

# THE CD SYSTEM OF LEUKOCYTE SURFACE MOLECULES

APPENDIX 4A

## Monoclonal Antibodies to Human Cell Surface Antigens

APPENDIX 4A

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### ABSTRACT

Many of the leukocyte cell surface molecules are known by "CD" numbers. In this Appendix, a short introduction describes the history and the use of CD nomenclature and provides a few key references to enable access to the wider literature. This is followed by a table that lists all human molecules with approved CD names, tabulating alternative names, key structural features, cellular expression, major known functions, and usefulness of the molecules or antibodies against them in research or clinical applications. *Curr. Protoc. Immunol.* 80:A.4A.1-A.4A.73. © 2008 by John Wiley & Sons, Inc.

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### INTRODUCTION

During the last 25 years, large numbers of monoclonal antibodies (MAbs) have been produced that have facilitated the purification and functional characterization of a plethora of leukocyte surface molecules. The antibodies have been even more useful as markers for cell populations, allowing the counting, separation, and functional study of numerous subsets of cells of the immune system. A series of international workshops were instrumental in coordinating this development through multi-laboratory "blind" studies of thousands of antibodies. These HLDA (Human Leukocyte Differentiation Antigens) Workshops have, up until now, defined 500 different entities and assigned them cluster of differentiation (CD) designations. These are listed in Table A.4A.1.

CD designations continue to be assigned at regularly held international workshops on human leukocyte differentiation antigens and to be approved by the nomenclature committee of the International Union of Immunological Societies (IUIS). The latest workshop (the eighth) was held in Adelaide, Australia, in December 2004 (Zola et al., 2005), and was followed by a smaller Workshop intended to tie up a few loose ends (Zola et al., 2007a). The smaller Workshop used the name HCDM (Human Cell Differentiation Molecules), which was regarded as more representative of the expanded aims of the organization. However, the name HLDA is widely known and recognized. The next workshop, organized by Pablo Engel, will be referred to as HLDA9 and is currently being planned. HLDA9 will conclude with a meeting in Barcelona, Spain in 2009. Details of the 9th Workshop will be placed on the HLDA/HCDM Web site at <http://www.HLDA8.org> (also accessible as <http://www.hcdm.org>).

The CD System  
of Leukocyte  
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## CD ANTIBODIES/MOLECULES: DEFINITION

Initially, CD designation was intended to describe a cluster of MAbs that display the same cellular reactivity and identify the same molecular species. For instance, CD2 MAbs are reagents that react with a 50-kDa transmembrane glycoprotein expressed on resting T cells. Later, the CD designations were used to describe the recognized molecules, but had to be clarified by attaching the term antigen or molecule to the designation (e.g., CD2 molecule; Knapp et al., 1989). Currently, CD2 is generally used to designate the molecule, and CD2 antibody is used to designate the antibody.

In Table A.4A.1, the main characteristics of all human MAb groups (clusters) and leukocyte surface molecules to which CD designations have been assigned in the international workshops are summarized (also see *APPENDIX 4B*, which lists MAbs to mouse cell surface antigens). Although extensive, this table can provide only selected information. In particular, it was sometimes difficult to select exemplary MAbs to list. For some CD clusters, only a few MAbs are as yet characterized, but for others, the number of antibodies assigned in the Workshops is considerable. In addition, brief remarks concerning the molecular and/or functional characteristics of CD molecules and CD MAbs are included. For further details, the reader is referred to the extensive and well-documented proceedings of the individual Workshops (Bernard et al., 1984; Reinherz et al., 1986; McMichael et al., 1987; Knapp et al., 1989; Schlossman et al., 1995; Kishimoto et al., 1997; Mason et al., 2002, Zola et al., 2005, 2007a,b). Protein Reviews on the Web (PROW) is a database established by Stephen Shaw accessible via the Internet at <http://www.ncbi.nlm.nih.gov/PROW/>, which provides authoritative peer-reviewed summaries and links to genome and protein databases. Finally, more detailed information on every CD molecule is compiled in the book *Leukocyte and Stromal Cell Molecules* (Zola et al., 2007), while the HLDA Web site (<http://www.hlda8.org>) provides links to a variety of molecular databases on the Web.

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*Table A.4A.1 appears starting on the next page.*

**Table A.4A.1** CD Molecules<sup>a,b</sup>

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD1 family	<b>CD1a:</b> T6/leu-6; <b>CD1b:</b> R1; <b>CD1c:</b> M241, R7; <b>CD1d:</b> R3; <b>CD1e:</b> R2	A group of 5 genes coding 36- to 49-kDa type I integral membrane Ig superfamily members with structural similarity to MHC class I; associated with $\beta$ 2 microglobulin	Thymocytes but not mature T cells. Expressed at varying levels on antigen-presenting cells.	Present nonpeptide antigens including lipids and glycolipids to T cells (group 1 = CD1a,b,c to conventional T cells; group2 = CD1d to NK T cells only). Members have various secondary roles.	—
<b>CD2</b>	SRBC receptor, LFA-2, T11	50 kDa Ig superfamily type I integral glycoprotein with one C2-like and one V-like domain. Long intracytoplasmic tail rich in prolines and basic residues.	All T cells, thymocytes, NK cells	Adhesion molecule, binding LFA-3 (CD58). Binding to sheep CD58 is the basis of the sheep rosette reaction, used to identify and purify T cells. Other ligands (of lower affinity) are CD48 and possibly CD59, CD15. CD2 binding by ligands induces T cell activation. KO mice have apparently healthy immune systems.	Original T cell marker, used in typing leukemias
<b>CD3 family</b>	CD3 complex, T3, Leu4	Multimolecular complex of Ig superfamily members ( $\gamma, \delta, \epsilon$ ) and molecules related to FcR $\gamma$ chain ( $\zeta, \eta$ ): CD3- $\gamma$ , 25 kDa; CD3- $\delta$ , 20 kDa; CD3- $\epsilon$ , 20 kDa; CD3- $\zeta$ , 16kD; CD3- $\eta$ , 22kD	T lineage cells	Required for cell surface expression of T cell receptor and signal transduction	Best marker for cells of T lineage
<b>CD4</b>	OKT4, Leu 3a, L3T4, T4	55 kDa type I transmembrane Ig superfamily member with one V-type and 3 C-type domains stabilized by disulfide bonds	Thymocyte subsets, T cells that recognize peptide antigen associated with MHC class II (helper T cells), PB monocytes, Langerhans cells, monocyte-derived dendritic cells	Coreceptor for MHC class II antigen restricted T cell activation, involved in thymic differentiation, primary receptor for HIV infection	Essential for helper T cell response to antigen, used as marker for helper T cells and for monitoring progression of AIDS

