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(54) **METHOD FOR MODULATING THE BINDING ACTIVITY OF A NOVEL ICAM-3 BINDING RECEPTOR ON SINUSOIDAL ENDOTHELIAL CELLS IN LIVER AND LYMPH NODES**

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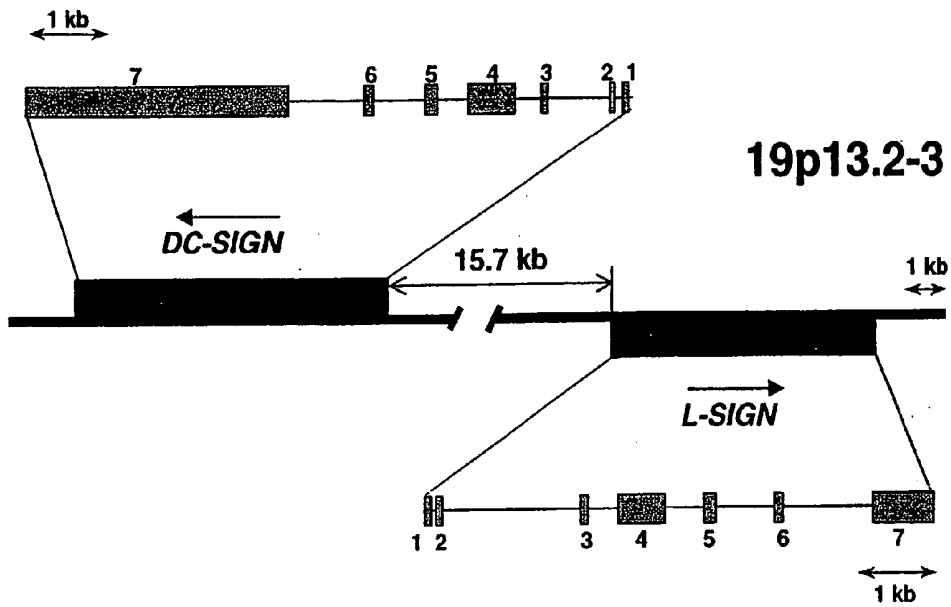
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(57) **ABSTRACT**

The invention relates to the use of a compound that binds to a C-type lectin on the surface of a sinusoid endothelial layer, in the preparation of a composition for modulating, in particular reducing, the immune response in animal, in particular a human or another mammal. The sinusoid endothelial layer may be either constituted by liver sinusoid endothelial cells (LSEC) or by the lymph node sinusoidal zone.

Fig. 1



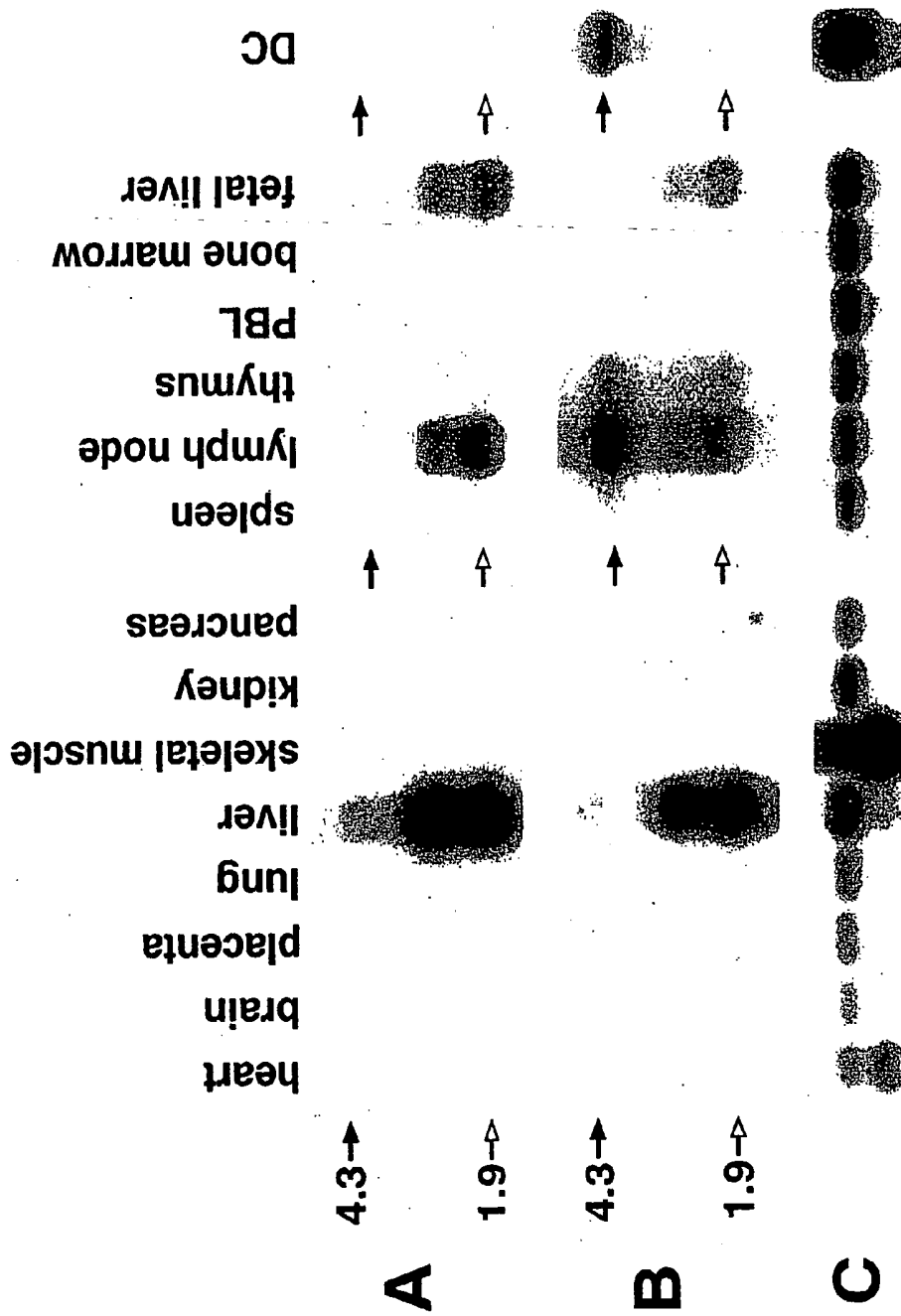
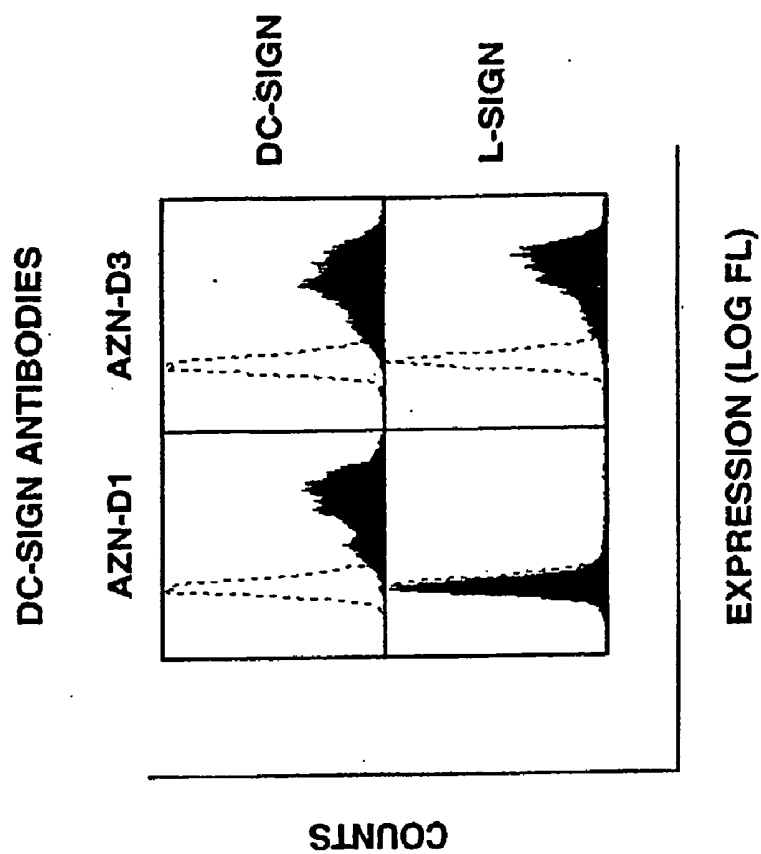


