ANTIBODIES TO PCSK9 AND USES THEREOF

The present invention is in the field of medicine. Particularly, the present invention relates to antibodies to proprotein convertase subtilisin/kexin type 9 (PCSK9), compositions comprising such PCSK9 antibodies, and methods of using PCSK9 antibodies for the treatment of hyperlipidemia or hypercholesterolemia.

Proprotein convertase subtilisin/kexin type 9 (PCSK9) is a secreted serine protease, generated primarily in the liver, that regulates plasma concentrations of low density lipoprotein cholesterol (LDL-C). Secreted PCSK9 binds to and internalizes with the LDL receptor (LDLR) located on the surface of hepatocytes. LDLR functions to clear LDL-C from plasma by binding and transporting LDL particles to lysosomes for degradation. Once the LDL particle is delivered for degradation, the LDLR recycles to the hepatocyte cell surface to bind and clear additional LDL-C from the plasma. PCSK9 regulates plasma LDL-C by directing internalized LDLR for degradation rather than recycling to the cell surface, thus reducing LDL-C clearance. Studies in rodents in which PCSK9 is deficient or over-expressed have now confirmed that PCSK9 controls circulating LDL levels by modulating the levels of LDLR. The observation that circulating PCSK9 participates in the degradation of hepatic LDLR suggests that antibody neutralization of PCSK9 is a viable therapeutic approach for lowering of LDL-C. Further, it has been reported that statin drugs, the current standard of care for lowering LDL-C, may actually increase the expression and serum levels of PCSK9. Thus, a PCSK9 antibody also has the potential to reduce LDL-C in a manner synergistic with statin therapy.

PCSK9 antibodies and their effects on lowering plasma LDL-C are known in the art. For example, US2009/0246192, US2009/0142352, US2010/0166768, and WO2010/029513 disclose such PCSK9 antibodies and their use. However, to date, no antibody targeting PCSK9 has been approved for therapeutic use. Thus, there remains a need for alternative PCSK9 antibodies. In particular, there remains a need for alternative PCSK9 antibodies which reduce LDL-C with high potency. More particular still, there remains a need for alternative PCSK9 antibodies which reduce LDL-C with high potency and which provide sustained duration of action (e.g. sustained suppression of LDL-C

levels). Such antibodies would preferably also possess good physical-chemical properties to facilitate development, manufacturing, or formulation.

Summary

In one aspect of the present disclosure, there is provided an antibody, or antigen-binding fragment thereof, comprising a heavy chain variable region (HCVR) and a light chain variable region (LCVR), wherein the HCVR comprises the complementarity determining regions (CDRs) HCDR1, HCDR2 and HCDR3 and the LCVR comprises the CDRs LCDR1, LCDR2 and LCDR3, wherein the amino acid sequence of HCDR1 is given by SEQ ID NO: 1, the amino acid sequence of HCDR2 is given by SEQ ID NO: 2, the amino acid sequence of HCDR3 is given by SEQ ID NO: 3, the amino acid sequence of LCDR1 is given by SEQ ID NO: 4, the amino acid sequence of LCDR2 is given by SEQ ID NO: 5, and the amino acid sequence of LCDR3 is given by SEQ ID NO: 6, wherein said antibody, or antigen binding fragment thereof, binds to human PCSK9.

In another aspect of the present disclosure, there is provided an antibody comprising two heavy chains (HCs) and two light chains (LCs) wherein the amino acid sequence of each HC is given by SEQ ID NO: 9, and the amino acid sequence of each LC is given by SEQ ID NO: 10.

In yet another aspect of the present disclosure, there is provided an antibody consisting of two heavy chains and two light chains, wherein the amino acid sequence of each heavy chain is given by SEQ ID NO:9, and the amino acid sequence of each light chain is given by SEQ ID NO:10.

In a further aspect of the present disclosure, there is provided a pharmaceutical composition comprising an antibody or antigen-binding fragment as described herein and one or more pharmaceutically acceptable carriers, diluents or excipients.

In another aspect of the present disclosure, there is provided a use of an effective amount of an antibody or antigen-binding fragment as described herein in the manufacture of a medicament for treating hyperlipidemia or hypercholesterolemia.

In yet another aspect of the present disclosure, there is provided an antibody or antigen-binding fragment as described herein for use in therapy.

In a further aspect of the present disclosure, there is provided an antibody or antigen-binding fragment as described herein for use in the treatment of hyperlipidemia or hypercholesterolemia.

Description

The present invention provides an antibody, or antigen-binding fragment thereof, comprising a heavy chain variable region (HCVR) and a light chain variable region (LCVR), wherein the HCVR comprises the complementarity determining regions (CDRs) HCDR1, HCDR2 and HCDR3 and the LCVR comprises the CDRs LCDR1, LCDR2 and LCDR3, wherein the amino acid sequence of HCDR1 is given by SEQ ID NO: 1, the amino acid sequence of HCDR2 is given by SEQ ID NO: 2, the amino acid sequence of HCDR3 is given by SEQ ID NO: 3, the amino acid sequence of LCDR1 is given by SEQ ID NO: 4, the amino acid sequence of LCDR2 is given by SEQ ID NO: 5, and the amino acid sequence of LCDR3 is given by SEQ ID NO: 6, wherein said antibody or antigen-binding fragment thereof binds to human PCSK9. In an embodiment, the present invention provides an antibody, or antigen-binding fragment thereof, comprising a heavy chain variable region (HCVR) and a light chain variable region (LCVR), wherein the amino acid sequence of the HCVR is given by SEQ ID NO: 7 and the amino acid sequence of the LCVR is given by SEQ ID NO: 8, wherein said antibody or antigen-binding fragment thereof binds to human PCSK9. In another embodiment, the present invention provide an antibody, or antigen-binding fragment thereof, comprising two heavy chain variable regions (HCVRs) and two light chain variable regions wherein the amino acid sequence of each HCVR is given by SEQ ID NO: 7 and the amino acid sequence of each LCVR is given by SEQ ID NO: 8.

In another particular embodiment, the present invention provides an antibody, or an antigen-binding fragment thereof, comprising a heavy chain (HC) and a light chain (LC), wherein the amino acid sequence of the HC is given by SEQ ID NO: 9 and the amino acid sequence of the LC is given by SEQ ID NO: 10. In an even more particular embodiment, the present invention provides an antibody comprising two heavy chains (HCs) and two light chains (LCs) wherein the amino acid sequence of each HC is given by SEQ ID NO: 9 and the amino acid sequence of each LC is given by SEQ ID NO: 10. In a most particular embodiment, the present invention provides an antibody that consists of two HCs and two LCs, wherein the amino acid sequence of each HC is given by SEQ ID NO: 9 and the amino acid sequence of each LC is given by SEQ ID NO: 10.