<b>CD5</b>	T1, Ly1, Leu-1	67 kDa type I transmembrane monomeric glycoprotein member of scavenger receptor family with 3 scavenger receptor cysteine rich (SRCR) domains and intracellular ITAM domain	All T cells, low level on subset B cells including CLL and neonatal B cells	Putative ligand is CD72. CD5 participates in a membrane complex with CD3 or Ig. Cytoplasmic sequence binds PTK p56lck through SH2 domain.	Widely used as a marker for B-CLL cells
<b>CD6</b>	T12	105 or 130 kDa type I integral glycoprotein with three scavenger receptor cysteine rich (SRCR) extracellular domains with multiple N-glycosylation sites. Two alternatively spliced intracellular tails	Thymocytes, T cells, B cell CLL	Binds CD166 and possibly other ligands, suggesting adhesion function. Antibody ligation costimulates with signals through CD3	Can serve as a CLL marker; MAb has been used to deplete T cells from bone marrow for allogeneic transplantation
<b>CD7</b>	Leu 9, 3A1, gp40, T cell leukemia antigen	40 kDa type I transmembrane glycoprotein member of Ig superfamily. Has one V-type domain and the membrane proximal “stalk” has four consensus repeats.	T cell precursors, thymocytes, subset of peripheral T cells, pluripotent hematopoietic stem cells, T cell ALL, stem cell leukemia	Essential role in T cell interactions and T cell/B cell interactions, and may aid in prevention of autoimmune disease. May modulate cell adhesion.	Marker for T cell ALL, pluripotential stem cell leukemia. Potential therapeutic for rheumatoid arthritis and for immunosuppression.
<b>CD8</b>	<b>CD8A, CD8B1, OKT8, LeuT, LyT2, T8</b>	CD8 $\alpha$ (32-34 kDa) and CD8 $\beta$ (30-32 kDa) are members of Ig superfamily with homology to IgV light chains. Can form disulfide-linked heterodimer or CD8 $\alpha$ homodimer. Alternative splicing can give soluble CD8 $\alpha$ .	Thymocyte subset, T cells specific for antigen presented with MHC class I (cytotoxic T cells); some $\gamma\delta$ T cells and NK cells	Coreceptor for MHC class I restricted T cell activation	Marker for cytotoxic T cell subset
<b>CD9</b>	p24, MRP-1, tetraspanin-29	24 kDa type III membrane protein, 4 transmembrane domains, 2 extracellular domains, both termini cytoplasmic	Platelets, early B cells, activated T cells, eosinophils, basophils. Expression in other tissues.	Forms complexes with integrins and other tetraspanin members. Modulates cell adhesion and migration. Can trigger platelet activation and aggregation.	Leukemia immunophenotyping, bone marrow purging, inverse correlation with metastasis

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD10	<b>MME</b> , Common acute lymphoblastic leukemia antigen (CALLA), neutral endopeptidase	100 kDa type II transmembrane metalloprotease with varying levels of N-glycosylation. Contains zinc-binding motif.	Early B lineage cells and germinal center B cells; fetal thymocytes. Neutrophils, bone marrow stromal cells, some epithelia.	Peptidase activity may limit action of physiologically active peptides. Inhibition in vivo enhances B cell maturation.	Diagnostic marker for common (B lineage) acute lymphoblastic leukemia
CD11a	<b>ITGAL</b> , LFA-1 $\alpha$ chain	180 kDa type I transmembrane glycoprotein, member of integrin $\alpha$ -chain family. Extracellular sequence contains 12 N-glycosylation sites and 7 tandem repeats of which 3 contain putative cation-binding sites. Forms noncovalent association with CD18.	Leukocyte-restricted; highly expressed on lymphocytes, monocytes and macrophages; lower levels on polymorphonuclear cells	CD11a complexes with CD18 to form the integrin LFA-1, an adhesion and signal transduction molecule involved in inflammation. Transient aggregation of complex leads to increased affinity for ligands CD54, CD102, CD50.	Useful leukocytes marker in tissue pathology; antibodies are useful for reduction of bone marrow graft failure in children
CD11b	<b>ITGAM</b> , $\alpha$ -M integrin chain, Mac-1 $\alpha$ chain	170 kDa type I transmembrane glycoprotein member of integrin $\alpha$ -chain family. Extracellular portion heavily glycosylated and has 7 tandem repeats. Forms noncovalent association with CD18.	Myeloid and NK cells, some subsets of T and B cells	CD11b-CD18 forms the integrin Mac-19 (complement receptor 3), which binds multiple ligands including iC3b and several of the ICAMS. The complex forms an adhesion molecule with signaling activity. Appears to be involved in inflammation.	Used to detect monocytes and macrophages. Target of anti-inflammatory drug therapy.
CD11c	<b>ITGAX</b> , $\alpha$ chain of CR4, leukocyte surface antigen p150-95	150 kDa type I transmembrane glycoprotein integrin $\alpha$ -chain family member. Heavily glycosylated with 7 tandem repeats. Forms noncovalent association with CD18.	High on monocytes, macrophages, and NK cells. Weakly expressed by T and B cells.	CD11c-CD18 forms the integrin p150,95 which is the type 4 complement receptor, binding iC3b, as well as LPS, ICAM-1, and fibrinogen. Mediates cell-cell interactions in inflammation.	Used to detect myeloid cells in tissue studies
CDw12	p90-120	150-160 kDa. Antibodies detect a carbohydrate epitope on a phosphoprotein of unknown structure.	Monocytes, granulocytes, NK cells	Not known	—

