



(86) Date de dépôt PCT/PCT Filing Date: 2008/09/11
(87) Date publication PCT/PCT Publication Date: 2009/06/04
(45) Date de délivrance/Issue Date: 2017/05/09
(85) Entrée phase nationale/National Entry: 2010/05/18
(86) N° demande PCT/PCT Application No.: EP 2008/062104
(87) N° publication PCT/PCT Publication No.: 2009/068335
(30) Priorités/Priorities: 2007/11/29 (EP07121874.7);
2008/05/15 (EP08008993.1)

(51) Cl.Int./Int.Cl. *C07K 16/16* (2006.01),
A61K 39/395 (2006.01), *A61P 25/34* (2006.01),
C07K 16/44 (2006.01)

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(54) Titre : ANTICORPS MONOCLONAUX HUMAINS SPECIFIQUES A LA NICOTINE
(54) Title: HUMAN MONOCLONAL NICOTINE SPECIFIC ANTIBODIES

(57) **Abrégé/Abstract:**

The invention relates to recombinantly produced human monoclonal antibodies which are specifically binding nicotine and to nucleic acids encoding the same. The invention further relates to the use of such antibodies in the treatment of nicotine addiction.



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
4 June 2009 (04.06.2009)

PCT

(10) International Publication Number
WO 2009/068335 A1

(51) International Patent Classification:

C07K 16/16 (2006.01) *C07K 16/44* (2006.01)
A61K 39/395 (2006.01) *A61P 25/34* (2006.01)

(21) International Application Number:

PCT/EP2008/062104

(22) International Filing Date:

11 September 2008 (11.09.2008)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

07121874.7 29 November 2007 (29.11.2007) EP
08008993.1 15 May 2008 (15.05.2008) EP

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments
- with sequence listing part of description published separately in electronic form and available upon request from the International Bureau

(54) Title: HUMAN MONOCLONAL NICOTINE SPECIFIC ANTIBODIES

(57) Abstract: The invention relates to recombinantly produced human monoclonal antibodies which are specifically binding nicotine and to nucleic acids encoding the same. The invention further relates to the use of such antibodies in the treatment of nicotine addiction.

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HUMAN MONOCLONAL NICOTINE SPECIFIC ANTIBODIES

FIELD OF THE INVENTION

[0001] The invention relates to recombinantly produced human monoclonal antibodies which are specifically binding to nicotine and which are capable of preventing the passage of nicotine from the blood into the brain. The invention further relates to the use of such antibodies for passive immunization, preferably of humans, and to the use of such antibodies for the treatment of nicotine addiction in humans.

RELATED ART

[0002] Bjercke et al. 1986 (J Immunol Methods, Vol. 90(2) pp. 203-13) disclose stereospecific monoclonal antibodies against (S)-(-)-nicotine. The monoclonal anti-nicotine antibodies of Bjercke et al. 1986 were produced by the hybridoma technology and were, thus, derived from mouse cells. Bjercke et al. 1986 further describe the use of such monoclonal antibodies in the development of ELISA based assays for nicotine.

[0003] Isomura et al. 2001 (J. Org. Chem. Vol. 66 pp. 4115-4121) describe the preparation of haptens for the generation of antibodies specific for naturally occurring (S)-nicotine, (S)- and (R)-nornicotine, and the metabolite (S)-cotinine with high optical purity. The authors report preliminary data for antinicotine antibodies, including monoclonal antibodies. The monoclonal antibodies of Isomura et al. 2001 were obtained from mice and exhibit K_d values for nicotine binding of 1.6×10^{-7} M to 3.4×10^{-7} M.

[0004] Keyler et al. 2005 (Drug Metab Dispos, Vol. 33(7) pp. 1056-61) describe the passive immunization of rats with monoclonal antibodies against nicotine. The authors found, inter alia, a reduced distribution of nicotine to the brain upon passive immunization. Also the monoclonal antibodies of Keyler et al. 2005 were produced by hybridoma technology.

[0005] Pentel et al. 2006 (J Pharmacol Exp Ther, Vol. 317(2) pp. 660-6) studied inter alia the passive immunization of rats with the monoclonal antibody Nic311, an antibody described by Kepler et al. 2005, and hereby in particular the differential effects of passive immunization with this antibody on the acute and chronic distribution of nicotine to the brain. It has been suggested in the prior art that passive immunization of humans with nicotine specific antibodies may be useful in the treatment of nicotine addiction and may be supportive during smoking cessation. However, with respect to Nic311 Pentel et al. 2006 further conclude that a

therapeutic monoclonal antibody would need to be humanized to reduce its own immunogenicity for clinical use.

[0006] The monoclonal antibodies against nicotine which are known from the prior art are derived from non-human sources and are therefore therapeutically not useful due to their strong immunogenicity in humans and due to safety concerns resulting thereof.

SUMMARY OF THE INVENTION

[0007] The invention provides human monoclonal antibodies that are specifically binding nicotine, wherein preferably said monoclonal antibodies are fully human antibodies. Typically and preferably, the monoclonal antibodies disclosed herein are not immunogenic in humans and are therefore suitable for the passive immunization of humans. Furthermore, it has surprisingly been found that monoclonal antibodies of the invention are specifically binding (S)-(-)-nicotine and (R)-(+)-nicotine. Like (S)-(-)-nicotine also the (R)-(+)-stereoisomer of nicotine is present in the tobacco plant. In addition, it can be formed by the combustion process during smoking and has qualitatively similar activities on the central nervous system as (S)-(-)-nicotine (Hukkanen J. et al., 2005, Pharmacol. Rev. 57, 79-115).

[0008] The monoclonal antibodies of the invention were cloned following a procedure disclosed in PCT/EP2007/061570: (1) nicotine-specific B-cells of a human subject were selected; (2) VH and VL regions of these cells were cloned into an alphaviral library; (3) a cells surface display of scFv antibodies was performed on mammalian cells; (4) cells displaying nicotine specific scFv antibodies were selected; (5) VH and VL regions of these scFv antibodies were cloned; and (6) monoclonal antibodies specifically binding nicotine were expressed in different formats, e.g. as scFv-Fc-fusion or as human IgG2, preferably as fully human IgG2. Applying this procedure, seven independent antibody clones were obtained which, when expressed as scFv-Fc fusion or IgG2, bound nicotine with a Kd value in the nanomolar or low nanomolar range.

[0009] Thus, in one aspect, the invention relates to a monoclonal antibody specifically binding nicotine, wherein said monoclonal antibody is a human monoclonal antibody and wherein preferably said human monoclonal antibody is a fully human monoclonal antibody.

[0010] These clones were sequenced and human CDRs conferring specificity to nicotine were identified. It has surprisingly been found that several of these antibodies share the same CDRs in different combinations (see Table 1).

Table 1. SEQ ID NOs of CDR sequences of nicotine-specific human antibodies.

mAb	VH Chain			VL Chain		
	CDR 1	CDR 2	CDR 3	CDR 1	CDR 2	CDR 3
F018	1	2	3	5	8	9
F063	1	2	4	6	8	10
J004	1	2	4	7	8	10
J042	1	2	4	5	8	10
N049	1	2	4	6	8	10
I022	11	12	13	14	15	16
N038	17	18	19	20	21	22

[0011] In a further aspect, the invention relates to a monoclonal antibody specifically binding nicotine, wherein preferably said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody comprises at least one heavy chain variable region (HCVR), wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 1, 11 and 17, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 comprises or preferably consists of the peptide of any one of SEQ ID NOs 2, 12, and 18, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and/or (c) one HC CDR3, wherein said HC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 3, 4, 13 and 19, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR.

[0012] In a further aspect, the invention relates to a monoclonal antibody specifically binding nicotine, wherein preferably said monoclonal antibody is a human monoclonal antibody, wherein said monoclonal antibody comprises at least one light chain variable region (LCVR), wherein said LCVR comprises (a) one LC CDR1, wherein said LC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 5, 6, 7, 14 and 20; and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 comprises or preferably consists of the peptide of any one of SEQ ID NOs 8, 15 and 21, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and/or (c) one LC CDR3, wherein said LC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 9, 10, 16 and 22, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[0013] In a further aspect, the invention relates to a monoclonal antibody specifically binding nicotine, wherein preferably said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 1, 11 and 17, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 comprises or preferably consists of the peptide of any one of SEQ ID NOs 2, 12, and 18, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and/or (c) one HC CDR3, wherein said HC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 3, 4, 13 and 19, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and/or, preferably and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 5, 6, 7, 14 and 20; and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 comprises or preferably consists of the peptide of any one of SEQ ID NOs 8, 15 and 21, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and/or (c) one LC CDR3, wherein said LC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 9, 10, 16 and 22, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[0014] Typically and preferably, said monoclonal antibody is recombinantly produced. The monoclonal antibodies of the invention can be expressed in any naturally occurring or synthetic format. In a preferred embodiment said monoclonal antibody is an IgG, preferably an IgG2.

[0015] In a further aspect, the invention relates to a HCVR of a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is specifically binding (S)-(-)-nicotine and (R)-(+)-nicotine, and wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of any one of SEQ ID NOs 3 and 4.

[0016] In a further aspect, the invention relates to a LCVR of a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said

monoclonal antibody is specifically binding (S)-(-)-nicotine and (R)-(+)-nicotine, and wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of any one of SEQ ID NOs 5, 6, and 7; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8; (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of any one of SEQ ID NOs 9 and 10.

[0017] In a further aspect, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 100 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 100 nM. In a preferred embodiment, said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM, preferably 1 to 40 nM, and further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 70 nM, preferably 1 to 50 nM, further preferably 1 to 40 nM, again further preferably 1 to 20 nM, and still further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format. In a very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM, preferably 1 to 40 nM, and further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 20 nM, and further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format. In again a still very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format. Preferably, said monoclonal antibody is a human monoclonal antibody, wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 comprises or preferably consists of the peptide of any one

of SEQ ID NOs 1, 11 and 17, very preferably consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 comprises or preferably consists of the peptide of any one of SEQ ID NOs 2, 12, and 18, very preferably consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and/or (c) one HC CDR3, wherein said HC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 3, 4, 13 and 19, very preferably consists of the peptide of SEQ ID NO:3, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and/or, preferably and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 5, 6, 7, 14 and 20; very preferably consists of the peptide of SEQ ID NO:5, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 comprises or preferably consists of the peptide of any one of SEQ ID NOs 8, 15 and 21, very preferably consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and/or (c) one LC CDR3, wherein said LC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 9, 10, 16 and 22, very preferably consists of the peptide of SEQ ID NO:9, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[0018] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 10 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 10 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:3, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR;

and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:5, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:9, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR, and wherein preferably position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:24, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:26.

[0019] In a further aspect, the invention relates a nucleic acid molecule encoding a variable region or the invention, a monoclonal antibody of the invention or an individual chain thereof.

[0020] In a further aspect, the invention relates to an expression vector comprising at least one nucleic acid molecule of the invention. In a further aspect, the invention relates to a host cell comprising at least one nucleic acid molecule of the invention or at least one expression vector of the invention.

[0021] The monoclonal antibody of the invention is useful for passive immunization, preferably of humans and in the treatment of nicotine addiction. Thus, in a further aspect the invention relates to a pharmaceutical composition comprising at least one monoclonal antibody of the invention.

[0022] In a further aspect, the invention relates to a method of passive immunization, said method comprising administering to a subject an effective amount of the monoclonal antibody of the invention or an effective amount of the pharmaceutical composition of the invention.

[0023] In a further aspect, the invention relates to a method of treating nicotine addiction, said method comprising administering to a subject an effective amount of the monoclonal antibody of the invention or an effective amount of the pharmaceutical composition of the invention.

[0024] In a further aspect, the invention relates to a monoclonal antibody of the invention or a pharmaceutical composition of the invention, for use in passive immunization, preferably in a human.

[0025] In a further aspect, the invention relates to a monoclonal antibody of the invention or to the pharmaceutical composition of the invention, for use in the treatment of nicotine addiction, preferably in a human.

[0026] In a further aspect, the invention relates to the use of the monoclonal antibody of the invention in the manufacture of a medicament for passive immunization, preferably against nicotine.

[0027] In a further aspect, the invention relates to the use of the monoclonal antibody of the invention in the manufacture of a medicament for the treatment of nicotine addiction, preferably in a human.

[0028] A further aspect of the invention is the use of an antibody of the invention in a method of quantitative and/or qualitative detection of nicotine, preferably in a blood sample and most preferably by ELISA.

[0029] It is to be understood that all embodiments and technical features disclosed herein relate to all aspects of the invention, and in any possible combination.

DESCRIPTION OF THE FIGURES

[0030] **Figure 1.** Specificity of IgG2-F018. The binding of tritium-labeled (-)-nicotine (56 nM) to IgG2-F018 (50 nM) was measured by equilibrium dialysis in the presence of increasing concentrations of unlabeled (-)-nicotine, (-)-cotinine or acetylcholine. Averages of two independent experiments are given with standard deviation.

DETAILED DESCRIPTION OF THE INVENTION

[0031] „**Antibody**“: As used herein, the term “antibody” refers to a molecule, preferably a protein, which is capable of specifically binding an antigen, typically and preferably by binding an epitope or antigenic determinant of said antigen, or a hapten. Preferably, the term antibody refers to an antigen or hapten binding molecule comprising at least one variable region, wherein preferably said molecule comprises least one HCVR and/or at least one LCVR. Further preferably, the term antibody refers to an antigen or hapten binding molecule comprising at least one, preferably exactly two antigen binding sites, wherein each of said antigen binding site(s) is formed by one HCVR and one LCVR. Furthermore, the term antibody refers to whole antibodies, preferably of the IgG, IgA, IgE, IgM, or IgD class, more preferably of the IgG class, most preferably IgG1, IgG2, IgG3, and IgG4, and to antigen binding fragments thereof. In a preferred embodiment said whole antibodies comprise either a kappa or a lambda light chain. The term “antibody” also refers to antigen or hapten binding antibody fragments, preferably to proteolytic fragments and their recombinant analogues.

most preferably to Fab, Fab' and F(ab')₂, and Fv. The term antibody further encompasses a protein comprising at least one, preferably two variable regions, wherein further preferably said protein comprises exactly one HCVR and exactly one LCVR. In a preferred embodiment the term antibody refers to a single chain antibody, preferably to scFv. Thus, preferred antibodies are single chain antibodies, preferably scFvs, disulfide-linked Fvs (sdFv) and fragments comprising either a light chain variable region (LCVR) or a heavy chain variable region (HCVR). In the context of the invention the term "antibody" preferably refers to recombinant antibodies, including recombinant proteins consisting of a single polypeptide, wherein said polypeptide comprises at least one, preferably exactly one, variable region. In the context of the invention recombinant antibodies may further comprise functional elements, such as, for example, a linker region, a signal peptide or hydrophobic leader sequence, a detection tag and/or a purification tag (e.g. Fc).

[0032] "Fv": The term Fv refers to the smallest proteolytic fragment of an antibody capable of binding an antigen or hapten and to recombinant analogues of said fragment.

[0033] "single chain antibody": A single chain antibody is an antibody consisting of a single polypeptide. Preferred single chain antibodies consist of a polypeptide comprising at least one, preferably exactly one VR, wherein preferably said VR is a HCVR. More preferred single chain antibodies consist of a polypeptide comprising a at least one, preferably exactly one, HCVR and at least one, preferably exactly one, LCVR. Still more preferred single chain antibodies comprise exactly one HCVR and exactly one LCVR. Most preferred single chain antibodies are scFv, wherein said scFv consist of a single polypeptide comprising exactly one HCVR and exactly one LCVR, wherein said HCVR and said LCVR are linked to each other by a linker region, wherein preferably said linker region consists of at least 15, preferably of 15 to 20 amino acids (Bird et al. (1988) Science, 242(4877):423-426). Further preferred single chain antibodies are scFv, wherein said scFv are encoded by a coding region, wherein said coding region, in 5' to 3' direction, comprises in the following order: (1) a light chain variable region (LCVR) consisting of light chain framework (LC FR) 1, complementary determining region (LC CDR) 1, LC FR2, LC CDR 2, LC FR3, LC CDR3 and LC FR4 from a κ or λ light chain; (2) a flexible linker (L), and (3) a heavy chain variable region (HCVR) consisting of framework (HC FR) 1, complementary determining region (HC CDR) 1, HC FR2, HC CDR2, HC FR3, HC CDR3 and HC FR4. Alternatively, single chain antibodies are scFv, wherein said scFv are encoded by a coding region, wherein said coding region, in 5' to 3' direction, comprises in the following order: (1) a heavy chain variable region (HCVR) consisting of framework (HC FR) 1, complementary determining region (HC CDR) 1, HC FR2, HC CDR2,

HC FR3, HC CDR3 and HC FR4; (2) a flexible linker (L), and (3) a light chain variable region (LCVR) consisting of light chain framework (LC FR) 1, complementary determining region (LC CDR) 1, LC FR2, LC CDR2, LC FR3, LC DR3 and LC FR4 from a κ or λ light chain.

[0034] “diabody”: The term “diabody” refers to an antibody comprising two polypeptide chains, preferably two identical polypeptide chains, wherein each polypeptide chain comprises a HCVR and a LCVR, wherein said HCVR and said LCVR are linked to each other by a linker region, wherein preferably said linker region comprises at most 10 amino acids (Huston et al. (1988), PNAS 85(16):587958-83; Holliger et al. (1993), PNAS 90(14):6444-6448, Hollinger & Hudson, 2005, Nature Biotechnology 23(9):1126-1136; Arndt et al. (2004) FEBS Letters 578(3):257-261). Preferred linker regions of diabodies comprise 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 amino acids.

[0035] “human antibody”: As used herein, the term “human antibody” refers to an antibody, preferably a recombinant antibody, essentially having the amino acid sequence of a human immunoglobulin, or a fragment thereof, and includes antibodies isolated from human immunoglobulin libraries. In the context of the invention “human antibodies” may comprise a limited number of amino acid exchanges as compared to the sequence of a native human antibody. Such amino acid exchanges can, for example, be caused by cloning procedures. However, the number of such amino acid exchanges in human antibodies of the invention is preferably minimized. Preferably, the amino acid sequence of human antibodies is at least 85 %, preferably 90 %, more preferably 95 %, even more preferably at least 96 %, still more preferably 97 %, again still more preferably 98 %, again still more preferably 99 % and most preferably 100 % identical to that of native human antibodies. More preferably, the amino acid sequence of human antibodies is at least 85 %, preferably 90 %, more preferably 95 %, even more preferably at least 96 %, still more preferably 97 %, again still more preferably 98 %, again still more preferably 99 % and most preferably 100 % identical to that of native human antibodies which are specifically binding to the antigen or hapten of interest. Most preferably, the amino acid sequence of human antibodies is at least 85 %, preferably 90 %, more preferably 95 %, even more preferably at least 96 %, still more preferably 97 %, again still more preferably 98 %, again still more preferably 99 % and most preferably 100 % identical to that of native human antibodies which are specifically binding to nicotine, preferably to (S)-(-)-nicotine and/or to (R)-(+)-nicotine.

[0036] Preferred recombinant human antibodies differ from native human antibodies in at most 20, 15, 10, 9, 8, 7, 6, 5, 4, 3, 2, or 1 amino acid. Very preferably, differences in the

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amino acid sequence of recombinant human antibodies and native human antibodies are eliminated by means of molecular cloning, and thus, most preferably, the amino acid sequence of a recombinant human antibodies and native human antibodies are identical. Such antibodies are also referred to as "fully human antibodies". An illustrative example how a fully human antibody may be obtained from a human antibody selected from a human antibody library is provided in Example 6. Typically and preferably, fully human antibodies are not immunogenic in humans.

[0037] Preferred human antibodies comprise (a) least one, preferably one, HCVR, (b) at least one, preferably one, HCCR, (c) at least one, preferably one, LCVR, and (d) at least one, preferably one, LCCR, wherein said at least one HCVR, and/or said at least one HCCR, and/or said at least one LCVR, and/or said at least one LCCR are at least 85%, preferably 90%, more preferably 95 %, still more preferably at least 96 %, again still more preferably 97 %, again still more preferably 98 %, again still more preferably 99 %, and most preferably 100 % identical to the respective native human regions.

[0038] It is well established that the constant regions of immunoglobulins, including human immunoglobulins, exist in various allotypes, i.e. that the amino acid sequence of said constant regions may differ to a certain extent between individuals of a population. Allotypes of the constant regions of human immunoglobulins are very well studied and the sequence information is readily available to the artisan from various sources, including the Immuno Genetics Information System. It is to be understood that different allotypes of the constant regions of one immunoglobulin are interchangeable for the purpose of the invention. For example, the gamma 2 heavy chain of a monoclonal antibody of the invention may comprise any existing allotype of a human gamma 2 HCCR.

[0039] **"monoclonal antibody"**: As used herein, the term "monoclonal antibody" refers to an antibody population comprising only one single antibody species, i.e. antibodies having an identical amino acid sequence.

[0040] **"constant region (CR)"**: The term "constant region" refers to a light chain constant region (LCCR) or a heavy chain constant region (HCCR) of an antibody. Typically and preferably, said CR comprises one to four immunoglobulin domains characterized by disulfide stabilized loop structures. Preferred CRs are CRs of immunoglobulins, preferably of human immunoglobulins, wherein further preferably said immunoglobulins, preferably said human immunoglobulins are selected from the group consisting of IgG1, IgG2, IgG3, IgG4, IgA, IgE, IgM, and IgD. Very preferred CRs are human CRs comprising or consisting of an

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-12-

amino acid sequence available from public databases, including, for example the Immunogenetic Information System.

[0041] **light chain constant region (LCCR):** The LCCR, more specifically the kappa LCCR or the lambda LCCR, typically represents the C-terminal half of a native kappa or lambda light chain of an native antibody. A LCCR typically comprises about 110 amino acids representing one immunoglobulin domain.

[0042] **heavy chain constant region (HCCR):** The constant region of a heavy chain comprises about three quarters or more of the heavy chain of an antibody and is situated at its C-terminus. Typically the HCCR comprises either three or four immunoglobulin domains. Preferred HCCRs are selected from gamma HCCR, alpha HCCR, epsilon HCCR, my HCCR, and delta HCCR. Very preferred are gamma HCCR, wherein preferably said gamma HCCR is selected from gamma 1 HCCR, gamma 2 HCCR, gamma 3 HCCR, and gamma 4 HCCR, wherein most preferably said gamma HCCR is a gamma 2 HCCR.

[0043] **"variable region (VR)":** Refers to the variable region or variable domain of an antibody, more specifically to the heavy chain variable region (HCVR) or to the light chain variable region (LCVR). Typically and preferably, a VR comprises a single immunoglobulin domain. Preferred VRs are VRs of immunoglobulins, preferably of human immunoglobulins, wherein further preferably said immunoglobulins, preferably said human immunoglobulins, are selected from the group consisting of IgG1, IgG2, IgG3, IgG4, IgA, IgE, IgM, and IgD. VRs of various species are known in the art. Preferred VRs are human VRs, wherein the framework of said human VRs exhibit at least 80 %, preferably at least 85 %, more preferably 90 %, again more preferably at least 95 %, most preferably at least 99 % sequence identity with the framework of any known human VR sequence. Preferred VRs are human VRs, wherein the framework of said human VRs exhibit at least 80 %, preferably at least 85 %, more preferably 90 %, again more preferably at least 95 %, most preferably at least 99 % sequence identity with the framework of any human VR sequence available from public databases, most preferably with any human VR sequence available from the Immunogenetics Information System.

[0044] Each VR comprises so called complementarity determining regions (CDRs) which are determining the binding characteristics of the antibody and which are embedded in the so called framework. Typically and preferably, VRs comprise three CDRs, preferably CDR1, CDR2, and CDR3, which are embedded into the framework (FR 1-4). Thus, in a preferred embodiment, a VR comprises the following elements in the following order from the N- to the C-terminus: FR1 - CDR1 - FR2 - CDR2 - FR3 - CDR3 - FR4.

[0045] Generally VRs comprise or preferably consist of a polypeptide, wherein said polypeptide is a product of a member of a family of V-gene segments in combination with further gene segments as, for example, D and J gene segments (HCVR) or J gene segments (LCDR).

[0046] **“light chain variable region (LCVR)”**: Light chain variable regions are encoded by rearranged nucleic acid molecules and are either a kappa LCVR or a lambda LCVR. Human kappa LCVRs comprise a polypeptide, wherein said polypeptide is a product of a member of family 1 to 7 of human kappa V-gene segments. In the context of the invention preferred kappa LCVRs are human kappa LCVRs, preferably human kappa LCVRs which are encoded by a DNA which can be amplified from human B cells using a primer combination of any one of the oligonucleotides disclosed as SEQ ID NO:49 to 52 of PCT/EP2007/061570 with any one oligonucleotide disclosed as SEQ ID NO:53 to 56 of PCT/EP2007/061570, and further preferably, PCR conditions described in Example 3 or of PCT/EP2007/061570.