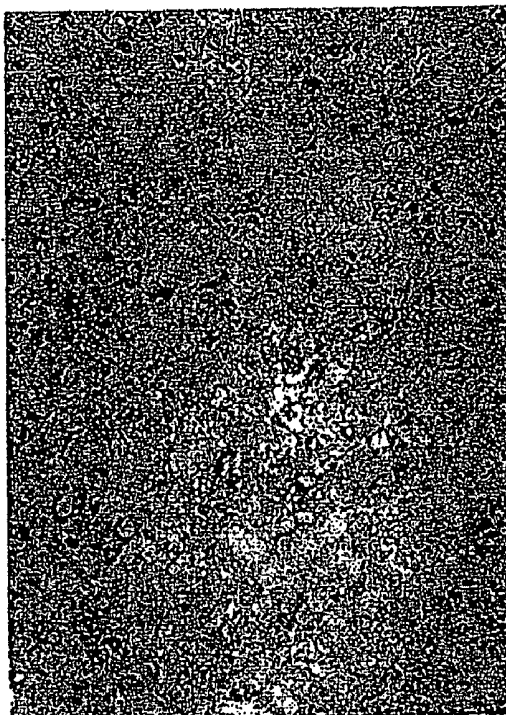
Fig.2

Fig. 3A

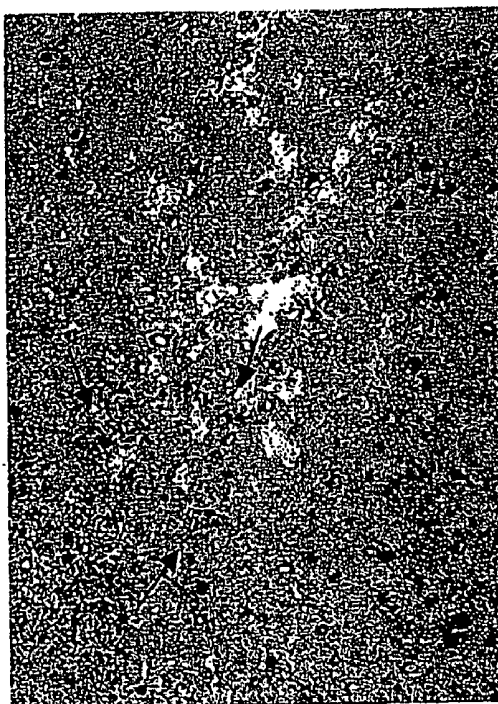


**Fig.3B**

**AZN-D3**



**AZN-D1**



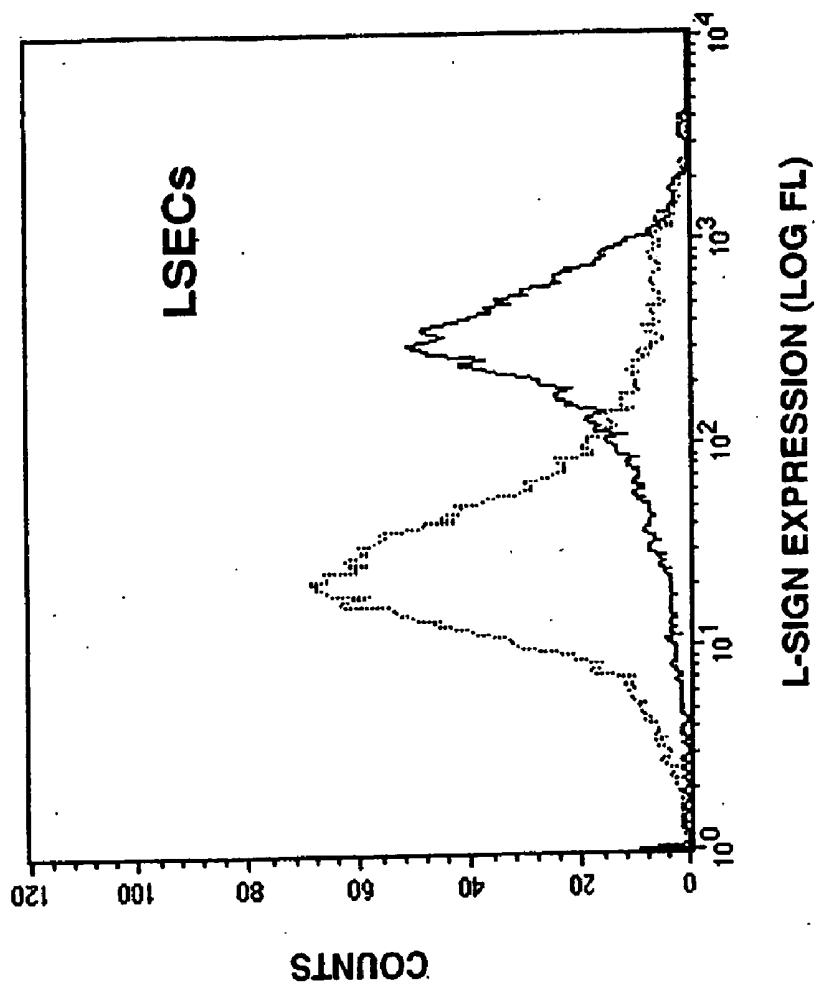


Fig.3C

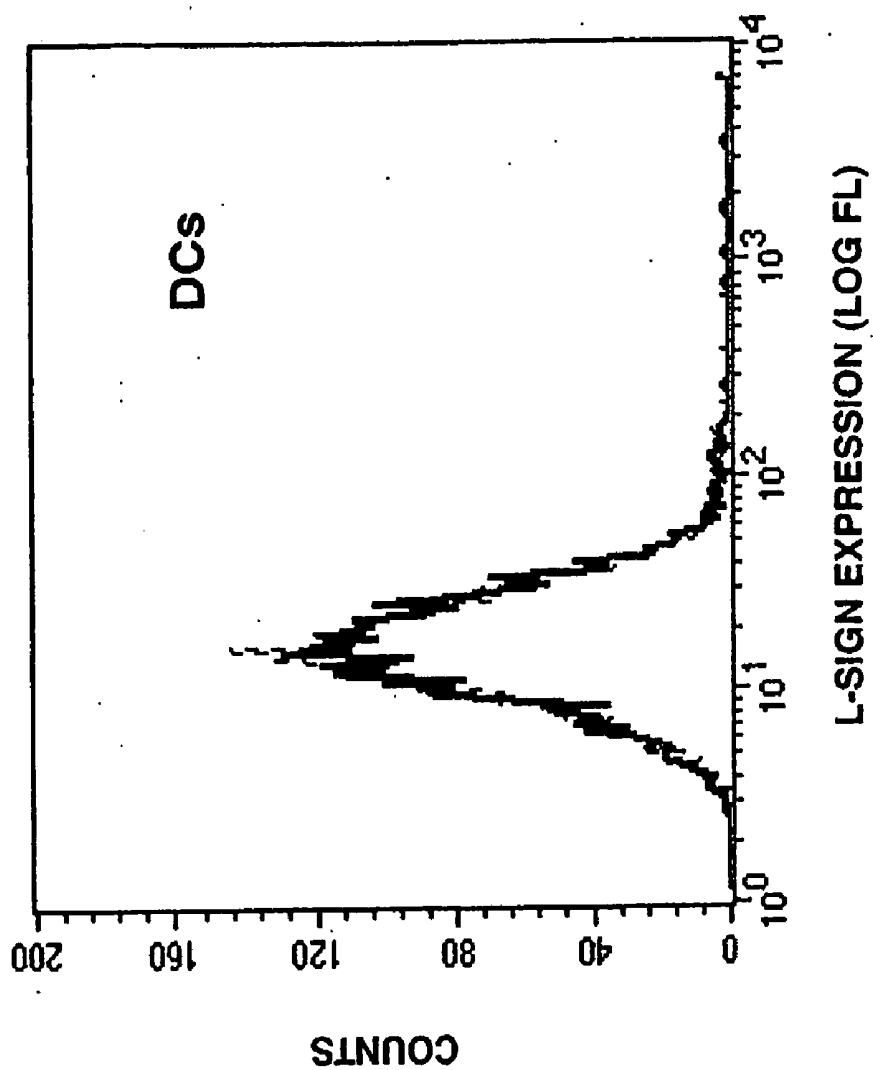


Fig. 3D

Fig. 4

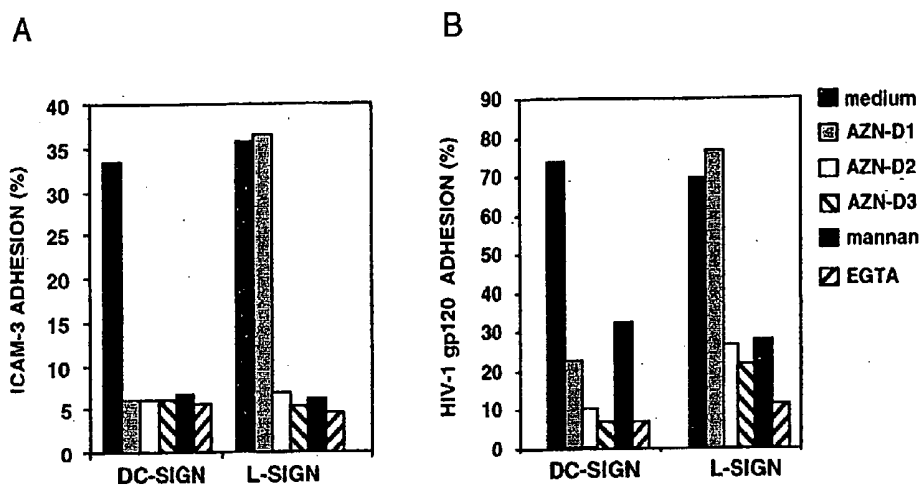


Fig. 5A

A

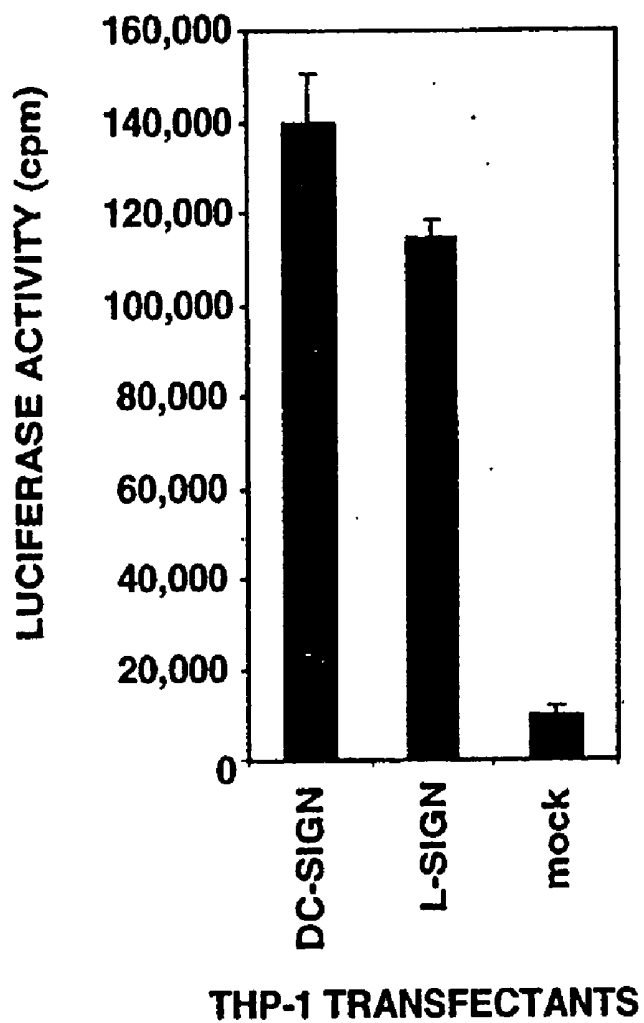


Fig. 5B

**B**

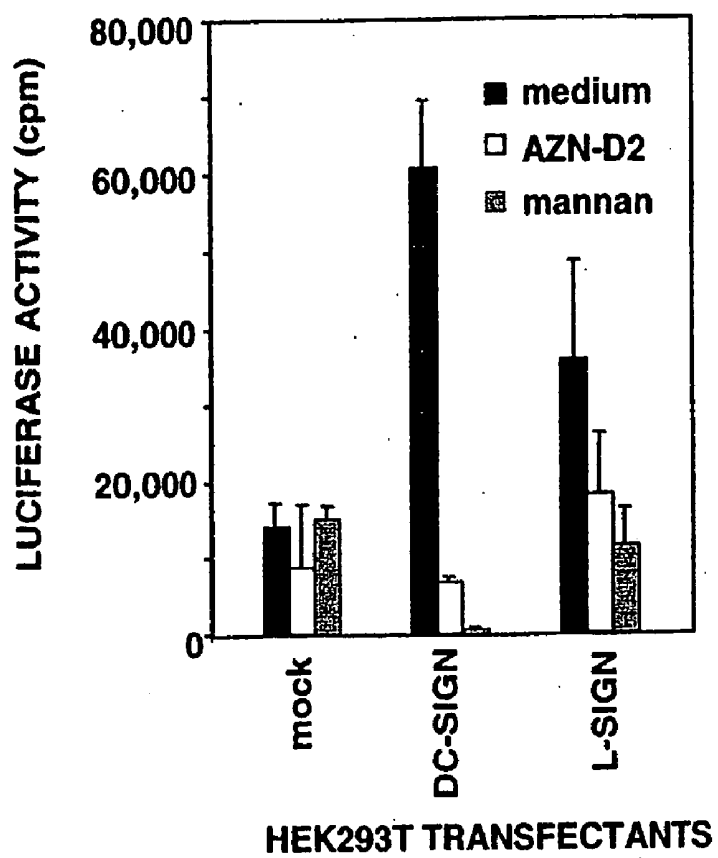


Fig. 5C

C

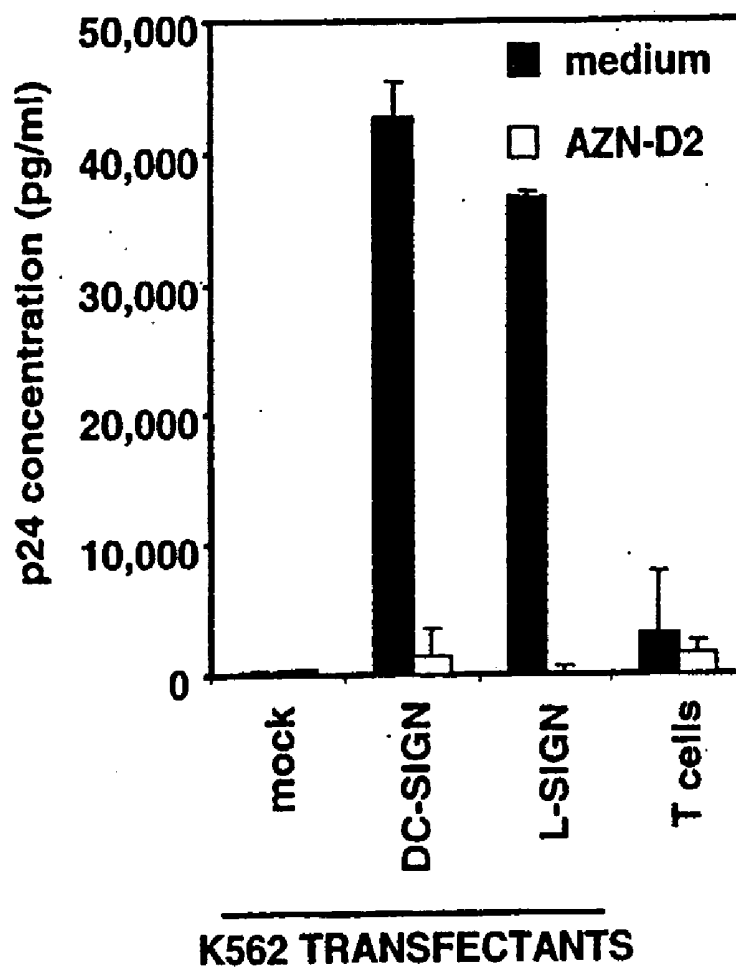


Fig. 6

DNA sequence 1200 b.p. atgagtgactcc ... agagacgaatag linear

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1/1                               31/11
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M S D S K E P R V Q Q L G L L E E D P T
61/21                               91/31
acc agt ggc atc aga ctt ttt cca aga gac ttt caa ttc cag cag ata cat ggc cac aag
T S G I R L F P R D F Q F Q Q I H G H K
121/41                               151/51
agc tct aca ggg tgt ctt ggc cat ggc gcc ctg gtg ctg caa ctc ctc tcc ttc atg ctc
S S T G C L G H G A L V L Q L L S F M L
181/61                               211/71
ttg gct ggg gtc ctg gtg gcc aac ctt gtc caa gtg tcc aag gtc ccc agc tcc cta agt
L A G V L V A N L V Q V S K V P S S L S
241/81                               271/91
cag gaa caa tcc gag caa gac gca atc tac cag aac ctg acc cag ctt aaa gct gca gtg
Q E Q S E Q D A I Y Q N L T Q L K A A V
301/101                               331/111
ggt gag ctc tca gag aaa tcc aag ctg cag gag atc tac cag gag ctg acc cag ctg aag
G E L S E K S K L Q E I Y Q E L T Q L K
361/121                               391/131
gct gca gtg ggt gag ttg cca gag aaa tcc aag ctg cag gag atc tac cag gag ctg acc
A A V G E L P E K S K L Q E I Y Q E L T
421/141                               451/151
cgg ctg aag gct gca gtg ggt gag ttg cca gag aaa tcc aag ctg cag gag atc tac cag
R L K A A V G E L P E K S K L Q E I Y Q
481/161                               511/171
gag ctg acc cag ctg aag gct gca gtg ggt gag ttg cca gag aaa tcc aag ctg cag gag
E L T Q L K A A V G E L P E K S K L Q E
541/181                               571/191
atc tac cag gag ctg acc cgg ctg aag gct gca gtg ggt gag ttg cca gag aaa tcc aag
I Y Q E L T R L K A A V G E L P E K S K
601/201                               631/211
ctg cag gag atc tac cag gag ctg acc cgg ctg aag gct gca gtg ggt gag ttg cca gag
L Q E I Y Q E L T R L K A A V G E L P E
661/221                               691/231
aaa tcc aag ctg cag gag atc tac cag gag ctg acc cag ctg aag gct gca gtg ggt gag
K S K L Q E I Y Q E L T Q L K A A V G E
721/241                               751/251
ttg cca gac cag tcc aag cag cag caa atc tat caa gaa ctg acc gat ttg aag act gca
L P D Q S K Q Q Q I Y Q E L T D L K T A
781/261                               811/271
ttt gaa cgc ctg tgc cgc cac tgt ccc aag gac tgg aca ttc ttc caa gga aac tgt tac
F E R L C R H C P K D W T F F Q G N C Y