CD13	<b>ANPEP</b> , aminopeptidase N, APN, gp150, EC 3.4.11.2	150 kDa type II transmembrane glycoprotein with metalloprotease and signaling ability. Forms noncovalent homodimer and is heavily glycosylated.	CFU-GM, granulocytes, monocytes, bone marrow stroma, osteoclasts, intestinal brush border, endothelial cells, fibroblasts, renal epithelial cells, brain cells	Zinc metalloproteinase; trims peptides bound to MHC class II; receptor for coronaviruses	CD13 autoantibodies associated with GVHD in bone marrow transplantation; marker for acute leukemias
<b>CD14</b>	LPS receptor	53-55 kDa GPI-linked glycoprotein with leucine-rich repeats	Osteoclasts, monocytes, macrophages, granulocytes, microglia. Present in plasma.	LPS receptor. LPS binding activates CD14 <sup>+</sup> cells, increasing cytokine production and expression of adhesion molecules.	Used as marker for monocytes and osteoclast progenitors
CD15	Lewis X, Le-X, X-Hapten, CD15u indicates sulfated Lewis X. CD15s indicates sialyl Lewis X.	Clustered carbohydrate epitope (3-fucosyl-N-acetyl lactosamine) attached to lipids or proteins	All forms expressed by granulocytes. Also on monocytes, macrophages, mast cells, Langerhans cells. Expressed on various epithelia.	CD15 binds CD62P, CD15s binds CD62E and CD62L. Leukocyte adhesion deficiency type II is associated with low levels of CD15, indicating an important function in adhesion.	Marker for mature granulocytes
CD16	<b>FCGR3A</b> , <b>FCGR3B</b> , Fc $\gamma$ receptor type IIIb (Fc $\gamma$ R IIIb)	50-80 kDa type I transmembrane glycoprotein member of Fc $\gamma$ family. CD16a associates with Fc $\epsilon$ 1- $\gamma$ chain or T cell receptor $\delta$ chain. CD16b is GPI-linked form. Has two extracellular C2 domains.	Transmembrane form on NK cells, macrophages, activated monocytes, mast cells. GPI-linked form on neutrophils.	Component of the type III Fc receptor for IgG, associated with TCR $\beta$ chain or the Fc $\epsilon$ RI $\gamma$ chain. Binds antibody-antigen complexes.	Used as a marker for NK cells
CD17	LacCer, lactosylceramide	Lactosyl disaccharide group, Gal $\beta$ 1-4Glc $\beta$ 1-1cer. Epitope not known to be found on glycoproteins.	Neutrophils, monocytes, granulocytes, basophils, platelets, subset of B cells, tonsillar DCs	Unknown. Binds to bacteria and may function in phagocytosis.	—
CD18	<b>ITGB2</b> , Integrin $\beta$ 2	95 kDa type I transmembrane glycoprotein with extensive N-glycosylation. Forms non-covalent associations with CD11 species.	Leukocytes, broadly expressed	Forms the adhesion molecule complexes LFA-1, Mac-1, p150,95 and $\alpha$ D $\beta$ 2 when complexed with CD11 species. CD18 deficiency results in leukocyte adhesion deficiency type 1 (LAD).	—

continued

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
<b>CD19</b>	B4, Bgp95	95 kDa type I transmembrane glycoprotein with 2 C-type Ig domains and multiple phosphorylation sites on long cytoplasmic domain	B lineage except plasma cells; FDC, malignant B cells	Signal transduction, part of B cell receptor complex with CD21 and CD81. Interaction with CD77 during germinal center formation, B cell homing, and apoptosis.	Major B lineage marker, CD19 MAb used in immunotherapy (e.g., Bexxar)
CD20	<b>MS4A1</b> , B1, Bgp35, Leu-16	35 kDa tetraspan protein existing in three forms dependent on activation state of cell. Both termini cytoplasmic.	B lineage from pre-B to plasma cells	Forms calcium channel when in complexes. Regulator of cell cycle progression and B cell activation, differentiation and proliferation.	CD20 MAb used for marker and immunotherapy of NHL (e.g., Rituximab)
CD21	<b>CR2</b> , C3d receptor, gp140, EBV receptor	145 kDa type I glycoprotein member of the complement control protein family. Extracellular region has 15-16 short consensus repeats.	Mature B cells and follicular dendritic cells	Receptor for C3d, and Epstein-Barr virus. Complexes with CD19, CD81 and leu 13 involved in B cell activation.	Used in leukemia phenotyping and in immunohistology
<b>CD22</b>	BL-CAM, Bgp135, Siglec2, Lyb8, LPAP	140 kDa type I transmembrane glycoprotein with 6 C2-like and 1 V-type domain. Also a 130 kDa isoform, with 5 C2-domains, coexpressed at lower levels. Cytoplasmic tail contains multiple ITIM domains.	Mature B cells and their malignancies. Cytoplasmic in early B cells.	Adhesion and signaling molecule regulating B cell function. Sialic acid binding lectin (Siglec). Binds numerous glycoproteins, including CD45.	Diagnosis and experimental therapy of mature B cell malignancies
CD23	<b>FCER2</b> , BLAST-2 low affinity IgE receptor B6, FcεRII, Leu-20	45 kDa type II integral membrane protein with C-type lectin domain and α-helical coiled-coil structure. Proteolytic cleavage results in soluble CD23 of varying sizes.	B cells, monocytes, FDC, T cells, eosinophils, Langerhans cells, platelets, thymic epithelium	Negative feedback regulation of IgE synthesis, triggering of cytokine release by monocytes	Serum CD23 is elevated in CLL and is an indicator of poor prognosis
<b>CD24</b>	BA-1, HAS (heat stable antigen homolog)	35-70 kDa GPI-linked glycoprotein with extensive glycosylation leading to varying molecular weights	All B lineage except plasma cells, mature granulocytes	Regulates binding capacity of CD49d/CD29. May also be involved in B cell differentiation.	Marker for staging B cell development



