain from human, to efficiently select antibodies that have high affinity to human FcRn (Menoret et al, Eur J Immunol, 40:2932, 2010).

[0039] To obtain a monoclonal antibody having a high affinity for FcRn, a transgenic rat (OmniRat™) was immunized by injecting human FcRn therein, and then B cells were extracted from the cells and fused with myeloma cells to generate a hybridoma, after which the produced antibody was purified from the generated hybridoma.

[0040] The antibody according to the present disclosure acts as a non-competitive inhibitor of IgG in binding to FcRn. The binding of the antibody of the present disclosure to FcRn results in the inhibition of pathogenic antibody to FcRn, which promotes the clearance (i.e., removal) of pathogenic antibody from the body of the subject to reduce the half-life of the pathogenic antibody.

[0041] As used herein, the term "pathogenic antibody" means antibodies that cause pathological conditions or diseases. Examples of such antibodies include, but are not limited to, anti-platelet antibodies, anti-acetylcholine antibodies, anti-nucleic acid antibodies, anti-phospholipid antibodies, anti-collagen antibodies, anti-ganglioside antibodies, anti-desmoglein antibodies, etc.

[0042] The antibody or a fragment thereof according to the present disclosure has an advantage in that it makes it possible to non-competitively inhibit the binding of pathogenic antibody to FcRn at physiological pH (i.e., pH 7.0-7.4). FcRn binds to its ligand (i.e., IgG) and does not substantially show affinity for IgG at physiological pH rather than acidic pH. Thus, the anti-FcRn antibody that binds specifically to FcRn at physiological pH acts as a non-competitive inhibitor of the binding of IgG to FcRn, and in this case, the binding of the anti-FcRn antibody to FcRn is not influenced by the presence of IgG. Thus, the inventive antibody that binds to FcRn non-competitively with IgG in a pH-independent manner has an advantage over conventional competitive inhibitors (i.e., antibodies that bind to FcRn competitively with IgG) in that it can treat diseases even at significantly low concentrations by the FcRn-mediated

signaling of IgG. In addition, in the procedure of intracellular migration in a state bound to FcRn, the anti-FcRn antibody according to the present disclosure maintains its binding to FcRn with an affinity higher than IgG in blood, and thus can inhibit the binding of IgG to FcRn even in endosomes that are acidic pH environments in which IgG can bind to FcRn, thereby promoting the clearance of IgG.

[0043] The antibody according to the present disclosure has an affinity for FcRn even in a physiological pH environment (i.e., pH 7.0-7.4) in which IgG does not bind to FcRn. At a pH of 6.0, the antibody of the present disclosure has a higher affinity for FcRn compared to serum IgG, suggesting that it acts as a non-competitive inhibitor.

[0044] The present disclosure is directed to an antibody binding specifically to FcRn or a fragment thereof comprising:

CDR1 comprising amino acid sequenceselected from the group consisting of SEQ ID No: 27 and 30;

CDR2 comprising amino acid sequencee selected from the group consisting of SEQ ID No: 28 and 31; and

CDR3 comprising amino acid sequence selected from the group consisting of SEQ ID No: 29 and 32.

[0045] Further, antibodies that bind specifically to FcRn having a KD (dissociation constant) of 0.01-2 nM at pH 6.0 and pH 7.4 also fall within the scope of the present disclosure. "KD" as used herein refers to equilibrium dissociation constant for antibody-antigen binding, and may be calculated using the following equation: KD = kd/ka, wherein ka indicates association rate constant, and kd indicates dissociation rate constant. The measurement of kd or ka can be performed at 25°C or 37°C.

[0046] The antibody of the present disclosure comprises:

CDR1 comprising amino acid sequence of SEQ ID No: 27, CDR2 comprising amino acid sequence of SEQ ID No: 28 and CDR3 comprising amino acid sequence of SEQ ID No: 29,

The amino acid sequences set forth in the above SEQ ID Nos. are amino acid sequences corresponding to the CDR1 to CDR3 of the heavy-chain variable region.

[0047] The antibody or antigen-binding fragment of the present disclosure comprises:

CDR1 comprising amino acid sequence of SEQ ID No: 30, CDR2 comprising amino acid sequence of SEQ ID No: 31 and CDR3 comprising amino acid sequence of SEQ ID No: 32,

The amino acid sequences set forth in the above SEQ ID Nos. are amino acid sequences corresponding to the CDR1 to CDR3 of the light-chain variable region.

[0048] Specifically, the antibody or antigen-binding fragment of the present disclosure comprises: one or more heavy chain variable region and light chain variable region selected from the group consisting of:
heavy chain variable region comprising CDR1 comprising amino acid sequence of SEQ ID No: 27, CDR2 comprising amino acid sequence of SEQ ID No: 28 and CDR3 comprising amino acid sequence of SEQ ID No: 29, and light chain variable region comprising CDR1 comprising amino acid sequence of SEQ ID No: 30, CDR2 comprising amino acid sequence of SEQ ID No: 31 and CDR3 comprising amino acid sequence of SEQ ID No: 32.

[0049] The antibody or antigen-binding fragment of the present disclosure comprises one or more heavy chain variable region and light chain variable region selected from the group consisting of:

heavy chain variable region comprising amino acid sequence of SEQ ID No: 4 and light chain variable region comprising amino acid sequence of SEQ ID No: 14; or

heavy chain variable region comprising amino acid sequence of SEQ ID No: 6 and light chain variable region comprising amino acid sequence of SEQ ID No: 16.

[0050] "Fragment" or "antibody fragment" as the terms are used herein in reference to an antibody refer to a polypeptide derived from an antibody polypeptide molecule (e.g., an antibody heavy or light chain polypeptide) that does not comprise a full length antibody polypeptide, but which still comprises at least a portion of a full length antibody polypeptide. Antibody fragments often comprise polypeptides that comprise a cleaved portion of a full length antibody polypeptide, although the term is not limited to such cleaved fragments. Since a fragment, as the term is used herein in reference to an antibody, encompasses fragments that comprise single polypeptide chains derived from antibody polypeptides (e.g. a heavy or light chain antibody polypeptides), it will be understood that an antibody fragment may not, on its own, bind an antigen.

[0051] Fragments of the antibody according to the present disclosure include, but are not limited to, single-chain antibodies, bispecific, trispecific, and multispecific antibodies such as diabodies, triabodies and tetrabodies, Fab fragments, $F(ab')_2$ fragments, Fd, scFv, domain antibodies, dual-specific antibodies, minibodies, scap (sterol regulatory binding protein cleavage activating protein), chelating recombinant antibodies, tribodies or bibodies, intrabodies, nanobodies, small modular immunopharmaceuticals (SMIP), binding-domain immunoglobulin fusion proteins, camelized antibodies, VHH containing antibodies, IgD antibodies, IgE antibodies, IgM antibodies, IgG1 antibodies, IgG2 antibodies, IgG3 antibodies,

IgG4 antibodies, derivatives in antibody constant regions, and synthetic antibodies based on protein scaffolds, which have the ability to bind to FcRn. It will be obvious to those skilled in the art that any fragment of the antibody according to the present disclosure will show the same properties as those of the antibody of the present disclosure.

[0052] In addition, antibodies having a mutation in the variable region are included in the scope of the present disclosure. Examples of such antibodies include antibodies having a conservative substitution of an amino acid residue in the variable region. As used herein, the term "conservative substitution" refers to substitution with another amino acid residue having properties similar to those of the original amino acid residue. For example, lysine, arginine and histidine have similar properties in that they have a basic side-chain, and aspartic acid and glutamic acid have similar properties in that they have an acidic side chain. In addition, glycine, aspargin, glutamine, serine, threonine, tyrosine, cysteine and tryptophan have similar properties in that they have an uncharged polar side-chain, and alanine, valine, leucine, threonine, isoleucine, proline, phenylalanine and methionine have similar properties in that they have a non-polar side-chain. Also, tyrosine, phenylalanine, tryptophan and histidine have similar properties in that they have an aromatic side-chain. Thus, it will be obvious to those skilled in the art that, even when substitution of amino acid residues in groups showing similar properties as described above occurs; it will show no particular change in the properties. Accordingly, antibodies having a mutation caused by conservative substitution in the variable region are included in the scope of the present disclosure.

[0053] In addition, the antibody according to the present disclosure or its fragment may be used as a conjugate with another substance. Substances that may be used as conjugates with the antibody according to the present disclosure or its fragment include therapeutic agents that are generally used for the treatment of autoimmune diseases, substances capable of inhibiting the activity of FcRn, and a moiety that is physically associated with the antibody to improve its stabilization and/or retention in circulation, for example, in blood, serum, lymph, or other tissues. For example, the FcRn-binding antibody can be associated with a polymer, e.g., a non-antigenic polymer such as polyalkylene oxide or polyethylene oxide. Suitable polymers will vary substantially by weight. Polymers having molecular number average weights ranging from about 200 to about 35,000 (or about 1,000 to about 15,000, and 2,000 to about 12,500) can be used. For example, the FcRn-binding antibody can be conjugated to water soluble polymers, e.g., hydrophilic polyvinyl polymers, e.g. polyvinylalcohol and polyvinylpyrrolidone. A non-limiting list of such polymers includes, but is not limited to, polyalkylene oxide homopolymers such as polyethylene glycol (PEG) or polypropylene glycols, polyoxyethylenated polyols, copolymers thereof and block copolymers thereof, provided that the water solubility of the block copolymers is maintained.

[0054] In another embodiment, the present disclosure is directed to a pharmaceutical composition for treating autoimmune disease comprising the anti-FcRn antibody, and one or more pharmaceutically acceptable carriers. Also, the present disclosure is directed to a pharmaceutical composition for use in a method of treating autoimmune disease comprising administering an effective amount of antibody binding specifically to FcRn to a patient in need

thereof.

[0055] The pharmaceutical composition may comprise a pharmaceutically acceptable carrier, excipient, and the like, which are well known in the art. The pharmaceutically acceptable carriers should be compatible with the active ingredient such as the antibody or a fragment thereof according to the present disclosure and may be physiological saline, sterile water, Ringer's solution, buffered saline, dextrose solution, maltodextrin solution, glycerol, ethanol, or a mixture of two or more thereof. In addition, the pharmaceutical composition of the present disclosure may, if necessary, comprise other conventional additives, including antioxidants, buffers, and bacteriostatic agents. Further, the pharmaceutical composition of the present disclosure may be formulated as injectable forms such as aqueous solutions, suspensions or emulsions with the aid of diluents, dispersants, surfactants, binders and lubricants. In addition, the pharmaceutical composition of the present disclosure may be provided by formulating into a various form such as powder, tablet, capsule, liquid, inject, ointment, syrup etc, and single-dosage or multi-dosage container such as sealed ample or vial.

[0056] The pharmaceutical composition of the present disclosure may be applied to all autoimmune diseases that are mediated by IgG and FcRn, and typical examples of such autoimmune diseases include, but are not limited to, immune neutropenia, Guillain-Barré syndrome, epilepsy, autoimmune encephalitis, Isaac's syndrome, nevus syndrome, pemphigus vulgaris, Pemphigus foliaceus, Bullous pemphigoid, epidermolysis bullosa acquisita, pemphigoid gestationis, mucous membrane pemphigoid, antiphospholipid syndrome, autoimmune anemia, autoimmune Grave's disease, Goodpasture's syndrome, myasthenia gravis, multiple sclerosis, rheumatoid arthritis, lupus, idiopathic thrombocytopenic purpura, lupus nephritis and membranous nephropathy.

[0057] In the treatment method, the dose of the antibody can be suitably determined by taking into consideration the patient's severity, condition, age, case history and the like. For example, the antibody may be administered at a dose of 1 mg/kg to 2 g/kg. The antibody may be administered once or several times.

[0058] The pharmaceutical composition of the present disclosure can be administered orally or parenterally. The pharmaceutical composition according to the present disclosure can be administered by various routes, including, but not limited to, oral, intravenous, intramuscular, intra-arterial, intramedullary, intradural, intracardial, transdermal, subcutaneous, intraperitoneal, gastrointestinal, sublingual, and local routes. The dose of the composition of the present disclosure may vary depending on various factors, such as a patient's body weight, age, sex, health condition and diet, the time and method of administration, excretion rate, and severity of a disease, and may be easily determined by a person of ordinary skill in the art. Generally, 1-200 mg/kg, and preferably, 1-40 mg/kg of the composition may be administered to patients afflicted with autoimmune or alloimmune conditions, and these regimens are preferably designed to reduce the serum endogenous IgG concentration to less than 75% of pretreatment values. Intermittent and/or chronic (continuous) dosing strategies may be applied in view of the conditions of patients.

[0059] In another embodiment, the present disclosure also provides a diagnostic composition comprising the antibody of the present disclosure or a fragment thereof, and a diagnostic method that uses the diagnostic composition. In other words, the antibody of the present disclosure or a fragment thereof, which binds to FcRn, has in vitro and in vivo diagnostic utilities.

[0060] In another embodiment, the present disclosure is directed to a composition for detecting FcRn comprising the anti-FcRn antibody or a fragment thereof. The present disclosure also provides a method for detecting FcRn in vitro comprising using the anti-FcRn antibody, and provides the anti-FcRn antibody for use in an in vivo method of detecting FcRn.

[0061] The in vitro detection method might, for example, include (1) bringing a sample into contact with the FcRn-binding antibody; (2) detecting the formation of a complex between the FcRn-binding antibody and the sample; and/or (3) bringing a reference sample (e.g., a control sample) into contact with the antibody; and (4) determining the degree of formation of the complex between the antibody and the sample by comparison with that in the reference sample. A change (e.g., a statistically significant change) in the formation of the complex in the sample or the subject as compared to that in the control sample or subject indicates the presence of FcRn in the sample.