841/281                               871/291
ttc atg tct aac tcc cag cgg aac tgg cac aac tcc gtc acc gcc tgc cag gaa gtg agg
F M S N S Q R N W H N S V T A C Q E V R
901/301                               931/311
gcc cag ctc gtc gta atc aaa act gct gag gag cag aac ttc cta cag ctg cag act tcc
A Q L V V I K T A E E Q N F L Q L Q T S
961/321                               991/331
agg agt aac cgc ttc tcc tgg atg gga ctt tca gac cta aat cag gaa ggc acg tgg caa
R S N R F S W M G L S D L N Q E G T W Q
1021/341                               1051/351
tgg gtg gac ggc tca cct ctg tca ccc agc ttc cag cgg tac tgg aac agt gga gaa ccc
W V D G G S P L S P S F Q R Y W N S G E P
1081/361                               1111/371
aac aat agc ggg aat gaa gac tgt gcg gaa ttt agt ggc agt ggc tgg aac gac aat cga
N N S G N E D C A E F S G S G W N D N R
1141/381                               1171/391
tgt gac gtt gac aat tac tgg atc tgc aaa aag ccc gca gcc tgc ttc aga gac gaa tag
C D V D N Y W I C K K P A A C F R D E *

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1 MSDSKEPRVQQLGELLEEDPTTSGIRLEPRDFQFQIHHGKSSSTGCLGHGALVLLSFMNL

61 LAGVLEVANLVQVSKVPSSLSQEQSEQDAIYQNLTLQKAAVGELSEKSKLQEIYQELTQLK

121 AAVGELPEKSKLQEIYQELTRLKAAVGELPEKSKLQEIYQELTQKAAVGELPEKSKLQEI

181 IYQELTRLKAAVGELPEKSKLQEIYQELTRLKAAVGELPEKSKLQEIYQELTQKAAVGE

241 LPDQSKQQIYQELTDLKTAFERLCRHCPRDWTFFQGNCFMSNSQRNWHNSVTACQEVRL

301 AQLVVIKTAEEQNFLOLQTSRSNRFSWMLSDLNQEGTWQWVDGSPSPSEQRYWNSGEP

361 NNSGMEDCAEESGSGWNDNRCDVDNYWICKKPAACFRDEZ

Fig. 7

**METHOD FOR MODULATING THE BINDING  
ACTIVITY OF A NOVEL ICAM-3 BINDING  
RECEPTOR ON SINUSOIDAL ENDOTHELIAL  
CELLS IN LIVER AND LYMPH NODES**

[0001] The present invention relates to the use of a compound binding to a C-type lectin located on the surface of sinusoid endothelial cells in liver and lymph nodes for modulating the immune response in animals.

[0002] The molecule DC-SIGN has recently been identified as a DC-specific adhesion receptor that mediates the interaction between DCs and resting T cells through high affinity binding to ICAM-3, thereby facilitating the initiation of primary immune responses. DC-SIGN was shown to be identical to the previously reported type II membrane-associated C-type lectin (Geijtenbeek, T. B. et al., 2000, *Cell* 100:575-585) that binds HIV-1 envelope glycoprotein gp120 in a CD4-independent manner. The affinity of DC-SIGN exceeds that of CD4 for HIV-1 gp120 (Curtis, B. M. et al., 1992, *Proc Natl Acad Sci USA* 89:8356-8360), and upon capture of HIV-1, DC-SIGN does not appear to promote viral entry into the DC itself, but rather enhances infection of T cells in trans (Geijtenbeek, T. B. et al., 2000, *Cell* 100:587-597). DC-SIGN-associated HIV-1 remains infectious over a prolonged period of time, perhaps contributing to the infectious potential of the virus during its transport by DCs from the periphery to lymphoid organs.