The present invention further provides pharmaceutical compositions comprising an antibody or antigen-binding fragment of the present invention and one or more pharmaceutically acceptable carriers, diluents or excipients. More particularly, the pharmaceutical compositions of the present invention further comprise one or more additional therapeutic agents.

In addition, the present invention provides a method of treating hyperlipidemia or hypercholesterolemia comprising administering to a patient in need thereof, an effective amount of an antibody or antigen-binding fragment of the present invention. The present invention also provides the antibody or an antigen binding fragment thereof of the present invention for use in therapy. More particularly, the present invention provides the antibody or an antigen binding fragment thereof of the present invention for use in the treatment of hyperlipidemia or hypercholesterolemia. In addition, the present invention provides the use of the antibody or an antigen binding fragment thereof of the present invention in the manufacture of a medicament for the treatment of hyperlipidemia or hypercholesterolemia.

The present invention also relates to nucleic acid molecules and expression vectors encoding the antibody or antigen-binding fragment of the present invention. Further, the present invention provides an antibody prepared according to a process, wherein said process comprises (a) cultivating a host cell comprising a first polynucleotide sequence encoding the polypeptide sequence given by SEQ ID NO: 9 and a second polynucleotide sequence encoding a second polypeptide sequence given by SEQ ID NO:10, under conditions such that said polypeptide sequences are expressed; and (b) recovering from said host cell an antibody comprising a heavy chain and a light chain, wherein the polypeptide sequence of said heavy chain is given by SEQ ID NO:9 and the polypeptide sequence of said light chain is given by SEQ ID NO:10. More particularly, the antibody produced by the afore-mentioned process comprises two heavy chains and two light chains, wherein the polypeptide sequence of each heavy chain is given by SEQ ID NO:9 and the polypeptide sequence of each light chain is given by SEQ ID NO:10.

A full-length antibody is an immunoglobulin molecule comprising 2 heavy (H) chains and 2 light (L) chains interconnected by disulfide bonds. The amino terminal portion of each chain includes a variable region of about 100-110 amino acids primarily responsible for antigen recognition via the complementarity determining regions (CDRs)

contained therein. The carboxy-terminal portion of each chain defines a constant region primarily responsible for effector function. Light chains are classified as kappa or lambda, which are each characterized by a particular constant region as known in the art. Heavy chains are classified as gamma, mu, alpha, delta, or epsilon, and define the isotype of an antibody as IgG, IgM, IgA, IgD, or IgE, respectively. IgG antibodies can be further divided into subclasses, e.g., IgG1, IgG2, IgG3, IgG4. Each heavy chain type is also characterized by a particular constant region with a sequence well known in the art. "Antigen-binding fragment", as used herein, refers to Fab fragments, Fab' fragments, $F(ab')_2$ fragments, and single chain Fv fragments that bind to human PCSK9. The term "bind (or 'binds') to human PCSK9", as used herein, refers to interaction with an epitope on human PCSK9 given by the amino acid sequence of SEQ ID NO: 14. The term "epitope" as used herein refers to discrete, three-dimensional sites on an antigen that are recognized by the antibodies or antigen-binding fragments of the invention.

The CDRs are interspersed with regions that are more conserved, termed framework regions ("FR"). Each light chain variable region (LCVR) and heavy chain variable region (HCVR) is composed of 3 CDRs and 4 FRs, arranged from amino-terminus to carboxy-terminus in the following order: FR1, CDR1, FR2, CDR2, FR3, CDR3, FR4. The 3 CDRs of the light chain are referred to as "LCDR1, LCDR2, and LCDR3" and the 3 CDRs of the heavy chain are referred to as "HCDR1, HCDR2, and HCDR3." The CDRs contain most of the residues which form specific interactions with the antigen. The numbering and positioning of CDR amino acid residues within the LCVR and HCVR regions of the antibodies or antigen-binding fragments of the present invention may be determined in accordance with the well-known Kabat numbering convention (LCDR 1-3, HCDR2-3), or in accordance with Kabat plus Chothia (HCDR1).

Methods for producing and purifying antibodies and antigen-binding fragments are well known in the art and can be found, for example, in Harlow and Lane (1988) *Antibodies, A Laboratory Manual*, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York, chapters 5-8 and 15. For example, mice can be immunized with human PCSK9, or fragments thereof, and the resulting antibodies can then be recovered, purified, and the amino acid sequences determined using conventional methods well known in the art. Antigen-binding fragments can also be prepared by conventional methods. The antibody or antigen binding fragments of the present invention are

engineered to contain one or more human framework regions surrounding CDRs derived from a non-human antibody. Human framework germline sequences can be obtained from ImMunoGeneTics (IMGT) via their website http://imgt.cines.fr, or from *The Immunoglobulin Facts Book* by Marie-Paule Lefranc and Gerard Lefranc, Academic Press, 2001, ISBN 012441351. Particular, germline light chain frameworks for use in the antibody or antigen binding fragments of the present invention include A3 and O2. Particular germline heavy chain framework regions for use in the antibody or antigen binding fragments of the present invention include VH3-21 and VH3-23.

The engineered antibodies or antigen binding fragments of the present invention may be prepared and purified using known methods. For example, cDNA sequences encoding a heavy chain (for example, the amino acid sequence given by SEQ ID NO: 9) and a light chain (for example, the amino acid sequence given by SEQ ID NO: 10) may be cloned and engineered into a GS (glutamine synthetase) expression vector. The engineered immunoglobulin expression vector may then be stably transfected in CHO cells. As one of skill in the art will appreciate, mammalian expression of antibodies will result in glycosylation, typically at highly conserved N-glycosylation sites in the Fc region. Stable clones may be verified for expression of an antibody specifically binding to human PCSK9. Positive clones may be expanded into serum-free culture medium for antibody production in bioreactors. Media, into which an antibody has been secreted, may be purified by conventional techniques. For example, the medium may be conveniently applied to a Protein A or G Sepharose FF column that has been equilibrated with a compatible buffer, such as phosphate buffered saline. The column is washed to remove nonspecific binding components. The bound antibody is eluted, for example, by pH gradient and antibody fractions are detected, such as by SDS-PAGE, and then pooled. The antibody may be concentrated and/or sterile filtered using common techniques. Soluble aggregate and multimers may be effectively removed by common techniques, including size exclusion, hydrophobic interaction, ion exchange, or hydroxyapatite chromatography. The product may be immediately frozen, for example at -70°C, or may be lyophilized.