[0062] The in vivo detection method may include: (1) administering the FcRn-binding antibody to a subject; and (2) detecting the formation of a complex between the FcRn-binding antibody and the subject. The detecting may include determining location or time of formation of the complex. The FcRn-binding antibody can be directly or indirectly labeled with a detectable substance to facilitate detection of the bound or unbound antibody. Suitable detectable substances include various enzymes, prosthetic groups, fluorescent materials, luminescent materials, and radioactive materials. The formation of a complex between the FcRn-binding antibody and FcRn can be detected by measuring or visualizing the antibody bound or not bound to FcRn. A conventional detection assay, for example, enzyme-linked immunosorbent assay (ELISA), radioimmunoassay (RIA) or tissue immunohistochemistry may be used. In addition to labeling of the FcRn-binding antibody, the presence of FcRn can be assayed in a sample by competition immunoassay using a standard labeled with a detectable substance and an unlabeled FcRn-binding antibody. In one example of this assay, the biological sample, the labeled standard and the FcRn-binding antibody are combined and the amount of labeled standard unbound to FcRn is determined. The amount of FcRn in the biological sample is inversely proportional to the amount of labeled standard unbound to FcRn.

[0063] For detection purposes, the antibody of the present disclosure or a fragment thereof can be labeled with a fluorophore and a chromophore. Because antibodies and other proteins absorb light having wavelengths up to about 310 nm, the fluorescent moieties should be selected to have substantial absorption at wavelengths above 310 nm and preferably above 400 nm. The antibody of the present disclosure or a fragment thereof can be labeled with a variety of suitable fluorescers and chromophores. One group of fluorescers is xanthene dyes,

which include fluoresceins and rhodamines. Another group of fluorescent compounds are naphthylamines. Once labeled with a fluorophore or chromophore, the antibody can be used to detect the presence or localization of the FcRn in a sample, e.g., using fluorescent microscopy (such as confocal or deconvolution microscopy).

[0064] Detection of the presence or localization of FcRn using the antibody of the present disclosure or a fragment thereof can be performed by various methods such as histological analysis, protein arrays and FACS (Fluorescence Activated Cell Sorting).

[0065] In the present disclosure, the presence of FcRn or FcRn-expressing tissue *in vivo* can be performed by an *in vivo* Imaging method. The method includes (i) administering to a subject (e.g., a patient having an autoimmune disorder) an anti-FcRn antibody, conjugated to a detectable marker; and (ii) exposing the subject to a means for detecting said detectable marker to the FcRn-expressing tissues or cells. For example, the subject is imaged, e.g., by NMR or other tomographic means. Examples of labels useful for diagnostic imaging include radiolabels, fluorescent labels, positron emitting isotopes, chemiluminescers, and enzymatic markers. A radiolabeled antibody can also be used for in vitro diagnostic tests. The specific activity of a isotopically-labeled antibody depends upon the half life, the isotopic purity of the radioactive label, and how the label is incorporated into the antibody.

[0066] In another embodiment, the present disclosure is directed to polynucleotide sequences that encode the antibody of the present disclosure or a fragment thereof.

[0067] Specifically, a polynucleotide sequence of the antibody of the present disclosure or a fragment thereof is a sequence that encodes heavy chain of the antibody of the present disclosure is SEQ ID No: 3 or 5, and/or a sequence that encodes light chain of the antibody of the present disclosure is SEQ ID No: 13 or 15.

[0068] In another embodiment, the present disclosure is directed to a recombinant expression vector comprising the polynucleotide, host cell, which is transected with the recombinant expression vector and method of preparing an antibody binding specifically to FcRn or a fragment thereof by using the recombinant expression vector and host cell.

[0069] In one embodiment, the antibody or a fragment thereof according to the present disclosure is preferably produced by expression and purification using a gene recombination method. Specifically, the variable regions that encode the inventive antibody that binds specifically to FcRn are produced by being expressed in separate host cells or simultaneously in a single host cell.

[0070] As used herein, the term "recombinant vector" refers to an expression vector capable of expressing the protein of interest in a suitable host cell and means a DNA construct including essential regulatory elements operably linked to express a nucleic acid insert. As used herein, the term "operably linked" means that a nucleic acid expression control sequence is functionally linked to a nucleic acid sequence encoding the protein of interest so as to execute

general functions. Operable linkage with the recombinant vector can be performed using a gene recombination technique well known in the art, and site-specific DNA cleavage and ligation can be easily performed using enzymes generally known in the art.

[0071] A suitable expression vector that may be used in the present disclosure may include expression regulatory elements such as a promoter, an operator, an initiation codon, a stop codon, a polyadenylation signal, and an enhancer, as well as a signal sequence for membrane targeting or secretion. The initiation and stop codons are generally considered as part of a nucleotide sequence encoding the immunogenic target protein, and are necessary to be functional in an individual to whom a genetic construct has been administered, and must be in frame with the coding sequence. Promoters may generally be constitutive or inducible. Prokaryotic promoters include, but are not limited to, lac, tac, T3 and T7 promoters. Eukaryotic promoters include, but are not limited to, simian virus 40 (SV40) promoter, mouse mammary tumor virus (MMTV) promoter, human immunodeficiency virus (HIV) promoter such as the HIV Long Terminal Repeat (LTR) promoter, moloney virus promoter, cytomegalovirus (CMV) promoter, epstein barr virus (EBV) promoter, rous sarcoma virus (RSV) promoter, as well as promoters from human genes such as human β-actin, human hemoglobin, human muscle creatine and human metallothionein. The expression vector may include a selectable marker that allows selection of host cells containing the vector. Genes coding for products that confer selectable phenotypes, such as resistance to drugs, nutrient requirement, resistance to cytotoxic agents or expression of surface proteins, are used as general selectable markers. Since only cells expressing a selectable marker survive in the environment treated with a selective agent, transformed cells can be selected. Also, a replicable expression vector may include a replication origin, a specific nucleic acid sequence that initiates replication. Recombinant expression vectors that may be used in the present disclosure include various vectors such as plasmids, viruses and cosmids. The kind of recombinant vector is not specifically limited and the recombinant vector could function to express a desired gene and produce a desired protein in various host cells such as prokaryotic and eukaryotic cells. However, it is preferred to use a vector that can produce a large amount of a foreign protein similar to a natural protein while having strong expression ability with a promoter showing strong activity.

[0072] In the present disclosure, a variety of expression host/vector combinations may be used to express the antibody or or a fragment thereof according to the present disclosure. For example, expression vectors suitable for the eukaryotic host include, but are not limited to, SV40, bovine papillomavirus, adenovirus, adeno-associated virus, cytomegalovirus, and retrovirus. Expression vectors that may be used for bacterial hosts include bacterial plasmids such as pET, pRSET, pBluescript, pGEX2T, pUC, col E1, pCR1, pBR322, pMB9 and derivatives thereof, a plasmid such as RP4 having a wider host range, phage DNA represented as various phage lambda derivatives such as gt10, gt11 and NM989, and other DNA phages such as M13 and filamentous single-stranded DNA phage. Expression vectors useful in yeast cells include 2μm plasmid and derivatives thereof. A vector useful in insect cells is pVL941.

[0073] The recombinant vector is introduced into a host cell to form a transformant. Host cells

suitable for use in the present disclosure include prokaryotic cells such as E. coli, Bacillus subtilis, Streptomyces sp., Pseudomonas sp., Proteus mirabilis and Staphylococcus sp., fungi such as Aspergillus sp., yeasts such as Pichia pastoris, Saccharomyces cerevisiae, Schizosaccharomyces sp., and Neurospora crassa, and eukaryotic cells such as lower eukaryotic cells, and higher other eukaryotic cells such as insect cells.

[0074] Host cells that may be used in the present disclosure are preferably derived from plants and mammals, and examples thereof include, but are not limited to, monkey kidney cells (COS7), NSO cells, SP2/0, Chinese hamster ovary (CHO) cells, W138, baby hamster kidney (BHK) cells, MDCK, myeloma cells, HuT 78 cells and HEK293 cells. Preferably, CHO cells are used.

[0075] In the present disclosure, transfection or transformation into a host cell includes any method by which nucleic acids can be introduced into organisms, cells, tissues or organs, and, as known in the art, may be performed using a suitable standard technique selected according to the kind of host cell. These methods include, but are not limited to, electroporation, protoplast fusion, calcium phosphate ($CaPO_4$) precipitation, calcium chloride ($CaCl_2$) precipitation, agitation with silicon carbide fiber, and agrobacterium-, PEG-, dextran sulfate-, lipofectamine- and desiccation/inhibition-mediated transformation.

[0076] The FcRn-specific antibody or a fragment thereof according to the present disclosure can be produced in large amounts by culturing the transformant comprising the recombinant vector in nutrient medium, and the medium and culture conditions that are used in the present disclosure can be suitable selected depending on the kind of host cell. During culture, conditions, including temperature, the pH of medium, and culture time, can be controlled so as to be suitable for the growth of cells and the mass production of protein. The antibody or antibody fragment produced by the recombination method as described can be collected from the medium or cell lysate and can be isolated and purified by conventional biochemical isolation techniques (Sambrook et al., Molecular Cloning: A laborarory Manual, 2nd Ed., Cold Spring Harbor Laboratory Press(1989); Deuscher, M., Guide to Protein Purification Methods Enzymology, Vol. 182. Academic Press. Inc., San Diego, CA(1990)). These techniques include, but are not limited to, electrophoresis, centrifugation, gel filtration, precipitation, dialysis, chromatography (ion exchange chromatography, affinity chromatography, immunosorbent chromatography, size exclusion chromatograaphy, etc.), isoelectric point focusing, and various modifications and combinations thereof. Preferably, the antibody or the antibody fragment is isolated and purified using protein A.

[0077] The antibodies of the present disclosure showed antigen binding abilities (KD values) from about 300 pM or less to about 2 nM or less at pH 7.4, and also showed KD values from 2 nM or less to 900 pM or less at pH 6.0. The antibodies of the present disclosure have a strong hFcRn binding affinity of 0.01-2 nM and thus it is believed that the antibodies bound to the outside of cells maintain even their binding to endosomes, suggesting that these antibodies have an excellent effect of blocking the binding of autoantibodies to hFcRn. In addition, this effect of blocking the binding of autoantibodies to hFcRn was also confirmed in a blocking

assay performed using human FcRn-expressing cells and FACS.

Examples

[0078] Hereinafter, the present disclosure will be described in further detail with reference to examples. It will be obvious to a person having ordinary skill in the art that these examples are illustrative purposes only and are not to be construed to limit the scope of the present disclosure.

Example 1: Construction of anti-FcRn-expresing library using transgenic rats

[0079] Immunization was performed using a total of six transgenic rats (OmniRat®, OMT). As an immunogen, human FcRn was used. Both footpads of the rats were immunized eight times with 0.0075 mg of human FcRn (each time) together with an adjuvant at 3-day intervals for 24 days. On day 28, the rats were immunized with 5-10 μg of the immunogen diluted in PBS buffer. On day 28, rat serum was collected and used to measure the antibody titer. On day 31, the rats were euthanized, and the popliteal lymph node and the inguinal lymph node were recovered for fusion with P3X63/AG8.653 myeloma cells.

[0080] ELISA analysis was performed to measure the antibody titer in rat serum. Specifically, human FcRn was diluted in PBS (pH 6.0 or pH 7.4) buffer to make 2 μg/mL of a solution, and 100 μl of the solution was coated on each well of a 96-well plate, and then incubated at 4°C for at least 18 hours. Each well was washed three times with 300 μL of washing buffer (0.05% Tween 20 in PBS) to remove unbound human FcRn, and then 200 μL of blocking buffer was added to each well and incubated at room temperature for 2 hours. A test serum sample was diluted at 1/100, and then the solution was serially 2-fold diluted to make a total of 10 test samples having a dilution factor of 1/100 to 1/256,000). After blocking, each well was washed with 300 μL of washing buffer, and then each test sample was added to each cell and incubated at room temperature for 2 hours. After washing three times, 100 μL of a 1:50,000 dilution of secondary detection antibody in PBS buffer was added to each well and incubated at room temperature for 2 hours. After washing three times again, 100 μL of TMB solution was added to each well and allowed to react at room temperature for 10 minutes, and then 50 μL of 1M sulfuric acid-containing stop solution was added to each well to stop the reaction, after which the OD value at 450 nm was measured with a microplate reader. Regarding the anti-hFcRn IgG titer resulting from immunization was higher than that in the pre-immune serum of the rats, which was not immunized with the OD value at 450 nm in the 1/100 dilution condition 1.0 or higher, suggesting that the rats were well immunized.

[0081] A total of three hybridoma libraries A, B and C fused using polyethylene glycol were made. Specifically, transgenic rats 1 and 5 were used to make hybridoma library A, and rats 2 and 6 were used to make hybridoma library B, and rats 3 and 4 were used to make hybridoma

library C. A hybridoma library fusion mixture for constructing each hybridoma library was cultured in HAT-containing medium for 7 days so that only cells fused to HAT would be selected. Hybridoma cells viable in the HAT medium were collected and cultured in HT media for about 6 days, and then the supernatant was collected, and the amount of rat IgG in the supernatant was measured using a rat IgG ELISA kit (RD-biotech). Specifically, each sample was diluted at 1:100, and 100 μL of the dilution was added to each well of an ELISA plate and mixed with peroxidase-conjugated anti-rat IgG, followed by reaction at room temperature for 15 minutes. 100 μL of TMB solution was added to each well and allowed to react at room temperature for 10 minutes, and then 50 μL of 1M sulfuric acid-containing stop solution was added to each well to stop the reaction. Next, the OD value at 450 nm was measured with a microplate reader.