CD25	TAC, <b>IL2RA</b> , IL-2 receptor $\alpha$ chain	55 kDa type I transmembrane glycoprotein with two complement control protein (CCP) domains. Associates with CD122 and CD132 to form IL2R. Proteolytic fragment found in serum.	Constitutively expressed by CD4 <sup>+</sup> CD25 <sup>+</sup> natural regulatory T cells. Also on activated T, B cells and monocytes. Low level on subset of resting T cells.	Involved in ligand binding rather than signaling	Membrane-bound and soluble CD25 are used to monitor cell activation in immune response
CD26	<b>DPPA</b> , dipeptidyl peptidase (DPPIV), adenosine deaminase-binding protein	110 kDa type II transmembrane glycoprotein, lacking homology to other protein families	Mature thymocytes, activated T and B cells, NK cells, monocytes, epithelial cells in intestine, kidney, prostate, and bile duct	ADA binding and enzymatic activities are independent. Associates with CD45 in cell membrane, and binds collagen. Appears to act as a costimulatory molecule as well as having adhesion properties.	Potential therapeutic agent in control of type II diabetes. Marker of autoimmune disease.
CD27	<b>TNFRSF7</b> , T14, S152, Tp55	55 kDa type I transmembrane member of TNF receptor superfamily. Cysteine linked homodimer, each monomer with 2 TNF receptor domains; intracellular serine phosphorylation site but lacks the death domain.	Hematopoietic stem cells, early progenitor cells, medullary thymocytes, activated B cells, NK cells. Constitutive on T cells. Soluble form found in serum.	Ligand for CD70. Activation on HSC inhibits differentiation to leukocytes. Binding of ligand to CD27 regulates expansion and differentiation of effector cells.	Marker for naive T cells. Increased soluble CD27 in inflammatory conditions.
<b>CD28</b>	Tp44, T44	44 kDa type I transmembrane glycoprotein member of Ig superfamily. Expressed as disulfide-linked homodimer, each monomer having a V-type domain. Structurally similar to CD152.	T cell subset, activated B cells	Ligand for CD80/CD86, involved in costimulation of T cell effector function and T cell dependent antibody production. Blocking CD28 interaction with CD80/CD86 causes functional inactivation of T cells.	Potential target for immunosuppression
CD29	<b>ITGBP1</b> , integrin $\beta$ 1 chain, VLA $\beta$ chain, platelet GPIIa	130 kDa transmembrane glycoprotein, major $\beta$ chain of VLA protein family. Heavily N-glycosylated. Forms heterodimer with any integrin $\alpha$ subunit	Broad: T cells, B cells, monocytes, platelets, fibroblasts, endothelial cells, mast cells, adipocytes, hepatocytes, smooth muscle cells; not on RBC, weak on neutrophils	Adhesion to ligands such as VCAM-1, MAdCAM-1, adhesion to matrix proteins collagen, laminin, fibronectin. Critical for embryogenesis and development; essential for hematopoietic stem cell differentiation.	—

*continued*

Table A.4A.1 CD Molecules<sup>a,b</sup>, continued

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD30	<b>TNFRSF8</b> , Ki-1, Ber H2	105 kDa TNFR family type I transmembrane glycoprotein. Has 5 cysteine-rich TNFR domains and central hinge region.	Activated B, T, and NK cells, and monocytes. Reed-Sternberg cells in Hodgkin's lymphoma and many other malignant cell lines.	Involved in negative selection of T cells in thymus. Plays a role in TCR-mediated cell death and reduction in cytolytic activity. Binds to CD153.	Elevated soluble CD30 correlates with activity of HepB infection; CD30 <sup>+</sup> lymphomas have better prognosis
CD31	<b>PECAM-1</b> (platelet/endothelial cell adhesion molecule-1), endocam, platelet GPIIa	130-140 kDa type I integral membrane glycoprotein with 6 C2-type domains and a cytoplasmic tail containing an ITIM-like sequence. N-linked carbohydrate comprises ~40% of mol. wt.	Vascular endothelium, polymorphs, platelets, B cells, T cell subsets; soluble forms in serum	Adhesion molecule concentrated at endothelial cell junctions, thought to be involved in leukocyte transmigration. Adhesion through homophilic and heterophilic binding but ligands (other than CD31 and CD38) not clear.	Associated with GVHD in bone marrow transplantation
CD32	<b>FCGR2A</b> , FcγR II	40 kDa Ig superfamily protein with three isoforms (FcγRIIa, b, and c) and multiple splice variants. Two C2-type Ig domains, intracellular region has ITAM (a, c isoforms) or ITIM (b isoforms) domains.	Monocytes, polymorphs, B cells, T cell subset, eosinophils, NK cells, platelets. Different cell types express different isoforms.	Low-affinity Fc receptor, binds aggregates or immune complexes effectively; binds Ig G2 preferentially. "b" isoform mediates feedback inhibition of B cell responses, while ITAM-bearing "a" isoforms mediate activation	A polymorphism in the extracellular region of the a and c isoforms may be related to pathology, since only the H131 allele binds IgG2
<b>CD33</b>	My9; gP67; Siglec3	67 kDa type I transmembrane glycoprotein and smallest member of Siglec group. One extracellular C2 and one V domain, with 5 sites for N-glycosylation. Two intracellular ITIM domains.	Principally restricted to myeloid cells; strong on monocytes, macrophages, mast cells, Langerhans cells; weak on polymorphs. Seen on hematopoietic progenitor cells, but not the earliest stem cells.	Binds α-2, 3 linked sialic acid and is thus a member of sialo adhesion family. Intracellular tyrosine suggests signaling role, but precise function not known.	Phenotypic marker in AML. Humanized CD33 antibody conjugated to cytotoxic drug used to treat AML patients.
<b>CD34</b>	My10, gp105-120	105-120 kDa type I transmembrane glycoprotein with sialomucin-like features. Heavily glycosylated.	Hematopoietic precursor cells, bone marrow stromal cells, capillary endothelium	Ligand for CD62L (L-selectin). Probable cytoadhesion molecule that interacts with CD62E and CD62L.	Marker for stem cells, used in stem cell enrichment

CD35	Complement receptor type 1, <b>CR1</b> , C3b/C4b receptor, immune adherence receptor	190-280 kDa type I transmembrane glycoprotein, extracellular domain consists of tandemly repeated complement control protein repeats, grouped into long homologous repeats. Mol. wt. polymorphisms due to varying repeat sequences encoded by different alleles (A type most common (80%), B type 18%).	Erythrocytes, neutrophils, monocytes, eosinophils, B lymphocytes, 10% to 15% of T cells	Receptor for C3b and C4b bound to immune complexes, cofactor for cleavage of C3b and C4b by plasma serine protease, factor 1. Major role in removal and processing of immune complexes.	Soluble CD35 in clinical trials as complement inhibitor
<b>CD36</b>	GPIV, OKM-5, GPIIb, PASIV	85 kDa glycoprotein with two transmembrane domains forming extracellular loop. Member of scavenger receptor family.	Platelets, mature monocytes, macrophages, microvascular endothelial cells, mammary endothelial cells	Scavenger receptor for LDL; recognition and phagocytosis of apoptotic cells. Cell adhesion in platelet adhesion and aggregation. Role in innate immune system, presenting ligands to TLR2 and TLR6.	—
<b>CD37</b>	gp52-40, Tspan26	40-64 kDa tetraspan glycoprotein, with 2 to 3 N-linked carbohydrates and protein core of 26 kDa	High density on B cells, lost on maturation to plasma cells; low density on T cells and other leukocytes	Forms complexes in B cell membrane with CD53, CD81, CD82, and MHC-II, which may be involved in antigen transport and processing	Marker of B cells and B cell malignancies
<b>CD38</b>	T10, gp45, ADP-ribosyl cyclase	45kDa type II transmembrane glycoprotein. 4 N-glycosylation sites and 6 disulfide bridges. Soluble form found in serum.	Early B and T cells, activated T cells, germinal center B cells, plasma cells. Hematopoietic progenitors at a restricted differentiation stage. Tissues with high glucose metabolism.	Multifunctional adhesion molecule, binding to CD31. Ligation induces cell activation and proliferation or death. Also has NAD <sup>+</sup> glycohydrolase, ADP-ribosyl cyclase, and ADP-ribose hydrolase activity. Signaling involves B or T cell receptors.	Phenotypic marker in leukemia and in HIV-1; used to purify bone marrow and germinal center subsets
CD39	<b>ENTPD1</b> , gp80, ectoapyrase, E-ATPDase	78 kDa ectoapyrase glycoprotein with 2 transmembrane domains and both termini cytoplasmic forming extracellular loop. 5 conserved apyrase regions.	Mantle zone B cells, activated T cells, NK cells, macrophages, Langerhans cells, dendritic cells, platelets and endothelial cells	Cation-dependent enzyme that hydrolyses ATP and ADP, inhibiting inflammatory and thrombotic responses	—