[0047] Human lambda LCVRs comprise a polypeptide, wherein said polypeptide is a product of a member of family 1 to 11 of human lambda V-gene segments. In the context of the invention preferred lambda LCVRs are human lambda LCVRs, preferably human lambda LCVRs which are encoded by a DNA which can be amplified from human B cells using a primer combination of any one of SEQ ID NO:57 to 65 of PCT/EP2007/061570 with any one of SEQ ID NO:66 to 68 of PCT/EP2007/061570, and further preferably, PCR conditions described in Example 3 of PCT/EP2007/061570.

[0048] Typically and preferably, LCVRs comprise three LC CDRs, preferably LC CDR1, LC CDR2, and LC CDR3, which are embedded into the light chain framework (LC FR 1-4). Thus, in a preferred embodiment, a LCVR comprises the following elements in the following order from the N- to the C-terminus: LC FR1 - LC CDR1 - LC FR2 - LC CDR2 - LC FR3 - LC CDR3 - LC FR4.

[0049] **“heavy chain variable region (HCVR)”**: Heavy chain variable regions are encoded by rearranged nucleic acid molecules. Human HCVRs comprise a polypeptide, wherein said polypeptide is a product of a member of family 1 to 7 of human lambda V-gene segments. In the context of the invention preferred HCVRs are human HCVRs, preferably human HCVRs which are encoded by a DNA which can be amplified from human B cells using a primer combination of any one of SEQ ID NO:42 to 47 of PCT/EP2007/061570 with SEQ ID NO:48 of c PCT/EP2007/061570 and, further preferably, PCR conditions described in Example 3 of PCT/EP2007/061570.

[0050] Typically and preferably, HCVRs comprise three HC CDRs, preferably HC CDR1, HC CDR2, and HC CDR3, which are embedded into the heavy chain framework (HC FR 1-4). Thus, in a preferred embodiment, a HCVR comprises the following elements in the following order from the N- to the C-terminus: HC FR1 - HC CDR1 - HC FR2 - HC CDR2 - HC FR3 - HC CDR3 - HC FR4.

[0051] “CDR”: The complementarity determining region (CDR) 1, 2 and 3 of the HCVR and of the LCVR, respectively, of an antibody can be identified by methods generally known in the art. For the purpose of this application, CDR and FR boundaries are defined as set forth by Scavenger et al. 1999 (Exp Clin Immunogenet., Vol. 16 pp. 234-240), or by Lefranc et al. 2003 (Developmental and Comparative Immunology Vol. 27 pp. 55-77).

[0052] “**antigen**”: As used herein, the term “antigen” refers to a molecule which is bound by an antibody. An antigen is recognized by the immune system and/or by a humoral immune response and can have one or more epitopes, preferably B-cell epitopes, or antigenic determinants.

[0053] “**hapten**”: The term “hapten” generally refers to a chemical compound, wherein said compound is not capable of inducing an immune response in an animal by itself, but wherein said compound will be capable of inducing an immune response in an animal when said compound is bound to a carrier, preferably to a carrier protein. In the context of the invention, “hapten” refers to nicotine.

[0054] “**nicotine**”: The term “nicotine” as used herein preferably refers to (S)-(-)-nicotine or (R)-(+)-nicotine, or any mixture thereof. Most preferably, nicotine refers to (S)-(-)-nicotine.

[0055] “**specifically binding**”: The specificity of an antibody relates to the antibody’s capability of specifically binding an antigen or hapten. The specificity of this interaction between the antibody and the antigen/hapten (affinity) is characterized by a binding constant or, inversely, by a dissociation constant (K_d). It is to be understood that the apparent affinity of an antibody to an antigen/hapten in a multivalent interaction depends on the structure of the antibody and of the antigen/hapten, and on the actual assay conditions. The apparent affinity of an antibody to an antigen/hapten in a multivalent interaction may be significantly higher than in a monovalent interaction due to avidity. Thus, affinity is preferably determined under conditions favoring monovalent interactions. K_d can be determined by methods known in the art. K_d of a given combination of antibody and antigen/hapten is preferably determined by ELISA, wherein a constant amount of immobilized antigen/hapten is contacted with a serial dilution of a known concentration of a purified antibody, preferably a monovalent antibody,

for example scFv or Fab fragment. K_d is then determined as the concentration of the antibody where half-maximal binding is observed. In a preferred embodiment K_d is determined by equilibrium dialysis, preferably under conditions as described in Example 7. Alternatively, K_d of a monovalent interaction of an antibody and an antigen/hapten is determined by Biacore analysis as the ratio of on rate (k_{on}) and off rate (k_{off}). Lower values of K_d indicate a more specific binding of the antibody to the antigen/hapten than higher values. In the context of the application, an antibody is considered to be “specifically binding an antigen/hapten”, when the dissociation constant (K_d), preferably determined as described above, and further preferably determined in a monovalent interaction, is at most 1 mM ($\leq 10^{-3}$ M), preferably at most 1 μ M ($\leq 10^{-6}$ M), most preferably at most 1 nM ($\leq 10^{-9}$ M). Very preferred are antibodies capable of binding an antigen/hapten with a K_d of less than 100 nM (“low nanomolar range”), wherein further preferably K_d is determined in a monovalent interaction. Further preferred antibodies are capable of binding an antigen/hapten with a K_d of 1 to 1000 nM, more preferably of 5 to 800 nM, still more preferably of 5 to 90 nM, most preferably of 5 to 50 nM, wherein further preferably K_d is determined in a monovalent interaction.

[0056] “equal”: In the context of the application the values of two dissociation constants (K_d) of a monoclonal antibody and a substance are regarded as being “equal” when said values differ by a factor of at most 10, preferably at most 9, more preferably at most 8, still more preferably at most 7, still more preferably at most 6, still more preferably at most 5, still more preferably at most 4, still more preferably at most 3, still more preferably at most 2, and most preferably at most 1.5. In a very preferred embodiment two K_d values are regarded as being equal when they differ by a factor of less than 5.

[0057] “effective amount”: A therapeutically effective amount of a monoclonal antibody of the invention or of a pharmaceutical composition of the invention generally refers to an amount necessary to achieve, at dosages and periods of time necessary, the desired therapeutic result, wherein preferably said result is preventing, reducing or slowing down the nicotine entry into the brain, preferably in a human, and/or, ultimately, smoking cessation. With respect to a therapeutic treatment of a human, an “effective amount” typically refers to an amount of 1 mg to 1000 mg, preferably 10 mg to 500 mg, more preferably 10 mg to 300 mg, still more preferably 50 mg to 200 mg, and most preferably about 100 mg of said monoclonal antibody.

[0058] “Tag”: The term tag, preferably a purification or detection tag, refers to a polypeptide segment that can be attached to a second polypeptide to provide for purification

or detection of the second polypeptide or provides sites for attachment of the second polypeptide to a substrate. In principle, any peptide or protein for which an antibody or other specific binding agent is available can be used as an affinity tag. Tags include haemagglutinin tag, myc tag, poly-histidine tag, protein A, glutathione S transferase, Glu-Glu affinity tag, substance P, FLAG peptide, streptavidin binding peptide, or other antigenic epitope or binding domain (mostly taken from US06686168).

[0059] A library-based screening method for the identification, isolation and cloning of scFv specifically binding an antigen or hapten of interest is disclosed in PCT/EP2007/061570. In particular, said method allows for the identification, isolation and cloning of human scFv and for the subsequent generation of fully human antibodies, including Fab fragments and whole IgG. Applying said technology, human monoclonal antibodies specifically binding nicotine have been identified and cloned.

[0060] In one aspect, the invention provides a monoclonal antibody specifically binding nicotine, wherein said monoclonal antibody is a human monoclonal antibody, wherein preferably said nicotine is selected from (S)-(-)-nicotine and (R)-(+)-nicotine, and wherein most preferably said nicotine is (S)-(-)-nicotine; and wherein further preferably said human monoclonal antibody is a fully human monoclonal antibody.

[0061] In a preferred embodiment said monoclonal antibody is specifically binding (S)-(-)-nicotine and (R)-(+)-nicotine.

[0062] In one embodiment said monoclonal antibody is binding nicotine, preferably (S)-(-)-nicotine, with a dissociation constant K_d of 1 to 1000 nM, more preferably of 1 to 800 nM, still more preferably of 1 to 100 nM, most preferably of 5 to 90 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format. In a further preferred embodiment K_d is determined in a monovalent interaction, most preferably in an assay essentially as described in Example 7.

[0063] In a further preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 100 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 100 nM.

[0064] In a more preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 0.1 to 100 nM, preferably 0.1 to 70 nM,

further preferably 0.1 to 50 nM, again further preferably 0.1 to 40 nM, again further preferably 0.1 to 20 nM, and further preferably 0.1 to 10 nM, and further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 0.1 to 100 nM, preferably 0.1 to 70 nM, further preferably 0.1 to 50 nM, again further preferably 0.1 to 40 nM, again further preferably 0.1 to 20 nM, and again further preferably 0.1 to 10 nM, and still further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format. In a still very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 0.1 to 40 nM, and further preferably 0.1 to 10 nM, and still further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 0.1 to 50 nM, preferably 0.1 to 20 nM, and further preferably 0.1 to 10 nM, and still further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format. In again another very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 0.1 to 10 nM, preferably 1 to 10 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 0.1 to 10 nM, preferably 1 to 10 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format.

[0065] In a further preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 1000 nM, preferably 1 to 800 nM, still more preferably 1 to 100 nM, again further preferably 1 to 70 nM, again further preferably 1 to 50 nM, again further preferably 1 to 40 nM, again further preferably 1 to 20 nM, and still further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 1000 nM, preferably 1 to 800 nM, still more preferably 1 to 100 nM, again further preferably 1 to 70 nM, again further preferably 1 to 50 nM, again further preferably 1 to 40 nM, again further preferably 1 to 20 nM, and still further preferably 1 to 10 nM, wherein further preferably K_d is determined using

said monoclonal antibody in the IgG2 format. In a very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 100 nM, preferably 1 to 70 nM, again further preferably 1 to 40 nM, and further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 100 nM, preferably 1 to 70 nM, again further preferably 1 to 50 nM, again further preferably 1 to 40 nM, again further preferably 1 to 20 nM, and further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format. In a still very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM, preferably 1 to 40 nM, and further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 50 nM, preferably 1 to 20 nM, and further preferably 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format. In again a still very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format.

[0066] In a further preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is lower than 100 nM, preferably lower than 70 nM, further preferably lower than 50 nM, again further preferably lower than 40 nM, again further preferably lower than 20 nM, and again further preferably lower than 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine lower than 100 nM, preferably lower than 70 nM, further preferably lower than 50 nM, again further preferably lower than 40 nM, again further preferably lower than 20 nM, and again further preferably lower than 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format. In a very preferred embodiment said

monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is lower than 70 nM, preferably lower than 40 nM, and further preferably lower than 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is lower than 50 nM, preferably lower than 20 nM, and further preferably lower than 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format. In a still very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is lower than 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is lower than 20, preferably lower than 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format. In again a still very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is lower than 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is lower than 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format.

[0067] In a further preferred embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is equal to the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format.

[0068] In another preferred embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 2 to 5 times higher, preferably about 2 times higher, and most preferably 2 times higher than the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-

nicotine, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format.

[0069] In a further preferred embodiment said monoclonal antibody is capable of preventing, reducing or slowing down the nicotine entry into the brain, preferably in a human. In a further preferred embodiment said monoclonal antibody is capable of reducing the nicotine entry into the brain, preferably by at least 10 %, 20 %, 30 %, 40 %, 50 %, 60 %, 70 %, 80 %, or 90 % when assayed under conditions essentially as described in Example 8. Most preferably said monoclonal antibody is capable of reducing the nicotine entry into the brain, preferably by at least 60 % when assayed under conditions essentially as described in Example 8.

[0070] In a further preferred embodiment said monoclonal antibody is capable of preventing, reducing or slowing down the nicotine entry into the brain of a subject, preferably of a human, when administered to said subject, preferably to said human, wherein preferably said monoclonal antibody is administered to said subject, preferably to said human, in an amount of 1 mg to 1000 mg, preferably 10 mg to 500 mg, more preferably 10 mg to 300 mg, still more preferably 50 mg to 200 mg, and most preferably about 100 mg.

[0071] The specificity of an antibody is mainly determined by the amino acid sequence of the complementarity determining regions (CDRs) in the heavy chain variable regions (HCVR) of said antibody and/or by the CDRs in the light chain variable regions said antibody (LCVR). The invention discloses CDRs of HCVRs (HC CDRs) and CDRs of the LCVRs (LC CDRs) of monoclonal antibodies, wherein said monoclonal antibodies are capable of specifically binding nicotine.

[0072] Thus, in a preferred embodiment said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 1, 11 and 17, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 comprises or preferably consists of the peptide of any one of SEQ ID NOs 2, 12, and 18, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and/or (c) one HC CDR3, wherein said HC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 3, 4, 13 and 19, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR.

[0073] In a further preferred embodiment said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 5, 6, 7, 14 and 20; and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 comprises or preferably consists of the peptide of any one of SEQ ID NOs 8, 15 and 21, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and/or (c) one LC CDR3, wherein said LC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 9, 10, 16 and 22, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[0074] It has surprisingly been found that some of the monoclonal antibodies which are capable of binding nicotine with a K_d in the nanomolar range, in particular F018, F063, J004, J042 and N049, share identical HC CDRs and/or LC CDRs in different combinations (cf. Table 1). Furthermore, it has surprisingly been found that heavy and light chain variable regions of antibodies F018, F063, J004, J042 and N049 are very closely related to one another and differed only at few amino acid positions.

[0075] Thus, in a very preferred embodiment (a) said HC CDR1 comprises or preferably consists of the peptide of SEQ ID NO:1; (b) said HC CDR2 comprises or preferably consists of the peptide of SEQ ID NO:2; and (c) said HC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 3 and 4, wherein preferably (a) said LC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 5, 6 and 7; (b) said LC CDR2 comprises or preferably consists of the peptide of SEQ ID NO:8; and (c) said LC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 9 and 10.

[0076] In a preferred embodiment, said HCVR comprises a framework, wherein said framework is a product of a member of the VH family of V-gene segments, preferably of the VH4 family of V-gene segments, combined with a JH-gene segment.

[0077] In a very preferred embodiment (a) said HC CDR1 consists of the peptide of SEQ ID NO:1; (b) said HC CDR2 consists of the peptide of SEQ ID NO:2; and (c) said HC CDR3 consists of the peptide of SEQ ID NO:3.

[0078] In a further very preferred embodiment (a) said HC CDR1 consists of the peptide of SEQ ID NO:1; (b) said HC CDR2 consists of the peptide of SEQ ID NO:2; and (c) said HC CDR3 consists of the peptide of SEQ ID NO:4.

[0079] In one embodiment position 7 to 117 of said HCVR consists of the peptide of any one of SEQ ID NOs 24, 28, 33, and 39. In another embodiment position 7 to 117 of said HCVR is encoded by the nucleic acid of any one of SEQ ID NOs 23, 27, 32, 29, and 38.

[0080] The antibodies of the invention may differ from fully human antibodies in certain amino acid positions of the VRs due to cloning artifacts, wherein typically these positions are located near the N- and/or C-terminus of the variable region. Preferably, these artifacts are removed from the antibody in order to obtain fully human antibodies. A method for the generation of fully human monoclonal antibodies from antibodies still comprising said cloning artifacts is illustrated in Example 6. A similar approach is applied to all HCVRs and LCVRs disclosed herein. For example, in order to obtain fully human HCVRs, position 1 to 6 of the HCVRs of the invention is replaced by SEQ ID NO:50. Thus, in a preferred embodiment position 1 to 6 of said HCVR consists of SEQ ID NO:50.

[0081] In a further embodiment, said LC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 5, 6 and 7; (b) said LC CDR2 comprises or preferably consists of the peptide of SEQ ID NO:8; and (c) said LC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 9 and 10.

[0082] In a further embodiment said LCVR comprises a framework, wherein said framework is a product of a member of the V lambda family of V-gene segments, preferably of the V lambda 1 family of V-gene segments, combined with a J lambda gene segment.

[0083] In a preferred embodiment said LC CDR1 consists of the peptide of SEQ ID NO:5; (b) said LC CDR2 consists of the peptide of SEQ ID NO:8; and (c) said LC CDR3 consists of the peptide of SEQ ID NO:9.

[0084] In a further preferred embodiment (a) said LC CDR1 consists of the peptide of SEQ ID NO:6; (b) said LC CDR2 consists of the peptide of SEQ ID NO:8; and (c) said LC CDR3 consists of the peptide of SEQ ID NO:10. In a further preferred embodiment (a) said LC CDR1 consists of the peptide of SEQ ID NO:7; (b) said LC CDR2 consists of the peptide of SEQ ID NO:8; and (c) said LC CDR3 consists of the peptide of SEQ ID NO:10. In a further preferred embodiment (a) said LC CDR1 consists of the peptide of SEQ ID NO:5; (b) said LC CDR2 consists of the peptide of SEQ ID NO:8; and (c) said LC CDR3 consists of the peptide of SEQ ID NO:10.

[0085] In a very preferred embodiment position 5 to 107 of said LCVR consist of the peptide of any one of SEQ ID NOs 26, 31, 35, 37, and 41. In a further very preferred embodiment position 5 to 107 of said LCVR is encoded by the nucleic acid of any one of SEQ ID NOs 25, 30, 34, 36, and 40. In a further preferred embodiment position 1 to 4 of said

LCVR consists of SEQ ID NO:51. In a further preferred embodiment position 108 to 110 of said LCVR consists of SEQ ID NO:53.

[0086] In a further very preferred embodiment (a) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:24, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:26; (b) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:28, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:31; (c) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:33, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:35; (d) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:28, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:37; or (e) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:39, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:41. In again a further very preferred embodiment (a) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:24, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:26.

[0087] In a further preferred embodiment, said human monoclonal antibody specifically binding nicotine comprises at least one HCVR and at least one LCVR, wherein position 7 to 117 of said HCVR is at least 80%, preferably 85%, more preferably 90%, again more preferably 95 %, even more preferably at least 96 %, still more preferably 97 %, again still more preferably 98 %, again still more preferably 99 % and most preferably 100 % identical to position 7 to 117 of SEQ ID NOs 24, 28, 33, and 39, preferably to position 7 to 117 of SEQ ID NO:24; and wherein position 5 to 107 of said LCVR is at least 80%, preferably 85%, more preferably 90%, again more preferably 95 %, even more preferably at least 96 %, still more preferably 97 %, again still more preferably 98 %, again still more preferably 99 % and most preferably 100 % identical to position 5 to 107 of SEQ ID NOs 26, 31, 35, 37, and 41, preferably to position 5 to 107 of SEQ ID NO:26.

[0088] Whether the amino acid sequence of a peptide or polypeptide has an amino acid sequence that is at least 80%, 85%, 90%, 95%, 97% or 99% identical to another, can be determined conventionally using known computer programs such the Bestfit program

[0089] In another preferred embodiment, said human monoclonal antibody specifically binding nicotine comprises at least one HCVR and at least one LCVR, wherein position 7 to 117 of said HCVR is at least 80%, preferably 85%, more preferably 90%, again more preferably 95 %, even more preferably at least 96 %, still more preferably 97 %, again still more preferably 98 %, again still more preferably 99 % and most preferably 100 % identical to position 7 to 117 of SEQ ID NOs 24, 28, 33, and 39, preferably to position 7 to 117 of SEQ

ID NO:24; and wherein position 5 to 107 of said LCVR is at least 80%, preferably 85%, more preferably 90%, again more preferably 95 %, even more preferably at least 96 %, still more preferably 97 %, again still more preferably 98 %, again still more preferably 99 % and most preferably 100 % identical to position 5 to 107 of SEQ ID NOs 26, 31, 35, 37, and 41, preferably to position 5 to 107 of SEQ ID NO:26, and wherein said HCVR comprises (i) one HC CDR1 consisting of the peptide of SEQ ID NO:1; (ii) one HC CDR2 consisting of the peptide of SEQ ID NO:2; and (iii) one HC CDR3 consisting of the peptide of SEQ ID NO:3, and wherein said LCVR comprises (i) one LC CDR1 consisting of the peptide of SEQ ID NO:5; (ii) one LC CDR2 consisting of the peptide of SEQ ID NO:8; (iii) one LC CDR3 consisting of the peptide of SEQ ID NO:9.

[0090] In a further very preferred embodiment (a) position 7 to 117 of said HCVR is encoded by the nucleic acid of SEQ ID NO:23, and wherein position 5 to 107 of said LCVR is encoded by the nucleic acid of SEQ ID NO:25; (b) position 7 to 117 of said HCVR is encoded by the nucleic acid of SEQ ID NO:27, and wherein position 5 to 107 of said LCVR is encoded by the nucleic acid of SEQ ID NO:30; (c) position 7 to 117 of said HCVR is encoded by the nucleic acid of SEQ ID NO:32, and wherein position 5 to 107 of said LCVR is encoded by the nucleic acid of SEQ ID NO:34; (d) position 7 to 117 of said HCVR is encoded by the nucleic acid of SEQ ID NO:29, and wherein position 5 to 107 of said LCVR is encoded by the nucleic acid of SEQ ID NO:36; or (e) position 7 to 117 of said HCVR is encoded by the nucleic acid of SEQ ID NO:38, and wherein position 5 to 107 of said LCVR is encoded by the nucleic acid of SEQ ID NO:40.

[0091] The antibodies of the invention may be produced in the format of single chain antibodies. Thus, in a further very embodiment said monoclonal antibody comprises or preferably consists of the peptide of any one of SEQ ID NOs 60, 62, 64, 66, and 68. In a further preferred embodiment said monoclonal antibody is a single chain antibody, wherein preferably said single chain antibody comprises or preferably consists of the peptide of any one of SEQ ID NOs 60, 62, 64, 66, and 68. In a further very preferred embodiment said monoclonal antibody comprises or preferably consists of a peptide, wherein said peptide is encoded by the nucleic acid of any one of SEQ ID NOs 59, 61, 63, 65, and 67.

[0092] In a further preferred embodiment said monoclonal antibody is expressed as a IgG, preferably as a IgG2. Thus, in a further preferred embodiment said monoclonal antibody comprises at least one gamma 2 heavy chain, wherein preferably said gamma 2 heavy chain comprises or preferably consists of the peptide of any one of SEQ ID NOs 73, 75, 77, and 80. In a further preferred embodiment said monoclonal antibody comprises at least one lambda

light chain, wherein preferably said lambda light chain comprises or preferably consists of the peptide of any one of SEQ ID NOs 74, 76, 78, 79, and 81.

[0093] In a very preferred embodiment said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda light chain, wherein (a) said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:73, and wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:74; (b) said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:75, and wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:76; (c) said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:77, and wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:78; (d) said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:75, and wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:79; or (e) said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:80, and wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:81.

[0094] In a further preferred embodiment said monoclonal antibody comprises a light chain constant region (LCCR), wherein preferably said LCCR is a lambda LCCR.

[0095] In another embodiment (a) said HC CDR1 comprises or preferably consists of the peptide of SEQ ID NO:11; (b) said HC CDR2 comprises or preferably consists of the peptide of SEQ ID NO:12; and (c) said HC CDR3 comprises or preferably consists of the peptide of SEQ ID NO:13, wherein preferably said HCVR comprises a framework, wherein said framework is a product of a member of the VH family of V-gene segments, preferably of the VH4 family of V-gene segments, combined with a JH-gene segment.

[0096] In a preferred embodiment (a) said HC CDR1 consists of the peptide of SEQ ID NO:11; (b) said HC CDR2 consists of the peptide of SEQ ID NO:12; and (c) said HC CDR3 consists of the peptide of SEQ ID NO:13.

[0097] In a further preferred embodiment position 7 to 121 of said HCVR consist of the peptide of SEQ ID NO:43. In a further preferred embodiment position 7 to 121 of said HCVR is encoded by the nucleic acid of SEQ ID NO:42. And in a further preferred embodiment position 1 to 6 of said HCVR consists of SEQ ID NO:50.

[0098] In a further preferred embodiment (a) said LC CDR1 comprises or preferably consists of the peptide of SEQ ID NO:14; (b) said LC CDR2 comprises or preferably consists of the peptide of SEQ ID NO:15; and (c) wherein said LC CDR3 comprises or preferably consists of the peptide of SEQ ID NO:16, wherein preferably said LCVR comprises a

framework, wherein further preferably said framework is a product of a member of the V kappa family of V-gene segments, preferably of the V kappa 3 family of V-gene segments, combined with a J kappa gene segment.

[0099] In a further preferred embodiment (a) said LC CDR1 consists of the peptide of SEQ ID NO:14; (b) said LC CDR2 consists of the peptide of SEQ ID NO:15; and (c) said LC CDR3 consists of the peptide of SEQ ID NO:16. In a further preferred embodiment position 5 to 104 of said LCVR consist of the peptide of SEQ ID NO:45. In a further preferred embodiment position 5 to 104 of said LCVR is encoded by the nucleic acid of SEQ ID NO:44. And in a further preferred embodiment 1 to 4 of said LCVR consists of SEQ ID NO:52. And in a further preferred embodiment position 105 to 107 of said LCVR consists of SEQ ID NO:54.