Example 2: Evaluation of the antigen binding affinity and IgG binding blocking ability of anti-hFcRn antibodies of hybridoma libraries

[0082] To analyze the binding of antibodies to human FcRn, the same ELISA analysis (pH 6.0 and pH 7.4) as mentioned above was performed. The results of evaluation of the hFcRn binding of the three hybridoma libraries A, B and C indicates that the hFcRn binding affinity was higher in the order of A > C > B at both pH 6.0 and pH 7.4.

[0083] Using the culture supernatants of the three hybridoma libraries, the evaluation of the hFcRn binding affinity by FACS at 5 ng/mL and 25 ng/mL was performed at pH 6.0 and pH 7.4. Human FcRn-stable expressing HEK293 cells were detached from a flask, and then suspended in reaction buffer (0.05% BSAin PBS, pH 6.0 or pH 7.4). The suspension was diluted to a cell density of 2×10^6 cells/mL, and 50 μL of the dilution was added to each well of a 96-well plate. Then, 50 μL of the hybridoma library culture supernatant diluted to each of 10 ng/mL and 50 ng/mL was added to each well and suspended to allow antibody to bind. A488 rabbit anti-IgG goat antibody was diluted at 1:200 in reaction buffer, and 100 μL of the dilution was added to each well and mixed with the cell pellets to perform a binding reaction, and then 150 μL of reaction buffer was added to each well. Measurement was performed in FACS (BD). Like the ELISA results, it could be seen that hybridoma library A showed the highest binding affinity.

[0084] Evaluation of the human FcRn blocking ability of the hybridoma library by FACS was performed at pH 6.0. Specifically, naive HEK293 cells and human FcRn-overexpressing HEK293 cells were suspended in reaction buffer (0.05% BSA in PBS, pH 6.0). 1×10^5 cells were added to a 96-well plate, and treated with each of 4 nM of each hybridoma library culture supernatant and 0.4 nM of a 10-fold dilution of the supernatant. To confirm the hIgG blocking ability, 100 nM A488-hIgG1 was added to each well, and then incubated on ice for 90 minutes. After completion of the reaction, the cell pellets were washed with 100 μL of reaction buffer, and transferred into a U-shaped round bottom tube, followed by measurement in FACS. The amount of 100 nM A488-hIgG1 remaining in the human FcRn-overexpressing stable cells was

measured, and then the blocking (%) was calculated. As an isotype control, hIgG1 was used, and as a positive control, previously developed HL161-1Ag antibody was used to comparatively evaluate the antibody blocking effect. Each control was analyzed at concentrations of 1 μM and 2 μM, and the hybridoma library sample was measured at two concentrations of 0.4 nM and 4 nM. As a result, it was found that hybridoma library A showed the highest blocking effect.

Example 3: Isolation of hybridoma clone by FACS and selection of human antibodies

[0085] Using hybridoma library A showing the highest human FcRn binding affinity and blocking effect, clones were isolated by FACS (flow cytometry) to thereby obtain a total of 442 single clones. The isolated monoclones were cultured in HT media, and the supernatant was collected. Antibody-expressing hybridoma clones binding to hFcRn in the supernatant were selected by FACS. As a result, it could be seen that 100 clones (M1-M100) did strongly bind to the hFcRn-expressing HEK293 cells.

[0086] RNA was isolated from the 100 monoclones selected by FACS analysis and the isolated RNA was sequenced. In the first-step sequencing, 88 of the 100 monoclones were sequenced, and divided according to the amino acid sequence into a total of 35 groups (G1 to G38). The culture supernatants of the representative clones of 33 groups excluding two clones (G33 and G35) whose media were not available were diluted at a concentration of 100 ng/mL, and the binding affinity for hFcRn was evaluated by ELISA.

[0087] In the same manner as described above, evaluation of the hFcRn binding affinity by FACS was performed at pH 6.0 and 7.4. The order of the binding affinity of the clones was similar between the pHs, and the binding intensity appeared at various levels.

[0088] In addition, evaluation of the hFcRn blocking effects of the 33 clones was performed by FACS at pH 6.0. The blocking (%) was calculated based on the measured MFI value. Based on the results of analysis of the blocking % at a concentration of 1667 pM, the clones were divided into a total of the following four groups: group A: 70-100%; group B: 30-70%; group C: 10-30%; and group D: 10% or less.

[0089] For kinetic analysis of the hybridoma clones by SPR, human FcRn was immobilized, and then the analysis was performed using the hybridoma culture as an analyte. Most of the clones excluding several clones showed a k_{on} of 10^6 M or higher and a k_{off} value of 10^{-3} M or lower. In conclusion, it was shown that all the clones had a KD value of 10^{-9} to 10^{-11} M.

[0090] Among the five hybridoma clones, the genes of 18 clones having no N-glycosylation site or free cysteine in the CDR sequences of groups A and B divided according to the results of analysis of the hFcRn blocking effect were converted to whole human IgG sequences.

[0091] Specifically, the amino acid sequence similarity between the VH and VL of the 18 selected antibodies and the human germ line antibody group was examined using the Ig BLAST program of the NCBI webpage.

[0092] In order to clone the 18 human antibody genes, restriction enzyme recognition sites were inserted into both ends of the genes in the following manner. EcoRI/ApaI were inserted into the heavy-chain variable domain (VH); EcoRI/XhoI were inserted into the light-chain lambda variable domain (VL(λ)); EcoRI/NheI restriction enzyme recognitions sites were inserted into the light-chain kappa variable domain (VL(x)). In the case of the light-chain variable domain, the light-chain lambda variable (VL(λ)) gene sequence was linked to the human light-chain constant (LC(λ) region gene during gene cloning, and the light-chain kappa variable (VL(κ)) gene sequence was linked to the human light-chain constant (LC(κ) region gene.

[0093] In cloning into pCHO1.0 expression vectors for expression of antibodies in animal cells, the light-chain and heavy-chain genes were inserted after cleavage with EcoRV, PacI, AvrII and BstZ17I restriction enzymes. In order to examine whether pCHO1.0 expression vectors containing the 18 selected human antibody genes were consistent with the synthesized gene sequences, DNA sequencing was performed.

[0094] Using the pCHO1.0 expression vectors that are animal cell expression systems containing all the antibody light-chain and heavy-chain genes, whole human IgG was expressed. The human antibody was obtained by transiently transfecting the plasmid DNA of each of the antibodies into CHO-S cells and purifying the antibody, secreted into the medium, by protein A column.

[0095] Human IgG was injected into hFcRn-expressing Tg32 (hFcRn+/+, hβ2m+/+, mFcRn-/-, mβ2m-/-) mice (Jackson Laboratory), and then the 18 human antibodies converted to the human IgG sequences were administered to the mice in order to examine whether the antibodies would influence the catabolism of human IgG.

[0096] Based on the in vitro analysis results for binding affinity (KD) for the antigen and the analysis of human FcRn binding affinity and blocking effect by FACS, and the *in vivo* analysis of catabolism of human IgG, four human anti-FcRn antibody proteins (HL161A, HL161B, HL161C and HL161D) that most effectively acted were selected (FIG. 1). Antibodies HL161A, HL161C and HL161D are not according to the invention. In addition, an HL161BK antibody having no N-glycosylation site was prepared by substituting asparagine (N) at position 83 of the heavy-chain variable framework of the HL161B antibody with lysine (K). The nucleotide sequences, amino acid sequences and CDR sequences of the light-chain and heavy-chain variable regions of each antibody are shown in Tables 1, 2 and 3.

Table 1

[0097]

[Table 1]

Polynucleotide sequences of heavy-chain and light-chain variable domains of selected human FcRn antibodies				
Antibody name	Heavy-chain variable domain sequence		Light-chain variable domain sequence	
	SEQ ID NO.	Polynucleotide sequence	SEQ ID NO.	Polynucleotide sequence
HL161A (not according to the invention)	1	GAAGTGCAGC TGCTGGAATC CGGCGGAGGC CTGGTGCAGC CTGGCGGCTC TCTGAGACTG TCCTGCGCCG CCTCCGAGTT CACCTTCGGC AGCTGCGTGA TGACCTGGGT CCGACAGGCT CCCGGCAAGG GCCTGGAATG GGTGTCCGTG ATCTCCGGCT CCGGCGGCTC CACCTACTAC GCCGACTCTG	11	TCTTACGTGC TGACCCAGCC CCCCTCCGTG TCTGTGGCTC CTGGCCAGAC CGCCAGAATC ACCTGTGGCG GCAACAACAT CGGCTCCACC TCCGTGCACT GGTATCAGCA GAAGCCCGGC CAGGCCCCCG TGCTGGTGGT GCACGACGAC TCCGACCGGC CTTCTGGCAT CCCTGAGCGG TTCTCCGGCT
		TGAAGGGCCG GTTCACCATC TCCCGGGACA ACTCCAAGAA CACCCTGTAC CTGCAGATGA ACTCCCTGCG GGCCGAGGAC ACCGCCGTGT ACTACTGCGC CAAGACCCCC		CCAACTCCGG CAACACCGCC ACCCTGACCA TCTCCAGAGT GGAAGCCGGC GACGAGGCCG ACTACTACTG CCAAGTGCGA GACTCCTCCT CCGACCACGT GATCTTCGGC

Polynucleotide sequences of heavy-chain and light-chain variable domains of selected human FcRn antibodies				
Antibody name	Heavy-chain variable domain sequence		Light-chain variable domain sequence	
	SEQ ID NO.	Polynucleotide sequence	SEQ ID NO.	Polynucleotide sequence
		CAAGACCCCC TGGTGGCTGC GGTCCCCCTT CTTCGATTAC TGGGGCCAGG GCACCCTGGT GACAGTGTCC TCC		GATCTTCGGC GGAGGCACCA AGCTGACCGT GCTGGGCCAG CCTAAGGCCG CTCCCTCCGT GACCCTG
HL161B	3	CAACTGTTGC TCCAGGAATC CGGTCCTGGT CTTGTAAAGC CATCTGAGAC TCTCTCCCTT ACCTGTACCG TTAGCGGAGG AAGTCTTTCC TCAAGCTTCT CCTACTGGGT GTGGATCAGA CAGCCTCCCG GAAAAGGGTT GGAGTGGATT GGCACAATAT ACTACTCCGG	13	TCTTACGTGC TGACCCAGTC CCCCTCCGTG TCCGTGGCTC CTGGCCAGAC CGCCAGAATC ACCTGTGGCG GCAACAACAT CGGCTCCAAG TCCGTGCACT GGTATCAGCA GAAGCCCGGC CAGGCCCCCG TGCTGGTGGT GTACGACGAC TCCGACCGGC CCTCTGGCAT
		CAACACTTAC TATAACCCCA GCCTGAAGAG CAGGCTGACT ATCTCTGTCG ACACCAGTAA AAATCACTTT		CCCTGAGCGG TTCTCCGCCT CCAACTCCGG CAACACCGCC ACCCTGACCA TCTCCAGAGT GGAAGCCGGC

Polynucleotide sequences of heavy-chain and light-chain variable domains of selected human FcRn antibodies				
Antibody name	Heavy-chain variable domain sequence		Light-chain variable domain sequence	
	SEQ ID NO.	Polynucleotide sequence	SEQ ID NO.	Polynucleotide sequence
		TCTCTGAATC TGTCTTCAGT GACCGCAGCC GACACCGCCG TGTATTATTG CGCTCGGCGC GCCGGGATTC TGACAGGCTA TCTGGATTCA TGGGGCCAGG GGACATTGGT TACAGTGTCT AGT		GACGAGGCCG ACTACTACTG CCAAGTGTGG GACTCCTCCT CCGACCACGT GGTGTTCGGC GGAGGCACCA AGCTGACCGT GCTGGGCCAG CCTAAGGCCG CTCCCTCCGT GACCCTG
HL161BK	5	CAGCTGCTGC TGCAAGAATC CGGCCCTGGC CTGGTGAAAC CCTCCGAGAC ACTGTCCCTG ACCTGCACCG TGTCCGGCGG CTCCCTGTCC TCCAGCTTCT CCTACTGGGT CTGGATCCGG CAGCCCCCTG GCAAGGGCCT GGAATGGATC	15	TCTTACGTGC TGACCCAGTC CCCCTCCGTG TCCGTGGCTC CTGGCCAGAC CGCCAGAATC ACCTGTGGCG GCAACAACAT CGGCTCCAAG TCCGTGCACT GGTATCAGCA GAAGCCCGGC CAGGCCCCCG TGCTGGTGGT GTACGACGAC
		GGCACCATCT ACTACTCCGG CAACACCTAC TACAACCCCA		TCCGACCGGC CCTCTGGCAT CCCTGAGCGG TTCTCCGCCT