The antibodies of the present invention are monoclonal antibodies. "Monoclonal antibody" or "mAb", as used herein, refers to an antibody that is derived from a single copy or clone including, for example, any eukaryotic, prokaryotic, or phage clone, and

not the method by which it is produced. Monoclonal antibodies and antigen-binding fragments thereof can be produced, for example, by hybridoma technologies, recombinant technologies, phage display technologies, synthetic technologies, e.g., CDR-grafting, or combinations of such or other technologies known in the art.

In another embodiment of the present invention, the antibody or antigen-binding fragment thereof, or the nucleic acid encoding the same, is provided in isolated form. As used herein, the term "isolated" refers to a protein, peptide or nucleic acid which is free or substantially free from other macromolecular species found in a cellular environment. "Substantially free", as used herein, means the protein, peptide or nucleic acid of interest comprises more than 80% (on a molar basis) of the macromolecular species present, preferably more than 90% and more preferably more than 95%.

The antibodies or antigen-binding fragments of the present invention can be used in the treatment of patients. The term "treating" (or "treat" or "treatment") refers to slowing, interrupting, arresting, alleviating, stopping, reducing, or reversing the progression or severity of an existing symptom, disorder, condition, or disease. "Patient", as used herein, refers to a human or non-human mammal, but preferably refers to a human. As used herein the term "effective amount" refers to the amount or dose of an antibody or antigen-binding fragment of the present invention which, upon single or multiple dose administration to the patient, provides the desired effect in the patient under treatment. An effective amount can be readily determined by the attending diagnostician, as one skilled in the art, by considering a number of factors such as the species of mammal; its size, age, and general health; the specific disease involved; the degree or severity of the disease; the response of the individual patient; the particular antibody administered; the mode of administration; the bioavailability characteristics of the preparation administered; the dose regimen selected; and the use of any concomitant medications.

The antibodies or antigen-binding fragments of the present invention, or pharmaceutical compositions comprising the same, may be administered by parenteral routes (e.g., subcutaneous, intravenous, intraperitoneal, intramuscular, or transdermal). Pharmaceutical compositions of the present invention can be prepared by methods well known in the art (e.g., *Remington: The Science and Practice of Pharmacy*, 19th ed. (1995), A. Gennaro et al., Mack Publishing Co.) and comprise an antibody, or antigen-

binding fragment thereof as disclosed herein, and one or more pharmaceutically acceptable carriers, diluents, or excipients. For example, an antibody or antigen-binding fragment of the present invention can be formulated with agents such as sodium citrate, citric acid, polysorbate 80, and sucrose and the resulting composition may then be lyophilized and stored at 2°C - 8°C. The lyophilized composition may then be reconstituted with sterile water for injection prior to administration.

The following Examples further illustrate the invention, however, it is understood that the Examples are set forth by way of illustration and not limitation, and that various modifications may be made by one of ordinary skill in the art.

Example 1

Engineered PCSK9 Antibody

A murine host is immunized with a peptide comprising a C-terminal truncated fragment of human PCSK9 (SEQ ID NO: 17) and a PCSK9 binding IgG antibody is isolated and cloned using standard methods. The CDRs of the isolated murine Fab are randomized by mutagenesis and resulting antibodies screened for affinity to human PCSK9. Affinity enhancing mutations are combined and the optimized CDRs are engineered onto human VH3-21 and A3 heavy and light chain frameworks, respectively. To further optimize the biophysical properties of the humanized antibody, targeted replacements of aromatic and hydrophobic amino acids within the CDR sequences are made. Randomized CDR libraries are also screened for additional affinity enhancing mutations. Beneficial CDR mutations are randomly combined and expressed, and resulting antibodies screened for affinity to human PCSK9. A full length humanized and optimized PCSK9 antibody having the following amino acid sequences is obtained:

mAb Fragment	Amino acid sequence
HCDR1	SEQ ID NO: 1
HCDR2	SEQ ID NO: 2
HCDR3	SEQ ID NO: 3
HCVR	SEQ ID NO: 7

HC	SEQ ID NO: 9
LCDR1	SEQ ID NO: 4
LCDR2	SEQ ID NO: 5
LCDR3	SEQ ID NO: 6
LCVR	SEQ ID NO: 8
LC	SEQ ID NO: 10

The corresponding cDNA sequences encoding the heavy and light chain amino acid sequences of SEQ ID NO: 9 and SEQ ID NO: 10, respectively, are as follows:

mAb Fragment	cDNA sequence encoding
HC	SEQ ID NO: 11
LC	SEQ ID NO: 12

Example 2

Expression of Engineered PCSK9 Antibody

The engineered PCSK9 antibody of Example 1 may be expressed in a stably transfected CHO cell line. A glutamine synthetase (GS) expression vector containing the cDNA of SEQ ID NO: 11 (encoding the heavy chain amino acid sequence of SEQ ID NO: 9) and SEQ ID NO: 12 (encoding the light chain amino acid sequence of SEQ ID NO: 10) is used to transfect the Chinese hamster cell line, CHOK1SV (Lonza Biologics PLC, Slough, United Kingdom) by electroporation. The expression vector encodes an SV Early (Simian Virus 40E) promoter and the gene for GS. Expression of GS allows for the biochemical synthesis of glutamine, an amino acid required by the CHOK1SV cells. Post-transfection, cells undergo bulk selection with 50μM L-methionine sulfoximine (MSX). The inhibition of GS by MSX is utilized to increase the stringency of selection. Cells with integration of the expression vector cDNA into transcriptionally active regions of the host cell genome can be selected against CHOK1SV wild type cells, which express an endogenous level of GS. Bulk culture is subjected to single-cell cloning using

Fluorescence-Activated Cell Sorting (FACS) technology and the clonal cell lines are expanded and screened for expression of the engineered PCSK9 antibody of Example 1.