[00100] In a very preferred embodiment position 7 to 121 of said HCVR consist of the peptide of SEQ ID NO:43, and position 5 to 104 of said LCVR consist of the peptide of SEQ ID NO:45. In a very preferred embodiment position 7 to 121 of said HCVR is encoded by the nucleic acid of SEQ ID NO:42, and position 5 to 104 of said LCVR is encoded by the nucleic acid of SEQ ID NO:44.

[00101] In a further very preferred embodiment said monoclonal antibody comprises or preferably consists of the peptide of SEQ ID NO:70. In a further very preferred embodiment said monoclonal antibody is a single chain antibody, wherein said single chain antibody comprises or preferably consists of the peptide of SEQ ID NO:70. In a further very preferred embodiment said monoclonal antibody comprises or preferably consists of a peptide, wherein said peptide is encoded by the nucleic acid of SEQ ID NO:69.

[00102] In a further very preferred embodiment said monoclonal antibody comprises at least one gamma 2 heavy chain, wherein said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:82. In a further very preferred embodiment said monoclonal antibody comprises at least one kappa light chain, wherein said kappa light chain comprises or preferably consists of the peptide of SEQ ID NO:83. In a further very preferred embodiment said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one kappa light chain, wherein said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:82, and wherein said kappa light chain comprises or preferably consists of the peptide of SEQ ID NO:83.

[00103] In a further preferred embodiment said monoclonal antibody comprises a light chain constant region (LCCR), wherein preferably said LCCR is a kappa LCCR.

[00104] In a further embodiment (a) said HC CDR1 comprises or preferably consists of the peptide of SEQ ID NO:17; (b) said HC CDR2 comprises or preferably consists of the peptide of SEQ ID NO:18; and (c) said HC CDR3 comprises or preferably consists of the peptide of SEQ ID NO:19, wherein preferably said HCVR comprises a framework, wherein said framework is a product of a member of the VH family of V-gene segments, preferably of the VH4 family of V-gene segments, combined with a JH-gene segment.

[00105] In a preferred embodiment (a) said HC CDR1 consists of the peptide of SEQ ID NO:17; (b) said HC CDR2 consists of the peptide of SEQ ID NO:18; and (c) said HC CDR3 consists of the peptide of SEQ ID NO:19. In a very preferred embodiment position 7 to 121 of said HCVR consist of the peptide of SEQ ID NO:47. In a further very preferred embodiment position 7 to 121 of said HCVR is encoded by the nucleic acid of SEQ ID NO:46. In a further preferred embodiment position 1 to 6 of said HCVR consists of SEQ ID NO:50.

[00106] In a further embodiment (a) said LC CDR1 comprises or preferably consists of the peptide of SEQ ID NO:20; (b) said LC CDR2 comprises or preferably consists of the peptide of SEQ ID NO:21; and (c) wherein said LC CDR3 comprises or preferably consists of the peptide of SEQ ID NO:22, wherein preferably said LCVR comprises a framework, wherein said framework is a product of a member of the V lambda family of V-gene segments, preferably of the V lambda 1 family of V-gene segments, combined with a J lambda gene segment.

[00107] In a preferred embodiment (a) said LC CDR1 consists of the peptide of SEQ ID NO:20; (b) said LC CDR2 consists of the peptide of SEQ ID NO:21; and (c) said LC CDR3 consists of the peptide of SEQ ID NO:22.

[00108] In a further preferred embodiment position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:49. In a further preferred embodiment position 5 to 107 of said LCVR is encoded by the nucleic acid of SEQ ID NO:48. And in a preferred embodiment position 1 to 4 of said LCVR consists of SEQ ID NO:51. And in a preferred embodiment position 108 to 110 of said LCVR consists of SEQ ID NO:53.

[00109] In a very preferred embodiment position 7 to 121 of said HCVR consist of the peptide of SEQ ID NO:47, and position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:49.

[00110] In a very preferred embodiment position 7 to 121 of said HCVR is encoded by the nucleic acid of SEQ ID NO:46, and position 5 to 107 of said LCVR is encoded by the nucleic acid of SEQ ID NO:48.

[00111] In a preferred embodiment said monoclonal antibody comprises or preferably consists of the peptide of SEQ ID NO:72. In further preferred embodiment said monoclonal antibody is a single chain antibody, wherein said single chain antibody comprises or preferably consists of the peptide of SEQ ID NO:72. In a preferred embodiment said monoclonal antibody comprises or preferably consists of a peptide, wherein said peptide is encoded by the nucleic acid of SEQ ID NO:71.

[00112] In a further preferred embodiment said monoclonal antibody comprises at least one gamma 2 heavy chain, wherein preferably said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:84.

[00113] In a further preferred embodiment said monoclonal antibody comprises at least one lambda light chain, wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:85.

[00114] In a very preferred embodiment said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda light chain, wherein said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:84, and wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:85.

[00115] In a further preferred embodiment said monoclonal antibody comprises a light chain constant region (LCCR), wherein preferably said LCCR is a lambda LCCR.

[00116] A monoclonal antibody of the invention can be recombinantly produced in any naturally occurring or synthetic format. The following embodiments thus explicitly refer to all aspects and embodiments of the invention. In one embodiment said monoclonal antibody is a recombinant antibody. In a preferred embodiment the monoclonal antibody of the invention is an antibody selected from the group consisting of: (a) single chain antibody, preferably scFv; (b) Fab fragment; (c) F(ab')₂ fragment; (d) scFv-Fc fusion; (e) IgG1; (f) IgG2; (g) IgG3; (h) IgG4; (i) IgA; (j) IgE; (k) IgM; (l) IgD; and (m) diabody.

[00117] In a preferred embodiment said monoclonal antibody comprises or preferably consists of exactly one HCVR and/or of exactly one LCVR.

[00118] In a further preferred embodiment said monoclonal antibody comprises a heavy chain constant region (HCCR), wherein preferably said HCCR is selected from (a) gamma HCCR, (b) alpha HCCR, (c) epsilon HCCR, (d) my HCCR, and (e) delta HCCR, wherein further preferably said HCCR, and preferably said gamma HCCR, alpha HCCR, epsilon HCCR, my HCCR, and/or delta HCCR, is a human HCCR.

[00119] In still further preferred embodiment said HCCR is a gamma HCCR, wherein preferably said gamma HCCR is selected from (a) gamma 1 HCCR; (b) gamma 2 HCCR; (d)

gamma 3 HCCR; and (c) gamma 4 HCCR; wherein preferably said gamma HCCR is a gamma 2 HCCR.

[00120] In a further preferred embodiment said monoclonal antibody comprises a light chain constant region (LCCR), wherein preferably said LCCR is selected from (a) lambda LCCR; and (b) kappa LCCR, wherein further preferably said LCCR, and most preferably said lambda LCCR and/or said kappa LCCR, is a human LCCR.

[00121] Preferably, the monoclonal antibody of the invention is an IgG2, most preferably a fully human IgG2. Thus, in a preferred embodiment said monoclonal antibody comprises two, preferably exactly two, of said gamma 2 heavy chains, wherein further preferably said two, preferably said exactly two of said gamma 2 heavy chains are identical.

[00122] In a further preferred embodiment said monoclonal antibody comprises two, preferably exactly two light chains, wherein preferably said light chains are selected from (a) lambda light chain; and (b) kappa light chain; wherein still further preferably said two, preferably said exactly two of said light chains are identical.

[00123] Preferably, said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 1, 11 and 17, very preferably consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 comprises or preferably consists of the peptide of any one of SEQ ID NOs 2, 12, and 18, very preferably consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and/or (c) one HC CDR3, wherein said HC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 3, 4, 13 and 19, very preferably consists of the peptide of SEQ ID NO:3, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and/or, preferably and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 5, 6, 7, 14 and 20; very preferably consists of the peptide of SEQ ID NO:5, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 comprises or preferably consists of the peptide of any one of SEQ ID NOs 8, 15 and 21, very preferably consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and/or (c) one LC CDR3, wherein said LC CDR3 comprises or preferably consists of the peptide of any

one of SEQ ID NOs 9, 10, 16 and 22, very preferably consists of the peptide of SEQ ID NO:9, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00124] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine; and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:3, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:5, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:9, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00125] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 0.1 to 10 nM, preferably 1 to 10 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 0.1 to 10 nM, preferably 1 to 10 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the

peptide of SEQ ID NO:3, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:5, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:9, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00126] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 0.1 to 10 nM, preferably 1 to 10 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 0.1 to 10 nM, preferably 1 to 10 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein said monoclonal antibody comprises a gamma 2 heavy chain and a lambda light chain, wherein said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:73, and wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:74.

[00127] In another preferred embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is equal to, preferably 2 to 5 times higher, more preferably about 2 times higher, and most preferably 2 times higher than said binding of said monoclonal antibody to said (R)-(+)-nicotine, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:3, and wherein preferably said HC CDR3 is located at CDR3 position

within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:5, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:9, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00128] Preferably, said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 1, 11 and 17, very preferably consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 comprises or preferably consists of the peptide of any one of SEQ ID NOs 2, 12, and 18, very preferably consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and/or (c) one HC CDR3, wherein said HC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 3, 4, 13 and 19, very preferably consists of the peptide of SEQ ID NO:3, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and/or, preferably and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 comprises or preferably consists of the peptide of any one of SEQ ID NOs 5, 6, 7, 14 and 20; very preferably consists of the peptide of SEQ ID NO:5, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 comprises or preferably consists of the peptide of any one of SEQ ID NOs 8, 15 and 21, very preferably consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and/or (c) one LC CDR3, wherein said LC CDR3 comprises or preferably consists of the peptide of any one of SEQ ID NOs 9, 10, 16 and 22, very preferably consists of the peptide of SEQ ID NO:9, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00129] In again a still very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is lower than 10 nM, wherein further preferably

K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is lower than 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:3, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:5, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:9, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00130] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine; and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:6, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at

CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00131] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 10 to 100 nM, preferably 25 to 75 nM, most preferably 25 to 35 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 0.1 to 10 nM, preferably 1 to 10 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:6, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00132] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 10 to 100 nM, preferably 25 to 75 nM, most preferably 25 to 35 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 0.1 to 10 nM, preferably 1 to 10 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format; said monoclonal antibody comprises a gamma 2

heavy chain and a lambda light chain, wherein said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:75, and wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:76.

[00133] In another preferred embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is equal to, preferably 2 to 7 times higher, more preferably about 5 times higher, and most preferably 5 times higher than said binding of said monoclonal antibody to said (R)-(+)-nicotine, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:6, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00134] In again a still very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is lower than 40 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is lower than 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1

position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:6, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00135] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine; and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:7, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00136] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the

dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 10 to 100 nM, preferably 25 to 75 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 20 nM, preferably 10 to 15 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:7, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00137] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 10 to 100 nM, preferably 25 to 75 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 20 nM, preferably 10 to 15 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein said monoclonal antibody comprises a gamma 2 heavy chain and a lambda light chain, wherein said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:77, and wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:78.

[00138] In another preferred embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine

is equal to, preferably 2 to 7 times higher, more preferably about 5 times higher, and most preferably 5 times higher than said binding of said monoclonal antibody to said (R)-(+)-nicotine, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:7, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00139] In again a still very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is lower than 75 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is lower than 15 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:7, and wherein preferably said

LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00140] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:5, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00141] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 20 to 60 nM, preferably 30 to 50 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 0.1 to 10 nM, preferably 1 to 10 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the

framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:5, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00142] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 20 to 60 nM, preferably 30 to 50 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 0.1 to 10 nM, preferably 1 to 10 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format; wherein said monoclonal antibody comprises a gamma 2 heavy chain and a lambda light chain, wherein said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:75, and wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:79.

[00143] In another preferred embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is equal to, preferably 2 to 7 times higher, more preferably about 4 times higher, and most preferably 4 times higher than said binding of said monoclonal antibody to said (R)-(+)-nicotine, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide

of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:5, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00144] In again a still very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is lower than 60 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is lower than 10 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:5, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00145] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:6, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00146] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 20 to 80 nM, preferably 30 to 75 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 0.1 to 15 nM, preferably 1 to 12 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1

consists of the peptide of SEQ ID NO:6, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00147] In a very preferred further embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 20 to 80 nM, preferably 30 to 75 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 0.1 to 15 nM, preferably 1 to 12 nM, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format; wherein said monoclonal antibody comprises a gamma 2 heavy chain and a lambda light chain, wherein said gamma 2 heavy chain comprises or preferably consists of the peptide of SEQ ID NO:80, and wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:81.

[00148] In another preferred embodiment, the invention relates to a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is equal to, preferably 2 to 7 times higher, more preferably about 3 times higher, and most preferably 3 times higher than said binding of said monoclonal antibody to said (R)-(+)-nicotine, wherein preferably K_d is determined using said monoclonal antibody in the IgG2 format, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:6, and wherein preferably said LC CDR1 is located at

CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR. In again a still very preferred embodiment said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is lower than 80 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is lower than 15 nM, wherein further preferably K_d is determined using said monoclonal antibody in the IgG2 format, and wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1, and wherein preferably said HC CDR1 is located at CDR1 position within the framework of said HCVR; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2, and wherein preferably said HC CDR2 is located at CDR2 position within the framework of said HCVR; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of SEQ ID NO:4, and wherein preferably said HC CDR3 is located at CDR3 position within the framework of said HCVR; and, wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of SEQ ID NO:6, and wherein preferably said LC CDR1 is located at CDR1 position within the framework of said LCVR; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8, and wherein preferably said LC CDR2 is located at CDR2 position within the framework of said LCVR; and (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:10, and wherein preferably said LC CDR3 is located at CDR3 position within the framework of said LCVR.

[00149] It is to be understood that it is well within the skill of the artisan to use a HCVR of a first antibody specifically binding nicotine, to select a corresponding LCVR from a suitable source, and to create a second antibody, wherein said second antibody comprises said HCVR of said first antibody and the selected LCVR, and wherein said second antibody is capable of binding nicotine with about the same specificity as said first antibody ("chain shuffling", see Example 9). It is furthermore apparent for the artisan that in an analogous manner the LCVR of a first antibody can be used to select a corresponding HCVR from a suitable source. Suitable sources for the amplification of LCVRs and/or HCVRs are, for example, cDNA from

naive human B cells, cDNA from B cells of a human subject immunized with a Nicotine-carrier conjugate, and fully synthetic libraries, such as Morphosys' HuCAL library. These methods are described in detail in Kang AS et al. (Proc Natl Acad Sci USA 88, 11120-11123, 1991), Marks JDet al. (Biotechnology (N Y) 10, 779-783, 1992), and Jespers et al. (Biotechnology (N Y) 12, 899-903, 1994).

[00150] Thus, one further aspect of the invention is a HCVR of a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is specifically binding (S)-(-)-nicotine and (R)-(+)-nicotine, and wherein said HCVR comprises: (a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1; (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2; and (c) one HC CDR3, wherein said HC CDR3 consists of the peptide of any one of SEQ ID NOs 3 and 4.

[00151] In a preferred embodiment position 7 to 117 of said HCVR consists of the peptide of any one of SEQ ID NOs 24, 28, 33, and 39.

[00152] A further aspect of the invention is a LCVR of a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is specifically binding (S)-(-)-nicotine and (R)-(+)-nicotine, and wherein said LCVR comprises: (a) one LC CDR1, wherein said LC CDR1 consists of the peptide of any one of SEQ ID NOs 5, 6, and 7; (b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8; (c) one LC CDR3, wherein said LC CDR3 consists of the peptide of any one of SEQ ID NOs 9 and 10.

[00153] In a preferred embodiment position 5 to 107 of said LCVR consist of the peptide of any one of SEQ ID NOs 26, 31, 35, 37, and 41.

[00154] In a further aspect, the invention relates a nucleic acid molecule encoding a variable region or the invention, a monoclonal antibody of the invention or an individual chain thereof. In a preferred embodiment said nucleic acid molecule is encoding a peptide selected from (a) a HCVR of the invention, wherein preferably said HCVR comprises or preferably consists of the peptide of any one of SEQ ID NOs 24, 28, 33, 39, 43, and 47; (b) a LCVR of the invention, wherein preferably said LCVR comprises or preferably consists of the peptide of any one of SEQ ID NOs 26, 31, 35, 37, 41, 45, and 49; (c) a single chain antibody of the invention, wherein preferably said single chain antibody comprises or preferably consists of the peptide of any one of SEQ ID NOs 60, 62, 64, 66, 68, 70, and 72; (d) a gamma 2 heavy chain of the invention, wherein preferably said gamma 2 heavy chain comprises or preferably consists of the peptide of any one of SEQ ID NOs 73, 75, 77, 80, 82, and 84; (e) a lambda

light chain of the invention, wherein preferably said lambda light chain comprises or preferably consists of the peptide of any one of SEQ ID NOs 74, 76, 78, 79, 81, and 85, (f) a kappa light chain of the invention, wherein preferably said kappa light chain comprises or preferably consists of the peptide of SEQ ID NO:83; and (g) a monoclonal antibody of the invention.

[00155] In a further preferred embodiment said nucleic acid molecule comprises or consists of the nucleotide sequence of any one of SEQ ID NOs 23, 27, 29, 32, 38, 42 and 46; and/or of the nucleotide sequence of any one of SEQ ID NOs 25, 30, 34, 36, 40, 44, and 48; and/or of the nucleotide sequence of any one of SEQ ID NOs 59, 61, 63, 65, 67, 69, and 71.

[00156] In a further aspect, the invention relates to an expression vector comprising at least one nucleic acid molecule of the invention. Expression vectors suitable for the expression of the monoclonal antibodies of the invention are disclosed, for example, in PCT/EP2007/061570.

[00157] In a further aspect, the invention relates to a host cell comprising at least one nucleic acid molecule or at least one expression vector of the invention, wherein preferably said host cell is a bacteria cell or an eukaryotic cell. In a preferred embodiment said host cell is a eukaryotic cell selected from (a) yeast cell, (b) insect cell; and (c) mammalian cell, wherein preferably said mammalian cell is selected from HEK-293T cell, CHO cell, and COS cell. Very preferably, said mammalian cells is a HEK-293T cell.

[00158] The monoclonal antibody of the invention can be incorporated into compositions suitable for administration to a subject. Thus, in a further aspect, the invention relates to a pharmaceutical composition comprising at least one monoclonal antibody of the invention, wherein preferably said pharmaceutical composition further comprises a pharmaceutically acceptable carrier, diluent or excipient. Pharmaceutically acceptable carriers, diluents and excipients are disclosed, for example, in Remington, The Science and Practice of Pharmacy, 19th edition, Gennaro (ed.), Mack publishing Co., Easton, PA, 1995. Pharmaceutical compositions of the invention are administered in a single dose or in multiple doses.

[00159] In a preferred embodiment said pharmaceutical composition, further comprises at least one further antibody, wherein preferably said at least one further antibody is specifically binding nicotine.

[00160] The monoclonal antibodies of the invention may be used in passive immunization, preferably of humans, and further preferably against nicotine. The monoclonal antibodies of the invention are therefore useful in the treatment of nicotine addiction. In a further aspect, the invention relates to a method of passive immunization, preferably against nicotine, said

method comprising administering to a subject an effective amount of the monoclonal antibody of the invention or an effective amount of the pharmaceutical composition of the invention.

[00161] The monoclonal antibody and/or the pharmaceutical composition of the invention are preferably administered to a subject, preferably to a human, using standard administration techniques, preferably selected from oral administration, intravenous administration, intraperitoneal administration, subcutaneous administration, pulmonary administration, transdermal administration, intramuscular administration, intranasal administration, buccal administration, sublingual administration, and suppository administration.

[00162] In a further aspect, the invention relates to a method of treating nicotine addiction, said method comprising administering to a subject an effective amount of the monoclonal antibody of the invention or an effective amount of the pharmaceutical composition of the invention, wherein preferably said subject is a human, and wherein further preferably said subject is addicted to nicotine.

[00163] In a further aspect, the invention relates to the monoclonal antibody of the invention or to the pharmaceutical composition of the invention, for use in passive immunization, preferably against nicotine, preferably in a human, wherein further preferably said monoclonal antibody is to be administered to said human.

[00164] In a further aspect, the invention relates to the monoclonal antibody of the invention or to the pharmaceutical composition of the invention, for use in the treatment of nicotine addiction, preferably in a human.

[00165] In a further aspect, the invention relates to the use of the monoclonal antibody of the invention in the manufacture of a medicament for passive immunization, preferably against nicotine.

[00166] In a further aspect, the invention relates to a monoclonal antibody of the invention for use in passive immunization, preferably against nicotine.

[00167] In a further aspect, the invention relates to the use of the monoclonal antibody of the invention in the manufacture of a medicament for the treatment of nicotine addiction, preferably in a human.

[00168] In a further aspect, the invention relates to a monoclonal antibody of the invention for use in a method of treating nicotine addiction, preferably in a human.

[00169] A further aspect of the invention is the use of an antibody of the invention in a method of quantitative and/or qualitative detection of nicotine, preferably in a blood sample and most preferably by ELISA.

[00170] It is to be understood that the all aspects of the invention relate to any monoclonal antibody which is disclosed herein.

EXAMPLES

EXAMPLE 1

Identification of Nicotine-specific single-chain antibodies by mammalian cell display

[00171] Peripheral blood mononuclear cells (PBMC) were isolated from 32 ml of heparinized blood of a Q β -Nicotine-vaccinated volunteer using the BD VacutainerTM CPTTM Tube method (BD Bioscience). PBMC were pre-incubated with Alexa 647nm-labeled Q β (3 μ g/ml) and mouse gamma globulin (10 μ g/ml; Jackson ImmunoResearch) and then stained with: (1) Q β -Nicotine(1 μ g/ml) in combination with a Alexa 488nm-labeled Q β -specific mouse mAb (1 μ g/ml) and a Alexa 488nm-labeled Nicotine-specific mouse mAb (1 μ g/ml); (2) PE-labeled mouse anti-human IgM (diluted 1:50; BD Biosciences Pharmingen), mouse anti-human IgD (diluted 1:100; BD Biosciences Pharmingen), mouse anti-human CD14 (diluted 1:50; BD Biosciences Pharmingen), and mouse anti-human CD3 (diluted 1:50; BD Biosciences Pharmingen) antibodies; and (4) PE-TexasRed-labeled mouse anti-human CD19 antibody (diluted 1:50; Caltag Laboratories). After staining, cells were washed and filtered, and 443 Nicotine-specific B cells (FL1-positive, FL2-negative, FL3-positive, FL4-negative) were sorted on a FACSVantage SE flow cytometer (Becton Dickinson).

[00172] Antigen-specific B cells were used for the construction of a Sindbis-based scFv cell surface display library essentially as described (see WO1999/025876A1 for Sindbis-based screening in general and PCT/EP2007/061570 for its application in antibody screening). Cells displaying Nicotine-specific scFv antibodies were isolated using RNase-Nicotine in combination with an RNase-specific rabbit polyclonal antibody (2.5 μ g/ml; Abcam) and a FITC-labeled donkey anti-rabbit IgG antibody (1.5 μ g/ml; Jackson ImmunoResearch). Each cell was sorted into a well of a 24-well plate containing 50 % confluent BHK feeder cells. Upon virus spread (2 days post sorting), the infected cells were tested by FACS analysis for Nicotine-binding to identify virus clones encoding Nicotine-specific scFv antibodies.

EXAMPLE 2

Gene rescue, ELISA screening and sequencing of Nicotine-specific antibodies

[00173] The supernatants of BHK cells encoding putative Nicotine-specific antibodies, each containing a monoclonal recombinant Sindbis virus, were subjected to RT-PCR as described

(see application PCT/EP2007/061570). The resulting PCR products, each comprising a scFv coding region, were digested with the restriction endonuclease SfiI and cloned into the expression vector pCEP-SP-Sfi-Fc (disclosed as SEQ ID NO:37 in application PCT/EP2007/061570), allowing for expression of scFv proteins fused to a C-terminal human Fc- γ 1 domain under the control of a CMV promoter.