Polynucleotide sequences of heavy-chain and light-chain variable domains of selected human FcRn antibodies				
Antibody name	Heavy-chain variable domain sequence		Light-chain variable domain sequence	
	SEQ ID NO.	Polynucleotide sequence	SEQ ID NO.	Polynucleotide sequence
		GCCTGAAGTC CCGGCTGACC ATCTCCGTGG ACACCTCCAA GAACCACTTC AGCCTGAAGC TGTCCTCCGT GACCGCCGCT GACACCGCCG TGTACTACTG TGCCAGAAGG GCCGGCATCC TGACCGGCTA CCTGGACTCT TGGGGCCAGG GCACCCTGGT GACAGTGTCC TCC		CCAACTCCGG CAACACCGCC ACCCTGACCA TCTCCAGAGT GGAAGCCGGC GACGAGGCCG ACTACTACTG CCAAGTGTGG GACTCCTCCT CCGACCACGT GGTGTTCGGC GGAGGCACCA AGCTGACCGT GCTGGGCCAG CCTAAGGCCG CTCCCTCCGT GACCCTG
HL161C (not according to the invention)	7	CAGGTGCAGC TCGTGCAGTC CGGCGCAGAG GTCAAAAAGC CTGGTGCATC TGTGAAAGTG AGTTGCAAGG CTAGCGGCTA CACCTTTACC GGATGTTATA TGCATTGGGT ACGCCAAGCC CCCGGACAAG	17	GACATCCAGA TGACCCAGTC ACCATCATCC CTTTCCGCAT CTGTCGGAGA TAGAGTGACT ATCACCTGCA GGGCTTCTCA AGGTATTTCC AACTACCTCG CCTGGTTCCA GCAAAAGCCA GGTAAAGCCC
		GCTTGGAATG		CAAAGAGCTT

Polynucleotide sequences of heavy-chain and light-chain variable domains of selected human FcRn antibodies				
Antibody name	Heavy-chain variable domain sequence		Light-chain variable domain sequence	
	SEQ ID NO.	Polynucleotide sequence	SEQ ID NO.	Polynucleotide sequence
		GATGGGGCGT ATCAACCCAA ACTCTGGCGG GACTAATTAC GCCCAGAAGT TTCAGGGAAG GGTGACTATG ACAAGGGACA CATCCATATC CACCGCTTAT ATGGACCTGT CTCGACTGCG GTCTGATGAT ACAGCCGTTT ATTACTGCGC CAGAGACTAC AGCGGATGGA GCTTCGATTA TTGGGGGCAG GGTACTTTGG TCACAGTTTC AAGT		GATCTACGCC GCTTCTAGTC TGCAGAGTGG AGTTCCTAGT AAGTTCTCCG GCTCTGGCAG TGGCACAGAT TTTACCTTGA CCATTTCCAG CCTGCAGTCT GAGGATTTCG CTACCTACTA TTGTCAGCAG TATGACAGCT ATCCCCCCAC ATTTGGGGGG GGCACTAAGG TGGAGATAAA ACGGACAGTG GCTGCCCCTT CTGTCTTTAT T
HL161D (not according to the invention)	9	CAGCTGCAGT TGCAGGAGTC AGGCCCCGGT TTGGTTAAGC CTTCTGAAAC CCTTTCTCTC ACATGCACAG TATCCGGTGG CTCCATCTCC AGTTCAAGTT	19	AGCTATGAGC TGACCCAGCC TCTGAGCGTA TCTGTCGCTC TCGGCCAGAC AGCCAGAATT ACCTGTGGCG GCAATAACAT AGGATCCAAA AATGTTCACT

Polynucleotide sequences of heavy-chain and light-chain variable domains of selected human FcRn antibodies				
Antibody name	Heavy-chain variable domain sequence		Light-chain variable domain sequence	
	SEQ ID NO.	Polynucleotide sequence	SEQ ID NO.	Polynucleotide sequence
		ACTACTGGGG		GGTATCAGCA
		ATGGATCCGG CAACCCCCAG GAAAAGGGCT GGAGTGGATT GGCAATATAT ATTACTCTGG GTCCACCTAT TACAACCCTT CCCTGATGAG TAGAGTGACC ATCAGCGTGG ACACAAGCAA AAACCAATTC AGCCTGAAGC TTTCTAGCGT GACCGCTGCC GACACAGCTG TCTATTACTG TGCCCGCCAG CTTAGTTATA ACTGGAATGA TAGGCTGTTT GATTACTGGG GCCAGGGGAC TCTCGTTACA GTCAGCAGC		AAAACCTGGC CAAGCTCCCG TGCTCGTGAT CTACCGGGAC TCTAACCGAC CCAGTGGAAT CCCCGAACGC TTTAGCGGTT CCAACTCTGG AAATACAGCT ACTCTGACTA TCTCCAGGGC TCAGGCCGGG GATGAGGCCG ATTACTACTG CCAGGTGTGG GACTCAAGCA CAGTGGTCTT CGGCGGAGGT ACCAAGTTGA CTGTTCTTGG GCAGCCAAAG GCCGCACCTT CAGTGACCCT G

Table 2

[0098]

[Table 2]

Amino acid sequences of heavy-chain and light-chain variable domains of selected human FcRn antibodies				
Antibody name	Heavy-chain variable domain sequence		Light-chain variable domain sequence	
	SEQ ID NO.		SEQ ID NO.	
HL161A (not according to the invention)	2	EVQLLESGGG LVQPGGSLRL SCAASEFTFG SCVMTWVRQA PGKGLEWVSV ISGSGGSTYY ADSVKGRFTI SRDNSKNTLY LQMNSLRAED TAVYYCAKTP WWLRSPFFDY WGQGTLVTVSS	12	SYVLTQPPSV SVAPGQTARI TCGGNNIGST SVHWYQQKPG QAPVLVVHDD SDRPSGIPER FSGSNSGNTA TLTISRVEAG DEADYYCQVR DSSSDHVIFG GGTKLTVLGQ PKAAPSVTL
HL161B	4	QLLLQESGPG LVKPSETLSL TCTVSGGSLS SSFSYWVWIR QPPGKGLEWI GTIYYSGNTY YNPSLKSRLT ISVDTSKNHF SLNLSSVTAA DTAVYYCARR AGILTGYLDS WGQGTLVTVSS	14	SYVLTQSPSV SVAPGQTARI TCGGNNIGSK SVHWYQQKPG QAPVLVVYDD SDRPSGIPER FSASNSGNTA TLTISRVEAG DEADYYCQVW DSSSDHVVFG GGTKLTVLGQ PKAAPSVTL
HL161BK	6	QLLLQESGPG LVKPSETLSL TCTVSGGSLS	16	SYVLTQSPSV SVAPGQTARI TCGGNNIGSK

Amino acid sequences of heavy-chain and light-chain variable domains of selected human FcRn antibodies				
Antibody name	Heavy-chain variable domain sequence		Light-chain variable domain sequence	
	SEQ ID NO.		SEQ ID NO.	
		SSFSYWVWIR QPPGKGLEWI GTIYYSGNTY		SVHWYQQKPG QAPVLVVYDD SDRPSGIPER
		YNPSLKSRLT ISVDTSKNHF SLKLSSVTAA DTAVYYCARR AGILTGYLDS WGQGTLVTVSS		FSASNSGNTA TLTISRVEAG DEADYYCQVW DSSSDHVVFG GGTKLTVLGQ PKAAPSVTL
HL161C (not according to the invention)	8	QVQLVQSGAE VKKPGASVKV SCKASGYTFT GCYMHWVRQA PGQGLEWMGR INPNSGGTNY AQKFQGRVTM TRDTSISTAY MDLSRLRSDD TAVYYCARDY SGWSFDYWGQ GTLVTVSS	18	DIQMTQSPSS LSASVGDRVT ITCRASQGIS NYLAWFQQKP GKAPKSLIYA ASSLQSGVPS KFSGSGSGTD FTLTISSLQS EDFATYYCQQ YDSYPPTFGG GTKVEIKRTV AAPSVFI
HL161D (not according to the invention)	10	QLQLQESGPG LVKPSETLSL TCTVSGGSIS SSSYYWGWIR QPPGKGLEWI GNIYYSGSTY YNPSLMSRVT ISVDTSKNQF	20	SYELTQPLSV SVALGQTARI TCGGNNIGSK NVHWYQQKPG QAPVLVIYRD SNRPSGIPER FSGSNSGNTA TLTISRAQAG

Amino acid sequences of heavy-chain and light-chain variable domains of selected human FcRn antibodies				
Antibody name	Heavy-chain variable domain sequence		Light-chain variable domain sequence	
	SEQ ID NO.		SEQ ID NO.	
		SLKLSSVTAA DTAVYYCARQ LSYNWNDRLF DYWGQGTLVT VSS		DEADYYCQVW DSSTVVFGGG TKLTVLGQPK AAPSVTL

Table 3

[0099]

[Table 3]

CDR sequences of heavy-chain and light-chain variable domains of selected human FcRn antibodies						
Antibody	Heavy-chain variable domain CDR			Light-chain variable domain CDR		
	CDR1	CDR2	CDR3	CDR1	CDR2	CDR3
SEQ ID NO.	21	22	23	24	25	26
HL161A (not according to the invention)	SCVMT	VISGSGG STYYAD SVKG	TPWWLR SPFFDY	GGNNIG STSVH	DDSDRP S	VRDSSS DHVI
SEQ ID NO.	27	28	29	30	31	32
HL161B (HL161BK)	FSYWV	TIYYSGN TYYNPS LKS	RAGILTG YLDS	GGNNIG SKSVH	DDSDRP S	QVWDSS SDHVV
SEQ ID NO.	33	34	35	36	37	38
HL161C (not according to the invention)	GCYMH	RINPNSG GTNYAQ KFQG	DYSGWS FDY	RASQGIS NYLA	AASSLQS	QQYDSY PPTF

CDR sequences of heavy-chain and light-chain variable domains of selected human FcRn antibodies						
Antibody	Heavy-chain variable domain CDR			Light-chain variable domain CDR		
	CDR1	CDR2	CDR3	CDR1	CDR2	CDR3
SEQ ID NO.	39	40	41	42	43	44
HL161D (not according to the invention)	SYYWG	NIYYSGS TYYNPS LMS	QLSYNW NDRLFD Y	GGNNIG SKNVH	RDSNRPS	QVWDSS TVV

Example 4: Measurement of antigen binding affinity of HL161A/HL161B/HL161C/HL161D antibodies by SPR

[0100] The binding affinities of HL161A, HL161B, HL161C and HL161D antibodies by SPR were measured by immobilizing water-soluble hFcRn as a ligand onto a Proteon GLC chip (Bio-Rad) and measuring the affinity. Antibodies HL161A, HL161C and HL161D are not according to the invention. Kinetic analysis was performed using a Proteon XPR36 system. shFcRn was immobilized on a GLC chip, and an antibody sample was allowed to react at a concentration of 5, and sensogram results were obtained. In kinetic analysis, a 1:1 Langmuir binding model was used, the analysis was repeated six times at each of pH 6.0 and pH 7.4, and the mean KD value was calculated. Following the immobilization step, the chip was activated under the conditions of EDAC/NHS 0.5X, 30 μL/min and 300 sec. For immobilization, shFcRn was diluted in acetate buffer (pH 5.5) to concentrations of 2 μg/mL and 250 μL, and the dilution was allowed to flow on the chip at a rate of 30 μL/min. When an immobilization level of 200-300 RU was reached, the reaction was stopped. Then, deactivation was performed using ethanolamine at a rate of 30 μL/min for 300 sec. Each of the HL161 antibodies was serially 2-fold diluted from a concentration of 10 nM to 5 nM, 2.5 nM, 1.25 nM, 0.625 nM, 0.312 nM, etc., thereby preparing samples. Sample dilution was performed using 1X PBST (pH 7.4) or 1X PBST (pH 6.0) at each pH. For sample analysis, association was performed at 50 μL/min for 200 sec, and the dissociation step was performed at 50 μL/min for 600 sec, after which regeneration was performed using glycine buffer (pH 2.5) at 100 μL/min for 18 sec. The kinetic analysis of each sample was repeated six times, and then the mean antigen binding affinity (KD) was measured. The kinetic parameters of the antibodies, which resulted from the SPR analysis, are shown in Table 4 below (FIGS. 2a to 2h).

Table 4

[0101]

[Table 4]

Results of kinetic analysis of antibody by human FcRn-immobilized SPR (Antibodies HL161A, HL161C and HL161D are not according to the invention)						
Antibody	pH 6.0			pH 7.4		
	k_{on} ($M^{-1}s^{-1}$)	k_{off}(s^{-1})	K_D (M)	k_{on} ($M^{-1}s^{-1}$)	k_{off}(s^{-1})	K_D (M)
HL161A	1.81×10^{6}	3.26×10^{-4}	1.80×10^{-10}	1.32×10^{6}	3.27×10^{-4}	2.47×10^{-10}
HL161B	9.12×10^{5}	7.35×10^{-4}	8.07×10^{-10}	7.10×10^{5}	1.25×10^{-3}	1.76×10^{-9}
HL161C	1.74×10^{6}	3.32×10^{-4}	1.91×10^{-10}	1.36×10^{6}	3.16×10^{-4}	2.32×10^{-10}
HL161D	9.70×10^{5}	1.38×10^{-3}	1.43×10^{-9}	6.99×10^{5}	1.24×10^{-3}	1.78×10^{-9}
$hIgG_1$	3.2×10^{5}	4.6×10^{-4}	1.4×10^{-9}	No binding	No binding	No binding

[0102] Example 5: Analysis of binding of HL161A/HL161B antibodies to human FcRn by FACS (Antibody HL161A is not according to the invention.)