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD40	<b>TNFRSF5</b> , Bp50	48 kDa type I integral membrane glycoprotein member of TNF/NGF receptor superfamily with 4 cysteine-rich TNF receptor domains	B cells, monocytes, dendritic cells, epithelial and endothelial cells, fibroblasts, interdigitating cells, and hematopoietic progenitor cells	Receptor for costimulatory signal to B cells, binding CD154 (CD40L). Involved in cognate T-B interaction. Mutations in the ligand are associated with the immune deficiency disorder hyper-IgM syndrome.	CD40 antibody can substitute for CD40 ligand in activating B cells
CD41	<b>ITGA2B</b> , glycoprotein IIb, $\alpha$ II $\beta$ integrin chain	135 kDa type I transmembrane protein post-translationally cleaved into disulfide-linked external $\alpha$ chain (120 kDa) and transmembrane $\beta$ chain (22 kDa). Forms complex with CD61.	Platelets and platelet precursors	CD41/CD61 complex involved in platelet activation and aggregation by acting as receptor for fibrinogen, fibronectin, and von Willebrand factor	Marker for megakaryoblastic leukemias and target in antithrombotic therapy
CD42a	<b>GP9</b> , platelet glycoprotein IX, gp9	17-22 kDa type I transmembrane protein that forms noncovalent complex with CD42b and CD42c. Contains single leucine rich repeat.	Platelets and megakaryocytes	CD42 complex functions as receptor for von Willebrand factor, mediating adhesion of platelets to subendothelial matrices. Amplifies response to thrombin during platelet activation.	—
CD42b	<b>GP1BA</b> , glycocalicin, platelet glycoprotein GP1b $\alpha$	145 kDa type I membrane mucin that forms core of CD42 complex. Contains 7 tandem leucine-rich repeats and is heavily glycosylated. Disulfide bond links CD42b to CD42c	Platelets and megakaryocytes	CD42 complex functions as receptor for von Willebrand factor, mediating adhesion of platelets to subendothelial matrices. Amplifies response to thrombin during platelet activation. CD42b contains vWF binding site.	—
CD42c	<b>GP1BB</b> , platelet glycoprotein GP1b- $\beta$	24 kDa type I transmembrane protein that forms non-covalent complex with CD42a and CD42b. Contains single leucine-rich repeat and is disulfide-bonded to CD42b.	Platelets and megakaryocytes	CD42 complex functions as receptor for von Willebrand factor, mediating adhesion of platelets to subendothelial matrices. Amplifies response to thrombin during platelet activation.	—

CD42d	<b>GP5</b> , platelet glycoprotein 5	82 kDa type I transmembrane member of CD42 complex. Contains 14 leucine rich repeat domains. Noncovalently associates with CD42a-b-c.	Platelets and megakaryocytes	CD42 complex functions as receptor for von Willebrand factor, mediating adhesion of platelets to subendothelial matrices. Amplifies response to thrombin during platelet activation.	—
CD43	Leukosialin, sialophorin, gp95, <b>SPN</b>	95-135 kDa type I transmembrane marker of cell surface mucin family. Highly O-glycosylated with extensive and variable sialylation. Soluble form shed into serum	All leukocytes except resting B cells	Possibly promotes and/or inhibits adhesion of leukocytes, depending on conditions, during migration. Possible ligands are CD54 and hyaluronic acid.	Histopathological marker for identification of normal and malignant T cells. Useful for leukemia and lymphoma phenotyping.
<b>CD44</b>	Phagocyte glycoprotein 1 (pgp1), Hermes antigen, HUTCH-1, H-CAM	90 kDa type I transmembrane glycoprotein with a cartilage link protein (hyaladhesin) module. Alternative splicing leads to multiple variant (CD44v) forms with differential expression and function. Six cysteine residues result in three intra-molecule disulfide bonds.	Leukocytes and erythrocytes. Variant forms widely expressed on endothelia and epithelia.	Adhesion, signaling and maintenance of polarity in epithelia. Adhesion in leukocytes via binding to hyaluronic acid. CD44v6 isoforms possibly involved in tumor metastasis.	CD44 variants useful phenotypic and prognostic markers in non-Hodgkin's lymphoma, gastric and colonic tumors, and breast cancer
CD45	<b>PTPRC</b> , leukocyte common antigen, LCA, B220, CD45R, RA, RO, RC, RB isoforms	180-220 kDa type I transmembrane glycoprotein; differential splicing of 3 exons yields isoforms RA, RB, RC, and RO. Contains 3 fibronectin type III domains in membrane proximal region and 2 intracellular phosphotyrosine phosphatase domains.	All hematopoietic cells, but highest on lymphocytes. Isoform expression changes with activation, and is characteristic of differentiated subsets of leukocytes. Multiple isoforms expressed on same cell type.	Has intrinsic tyrosine phosphatase activity. Essential for T and B cell antigen receptor-mediated activation. Cross-linking of CD45 induces apoptosis in lymphocytes.	Isoforms are used to discriminate naive and memory (RA/RO) cells
CD45RA	—	205-220 kDa isoform of CD45	"Naive" T cells, B cells	As for CD45	Used as a marker of "naive" lymphocytes