Example 3

Epitope Binding

The PCSK9 binding epitope of the murine IgG (from which the engineered PCSK9 antibody of Example 1 was derived) is determined by epitope extraction and hydrogen/deuterium exchange mass spectrometry and narrowed to a region within the linear amino acid sequence 160-181 of the catalytic domain of human PCSK9 (amino acid numbering based on full length human PCSK9 sequence, including the twenty-eight amino acid signal peptide.) The interaction of the engineered antibody of Example 1 with this epitope in the catalytic domain of human PCSK9 is confirmed by an evaluation of its binding to synthetic peptides corresponding to residues 160-181 (Table 1). The engineered antibody of Example 1 binds peptide 160-181 with higher affinity than intact human PCSK9, the difference being driven by a faster association rate (k_{on}). The dissociation rate (k_{off}) is within 2-fold of intact PCSK9, suggesting that the strength of the interactions (after binding has occurred) are similar. Furthermore, the data suggests that nearly all the binding determinants are contained within this linear region of PCSK9. Binding of the engineered antibody of Example 1 to peptide 166-181 is significantly weaker than peptide 160-181, demonstrating the role of an amino acid (or multiple amino acids) within the 160-165 region. Binding of the engineered antibody of Example 1 to peptide 163-174 was significantly stronger than 166-181, suggesting contribution from residues 163-165 as well.

Table 1: Binding kinetics and affinity of the antibody of Example 1 for peptides corresponding to sequences of the catalytic domain of human PCSK9

PCSK9 Fragment	Sequence	k_{on} (1/Ms)	k_{off} (1/s)	K_D (nM)
mature hPCSK9 C-term His*	(SEQ ID NO: 13)	8.67E +04	1.50E -04	1.8
hPCSK9 160-181**	RITPPRYRADEYQPPDGGSLVE (SEQ ID NO: 14)	1.45E +06	2.42E -04	0.17

hPCSK9 166-181**	YRADEYQPPDGGSLVE (SEQ ID NO: 15)	4.58E +06	1.56E -01	34
hPCSK9 163-174**	PPRYRADEYQPP (SEQ ID NO: 16)	2.75E +06	8.31E -03	3.0

* The hPCSK9 used is the mature form which lacks the twenty-eight amino acid signal peptide and which contains a C-terminal His tag.

** Amino acid numbering assigned in reference to complete human PCSK9, including the twenty-eight amino acid signal peptide

Example 4

Binding Kinetics and Affinity

A surface plasmon resonance (SPR) assay as well known in the art is used to assess the binding kinetics and affinity of a test PCSK9 antibody to human, cynomolgus monkey, mouse, rat, and rabbit PCSK9. Under physiological buffer conditions (ionic strength and pH) and temperature (37 °C), the engineered antibody of Example 1 binds to human PCSK9 with an average association rate (k_{on}) of 1.2 x 10^5 $M^{-1}s^{-1}$ and an average dissociation rate (k_{off}) of 1.2 x 10^{-3} s^{-1}. The average K_D for human PCSK9 binding for the engineered antibody of Example 1 was determined to be about 11 nM. The engineered antibody of Example 1 binds to cynomolgus PCSK9 with an average association rate (k_{on}) of 1.1 x 10^5 $M^{-1}s^{-1}$ and an average dissociation rate (k_{off}) of 2.5 x 10^{-3} s^{-1}, resulting in a K_D for cynomolgous PCSK9 binding of about 25 nM. Table 2 below shows a summary of additional results obtained with the engineered PCSK9 antibody of Example 1 using mouse, rat and rabbit PCSK9. These data indicate that the engineered PCSK9 antibody of Example 1 binds with nanomolar affinity to both human and cynomolgus PCSK9 under physiological conditions of pH, ionic strength, and temperature.

Table 2: Binding Kinetics and Affinity of the PCSK9 antibody of Example 1 to Human, Cynomolgus Monkey, Mouse, Rat and Rabbit PCSK9

Antigen	K_{on}	K_{off}	K_D	*n*
	Avg ± SD	*Avg ± SD*	*Avg ± SD*	
	$M^{-1}s^{-1}$ (10^5)	s^{-1} (10^{-3})	*nM*	

Human PCSK9*	1.2 ± 0.46	1.2 ± 0.18	11 ± 2.9	6
Cyno PCSK9*	1.1 ± 0.51	2.5 ± 0.79	25 ± 6.8	4
Mouse PCSK9**	NB	NB	NB	3
Rat PCSK9**	NB	NB	NB	2
Rabbit PCSK9**	NB	NB	NB	3

"NB" No binding detected; * Assay performed at 37 °C; ** Assay performed at 25 °C

Example 5

Inhibition of PCSK9 Binding to LDL Receptor

PCSK9 regulates plasma LDL-C by reducing LDLR content of the liver and thereby reducing LDL uptake by hepatocytes. The catalytic domain of PCSK9 is the site which binds to the LDLR. Thus, antibodies which recognize the catalytic domain of PCSK9 are expected to inhibit the binding of PCSK9 to the LDLR.

An AlphaLISA® format is used to determine the effect of a test PCSK9 antibody on PCSK9 binding to the LDL receptor. Recombinant full length PCSK9 used in the assay is expressed as a C-terminal HIS-tagged protein in a human embryonic kidney (HEK) 293 stable cell line (Qian et al., J. Lipid Res. 48: 1488–1498, 2007). Recombinant LDL receptor extracellular domain is expressed as a C-terminal FLAG-tagged protein in transiently transfected HEK 293E cells (Qian et al., J. Lipid Res. 48: 1488–1498, 2007). A murine anti-PCSK9 Mab which binds to the C-terminal domain of human PCSK9 is expressed in HEK293 cells and purified over Protein-G affinity column followed by Superdex 200. Monoclonal ANTI-FLAG® BioM2 antibody (Sigma) is a purified mouse IgG1 monoclonal antibody that is covalently attached to biotin by hydrazide linkage. ANTI-FLAG BioM2 will recognize the FLAG sequence at the N-terminus, Met-N-terminus or C-terminus of FLAG fusion proteins. ANTI-FLAG BioM2 can be detected by avidin or streptadivin conjugates. Monoclonal ANTI-FLAG BioM2-Biotin is supplied in 50% glycerol, 10 mM sodium phosphate, pH 7.25, 150 mM NaCl containing 0.02% sodium azide, and stored at -20°C.