[00174] For ELISA analysis, each of the clones was transfected into HEK-293T cells in a 24-well plate format, using Lipofectamin 2000 (Invitrogen) according to the manufacturer's recommendations. 2-3 days post transfection, supernatants containing transiently expressed scFv-Fc fusion proteins were harvested. To check for Nicotine-specific binding, ELISA plates were coated with Nicotine-conjugated RNase at a concentration of 4 μ g/ml in phosphate-buffered saline (PBS) over night at 4°C. In parallel, scFv-Fc expression levels were monitored in by sandwich ELISA. For this, an identical set of plates was coated with Fc γ -specific, goat anti-human F(ab')₂ antibody (Jackson ImmunoResearch Laboratories 109-006-098) at a concentration of 2.5 μ g/ml. The plates were then washed with wash buffer (PBS/0.05 % TweenTM) and blocked for 2h at room temperature with 3 % BSA in wash buffer. The plates were then washed again and incubated with 3-fold serial dilutions of the cell culture supernatants, starting at a dilution of 1/10. All dilutions were done in wash buffer. Plates were incubated at room temperature for 2 h and then extensively washed with wash buffer. Bound scFv-Fc fusion proteins were then detected by a 1 h incubation with a HRPO-labeled, Fc γ -specific, goat anti-human IgG antibody (Jackson ImmunoResearch Laboratories 109-035-098). After extensive washing with wash buffer, plates were developed with OPD solution (1 OPD tablet, 25 ml OPD buffer and 8 μ l 30 % H₂O₂) for 5 to 10 minutes and the reaction was stopped with 5 % H₂SO₄ solution. Plates were then read at OD 450 nm on an ELISA reader (Biorad Benchmark).

[00175] ELISA-positive clones encoding Nicotine-specific scFv antibodies were sequenced as described (see application PCT/EP2007/061570), including clones F018, F063, J004, J042, N049, I022 and N038 (see Table 2).

Table 2. SEQ ID NOs of nucleic acid sequences and amino acid sequences of nicotine specific scFv antibodies.

scFv	Nucleic Acid Sequence	Amino Acid Sequence
F018	59	60
F063	61	62
J004	63	64
J042	65	66
N049	67	68
I022	69	70
N038	71	72

[00176] Among these, all heavy chain variable regions comprised VH4 family sequences (SEQ ID NOs 24, 28, 33, 39, 43, and 47). The light chain variable regions comprised V λ 1 family sequences (SEQ ID NOs 26, 31, 35, 37, 41, and 49), with the exception of I022, which comprised a V κ 3 sequence (SEQ ID NO:45). Significantly, heavy and light chain variable regions of antibodies F018, F063, J004, J042 and N049 were very closely related to one another and differed only at few amino acid positions. The heavy chain variable regions of clones F063 and J042 were identical (SEQ ID NO:28). An overview over nucleic acid sequences and amino acid sequences comprised by the variable regions of nicotine binding antibodies is provided in Table 3.

Table 3. SEQ ID NOs of nucleic acid sequences and amino acid sequences comprised by HCVRs and LCVRs of nicotine specific antibodies.

scFv	Nucleic Acid Sequence (HCVR) ¹	Amino Acid Sequence (HCVR)	Nucleic Acid Sequence (LCVR) ²	Amino Acid Sequence (LCVR)
F018	23	24	25	26
F063	27	28	30	31
J004	32	33	34	35
J042	29	28	36	37
N049	38	39	40	41
I022	42	43	44 ³	45
N038	46	47	48	49

¹⁾ all HCVRs comprise VH4 sequences;

²⁾ all LCVRs except the LCVR of I022 comprise V lambda 1 sequences;

³⁾ LCVR of I022 comprises a V kappa 3 sequence;

EXAMPLE 3

Expression and purification of Nicotine-specific scFv-Fc fusion proteins

[00177] Large-scale expression of scFv-Fc fusion proteins was done in HEK-293T cells. One day before transfection, 5×10^6 293T cells were plated onto a 10 cm tissue culture plate for each protein to be expressed. Cells were then transfected with the respective scFv-Fc fusion construct using Lipofectamin Plus (Invitrogen) according to the manufacturer's recommendations, incubated one day, and replated on one 14 cm dish in the presence of 1 $\mu\text{g/ml}$ puromycin. After 3 days of selection, puromycin-resistant cells were transferred to three Poly-L-Lysine coated 14 cm plates and grown to confluency. Medium was then replaced by serum-free medium and supernatants containing the respective scFv-Fc fusion protein was collected every 3 days and filtered through a 0.22 μM Millex GV sterile filter (Millipore).

[00178] For each of the scFv-Fc fusion proteins, the consecutive harvests were pooled and applied to a protein A-sepharoseTM column. The column was washed with 10 column volumes of phosphate-buffered saline (PBS), and bound protein eluted with 0.1 M Glycine pH 3.6. 1 ml fractions were collected in tubes containing 0.1 ml of 1 M Tris pH 7.5 for neutralization. Protein-containing fractions were analyzed by SDS-PAGE and pooled. The buffer was exchanged with PBS by dialysis using 10'000 MWCO Slide-A-Lyzer dialysis cassettes (Pierce). The purified proteins in PBS were then filtered through 0.22 μM Millex GV sterile filters (Millipore) and aliquotted. Working stocks were kept at 4°C, whereas aliquots for long-term storage were flash-frozen in liquid nitrogen and kept -80°C.

EXAMPLE 4

Verification of Nicotine-specific binding by inhibition ELISA

[00179] To exclude possible linker specificity of the antibodies, binding to free Nicotine was verified by inhibition ELISA. Thus, ELISA plates were coated with Nicotine-conjugated RNase at a concentration of 4 $\mu\text{g/ml}$ in phosphate-buffered saline (PBS), over night at 4°C. The plates were then washed with wash buffer (PBS/0.05 % TweenTM) and blocked for 2 h at room temperature with 3 % BSA in wash buffer. The plates were then washed again and incubated with purified scFv-F018, scFv-F063, scFv-I022, scFv-J004, scFv-N038 and scFv-N049 at a concentration of 100ng/ml in the absence or presence of increasing concentrations of free nicotine (0.1 to 100 μM). Plates were incubated at room temperature for 2 h and then

extensively washed with wash buffer. Bound scFv-Fc fusion proteins were then detected by a 1 h incubation with a HRPO-labeled, Fc γ -specific, goat anti-human IgG antibody (Jackson ImmunoResearch Laboratories 109-035-098). After extensive washing with wash buffer, plates were developed with OPD solution (1 OPD tablet, 25 ml OPD buffer and 8 μ l 30% H₂O₂) for 5 to 10 minutes and the reaction was stopped with 5 % H₂SO₄ solution. Plates were then read at OD 450 nm on an ELISA reader (Biorad Benchmark). Binding of each of the antibodies to immobilized nicotine was efficiently inhibited by free nicotine, with IC₅₀ values in the low micromolar range.

EXAMPLE 5

Construction, expression, and purification of human Nicotine-specific IgG2

[00180] The heavy and light chain variable region coding segments of scFv-F018, scFv-F063, scFv-I022, scFv-J004, scFv-J042, scFv-N038 and scFv-N049 were amplified by PCR using variable region-specific transfer primers (disclosed as SEQ ID NOs 92 to 103 of application PCT/EP2007/061570). For example, the DNA encoding the light chain variable region of antibody F018 was amplified using the primers VL-SacI-F4 (5'-CAG GCG GCC GAG ATC GAG CTC ACT CAG C-3') and VL-EcoR5-B1 (5'-ACC GCC GAG GAT ATC CAG CTG GGT-3'). The DNA encoding the heavy chain variable region was amplified with the primers VH-XhoI-F (5'-SAG GTG CAG CTG CTC GAG TCK GG-3') and VH-ApaI-B (5'-GCC ACT AGT GAC CGA TGG GCC-3'). The DNAs encoding the other light and heavy chain variable regions were amplified accordingly.

[00181] The resulting λ or κ light chain variable region PCR products were digested with the restriction enzymes SacI and EcoR5, purified by agarose gel electrophoresis, and ligated into SacI-EcoR5 digested pCMV-LC- λ or pCMV-LC- κ , respectively (disclosed as SEQ ID NOs 110 and 71 of application PCT/EP2007/061570). The resulting vectors allow for expression of complete human light chains, including the signal peptide, e.g. the F018 λ light chain (SEQ ID NO:56). Similarly, the heavy chain variable region PCR products were digested with the restriction enzymes XhoI and ApaI, gel purified, and ligated into XhoI-ApaI digested pCMV-HC- γ 2 (disclosed as SEQ ID NO:78 of application PCT/EP2007/061570). The resulting vectors allow for expression of complete human γ 2 heavy chains, including the signal peptide, e.g. the F018 γ 2 heavy chain (SEQ ID NO:55).

[00182] Co-expression of each of the pCMV-LC- λ or - κ expression constructs with the corresponding pCMV-HC- γ 2 expression construct in principle allows for the production of whole IgG2. However, to increase yields and facilitate large-scale production of antibodies, heavy and light chain coding regions were first combined into a single, EBNA-based expression vector, pCB15 (disclosed as SEQ ID NO:104 of application PCT/EP2007/061570). For instance, for expression of antibody F018 as a whole IgG2, the γ 2 heavy chain coding region was excised from pCMV-F018-HC- γ 2 by digestion with the restriction enzymes AscI and PacI, the resulting 1403 bp fragment purified by agarose gel electrophoresis, and then ligated into AscI-PacI digested pCB15, yielding pCB15-F018-HC- γ 2. The F018 λ light chain coding region was then excised from pCMV-F018-LC- λ by digestion with NheI and PmeI, the resulting 723 bp fragment gel-purified, and then ligated into NheI-PmeI digested pCB15-F018-HC- γ 2, yielding the whole IgG expression vector pCB15-F018-IgG2 λ . Expression of whole IgG was done in HEK-293T cells, exactly as described for the scFv-Fc fusion proteins (Example 2).

EXAMPLE 6

Construction, expression, and purification of fully human Nicotine-specific IgG2

[00183] The pCB15 expression vectors constructed as described in Example 4 direct the synthesis of whole IgG2 molecules that are largely human. However, compared to a fully human antibody, there are still two minor differences. First, the sequence of the heavy or light chain signal peptide is encoded by the expression vector and typically does not correspond to the native signal peptide of the variable region in question. Second, amino acid positions flanking the heavy or light chain variable region are predetermined by the vector, e.g. due to the presence of restriction sites. Thus, in order to generate fully human mAbs, these differences need to be corrected for each of the heavy and light chain expression vectors.

For example, a vector directing expression of a fully human F018 γ 2 heavy chain, including the native signal peptide (SEQ ID NO:57) was generated as follows. The F018 heavy chain variable region was first amplified by PCR from the plasmid pCMV-F018-HC- γ 2 using the primers F018-HC-fh-F1 (5'-TTC CTC CTG TTG GTG GCA GCA CCC AGG TGG GTG CTG TCC CAG CTG CAA CTG CAG GAG TC-3') and F018-HC-fh-B1 (5'-GAC CGA TGG GCC CTT GGT GGA AGC-3'). The resulting PCR product was then further amplified

using the primers F018-HC-fh-F2 (5'-GAG GGC GCG CCA CCA TGA AGC ACC TGT GGT TCT TCC TCC TGT TGG TGG CAG C-3') and F018-HC-fh-B1. The final PCR product was digested with the restriction enzymes AscI and ApaI, purified by agarose gel electrophoresis, and ligated into AscI-ApaI digested pCMV-HC- γ 2, yielding the plasmid pCMV-fhF018-HC- γ 2.

[00184] Similarly, a vector directing expression of a fully human F018 λ light chain including the native signal peptide (SEQ ID NO:58) was generated as follows. First, the F018 light chain variable region was amplified by PCR from pCMV-F018-LC- λ using the primers F018-LC-fh-F1 (5'-CCT CCT CAC CCT CCT CAC TCA CTG CGC CGG GTC CTG GGC CCA GTC TGT GCT CAC-3') and F018-LC-fh-B1 (5'-GGG CTG ACC TAG CAC GGT CAG CTG GGT GCC-3'). In parallel, the λ light chain was amplified using the primers F018-LC-fh-F3 (5'-GGC ACC CAG CTG ACC GTG CTA GGT CAG CCC-3') and T7 (5'-TAA TAC GAC TCA CTA TAG GG-3'). Second, the resulting PCR products were assembled by PCR using the primers F018-LC-fh-F2 (5'-GAG GCT AGC GCC ACC ATG GCC GGC TTC CCC CTC CTC CTC ACC CTC CTC ACT C-3') and T7. The final PCR product was digested with the restriction enzymes NheI and PmeI, purified by agarose gel electrophoresis, and ligated into NheI-PmeI digested pCMV-LC- κ , yielding the plasmid pCMV-fhF018-LC- λ .

[00185] The vector pCB15-fhF018-IgG2 λ , directing the expression of a fully human mAb F018, was constructed by sequential cloning of heavy and light chain coding regions into pCB15, using the cloning strategy set forth in Example 4. Expression vectors directing expression of fully human mAbs F063, I022, J004, J042, N038 and N049 are constructed in a similar manner.

EXAMPLE 7

Determination of Affinities by Equilibrium Dialysis.

[00186] Affinity of antibodies for (S)-(-)-nicotine was determined by equilibrium dialysis using a DispoEquilibriumDialyzer (Harvard Biosciences). Two chambers of the dialyzer were separated by a membrane (10'000 Da cut-off). One chamber was filled with purified scFv-Fc or IgG2 at a concentration of 5.4 μ g/ml or 7.5 μ g/ml in PBS/2% BSA, respectively, whereas the other chamber did not contain antibody. Concentrations of tritium-labeled (S)-(-)-nicotine

(Amersham) ranging from 3 to 444 nM were used. Equilibrium dialysis was allowed to proceed for 48-72 h. Aliquots from both sides of the chamber were taken and radioactivity measured in a scintillation counter. Radioactivity corresponding to antibody-bound (S)-(-)-nicotine was calculated by subtracting the radioactivity measured for the chamber containing no antibody from the one containing the antibody. The free (S)-(-)-nicotine concentration was determined from the radioactivity measured for the chamber containing no antibody. The equilibrium dissociation constant (K_d) was derived from the fit of a one-site binding model to the measured bound radioactivity as a function of the free (S)-(-)-nicotine concentration. Most nicotine-specific antibodies bound free (S)-(-)-nicotine with K_d values in the low nanomolar range (Table 4). The IgG2 antibodies had affinities comparable to the scFv-Fc, with K_d values that differed by no more than approximately 2-fold. The IgG2-F018 had a dissociation constant of 7 nM, almost 2-fold lower than the one measured for scFv-Fc-F018 and at least 4 times lower than the K_d of the other IgG2. It is noteworthy that the affinity of polyclonal antibodies against (S)-(-)-nicotine is in the range of 30-70 nM, *i.e.* considerably lower than the affinity of clone F018 (Maurer P. et al., 2005, Eur. J. Immunol. 35, 2031-2040).

Table 4. Dissociation constants K_d values (nM) measured by equilibrium dialysis. Values shown are the mean $\pm$ SD of at least 2 independent experiments, except for IgG2-N038, which was measured only once.

format	F018	F063	I022	J004	J042	N038	N049
scFv-Fc	11.5 $\pm$ 1.5	70.5 $\pm$ 14	42.5 $\pm$ 17	33.3 $\pm$ 2	47.0 $\pm$ 3.1	686.3 $\pm$ 58	72.7 $\pm$ 5.6
IgG2	7.4 $\pm$ 1.2	31.4 $\pm$ 13	89.9 $\pm$ 9.8	64.5 $\pm$ 2.2	30.2 $\pm$ 11	743.8	35.6 $\pm$ 3.5

[00187] Cross-reactivity of mAb IgG2-F018 to (-)-cotinine and acetylcholine was determined by co-incubation of 10 fold serial dilutions of these compounds (1 nM to 100 μ M) with 56 nM tritium-labeled (S)-(-)-nicotine in the equilibrium dialysis chambers as described above (Figure 1). As expected, unlabeled (-)-nicotine readily displaced tritium-labeled (S)-(-)-nicotine. In contrast, acetylcholine, which is structurally unrelated to nicotine but binds to the same binding pocket of the nicotinic acetylcholine receptor (Celie P.H. et al., 2004, Neuron 41, 907-914), did not interfere with (S)-(-)-nicotine binding even at a 4000 fold molar excess. Similarly, (-)-cotinine, which is the major metabolic product of (S)-(-)-nicotine and present in

a 10-20 fold molar excess over nicotine in the blood of smokers (Benowitz N.L., 1997, Br. J. Clin. Pharmacol. 43, 259-267), did not effectively compete with (S)-(-)-nicotine for binding to IgG2-F018. Based on the IC₅₀ observed, it can be estimated that IgG2-F018 binds (-)-cotinine about 1000 fold less strongly than (S)-(-)-nicotine. Therefore, the presence of a molar excess of (-)-cotinine in the blood of a smoker is unlikely to interfere with the therapeutic efficacy of IgG2-F018.

[00188] We next determined the affinities of mAbs IgG2-F018, -F063, -J004, -J042 and -N049 for the (R)-(+)-isomer of nicotine. This stereoisomer is present in the tobacco plant. In addition, it can be formed by the combustion process during smoking and has qualitatively similar activities on the central nervous system as (S)-(-)-nicotine (Hukkanen J. et al., 2005, Pharmacol. Rev. 57, 79-115). Thus, the binding of a fixed concentration of tritium-labeled (S)-(-)-nicotine (F018: 56 nM; F063, J004, J042, N049: 111 nM) to each of the antibodies was measured by equilibrium dialysis in the presence of increasing concentrations of unlabeled (R)-(+)-nicotine (1 nM to 100 μ M). The equilibrium dissociation constant (K_d) was derived from the fit of a one-site competition model to the measured bound radioactivity as a function of the (R)-(+)-nicotine concentration. Surprisingly, (R)-(+)-nicotine was highly efficient in competing with (S)-(-)-nicotine for binding to each of the antibodies, with K_d values that were about 2 to 5 fold lower than those of (S)-(-)-nicotine (Table 5).

Table 5. Dissociation constants K_d (nM) of antibody-(R)-(+)-nicotine interactions measured by equilibrium dialysis.

format	F018	F063	J004	J042	N049
IgG2	3.1	6.6	12.6	7.7	10.5

EXAMPLE 8

Evaluation of Nicotine distribution in Plasma and Brain in Mice.

[00189] Groups of 5 to 6 female Balb/c mice were injected i.p. with 0.1 to 3 mg of each of the recombinant human IgG2 monoclonal antibodies. One day later, inhibition of nicotine entry into the brain was analyzed by intravenous injection of tritium-labelled (S)-(-)-nicotine (Amersham) (375, 750 or 1500 ng) into the tail vein. Mice were sacrificed 5 min later by CO₂ asphyxiation and blood and brain were collected. Nicotine concentrations in serum and brain

were calculated from the radioactivity present. Brain nicotine concentration was corrected for the blood content of brain (3 μ l/100 mg). The percent reduction of nicotine uptake into the brain was calculated relative to the nicotine concentrations found in brains of mice injected with control IgG. With all nicotine-specific antibodies tested, a reduction in the distribution of nicotine to the brain was observed. With most antibodies, the reduction observed at a dose of 0.5 mg per mouse was typically 40 % or more. The most potent mAb under these experimental conditions was F018, which consistently reduced entry of nicotine to the brain by more than 60 % (Tables 6 and 7).

Table 6. Inhibition of nicotine entry into brain of mice by nicotine-specific antibodies (passive immunization with 0.5 mg IgG2; challenge with 750 ng nicotine).

antibody	brain nicotine (cpm/g)	% reduction
control IgG	131559 $\pm$ 14650	-
F018	46717 $\pm$ 3550	64
J004	77002 $\pm$ 9293	41
J042	72678 $\pm$ 7423	45
N049	68395 $\pm$ 2885	48

Table 7. Inhibition of nicotine entry into brain of mice by nicotine-specific antibodies (passive immunization with 0.5 mg IgG2; challenge with 750 ng nicotine).

antibody	brain nicotine (cpm/g)	% reduction
control IgG	114048 $\pm$ 13786	-
F018	42803 $\pm$ 3751	62
F063	54783 $\pm$ 3909	52
I022	68687 $\pm$ 5498	40
N038	91823 $\pm$ 14311	19

EXAMPLE 9

Use of the heavy chain variable region of anti-Nicotine antibody F018 to identify a complementary light chain variable region (“chain shuffling”).

[00190] The nucleotide sequence of all primers used in the present example, and for which no sequence is provided herein can be found under the identical designation in: Phage Display - A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2001, Protocol 9.2.

[00191] The DNA sequence encoding the heavy chain variable region of antibody F018 is amplified by PCR from a DNA molecule comprising the scFv-F018 sequence (SEQ ID NO:59) using the primers HSCVH35-FL and HSC-F018-B (5'-CCT GGC CGG CCT GGC CAC TAG TGA CCG ATG GGC CCT TGG TGG AAG C-3', SEQ ID NO:86). A library of DNA sequences encoding human κ light chain variable regions is amplified by PCR from the cDNA of B cells from a human subject immunized with a Nicotine-carrier conjugate, using an equimolar mix of the 4 sense primers HSCK1-F, HSCK24-F, HSCK3-F and HSCK5-F, plus an equimolar mix of the 4 antisense primers HSCJK14o-B, HSCJK2o-B, HSCJK3o-B and HSCJK5o-B. A library of DNA sequences encoding human λ light chain variable regions is amplified by PCR from the cDNA of B cells from a human subject immunized with a Nicotine-carrier conjugate, using an equimolar mix of the 9 sense primers HSCLam1a, HSCLam1b, HSCLam2, HSCLam3, HSCLam4, HSCLam6, HSCLam78, HSCLam9 and HSCLam10, plus an equimolar mix of 3 antisense primers HSCJLam1236, HSCJLam4 and HSCJLam57.

[00192] For selection of complementary light chain variable regions, scFv coding regions are assembled by PCR overlap extension of the F018 VH PCR product with either the the V κ library PCR product or the V λ library PCR product using the primers RSC-F and RSC-B. The resulting ~750-800 bp PCR products encode a 5' light chain variable region library (either κ or λ) and the 3' heavy chain variable region of Nicotine-specific antibody F018, linked by an 18 amino acid flexible linker, and flanked by two SfiI restriction sites. The scFv- κ and - λ library fragments are pooled in equimolar ratio, digested with the restriction endonuclease SfiI, and cloned into the vector pDel-SP-TM for screening by Sindbis-based scFv cell surface display essentially as described in Example 1. Alternatively, the SfiI-digested scFv library fragments are cloned into SfiI-digested pComb3H (Rader C, Barbas CF 3rd., 1997, Curr Opin Biotechnol. 8, 503-508). Antibodies are then expressed and selected for binding to immobilized RNase-Nicotine conjugate by phage display using procedures described (Phage Display: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2001).

SEQUENCE LISTING IN ELECTRONIC FORM

In accordance with Section 111(1) of the Patent Rules, this description contains a sequence listing in electronic form in ASCII text format (file: 52039-20 Seq 10-MAY-10 v1.txt).

A copy of the sequence listing in electronic form is available from the Canadian Intellectual Property Office.

The sequences in the sequence listing in electronic form are reproduced in the following table.