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD45RO	—	Isoforms of CD45 (see CD45 entry) with no insertion at the splice insertion point	T cell subset, described as memory T cells. CD45RA <sup>+</sup> RO cells lose RA and acquire RO upon activation. Also on monocytes.	As for CD45	Widely used as a marker of previously activated or “memory” T cells
CD46	Membrane cofactor protein, <b>MCP</b>	65/75 kDa type I transmembrane protein with 4 N-terminal complement control protein domains. 4 isoforms generated by alternate splicing plus glycosylation.	Variably expressed on all nucleated cells except unfertilized oocytes. High expression at blood-brain barrier, salivary gland and kidney ducts, moderate expression on lymphocytes and endothelium, increased expression on tumor cells.	Cofactor for factor I proteolytic cleavage of C3b and C4b, protecting host tissues from complement-mediated damage. Also serves as receptor for a number of pathogens, including measles virus. No CD46 mutations or deficiencies have been identified.	—
<b>CD47</b>	Integrin-associated protein (IAP), ovarian carcinoma antigen OA3	50-55 kDa Ig superfamily member with one V-type domain and 5 transmembrane-spanning regions	Broadly expressed on all human cells so far tested, except Rh-negative RBCs. Strong expression in brain.	Binds and activates CD172a (leukocyte inhibitory receptor signal regulatory protein $\alpha$ ; SIRP $\alpha$ ) on phagocytic cells, preventing phagocytosis of self blood cells	—
<b>CD47R</b>	formerly CDw149	CD47R MAbs have a low affinity for the CD47 molecule	—	—	—
<b>CD48</b>	BLAST-1, Hulym3, OX45, BCM1	45 kDa GPI-linked surface glycoprotein. One C2 and one V-type domain.	Pan leukocyte; not neutrophils or platelets. Expression up-regulated on activated lymphocytes.	Ligand for natural killer cell inhibitory receptor (CD244). In homotypic cells, this interaction augments immune response, otherwise interaction inhibits NK effector functions.	Fewer CD48 <sup>+</sup> lymphocytes in patients with paroxysmal nocturnal hemoglobinuria

CD49a	<b>ITGA1</b> , $\alpha 1$ , very late antigen, VLA 1a	210 kDa type I transmembrane molecule of integrin $\alpha$ subclass. Potentially heavily glycosylated. Noncovalently associates with CD29.	Activated T cells, monocytes, cultured neuronal cells, melanoma cells, mesenchymal cells including smooth muscle cells, fibroblasts, hepatocytes, microvascular endothelium	Adhesion receptor for collagen IV and laminin-1; involved in leukocyte migration into tissues	Up-regulated in several inflammatory diseases of human intestine
CD49b	Integrin $\alpha 2$ chain, VLA-2 $\alpha$ chain, platelet gpl $\alpha$ , <b>ITGA2</b>	165 kDa type I transmembrane protein of integrin $\alpha$ subclass. N-linked glycosylation. Noncovalently associates with CD29.	Platelets, megakaryocytes, activated T cells, B lymphocytes, monocytes, epithelial cells, endothelial cells, fibroblasts	Covalently associated with integrin $\beta 1$ chain to form VLA-2. Complex mediates cell adhesion to collagen type I and laminin. Promotes wound healing by collagen contraction.	—
CD49c	$\alpha 3$ , VLA-3 $\alpha$ chain, <b>ITGA3</b>	145-150 kDa type I transmembrane protein of integrin $\alpha$ subclass. Heavily glycosylated. Noncovalently associates with CD29. Cleaved into heavy (125 kDa) and light (30 kDa) chains and expressed as disulfide-linked protein.	T and B lymphocytes, monocytes and adherent cell lines	Component of VLA-3 adhesion receptor for laminin-V, laminin-1, fibronectin, collagen, entactin	—
CD49d	$\alpha 4$ integrin, VLA-4 $\alpha$ chain, <b>ITGA4</b>	145 kDa type I transmembrane protein of integrin $\alpha$ subclass. Heavily glycosylated. Noncovalently associates with CD29 to form VLA-4.	Broad, including B cells, monocytes, T cells, eosinophils, basophils, NK cells, dendritic cells, not platelets, not neutrophils	Associates with either $\beta 1$ or $\beta 7$ integrin chains providing cell adhesion to VCAM-1, MAdCAM-1, fibronectin, thrombospondin. Involved in multiple inflammatory responses, essential to differentiation and migration of hematopoietic stem cells; role in tumor progression and metastasis.	—
CD49e	$\alpha 5$ , VLA-5 $\alpha$ chain, <b>ITGA5</b>	160 kDa type I transmembrane protein of integrin $\alpha$ subclass. Heavily glycosylated. Cleaved into heavy (135 kDa) and light (25 kDa) chains and expressed as disulfide-linked molecule.	Thymocytes, activated and memory T cells, early and activated B cells, monocytes, NK cells, dendritic cells, osteoblasts, endothelia	Binds to RGD sequence of fibronectin. Important in maintaining integrity of endothelial monolayer, as well as adhesion of cells to fibronectin. Involved in monocyte migration into extravascular tissues and regulation of cell survival and apoptosis.	—