AlphaLISA® experiments are conducted in 384-well white proxiplates (Perkin Elmer) using 25mM HEPES; pH 7.5, 100mM NaCl, 2.5mM CaCl2, 0.5% TX-100, 0.1% Casein, 1mg/ml Dextran-500, and 0.05% Proclin-300 as buffer. The assay uses AlphaLISA® Streptavidin Donor Beads (Perkin Elmer) and the murine anti-PCSK9 Mab conjugated to AlphaLISA® Acceptor beads. When the beads are brought into close proximity via interaction of the binding partners, PCSK9 and LDLR, singlet oxygen is transferred from the donor bead to the acceptor bead. Upon laser excitation at 680nm, the singlet oxygen excites the acceptor bead to emit light. The acceptor beads are linked to the murine anti-PCSK9 Mab by reductive amination using $NaBH_3CN$ (Sigma) and stored at 4°C. The murine anti-PCSK9 Mab-conjugated acceptor beads (22µg/ml) are preloaded with 2.22 nM PCSK9 for one hr. The donor beads (44µg/ml) are preloaded with 5.55 nM ANTI-FLAG® BioM2 and 2.22 nM of FLAG-tagged LDLR for one hr. After preloading, 2µl of the test PCSK9 antibody or control IgG are added to a proxiplate containing 9µl of each bead mixture (final concentration of PCSK9 and LDLR = 1nM) using a fully automated Multimek (Beckman), and allowed to bind overnight at room temperature. The AlphaLISA® signal (counts per second) are measured on the Envision Turbo (Perkin Elmer). All experiments with the AlphaLISA® assay are conducted under low light conditions.

Following procedures substantially as described above, the binding of human PCSK9 to the LDLR in the AlphaLISA® assay increased as a function of PCSK9 concentration. The addition of the engineered PCSK9 antibody of Example 1 (test PCSK9 antibody) caused a concentration-related and complete inhibition of PCSK9 binding to LDLR, with an average IC50 of about 90 pM. The control IgG4 had no effect in the assay. The results of this assay demonstrate that the engineered PCSK9 antibody of Example 1 inhibits binding of human PCSK9 to the LDLR.

Example 6

Inhibition of PCSK9 Function on HepG2 Cells

To determine the effect of a test PCSK9 antibody on the density of LDLR on hepatocytes, human HepG2 cells are cultured in poly-D-lysine coated T75 flasks. After 24 hours, cells are seeded at 5,000 cells per well in 100 ul of DMEM / F-12 (3:1) medium

containing 5% (v/v) human lipoprotein depleted serum (LPDS; Intracel) in poly-D-lysine coated 96 well black plates (Becton-Dickinson). After overnight incubation in LPDS-containing medium, cells are incubated with 69 nM (5ug/mL) C-terminal HIS-tagged recombinant human PCSK9 and a test PCSK9 antibody or an IgG4 control antibody at concentrations ranging from 2.6 to 1333 nM for 2 hours. All incubations are carried out at 37°C. LDLR levels are monitored with an LDLR antibody (Progen) fluorescently labeled with Zenon® Alexa Fluor® 488 Mouse IgG2b Labeling Kit (Invitrogen). The cells are incubated with the detection antibody for 90 min at room temperature and then fixed for 10 min using a formalin-free fixative (Prefer; ANATECH, Ltd) with subsequent permeablization in 0.01% Triton X-100. The cells are stained with 10 ug/ml of propidium iodide (Invitrogen) to determine total cell number. The LDLR signal is quantitated using an Acumen Explorer™ laser-scanning fluorescence microplate cytometer fluorescence detector (TTP LabTech).

Following procedures substantially as described above, human PCSK9 causes a concentration-dependent reduction of LDLR on HepG2 cells, with an EC50 of 18 nM. The engineered PCSK9 antibody of Example 1 (test PCSK9 antibody) inhibited PCSK9-induced suppression of LDLR on HepG2 cells with an IC50 of 104 nM. The human IgG4 control was relatively inactive at concentrations up to 1333 nM. These data demonstrate that the engineered PCSK9 antibody of Example 1 inhibits PCSK9-mediated LDLR degradation.

Example 7

Inhibition of PCSK9-induced Reduction of LDL Uptake

To determine the effect of a test PCSK9 antibody on LDL uptake, HepG2 cells are seeded at 5,000 cells per well in 100 ul of DMEM / F-12 (3:1) medium supplemented with 5% human LPDS on poly-D-lysine coated 96-well black plates and incubated at 37°C in an atmosphere of 5% CO_2 for 18 hours. Human PCSK9 (69 nM) is added to the cells with or without a PCSK9 test antibody or a human IgG4 control at concentrations ranging from 2.6 nM to 1333 nM and pre-incubated with cells for 2 hr at 37°C. Following the addition of 100 ng/well of fluorescently-labeled LDL (BODIPY-LDL, Invitrogen), the cells are then incubated for 4 hr at 37°C. Cells are fixed in a formalin-free fixative (Prefer; ANATECH, Ltd.) for 20 min at room temperature. After washing

cells twice with PBS, cells are permeablized with PBS buffer containing 0.01% Triton X-100 for 15 min at room temperature and stained with 10 ug/mL of propidium iodide to determine total cell number. LDL uptake is determined using an Acumen Explorer™ laser-scanning fluorescence microplate cytometer and expressed as a percentage of fluorescent cells relative to total cells. The response to test PCSK9 antibody or control IgG is expressed as percentage inhibition of PCSK9, i.e., the percent return to maximum LDL uptake in the absence of PCSK9 relative to baseline LDL-C uptake in the presence of PCSK9 alone. Corresponding IC50 values for inhibition of PCSK9-induced reduction of LDL uptake are also calculated.

Following procedures substantially as described above, human PCSK9 caused a concentration-related reduction of LDL uptake in HepG2 cells with an EC50 of 32 nM. The engineered PCSK9 antibody of Example 1 reversed the PCSK9-induced inhibition, reflected as increased LDL uptake, whereas the control IgG did not reverse the inhibition. Specifically, the engineered PCSK9 antibody of Example 1 demonstrated a mean maximum percent inhibition of PCSK9 of 84% and an average IC50 of 194 nM. These data demonstrate that the engineered PCSK9 antibody of Example 1 inhibits PCSK9-induced reduction of LDL uptake.

Example 8

In vivo Efficacy

To determine the *in vivo* pharmacokinetic (PK) and/or pharmacodynamic (PD) effects of a test PCSK9 antibody, the test antibody may be administered to normal cynomolgus monkeys and various PK and/or PD parameters subsequently determined. For example, a test PCSK9 antibody may be administered intravenously or subcutaneously to healthy, naive cynomolgus monkeys and serum concentrations of the test antibody may then be measured by use of a human IgG sandwich ELISA. Serum concentrations taken over various timepoints after antibody administration may be used to determine various PK parameters of the test antibody, including T1/2, Cmax, AUC and plasma clearance (CL). Similarly, a test PCSK9 antibody may be administered intravenously or subcutaneously to healthy, naive cynomolgus monkeys and serum concentrations of LDL-C may be measured by autoanalyzer (Direct LDL-C Plus, 2nd Gen., Roche Diagnostics).