[0103] Using human FcRn-expressing stable HEK293 cells, binding to FcRn at each pH was analyzed using a FACS system. The FcRn binding test using FACS was performed in reaction buffer at pH 6.0 and pH 7.4. Specifically, 100,000 human FcRn-expressing stable HEK293 cells were washed with PBS buffer and centrifuged in a table microcentrifuge at 4500 rpm for 5 minutes to obtain cell pellets. The antibody was added to 100 µl of pH 6.0 or pH 7.4 PBS/10 mM EDTA. The remaining cells pellets were suspended in reaction buffer, and cell counting was performed. 10 µL of the cell suspension was added to a slide, and the number of the cells in the cell suspension was counted in a TC10 system, after which the cell suspension was diluted with reaction buffer to a cell concentration of 2×10^6 cells/mL. Each antibody sample was diluted to 500 nM. For analysis at pH 6.0, the dilution was diluted to 20 nM in a 96-well v-bottom plate, and 50 µL of the dilution was added to each well. For analysis at pH 7.4, 500 nM antibody sample was diluted by 3-fold serial dilution, and analyzed at a concentration ranging from 250 nM to 0.11 nM. 50 µL of the cells diluted to 2×10^6 cells/mL were added to each well and suspended. The plate was mounted in a rotator at 4°C and rotated at an angle of 15° and 10 rpm for 90 minutes. After completion of the reaction, the plate was taken out of the rotator and centrifuged at 2000 rpm for 10 minutes, and the supernatant was removed. A488 anti-hIgG goat antibody was diluted at 1:200 in reaction buffer, and 100 µL of the antibody dilution was added to each well and suspended. Next, the plate was mounted again in a rotator at 4°C and rotated at an angle of 15° and 10 rpm for 90 minutes. After completion of the reaction, the plate was taken out of the rotator and centrifuged at 2000 rpm for 10 minutes, and the supernatant was removed. After the washing procedure was performed once more, 100 µL of reaction buffer was added to each well to dissolve the cell pellets, and the plate was transferred into a blue test tube. Next, 200 µL of reaction buffer was added to each well, and then measurement was performed in FACS. The FACS measurement was performed under

the following conditions: FS 108 volts, SS 426 volts, FL1 324 volts, FL2 300 volts. These cells were analyzed by FACS using BD FACSDiva™ v6.1.3 software (BD Bioscience). The results were expressed as Mean Fluorescence Intensity (MFI) (FIG. 3). The HL161A and HL161B antibodies showed MFI values of 10.59 and 8.34, respectively, at a concentration of 10 nM and pH 6.0. At pH 7.4 and a concentration of 0.11-250 nM, the antibodies showed EC50 (Effective Concentration 50%) values of 2.46 nM and 1.20 nM, respectively, as analyzed by 4 parameter logistic regression using the MFI values.

[0104] Example 6: Analysis of blocking effects of HL161A/HL161B antibodies by FACS (Antibody HL161Ais not according to the invention.)

[0105] HEK293 cells that express hFcRn on the cell surface were treated with the two antibodies analyzed for their binding affinity for cell surface human FcRn, and the blocking effects of the antibodies were examined based on a reduction in the binding of Alexa-Fluo-488-labelled hIgG 1. The analysis procedure was performed in the following manner.

[0106] 2 mL of 1 x TE was added to each type of naive HEK293 cells and human FcRn-overexpressing stable HEK293 cells, which were incubated in a 5% CO_2 incubator at 37°C for 1 min. The cells were recovered from the flasks, and 8 mL of reaction buffer (pH 6.0) was added thereto, after which the cells were transferred into a 50 mL cornical tube. The cell suspension was centrifuged at 2000 rpm for 5 minutes to remove the supernatant, and 1 mL of reaction buffer (pH 6.0) was added to each cell pellet. Then, the cell suspension was transferred into a fresh 1.5 mL Eppendorf tube. Next, the cell suspension was centrifuged at 4000 rpm for 5 minutes, and the supernatant was removed. Then, reaction buffer (pH 6.0) was added to the remaining cell pellet, and the cell number of the cell suspension was counted. Finally, the cell suspension was diluted with reaction buffer to a cell concentration of 2.5×10^6 cells/mL.

[0107] Each antibody sample was diluted to 400 nM, and then diluted by 4-fold serial dilution in a 96-well v-bottom plate. 50 µL of the sample diluted to a final concentration of 200 nM to 0.01 nM was added to each well. Then, 10 µL of Alex488-hIgG1 diluted with 1 µM reaction buffer (pH 6.0) was each well. Finally, 40 µL of cells diluted to a cell concentration of 2.5×10^6 cells/mL were added to each well and suspended. The plate was mounted in a rotator at 4°C and rotated at an angle of 15° and 10 rpm for 90 minutes. After completion of the reaction, the plate was taken out of the rotator, and centrifuged at 2000 rpm for 10 minutes to remove the supernatant. 100 µL of reaction buffer was added to each well to dissolve the cell pellets, and the plate was transferred into a blue test tube. Then, 200 µL of reaction buffer was added to each well, and measurement was performed in FACS. The FACS measurement was performed under the following conditions: FS 108 volts, SS 426 volts, FL1 324 volts, FL2 300 volts. These cells were analyzed by FACS using BD FACSDiva™ v6.1.3 software (BD Bioscience). The results were expressed as mean fluorescence intensity (MFI). The MFI of the test group was processed after subtracting the measured MFI value of the cells alone (background signal). The percentage of the MFI of the competitor-containing tube relative to

100% of a control tube (Alexa Fluor 488 alone, and no competitor) was calculated.

$$\text{Blocking}(\%) = \left\{ \frac{\text{MFI of hFcRn stable (Competitor + A488-hIgG1)} - \text{MFI of HEK293 (A488-hIgG1)}}{\text{MFI of hFcRn stable (A488-hIgG1)} - \text{MFI of HEK293 (A488-hIgG1)}} \right\} \times 100$$

[0108] When the MFI was lower than the MFI of the human IgG1 competitor-containing tube, the competitor antibody was determined to have high competition rate. Based on the measured blocking effects (%) of the HL161A and HL161B antibodies under the conditions of pH 6.0 and concentration of 0.01-200 nM, 4-parameter logistic regression was performed. As a result, it was shown that the HL161A and HL161B antibodies showed IC50 (Inhibitory Concentration 50%) values of 0.92 nM and 2.24 nM, respectively (FIG. 4).

[0109] Example 7: Test for effects of HL161A/HL161B in mFcRn -/- hFCRN transgenic 32 (Tg32) mice (Antibody HL161A is not according to the invention.)

[0110] Human IgG was injected into human FcRn-expressing Tg32 (hFcRn+/+, hβ2m+/+, mFcRn-/-, mβ2m-/-) mice (Jackson Laboratory), and then HL161A and HL161B together with human IgG were administered to the mice in order to examine whether the antibodies would influence the catabolism of human IgG.

[0111] HL161A and HL161B antibodies and human IgG (Greencross, IVglobulinS) were dispensed for 4-day administration at dose of 5, 10 and 20 mg/kg and stored, and PBS (phosphate buffered saline) buffer (pH 7.4) was used as a vehicle and a 20 mg/kg IgG1 control. Human FcRn Tg32 mice were adapted for about 7 days and given water and feed *ad libitum.* Temperature (23 ± 2 °C), humidity (55 ± 5%) and 12-hr-light/12-hr-dark cycles were automatically controlled. Each animal group consisted of 4 mice. To use human IgG as a tracer, biotin-conjugated hIgG was prepared using a kit (Pierce, Cat#. 21327). At 0 hour, 5 mg/kg of biotin-hIgG and 495 mg/kg of human IgG were administered intraperitoneally to saturate IgG *in vivo.* At 24, 48, 72 and 96 hours after administration of biotin-IgG, each drug was injected intraperitoneally at doses of 5, 10 and 20 mg/kg once a day. For blood collection, the mice were lightly anesthetized with Isoflurane (JW Pharmaceutical), and then blood was collected from the retro-orbital plexus using a heparinized Micro-hematocrit capillary tube (Fisher) at 24, 48, 72, 96, 120 and 168 hours after administration of biotin-IgG. At 24, 48, 72 and 96 hours, the drug was administered after blood collection. Immediately after 0.1 mL of whole blood was received in an Eppendorf tube, plasma was separated by centrifugation and stored in a deep freezer (Thermo) at -70°C until analysis.

[0112] The level of biotin-hIgG1 in the collected blood was analyzed by ELISA in the following manner. 100 μl of Neutravidin (Pierce, 31000) was added to a 96-well plate (Costar, Cat. No: 2592) to a concentration of 1.0 μg/ml, and then coated at 4°C for 16 hours. The plate was washed three times with buffer A (0.05 % Tween-20, 10 mM PBS, pH 7.4), and then incubated in 1% BSA-containing PBS (pH 7.4) buffer at room temperature for 2 hours. Next, the plate was washed three times with buffer A, and then a Neutravidin plate was prepared with 0.5 % BSA-

containing PBS (pH 7.4) buffer so as to correspond to 1 μg/ml. A blood sample was serially diluted 500-1000-fold in buffer B (100 mM MES, 150 mM NaCl, 0.5 % BSA IgG-free, 0.05 % Tween-20, pH 6.0), and 150 μl of the dilution was added to each well of the plate. The added sample was allowed to react at room temperature for 1 hour. Next, the plate was washed three times with buffer A, and then 200 μl of 1 nM HRP-conjugated anti-human IgG goat antibody was added to each well and incubated at 37°C for 2 hours. Next, the plate was washed three times with ice cold buffer B, and then 100 μl of the substrate solution tetramethylbenzidine (RnD, Cat. No: DY999) was added to each well and allowed to react at room temperature for 15 minutes. 50 μl of 1.0 M sulfuric acid solution (Samchun, Cat. No: S2129) was added to each well to stop the reaction, after which the absorbance at 450 nm was measured.

[0113] The concentration of biotin-IgG after 24 hours (approximately Tmax of biotin-IgG in mice; before the occurrence of catabolism of biotin-IgG) was set at 100%, and the percentages of the concentration at other time points relative to the concentration at 24 hours are shown in FIG. 10. The results of the analysis indicated that the half-lives of the vehicle and the 20 mg/kg IgG1 control were 103 hours and 118 hours, respectively. However, the blood IgG half-life of the HL161A antibody, which showed excellent human FcRn binding affinity and blocking effect in the *in vitro* analysis and the fastest IgG catabolism in the human FcRn transgenic Tg32 mice, were 30, 23 and 18 hours at varying doses. In addition, the HL161B antibody showed IgG half-lives of 41, 22 and 21 hours. This suggests that the pH-independent and Fc-non-competitive antibodies for hFcRn have the effect of increasing the catabolism of endogenous antibodies (FIGS. 5a and 5b).

[0114] Example 8: Test for effects of HL161A/HL161B in monkeys (Antibody HL161Ais not according to the invention.)

[0115] Using cynomolgus monkeys having a homology of 96% to human FcRn, the monkey IgG, IgA, IgM and albumin levels by administration of the HL161A and HL161B antibodies were analyzed, and the pharmacokinetics (PK) profiles of the antibodies were analyzed.

1) Analysis of change in expression of immunoglobulin G in monkey blood

[0116] First, a change in monkey IgG was measured by ELISA analysis. 100 μL of anti-human IgG Fc antibody (BethylLab, A80-104A) was loaded into each well of a 96-well plate (Costar, Cat. No: 2592) to a concentration of 4.0 μg/mL, and then coated at 4°C for 16 hours. The plate was washed three times with washing buffer (0.05% Tween-20, 10mM PBS, pH 7.4), and then incubated with 1% BSA-containing PBS (pH7.4) buffer at room temperature for 2 hours. The standard monkey IgG was used at a concentration of 3.9-500 ng/mL, and the blood sample was diluted 80,000-fold in 1% BSA-containing PBS (pH7.4) buffer, and the dilution was loaded into the plate and incubated at room temperature for 2 hours. Next, the plate was washed three times with washing buffer, and then 100 μL of a 20,000-fold dilution of anti-hIgG antibody (Biorad, 201005) was loaded into the plate and allowed to react at room temperature for 1 hour. After each plate was washed, 100 μL of the substrate solution 3,3',5,5'-

tetramethylbenzidine (RnD, Cat. No: DY999) was loaded into the plate and allowed to react at room temperature for 7 minutes, after which 50 μL of 1.0 M sulfuric acid solution (Samchun, Cat. No: S2129) was added to each well to stop the reaction. For analysis, absorbance (OD) was measured using a 450 nm and 540 nm absorbance reader (MD, Model: VersaMax). As a result, it was shown that, when each of the HL161A and HL161B antibodies was administered intravenously into cynomolgus monkey at doses of 5 and 20 mg/kg once a week, the monkey IgG level decreased in a dose-dependent manner, and the HL161 antibodies effectively blocked the IgG-FcRn interaction. 5 mg/kg of HL161A reduced the monkey IgG level to 47.1% on day 9, and 20 mg/kg of HL161A reduced the monkey IgG level to 29.6% on day 10. 5 mg/kg of HL161B reduced the monkey IgG level to 53.6% on day 10, and 20 mg/kg of HL161B reduced the monkey IgG level to 31% on day 9, suggesting that the two antibodies showed similar results (Table 5 and FIGS. 6a and 6c). In addition, the change in monkey IgG level by intravenous administration of HL161A and HL161B was compared between individuals, and as a result, it was shown that the monkey IgG level was decreased between individuals in a very similar way.