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Bauer, Monika
Beerli, Roger

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 20 25 30
 Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Trp Ile Gly Ser Ile Ser
 35 40 45
 Tyr Ser Gly Ser Thr Tyr Tyr Asn Pro Ser Leu Lys Ser Arg Val Thr
 50 55 60

71

```

Ile Ser Val Asp Thr Ser Lys Asn Gln Phe Ser Leu Lys Leu Thr Ser
65          70          75          80
Val Thr Ala Ala Asp Thr Ala Val Tyr Tyr Cys Ala Arg Ile Leu Trp
          85          90          95
Phe Gly Glu Tyr Leu Gly Asp Tyr Trp Gly Gln Gly Thr Leu Val Thr
          100          105          110
Val Ser Ser
          115

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<210> 44
<211> 300
<212> DNA
<213> Homo sapiens

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<400> 44
accagtcctc caggcaccct gtctttgtct ccaggggaaa gagccaccct ctctgcagg      60
gccagtcaga gtgtagcaa ctacttagcc tggtagcagg agaaacctgg ccaggctccc      120
aggctcctca tctatgggtgc atccagcagg gccactggca tcccagacag gttcagtggc      180
agtgggtctg ggacagactt cactctcacc atcagcagac tggagcctga agattttgca      240
gtgtatcact gtcagcaata ttatagtact ccgtggacgt tcggccaagg gaccaaagtg      300

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<210> 45
<211> 100
<212> PRT
<213> Homo sapiens

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<400> 45
Thr Gln Ser Pro Gly Thr Leu Ser Leu Ser Pro Gly Glu Arg Ala Thr
1          5          10          15
Leu Ser Cys Arg Ala Ser Gln Ser Val Ser Asn Tyr Leu Ala Trp Tyr
          20          25          30
Gln Gln Lys Pro Gly Gln Ala Pro Arg Leu Leu Ile Tyr Gly Ala Ser
          35          40          45
Ser Arg Ala Thr Gly Ile Pro Asp Arg Phe Ser Gly Ser Gly Ser Gly
          50          55          60
Thr Asp Phe Thr Leu Thr Ile Ser Arg Leu Glu Pro Glu Asp Phe Ala
65          70          75          80
Val Tyr His Cys Gln Gln Tyr Tyr Ser Thr Pro Trp Thr Phe Gly Gln
          85          90          95
Gly Thr Lys Val
          100

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<210> 46
<211> 345
<212> DNA
<213> Homo sapiens

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<400> 46
tctggcccag gactggtgaa gccttcggag accctgtccc tcacctgcgc tgtctctggt      60
tactccatca gcagtgggta ctactggggc tggatccggc agccccagg gaaggggctg      120
gagtggattg ggagtagcaa tcatagtggg agcacctact acaaccgctc cctcaggagt      180
cgagtcacca tatcagtaga cacgtccaag aaccaattct ccctgaaggc gaactctgtg      240
accgccgcag acacggccgt ttattactgt gcgagagagg cggggatatag cagcagctgg      300
tactttgact actgggggtca gggaaccctg gtcaccgtct cctca                345

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<210> 47
 <211> 115
 <212> PRT
 <213> Homo sapiens

<400> 47
 Ser Gly Pro Gly Leu Val Lys Pro Ser Glu Thr Leu Ser Leu Thr Cys
 1 5 10 15
 Ala Val Ser Gly Tyr Ser Ile Ser Ser Gly Tyr Tyr Trp Gly Trp Ile
 20 25 30
 Arg Gln Pro Pro Gly Lys Gly Leu Glu Trp Ile Gly Ser Ser Asn His
 35 40 45
 Ser Gly Ser Thr Tyr Tyr Asn Pro Ser Leu Arg Ser Arg Val Thr Ile
 50 55 60
 Ser Val Asp Thr Ser Lys Asn Gln Phe Ser Leu Lys Val Asn Ser Val
 65 70 75 80
 Thr Ala Ala Asp Thr Ala Val Tyr Tyr Cys Ala Arg Glu Ala Gly Tyr
 85 90 95
 Ser Ser Ser Trp Tyr Phe Asp Tyr Trp Gly Gln Gly Thr Leu Val Thr
 100 105 110
 Val Ser Ser
 115

<210> 48
 <211> 309
 <212> DNA
 <213> Homo sapiens

<400> 48
 acgcagccgc cctcagtgtc tgcggcccca ggacagaagg tcaccatctc ctgctctgga 60
 agcagctcca acattgggaa taattatgta tcctggtacc agcagctccc aggaacagcc 120
 cccaaactcc tcatttatga caataataag cgaccctcag ggattcctga ccgattctct 180
 ggctccaagt ctggcacgtc agccaccctg ggcatcaccg gactccagac tggggacgag 240
 gccgattatt actgcggaac atgggatagc agcctgagtg cttgggtgtt cggcggaggg 300
 acccagctg 309

<210> 49
 <211> 103
 <212> PRT
 <213> Homo sapiens

<400> 49
 Thr Gln Pro Pro Ser Val Ser Ala Ala Pro Gly Gln Lys Val Thr Ile
 1 5 10 15
 Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly Asn Asn Tyr Val Ser Trp
 20 25 30
 Tyr Gln Gln Leu Pro Gly Thr Ala Pro Lys Leu Leu Ile Tyr Asp Asn
 35 40 45
 Asn Lys Arg Pro Ser Gly Ile Pro Asp Arg Phe Ser Gly Ser Lys Ser
 50 55 60
 Gly Thr Ser Ala Thr Leu Gly Ile Thr Gly Leu Gln Thr Gly Asp Glu
 65 70 75 80
 Ala Asp Tyr Tyr Cys Gly Thr Trp Asp Ser Ser Leu Ser Ala Trp Val
 85 90 95
 Phe Gly Gly Gly Thr Gln Leu
 100

<210> 50
 <211> 6
 <212> PRT
 <213> Homo sapiens

<220>
 <221> A1
 <222> (2)..(2)
 <223> Xaa is any amino acid selected from valine and leucine

<220>
 <221> A2
 <222> (6)..(6)
 <223> Xaa is any amino acid selected from glutamic acide and glutamine

<400> 50
 Gln Xaa Gln Leu Gln Xaa
 1 5

<210> 51
 <211> 4
 <212> PRT
 <213> Homo sapiens

<400> 51
 Gln Ser Val Leu
 1

<210> 52
 <211> 4
 <212> PRT
 <213> Homo sapiens

<220>
 <221> A1
 <222> (4)..(4)
 <223> Xaa is any amino acid selected from leucine and methionine

<400> 52
 Glu Ile Val Xaa
 1

<210> 53
 <211> 3
 <212> PRT
 <213> Homo sapiens

<400> 53
 Thr Val Leu
 1

<210> 54
 <211> 3
 <212> PRT
 <213> Homo sapiens

<220>
 <221> A1
 <222> (1)..(1)
 <223> Xaa is any amino acid selected from aspartic acid and glutamic acid

<400> 54
 Xaa Ile Lys
 1

<210> 55
 <211> 462
 <212> PRT
 <213> Homo sapiens

<400> 55
 Met Asp Trp Thr Trp Arg Ile Leu Phe Leu Val Ala Ala Ala Thr Gly
 1 5 10 15
 Ala His Ser Gln Met Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys
 20 25 30
 Pro Ser Glu Thr Leu Ser Leu Thr Cys Thr Val Ser Gly Gly Ser Ile
 35 40 45
 Trp Gly Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Trp Ile Gly
 50 55 60
 Ser Ile Tyr Ser Ser Gly Ser Thr Tyr Tyr Asn Pro Ser Leu Lys Ser
 65 70 75 80
 Arg Val Thr Thr Ser Val Asp Thr Ser Lys Asn Gln Phe Ser Leu Arg
 85 90 95
 Leu Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Tyr Cys Val Ala
 100 105 110
 Trp Phe Gly Asp Leu Leu Ser Leu Lys Gly Val Glu Leu Trp Gly Gln
 115 120 125
 Gly Thr Leu Val Thr Val Ser Ser Ala Ser Thr Lys Gly Pro Ser Val
 130 135 140
 Phe Pro Leu Ala Pro Cys Ser Arg Ser Thr Ser Glu Ser Thr Ala Ala
 145 150 155 160
 Leu Gly Cys Leu Val Lys Asp Tyr Phe Pro Glu Pro Val Thr Val Ser
 165 170 175
 Trp Asn Ser Gly Ala Leu Thr Ser Gly Val His Thr Phe Pro Ala Val
 180 185 190
 Leu Gln Ser Ser Gly Leu Tyr Ser Leu Ser Ser Val Val Thr Val Pro
 195 200 205
 Ser Ser Asn Phe Gly Thr Gln Thr Tyr Thr Cys Asn Val Asp His Lys
 210 215 220
 Pro Ser Asn Thr Lys Val Asp Lys Thr Val Glu Arg Lys Cys Cys Val
 225 230 235 240
 Glu Cys Pro Pro Cys Pro Ala Pro Pro Val Ala Gly Pro Ser Val Phe
 245 250 255
 Leu Phe Pro Pro Lys Pro Lys Asp Thr Leu Met Ile Ser Arg Thr Pro
 260 265 270
 Glu Val Thr Cys Val Val Val Asp Val Ser His Glu Asp Pro Glu Val
 275 280 285
 Gln Phe Asn Trp Tyr Val Asp Gly Val Glu Val His Asn Ala Lys Thr
 290 295 300
 Lys Pro Arg Glu Glu Gln Phe Asn Ser Thr Phe Arg Val Val Ser Val
 305 310 315 320
 Leu Thr Val Val His Gln Asp Trp Leu Asn Gly Lys Glu Tyr Lys Cys
 325 330 335

75

Lys	Val	Ser	Asn	Lys	Gly	Leu	Pro	Ala	Pro	Ile	Glu	Lys	Thr	Ile	Ser
			340					345					350		
Lys	Thr	Lys	Gly	Gln	Pro	Arg	Glu	Pro	Gln	Val	Tyr	Thr	Leu	Pro	Pro
		355					360					365			
Ser	Arg	Glu	Glu	Met	Thr	Lys	Asn	Gln	Val	Ser	Leu	Thr	Cys	Leu	Val
	370					375					380				
Lys	Gly	Phe	Tyr	Pro	Ser	Asp	Ile	Ala	Val	Glu	Trp	Glu	Ser	Asn	Gly
385					390					395					400
Gln	Pro	Glu	Asn	Asn	Tyr	Lys	Thr	Thr	Pro	Pro	Met	Leu	Asp	Ser	Asp
			405					410					415		
Gly	Ser	Phe	Phe	Leu	Tyr	Ser	Lys	Leu	Thr	Val	Asp	Lys	Ser	Arg	Trp
			420					425					430		
Gln	Gln	Gly	Asn	Val	Phe	Ser	Cys	Ser	Val	Met	His	Glu	Ala	Leu	His
		435					440					445			
Asn	His	Tyr	Thr	Gln	Lys	Ser	Leu	Ser	Leu	Ser	Pro	Gly	Lys		
	450					455					460				

<210> 56
 <211> 235
 <212> PRT
 <213> Homo sapiens

<400> 56

Met	Ala	Trp	Ala	Leu	Leu	Leu	Leu	Thr	Leu	Leu	Thr	Gln	Gly	Thr	Gly
1				5					10					15	
Ser	Trp	Ala	Gln	Ser	Glu	Leu	Thr	Gln	Pro	Pro	Ser	Ala	Ser	Gly	Thr
			20					25					30		
Pro	Gly	Gln	Arg	Val	Thr	Ile	Ser	Cys	Ser	Gly	Ser	Ser	Ser	Asn	Ile
		35					40					45			
Gly	Ser	Asn	Tyr	Val	Tyr	Trp	Tyr	Gln	Gln	Leu	Pro	Gly	Thr	Ala	Pro
	50					55					60				
Lys	Leu	Leu	Ile	Tyr	Arg	Asn	Asn	Gln	Arg	Pro	Ser	Gly	Val	Pro	Asp
65				70						75					80
Arg	Phe	Ser	Gly	Ser	Lys	Ser	Gly	Thr	Ser	Ala	Ser	Leu	Ala	Ile	Ser
			85					90						95	
Gly	Leu	Arg	Ser	Glu	Asp	Glu	Ala	Asp	Tyr	Tyr	Cys	Ala	Ala	Trp	Asp
			100					105					110		
Asp	Ser	Leu	Ser	Ala	Trp	Val	Phe	Gly	Gly	Gly	Thr	Gln	Leu	Asp	Ile
	115						120					125			
Leu	Gly	Gln	Pro	Lys	Ala	Ala	Pro	Ser	Val	Thr	Leu	Phe	Pro	Pro	Ser
	130					135					140				
Ser	Glu	Glu	Leu	Gln	Ala	Asn	Lys	Ala	Thr	Leu	Val	Cys	Leu	Ile	Ser
145				150						155					160
Asp	Phe	Tyr	Pro	Gly	Ala	Val	Thr	Val	Ala	Trp	Lys	Ala	Asp	Ser	Ser
			165					170						175	
Pro	Val	Lys	Ala	Gly	Val	Glu	Thr	Thr	Thr	Pro	Ser	Lys	Gln	Ser	Asn
			180					185					190		
Asn	Lys	Tyr	Ala	Ala	Ser	Ser	Tyr	Leu	Ser	Leu	Thr	Pro	Glu	Gln	Trp
	195						200					205			
Lys	Ser	His	Arg	Ser	Tyr	Ser	Cys	Gln	Val	Thr	His	Glu	Gly	Ser	Thr
	210					215					220				
Val	Glu	Lys	Thr	Val	Ala	Pro	Thr	Glu	Cys	Ser					
225					230					235					

<210> 57
 <211> 462
 <212> PRT
 <213> Homo sapiens

<400> 57

Met	Lys	His	Leu	Trp	Phe	Phe	Leu	Leu	Leu	Val	Ala	Ala	Pro	Arg	Trp
1				5					10					15	
Val	Leu	Ser	Gln	Leu	Gln	Leu	Gln	Glu	Ser	Gly	Pro	Gly	Leu	Val	Lys
			20					25					30		
Pro	Ser	Glu	Thr	Leu	Ser	Leu	Thr	Cys	Thr	Val	Ser	Gly	Gly	Ser	Ile
		35					40					45			
Trp	Gly	Trp	Ile	Arg	Gln	Pro	Pro	Gly	Lys	Gly	Leu	Glu	Trp	Ile	Gly
	50					55					60				
Ser	Ile	Tyr	Ser	Ser	Gly	Ser	Thr	Tyr	Tyr	Asn	Pro	Ser	Leu	Lys	Ser
65					70					75				80	
Arg	Val	Thr	Thr	Ser	Val	Asp	Thr	Ser	Lys	Asn	Gln	Phe	Ser	Leu	Arg
				85					90					95	
Leu	Ser	Ser	Val	Thr	Ala	Ala	Asp	Thr	Ala	Val	Tyr	Tyr	Cys	Val	Ala
			100					105					110		
Trp	Phe	Gly	Asp	Leu	Leu	Ser	Leu	Lys	Gly	Val	Glu	Leu	Trp	Gly	Gln
		115					120					125			
Gly	Thr	Leu	Val	Thr	Val	Ser	Ser	Ala	Ser	Thr	Lys	Gly	Pro	Ser	Val
	130					135					140				
Phe	Pro	Leu	Ala	Pro	Cys	Ser	Arg	Ser	Thr	Ser	Glu	Ser	Thr	Ala	Ala
145					150					155				160	
Leu	Gly	Cys	Leu	Val	Lys	Asp	Tyr	Phe	Pro	Glu	Pro	Val	Thr	Val	Ser
				165					170					175	
Trp	Asn	Ser	Gly	Ala	Leu	Thr	Ser	Gly	Val	His	Thr	Phe	Pro	Ala	Val
			180					185					190		
Leu	Gln	Ser	Ser	Gly	Leu	Tyr	Ser	Leu	Ser	Ser	Val	Val	Thr	Val	Pro
		195					200					205			
Ser	Ser	Asn	Phe	Gly	Thr	Gln	Thr	Tyr	Thr	Cys	Asn	Val	Asp	His	Lys
	210					215					220				
Pro	Ser	Asn	Thr	Lys	Val	Asp	Lys	Thr	Val	Glu	Arg	Lys	Cys	Cys	Val
225					230					235				240	
Glu	Cys	Pro	Pro	Cys	Pro	Ala	Pro	Pro	Val	Ala	Gly	Pro	Ser	Val	Phe
				245					250					255	
Leu	Phe	Pro	Pro	Lys	Pro	Lys	Asp	Thr	Leu	Met	Ile	Ser	Arg	Thr	Pro
			260					265						270	
Glu	Val	Thr	Cys	Val	Val	Val	Asp	Val	Ser	His	Glu	Asp	Pro	Glu	Val
		275					280					285			
Gln	Phe	Asn	Trp	Tyr	Val	Asp	Gly	Val	Glu	Val	His	Asn	Ala	Lys	Thr
	290					295					300				
Lys	Pro	Arg	Glu	Glu	Gln	Phe	Asn	Ser	Thr	Phe	Arg	Val	Val	Ser	Val
305					310					315				320	
Leu	Thr	Val	Val	His	Gln	Asp	Trp	Leu	Asn	Gly	Lys	Glu	Tyr	Lys	Cys
				325					330					335	
Lys	Val	Ser	Asn	Lys	Gly	Leu	Pro	Ala	Pro	Ile	Glu	Lys	Thr	Ile	Ser
			340					345					350		
Lys	Thr	Lys	Gly	Gln	Pro	Arg	Glu	Pro	Gln	Val	Tyr	Thr	Leu	Pro	Pro
		355					360					365			
Ser	Arg	Glu	Glu	Met	Thr	Lys	Asn	Gln	Val	Ser	Leu	Thr	Cys	Leu	Val
	370					375					380				
Lys	Gly	Phe	Tyr	Pro	Ser	Asp	Ile	Ala	Val	Glu	Trp	Glu	Ser	Asn	Gly
385					390					395				400	
Gln	Pro	Glu	Asn	Asn	Tyr	Lys	Thr	Thr	Pro	Pro	Met	Leu	Asp	Ser	Asp
			405						410					415	
Gly	Ser	Phe	Phe	Leu	Tyr	Ser	Lys	Leu	Thr	Val	Asp	Lys	Ser	Arg	Trp
			420					425					430		
Gln	Gln	Gly	Asn	Val	Phe	Ser	Cys	Ser	Val	Met	His	Glu	Ala	Leu	His
		435					440					445			
Asn	His	Tyr	Thr	Gln	Lys	Ser	Leu	Ser	Leu	Ser	Pro	Gly	Lys		
	450					455					460				

<210> 58
 <211> 235
 <212> PRT
 <213> Homo sapiens

<400> 58
 Met Ala Gly Phe Pro Leu Leu Leu Thr Leu Leu Thr His Cys Ala Gly
 1 5 10 15
 Ser Trp Ala Gln Ser Val Leu Thr Gln Pro Pro Ser Ala Ser Gly Thr
 20 25 30
 Pro Gly Gln Arg Val Thr Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile
 35 40 45
 Gly Ser Asn Tyr Val Tyr Trp Tyr Gln Gln Leu Pro Gly Thr Ala Pro
 50 55 60
 Lys Leu Leu Ile Tyr Arg Asn Asn Gln Arg Pro Ser Gly Val Pro Asp
 65 70 75 80
 Arg Phe Ser Gly Ser Lys Ser Gly Thr Ser Ala Ser Leu Ala Ile Ser
 85 90 95
 Gly Leu Arg Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ala Trp Asp
 100 105 110
 Asp Ser Leu Ser Ala Trp Val Phe Gly Gly Gly Thr Gln Leu Thr Val
 115 120 125
 Leu Gly Gln Pro Lys Ala Ala Pro Ser Val Thr Leu Phe Pro Pro Ser
 130 135 140
 Ser Glu Glu Leu Gln Ala Asn Lys Ala Thr Leu Val Cys Leu Ile Ser
 145 150 155 160
 Asp Phe Tyr Pro Gly Ala Val Thr Val Ala Trp Lys Ala Asp Ser Ser
 165 170 175
 Pro Val Lys Ala Gly Val Glu Thr Thr Thr Pro Ser Lys Gln Ser Asn
 180 185 190
 Asn Lys Tyr Ala Ala Ser Ser Tyr Leu Ser Leu Thr Pro Glu Gln Trp
 195 200 205
 Lys Ser His Arg Ser Tyr Ser Cys Gln Val Thr His Glu Gly Ser Thr
 210 215 220
 Val Glu Lys Thr Val Ala Pro Thr Glu Cys Ser
 225 230 235

<210> 59
 <211> 796
 <212> DNA
 <213> Homo sapiens

<220>
 <221> misc_feature
 <222> (1)..(1)
 <223> n is a, c, g, or t

<220>
 <221> misc_feature
 <222> (796)..(796)
 <223> n is a, c, g, or t

<400> 59
 nggcccaggc ggccgagctc gtgctgactc agccaccttc agcgtctggg acccccgggc 60
 agaggggtcac catctcttgt tctggaagca gctccaacat cggaagtaat tatgtatact 120
 ggtaccagca gctcccagga acggcccca aactcctcat ctataggaat aatcagcggc 180
 cctcaggggt ccctgaccga ttctctggct ccaagtctgg cacctcagcc tccttgccca 240
 tcagtgggct ccggtccgag gatgaggctg attattactg tgcagcatgg gatgacagcc 300
 tgagtgcttg ggtgttcggc ggaggcaccc agctgaccgt cctcggtggg ggttcctcta 360

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gatcttcctc ctctggtggc ggtgggtcgg gcggtggtgg ggaggtgcag ctggtgcagt 420
ctggcccagg actggtgaag ccttcggaga ccctgtccct cacctgcact gtctctggtg 480
gctccatctg gggctggatc cgccagcccc cagggaaggg gctggagtgg attgggagta 540
tctattctag tgggagcacc tactacaacc cgtccctcaa gagtcgagtc accacatccg 600
tagacacgtc caagaaccag ttctccctga ggctgagctc tgtgaccgcc gcagacacgg 660
ctgtgtatta ctgtgtggcg tggttcgggg acttattatc gttgaagggg gttgaattgt 720
ggggccaggg aaccctggtc accgtctcct cagcttcac caagggccca tcggtcacta 780
gtggccaggc cggccn 796

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<210> 60
<211> 261
<212> PRT
<213> Homo sapiens

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<220>
<221> misc_feature
<222> (1)..(1)
<223> Xaa can be any naturally occurring amino acid

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<400> 60
Xaa Ala Glu Leu Val Leu Thr Gln Pro Pro Ser Ala Ser Gly Thr Pro
1          5          10          15
Gly Gln Arg Val Thr Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly
20          25          30
Ser Asn Tyr Val Tyr Trp Tyr Gln Gln Leu Pro Gly Thr Ala Pro Lys
35          40          45
Leu Leu Ile Tyr Arg Asn Asn Gln Arg Pro Ser Gly Val Pro Asp Arg
50          55          60
Phe Ser Gly Ser Lys Ser Gly Thr Ser Ala Ser Leu Ala Ile Ser Gly
65          70          75          80
Leu Arg Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ala Trp Asp Asp
85          90          95
Ser Leu Ser Ala Trp Val Phe Gly Gly Gly Thr Gln Leu Thr Val Leu
100         105         110
Gly Gly Gly Ser Ser Arg Ser Ser Ser Ser Gly Gly Gly Gly Ser Gly
115         120         125
Gly Gly Gly Glu Val Gln Leu Val Gln Ser Gly Pro Gly Leu Val Lys
130         135         140
Pro Ser Glu Thr Leu Ser Leu Thr Cys Thr Val Ser Gly Gly Ser Ile
145         150         155         160
Trp Gly Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Trp Ile Gly
165         170         175
Ser Ile Tyr Ser Ser Gly Ser Thr Tyr Tyr Asn Pro Ser Leu Lys Ser
180         185         190
Arg Val Thr Thr Ser Val Asp Thr Ser Lys Asn Gln Phe Ser Leu Arg
195         200         205
Leu Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Tyr Cys Val Ala
210         215         220
Trp Phe Gly Asp Leu Leu Ser Leu Lys Gly Val Glu Leu Trp Gly Gln
225         230         235         240
Gly Thr Leu Val Thr Val Ser Ser Ala Ser Thr Lys Gly Pro Ser Val
245         250         255
Thr Ser Gly Gln Ala
260

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```

<210> 61
<211> 796

```

<212> DNA
<213> Homo sapiens

<220>
<221> misc_feature
<222> (1)..(1)
<223> n is a, c, g, or t

<220>
<221> misc_feature
<222> (796)..(796)
<223> n is a, c, g, or t

<400> 61
 nggcccaggc ggccgagctc gtgctgactc agccaccctc agtgtctggg acccccgggc 60
 agaggggtcac cgtctcttgt tctggaagca gctctaacat cggaagtaaa aatgtataact 120
 ggtaccagca gctcccagga acggccccca aactcctcat ctataggaat aatcagcggc 180
 cctcaggggt ccctgaccga ttctctggct ccaagtctgg cacctcagcc tccctggcca 240
 tcagtgggct ccggtccgag gatgaggctg attattactg tgcagcatgg gatgacagcc 300
 tgagtgggtg ggtgttcagc ggaggcacca aggtgaccgt cctaggtggg gggttcctcta 360
 gatcttcctc ctctgggtggc ggtggctcgg gcggtgggtg ggaggtgcag ctggtggagt 420
 ctggcccagg actggtgaag ccttcggaga ccctgtccct cacctgcact gtctctgggtg 480
 gctccatctg gggctggatc cgccagcccc cagggaaggg gctggagtgg attgggagta 540
 tctattctag tgggagcacc tactacaacc cgctccctcaa gagtcgagtc accatatccg 600
 tagacacgtc caagaaccag ttctccctga ggctgagctc tgtgaccgcc gcagacacgg 660
 ctgtgtatta ctgtgtggtg tgggtcgggg acttattatc gttgaagggg gtcgaattgt 720
 ggggccaggg aaccctggtc accgtctcct cagcttcac caagggccca tcggtcacta 780
 gtggccaggc cgcccn 796

<210> 62
<211> 261
<212> PRT
<213> Homo sapiens

<220>
<221> misc_feature
<222> (1)..(1)
<223> Xaa can be any naturally occurring amino acid

<400> 62
 Xaa Ala Glu Leu Val Leu Thr Gln Pro Pro Ser Val Ser Gly Thr Pro
 1 5 10 15
 Gly Gln Arg Val Thr Val Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly
 20 25 30
 Ser Lys Asn Val Tyr Trp Tyr Gln Gln Leu Pro Gly Thr Ala Pro Lys
 35 40 45
 Leu Leu Ile Tyr Arg Asn Asn Gln Arg Pro Ser Gly Val Pro Asp Arg
 50 55 60
 Phe Ser Gly Ser Lys Ser Gly Thr Ser Ala Ser Leu Ala Ile Ser Gly
 65 70 75 80
 Leu Arg Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ala Trp Asp Asp
 85 90 95
 Ser Leu Ser Gly Trp Val Phe Ser Gly Gly Thr Lys Val Thr Val Leu
 100 105 110
 Gly Gly Gly Ser Ser Arg Ser Ser Ser Ser Gly Gly Gly Gly Ser Gly
 115 120 125
 Gly Gly Gly Glu Val Gln Leu Val Glu Ser Gly Pro Gly Leu Val Lys
 130 135 140

```

Pro Ser Glu Thr Leu Ser Leu Thr Cys Thr Val Ser Gly Gly Ser Ile
145                      150                      155                      160
Trp Gly Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Trp Ile Gly
                      165                      170                      175
Ser Ile Tyr Ser Ser Gly Ser Thr Tyr Tyr Asn Pro Ser Leu Lys Ser
                      180                      185                      190
Arg Val Thr Ile Ser Val Asp Thr Ser Lys Asn Gln Phe Ser Leu Arg
                      195                      200                      205
Leu Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Tyr Cys Val Val
                      210                      215                      220
Trp Phe Gly Asp Leu Leu Ser Leu Lys Gly Val Glu Leu Trp Gly Gln
225                      230                      235                      240
Gly Thr Leu Val Thr Val Ser Ser Ala Ser Thr Lys Gly Pro Ser Val
                      245                      250                      255
Thr Ser Gly Gln Ala
                      260

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<210> 63
<211> 796
<212> DNA
<213> Homo sapiens

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<220>
<221> misc_feature
<222> (1)..(1)
<223> n is a, c, g, or t

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<220>
<221> misc_feature
<222> (796)..(796)
<223> n is a, c, g, or t