[0003] A previous search by Yokoyama-Kobayashi et al. (1999, *Gene* 228:161-167) for cDNA clones encoding type II membrane proteins resulted in the identification of a partial clone that was homologous, but not identical to the cDNA encoding the molecule now known as DC-SIGN. The putative protein product contained a deletion of 28 amino acids in the cytoplasmic domain and was lacking the entire C-type lectin domain relative to the cDNA encoding DC-SIGN.

[0004] More recently, Soilleux et al. (2000, *J Immunol* 165:2937-2942) described the full length cDNA-sequence of the related gene, which they called DC-SIGNR. The genomic organization of DC-SIGN and DC-SIGNR was compared, indicating a high degree of similarity. Concomitant expression of the two genes in placenta, endometrium, and stimulated KG1 cells (a cell line that phenotypically resembles myeloid DCs) was observed, although the expression of DC-SIGNR was very low in both endometrium and stimulated KG1 cells.

[0005] In the research that led to the present invention it was now found that the DC-SIGNR gene is expressed at considerably high levels in only two tissues, liver and lymph node, but not in monocyte derived dendritic cells. The receptor was renamed "L-SIGN" because it is a liver/lymph node-specific ICAM-3 grabbing nonintegrin.

[0006] The homologous human C-type lectins DC-SIGN and L-SIGN appear to be the products of a recent gene duplication. The corresponding proteins share the same domain organization and overlapping, if not completely identical, ligand specificity. The most diverse region of these molecules occurs in their cytoplasmic tails.

[0007] Another obvious difference between the genes for DC-SIGN and L-SIGN is the repeat polymorphism in exon 4 of L-SIGN, which is conserved in DC-SIGN (Table 1). The neck domain of L-SIGN may contain from three to nine

repeats while DC-SIGN always consisted of seven repeats among the Caucasians tested. No difference was observed between L-SIGN molecules containing six or L-SIGN molecules containing seven repeats in ligand binding, nor HIV-1 capture and enhancement experiments.

[0008] Although the SIGN genes have maintained sequence and functional similarity over their evolutionary history, it was now surprisingly found according to the invention that regulatory elements determining their tissue distribution have evolved along unique paths. Northern analysis of mRNA expression clearly indicated expression of DC-SIGN in monocyte-derived DCs and in tissues where DCs reside, whereas expression of L-SIGN in DCs was undetectable (FIG. 2). Further, L-SIGN was not detected on monocyte-derived DCs using antibodies specific to L-SIGN (FIG. 3C). Thus, it was found that unique cell types in the lymph node express one, but not both SIGN molecules: L-SIGN is expressed by endothelial cells, as it is in liver, while DC-SIGN is expressed by DCs in T cell area of lymph node. This difference in expression pattern could not be expected based on the sequence homology.

[0009] Liver sinusoids are specialized capillary vessels characterized by the presence of resident macrophages adhering to the endothelial lining. The LSEC-leukocyte interactions, which require expression of adhesion molecules on the cell surfaces, constitute a central mechanism of peripheral immune surveillance in the liver. The mannose receptor as well as other costimulatory receptors such as MHC class II, CD80, and CD86 are known to be expressed on LSECs and to mediate the clearance of many potentially antigenic proteins from the circulation in a manner similar to DCs in lymphoid organs.

[0010] The inventors established that L-SIGN fits in this category of receptors on LSECs, as its tissue location and ligand binding properties strongly implicate a physiologic role for this receptor in antigen clearance, as well as in LSEC-leukocyte adhesion. The high expression of ICAM-3 on apoptotic cells are the means by which these cells are trapped by L-SIGN-expressing cells in the liver and subsequently cleared.

[0011] Like DC-SIGN, L-SIGN is a membrane-associated lectin that enhances HIV-1 infection. The expression of L-SIGN in liver sinusoids indicates that LSECs, which are in continual contact with passing leukocytes, capture HIV-1 from the blood and promote trans-infection of T cells.

[0012] In addition, LSECs themselves may be susceptible to HIV-1 infection. Thus, it is possible that L-SIGN promotes infection of these cells thereby establishing a reservoir for production of new virus to pass on to T lymphocytes trafficking through the liver sinusoid.

[0013] Based on the above observations, the present invention relates to the use of a compound that binds to a C-type lectin on the surface of cells of a sinusoid endothelial layer, in the preparation of a composition for modulating, in particular reducing, the immune response in a animal, in particular a human or another mammal. The C-type lectin on the surface of cells of a sinusoid endothelial layer is in particular L-SIGN.

[0014] The cells of the sinusoid endothelial layer may either be constituted by liver sinusoid endothelial cells (LSEC) or cells of the lymph node sinusoidal zone.

[0015] The composition of the invention may be used for modulating, in particular reducing, one or more interactions between a cell of a sinusoid endothelial layer, in particular a LSEC, and a cell expressing ICAM-2 and/or ICAM-3, in particular a T cell. More in particular, the composition is used for modulating, in particular reducing, the adhesion between a cell of a sinusoid endothelial layer, in particular a LSEC, and a cell expressing ICAM-2 and/or ICAM-3, in particular a T cell, in particular between a C-type lectin on the surface of a LSEC and an ICAM receptor on the surface of a T cell, in particular an ICAM-2 or ICAM-3 receptor on the surface of a T cell.

[0016] The composition prepared according to the invention is applied for preventing or inhibiting immune responses to specific antigens, for inducing tolerance, for immunotherapy, for immunosuppression, for the treatment of autoimmune diseases, and/or for the treatment of allergy.

[0017] According to a further aspect thereof, the invention relates to the use of a compound that binds or can bind to a C-type lectin on the surface of a cell of the sinusoid endothelial layer, in particular a LSEC, in the preparation of a composition for inhibiting the HIV infection of cells of a sinusoid endothelial layer, in particular LSECs, in particular for inhibiting the adhesion of HIV surface protein (i.e. gp120) to the surface of a cell of a sinusoid endothelial layer, in particular a LSEC and thereby the entry of HIV into said cell.

[0018] The invention furthermore relates to the use of a compound that binds or can bind to a C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, in the preparation of a composition for inhibiting the transfer of HIV from cells of a sinusoid endothelial layer (that may or may not be infected themselves), in particular a LSEC, to non-infected T cells.

[0019] Alternatively, the invention provides the use of a combination of: 1) a compound that binds to a C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC; and attached thereto: 2) an antigen or a fragment or part thereof; in the preparation of a composition for modulating, in particular generating, increasing and/or promoting, an immune response in an animal, in particular a human or other mammal, against said antigen. Preferably, the antigen is covalently bonded to or fused with the compound that can bind to the C-type lectin. The antigen is for example chosen from cancer antigens which can be used to generate an immune response against tumor cells that contain or express said antigen, or antigens as used in vaccines against infectious diseases.

[0020] The compound that can bind to a C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, is preferably chosen from the group consisting of mannose carbohydrates, such as mannan and D-mannose; fucose carbohydrates, such as L-fucose; plant lectins such as concanavalin A; antibiotics, such as pradimicin A; sugars such as N-acetyl-D-glucosamine and galactose; proteins such as gp120 and analogs or fragments thereof; and antibodies directed against a C-type lectin as expressed on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, or a part, fragment or epitope thereof.

[0021] The C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, is prefer-

ably a protein with the amino acid sequence of FIG. 7, or a natural variant or equivalent thereof.

[0022] Alternatively, the compound that can bind to a C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, is a monoclonal antibody, preferably a monoclonal antibody directed against a C-type lectin with the amino acid sequence of FIG. 7 or a natural variant or equivalent thereof; and/or a part, fragment or epitope thereof.

[0023] According to a further aspect thereof the invention relates to an antibody, preferably monoclonal antibody, directed against a C-type lectin with the amino acid sequence of FIG. 7 or a natural variant or equivalent thereof; and/or a part, fragment or epitope thereof. This antibody is preferably AZN-D3, which is obtainable by a method as described in the examples.

[0024] The invention further relates to a pharmaceutical composition, containing at least one such antibody and at least one carrier, excipient, adjuvant and/or formulant.

[0025] Another aspect of the present invention relates to a combination of: 1) a compound that binds to a C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC; and attached thereto: 2) an antigen or a fragment or part thereof. Preferably, the antigen is covalently bonded to or fused with the compound that can bind to the C-type lectin.

[0026] In a combination according to the invention the antigen is for example chosen from cancer antigens which can be used to generate an immune response against tumor cells that contain or express said antigen, or antigens as used in vaccines against infectious diseases.

[0027] The compound that can bind to a C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, is preferably chosen from the group consisting of mannose carbohydrates, such as mannan and D-mannose; fucose carbohydrates, such as L-fucose; plant lectins such as concanavalin A; antibiotics, such as pradimicin A; sugars such as N-acetyl-D-glucosamine and galactose; proteins such as gp120 and analogs or fragments thereof; and antibodies directed against a C-type lectin as expressed on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, or a part, fragment or epitope thereof.

[0028] The antibodies of the invention can furthermore be used in the detection of cells of a sinusoid endothelial layer, in particular LSECs, in a biological sample and in the isolation, preparation and/or purification of cells of a sinusoid endothelial layer, in particular LSECs, from a biological sample or a culture medium.

[0029] Alternatively, such antibody can find an application in an assay for determining the presence and/or the expression of C-type lectins, in particular a C-type lectin with the amino acid sequence of FIG. 7 or a natural variant or equivalent thereof; and/or a part, fragment or epitope thereof, in a biological sample.

[0030] Furthermore, the invention relates to a method for producing, isolating and/or purifying cells of a sinusoid

endothelial layer, in particular LSECs, from a biological sample or a culture medium, comprising the steps of:

[0031] a) contacting a biological sample or a culture medium that contains said cells with an antibody according to the invention;

[0032] b) separating the cells that bind to said antibody from cells that do not bind to said antibody, and optionally from any further constituents of the sample or medium;

[0033] and optionally further comprises the step of:

[0034] c) separating the cells that bind to the antibody from said antibody.

[0035] Preferably, the antibody is attached to a column or matrix, to (para)magnetic beads or to a similar solid support. Biological samples to be tested may be biological fluids such as blood, plasma or lymph fluid.

[0036] Finally, the invention provides cells of a sinusoid endothelial layer, in particular LSECs, obtained via the method described above.