Following procedures substantially as described above, the pharmacokinetics of the engineered PCSK9 antibody of Example 1 was evaluated in healthy cynomolgus monkeys following single dose intravenous administrations of 1, 5 or 15 mg/kg, and after a single subcutaneous dose of 5 mg/kg. Pharmacokinetic parameters determined from these studies are provided in Table 3, below.

Table 3. Pharmacokinetic parameters for the engineered PCSK9 antibody of Example 1 in cynomolgus monkeys.

Intravenous (n = 4 / group)				
Dose (mg/kg)	$T_{1/2}$ (d)	C_{max} (µg/mL)	AUC_{total} (hr*µg/mL)	CL (mL/hr/kg)
1	5.4 ± 1.0	19.8 ± 1.1	2218 ± 222	0.45 ± 0.04
5	7.3 ± 1.3	107.3 ± 3.2	14378 ± 1374	0.35 ± 0.04
15	8.4 ± 3.0	260.3 ± 45.0	57290 ± 16535	0.28 ± 0.07

Subcutaneous (n = 3 / group)						
Dose (mg/kg)	T_{max} (days)	C_{max} (µg/mL)	$T_{1/2}$ (d)	AUC_{total} (hr*µg/mL)	CL/F (mL/hr/kg)	%F
5	2.7 ± 0.6	32.4 ± 1.9	5.4 ± 0.7	11575 ± 1345	0.44 ± 0.05	81

Serum LDL was measured following administration of the engineered PCSK9 antibody of Example 1 in two independent studies. In both studies, evidence of LDL-C suppression was apparent by 24 hours post-administration with the engineered PCSK9 antibody of Example 1. After intravenous (i.v.) administration of the antibody of Example 1 at 5 mg/kg, a maximal mean LDL-C decrease of 60% (Study 1) and 25% (Study 2) was observed. At 5 mg/kg i.v., mean LDL-C suppression was maintained for approximately 8-weeks (Study 1) and 2-weeks (Study 2). In Study 2, there was a modest effect of dose (1 to 15 mg/kg) on the magnitude of LDL-C suppression (25 to 35%). The effect of dose on duration of LDL-C suppression was more evident. When administered

subcutaneously (5 mg/kg), the engineered antibody of Example 1 was effective in suppressing LDL-C levels to a magnitude similar to that observed after intravenous dosing. There was no effect on serum high density lipoprotein cholesterol following administration of any dose of the engineered antibody of Example 1.

Example 9

Physical-Chemical Properties of Engineered PCSK9 Antibody

The engineered PCSK9 antibody of Example 1 was also found to have good solubility, chemical stability, and physical stability.

A. Solubility

Sufficiently high solubility is desired to enable convenient dosing. For example, a 1 mg/kg dose administered by a 1.0 mL injection into a 100 kg patient will require solubility of 100 mg/mL. In addition, maintaining the antibody in a monomeric state without high molecular weight (HMW) aggregation at high concentration is also desirable. To determine solubility of a test antibody, the antibody may be dialyzed into (1) 10mM citrate pH6; (2) 10 mM citrate pH6, 150 mM NaCl; and (3) phosphate buffered saline (PBS) pH7.4. Recovered dialysate may then be analyzed by analytical size exclusion chromatography (SEC) to measure percent HMW. Test antibody may then be concentrated in a 4 mL centrifugal concentrator at ~25 C until solubility limit is reached or void volume of the concentrator is reached. If void volume is reached, concentration is reported as $\geq$. Concentrated antibody may then be analyzed by SEC to measure percent HMW. To determine if any increase in %HMW upon concentration is reversible, the concentrated sample may be diluted to 1 mg/mL and analyzed by SEC.

Following procedures substantially as described above, the engineered PCSK9 antibody of Example 1 displayed a solubility of greater than 128 mg/mL under all conditions tested. In addition, only low levels of HMW were present at high concentration.

Table 4: Percent HMW of Solubility Samples determined by SEC

	% HMW (Dialysate)	% HMW (Concentrate)	% HMW (1 mg/mL dilution)
10 mM Citrate, pH6	0.75 %	1.60 %	0.93 %
10 mM Citrate, 150 mM NaCl, pH6	0.62 %	1.39%	0.90 %
PBS, pH7.4	0.94 %	2.00 %	1.34%

B. Chemical Stability

Chemical stability facilitates the development of drug formulations with sufficient shelf-life. To assess the chemical stability of a test antibody, the antibody may be formulated at a concentration of 1 mg/mL in 10 mM citrate buffered at pH4, pH5, pH6, or pH7. The formulated samples are then incubated for 4 weeks at 4°C, 25°C, and 40°C in an accelerated degradation study. Changes in the charge profile of the antibody, reflecting chemical changes, may be assessed using capillary isoelectric focusing (cIEF) according to standard procedures. Following procedures substantially as described above, an analysis of the chemical stability of the engineered antibody of Example 1 provided the following results.

Table 5: Chemical stability determined by cIEF

	Change in % main peak after 4 weeks (relative to 4°C)	
	(25°C storage)	(40°C storage)
10 mM Citrate, pH5	-0.4	NT
10 mM Citrate, pH6	-4.1	-24.7
10 mM Citrate, pH7	-7.7	NT

The results demonstrate that after 4 weeks storage at 25°C, the % main peak decreases by only 4.1 percentage points when formulated at pH6 (a common pH used in antibody formulation), indicating that the engineered PCSK9 antibody of Example 1 has sufficient chemical stability to facilitate the development of solution formulations with adequate shelf-life. Furthermore, the antibody also displays good chemical stability at pH5 and, to a lesser extent pH7, indicating that the antibody has stability characteristics that may permit formulation over a range of pH units.

C. Physical Stability

To assess the physical stability of a test antibody, the antibody may be formulated at a protein concentration of 1 mg/mL in 10 mM citrate buffered at pH4, pH5, pH6, or pH7 (or 10mM Tris, pH 8). The samples are then incubated for 4 weeks at 4°C, 25°C, and 40°C in an accelerated degradation study. Following the incubations, physical stability is assessed using size exclusion chromatography (SEC), which separates the desired monomeric antibody from aggregated high molecular weight (HMW) antibody.