```

```

<400> 63
nggcccaggc ggccgggctc gtggtgacgc agccgccctc agtgtctggg acccccgggc 60
agaggggtcac catctcttgt tctggaagca gctccaacat cggaagtagt tatgtatact 120
ggtaccagca gctcccagga acggccccca aactcctcat ctataggaat aatcagcggc 180
cctcaggggt ccctgaccga ttctctggct ccaagtctgg cacctcagcc tccctggcca 240
tcagtgggct ccggtccgag gatgaggctg attattactg tgcagcatgg gatgacagcc 300
tgagtgggtt ggtgttcggc ggaggcaccg agctgaccgt cctcgggtgg ggttcctcta 360
gatcttcctc ctctggtggc ggtggctcgg gcggtggtgg ggaggtgcag ctggtggagt 420
ctggcccagg actggtgaag ccttcggaga ccctgtccca cacctgcact gtctctggtg 480
gctccatctg gggctggatc cgccagcccc caggggaagg gctggagtgg attgggagta 540
tctattctag tgggagcacc tactacaacc cgtccctcaa gagtcgagtc accatatccg 600
tagacacgtc caagaaccag ttctccctga ggctgagctc tgtgaccgcc gcagacacgg 660
ctgtgtatta ctgtgtggtg tggttcgggg acttattatc gttgaagggg gttgaattgt 720
ggggccaggg aaccctggtc accgtctcct cagcttccac caagggccca tcggtcacta 780
gtggccaggc cggccn

```

```

<210> 64
<211> 261
<212> PRT
<213> Homo sapiens

```

```

<220>
<221> misc_feature
<222> (1)..(1)
<223> Xaa can be any naturally occurring amino acid

```

<400> 64

```

Xaa Ala Gly Leu Val Val Thr Gln Pro Pro Ser Val Ser Gly Thr Pro
1          5          10          15
Gly Gln Arg Val Thr Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly
20          25          30
Ser Ser Tyr Val Tyr Trp Tyr Gln Gln Leu Pro Gly Thr Ala Pro Lys
35          40          45
Leu Leu Ile Tyr Arg Asn Asn Gln Arg Pro Ser Gly Val Pro Asp Arg
50          55          60
Phe Ser Gly Ser Lys Ser Gly Thr Ser Ala Ser Leu Ala Ile Ser Gly
65          70          75          80
Leu Arg Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ala Trp Asp Asp
85          90          95
Ser Leu Ser Gly Trp Val Phe Gly Gly Gly Thr Glu Leu Thr Val Leu
100         105         110
Gly Gly Gly Ser Ser Arg Ser Ser Ser Ser Gly Gly Gly Gly Ser Gly
115         120         125
Gly Gly Gly Glu Val Gln Leu Val Glu Ser Gly Pro Gly Leu Val Lys
130         135         140
Pro Ser Glu Thr Leu Ser His Thr Cys Thr Val Ser Gly Gly Ser Ile
145         150         155         160
Trp Gly Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Trp Ile Gly
165         170         175
Ser Ile Tyr Ser Ser Gly Ser Thr Tyr Tyr Asn Pro Ser Leu Lys Ser
180         185         190
Arg Val Thr Ile Ser Val Asp Thr Ser Lys Asn Gln Phe Ser Leu Arg
195         200         205
Leu Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Tyr Cys Val Val
210         215         220
Trp Phe Gly Asp Leu Leu Ser Leu Lys Gly Val Glu Leu Trp Gly Gln
225         230         235         240
Gly Thr Leu Val Thr Val Ser Ser Ala Ser Thr Lys Gly Pro Ser Val
245         250         255
Thr Ser Gly Gln Ala
260

```

<210> 65

<211> 796

<212> DNA

<213> Homo sapiens

<220>

<221> misc_feature

<222> (1)..(1)

<223> n is a, c, g, or t

<220>

<221> misc_feature

<222> (796)..(796)

<223> n is a, c, g, or t

<400> 65

```

nggcccaggc ggccgagcac gtggtgaccc aggagccctc agtgtctggg acccccgggc 60
agaggggtcac catctcttgt tctggaagca gctccaacat cggaagtaat tatgtatact 120
ggtaccagca gctcccagga acggccccc aactcctcat ctataggaat aatcagcggc 180
cctcaggggc ccctgaccga ttctctggct ccaagtctgg cacctcagcc tcctggcca 240
tcagtgggct ccggtccgag gatgaggctg attattactg tgcagcatgg gatgacagcc 300
tgagtgggtt ggtgttcggc ggaggggacca agctgaccgt cctaggcggg ggttcctcta 360
gatcttcctc ctctggtggc ggtggctcgg gcggtggtgg gcaggtgcag ctgcaggagt 420

```

```

cgggcccagg actggtgaag ccttcggaga ccctgtccct cacctgcact gtctctggtg 480
gctccatctg gggctggatc cgccagcccc caggggaaggg gctggagtgg attgggagta 540
tctattctag tgggagcacc tactacaacc cgtccctcaa gagtcgagtc accatatccg 600
tagacacgtc caagaaccag ttctccctga ggctgagctc tgtgaccgcc gcagacacgg 660
ctgtgtatta ctgtgtggtg tggttcgggg acttattatc gttgaagggg gttgaattgt 720
ggggccaggg aaccctgggc accgtctcct cagcttccac caagggccca tcggtcacta 780
gtggccaggc cgcccn 796

```

```

<210> 66
<211> 261
<212> PRT
<213> Homo sapiens

```

```

<220>
<221> misc_feature
<222> (1)..(1)
<223> Xaa can be any naturally occurring amino acid

```

```

<400> 66
Xaa Ala Glu His Val Val Thr Gln Glu Pro Ser Val Ser Gly Thr Pro
1          5          10          15
Gly Gln Arg Val Thr Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly
          20          25          30
Ser Asn Tyr Val Tyr Trp Tyr Gln Gln Leu Pro Gly Thr Ala Pro Lys
          35          40          45
Leu Leu Ile Tyr Arg Asn Asn Gln Arg Pro Ser Gly Ala Pro Asp Arg
          50          55          60
Phe Ser Gly Ser Lys Ser Gly Thr Ser Ala Ser Leu Ala Ile Ser Gly
65          70          75          80
Leu Arg Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ala Trp Asp Asp
          85          90          95
Ser Leu Ser Gly Trp Val Phe Gly Gly Gly Thr Lys Leu Thr Val Leu
          100          105          110
Gly Gly Gly Ser Ser Arg Ser Ser Ser Ser Gly Gly Gly Gly Ser Gly
          115          120          125
Gly Gly Gly Gln Val Gln Leu Gln Glu Ser Gly Pro Gly Leu Val Lys
          130          135          140
Pro Ser Glu Thr Leu Ser Leu Thr Cys Thr Val Ser Gly Gly Ser Ile
145          150          155          160
Trp Gly Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Trp Ile Gly
          165          170          175
Ser Ile Tyr Ser Ser Gly Ser Thr Tyr Tyr Asn Pro Ser Leu Lys Ser
          180          185          190
Arg Val Thr Ile Ser Val Asp Thr Ser Lys Asn Gln Phe Ser Leu Arg
          195          200          205
Leu Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Tyr Cys Val Val
          210          215          220
Trp Phe Gly Asp Leu Leu Ser Leu Lys Gly Val Glu Leu Trp Gly Gln
225          230          235          240
Gly Thr Leu Val Thr Val Ser Ser Ala Ser Thr Lys Gly Pro Ser Val
          245          250          255
Thr Ser Gly Gln Ala
          260

```

```

<210> 67
<211> 796
<212> DNA
<213> Homo sapiens

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<220>
 <221> misc_feature
 <222> (1)..(1)
 <223> n is a, c, g, or t

<220>
 <221> misc_feature
 <222> (796)..(796)
 <223> n is a, c, g, or t

<400> 67
 nggccagggc ggccgagctc gtgctgactc agccacccac agtgtctggg acccccgggc 60
 agaggggtcac catctcttgt tctggaagca gctccaacat cggaagtaaa aatgtataact 120
 ggtaccagca gctcccagga acggccccca aactcctcat ctataggaat aatcagcggc 180
 cctcaggggt ccttgaccga ttctctggct ccaagtctgg cacctcagcc tccctggcca 240
 tcagtgggct ccggtccgag gatgaggctg attattactg tgcagcatgg gatgacagcc 300
 tgagtgggtg ggtgttcggc ggaggcacca aggtgaccgt cctaggtggg ggttcctcta 360
 gatcttcctc ctctgggtggc ggtggctcgg gcggtgggtg gcagatcacc ttgaaggagt 420
 ctggcccagg actggtgaag ccttcggaga ccctgtccct cacctgcact gtctctgggtg 480
 gttccatctg gggctggatc cgccagcccc caggggaagg gctggagtgg attgggagta 540
 tctattctag tgggagcacc tactacaacc cgtccctcaa gagtcgagtc accatatccg 600
 tagacacgtc cgagaaccag ttctccctga ggctgagctc tgtgaccgcc gcagacacgg 660
 ctgtgtatta ctgtgtggtg tggttcgggg acttattatc gttgaagggg gttgaattgt 720
 ggggccaggg aaccctggtc accgtctcct cagcttcac caagggccca tcggtcacta 780
 gtggccaggc cgccn 796

<210> 68
 <211> 261
 <212> PRT
 <213> Homo sapiens

<220>
 <221> misc_feature
 <222> (1)..(1)
 <223> Xaa can be any naturally occurring amino acid

<400> 68
 Xaa Ala Glu Leu Val Leu Thr Gln Pro Pro Thr Val Ser Gly Thr Pro
 1 5 10 15
 Gly Gln Arg Val Thr Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly
 20 25 30
 Ser Lys Asn Val Tyr Trp Tyr Gln Gln Leu Pro Gly Thr Ala Pro Lys
 35 40 45
 Leu Leu Ile Tyr Arg Asn Asn Gln Arg Pro Ser Gly Val Pro Asp Arg
 50 55 60
 Phe Ser Gly Ser Lys Ser Gly Thr Ser Ala Ser Leu Ala Ile Ser Gly
 65 70 75 80
 Leu Arg Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ala Trp Asp Asp
 85 90 95
 Ser Leu Ser Gly Trp Val Phe Gly Gly Gly Thr Lys Val Thr Val Leu
 100 105 110
 Gly Gly Gly Ser Ser Arg Ser Ser Ser Gly Gly Gly Gly Ser Gly
 115 120 125
 Gly Gly Gly Gln Ile Thr Leu Lys Glu Ser Gly Pro Gly Leu Val Lys
 130 135 140
 Pro Ser Glu Thr Leu Ser Leu Thr Cys Thr Val Ser Gly Gly Ser Ile
 145 150 155 160
 Trp Gly Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Trp Ile Gly
 165 170 175

```

Ser Ile Tyr Ser Ser Gly Ser Thr Tyr Tyr Asn Pro Ser Leu Lys Ser
      180      185      190
Arg Val Thr Ile Ser Val Asp Thr Ser Glu Asn Gln Phe Ser Leu Arg
      195      200      205
Leu Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Tyr Cys Val Val
      210      215      220
Trp Phe Gly Asp Leu Leu Ser Leu Lys Gly Val Glu Leu Trp Gly Gln
      225      230      235      240
Gly Thr Leu Val Thr Val Ser Ser Ala Ser Thr Lys Gly Pro Ser Val
      245      250      255
Thr Ser Gly Gln Ala
      260

```

```

<210> 69
<211> 796
<212> DNA
<213> Homo sapiens

```

```

<220>
<221> misc_feature
<222> (1)..(1)
<223> n is a, c, g, or t

```

```

<220>
<221> misc_feature
<222> (796)..(796)
<223> n is a, c, g, or t

```

```

<400> 69
nggcccaggc ggccgagctc cacatgaccc agtctccagg caccctgtct ttgtctccag      60
gggaaagagc caccctctcc tgcagggcca gtcagagtgt tagcaactac ttagcctggt      120
accagcagaa acctggccag gctcccaggc tcctcatcta tgggtgcatcc agcagggcca      180
ctggcatccc agacagggttc agtggcagtg ggtctgggac agacttcaact ctcaccatca      240
gcagactgga gcctgaagat tttgcagtgt atcactgtca gcaatattat agtactccgt      300
ggacgttcgg ccaagggacc aaagtggata tcaaagggtg ttcctctaga tcttcctcct      360
ctggtggcgg tggctcgggc ggtggtgggc aggtgcagct gcaggagtcg ggcccaggac      420
tgggtgaagc ttcggagacc ctgtccctca cctgcactgt ctctggtggc tccatcagca      480
gtactagtta ctactggggc tggatccgcc agccccagg gaaggggctg gagtggattg      540
ggagtatctc ttatagtggg agcacctact acaaccgcgc cctcaagagt cgagtcacca      600
tatccgtaga cacgtccaag aaccagttct ccctgaagct gacctctgtg accgccgcag      660
acacggctgt gtattactgt gcgaggatac tatggttcgg agagtaccta ggggactact      720
ggggccaggg aaccctggtc accgtctcct cagcctccac caagggccca tcggtcacta      780
gtggccaggc cggccn                                     796

```

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<210> 70
<211> 261
<212> PRT
<213> Homo sapiens

```

```

<220>
<221> misc_feature
<222> (1)..(1)
<223> Xaa can be any naturally occurring amino acid

```

```

<400> 70
Xaa Ala Glu Leu His Met Thr Gln Ser Pro Gly Thr Leu Ser Leu Ser
1          5          10          15

```

Pro Gly Glu Arg Ala Thr Leu Ser Cys Arg Ala Ser Gln Ser Val Ser
 20 25 30
 Asn Tyr Leu Ala Trp Tyr Gln Gln Lys Pro Gly Gln Ala Pro Arg Leu
 35 40 45
 Leu Ile Tyr Gly Ala Ser Ser Arg Ala Thr Gly Ile Pro Asp Arg Phe
 50 55 60
 Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr Leu Thr Ile Ser Arg Leu
 65 70 75 80
 Glu Pro Glu Asp Phe Ala Val Tyr His Cys Gln Gln Tyr Tyr Ser Thr
 85 90 95
 Pro Trp Thr Phe Gly Gln Gly Thr Lys Val Asp Ile Lys Gly Gly Ser
 100 105 110
 Ser Arg Ser Ser Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly Gln
 115 120 125
 Val Gln Leu Gln Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu Thr
 130 135 140
 Leu Ser Leu Thr Cys Thr Val Ser Gly Gly Ser Ile Ser Ser Thr Ser
 145 150 155 160
 Tyr Tyr Trp Gly Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Trp
 165 170 175
 Ile Gly Ser Ile Ser Tyr Ser Gly Ser Thr Tyr Tyr Asn Pro Ser Leu
 180 185 190
 Lys Ser Arg Val Thr Ile Ser Val Asp Thr Ser Lys Asn Gln Phe Ser
 195 200 205
 Leu Lys Leu Thr Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Tyr Cys
 210 215 220
 Ala Arg Ile Leu Trp Phe Gly Glu Tyr Leu Gly Asp Tyr Trp Gly Gln
 225 230 235 240
 Gly Thr Leu Val Thr Val Ser Ser Ala Ser Thr Lys Gly Pro Ser Val
 245 250 255
 Thr Ser Gly Gln Ala
 260

<210> 71
 <211> 808
 <212> DNA
 <213> Homo sapiens

<220>
 <221> misc_feature
 <222> (1)..(1)
 <223> n is a, c, g, or t

<220>
 <221> misc_feature
 <222> (808)..(808)
 <223> n is a, c, g, or t

<400> 71
 nggccagggc ggccgagctc ctggtgacgc agccgccctc agtgtctgcg gccccaggac 60
 agaaggtcac catctcctgc tctggaagca gctccaacat tgggaataat tatgtatcct 120
 ggtaccagca gctcccagga acagccccc aactcctcat ttatgacaat aataagcgac 180
 cctcagggat tcctgaccga ttctctggct ccaagtctgg cacgtcagcc accctgggca 240
 tcaccggact ccagactggg gacgaggccg attattactg cggaacatgg gatagcagcc 300
 tgagtgcttg ggtgttcggc ggagggaccc agctgaccgt cctcggcggt ggttcctcta 360
 gatcttctc ctctggtggc ggtggctcgg gcggtggtgg agaggtgcag ctggtgcagt 420
 ctggcccagg actggtgaag ccttcggaga ccctgtccct cacctgcgct gtctctggtt 480
 actccatcag cagtgggttac tactggggct ggatccggca gccccaggg aaggggctgg 540
 agtggattgg gagtagcaat catagtggga gcacctacta caaccgtcc ctcaggagtc 600

86

```

gagtcacccat atcagtagac acgtccaaga accaattctc cctgaagggtg aactctgtga 660
ccgccgcaga cacggccggtt tattactgtg cgagagagggc ggggtatagc agcagctggt 720
actttgacta ctgggggtcag ggaaccctgg tcaccgtctc ctcagcctcc accaagggcc 780
catcggtcac tagtggccag gccggccn 808

```

```

<210> 72
<211> 265
<212> PRT
<213> Homo sapiens

```

```

<220>
<221> misc_feature
<222> (1)..(1)
<223> Xaa can be any naturally occurring amino acid

```

```

<400> 72
Xaa Ala Glu Leu Leu Val Thr Gln Pro Pro Ser Val Ser Ala Ala Pro
1          5          10          15
Gly Gln Lys Val Thr Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly
20          25          30
Asn Asn Tyr Val Ser Trp Tyr Gln Gln Leu Pro Gly Thr Ala Pro Lys
35          40          45
Leu Leu Ile Tyr Asp Asn Asn Lys Arg Pro Ser Gly Ile Pro Asp Arg
50          55          60
Phe Ser Gly Ser Lys Ser Gly Thr Ser Ala Thr Leu Gly Ile Thr Gly
65          70          75          80
Leu Gln Thr Gly Asp Glu Ala Asp Tyr Tyr Cys Gly Thr Trp Asp Ser
85          90          95
Ser Leu Ser Ala Trp Val Phe Gly Gly Gly Thr Gln Leu Thr Val Leu
100         105         110
Gly Gly Gly Ser Ser Arg Ser Ser Ser Ser Gly Gly Gly Gly Ser Gly
115         120         125
Gly Gly Gly Glu Val Gln Leu Val Gln Ser Gly Pro Gly Leu Val Lys
130         135         140
Pro Ser Glu Thr Leu Ser Leu Thr Cys Ala Val Ser Gly Tyr Ser Ile
145         150         155         160
Ser Ser Gly Tyr Tyr Trp Gly Trp Ile Arg Gln Pro Pro Gly Lys Gly
165         170         175
Leu Glu Trp Ile Gly Ser Ser Asn His Ser Gly Ser Thr Tyr Tyr Asn
180         185         190
Pro Ser Leu Arg Ser Arg Val Thr Ile Ser Val Asp Thr Ser Lys Asn
195         200         205
Gln Phe Ser Leu Lys Val Asn Ser Val Thr Ala Ala Asp Thr Ala Val
210         215         220
Tyr Tyr Cys Ala Arg Glu Ala Gly Tyr Ser Ser Ser Trp Tyr Phe Asp
225         230         235         240
Tyr Trp Gly Gln Gly Thr Leu Val Thr Val Ser Ser Ala Ser Thr Lys
245         250         255
Gly Pro Ser Val Thr Ser Gly Gln Ala
260         265

```

```

<210> 73
<211> 443
<212> PRT
<213> Homo sapiens

```

<400> 73

Gln	Leu	Gln	Leu	Gln	Glu	Ser	Gly	Pro	Gly	Leu	Val	Lys	Pro	Ser	Glu
1				5					10					15	
Thr	Leu	Ser	Leu	Thr	Cys	Thr	Val	Ser	Gly	Gly	Ser	Ile	Trp	Gly	Trp
			20					25					30		
Ile	Arg	Gln	Pro	Pro	Gly	Lys	Gly	Leu	Glu	Trp	Ile	Gly	Ser	Ile	Tyr
		35					40					45			
Ser	Ser	Gly	Ser	Thr	Tyr	Tyr	Asn	Pro	Ser	Leu	Lys	Ser	Arg	Val	Thr
	50					55					60				
Thr	Ser	Val	Asp	Thr	Ser	Lys	Asn	Gln	Phe	Ser	Leu	Arg	Leu	Ser	Ser
65					70					75					80
Val	Thr	Ala	Ala	Asp	Thr	Ala	Val	Tyr	Tyr	Cys	Val	Ala	Trp	Phe	Gly
				85					90					95	
Asp	Leu	Leu	Ser	Leu	Lys	Gly	Val	Glu	Leu	Trp	Gly	Gln	Gly	Thr	Leu
			100					105					110		
Val	Thr	Val	Ser	Ser	Ala	Ser	Thr	Lys	Gly	Pro	Ser	Val	Phe	Pro	Leu
		115					120					125			
Ala	Pro	Cys	Ser	Arg	Ser	Thr	Ser	Glu	Ser	Thr	Ala	Ala	Leu	Gly	Cys
	130					135					140				
Leu	Val	Lys	Asp	Tyr	Phe	Pro	Glu	Pro	Val	Thr	Val	Ser	Trp	Asn	Ser
145					150					155					160
Gly	Ala	Leu	Thr	Ser	Gly	Val	His	Thr	Phe	Pro	Ala	Val	Leu	Gln	Ser
				165					170					175	
Ser	Gly	Leu	Tyr	Ser	Leu	Ser	Ser	Val	Val	Thr	Val	Pro	Ser	Ser	Asn
			180					185					190		
Phe	Gly	Thr	Gln	Thr	Tyr	Thr	Cys	Asn	Val	Asp	His	Lys	Pro	Ser	Asn
		195					200					205			
Thr	Lys	Val	Asp	Lys	Thr	Val	Glu	Arg	Lys	Cys	Cys	Val	Glu	Cys	Pro
	210					215					220				
Pro	Cys	Pro	Ala	Pro	Pro	Val	Ala	Gly	Pro	Ser	Val	Phe	Leu	Phe	Pro
225					230					235					240
Pro	Lys	Pro	Lys	Asp	Thr	Leu	Met	Ile	Ser	Arg	Thr	Pro	Glu	Val	Thr
				245					250					255	
Cys	Val	Val	Val	Asp	Val	Ser	His	Glu	Asp	Pro	Glu	Val	Gln	Phe	Asn
			260					265					270		
Trp	Tyr	Val	Asp	Gly	Val	Glu	Val	His	Asn	Ala	Lys	Thr	Lys	Pro	Arg
		275					280					285			
Glu	Glu	Gln	Phe	Asn	Ser	Thr	Phe	Arg	Val	Val	Ser	Val	Leu	Thr	Val
	290					295					300				
Val	His	Gln	Asp	Trp	Leu	Asn	Gly	Lys	Glu	Tyr	Lys	Cys	Lys	Val	Ser
305					310					315					320
Asn	Lys	Gly	Leu	Pro	Ala	Pro	Ile	Glu	Lys	Thr	Ile	Ser	Lys	Thr	Lys
				325					330					335	
Gly	Gln	Pro	Arg	Glu	Pro	Gln	Val	Tyr	Thr	Leu	Pro	Pro	Ser	Arg	Glu
			340					345					350		
Glu	Met	Thr	Lys	Asn	Gln	Val	Ser	Leu	Thr	Cys	Leu	Val	Lys	Gly	Phe
		355					360					365			
Tyr	Pro	Ser	Asp	Ile	Ala	Val	Glu	Trp	Glu	Ser	Asn	Gly	Gln	Pro	Glu
	370					375					380				
Asn	Asn	Tyr	Lys	Thr	Thr	Pro	Pro	Met	Leu	Asp	Ser	Asp	Gly	Ser	Phe
385					390					395					400
Phe	Leu	Tyr	Ser	Lys	Leu	Thr	Val	Asp	Lys	Ser	Arg	Trp	Gln	Gln	Gly
				405					410					415	
Asn	Val	Phe	Ser	Cys	Ser	Val	Met	His	Glu	Ala	Leu	His	Asn	His	Tyr
			420					425					430		
Thr	Gln	Lys	Ser	Leu	Ser	Leu	Ser	Pro	Gly	Lys					
		435					440								