continued

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD49f	$\alpha$ 6, VLA-6 $\alpha$ chain, platelet GPIc, <b>ITGA6</b>	150 kDa type I transmembrane protein of integrin $\alpha$ subclass. Cleaved into heavy (120 kDa) and light (30 kDa) chains and expressed as disulfide-linked protein. Noncovalently associates with CD29 to form VLA-6. Two cytoplasmic domain splice variants have tissue-specific expression.	Platelets, megakaryocytes, monocytes, T cells, thymocytes, nonlymphoid epithelial, many cultured adherent cell lines	Adhesion receptor for laminins, invasin, and merosin. Also involved in embryogenesis, migration, and cell-surface mediated signaling. Enables interaction between epithelial cells and basement membrane during wound healing. Involved in tumor metastasis.	—
CD50	<b>ICAM-3</b> , intercellular adhesion molecule 3	120-170 kDa type I integral membrane protein with five C2-type domains. Mol. wt. varies depending on cell of expression and extent of glycosylation.	Leukocytes, Langerhans cells, endothelial cells	Regulates LFA/ICAM1 and integrin- $\beta$ 1 dependent adhesion, provides costimulatory signal during immune response leading to polarization of microtubular cytoskeleton	—
CD51	Integrin $\alpha$ chain, vitronectin receptor $\alpha$ chain, <b>ITGAV</b>	150 kDa type I integral membrane protein of integrin $\alpha$ subclass. Forms noncovalent associations with several integrin $\beta$ chains. Cleaved to form disulfide-linked protein with heavy (125 kDa) and light (24 kDa) chains.	As $\alpha$ V $\beta$ 1 complex on fibroblasts and neuroblastoma cells; as $\alpha$ V $\beta$ 3 on endothelial cells, cultured/activated monocytes and macrophages platelets, activated T cells, some B cells, osteoclasts	Complex of CD51/CD61 (aVb3) binds RGD motifs in ECM proteins vitronectin, fibronectin, fibrinogen, von Willebrand factor, laminin, thrombospondin. Complex of CD51/CD29 (aVb1) binds fibronectin. CD51/CD61 acts as activation-independent receptor for platelet attachment. CD51/CD61 also mediates leukocyte-endothelial cell adhesion, initiates bone resorption and possibly has role in angiogenesis.	—
CD52	Campath-1, <b>CDW52</b>	25-29 kDa GPI-anchored membrane glycopeptide, consisting of 12 amino acid residues bearing a complex N-linked carbohydrate structure	Thymocytes, lymphocytes, monocytes, macrophages, peripheral dendritic cells, eosinophils, male reproductive tract epithelium and mature sperm (absorbed from seminal fluid)	Not known, but present at high concentrations ( $5 \times 10^5$ molecules per lymphocyte). CD52-negative cells (in patients treated with anti-CD52 antibody) appear to function normally.	Humanized antibodies used to reduce lymphocyte numbers and function in autoimmune disease and organ or bone marrow transplantation



CD53	MRC OX-44 (rat), tetraspanin 25	32-42 kDa tetraspan superfamily member. Both termini cytoplasmic.	Highest on monocytes and B cells, also on thymocytes, T cells, granulocytes, osteoblasts, osteoclasts. Not on erythrocytes, platelets, and nonhematopoietic cells.	CD53 cross-linking induces calcium mobilization, signal transduction, and oxidative burst formation in monocytes, and promotes activation of B cells	—
CD54	ICAM-1, intercellular adhesion molecule 1	80-114 kDa type I transmembrane glycoprotein member of Ig superfamily with 5 C2-type domains and extensive glycosylation. Soluble form in serum.	Absent from resting leukocytes but expressed on activated T, B cells and monocytes. Low levels on endothelia, increased in inflammatory states.	Adhesion molecule binding to LFA-I, Mac-I, fibrinogen, hyaluronan, CD43. Major signaling adhesion molecule in inflammatory and immune reactions. Receptor for rhinoviruses.	Potential target for immunosuppressive antibodies in transplantation; serum levels of soluble CD54 are potentially useful indicators of inflammation
CD55	DAF, decay accelerating factor	70/50 kDa type I GPI-anchored glycoprotein with four complement control protein domains. Mol. wt. variance due to glycosylations.	Wide expression on most cells including erythrocytes. Low expression on NK cells. Overexpressed by various tumors.	Protects against inappropriate complement activation; binds C3b and C4b to inhibit C3 convertase formation. Binds C3bBb and C4b2a to accelerate decay of C3 convertases.	CD55 loss associated with paroxysmal nocturnal hemoglobinuria. Possible target for tumor therapy.
CD56	NKHI, NCAM1	180 kDa (long cytoplasmic) 140 kDa (short cytoplasmic), 120kDa (GPI-linked) Ig superfamily member. Hematopoietic form is 140 kDa. 5 C2-type domains and 2 fibronectin type III domains. Variable glycosylation, which includes the CD57 epitope.	Isoforms on neural cells (NCAM), muscle cells, embryonic tissue and tumors. In hematopoietic cells, restricted to NK cells and T cells subset.	Adhesion molecule in neuronal tissue; knockout mice show neurologic abnormalities. Function on NK cells not known, but possibly involved in homophilic adhesion of these cells.	NK cells marker; NK subsets “split” according to level of CD56 expression. Identification of various solid tumors.
CD57	HNK1	Sulfated trisaccharide epitope SO <sub>4</sub> .3GlcAβ1-3Galβ1-4GlcNAC, expressed on glycolipids	Subsets of NK and T cells, neural tissue	Adhesion reaction via laminin and L- and P-selectin binding. Important in myelin structure in the nervous system.	NK cell marker. Target of autoantibodies in peripheral neuropathy. Expressed on some solid tumors.

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
<b>CD58</b>	LFA-3, lymphocyte function associated antigen-3	40-70 kDa type I integral member of CD2 subfamily or Ig superfamily. Alternate transmembrane or GPI-anchored forms, both with C2-type and V-type domains, and N-linked glycosylation.	Leukocytes, erythrocytes, endothelial, and epithelial cells, fibroblasts, and smooth muscle cells	Ligand for CD2, costimulating signal in immune response, mediates adhesion between killer and target cells, APC, and T cells, thymocytes, and thymic epithelial cells	Sheep CD58 mediates SRBC rosetting of human T cells
<b>CD59</b>	MACIF, MIRL, P-18, protectin	18-25 kDa GPI-anchored protein. Member of Ly6 superfamily with one cysteine-rich Ly6 domain. Structurally related to snake venom neurotoxins.	Widely expressed on all cells in all tissues. Erythrocyte expression is essential for their survival.	Associates with CD9, inhibits terminal steps of polymerization of membrane attack complex. Protects cells from complement-mediated lysis.	CD59 transgenic pigs are being studied for use of their tissues in xenotransplantation
CD60	CD60a, CD60b, CD60c	Glycosylation epitopes GD3 (CD60a), 9-0-acetyl GD3 (CD60b), 7-0-acetyl GD3 (CD60c)	CD60a: melanocytes, adrenal medullary cells, glial cells, neurons, pancreatic islet cells, thymocytes, subset peripheral T cells. CD60b: T cell subsets, activated B cells, neuroectodermal cells in thymus epithelium. CD60c: T cells.	CD60 <sup>+</sup> T cells act as helper cells to B cells and secrete greater levels of IL-4. CD60a involved in regulation of apoptosis and induction of mitochondrial permeability during apoptosis.	Strong marker for malignant melanoma. High frequency of CD60 <sup>+</sup> T cells in synovial fluid of normal and arthritic patients and in cutaneous psoriatic lesions. CD60 expression may correlate with CD4 T <sub>H</sub> 2 type cytokine profile.
CD61	Glycoprotein IIIa, $\beta$ 3 integrin, <b>ITGB3</b>	110 kDa type I integral protein, member of $\beta$ integrin family. Cysteine-rich single-chain protein with glycosylations.	Platelets and megakaryocytes as CD41/CD61 complex, endothelium, smooth muscle, some B cells, monocytes, macrophages, platelets, osteoclasts, some mast cells, fibroblasts, and tumor cells as CD51/CD61 complex	Common $\beta$ subunit of CD41/61 and CD51/61, CD41/61 mediates attachment to matrix proteins fibrinogen, fibronectin, von Willebrand factor. CD51/CD61 binds RGD motifs in matrix proteins and plays a role in tumor metastasis.	Absent or dysfunctional CD41/CD61 complex on platelets leads to the bleeding disorder Glanzmann's thrombasthenia