Table 6 summarizes the results of an analysis of the physical stability of the engineered PCSK9 antibody of Example 1, following procedures substantially as described above. The data shows that at pH5, pH6, and pH7, the change in HMW over 4 weeks at 25°C or 40°C was less than 1% indicating that this antibody has good physical stability and is resistant to self-association and aggregation.

Table 6: Percent HMW of Physical Stability Samples

	% HMW determined by SEC				
	pH4	pH5	pH6	pH7	pH8
Initial Sample	0.26	0.32	0.40	0.50	1.31
25C for 4 weeks	0.37	0.44	0.51	0.66	2.10
40C for 4 weeks	20.34	1.15	1.02	1.32	3.41

Sequences

HCDR1 (SEQ ID NO: 1):
GFPFSKLGMV

HCDR2 (SEQ ID NO: 2):
TISSGGGYTYYPDSVKG

HCDR3 (SEQ ID NO: 3):
EGISFQGGTYTYVMDY

LCDR1 (SEQ ID NO: 4):
RSSKSLLHRNGITYSY

LCDR2 (SEQ ID NO: 5):
QLSNLAS

LCDR3 (SEQ ID NO: 6):
YQNLELPLT

HCVR (SEQ ID NO: 7):
EVQLVESGGGLVKPGGSLRLSCAASGFPFSKLGMVWVRQAPGKGLEWVSTISSG
GGYTYYPDSVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYCAREGISFQGGTY
TYVMDYWGQGTLVTVSS

LCVR (SEQ ID NO: 8):
DIVMTQSPLSLPVTPGEPASISCRSSKSLLHRNGITYSYWYLQKPGQSPQLLIYQLS
NLASGVPDRFSGSGSGTDFTLKISRVEAEDVGVYYCYQNLELPLTFGQGTKVEIK

HC (SEQ ID NO: 9):
EVQLVESGGGLVKPGGSLRLSCAASGFPFSKLGMVWVRQAPGKGLEWVSTISSG
GGYTYYPDSVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYCAREGISFQGGTY

TYVMDYWGQGTLVTVSSASTKGPSVFPLAPCSRSTSESTAALGCLVKDYFPEPVT
VSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTKTYTCNVDHKPSNTK
VDKRVESKYGPPCPPCPAPEAAGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSQE
DPEVQFNWYVDGVEVHNAKTKPREEQFNSTYRVVSVLTVLHQDWLNGKEYKC
KVSNKGLPSSIEKTISKAKGQPREPQVYTLPPSQEEMTKNQVSLTCLVKGFYPSDI
AVEWESNGQPENNYKTTPPVLDSDGSFFLYSRLTVDKSRWQEGNVFSCSVMHEA
LHNHYTQKSLSLSLG

LC (SEQ ID NO: 10):

DIVMTQSPLSLPVTPGEPASISCRSSKSLLHRNGITYSYWYLQKPGQSPQLLIYQLS
NLASGVPDRFSGSGSGTDFTLKISRVEAEDVGVYYCYQNLELPLTFGQGTKVEIK
RTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQES
VTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC

HC cDNA (SEQ ID NO: 11):

GAGGTGCAGCTGGTGGAGTCTGGGGGAGGCTTGGTAAAGCCTGGGGGGTCCC
TGAGACTCTCCTGTGCAGCCTCTGGATTCCCGTTCAGTAAGCTCGGCATGGTT
TGGGTCCGCCAGGCTCCAGGGAAGGGGCTGGAGTGGGTCTCAACCATTAGTA
GTGGTGGTGGTTACACATACTATCCAGACAGTGTGAAGGGGCGGTTCACCAT
CTCCAGAGACAATGCCAAGAACTCACTGTATCTGCAAATGAACAGCCTGAGA
GCCGAGGACACGGCCGTATATTACTGTGCGAGAGAAGGAATTAGCTTTCAGG
GTGGCACCTACACTTATGTTATGGACTACTGGGGCCAGGGCACCCTGGTCACC
GTCTCCTCAGCCTCCACCAAGGGCCCATCGGTCTTCCCGCTAGCGCCCTGCTC
CAGGAGCACCTCCGAGAGCACAGCCGCCCTGGGCTGCCTGGTCAAGGACTAC
TTCCCCGAACCGGTGACGGTGTCGTGGAACTCAGGCGCCCTGACCAGCGGCG
TGCACACCTTCCCGGCTGTCCTACAGTCCTCAGGACTCTACTCCCTCAGCAGC
GTGGTGACCGTGCCCTCCAGCAGCTTGGGCACGAAGACCTACACCTGCAACG
TAGATCACAAGCCCAGCAACACCAAGGTGGACAAGAGAGTTGAGTCCAAATA
TGGTCCCCCATGCCCACCCTGCCCAGCACCTGAGGCCGCCGGGGGACCATCA
GTCTTCCTGTTCCCCCCAAAACCCAAGGACACTCTCATGATCTCCCGGACCCC
TGAGGTCACGTGCGTGGTGGTGGACGTGAGCCAGGAAGACCCCGAGGTCCAG
TTCAACTGGTACGTGGATGGCGTGGAGGTGCATAATGCCAAGACAAAGCCGC

GGGAGGAGCAGTTCAACAGCACGTACCGTGTGGTCAGCGTCCTCACCGTCCT
GCACCAGGACTGGCTGAACGGCAAGGAGTACAAGTGCAAGGTCTCCAACAA
AGGCCTCCCGTCCTCCATCGAGAAAACCATCTCCAAAGCCAAAGGGCAGCCC
CGAGAGCCACAGGTGTACACCCTGCCCCCATCCCAGGAGGAGATGACCAAGA
ACCAGGTCAGCCTGACCTGCCTGGTCAAAGGCTTCTACCCCAGCGACATCGCC
GTGGAGTGGGAAAGCAATGGGCAGCCGGAGAACAACTACAAGACCACGCCT
CCCGTGCTGGACTCCGACGGCTCCTTCTTCCTCTACAGCAGGCTAACCGTGGA
CAAGAGCAGGTGGCAGGAGGGGAATGTCTTCTCATGCTCCGTGATGCATGAG
GCTCTGCACAACCACTACACACAGAAGAGCCTCTCCCTGTCTCTGGGTTGA

LC cDNA (SEQ ID NO: 12)