[0037] The present invention is further illustrated in the example that follows and in which reference is made to the following figures:

[0038] **FIG. 1.** Schematic representation of the DC-SIGN/L-SIGN genetic map. Physical distances and gene orientation are based on the sequence provided from BAC clone CTD-2102F19 (GenBank AC008812).

[0039] **FIG. 2.** Northern blot analysis of DC-SIGN and L-SIGN. Positions of the 4.3 kb (arrows with solid heads) and 1.9 kb (arrows with open heads) sizes are marked on the left. (A) Hybridization with the L-SIGN-specific probe indicating expression of the gene in liver, lymph node, and weakly in thymus. (B) Hybridization with the probe recognizing both genes. 4.3 kb bands represent DC-SIGN mRNA. The light upper band (~4.2 kb) evident in liver and lymph node using the L-SIGN-specific probe (**FIG. 3A**) is distinct from DC-SIGN mRNA (4.3 kb) due to the specificity of the probe, intensity patterns, and slight differences in size. (C) Reprobing of the blots with the  $\beta$ -actin cDNA control probe.

[0040] **FIG. 3.** L-SIGN is expressed on LSECs and not on monocyte-derived DCs. (A) The antibody AZN-D1 is DC-SIGN-specific whereas AZN-D3 cross-reacts with L-SIGN. Stable DC-SIGN and L-SIGN K562 transfectants were stained with either AZN-D1 or AZN-D3. (B) Immunohistochemical analysis of DC-SIGN and L-SIGN expression in the human liver. Serial sections were stained with either AZN-D1 (DC-SIGN-specific) or with AZN-D3 (detects both DC-SIGN and L-SIGN). AZN-D1 stains infrequent cells that may be DCs (arrows), whereas AZN-D3 stains cells lining sinusoids. (C) Expression of L-SIGN in liver is restricted to LSECs. One day after isolation, primary human liver cells were incubated with fluorochrome labeled ovalbumin. L-SIGN expression was determined by indirect immunofluorescence using an L-SIGN-specific polyclonal antibody. Cells that have taken up ovalbumin (LSECs) and those that did not take up ovalbumin (hepatocytes and other resident hepatic cells) are represented by solid and broken lines, respectively, by gating on the respective cell populations.  $2 \times 10^5$  cells were analyzed. (D) L-SIGN is not expressed by monocyte-derived DCs. Immature DCs, cul-

tured from monocytes in the presence of GM-CSF and IL-4, do not stain with anti-L-SIGN polyclonal antibody, as determined by FACScan analysis. Solid line indicates staining with anti-L-SIGN polyclonal serum, whereas stippled line (hidden under solid line) represents staining with rabbit pre-immune serum.

[0041] **FIG. 4.** L-SIGN binds ICAM-3 (A) and HIV-1 gp120 (B). Adhesion of ICAM-3 and gp120 to the K562-L-SIGN and K562-DC-SIGN cells was measured with the fluorescent bead adhesion assay (Geijtenbeek, T. B. et al., 1999, Blood 94:754-764). The y-axis represents the percent cells binding ligand-coated fluorescent beads. The L-SIGN-cross-reacting mAb AZN-D2 (20  $\mu$ g/ml) and AZN-D3 (20  $\mu$ g/ml) inhibit the adhesion of ICAM-3 and gp120 to L-SIGN, in contrast to the DC-SIGN-specific mAb AZN-D1 (20  $\mu$ g/ml). Adhesion of both ICAM-3 and gp120 to the K562 transfectants is also inhibited by either-mannan (20  $\mu$ g/ml) or EGTA (5 mM). Adhesion of both ligands to mock transfectants was less than 5%. One representative experiment out of three is shown (SD<5%).

[0042] **FIG. 5.** L-SIGN captures and enhances infection of T cells with HIV-1 in trans. (A) L-SIGN captures HIV-1 and transmits it to target cells. Stable DC-SIGN or L-SIGN expressing THP-1 transfectants were pre-incubated with HIV-luc/JRFL pseudovirions to allow capture of the virus. Cells were washed and THP-1 transfectants were co-cultured with Hut/CCR5 target cells. Cell lysates were obtained after 3 days and analyzed for luciferase activity. For each of the co-culture conditions employed, mock infected controls were uniformly less than 100 counts per second in activity. Each data set represents the mean of four separate wells of infected cells. One representative experiment out of two is shown. (B) L-SIGN enhances infection of T cells by pseudotyped HIV-1. HEK293T cells were transiently transfected with cDNA encoding DC-SIGN, L-SIGN or empty vector. Control cells were preincubated with AZN-D2 (20  $\mu$ g/ml) or mannan (20  $\mu$ g/ml). Low amounts of pseudotyped HIV-1<sub>ADA</sub> were added together with activated T cells as described previously (Geijtenbeek, T. B. et al., 2000, Cell 100: 587-597). Infectivity was determined after two days by measuring luciferase activity. One representative experiment of two performed is shown. Each experiment was done in triplicate wells. (C) L-SIGN enhances infection of T cells by replication competent HIV-1. Stable K562 transfectants of both L-SIGN and DC-SIGN were incubated with low virus concentrations of replication-competent M-tropic strain HIV-1<sub>JR-CSF</sub> (TCID<sub>50</sub> 100/ml). To determine the specificity, cells were preincubated with AZN-D2 (20  $\mu$ g/ml). After two hours, activated T cells were added as described previously (Geijtenbeek, T. B. et al., 2000, Cell 100:575-585). Culture supernatants were collected at day 14 after K562-T cell co-culture and HIV-1 production was measured using ELISA to determine p24 antigen levels. In control experiments, the same amount of virus was added directly to T cells. One representative experiment out of three is shown. Each data set represents the mean of three separate wells of infected cells.

[0043] **FIG. 6.** Coding DNA sequence of L-SIGN

[0044] **FIG. 7.** Amino acid sequence of L-SIGN.

## EXAMPLE

## Materials and Methods

## 1. Characterization of DC-SIGN and LD2 cDNA

[0045] The full DC-SIGN and L-SIGN cDNA sequences were submitted to GenBank under accession numbers AF290886 and AF290887, respectively. The L-SIGN cDNA sequence represents a variant containing 6 repeats in exon 4. The 5' and 3' ends of the transcripts (except 3' end of the DC-SIGN mRNA) were determined by 5'RACE (Clontech, Palo Alto, Calif.). The length of the 3' end of the DC-SIGN mRNA was estimated based on Northern analysis data (transcript size), and RT-PCR data using forward primers specific for the 1.3 kb DC-SIGN cDNA sequence (Curtis, B. M. et al., 1992, *Proc Natl Acad Sci USA* 89:8356-8360) and reverse primers specific for several GenBank ESTs (e.g. AI472111, AA454170) mapping downstream of alleged 3' end of DC-SIGN. A cDNA fragment containing the full coding sequence of L-SIGN (nt 39 to 1184, GenBank AF290887) was amplified from human placental mRNA (Clontech) and cloned into the expression vectors pcDNA3.1/V5-His/TOPO (pcDNA3-L-SIGN) and pCDM8 (pCDM8-L-SIGN).

## 2. Radiation Hybrid (RH) Mapping

[0046] PCR-based RH mapping with DC-SIGN- and L-SIGN-specific primers was performed using the Genebridge 4 RH panel (Research Genetics, Huntsville, Ala.). The PCR results were submitted to the Gene Map server at the Sanger Center (<http://www.sanger.ac.uk/Software/Rhserver>). The chromosomal position of markers linked to the genes was determined searching the GenAtlas database (<http://web.cit2.fr/GENATLAS>) and the genetic map of human chromosome 19 provided by the Marshfield Clinic (Marshfield, Wis., <http://research.marshfieldclinic.org/genetics/>).

3. Genotype Analysis of L-SIGN and DC-SIGN  
Exon 4

[0047] The repeat region in exon 4 was amplified with the following pairs of primers:

[0048] 1) L28, TGTTCAAGGTCCCCAGCTCCC, and L32, GAACTCACCAAATGCAGTCTTCAAATC, for L-SIGN;

[0049] 2) DL27, TGTTCAAGGTCCCCAGCTCC, and DI4R, CCCC GTGTTCTCATTTCACAG, for DC-SIGN. The cycle conditions were as follows: 94° C. for 5 sec and 68° C. for 1 min. Alleles were distinguished by agarose gel electrophoresis and ethidium bromide staining.

## 4. Northern Blot Analysis

[0050] Total RNA from cultured human immature DCs (see below) was isolated using Trizol (Life Technologies, Rockville, Md.). Ten  $\mu$ g of the isolated RNA were electrophoresed on a 1% agarose gel, transferred to Hybond-XL (Amersham Pharmacia Biotech, Buckinghamshire, England) as described (Chomczynski, P. 1992. *Anal Biochem* 201:134-139), and used for Northern analysis along with two human multiple tissue Northern blots (Clontech). Three probes were subsequently hybridized to the blots:

[0051] 1) an L-SIGN-specific probe (nt 100 to 183, GenBank AF290887),

[0052] 2) a probe recognizing both DC-SIGN and L-SIGN (nt 1 to 1233, GenBank AF290886) and

[0053] 3) an actin control probe (Clontech).

[0054] Hybridization procedures were performed according to manufacturer specifications (Clontech).

## 5. Antibodies

[0055] Anti-DC-SIGN mAb AZN-D1 and AZN-D2 were described previously (Geijtenbeek, T. B. et al., 2000b, *Cell* 100:575-585). mAb AZN-D3 was obtained by screening hybridoma supernatants of BALB/c mice immunized with THP-1-DC-SIGN cells (Geijtenbeek, T. B. et al., 2000a, *Cell* 100:587-597) for the ability to stain both DC-SIGN and L-SIGN. Anti-DC-SIGN mAb AZN-D2 also cross-reacts with L-SIGN, as was initially determined by staining of K562-L-SIGN cells (data not shown). Anti-L-SIGN rabbit antiserum was generated by immunization with two L-SIGN-specific peptides, PTTSGIRLFPRD and WNDN-RCDVDNYW (Veritas, Inc. Laboratories, Rockville, Md.).