<210> 74
 <211> 216
 <212> PRT
 <213> Homo sapiens

<400> 74
 Gln Ser Val Leu Thr Gln Pro Pro Ser Ala Ser Gly Thr Pro Gly Gln
 1 5 10 15
 Arg Val Thr Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly Ser Asn
 20 25 30
 Tyr Val Tyr Trp Tyr Gln Gln Leu Pro Gly Thr Ala Pro Lys Leu Leu
 35 40 45
 Ile Tyr Arg Asn Asn Gln Arg Pro Ser Gly Val Pro Asp Arg Phe Ser
 50 55 60
 Gly Ser Lys Ser Gly Thr Ser Ala Ser Leu Ala Ile Ser Gly Leu Arg
 65 70 75 80
 Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ala Trp Asp Asp Ser Leu
 85 90 95
 Ser Ala Trp Val Phe Gly Gly Gly Thr Gln Leu Thr Val Leu Gly Gln
 100 105 110
 Pro Lys Ala Ala Pro Ser Val Thr Leu Phe Pro Pro Ser Ser Glu Glu
 115 120 125
 Leu Gln Ala Asn Lys Ala Thr Leu Val Cys Leu Ile Ser Asp Phe Tyr
 130 135 140
 Pro Gly Ala Val Thr Val Ala Trp Lys Ala Asp Ser Ser Pro Val Lys
 145 150 155 160
 Ala Gly Val Glu Thr Thr Thr Pro Ser Lys Gln Ser Asn Asn Lys Tyr
 165 170 175
 Ala Ala Ser Ser Tyr Leu Ser Leu Thr Pro Glu Gln Trp Lys Ser His
 180 185 190
 Arg Ser Tyr Ser Cys Gln Val Thr His Glu Gly Ser Thr Val Glu Lys
 195 200 205
 Thr Val Ala Pro Thr Glu Cys Ser
 210 215

<210> 75
 <211> 443
 <212> PRT
 <213> Homo sapiens

<400> 75
 Gln Leu Gln Leu Gln Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
 1 5 10 15
 Thr Leu Ser Leu Thr Cys Thr Val Ser Gly Gly Ser Ile Trp Gly Trp
 20 25 30
 Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Trp Ile Gly Ser Ile Tyr
 35 40 45
 Ser Ser Gly Ser Thr Tyr Tyr Asn Pro Ser Leu Lys Ser Arg Val Thr
 50 55 60
 Ile Ser Val Asp Thr Ser Lys Asn Gln Phe Ser Leu Arg Leu Ser Ser
 65 70 75 80
 Val Thr Ala Ala Asp Thr Ala Val Tyr Tyr Cys Val Val Trp Phe Gly
 85 90 95
 Asp Leu Leu Ser Leu Lys Gly Val Glu Leu Trp Gly Gln Gly Thr Leu
 100 105 110
 Val Thr Val Ser Ser Ala Ser Thr Lys Gly Pro Ser Val Phe Pro Leu
 115 120 125
 Ala Pro Cys Ser Arg Ser Thr Ser Glu Ser Thr Ala Ala Leu Gly Cys
 130 135 140

Leu	Val	Lys	Asp	Tyr	Phe	Pro	Glu	Pro	Val	Thr	Val	Ser	Trp	Asn	Ser
145					150					155					160
Gly	Ala	Leu	Thr	Ser	Gly	Val	His	Thr	Phe	Pro	Ala	Val	Leu	Gln	Ser
				165					170					175	
Ser	Gly	Leu	Tyr	Ser	Leu	Ser	Ser	Val	Val	Thr	Val	Pro	Ser	Ser	Asn
			180					185					190		
Phe	Gly	Thr	Gln	Thr	Tyr	Thr	Cys	Asn	Val	Asp	His	Lys	Pro	Ser	Asn
		195					200					205			
Thr	Lys	Val	Asp	Lys	Thr	Val	Glu	Arg	Lys	Cys	Cys	Val	Glu	Cys	Pro
	210					215					220				
Pro	Cys	Pro	Ala	Pro	Pro	Val	Ala	Gly	Pro	Ser	Val	Phe	Leu	Phe	Pro
225					230					235					240
Pro	Lys	Pro	Lys	Asp	Thr	Leu	Met	Ile	Ser	Arg	Thr	Pro	Glu	Val	Thr
				245					250					255	
Cys	Val	Val	Val	Asp	Val	Ser	His	Glu	Asp	Pro	Glu	Val	Gln	Phe	Asn
			260					265					270		
Trp	Tyr	Val	Asp	Gly	Val	Glu	Val	His	Asn	Ala	Lys	Thr	Lys	Pro	Arg
		275					280					285			
Glu	Glu	Gln	Phe	Asn	Ser	Thr	Phe	Arg	Val	Val	Ser	Val	Leu	Thr	Val
	290					295					300				
Val	His	Gln	Asp	Trp	Leu	Asn	Gly	Lys	Glu	Tyr	Lys	Cys	Lys	Val	Ser
305					310					315					320
Asn	Lys	Gly	Leu	Pro	Ala	Pro	Ile	Glu	Lys	Thr	Ile	Ser	Lys	Thr	Lys
				325					330					335	
Gly	Gln	Pro	Arg	Glu	Pro	Gln	Val	Tyr	Thr	Leu	Pro	Pro	Ser	Arg	Glu
			340					345					350		
Glu	Met	Thr	Lys	Asn	Gln	Val	Ser	Leu	Thr	Cys	Leu	Val	Lys	Gly	Phe
		355					360					365			
Tyr	Pro	Ser	Asp	Ile	Ala	Val	Glu	Trp	Glu	Ser	Asn	Gly	Gln	Pro	Glu
	370					375					380				
Asn	Asn	Tyr	Lys	Thr	Thr	Pro	Pro	Met	Leu	Asp	Ser	Asp	Gly	Ser	Phe
385					390					395					400
Phe	Leu	Tyr	Ser	Lys	Leu	Thr	Val	Asp	Lys	Ser	Arg	Trp	Gln	Gln	Gly
				405					410					415	
Asn	Val	Phe	Ser	Cys	Ser	Val	Met	His	Glu	Ala	Leu	His	Asn	His	Tyr
			420					425					430		
Thr	Gln	Lys	Ser	Leu	Ser	Leu	Ser	Pro	Gly	Lys					
		435					440								

<210> 76
 <211> 216
 <212> PRT
 <213> Homo sapiens

<400> 76

Gln	Ser	Val	Leu	Thr	Gln	Pro	Pro	Ser	Val	Ser	Gly	Thr	Pro	Gly	Gln
1				5					10					15	
Arg	Val	Thr	Val	Ser	Cys	Ser	Gly	Ser	Ser	Ser	Asn	Ile	Gly	Ser	Lys
			20					25					30		
Asn	Val	Tyr	Trp	Tyr	Gln	Gln	Leu	Pro	Gly	Thr	Ala	Pro	Lys	Leu	Leu
		35					40					45			
Ile	Tyr	Arg	Asn	Asn	Gln	Arg	Pro	Ser	Gly	Val	Pro	Asp	Arg	Phe	Ser
	50					55					60				
Gly	Ser	Lys	Ser	Gly	Thr	Ser	Ala	Ser	Leu	Ala	Ile	Ser	Gly	Leu	Arg
65					70					75					80
Ser	Glu	Asp	Glu	Ala	Asp	Tyr	Tyr	Cys	Ala	Ala	Trp	Asp	Asp	Ser	Leu
				85					90					95	
Ser	Gly	Trp	Val	Phe	Ser	Gly	Gly	Thr	Lys	Val	Thr	Val	Leu	Gly	Gln
			100					105						110	

Pro	Lys	Ala	Ala	Pro	Ser	Val	Thr	Leu	Phe	Pro	Pro	Ser	Ser	Glu	Glu
		115					120					125			
Leu	Gln	Ala	Asn	Lys	Ala	Thr	Leu	Val	Cys	Leu	Ile	Ser	Asp	Phe	Tyr
	130					135					140				
Pro	Gly	Ala	Val	Thr	Val	Ala	Trp	Lys	Ala	Asp	Ser	Ser	Pro	Val	Lys
145					150					155					160
Ala	Gly	Val	Glu	Thr	Thr	Thr	Pro	Ser	Lys	Gln	Ser	Asn	Asn	Lys	Tyr
				165					170					175	
Ala	Ala	Ser	Ser	Tyr	Leu	Ser	Leu	Thr	Pro	Glu	Gln	Trp	Lys	Ser	His
			180					185					190		
Arg	Ser	Tyr	Ser	Cys	Gln	Val	Thr	His	Glu	Gly	Ser	Thr	Val	Glu	Lys
	195						200					205			
Thr	Val	Ala	Pro	Thr	Glu	Cys	Ser								
	210					215									

<210> 77
 <211> 443
 <212> PRT
 <213> Homo sapiens

<400> 77

Gln	Leu	Gln	Leu	Gln	Glu	Ser	Gly	Pro	Gly	Leu	Val	Lys	Pro	Ser	Glu
1				5					10					15	
Thr	Leu	Ser	His	Thr	Cys	Thr	Val	Ser	Gly	Gly	Ser	Ile	Trp	Gly	Trp
			20					25					30		
Ile	Arg	Gln	Pro	Pro	Gly	Lys	Gly	Leu	Glu	Trp	Ile	Gly	Ser	Ile	Tyr
		35					40					45			
Ser	Ser	Gly	Ser	Thr	Tyr	Tyr	Asn	Pro	Ser	Leu	Lys	Ser	Arg	Val	Thr
	50					55					60				
Ile	Ser	Val	Asp	Thr	Ser	Lys	Asn	Gln	Phe	Ser	Leu	Arg	Leu	Ser	Ser
65					70					75					80
Val	Thr	Ala	Ala	Asp	Thr	Ala	Val	Tyr	Tyr	Cys	Val	Val	Trp	Phe	Gly
				85					90					95	
Asp	Leu	Leu	Ser	Leu	Lys	Gly	Val	Glu	Leu	Trp	Gly	Gln	Gly	Thr	Leu
			100					105					110		
Val	Thr	Val	Ser	Ser	Ala	Ser	Thr	Lys	Gly	Pro	Ser	Val	Phe	Pro	Leu
		115						120				125			
Ala	Pro	Cys	Ser	Arg	Ser	Thr	Ser	Glu	Ser	Thr	Ala	Ala	Leu	Gly	Cys
	130					135					140				
Leu	Val	Lys	Asp	Tyr	Phe	Pro	Glu	Pro	Val	Thr	Val	Ser	Trp	Asn	Ser
145					150					155					160
Gly	Ala	Leu	Thr	Ser	Gly	Val	His	Thr	Phe	Pro	Ala	Val	Leu	Gln	Ser
			165						170					175	
Ser	Gly	Leu	Tyr	Ser	Leu	Ser	Ser	Val	Val	Thr	Val	Pro	Ser	Ser	Asn
			180					185					190		
Phe	Gly	Thr	Gln	Thr	Tyr	Thr	Cys	Asn	Val	Asp	His	Lys	Pro	Ser	Asn
	195					200						205			
Thr	Lys	Val	Asp	Lys	Thr	Val	Glu	Arg	Lys	Cys	Cys	Val	Glu	Cys	Pro
	210					215						220			
Pro	Cys	Pro	Ala	Pro	Pro	Val	Ala	Gly	Pro	Ser	Val	Phe	Leu	Phe	Pro
225					230					235					240
Pro	Lys	Pro	Lys	Asp	Thr	Leu	Met	Ile	Ser	Arg	Thr	Pro	Glu	Val	Thr
			245						250					255	
Cys	Val	Val	Val	Asp	Val	Ser	His	Glu	Asp	Pro	Glu	Val	Gln	Phe	Asn
			260					265					270		
Trp	Tyr	Val	Asp	Gly	Val	Glu	Val	His	Asn	Ala	Lys	Thr	Lys	Pro	Arg
	275					280						285			
Glu	Glu	Gln	Phe	Asn	Ser	Thr	Phe	Arg	Val	Val	Ser	Val	Leu	Thr	Val
	290					295					300				

Val	His	Gln	Asp	Trp	Leu	Asn	Gly	Lys	Glu	Tyr	Lys	Cys	Lys	Val	Ser
305					310					315					320
Asn	Lys	Gly	Leu	Pro	Ala	Pro	Ile	Glu	Lys	Thr	Ile	Ser	Lys	Thr	Lys
				325					330						335
Gly	Gln	Pro	Arg	Glu	Pro	Gln	Val	Tyr	Thr	Leu	Pro	Pro	Ser	Arg	Glu
			340					345					350		
Glu	Met	Thr	Lys	Asn	Gln	Val	Ser	Leu	Thr	Cys	Leu	Val	Lys	Gly	Phe
		355					360					365			
Tyr	Pro	Ser	Asp	Ile	Ala	Val	Glu	Trp	Glu	Ser	Asn	Gly	Gln	Pro	Glu
	370					375					380				
Asn	Asn	Tyr	Lys	Thr	Thr	Pro	Pro	Met	Leu	Asp	Ser	Asp	Gly	Ser	Phe
385					390					395					400
Phe	Leu	Tyr	Ser	Lys	Leu	Thr	Val	Asp	Lys	Ser	Arg	Trp	Gln	Gln	Gly
				405					410					415	
Asn	Val	Phe	Ser	Cys	Ser	Val	Met	His	Glu	Ala	Leu	His	Asn	His	Tyr
			420					425					430		
Thr	Gln	Lys	Ser	Leu	Ser	Leu	Ser	Pro	Gly	Lys					
		435					440								

<210> 78
 <211> 216
 <212> PRT
 <213> Homo sapiens

<400> 78

Gln	Ser	Val	Leu	Thr	Gln	Pro	Pro	Ser	Val	Ser	Gly	Thr	Pro	Gly	Gln
1				5					10					15	
Arg	Val	Thr	Ile	Ser	Cys	Ser	Gly	Ser	Ser	Ser	Asn	Ile	Gly	Ser	Ser
			20					25					30		
Tyr	Val	Tyr	Trp	Tyr	Gln	Gln	Leu	Pro	Gly	Thr	Ala	Pro	Lys	Leu	Leu
		35					40					45			
Ile	Tyr	Arg	Asn	Asn	Gln	Arg	Pro	Ser	Gly	Val	Pro	Asp	Arg	Phe	Ser
	50					55					60				
Gly	Ser	Lys	Ser	Gly	Thr	Ser	Ala	Ser	Leu	Ala	Ile	Ser	Gly	Leu	Arg
65					70					75					80
Ser	Glu	Asp	Glu	Ala	Asp	Tyr	Tyr	Cys	Ala	Ala	Trp	Asp	Asp	Ser	Leu
				85					90					95	
Ser	Gly	Trp	Val	Phe	Gly	Gly	Gly	Thr	Glu	Leu	Thr	Val	Leu	Gly	Gln
			100					105					110		
Pro	Lys	Ala	Ala	Pro	Ser	Val	Thr	Leu	Phe	Pro	Pro	Ser	Ser	Glu	Glu
		115					120					125			
Leu	Gln	Ala	Asn	Lys	Ala	Thr	Leu	Val	Cys	Leu	Ile	Ser	Asp	Phe	Tyr
	130					135					140				
Pro	Gly	Ala	Val	Thr	Val	Ala	Trp	Lys	Ala	Asp	Ser	Ser	Pro	Val	Lys
145					150					155					160
Ala	Gly	Val	Glu	Thr	Thr	Thr	Pro	Ser	Lys	Gln	Ser	Asn	Asn	Lys	Tyr
				165					170					175	
Ala	Ala	Ser	Ser	Tyr	Leu	Ser	Leu	Thr	Pro	Glu	Gln	Trp	Lys	Ser	His
			180					185					190		
Arg	Ser	Tyr	Ser	Cys	Gln	Val	Thr	His	Glu	Gly	Ser	Thr	Val	Glu	Lys
		195					200					205			
Thr	Val	Ala	Pro	Thr	Glu	Cys	Ser								
		210				215									

<210> 79
 <211> 216
 <212> PRT
 <213> Homo sapiens

<400> 79

Gln	Ser	Val	Leu	Thr	Gln	Glu	Pro	Ser	Val	Ser	Gly	Thr	Pro	Gly	Gln
1				5					10					15	
Arg	Val	Thr	Ile	Ser	Cys	Ser	Gly	Ser	Ser	Ser	Asn	Ile	Gly	Ser	Asn
			20					25					30		
Tyr	Val	Tyr	Trp	Tyr	Gln	Gln	Leu	Pro	Gly	Thr	Ala	Pro	Lys	Leu	Leu
		35					40					45			
Ile	Tyr	Arg	Asn	Asn	Gln	Arg	Pro	Ser	Gly	Ala	Pro	Asp	Arg	Phe	Ser
	50					55					60				
Gly	Ser	Lys	Ser	Gly	Thr	Ser	Ala	Ser	Leu	Ala	Ile	Ser	Gly	Leu	Arg
65					70					75					80
Ser	Glu	Asp	Glu	Ala	Asp	Tyr	Tyr	Cys	Ala	Ala	Trp	Asp	Asp	Ser	Leu
				85					90					95	
Ser	Gly	Trp	Val	Phe	Gly	Gly	Gly	Thr	Lys	Leu	Thr	Val	Leu	Gly	Gln
			100					105					110		
Pro	Lys	Ala	Ala	Pro	Ser	Val	Thr	Leu	Phe	Pro	Pro	Ser	Ser	Glu	Glu
		115					120					125			
Leu	Gln	Ala	Asn	Lys	Ala	Thr	Leu	Val	Cys	Leu	Ile	Ser	Asp	Phe	Tyr
	130					135					140				
Pro	Gly	Ala	Val	Thr	Val	Ala	Trp	Lys	Ala	Asp	Ser	Ser	Pro	Val	Lys
145					150					155					160
Ala	Gly	Val	Glu	Thr	Thr	Thr	Pro	Ser	Lys	Gln	Ser	Asn	Asn	Lys	Tyr
				165					170					175	
Ala	Ala	Ser	Ser	Tyr	Leu	Ser	Leu	Thr	Pro	Glu	Gln	Trp	Lys	Ser	His
			180					185					190		
Arg	Ser	Tyr	Ser	Cys	Gln	Val	Thr	His	Glu	Gly	Ser	Thr	Val	Glu	Lys
		195					200					205			
Thr	Val	Ala	Pro	Thr	Glu	Cys	Ser								
	210					215									

<210> 80

<211> 443

<212> PRT

<213> Homo sapiens

<400> 80

Gln	Leu	Gln	Leu	Gln	Glu	Ser	Gly	Pro	Gly	Leu	Val	Lys	Pro	Ser	Glu
1				5					10					15	
Thr	Leu	Ser	Leu	Thr	Cys	Thr	Val	Ser	Gly	Gly	Ser	Ile	Trp	Gly	Trp
			20					25					30		
Ile	Arg	Gln	Pro	Pro	Gly	Lys	Gly	Leu	Glu	Trp	Ile	Gly	Ser	Ile	Tyr
		35					40					45			
Ser	Ser	Gly	Ser	Thr	Tyr	Tyr	Asn	Pro	Ser	Leu	Lys	Ser	Arg	Val	Thr
	50					55					60				
Ile	Ser	Val	Asp	Thr	Ser	Glu	Asn	Gln	Phe	Ser	Leu	Arg	Leu	Ser	Ser
65					70					75					80
Val	Thr	Ala	Ala	Asp	Thr	Ala	Val	Tyr	Tyr	Cys	Val	Val	Trp	Phe	Gly
				85					90					95	
Asp	Leu	Leu	Ser	Leu	Lys	Gly	Val	Glu	Leu	Trp	Gly	Gln	Gly	Thr	Leu
			100					105					110		
Val	Thr	Val	Ser	Ser	Ala	Ser	Thr	Lys	Gly	Pro	Ser	Val	Phe	Pro	Leu
		115						120				125			
Ala	Pro	Cys	Ser	Arg	Ser	Thr	Ser	Glu	Ser	Thr	Ala	Ala	Leu	Gly	Cys
	130					135					140				
Leu	Val	Lys	Asp	Tyr	Phe	Pro	Glu	Pro	Val	Thr	Val	Ser	Trp	Asn	Ser
145					150					155					160
Gly	Ala	Leu	Thr	Ser	Gly	Val	His	Thr	Phe	Pro	Ala	Val	Leu	Gln	Ser
				165					170					175	

Ser	Gly	Leu	Tyr	Ser	Leu	Ser	Ser	Val	Val	Thr	Val	Pro	Ser	Ser	Asn
			180					185					190		
Phe	Gly	Thr	Gln	Thr	Tyr	Thr	Cys	Asn	Val	Asp	His	Lys	Pro	Ser	Asn
		195					200					205			
Thr	Lys	Val	Asp	Lys	Thr	Val	Glu	Arg	Lys	Cys	Cys	Val	Glu	Cys	Pro
	210					215					220				
Pro	Cys	Pro	Ala	Pro	Pro	Val	Ala	Gly	Pro	Ser	Val	Phe	Leu	Phe	Pro
225					230					235					240
Pro	Lys	Pro	Lys	Asp	Thr	Leu	Met	Ile	Ser	Arg	Thr	Pro	Glu	Val	Thr
				245					250					255	
Cys	Val	Val	Val	Asp	Val	Ser	His	Glu	Asp	Pro	Glu	Val	Gln	Phe	Asn
			260					265					270		
Trp	Tyr	Val	Asp	Gly	Val	Glu	Val	His	Asn	Ala	Lys	Thr	Lys	Pro	Arg
		275					280					285			
Glu	Glu	Gln	Phe	Asn	Ser	Thr	Phe	Arg	Val	Val	Ser	Val	Leu	Thr	Val
	290					295					300				
Val	His	Gln	Asp	Trp	Leu	Asn	Gly	Lys	Glu	Tyr	Lys	Cys	Lys	Val	Ser
305					310					315					320
Asn	Lys	Gly	Leu	Pro	Ala	Pro	Ile	Glu	Lys	Thr	Ile	Ser	Lys	Thr	Lys
				325					330					335	
Gly	Gln	Pro	Arg	Glu	Pro	Gln	Val	Tyr	Thr	Leu	Pro	Pro	Ser	Arg	Glu
			340					345					350		
Glu	Met	Thr	Lys	Asn	Gln	Val	Ser	Leu	Thr	Cys	Leu	Val	Lys	Gly	Phe
		355					360					365			
Tyr	Pro	Ser	Asp	Ile	Ala	Val	Glu	Trp	Glu	Ser	Asn	Gly	Gln	Pro	Glu
	370					375					380				
Asn	Asn	Tyr	Lys	Thr	Thr	Pro	Pro	Met	Leu	Asp	Ser	Asp	Gly	Ser	Phe
385					390					395					400
Phe	Leu	Tyr	Ser	Lys	Leu	Thr	Val	Asp	Lys	Ser	Arg	Trp	Gln	Gln	Gly
				405					410					415	
Asn	Val	Phe	Ser	Cys	Ser	Val	Met	His	Glu	Ala	Leu	His	Asn	His	Tyr
			420					425					430		
Thr	Gln	Lys	Ser	Leu	Ser	Leu	Ser	Pro	Gly	Lys					
		435					440								

<210> 81
 <211> 216
 <212> PRT
 <213> Homo sapiens

<400> 81
 Gln Ser Val Leu Thr Gln Pro Pro Thr Val Ser Gly Thr Pro Gly Gln
 1 5 10 15
 Arg Val Thr Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly Ser Lys
 20 25 30
 Asn Val Tyr Trp Tyr Gln Gln Leu Pro Gly Thr Ala Pro Lys Leu Leu
 35 40 45
 Ile Tyr Arg Asn Asn Gln Arg Pro Ser Gly Val Pro Asp Arg Phe Ser
 50 55 60
 Gly Ser Lys Ser Gly Thr Ser Ala Ser Leu Ala Ile Ser Gly Leu Arg
 65 70 75 80
 Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ala Trp Asp Asp Ser Leu
 85 90 95
 Ser Gly Trp Val Phe Gly Gly Gly Thr Lys Val Thr Val Leu Gly Gln
 100 105 110
 Pro Lys Ala Ala Pro Ser Val Thr Leu Phe Pro Pro Ser Ser Glu Glu
 115 120 125
 Leu Gln Ala Asn Lys Ala Thr Leu Val Cys Leu Ile Ser Asp Phe Tyr
 130 135 140

Pro	Gly	Ala	Val	Thr	Val	Ala	Trp	Lys	Ala	Asp	Ser	Ser	Pro	Val	Lys
145					150				155						160
Ala	Gly	Val	Glu	Thr	Thr	Thr	Pro	Ser	Lys	Gln	Ser	Asn	Asn	Lys	Tyr
				165					170						175
Ala	Ala	Ser	Ser	Tyr	Leu	Ser	Leu	Thr	Pro	Glu	Gln	Trp	Lys	Ser	His
			180					185					190		
Arg	Ser	Tyr	Ser	Cys	Gln	Val	Thr	His	Glu	Gly	Ser	Thr	Val	Glu	Lys
		195					200					205			
Thr	Val	Ala	Pro	Thr	Glu	Cys	Ser								
	210					215									