GATATTGTGATGACTCAGTCTCCACTCTCCCTGCCCGTCACCCCTGGAGAGCC
GGCCTCCATCTCCTGCAGGTCTAGTAAGAGTCTCTTACATCGTAATGGCATCA
CTTATTCGTATTGGTACCTGCAGAAGCCAGGGCAGTCTCCACAGCTCCTGATC
TATCAGCTGTCCAACCTTGCCTCAGGAGTCCCAGACAGGTTCAGTGGCAGTGG
GTCAGGCACTGATTTCACACTGAAAATCAGCAGGGTGGAGGCTGAGGATGTT
GGAGTTTATTACTGCTATCAAAATCTAGAACTTCCGCTCACGTTCGGCCAGGG
CACCAAGGTGGAAATCAAACGGACTGTGGCTGCACCATCTGTCTTCATCTTCC
CGCCATCTGATGAGCAGTTGAAATCTGGAACTGCCTCTGTTGTGTGCCTGCTG
AATAACTTCTATCCCAGAGAGGCCAAAGTACAGTGGAAGGTGGATAACGCCC
TCCAATCGGGTAACTCCCAGGAGAGTGTCACAGAGCAGGACAGCAAGGACA
GCACCTACAGCCTCAGCAGCACCCTGACGCTGAGCAAAGCAGACTACGAGAA
ACACAAAGTCTACGCCTGCGAAGTCACCCATCAGGGCCTGAGCTCGCCCGTC
ACAAAGAGCTTCAACAGGGGAGAGTGCTAA

hPCSK9 (SEQ ID NO: 13):

RAQEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDPWRLPGTYVVVL
KEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKL
PHVDYIEEDSSVFAQSIPWNLERITPPRYRADEYQPPDGGSLVEVYLLDTSIQSDH
REIEGRVMVTDFENVPEEDGTRFHRQASKCDSHGTHLAGVVSGRDAGVAKGAS
MRSLRVLNCQGKGTVSGTLIGLEFIRKSQLVQPVGPLVVLLPLAGGYSRVLNAAC
QRLARAGVVLVTAAGNFRDDACLYSPASAPEVITVGATNAQDQPVTLGTLGTNF

GRCVDLFAPGEDIIGASSDCSTCFVSQSGTSQAAAHVAGIAAMMLSAEPELTLAE
LRQRLIHFSAKDVINEAWFPEDQRVLTPNLVAALPPSTHGAGWQLFCRTVWSAH
SGPTRMATAVARCAPDEELLSCSSFSRSGKRRGERMEAQGGKLVCRAHNAFGGE
GVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDL
GTHKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVAC
EEGWTLTGCSALPGTSHVLGAYAVDNTCVVRSRDVSTTGSTSEGAVTAVAICCR
SRHLAQASQELQDVHHHHHH

hPCSK9 160-181 (SEQ ID NO: 14):
RITPPRYRADEYQPPDGGSLVE

hPCSK9 166-181 (SEQ ID NO: 15):
YRADEYQPPDGGSLVE

hPCSK9 163-174 (SEQ ID NO: 16):
PPRYRADEYQPP

C-terminal truncated hPCSK9 (SEQ ID NO: 17):
QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDPWRLPGTYVVVLKE
ETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH
VDYIEEDSSVFAQSIPWNLERITPPRYRADEYQPPDGGSLVEVYLLDTSIQSDHREI
EGRVMVTDFENVPEEDGTRFHRQASKCDSHGTHLAGVVSGRDAGVAKGASMRS
LRVLNCQGKGTVSGTLIGLEFIRKSQLVQPVGPLVVLLPLAGGYSRVLNAACQRL
ARAGVVLVTAAGNFRDDACLYSPASAPEVITVGATNAQDQPVTLGTLGTNFGRC
VDLFAPGEDIIGASSDCSTCFVSQSGTSQAAAHVAGIAAMMLSAEPEL

We claim:

1. An antibody, or antigen-binding fragment thereof, comprising a heavy chain variable region (HCVR) and a light chain variable region (LCVR), wherein the HCVR comprises the complementarity determining regions (CDRs) HCDR1, HCDR2 and HCDR3 and the LCVR comprises the CDRs LCDR1, LCDR2 and LCDR3, wherein the amino acid sequence of HCDR1 is given by SEQ ID NO: 1, the amino acid sequence of HCDR2 is given by SEQ ID NO: 2, the amino acid sequence of HCDR3 is given by SEQ ID NO: 3, the amino acid sequence of LCDR1 is given by SEQ ID NO: 4, the amino acid sequence of LCDR2 is given by SEQ ID NO: 5, and the amino acid sequence of LCDR3 is given by SEQ ID NO: 6, wherein said antibody, or antigen binding fragment thereof, binds to human PCSK9.
2. The antibody or antigen-binding fragment of claim 1, comprising a heavy chain variable region (HCVR) and a light chain variable region (LCVR), wherein the amino acid sequence of the HCVR is given by SEQ ID NO: 7 and the amino acid sequence of the LCVR is given by SEQ ID NO: 8.
3. The antibody or antigen-binding fragment of claim 2, comprising two HCVRs and two LCVRs wherein the amino acid sequence of each HCVR is given by SEQ ID NO: 7, and the amino acid sequence of each LCVR is given by SEQ ID NO: 8.
4. The antibody or antigen-binding fragment of claim 1, comprising a heavy chain (HC) and a light chain (LC), wherein the amino acid sequence of the HC is given by SEQ ID NO: 9, and the amino acid sequence of the LC is given by SEQ ID NO: 10.
5. The antibody or antigen-binding fragment of claim 4, comprising two heavy chains (HCs) and two light chains (LCs) wherein the amino acid sequence of each HC is given by SEQ ID NO: 9, and the amino acid sequence of each LC is given by SEQ ID NO: 10.
6. An antibody comprising two heavy chains (HCs) and two light chains (LCs) wherein the amino acid sequence of each HC is given by SEQ ID NO: 9, and the amino acid sequence of each LC is given by SEQ ID NO: 10.

7. An antibody consisting of two heavy chains and two light chains, wherein the amino acid sequence of each heavy chain is given by SEQ ID NO:9, and the amino acid sequence of each light chain is given by SEQ ID NO:10.
8. A pharmaceutical composition comprising an antibody or antigen-binding fragment of claim 1 and one or more pharmaceutically acceptable carriers, diluents or excipients.
9. Use of an effective amount of an antibody or antigen-binding fragment of claim 1 or 6 in the manufacture of a medicament for treating hyperlipidemia or hypercholesterolemia.
10. An antibody or antigen-binding fragment of claim 1 or 6 for use in therapy.
11. An antibody or antigen-binding fragment of claim 1 or 6 for use in the treatment of hyperlipidemia or hypercholesterolemia.