## 6. Cells

[0056] DCs were cultured from monocytes in the presence of 500 U/ml IL4 and 800 U/ml GM-CSF (Schering-Plough, Brussels, Belgium) (Sallusto, F., and A. Lanzavecchia. 1994. *J Exp Med* 179:1109-1118; Romani, N. et al., 1994, *J Exp Med* 180:83-93). At day 7 the cells expressed high levels of MHC class I and II,  $\alpha$ M $\beta$ 2 (CD11b),  $\alpha$ X $\beta$ 2 (CD11c), DC-SIGN and ICAM-1, moderate levels of LFA-1 and CD86, and low levels of CD14, as measured by flow cytometry. Stable K562 transfectants expressing L-SIGN (K562-L-SIGN) were generated by co-transfection of K562 with the pCDM8-L-SIGN plasmid and the pGK-neo vector by electroporation (Lub, M. et al., 1997, *Mol Biol Cell* 8:719-728). Stable K562-DC-SIGN transfectants were generated in a similar manner using pRc/CMV-DC-SIGN (2). THP-1-DC-SIGN cells were described previously (Geijtenbeek, T. B. et al., 2000b, *Cell* 100:575-585).

[0057] Stable THP-1-L-SIGN transfectants were generated by electroporation of THP-1 cells with pcDNA3-L-SIGN, selection for G418-resistance, and positive sorting for L-SIGN expression using mAb AZN-D3. All cell lines were maintained in RPMI medium supplemented with 10% fetal bovine serum in addition to specific cytokine or antibiotic requirements as indicated. K562 and THP-1 are monocytic cell lines.

[0058] HEK293T are human embryonic kidney cell containing a single temperature-sensitive allele of SV-40 large T antigen. GHOST cells are HIV-indicator cells derived from human osteosarcoma cells (Cecilia, D. et al., 1998, *J Virol* 72:6988-6996). Hut/CCR5 cells are the transformed human T cell line Hut78 stably transduced with CCR5.

## 7. Fluorescent Beads Adhesion Assay

[0059] Carboxylate-modified TransFluorSpheres (488/645 nm, 1.0  $\mu$ m; Molecular Probes, Eugene, Oreg.) were coated with ICAM-3 as was previously described for ICAM-1 (Geijtenbeek, T. B. et al., 1999, *Blood* 94:754-764). Fluorescent beads were coated with M-tropic HIV-1<sub>MN</sub> envelope glycoprotein gp120 as follows: Streptavidin-coated fluorescent beads were incubated with biotinylated F(ab')<sub>2</sub> fragment rabbit anti-sheep IgG (6  $\mu$ g/ml; Jackson

Immunoresearch) followed by an overnight incubation with sheep-anti-gp120 antibody D7324 (Aalto Bio Reagents Ltd, Dublin, Ireland) at 4° C. The beads were washed and incubated with 250 ng/ml purified HIV-1 gp120 (provided by Immunodiagnostics, Inc through the NIH AIDS Research and Reference Reagent Program) overnight at 4° C.

[0060] The fluorescent beads adhesion assay was performed as described by Geijtenbeek et al.(1999, supra). Briefly, cells were resuspended in adhesion buffer (20 mM Tris-HCl pH 8.0, 150 mM NaCl, 1 mM CaCl<sub>2</sub>, 2 mM MgCl<sub>2</sub>, 0.5 BSA) at a final concentration of 5×10<sup>6</sup> cells/ml. 50,000 cells were pre-incubated with mAb (20 μg/ml) for 10 min at room temperature. Ligand-coated fluorescent beads (20 beads/cell) were added and the suspension was incubated for 30 min at 37° C. Adhesion was determined by measuring the percentage of cells that bound fluorescent beads using flow cytometry on a FACScan (Becton Dickinson, Oxnard, Calif.).

#### 8. Detection of L-SIGN on Primary Human Liver Sinusoidal Endothelial Cells (LSECs)

[0061] Liver tissue was obtained from a patient undergoing liver surgery after having received written consent. Isolation of primary human liver cells was performed as previously described (Hegenbarth, S. et al., 2000, *Hum Gene Ther* 11:481-486). Cells were cultured on collagen type I coated tissue culture plates in supplemented Williams E Medium (Hild, M. et al., 1998, *J Virol* 72:2600-2606). The day after isolation, liver cells were incubated with Texas-Red labelled ovalbumin (10 μg/ml) (Molecular Probes, Leiden, Netherlands) for two hours and detached from the matrix by gentle trypsin treatment. Cells were stained with rabbit anti-L-SIGN antiserum followed by goat-anti-rabbit-Ig FITC (Dianova, Hamburg, Germany) and analyzed with a FACScan (Becton Dickinson, Heidelberg, Germany) using CellQuest software. Ovalbumin uptake was characteristic of LSECs only and not Kupffer cells, as verified by co-staining of ovalbumin-positive cells with an endothelial cell-specific marker, acetylated LDL, using confocal microscopy.

#### 9. HIV-1 Infection Assays

[0062] The infection assays were performed as described previously (Geijtenbeek, 2000a, supra; Geijtenbeek 2000b, supra). Pseudotyped HIV-1 stocks were generated by calcium-phosphate transfections of HEK293T cells with the proviral vector plasmid NL-Luc-E<sup>-</sup>R<sup>-</sup> containing a firefly luciferase reporter gene (Connor, R. I. et al., 1995, *Virology* 206:935-944) and expression plasmids for either ADA or JRFL gp160 envelopes. Viral stocks were evaluated by limiting dilution on GHOST CXCR4/CCR5 and 293T-CD4-CCR5 cells.

[0063] In HIV-1 cell capture assays, DC-SIGN or L-SIGN expressing THP-1 transfectants (250,000 cells) were pre-incubated with pseudotyped HIV-1 (multiplicity of infection ~0.1 with regard to target cell concentration) in a total volume of 0.5 ml for 3 hr to allow cellular adsorption of the virus. After the 3 hr incubation, cells were washed with 2 volumes PBS and the THP-1 transfectants were co-cultured with Hut/CCR5 targets (100,000 cells) in the presence of 10 μg/ml polybrene in 1 ml cell culture medium. Cell lysates were obtained after 3 days and analyzed for luciferase activity.

[0064] In contrast, HIV-1 enhancement assays utilized suboptimal concentrations of virus (typically <0.05 m.o.i.) without a wash step. Briefly, DC-SIGN or L-SIGN trans-

fectants (50,000 cells) were incubated with identical virus concentrations (either pseudotyped HIV-1 or replication-competent M-tropic strain HIV-1<sub>JR-CSF</sub>), and after 2 hr activated T cells (100,000 cells) were added. Cell lysates were obtained after several days and analyzed for either luciferase activity or p24 antigen levels. T cells were activated by culturing them in the presence of IL-2 (10 U/ml) and PHA (10 μg/ml) for 2 days.

#### 10. Immunohistochemical Analysis

[0065] Staining of the tissue cryosections was performed as described previously (Geijtenbeek, 2000b, supra). Cryosections (8μ) of the tissues were fixed in 100% acetone (10 min), washed with PBS and incubated with the first antibody (10 μg/ml) for 60 min at 37° C. After washing, the final staining was performed with the ABC-PO/ABC-AP Vectastain kit (vector Laboratories, Burlingame, Calif.) according to the manufacturer's protocol. Nuclear staining was performed with hematoxylin.

#### Results

##### 1. Genomic Map of DC-SIGN and L-SIGN

[0066] A fine map of the DC-SIGN/L-SIGN gene locus was determined using information from the human BAC clone CTD-2102F19 sequence, which is now available in GenBank (AC008812) (FIG. 1). DC-SIGN and L-SIGN are positioned in a head-to-head orientation 15.7 kb apart. RH mapping indicated that DC-SIGN and L-SIGN are located on chromosome 19p13.2-3 near the marker D19S912 (lod score values >11.1) with DC-SIGN positioned more telomeric. In agreement with the RH data, the D19S912 marker is found at a distance of about 37 kb centromeric to L-SIGN on the BAC sequence.

##### 2. Polymorphism in Exon 4 of L-SIGN

[0067] Exon 4 of both DC-SIGN and L-SIGN contain repeats of 69 bp that encode repeating units of 23 amino acids. These repeats form a neck between the carbohydrate recognition domain and the transmembrane domain of the SIGN molecules. The L-SIGN cDNA clone isolated from placental mRNA contained the entire coding region of the gene, but only 6 full repeats were present in the sequence corresponding to exon 4, in contrast to 7 full repeats identified in the cDNA reported by Soilleux et al. (2000, supra). This indicated that the repeat region of L-SIGN is polymorphic. Analysis of exon 4 in 350 Caucasian individuals showed the presence of seven alleles based on number of repeats (ranging from 3 to 9), the most common of which was the allele containing 7 repeats (Table 1). Analysis of DC-SIGN exon 4 in 150 Caucasians did not reveal any variability.

##### 3. Northern Analysis of DC-SIGN and L-SIGN

[0068] L-SIGN mRNA exhibits about 90% similarity to DC-SIGN mRNA over the entire coding region, but there is only 53% similarity between exons 2 of the genes. Therefore, exon 2 sequence was used to generate a probe (84 nt) that was L-SIGN specific in Northern analysis. The probe hybridized to mRNA of about 1.9, 2.6 and 4.2 kb in size in liver and lymph node, and a weak 1.9 kb band was detected in thymus (FIG. 2A). The 1.9 kb band, which is prominent in lymph node and fetal liver, corresponds to the predicted size of L-SIGN. The upper bands (one of which, 2.6 kb, is substantial in adult liver) are likely to be alternative tran-

scripts, but RACE and RT-PCR techniques have not indicated the presence of untranslated regions varying in length nor alternative splice variants.

[0069] Northern blots were reprobbed with a 1.2 kb fragment containing the entire coding sequence of DC-SIGN, which recognizes both DC- and L-SIGN mRNA due to their high sequence similarity (FIG. 2B). Once again, the bands representing L-SIGN transcripts were observed in liver, lymph node and fetal liver. Additionally, a 4.3 kb transcript representing DC-SIGN was detected in monocyte-derived DCs and lymph node, and to a lesser extent in placenta, spleen, thymus, and possibly, liver.

[0070] L-SIGN mRNA was also detected in placenta and DCs using a more sensitive RT-PCR technique, but the level of expression in these tissues is too low to be detected by Northern hybridization. The probe which recognizes both DC-SIGN and L-SIGN transcripts with nearly equal sensitivity clearly indicated differential tissue distribution of the two gene products: L-SIGN is primarily transcribed in liver and lymph node, whereas DC-SIGN is specifically expressed in DCs and in tissues that accommodate DCs (FIG. 2). L-SIGN mRNA is not detected by Northern analysis in DCs, peripheral blood lymphocytes, nor spleen (FIG. 2).