Table 5

[0117]

[Table 5]

Change (%) in monkey IgG level by administration of HL161A and HL161B					
Day	Vehicle	HL161A (not according to the invention)		HL161B	
		5 mg/kg	20 mg/kg	5 mg/kg	20 mg/kg
0 day	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0
0.5 day	99.0±4.8	81.5±1.8	101.5±9.0	94.3±5.4	96.2±3.0
1 day	97.6±15.9	67.2±2.0	86.2±11.9	83.9±24.7	94.1±7.0
2 day	97.8±6.2	63.0±3.3	74.2±14	73.7±11.3	71.7±5.4
3 day	104.5±13.1	61.8±8.0	59.2±11.0	68.3±9.3	61.3±6.0
4 day	100.9±16.7	55.3±4.1	45.1±4.6	65.5±12.2	44.3±5.6
5 day	103.4±12.5	60.8±8.3	38.8±4.9	65.0±11.9	38.4±3.7
6 day	113.3±8.5	64.9±11.7	39.7±6.4	66.4±11.3	39.0±5.4
7 day	116.9±23.3	58.7±4.7	39.6±5.4	61.4±8.0	37.5±3.2
7.5 day	92.4±10.4	51.2±7.2	38.7±7.8	62.8±8.3	39.3±0.4
8 day	94.6±8.7	48.0±9.3	36.1±5.3	60.7±7.5	39.6±5.9
9 day	117.6±14.3	47.1±4.4	33.8±5.0	54.3±6.9	31.0±3.1
10 day	115.1±16.7	49.7±8.9	29.6±5.8	53.6±4.9	32.8±4.3
11 day	114.6±18.9	47.7±4.2	30.4±6.5	54.7±4.2	39.9±9.1
12 day	109.5±13.1	51.7±3.1	32.9±5.7	56.5±4.7	46.7±9.1

Change (%) in monkey IgG level by administration of HL161A and HL161B					
Day	Vehicle	HL161A (not according to the invention)		HL161B	
		5 mg/kg	20 mg/kg	5 mg/kg	20 mg/kg
13 day	111.1±21.2	52.9±6.4	35.7±9.2	58.7±3.8	45.4±7.6
14 day	128.9±17.7	54.7±4.2	37.8±9.6	60.6±4.2	53.8±11.3
17 day	95.6±6.6	59.5±10.3	40.2±7.4	56.7±4.4	48.4±10.0
20 day	92.5±8.4	62.4±6.7	47.6±8.9	61.8±6.0	54.0±9.5
23 day	107.1±15.2	71.9±6.5	61.8±13.3	64.9±4.4	56.8±6.0
26 day	104.0±5.6	77.7±6.8	72.2±22.4	70.8±7.4	62.4±5.8
29 day	102.4±8.3	81.4±6.7	77.9±20.5	74.8±5.1	65.4±10.8

2) Analysis of pharmacokinetic profiles of HL161A/HL161B in monkey blood

[0118] The time-dependent pharmacokinetic profiles (PK) of HL161A and HL161B after intravenous administration were analyzed by competitive ELISA. Specifically, a solution of 2 μg/mL of Neutravidin was prepared, and 100 μL of the solution was coated on each well of a 96-well plate, and then incubated at 4°C for 18 hours. The plate was washed three time with 300 μL of wash buffer (0.05% Tween 20 containing 10mM PBS, pH 7.4), and then each well was incubated with 1% BSA-containing PBS (pH 7.4) buffer at 25°C for 2 hours. Biotinylated hFcRn was diluted with PBS to 1 μg/mL, and then 100 μL of the dilution was added to each well of the 96-well plate and incubated at 25°C for 1 hour. Next, the plate was washed three times with 300 μL of wash buffer to remove unbound hFcRn, and then a standard sample (0.156-20 ng/mL) was added to each well and incubated at 25°C for 2 hours. Next, the plate was washed three times with wash buffer, and 100 μL of a 1: 10,000 dilution of detection antibody in PBS was added to each well and incubated at 25°C for 1.5 hours. The plate was finally washed three times, and 100 μL of TMB solution was added to each buffer and incubated at room temperature for 5 minutes, after which 50 μL of 1M sulfuric acid as a reaction stop solution was added to each well to stop the reaction. Next, the absorbance at 450 nm was measured with a microplate reader. The analysis results for HL161A and HL161B are shown in Table 6 below, and as can be seen therein, the pharmacokinetic profile of the antibodies increased in a dose-dependent manner. The half-life (T1/2) of the antibodies was about 6-12 days, which was shorter than that of generally known antibodies. In addition, it was shown that the half-life, when observing overally, AUC and Cmax of HL161B were higher than those of HL 161A (FIGS. 7a and 7b).

Table 6

[0119]

[Table 6]

Analysis results for pharmacokinetic profiles of HL161A and HL161B at varying doses				
Ab (Dose)	Day	Cmax (mg/ml)	AUC (mg/ml.hr)	$T_{1/2}$ (hr)
HL161A (not according to the invention) (5 mg/kg)	0-7	157 ± 31	1,601 ± 501	6.9 ± 0.9
	7-14	157 ± 25	1,388 ± 334	10.3 ± 2.8
HL161A (not according to the invention) (20 mg/kg)	0-7	692 ± 138	13,947 ± 2,459	9.0 ± 0.6
	7-14	724 ± 125	12,699 ± 2,114	7.6 ± 1.6
HL161B (5 mg/kg)	0-7	178 ± 56	2,551 ± 1,356	7.9 ± 1.3
	7-14	187 ± 9	2,772 ± 466	9.4 ± 0.5
HL161B (20 mg/kg)	0-7	823 ± 38	21,867 ± 1,088	11.7 ± 1.0
	7-14	868 ± 66	16,116 ± 1,501	± 0.9

3) Analysis of change in IgM and IgA antibody levels in monkey blood

[0120] ELISA analysis for measuring IgM and IgA levels in monkey blood was performed in a manner similar to the ELISA method for measuring IgG levels. Specifically, 100 μL of anti-monkey IgM antibody (Alpha Diagnostic, 70033) or IgA antibody (Alpha Diagnostic, 70043) was added to each well of a 96-well plate to a concentration of 2.0 μg/mL, and then coated at 4°C for 16 hours. The plate was washed three times with wash buffer (0.05% Tween-20 containing 10mM PBS, pH 7.4), and then incubated with 1% BSA-containing PBS (pH7.4) buffer at room temperature for 2 hours. The standard monkey IgM was analyzed at a concentration of 7.8-1,000 ng/mL, and IgA was analyzed at 15.6-2,000 ng/mL. The blood sample was diluted 10,000- or 20,000-fold in 1% BSA-containing PBS (pH7.4) buffer, and the dilution was added to each well and incubated at room temperature for 2 hours. Next, the plate was washed three times with wash buffer, and then 100 μL of a 5,000-fold dilution of each of anti-monkey IgM secondary antibody (Alpha Diagnostic, 70031) and anti-monkey IgA secondary antibody (KPL, 074-11-011) was added to each well and allowed to react at room temperature for 1 hour. The plate was finally washed three times, and 100 μL of the substrate solution 3,3',5,5'-tetramethylbenzidine (RnD, Cat. No: DY999) was added to each well and allowed to react at room temperature for 7 minutes. Next, 50 μL of 1.0 M sulfur solution (Samchun, Cat. No: S2129) was added to each well to stop the reaction. The absorbance of each well was

measured with a 450 and 540 nm absorbance reader (MD, Model: VersaMax).

4) Analysis of change in albumin levels in monkey blood

[0121] The analysis of a change in albumin levels in monkey blood was performed using a commercial ELISA kit (Assaypro, Cat. No: EKA2201-1). Briefly, monkey serum as a test sample was 4000-fold diluted, and 25 μL of the dilution was added to each well of a 96-well plate coated with an antibody capable of binding to monkey albumin. 25 μL of biotinylated monkey albumin solution was added to each well and incubated at 25°C for 2 hours. The plate was washed three times with 200 μL of wash buffer, and then 50 μL of a 1: 100 dilution of streptavidin-peroxidase conjugated antibody was added to each well and incubated at 25°C for 30 minutes. The plate was finally washed three times, and then 50 μL of a substrate was added to each well and incubated at room temperature for 10 minutes. Next, 50 μL of a reaction stop solution was added to each well, and the absorbance at 450 nm was measured. As a result, the clear changes in monkey IgM, IgA and albumin levels by administration of the HL161A and HL161B antibodies were not observed throughout the test period (FIGS. 8a to 8c). Thus, it is concluded that the HL161 antibody is involved only in IgG levels and does not influence the levels of IgM and IgA, suggesting that it will have no significant influence on the decrease in immunity by a decrease in immunoglobulin levels. In addition, no significant change in the monkey albumin level was observed throughout the test period, suggesting that the HL161A and HL161B antibodies specifically block only the IgG-FcRn interactions.

5) Analysis of blood biochemical levels and urinary components

[0122] Finally, blood biochemical analysis and urinary analysis by administration of the antibodies were performed using samples on day 14 of the test. Blood biochemical markers, including aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), creatine phosphokinase (CPK), total bilirubin (TBIL), glucose (GLU), total cholesterol (TCHO), triglyceride (TG), total protein (TP), albumin (Alb), albumin/globulin (A/G), blood urea nitrogen (BUN), creatinine (CRE), inorganic phosphorus (IP), calcium (Ca), sodium (Na), potassium (K) and chloride (Cl), were analyzed using the Hitachi 7180 system. In addition, markers for urinary analysis, including leukocyte (LEU), nitrate (NIT), urobilinogen (URO), protein (PRO), pH, occult blood (BLO), specific gravity (SG), ketone body (KET), nilirubin (BIL), glucose (GLU), and ascorbic acid (ASC), were analyzed using the Mission U120 system. Although there were slight changes in the levels, the measured levels were included in the normal level ranges of cynomolgus monkeys.

REFERENCES CITED IN THE DESCRIPTION

Cited references

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- **LI et al.**J. Clin. Invest., 2005, vol. 115, 3440- [0006]
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- **DEUSCHER, M.**Guide to Protein Purification Methods EnzymologyAcademic Press. Inc.19900000vol. 182, [0076]

Patentkrav

1. Isoleret anti-FcRn-antistof eller et antigenbindende fragment deraf, som omfatter en variabel region af tung kæde, der omfatter CDR1, der omfatter en aminosyresekvens ifølge SEQ ID NO: 27, CDR2, der omfatter en aminosyresekvens ifølge SEQ ID NO: 28, og CDR3, der omfatter en aminosyresekvens ifølge SEQ ID NO: 29, og en variabel region af let kæde, der omfatter CDR1, der omfatter en aminosyresekvens ifølge SEQ ID NO: 30, CDR2, der omfatter en aminosyresekvens ifølge SEQ ID NO: 31, og CDR3, der omfatter en aminosyresekvens ifølge SEQ ID NO: 32; hvor antistoffet eller det antigenbindende fragment omfatter enten:
(i) en variabel region af tung kæde, der omfatter en aminosyresekvens ifølge SEQ ID NO: 4, og en variabel region af let kæde, der omfatter en aminosyresekvens ifølge SEQ ID NO: 14; eller
(ii) en variabel region af tung kæde, der omfatter en aminosyresekvens ifølge SEQ ID NO: 6, og en variabel region af let kæde, der omfatter en aminosyresekvens ifølge SEQ ID NO: 16.

2. Antistof eller antigenbindende fragment deraf ifølge krav 1, hvor antistoffet eller det antigenbindende fragment deraf omfatter et fuldlængde-antistof, Fab, $F(ab')_2$, Fv, scFv, dobbeltspecifikt antistof, bibody, minibody, tribody, bispecifikt antistof, trispecifikt antistof, multispecifikt antistof, diabody, triabody, tetrabody, intrabody, SMIP (small modular immunopharmaceutical) eller bindingsdomæne-immunoglobulin-fusionsprotein; og/eller hvor antistoffet omfatter et IgD-antistof, IgE-antistof, IgM-antistof, IgG1-antistof, IgG2-antistof, IgG3-antistof eller IgG4-antistof.

3. Polynukleotid, som koder for antistoffet eller det antigenbindende fragment deraf ifølge et hvilket som helst af kravene 1 eller 2.

4. Rekombinant ekspressionsvektor, som omfatter polynukleotidet ifølge krav 3.

5. Værtscelle, som er transficeret med den rekombinante ekspressionsvektor ifølge krav 4.

6. Fremgangsmåde til fremstilling af et anti-FcRn-antistof eller et antigenbindende fragment deraf, som omfatter: dyrkning af værtscellen ifølge krav 5 til frembringelse af antistoffet eller det antigenbindende fragment deraf; og isolering og oprensning af det dannede antistof eller antigenbindende fragment deraf.

7. Sammensætning, som omfatter antistoffet eller det antigenbindende fragment deraf ifølge et hvilket som helst af kravene 1 eller 2, hvor antistoffet eller det antigenbindende fragment deraf er mærket med et detektionsmærke.

8. Farmaceutisk sammensætning, som omfatter antistoffet eller det antigenbindende fragment deraf ifølge et hvilket som helst af kravene 1 eller 2 og et eller flere farmaceutisk acceptable bæremateriale.

9. Farmaceutisk sammensætning ifølge krav 8 til anvendelse i en fremgangsmåde til behandling af en patient, der lider af en autoimmunsygdom.