<210> 82
 <211> 447
 <212> PRT
 <213> Homo sapiens

<400> 82

Gln	Leu	Gln	Leu	Gln	Glu	Ser	Gly	Pro	Gly	Leu	Val	Lys	Pro	Ser	Glu
1				5				10						15	
Thr	Leu	Ser	Leu	Thr	Cys	Thr	Val	Ser	Gly	Gly	Ser	Ile	Ser	Ser	Thr
			20					25					30		
Ser	Tyr	Tyr	Trp	Gly	Trp	Ile	Arg	Gln	Pro	Pro	Gly	Lys	Gly	Leu	Glu
		35					40					45			
Trp	Ile	Gly	Ser	Ile	Ser	Tyr	Ser	Gly	Ser	Thr	Tyr	Tyr	Asn	Pro	Ser
	50					55					60				
Leu	Lys	Ser	Arg	Val	Thr	Ile	Ser	Val	Asp	Thr	Ser	Lys	Asn	Gln	Phe
65					70				75						80
Ser	Leu	Lys	Leu	Thr	Ser	Val	Thr	Ala	Ala	Asp	Thr	Ala	Val	Tyr	Tyr
				85					90					95	
Cys	Ala	Arg	Ile	Leu	Trp	Phe	Gly	Glu	Tyr	Leu	Gly	Asp	Tyr	Trp	Gly
			100					105					110		
Gln	Gly	Thr	Leu	Val	Thr	Val	Ser	Ser	Ala	Ser	Thr	Lys	Gly	Pro	Ser
		115					120					125			
Val	Phe	Pro	Leu	Ala	Pro	Cys	Ser	Arg	Ser	Thr	Ser	Glu	Ser	Thr	Ala
	130					135					140				
Ala	Leu	Gly	Cys	Leu	Val	Lys	Asp	Tyr	Phe	Pro	Glu	Pro	Val	Thr	Val
145					150					155					160
Ser	Trp	Asn	Ser	Gly	Ala	Leu	Thr	Ser	Gly	Val	His	Thr	Phe	Pro	Ala
				165					170						175
Val	Leu	Gln	Ser	Ser	Gly	Leu	Tyr	Ser	Leu	Ser	Ser	Val	Val	Thr	Val
			180					185					190		
Pro	Ser	Ser	Asn	Phe	Gly	Thr	Gln	Thr	Tyr	Thr	Cys	Asn	Val	Asp	His
		195					200					205			
Lys	Pro	Ser	Asn	Thr	Lys	Val	Asp	Lys	Thr	Val	Glu	Arg	Lys	Cys	Cys
	210					215					220				
Val	Glu	Cys	Pro	Pro	Cys	Pro	Ala	Pro	Pro	Val	Ala	Gly	Pro	Ser	Val
225					230					235					240
Phe	Leu	Phe	Pro	Pro	Lys	Pro	Lys	Asp	Thr	Leu	Met	Ile	Ser	Arg	Thr
				245					250					255	
Pro	Glu	Val	Thr	Cys	Val	Val	Val	Asp	Val	Ser	His	Glu	Asp	Pro	Glu
			260					265					270		
Val	Gln	Phe	Asn	Trp	Tyr	Val	Asp	Gly	Val	Glu	Val	His	Asn	Ala	Lys
		275					280					285			
Thr	Lys	Pro	Arg	Glu	Glu	Gln	Phe	Asn	Ser	Thr	Phe	Arg	Val	Val	Ser
	290					295					300				
Val	Leu	Thr	Val	Val	His	Gln	Asp	Trp	Leu	Asn	Gly	Lys	Glu	Tyr	Lys
305					310					315					320
Cys	Lys	Val	Ser	Asn	Lys	Gly	Leu	Pro	Ala	Pro	Ile	Glu	Lys	Thr	Ile
				325					330					335	

Ser	Lys	Thr	Lys	Gly	Gln	Pro	Arg	Glu	Pro	Gln	Val	Tyr	Thr	Leu	Pro
			340					345					350		
Pro	Ser	Arg	Glu	Glu	Met	Thr	Lys	Asn	Gln	Val	Ser	Leu	Thr	Cys	Leu
		355					360					365			
Val	Lys	Gly	Phe	Tyr	Pro	Ser	Asp	Ile	Ala	Val	Glu	Trp	Glu	Ser	Asn
	370					375					380				
Gly	Gln	Pro	Glu	Asn	Asn	Tyr	Lys	Thr	Thr	Pro	Pro	Met	Leu	Asp	Ser
385					390					395					400
Asp	Gly	Ser	Phe	Phe	Leu	Tyr	Ser	Lys	Leu	Thr	Val	Asp	Lys	Ser	Arg
			405						410					415	
Trp	Gln	Gln	Gly	Asn	Val	Phe	Ser	Cys	Ser	Val	Met	His	Glu	Ala	Leu
			420					425					430		
His	Asn	His	Tyr	Thr	Gln	Lys	Ser	Leu	Ser	Leu	Ser	Pro	Gly	Lys	
		435					440					445			

<210> 83
 <211> 214
 <212> PRT
 <213> Homo sapiens

<400> 83

Glu	Ile	Val	Met	Thr	Gln	Ser	Pro	Gly	Thr	Leu	Ser	Leu	Ser	Pro	Gly
1				5					10					15	
Glu	Arg	Ala	Thr	Leu	Ser	Cys	Arg	Ala	Ser	Gln	Ser	Val	Ser	Asn	Tyr
			20					25					30		
Leu	Ala	Trp	Tyr	Gln	Gln	Lys	Pro	Gly	Gln	Ala	Pro	Arg	Leu	Leu	Ile
		35					40					45			
Tyr	Gly	Ala	Ser	Ser	Arg	Ala	Thr	Gly	Ile	Pro	Asp	Arg	Phe	Ser	Gly
	50					55					60				
Ser	Gly	Ser	Gly	Thr	Asp	Phe	Thr	Leu	Thr	Ile	Ser	Arg	Leu	Glu	Pro
65					70					75				80	
Glu	Asp	Phe	Ala	Val	Tyr	His	Cys	Gln	Gln	Tyr	Tyr	Ser	Thr	Pro	Trp
				85					90					95	
Thr	Phe	Gly	Gln	Gly	Thr	Lys	Leu	Glu	Ile	Lys	Arg	Thr	Val	Ala	Ala
			100					105					110		
Pro	Ser	Val	Phe	Ile	Phe	Pro	Pro	Ser	Asp	Glu	Gln	Leu	Lys	Ser	Gly
		115					120					125			
Thr	Ala	Ser	Val	Val	Cys	Leu	Leu	Asn	Asn	Phe	Tyr	Pro	Arg	Glu	Ala
	130					135					140				
Lys	Val	Gln	Trp	Lys	Val	Asp	Asn	Ala	Leu	Gln	Ser	Gly	Asn	Ser	Gln
145					150					155					160
Glu	Ser	Val	Thr	Glu	Gln	Asp	Ser	Lys	Asp	Ser	Thr	Tyr	Ser	Leu	Ser
				165					170					175	
Ser	Thr	Leu	Thr	Leu	Ser	Lys	Ala	Asp	Tyr	Glu	Lys	His	Lys	Val	Tyr
			180					185					190		
Ala	Cys	Glu	Val	Thr	His	Gln	Gly	Leu	Ser	Ser	Pro	Val	Thr	Lys	Ser
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			210												

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<400> 84

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			20					25					30		
Tyr	Tyr	Trp	Gly	Trp	Ile	Arg	Gln	Pro	Pro	Gly	Lys	Gly	Leu	Glu	Trp
		35					40					45			
Ile	Gly	Ser	Ser	Asn	His	Ser	Gly	Ser	Thr	Tyr	Tyr	Asn	Pro	Ser	Leu
	50					55					60				
Arg	Ser	Arg	Val	Thr	Ile	Ser	Val	Asp	Thr	Ser	Lys	Asn	Gln	Phe	Ser
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Leu	Lys	Val	Asn	Ser	Val	Thr	Ala	Ala	Asp	Thr	Ala	Val	Tyr	Tyr	Cys
			85						90					95	
Ala	Arg	Glu	Ala	Gly	Tyr	Ser	Ser	Ser	Trp	Tyr	Phe	Asp	Tyr	Trp	Gly
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Gln	Gly	Thr	Leu	Val	Thr	Val	Ser	Ser	Ala	Ser	Thr	Lys	Gly	Pro	Ser
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Val	Phe	Pro	Leu	Ala	Pro	Cys	Ser	Arg	Ser	Thr	Ser	Glu	Ser	Thr	Ala
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145					150					155					160
Ser	Trp	Asn	Ser	Gly	Ala	Leu	Thr	Ser	Gly	Val	His	Thr	Phe	Pro	Ala
				165					170						175
Val	Leu	Gln	Ser	Ser	Gly	Leu	Tyr	Ser	Leu	Ser	Ser	Val	Val	Thr	Val
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Pro	Ser	Ser	Asn	Phe	Gly	Thr	Gln	Thr	Tyr	Thr	Cys	Asn	Val	Asp	His
		195					200					205			
Lys	Pro	Ser	Asn	Thr	Lys	Val	Asp	Lys	Thr	Val	Glu	Arg	Lys	Cys	Cys
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Phe	Leu	Phe	Pro	Pro	Lys	Pro	Lys	Asp	Thr	Leu	Met	Ile	Ser	Arg	Thr
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Pro	Glu	Val	Thr	Cys	Val	Val	Val	Asp	Val	Ser	His	Glu	Asp	Pro	Glu
			260					265					270		
Val	Gln	Phe	Asn	Trp	Tyr	Val	Asp	Gly	Val	Glu	Val	His	Asn	Ala	Lys
		275					280					285			
Thr	Lys	Pro	Arg	Glu	Glu	Gln	Phe	Asn	Ser	Thr	Phe	Arg	Val	Val	Ser
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Val	Leu	Thr	Val	Val	His	Gln	Asp	Trp	Leu	Asn	Gly	Lys	Glu	Tyr	Lys
305					310					315					320
Cys	Lys	Val	Ser	Asn	Lys	Gly	Leu	Pro	Ala	Pro	Ile	Glu	Lys	Thr	Ile
				325					330					335	
Ser	Lys	Thr	Lys	Gly	Gln	Pro	Arg	Glu	Pro	Gln	Val	Tyr	Thr	Leu	Pro
			340					345					350		
Pro	Ser	Arg	Glu	Glu	Met	Thr	Lys	Asn	Gln	Val	Ser	Leu	Thr	Cys	Leu
		355					360					365			
Val	Lys	Gly	Phe	Tyr	Pro	Ser	Asp	Ile	Ala	Val	Glu	Trp	Glu	Ser	Asn
	370					375					380				
Gly	Gln	Pro	Glu	Asn	Asn	Tyr	Lys	Thr	Thr	Pro	Pro	Met	Leu	Asp	Ser
385					390					395					400
Asp	Gly	Ser	Phe	Phe	Leu	Tyr	Ser	Lys	Leu	Thr	Val	Asp	Lys	Ser	Arg
				405					410					415	
Trp	Gln	Gln	Gly	Asn	Val	Phe	Ser	Cys	Ser	Val	Met	His	Glu	Ala	Leu
			420					425					430		
His	Asn	His	Tyr	Thr	Gln	Lys	Ser	Leu	Ser	Leu	Ser	Pro	Gly	Lys	
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<213> Homo sapiens

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 35 40 45
 Ile Tyr Asp Asn Asn Lys Arg Pro Ser Gly Ile Pro Asp Arg Phe Ser
 50 55 60
 Gly Ser Lys Ser Gly Thr Ser Ala Thr Leu Gly Ile Thr Gly Leu Gln
 65 70 75 80
 Thr Gly Asp Glu Ala Asp Tyr Tyr Cys Gly Thr Trp Asp Ser Ser Leu
 85 90 95
 Ser Ala Trp Val Phe Gly Gly Gly Thr Gln Leu Thr Val Leu Gly Gln
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 Pro Lys Ala Ala Pro Ser Val Thr Leu Phe Pro Pro Ser Ser Glu Glu
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 Leu Gln Ala Asn Lys Ala Thr Leu Val Cys Leu Ile Ser Asp Phe Tyr
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 Pro Gly Ala Val Thr Val Ala Trp Lys Ala Asp Ser Ser Pro Val Lys
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 Ala Gly Val Glu Thr Thr Thr Pro Ser Lys Gln Ser Asn Asn Lys Tyr
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 Ala Ala Ser Ser Tyr Leu Ser Leu Thr Pro Glu Gln Trp Lys Ser His
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 Thr Val Ala Pro Thr Glu Cys Ser
 210 215

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<400> 86
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CLAIMS:

1. A monoclonal antibody specifically binding nicotine, wherein said monoclonal antibody is a human monoclonal antibody, and

5 (a) wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises:

(i) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1;

(ii) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2; and

10 (iii) one HC CDR3, wherein said HC CDR3 consists of the peptide of any one of SEQ ID NOs 3 and 4; and

(b) wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises:

15 (i) one LC CDR1, wherein said LC CDR1 consists of the peptide of any one of SEQ ID NOs 5, 6, and 7;

(ii) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8;

(iii) one LC CDR3, wherein said LC CDR3 consists of the peptide of any one of SEQ ID NOs 9 and 10.

20 2. The monoclonal antibody of claim 1, wherein said HC CDR3 consists of the peptide of SEQ ID NO:3.

3. The monoclonal antibody of claim 1 or claim 2, wherein said LC CDR1 consists of the peptide of SEQ ID NO:5.

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4. The monoclonal antibody of any one of the claims 1 to 3, wherein said LC CDR3 consists of the peptide of SEQ ID NO:9.

5. The monoclonal antibody of any one of the claims 1 to 4, wherein

(a) position 7 to 117 of said HCVR consists of the peptide of any one of SEQ ID NOs 24, 28, 33, and 39; and

(b) wherein position 5 to 107 of said LCVR consist of the peptide of any one of SEQ ID NOs 26, 31, 35, 37, and 41.

6. The monoclonal antibody of any one of the claims 1 to 5, wherein said position 7 to 117 of said HCVR consists of the peptide of SEQ ID NO:24.

10 7. The monoclonal antibody of any one of the claims 1 to 6, wherein said position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:26

8. The monoclonal antibody of any one of the claims 1 to 7, wherein

(a) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:24, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:26;

15 (b) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:28, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:31;

(c) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:33, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:35;

20 (d) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:28, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:37; or

(e) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:39, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:41.

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9. The monoclonal antibody of any one of the claims 1 to 8, wherein position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:24, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:26.

10. The monoclonal antibody of any one of the claims 1 to 9, wherein said
5 monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda light chain, wherein

(a) said gamma 2 heavy chain comprises the peptide of SEQ ID NO:73, and wherein said lambda light chain comprises the peptide of SEQ ID NO:74;

(b) said gamma 2 heavy chain comprises the peptide of SEQ ID NO:75, and
10 wherein said lambda light chain comprises the peptide of SEQ ID NO:76;

(c) said gamma 2 heavy chain comprises the peptide of SEQ ID NO:77, and wherein said lambda light chain comprises the peptide of SEQ ID NO:78;

(d) said gamma 2 heavy chain comprises the peptide of SEQ ID NO:75, and wherein said lambda light chain comprises the peptide of SEQ ID NO:79; or

15 (e) said gamma 2 heavy chain comprises the peptide of SEQ ID NO:80, and wherein said lambda light chain comprises or preferably consists of the peptide of SEQ ID NO:81.

11. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda
20 light chain, wherein said gamma 2 heavy chain comprises the peptide of SEQ ID NO:75, and wherein said lambda light chain consists of the peptide of SEQ ID NO:76.

12. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda light chain, wherein said gamma 2 heavy chain consists of the peptide of SEQ ID NO:75, and
25 wherein said lambda light chain comprises the peptide of SEQ ID NO:76.

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13. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda light chain, wherein said gamma 2 heavy chain consists of the peptide of SEQ ID NO:75, and wherein said lambda light chain consists of the peptide of SEQ ID NO:76.

5 14. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda light chain, wherein said gamma 2 heavy chain comprises the peptide of SEQ ID NO:77, and wherein said lambda light chain consists of the peptide of SEQ ID NO:78.

10 15. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda light chain, wherein said gamma 2 heavy chain consists of the peptide of SEQ ID NO:77, and wherein said lambda light chain comprises the peptide of SEQ ID NO:78.

15 16. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda light chain, wherein said gamma 2 heavy chain consists of the peptide of SEQ ID NO:77, and wherein said lambda light chain consists of the peptide of SEQ ID NO:78.

20 17. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda light chain, wherein said gamma 2 heavy chain comprises the peptide of SEQ ID NO:75, and wherein said lambda light chain consists of the peptide of SEQ ID NO:79.

18. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda light chain, wherein said gamma 2 heavy chain consists of the peptide of SEQ ID NO:75, and wherein said lambda light chain comprises the peptide of SEQ ID NO:79.

25 19. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda

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light chain, wherein said gamma 2 heavy chain consists of the peptide of SEQ ID NO:75, and wherein said lambda light chain consists of the peptide of SEQ ID NO:79.

20. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda
5 light chain, wherein said gamma 2 heavy chain comprises the peptide of SEQ ID NO:80, and wherein said lambda light chain consists of the peptide of SEQ ID NO:81.

21. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda
10 light chain, wherein said gamma 2 heavy chain consists of the peptide of SEQ ID NO:80, and wherein said lambda light chain comprises the peptide of SEQ ID NO:81.

22. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda
light chain, wherein said gamma 2 heavy chain consists of the peptide of SEQ ID NO:80, and wherein said lambda light chain consists of the peptide of SEQ ID NO:81.

15 23. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda
light chain, wherein said gamma 2 heavy chain comprises the peptide of SEQ ID NO:73, and wherein said lambda light chain consists of the peptide of SEQ ID NO:74.

20 24. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda
light chain, wherein said gamma 2 heavy chain consists of the peptide of SEQ ID NO:73, and wherein said lambda light chain comprises the peptide of SEQ ID NO:74.

25 25. The monoclonal antibody of any one of the claims 1 to 9, wherein said monoclonal antibody comprises at least one gamma 2 heavy chain and at least one lambda
light chain, wherein said gamma 2 heavy chain consists of the peptide of SEQ ID NO:73, and wherein said lambda light chain consists of the peptide of SEQ ID NO:74.

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26. The monoclonal antibody of any one of the claims 1 to 25, wherein said monoclonal antibody is an IgG2.

27. The monoclonal antibody of any one of the claims 1 to 26, wherein said monoclonal antibody is specifically binding (S)-(-)-nicotine and (R)-(+)-nicotine.

5 28. The monoclonal antibody of any one of the claims 1 to 27, wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 100 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 100 nM.

10 29. The monoclonal antibody of any one of the claims 1 to 27, wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 50 nM.

15 30. The monoclonal antibody of any one of the claims 1 to 27, wherein said monoclonal antibody is binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 10 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 10 nM.

20 31. A HCVR of a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is specifically binding (S)-(-)-nicotine and (R)-(+)-nicotine; and wherein said HCVR comprises:

(a) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1;

25 (b) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2; and

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(c) one HC CDR3, wherein said HC CDR3 consists of the peptide of any one of SEQ ID NOs 3 and 4.

32. The HCVR of claim 31, wherein said HC CDR3 consists of the peptide of SEQ ID NO:3.

5 33. The HCVR of any one of the claims 31 or 32, wherein the dissociation constant Kd of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 100 nM; and wherein the dissociation constant Kd of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 100 nM.

10 34. The HCVR of any one of the claims 31 or 32, wherein the dissociation constant Kd of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM; and wherein the dissociation constant Kd of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 50 nM.

15 35. The HCVR of any one of the claims 31 or 32, wherein the dissociation constant Kd of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM; and wherein the dissociation constant Kd of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 20 nM.

20 36. The HCVR of any one of the claims 31 or 32, wherein the dissociation constant Kd of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM; and wherein the dissociation constant Kd of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 10 nM.

37. The HCVR of any one of the claims 31 to 36, wherein position 7 to 117 of said HCVR consists of the peptide of any one of SEQ ID NOs 24, 28, 33, and 39.

38. The HCVR of any one of the claims 31 to 36, wherein position 7 to 117 of said HCVR consists of the peptide of SEQ ID NO:24.

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39. A LCVR of a monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is specifically binding (S)-(-)-nicotine and (R)-(+)-nicotine; and wherein said LCVR comprises:

(a) one LC CDR1, wherein said LC CDR1 consists of the peptide of any one of
5 SEQ ID NOs 5, 6, and 7;

(b) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8;

(c) one LC CDR3, wherein said LC CDR3 consists of the peptide of any one of SEQ ID NOs 9 and 10.

10 40. The LCVR of claim 39, wherein said LC CDR1 consists of the peptide of SEQ ID NO:5.

41. The LCVR of any one of the claims 39 or 40, wherein said LC CDR3 consists of the peptide of SEQ ID NO:9.

42. The LCVR of any one of the claims 39 to 41, wherein the dissociation constant
15 Kd of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 100 nM; and wherein the dissociation constant Kd of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 100 nM.

43. The LCVR of any one of the claims 39 to 41, wherein the dissociation constant Kd of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM; and
20 wherein the dissociation constant Kd of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 50 nM.

44. The LCVR of any one of the claims 39 to 41, wherein the dissociation constant Kd of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM; and wherein the dissociation constant Kd of said binding of said monoclonal antibody to said
25 (R)-(+)-nicotine is 1 to 20 nM.

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45. The LCVR of any one of the claims 39 to 41, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 10 nM.

5 46. The LCVR of any one of the claims 39 to 45, wherein position 5 to 107 of said LCVR consist of the peptide of any one of SEQ ID NOs 26, 31, 35, 37, and 41.

47. The LCVR of any one of the claims 39 to 45, wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:26.

10 48. A monoclonal antibody, wherein said monoclonal antibody is a human monoclonal antibody, and wherein said monoclonal antibody is specifically binding (S)-(-)-nicotine and (R)-(+)-nicotine, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 100 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 100 nM.

15 49. The monoclonal antibody of claim 48, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 50 nM.

20 50. The monoclonal antibody of claim 48, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 20 nM.

25 51. The monoclonal antibody of claim 48, wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (S)-(-)-nicotine is 1 to 70 nM; and wherein the dissociation constant K_d of said binding of said monoclonal antibody to said (R)-(+)-nicotine is 1 to 10 nM.

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52. The monoclonal antibody of any one of the claims 48 to 51,

(a) wherein said monoclonal antibody comprises at least one HCVR, wherein said HCVR comprises:

5 (i) one HC CDR1, wherein said HC CDR1 consists of the peptide of SEQ ID NO:1;

(ii) one HC CDR2, wherein said HC CDR2 consists of the peptide of SEQ ID NO:2; and

(iii) one HC CDR3, wherein said HC CDR3 consists of the peptide of any one of SEQ ID NOs 3 and 4, and

10 (b) wherein said monoclonal antibody comprises at least one LCVR, wherein said LCVR comprises:

(i) one LC CDR1, wherein said LC CDR1 consists of the peptide of any one of SEQ ID NOs 5, 6, and 7;

15 (ii) one LC CDR2, wherein said LC CDR2 consists of the peptide of SEQ ID NO:8;

(iii) one LC CDR3, wherein said LC CDR3 consists of the peptide of any one of SEQ ID NOs 9 and 10.

53. The monoclonal antibody of claim 52, wherein said HC CDR3 consists of the peptide of SEQ ID NO:3.

20 54. The monoclonal antibody of any one of the claims 52 or 53, wherein said LC CDR1 consists of the peptide of SEQ ID NO:5.

55. The monoclonal antibody of any one of the claims 52 to 54, wherein said LC CDR3 consists of the peptide of any one of SEQ ID NO:9.

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56. The monoclonal antibody of any one of claims 52 to 55, wherein

(a) position 7 to 117 of said HCVR consists of the peptide of any one of SEQ ID NOs 24, 28, 33, and 39; and

5 (b) wherein position 5 to 107 of said LCVR consist of the peptide of any one of SEQ ID NOs 26, 31, 35, 37, and 41.

57. The monoclonal antibody of claim 56, wherein position 7 to 117 of said HCVR consists of the peptide of SEQ ID NO:24.

58. The monoclonal antibody of any one of the claims 56 or 57, wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NOs 26.

10 59. The monoclonal antibody of any one of claims 52 to 58, wherein

(a) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:24, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:26;

(b) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:28, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:31;

15 (c) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:33, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:35;

(d) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:28, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:37; or

20 (e) position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:39, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:41.

60. The monoclonal antibody of any one of claims 52 to 58, wherein position 7 to 117 of said HCVR consist of the peptide of SEQ ID NO:24, and wherein position 5 to 107 of said LCVR consist of the peptide of SEQ ID NO:26.

Figure 1/1