#### 4. L-SIGN is Expressed by Human LSECs and Not by DCs

[0071] To identify the cells expressing L-SIGN molecules *in vivo*, immunohistochemical analysis was performed using a pair of anti-DC-SIGN mAbs, one of which, AZN-D3, cross-reacted with L-SIGN, whereas another, AZN-D1, was DC-SIGN-specific (FIG. 3A). As expected from the Northern analysis, poor staining of liver tissue was observed using the DC-SIGN-specific mAb AZN-D1 (FIG. 3B) and the rare cells detected with this antibody are probably DCs residing in liver. In contrast, the mAb AZN-D3 brightly stained cells lining the sinusoids of the liver (FIG. 3B).

[0072] Monoclonal antibodies against the endothelial cell-specific marker CD31 gave a similar staining pattern on serial liver sections (data not shown), showing that L-SIGN is expressed by LSECs. To support this idea, primary human LSECs were distinguished from the other hepatic cells by uptake of ovalbumin, which is a unique characteristic of LSECs, and were tested for expression of L-SIGN directly. Staining of LSECs with polyclonal anti-L-SIGN antibodies indicated that L-SIGN is expressed exclusively by these cells in liver (FIG. 3C).

[0073] Both AZN-D1 and AZN-D3 stained lymph node equally well (data not shown). However, using L-SIGN-specific polyclonal antibodies, we found that L-SIGN is not expressed by monocyte-derived DCs (FIG. 3D), which supports conclusions from the Northern analysis. DC-SIGN and L-SIGN are expressed by different types of cells in the lymph node.

#### 5. L-SIGN Binds ICAM-3 and HIV-1 gp120

[0074] Both ICAM-3 and HIV-1<sub>MN</sub> gp120 have been shown to bind with high affinity to DC-SIGN in a Ca<sup>2+</sup> dependent manner. Using a flow cytometry-based adhesion assay (Geijtenbeek, 1999, *supra*), K562 cells transfected with L-SIGN were shown to bind ICAM-3 with high affinity (FIG. 4A). The L-SIGN-mediated binding was inhibited by the DC-SIGN/L-SIGN-specific mAb AZN-D2 and AZN-D3, mannan, or EGTA, but not by the DC-SIGN-

specific mAb AZN-D1, demonstrating that L-SIGN functions as a mannose binding C-type lectin with a high affinity for ICAM-3. L-SIGN was also able to bind to HIV-<sub>MN</sub> gp120 (FIG. 4B). Mock transfected cells did not bind either ICAM-3 or HIV-1<sub>MN</sub> gp-120 (data not shown).

#### 6. L-SIGN Enhances HIV-1 Infection

[0075] High affinity binding of L-SIGN to HIV-1 gp120 raised the possibility that, L-SIGN might bind infectious HIV-1 and enhance infection of target cells *in trans*. To test the role of L-SIGN as a trans-receptor in HIV-1 infection, THP-1 cells expressing either DC-SIGN or L-SIGN were pulsed with single-round infectious HIV-luciferase pseudotyped with M-tropic HIV-1<sub>JRFL</sub> envelope glycoprotein, washed to remove unbound virus, and incubated with target cells permissive for HIV-1 infection. Infection was evaluated after three days. Both the L-SIGN- and DC-SIGN-transfected THP-1 cells captured infectious HIV-1 and transmitted the virus to target cells, while mock transfected THP-1 cells did not (FIG. 5A).

[0076] Next it was investigated whether L-SIGN would be able to capture a limiting concentration of HIV-1 and efficiently present the virus to the permissive cells promoting infection. HEK293T cells expressing DC-SIGN or L-SIGN, or mock transfected cells were incubated with low titers of HIV-luciferase pseudotyped with HIV-1<sub>ADA</sub> envelope glycoprotein. The unwashed cells were then co-cultured with activated T cells. Minimal infection of target cells was observed from mock transfected HEK293T cells pulsed with HIV-1 (FIG. 5B). However, HEK293T cells transfected with L-SIGN enhanced HIV-1 infection of T cells *in trans* (FIG. 5B). The DC-SIGN-mediated enhancement was inhibited with the crossreactive AZN-D2 antibody, while partial inhibition was observed for L-SIGN. Mannan efficiently inhibited enhancement by both SIGN molecules.

[0077] Similar experiments to evaluate the ability of L-SIGN to enhance HIV-1 infection of T-cells were performed using replication competent virus. K562 cells transfected with L-SIGN, DC-SIGN, and empty vector were incubated with the M-tropic HIV-1<sub>JR-CSF</sub> strain at low virus concentrations for 2 hours and subsequently co-cultured with activated T cells (FIG. 5C). No viral replication was observed using mock transfected K562 cells, while L-SIGN transfectants transmitted HIV-1 to target cells, resulting in viral replication. Almost complete inhibition of HIV-1 replication with the DC-SIGN/L-SIGN-specific antibody AZN-D2 indicated the specificity of these receptors to enhance HIV-1 infection. Thus, non-DC lineage cells expressing L-SIGN within liver and possibly in lymph node also have the ability to capture and transmit HIV-1 to lymphocytes.

TABLE 1

Polymorphism of the repeat region in L-SIGN exon 4.	
No. of repeats	Allele frequency (%)
3	1 (0.3)
4	25 (3.6)
5	202 (28.9)
6	86 (12.2)
7	377 (53.9)
8	2 (0.3)
9	7 (1.0)

[0078]

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1          5          10          15

gaa gat cca aca acc agt ggc atc aga ctt ttt cca aga gac ttt caa      96
Glu Asp Pro Thr Thr Ser Gly Ile Arg Leu Phe Pro Arg Asp Phe Gln
          20          25          30

ttc cag cag ata cat ggc cac aag agc tct aca ggg tgt ctt ggc cat     144
Phe Gln Gln Ile His Gly His Lys Ser Ser Thr Gly Cys Leu Gly His
          35          40          45

ggc gcc ctg gtg ctg caa ctc ctc tcc ttc atg ctc ttg gct ggg gtc     192
Gly Ala Leu Val Leu Gln Leu Leu Ser Phe Met Leu Leu Ala Gly Val
          50          55          60

ctg gtg gcc aac ctt gtc caa gtg tcc aag gtc ccc agc tcc cta agt     240
Leu Val Ala Asn Leu Val Gln Val Ser Lys Val Pro Ser Ser Leu Ser
65          70          75          80

cag gaa caa tcc gag caa gac gca atc tac cag aac ctg acc cag ctt     288
Gln Glu Gln Ser Glu Gln Asp Ala Ile Tyr Gln Asn Leu Thr Gln Leu
          85          90          95

aaa gct gca gtg ggt gag ctc tca gag aaa tcc aag ctg cag gag atc     336
Lys Ala Ala Val Gly Glu Leu Ser Glu Lys Ser Lys Leu Gln Glu Ile
          100          105          110

tac cag gag ctg acc cag ctg aag gct gca gtg ggt gag ttg cca gag     384
Tyr Gln Glu Leu Thr Gln Leu Lys Ala Ala Val Gly Glu Leu Pro Glu
          115          120          125

aaa tcc aag ctg cag gag atc tac cag gag ctg acc cgg ctg aag gct     432
Lys Ser Lys Leu Gln Glu Ile Tyr Gln Glu Leu Thr Arg Leu Lys Ala
          130          135          140

gca gtg ggt gag ttg cca gag aaa tcc aag ctg cag gag atc tac cag     480
Ala Val Gly Glu Leu Pro Glu Lys Ser Lys Leu Gln Glu Ile Tyr Gln
145          150          155          160

gag ctg acc cag ctg aag gct gca gtg ggt gag ttg cca gag aaa tcc     528
Glu Leu Thr Gln Leu Lys Ala Ala Val Gly Glu Leu Pro Glu Lys Ser
          165          170          175

aag ctg cag gag atc tac cag gag ctg acc cgg ctg aag gct gca gtg     576
Lys Leu Gln Glu Ile Tyr Gln Glu Leu Thr Arg Leu Lys Ala Ala Val
          180          185          190

ggt gag ttg cca gag aaa tcc aag ctg cag gag atc tac cag gag ctg     624
Gly Glu Leu Pro Glu Lys Ser Lys Leu Gln Glu Ile Tyr Gln Glu Leu
          195          200          205

acc cgg ctg aag gct gca gtg ggt gag ttg cca gag aaa tcc aag ctg     672
Thr Arg Leu Lys Ala Ala Val Gly Glu Leu Pro Glu Lys Ser Lys Leu
          210          215          220

cag gag atc tac cag gag ctg acc cag ctg aag gct gca gtg ggt gag     720
Gln Glu Ile Tyr Gln Glu Leu Thr Gln Leu Lys Ala Ala Val Gly Glu
225          230          235          240

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Leu Lys Thr Ala Phe Glu Arg Leu Cys Arg His Cys Pro Lys Asp Trp
                260                          265                270

aca ttc ttc caa gga aac tgt tac ttc atg tct aac tcc cag cgg aac      864
Thr Phe Phe Gln Gly Asn Cys Tyr Phe Met Ser Asn Ser Gln Arg Asn
                275                          280                285

tgg cac aac tcc gtc acc gcc tgc cag gaa gtg agg gcc cag ctc gtc      912
Trp His Asn Ser Val Thr Ala Cys Gln Glu Val Arg Ala Gln Leu Val
                290                          295                300

gta atc aaa act gct gag gag cag aac ttc cta cag ctg cag act tcc      960
Val Ile Lys Thr Ala Glu Glu Gln Asn Phe Leu Gln Leu Gln Thr Ser
                305                          310                315                320

agg agt aac cgc ttc tcc tgg atg gga ctt tca gac cta aat cag gaa     1008
Arg Ser Asn Arg Phe Ser Trp Met Gly Leu Ser Asp Leu Asn Gln Glu
                325                          330                335

ggc acg tgg caa tgg gtg gac ggc tca cct ctg tca ccc agc ttc cag     1056
Gly Thr Trp Gln Trp Val Asp Gly Ser Pro Leu Ser Pro Ser Phe Gln
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cgg tac tgg aac agt gga gaa ccc aac aat agc ggg aat gaa gac tgt     1104
Arg Tyr Trp Asn Ser Gly Glu Pro Asn Asn Ser Gly Asn Glu Asp Cys
                355                          360                365

gcg gaa ttt agt ggc agt ggc tgg aac gac aat cga tgt gac gtt gac     1152
Ala Glu Phe Ser Gly Ser Gly Trp Asn Asp Asn Arg Cys Asp Val Asp
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aat tac tgg atc tgc aaa aag ccc gca gcc tgc ttc aga gac gaa tag     1200
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Gln Glu Gln Ser Glu Gln Asp Ala Ile Tyr Gln Asn Leu Thr Gln Leu
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Lys Ala Ala Val Gly Glu Leu Ser Glu Lys Ser Lys Leu Gln Glu Ile
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Tyr Gln Glu Leu Thr Gln Leu Lys Ala Ala Val Gly Glu Leu Pro Glu
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Gly Glu Leu Pro Glu Lys Ser Lys Leu Gln Glu Ile Tyr Gln Glu Leu  
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Thr Arg Leu Lys Ala Ala Val Gly Glu Leu Pro Glu Lys Ser Lys Leu  
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Gln Glu Ile Tyr Gln Glu Leu Thr Gln Leu Lys Ala Ala Val Gly Glu  
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Leu Pro Asp Gln Ser Lys Gln Gln Ile Tyr Gln Glu Leu Thr Asp  
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Leu Lys Thr Ala Phe Glu Arg Leu Cys Arg His Cys Pro Lys Asp Trp  
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Thr Phe Phe Gln Gly Asn Cys Tyr Phe Met Ser Asn Ser Gln Arg Asn  
 275 280 285