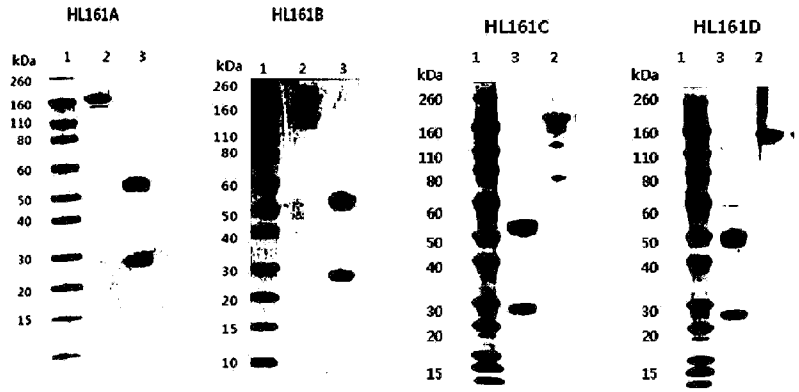
10. Farmaceutisk sammensætning til anvendelse ifølge krav 9, hvor autoimmunsygdommen er valgt fra gruppen, der består af immun neutropeni, Guillain-Barres syndrom, epilepsi, autoimmun encefalitis, Isaacs syndrom, nævus syndrom, pemfigus vulgaris, pemfigus foliaceus, bulløs pemfigoid, epidermolysis bullosa acquisita, pemfigoid gestationis, mukøs membran pemfigoid, antiphospholipidsyndrom, autoimmun anæmi, autoimmun Graves sygdom, Goodpastures syndrom, myasthenia gravis, multipel sklerose, rheumatoid arthritis, lupus, idiopatisk trombocytopenisk purpura, lupus nefritis og membranøs nefropati.

11. In vitro-fremgangsmåde til påvisning af FcRn, som omfatter anvendelse af antistoffet eller det antigenbindende fragment deraf ifølge et hvilket som helst af kravene 1 eller 2.

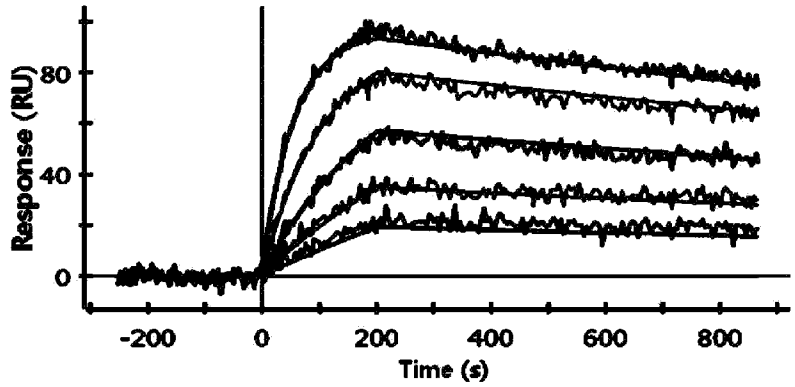
12. Antistof eller antigenbindende fragment deraf ifølge et hvilket som helst af kravene 1 eller 2 til anvendelse i en in vivo-fremgangsmåde til påvisning af FcRn.

DRAWINGS

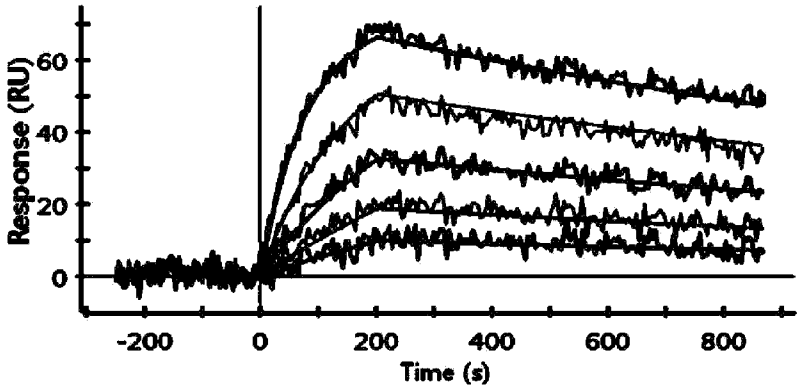
[Fig. 1]



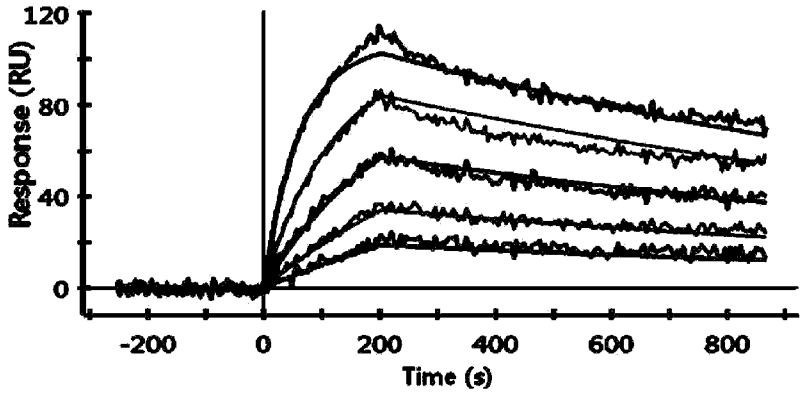
[Fig. 2a]



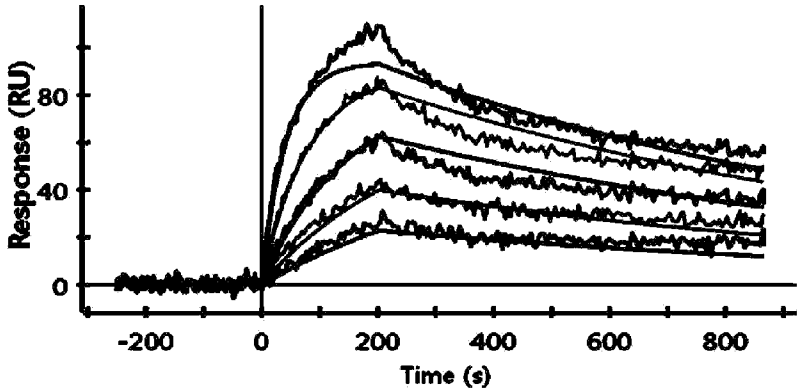
[Fig. 2b]



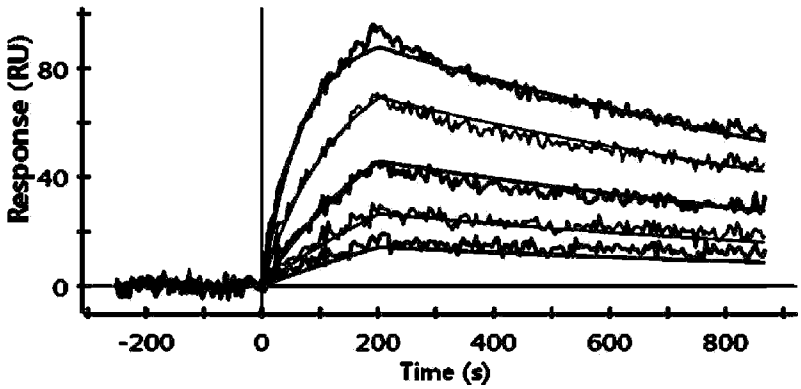
[Fig. 2c]



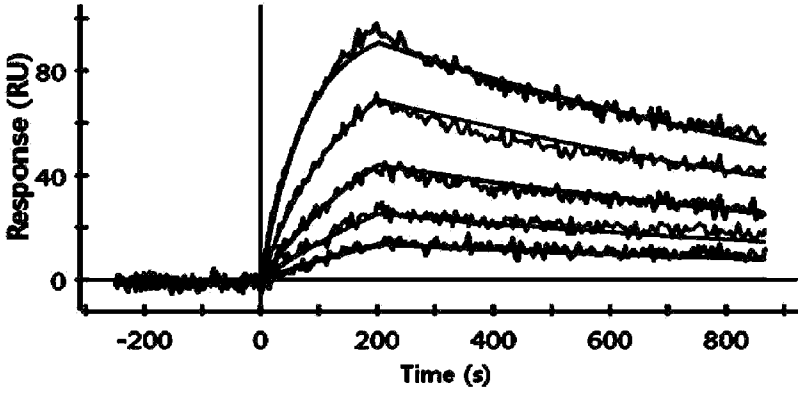
[Fig. 2d]



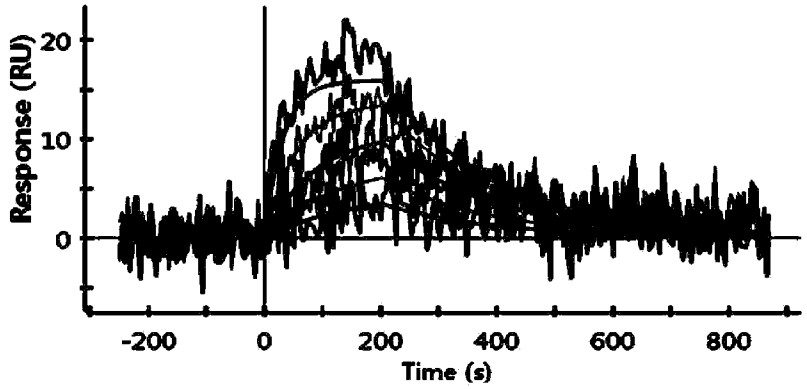
[Fig. 2e]



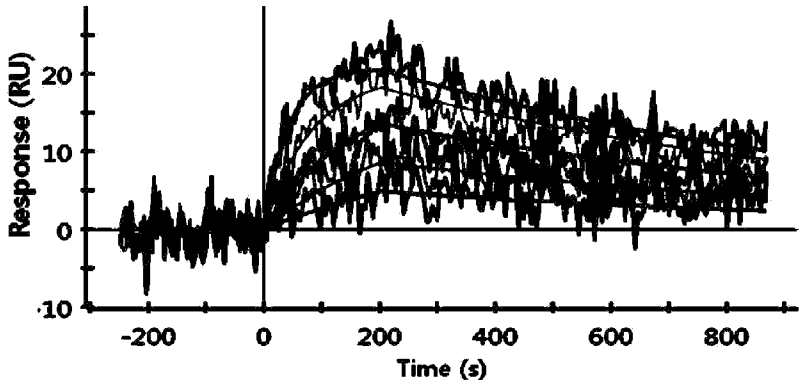
[Fig. 2f]



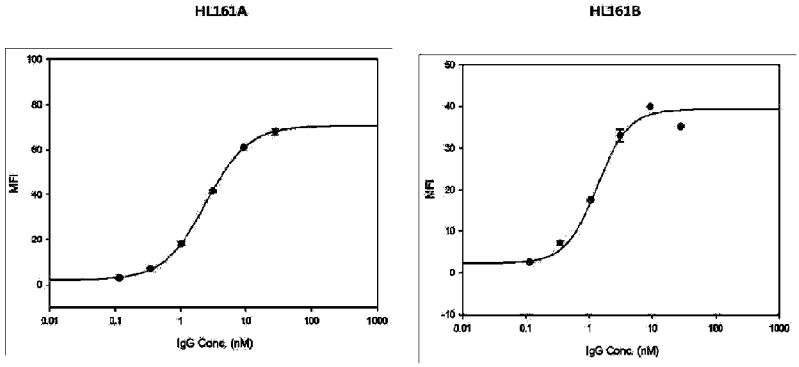
[Fig. 2g]



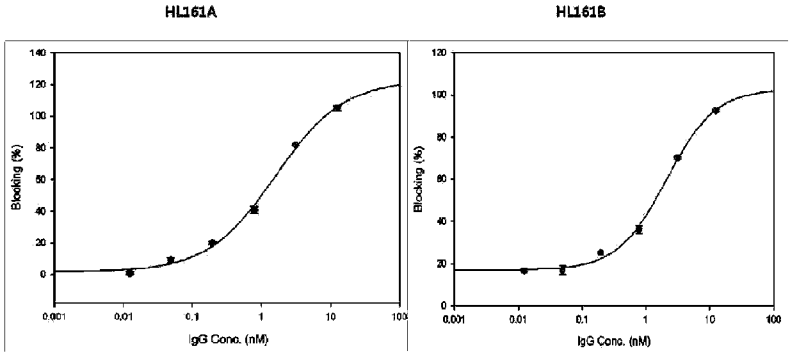
[Fig. 2h]



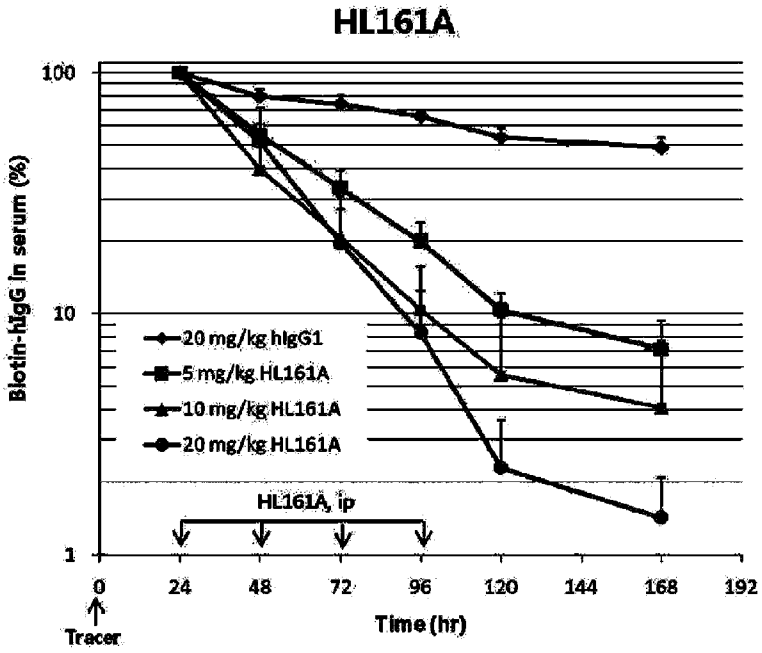
[Fig. 3]