Trp His Asn Ser Val Thr Ala Cys Gln Glu Val Arg Ala Gln Leu Val  
 290 295 300

Val Ile Lys Thr Ala Glu Glu Gln Asn Phe Leu Gln Leu Gln Thr Ser  
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Arg Ser Asn Arg Phe Ser Trp Met Gly Leu Ser Asp Leu Asn Gln Glu  
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Gly Thr Trp Gln Trp Val Asp Gly Ser Pro Leu Ser Pro Ser Phe Gln  
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Arg Tyr Trp Asn Ser Gly Glu Pro Asn Asn Ser Gly Asn Glu Asp Cys  
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1. Use of a compound that binds to a C-type lectin on the surface of a sinusoid endothelial layer, in the preparation of a composition for modulating, in particular reducing, the immune response in a animal, in particular a human or another mammal.

2. Use according to claim 1, wherein the sinusoid endothelial layer is constituted by liver sinusoid endothelial cells (LSEC).

3. Use according to claim 1, wherein the sinusoid endothelial layer is constituted by the lymph node sinusoidal zone.

4. Use according to claim 1 and/or 2, in the preparation of a composition for modulating, in particular reducing, one or more interactions between a cell of a sinusoid endothelial layer, in particular a LSEC, and a cell expressing ICAM-2 or ICAM-3, in particular a T cell.

5. Use according to claim 1 and/or 2 and/or 4, in the preparation of a composition for modulating, in particular reducing, the adhesion between a cell of a sinusoid endothelial layer, in particular a LSEC, and a cell expressing ICAM-2 or ICAM-3, in particular a T cell, in particular between a C-type lectin on the surface of a LSEC and an ICAM receptor on the surface of a cell expressing ICAM-2 or ICAM-3, in particular a T cell, in particular an ICAM-2 or ICAM-3 receptor on the surface of a T cell.

6. Use according to any of claims 1-5, in the preparation of a composition for preventing or inhibiting immune responses to specific antigens, for inducing tolerance, for immunotherapy, for immunosuppression, for the treatment of autoimmune diseases, and/or for the treatment of allergy.

7. Use of a compound that binds or can bind to a C-type lectin on the surface of a cell of the sinusoid endothelial layer, in particular a LSEC, in the preparation of a composition for-inhibiting the HIV infection of cells of a sinusoid endothelial layer, in particular LSECs, in particular for inhibiting the adhesion of HIV surface protein (i.e gp 120) to the surface of a cell of a sinusoid endothelial layer, in particular a LSEC and thereby the entry of HIV into said cell.

8. Use of a compound that binds or can bind to a C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, in the preparation of a composition for inhibiting the transfer of HIV from cells of a sinusoid endothelial layer, in particular a LSEC, to non-infected T cells.

9. Use of a combination of: 1) a compound that binds to a C-type lectin on the surface of a cell of a sinusoid endothelial layer, in a particular a LSEC; and attached thereto: 2) an antigen or a fragment or part thereof; in the preparation of a composition for modulating, in particular generating, increasing and/or promoting, an immune response in an animal, in particular a human or other mammal, against said antigen.

10. Use according to claim 9, in which the antigen is covalently bonded to or fused with the compound that can bind to the C-type lectin.

11. Use according to claim 9 or 10, in which the antigen is chosen from cancer antigens which can be used to generate an immune response against tumor cells that contain or express said antigen, or antigens as used in vaccines against infectious diseases.

12. Use according to any of claims 1-11, in which the compound that can bind to a C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, is chosen from the group consisting of mannose carbohydrates, such as mannan and D-mannose; fucose carbohydrates, such as L-fucose; plant lectins such as concanavalin A; antibiotics, such as pradimicin A; sugars such as N-acetyl-D-glucosamine and galactose; proteins such as gp120 and analogs or fragments thereof; and antibodies directed against a C-type-lectin as expressed on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, or a part, fragment or epitope thereof.

13. Use according to any of claims 1-11 in which the C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, is a protein with the amino acid sequence of FIG. 7, or a natural variant or equivalent thereof.

14. Use according to claim 12 or 13, in which the compound that can bind to a C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, is a monoclonal antibody, preferably a monoclonal antibody directed against a C-type lectin with the amino acid sequence of FIG. 7 or a natural variant or equivalent thereof; and/or a part, fragment or epitope thereof.

15. Antibody, preferably monoclonal antibody, directed against a C-type lectin with the amino acid sequence of FIG. 7 or a natural variant or equivalent thereof; and/or a part, fragment or epitope thereof.

**16.** Antibody according to claim 15, which is AZN-D3.

**17.** Pharmaceutical composition, containing at least one antibody according to claim 15 or **16**, and at least one carrier, excipient, adjuvant and/or formulant.

**18.** Combination of: 1) a compound that binds to a C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC; and attached thereto: 2) an antigen or a fragment or part thereof.

**19.** Combination according to claim 18, wherein the antigen is covalently bonded to or fused with the compound that can bind to the C-type lectin.

**20.** Combination according to claim 18 or **19**, in which the antigen is chosen from cancer antigens which can be used to generate an immune response against tumor cells that contain or express said antigen, or antigens as used in vaccines against infectious diseases.

**21.** Combination according to any of claims **18-20**, in which the compound that can bind to a C-type lectin on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, is chosen from the group consisting of mannose carbohydrates, such as mannan and D-mannose; fucose carbohydrates, such as L-fucose; plant lectins such as concanavalin A; antibiotics, such as pradimicin A; sugars such as N-acetyl-D-glucosamine and galactose; proteins such as gp120 and analogs or fragments thereof; and antibodies directed against a C-type lectin as expressed on the surface of a cell of a sinusoid endothelial layer, in particular a LSEC, or a part, fragment or epitope thereof.

**22.** Use of an antibody according to claim 15 or **16** in the detection of cells of a sinusoid endothelial layer, in particular LSECs, in a biological sample.

**23.** Use of an antibody according to claim 15 or **16** in the isolation, preparation and/or purification of cells of a sinusoid endothelial layer, in particular LSECs, from a biological sample or a culture medium.

**24.** Use of an antibody according to claim 15 or **16** in an assay for determining the presence and/or the expression of C-type lectins, in particular a C-type lectin with the amino acid sequence of **FIG. 6** or a natural variant or equivalent thereof; and/or a part, fragment or epitope thereof, in a biological sample.

**25.** Method for producing, isolating and/or purifying cells of a sinusoid endothelial layer, in particular LSECs, from a biological sample or a culture medium, comprising the steps of:

a) contacting a biological sample or a culture medium that contains said cells with an antibody according to claim 15 or **16**;

b) separating the cells that bind to said antibody from cells that do not bind to said antibody, and optionally from any further constituents of the sample or medium;

and optionally further comprises the step of:

c) separating the cells that bind to the antibody from said antibody.

**26.** Method according to claim 25, in which the antibody is attached to a column or matrix, to (para)magnetic beads or to a similar solid support.

**27.** Method according to claim 25 or **26**, in which the biological sample is a biological fluid such as blood, plasma or lymph fluid.

**28.** Cells of a sinusoid endothelial layer, in particular LSECs obtained via the method of claims **25** or **26**.

\* \* \* \* \*

专利名称(译)	调节新型icam-3结合受体对肝脏和淋巴结中窦状内皮细胞的结合活性的方法		
公开(公告)号	<a href="#">US20040091481A1</a>	公开(公告)日	2004-05-13
申请号	US10/451459	申请日	2001-12-21
[标]申请(专利权)人(译)	FIGDOR卡尔古斯塔夫 GEITJENBEEK TEUNIS BERNARD HERMAN KOOYK YVETTE VAN TORENSMA RUURD		
申请(专利权)人(译)	FIGDOR卡尔古斯塔夫 GEITJENBEEK TEUNIS BERNARD HERMAN KOOYK YVETTE VAN TORENSMA RUURD		
当前申请(专利权)人(译)	FIGDOR卡尔古斯塔夫 GEITJENBEEK TEUNIS BERNARD HERMAN KOOYK YVETTE VAN TORENSMA RUURD		
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发明人	FIGDOR, CARL GUSTAV GEITJENBEEK, TEUNIS BERNARD HERMAN KOOYK, YVETTE VAN TORENSMA, RUURD		
IPC分类号	C12N15/09 A61K38/00 A61K38/095 A61K39/00 A61K39/02 A61K39/21 A61K39/395 A61K45/00 A61P31/18 A61P37/02 A61P37/06 A61P37/08 A61P43/00 C07K14/705 C07K16/28 C12N5/00 C12N5 /071 C12R1/91 G01N33/53 C07K16/18		
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优先权	2000128143 2000-12-21 EP 2001200944 2001-03-13 EP		
外部链接	<a href="#">Espacenet</a> <a href="#">USPTO</a>		

摘要(译)

本发明涉及在窦状内皮层表面上与C型凝集素结合的化合物在制备用于调节，特别是减少动物，特别是人或人的免疫应答的组合物中的用途。另一种哺乳动物窦状内皮层可以由肝窦内皮细胞（LSEC）或淋巴结正弦区构成。

Fig. 1