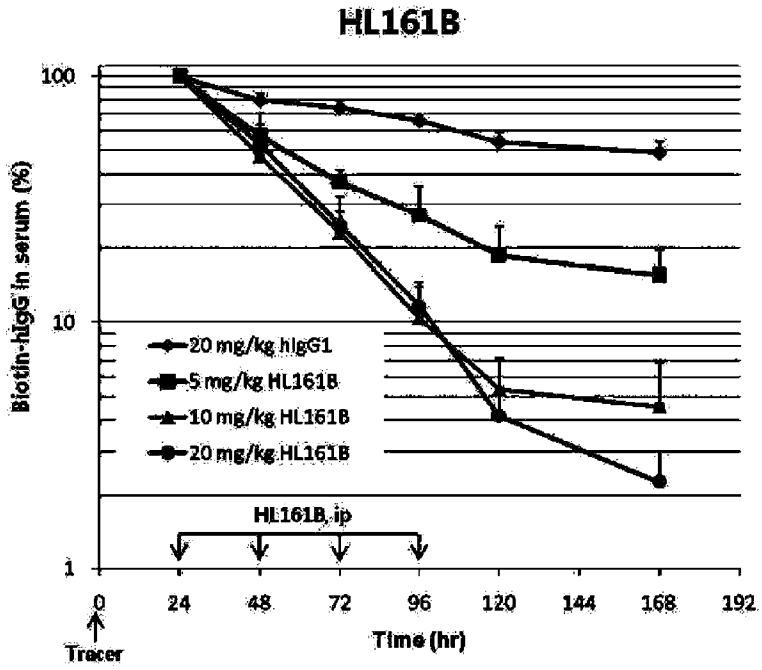
[Fig. 4]



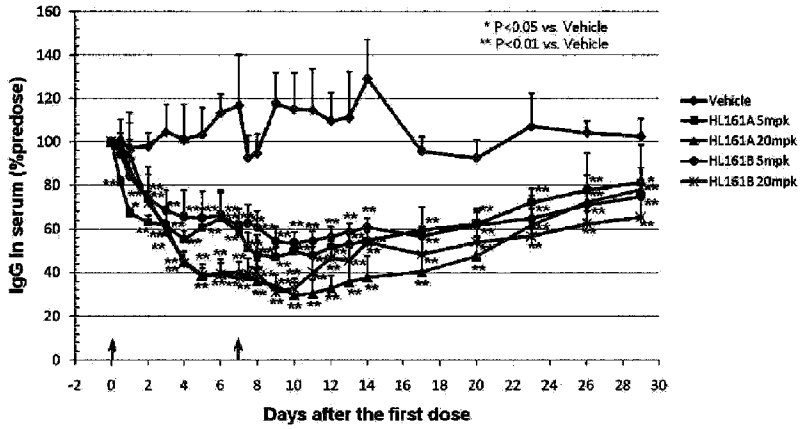
[Fig. 5a]



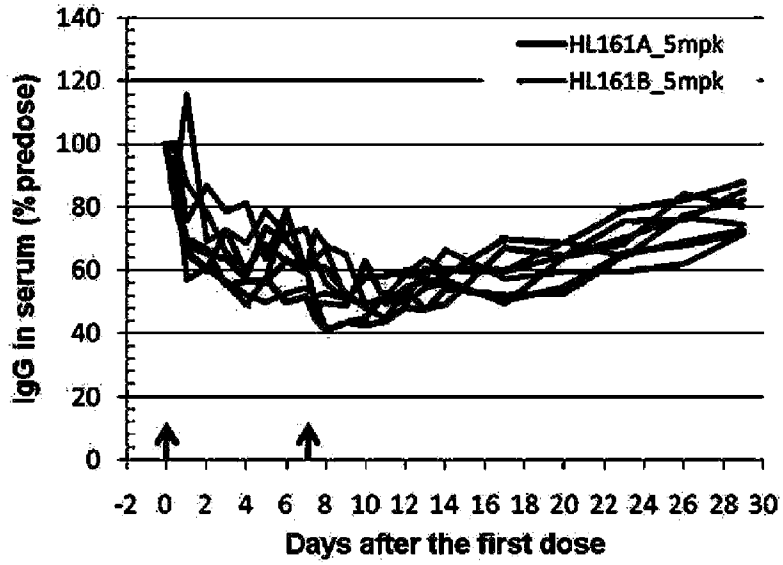
[Fig. 5b]


HL161B
Biotin-hIgG in serum (%)
100
10
1
20 mg/kg hIgG1
5 mg/kg HL161B
10 mg/kg HL161B
20 mg/kg HL161B
HL161B, ip
0
24
48
72
96
120
144
168
192
Tracer
Time (hr)

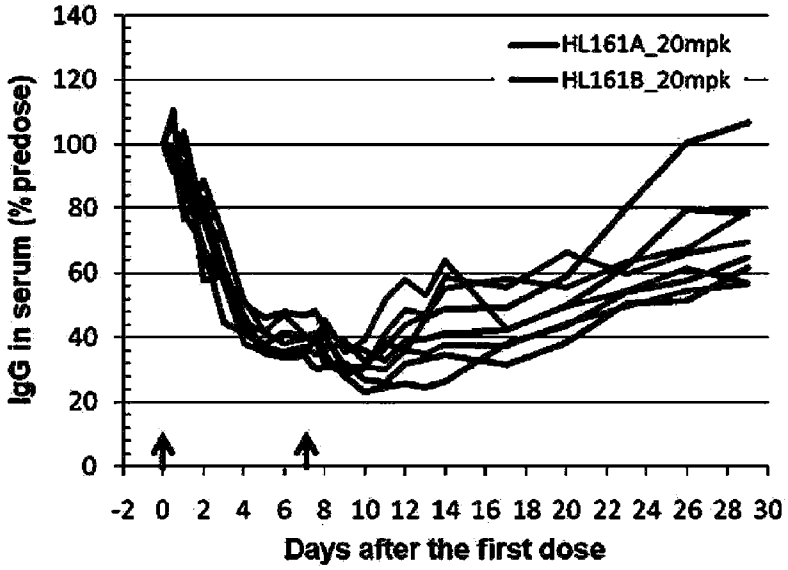
[Fig. 6a]


* P<0.05 vs. Vehicle
** P<0.01 vs. Vehicle
IgG in serum (%predose)
Days after the first dose
Vehicle
HL161A 5mpk
HL161A 20mpk
HL161B 5mpk
HL161B 20mpk

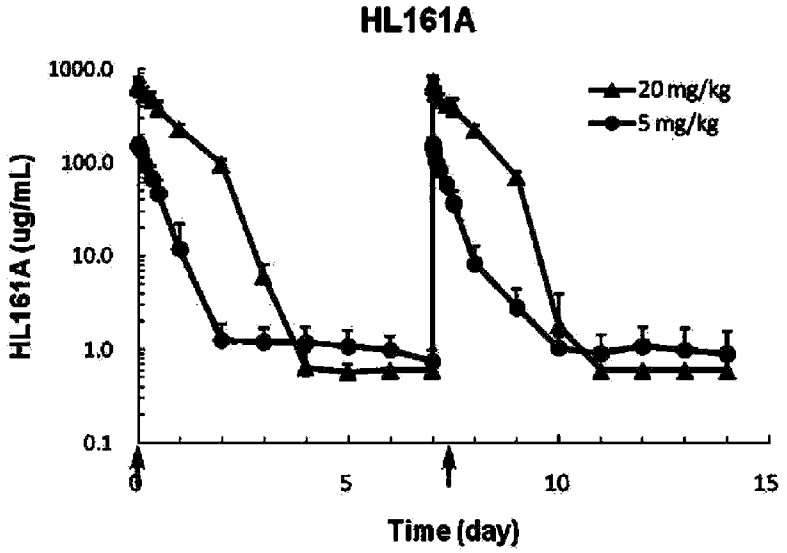
[Fig. 6b]


HL161A_5mpk
HL161B_5mpk
IgG in serum (% predose)
140
120
100
80
60
40
20
0
-2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Days after the first dose

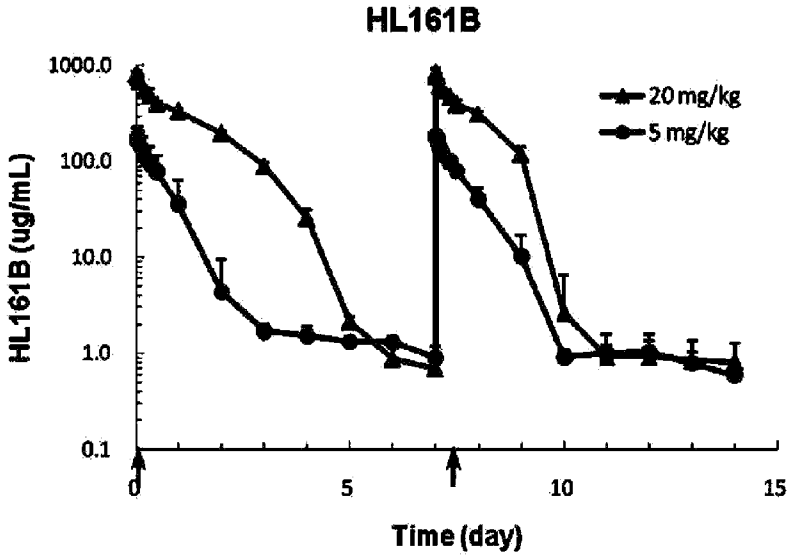
[Fig. 6c]


HL161A_20mpk
HL161B_20mpk
IgG in serum (% predose)
140
120
100
80
60
40
20
0
-2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Days after the first dose

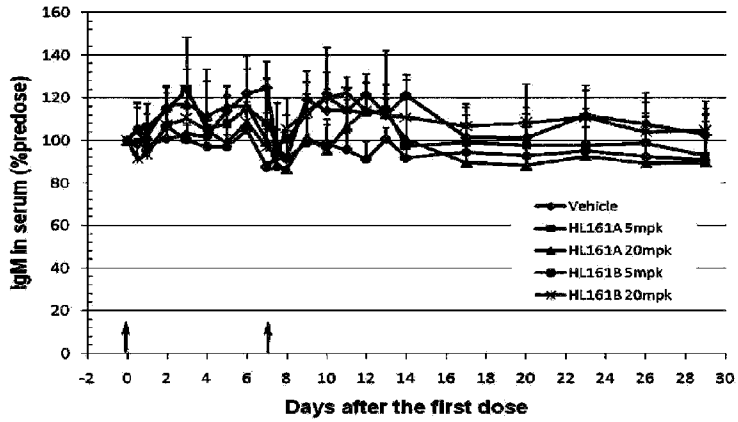
[Fig. 7a]


HL161A
1000.0
100.0
10.0
1.0
0.1
HL161A (ug/mL)
20 mg/kg
5 mg/kg
0
5
10
15
Time (day)

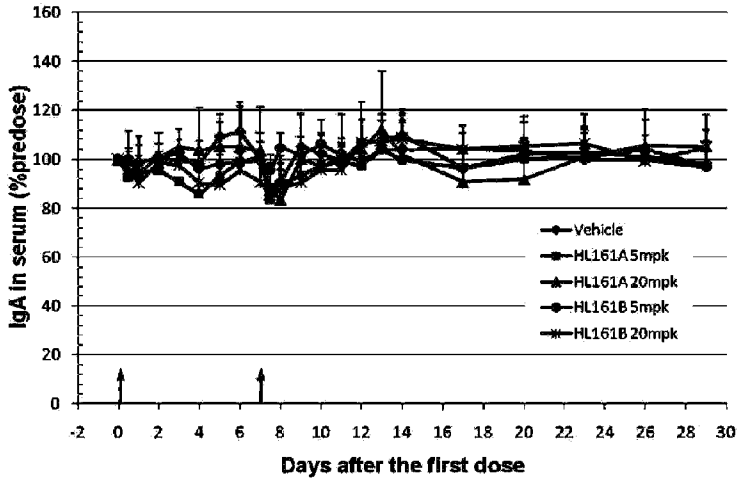
[Fig. 7b]


HL161B
1000.0
100.0
10.0
1.0
0.1
HL161B (ug/mL)
20 mg/kg
5 mg/kg
0
5
10
15
Time (day)

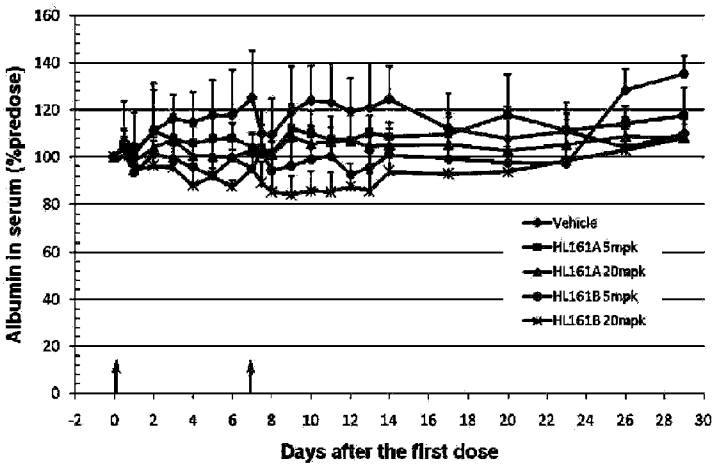
[Fig. 8a]



[Fig. 8b]



[Fig. 8c]



SEKVENSLISTE

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