CD62E	E-selectin, LECAM-2, ELAM-1, <b>SELE</b>	115 kDa type I transmembrane glycoprotein with an N-terminal C-type lectin domain followed by an EGF-like domain and 6 complement control domains	Endothelial cells in both acute and chronic inflammatory conditions. In noninflammatory state by skin, placenta, bone marrow endothelium.	Binds sialyl Lewis-X (CD15s) through the C-type lectin domain; ligands include ESL-1 and PSGL-1. Adhesion molecule involved in leukocyte extravasation; possibly also has role in tumor cell adhesion during metastasis. Mice deficient in CD62E and CD62P have reduced leukocyte recruitment to inflammatory sites.	—
CD62L	L-selectin, LAM-1, Mel-14, <b>SELL</b>	74-94 kDa type I transmembrane glycoprotein with an N-terminal C-type lectin domain followed by an EGF-like domain and 2 complement control protein domains	Lymphocytes, neutrophils, monocytes, NK cells. Among T cells, memory cells express CD62L preferentially. Expressed by some hematopoietic malignancies.	Binds glycoproteins bearing CD15s epitopes through the C-type lectin domain, and binds some unrelated polyanionic molecules including heparin sulfate. Involved in “rolling” of leukocytes on endothelium, a precursor to extravasation during inflammation. Mediates lymphocyte homing to high endothelial venules of peripheral lymphoid tissue.	Potential target for treatment of chronic inflammatory diseases such as asthma. Serum CD62L is indicator of inflammation.
CD62P	P-selectin, <b>SELP</b>	140 kDa type I transmembrane glycoprotein with an N-terminal C-type lectin domain followed by an EGF-like domain and nine complement control protein domains	Megakaryocytes, activated platelets and activated endothelium	Binds glycoproteins with CD15s (sialyl Lewis-X) epitopes, including CD162 (PSGL-1). Also binds unrelated polyanions. Endothelial CD62P is involved in the “rolling” reaction that precedes leukocyte extravasation. Role of CD62P overlaps with that of CD62E, if both are defective, inflammation defects are much more severe.	Potential target for treatment of chronic inflammatory diseases such as asthma. Serum CD62L is indicator of inflammation.
<b>CD63</b>	LIMP, gp55, LAMP-3 neuroglandular antigen, melanoma-associated antigen ME 491 Pltgr40, granulophysin	40-60 kDa lysosomal protein belonging to tetraspan superfamily. Major extracellular domain between transmembrane segments 3 and 4 is glycosylated.	Activated platelets, activated endothelium, degranulated granulocytes, monocytes, macrophages, all T cells, low level on subset B cells including CLL and neonatal B cells. Also found on neural tissues and fibroblasts and smooth muscle.	Associated on cell surface with CD49c, d, and f and CD11/CD18 integrin. Also associates with other tetraspan proteins, probably in large complexes. Rapidly translocated to cell surface on activation (especially platelets, endothelial cells, and granulocytes). Thought to be associated with early stages of melanoma progression.	Marker of platelet activation; marker for primary melanoma

continued

Table A.4A.1 CD Molecules<sup>a,b</sup>, continued

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD64	FcR1, FcγR1, high-affinity Fcγreceptor, <b>FCGR1A</b>	72 kDa type I transmembrane protein with 2 C2-type domains and one V-type domain. Extensively glycosylated. Unique cytoplasmic tail possibly has signaling function.	Constitutively expressed on monocytes, macrophages, subset of blood and germinal center dendritic cells	Receptor for Fc segment of IgG, mediating phagocytosis of immune complexes, ADCC, antigen capture for presentation to T cells and release of cytokines and reactive oxygen intermediates	Potential marker for AML subsets
CD65	Ceramide dodecasaccharide 4c	Ceramide oligosaccharide. Some antibodies recognize a sialylated form, CD65S	Granulocytes, monocytes, AML blasts, and some ALL blasts	Unknown, possible ligand for CD62E and CD62L. One study has implicated CD65 as a critical adhesion molecule for extravascular AML infiltration.	CD65s is useful marker for acute leukemia typing, including subset of pre-B ALL
CD66a	BGP biliary glycoprotein NCA-160, <b>CEACAM1</b>	140-180 kDa member of carcinoembryonic antigen (CEA) family. Contains 3 C2-type domains and one V-type domain with extensive glycosylation.	Granulocytes, epithelial cells. Also on NK cells, activated T cells, prostate gland and ducts.	Capable of homophilic and heterophilic adhesion, capable of activating neutrophils, receptor for <i>N. meningitidis</i> , <i>N. gonorrhoeae</i> . Expression down-regulated in malignancies, so possible role in tumor suppression.	—
CD66b	Previously CD67, CGM6, NCA-95, <b>CEACAM8</b>	95-100 kDa CEA family member, GPI-linked with 2 C2-type domains and one V-type domain	Granulocytes	Capable of heterophilic adhesion with CD66c, capable of activating neutrophils by transmembrane signaling. Shed during granulocyte activation, but function of soluble protein unknown.	Potential application in detecting sites of infection and inflammation
CD66c	NCA, nonspecific cross-reaction antigen, NCA-50/90, <b>CEACAM6</b>	90 kDa CEA family member, GPI linked with 2 C2-type domains and one V-type domain	Granulocytes and epithelial cells	Capable of homophilic and heterophilic adhesion to CD66a-e, CD62E. Activates neutrophils via transmembrane signaling.	Potential application in detecting sites of infection and inflammation
CD66d	CGM1, <b>CEACAM3</b>	35 kDa transmembrane CEA family member with single V-type domain	Granulocytes	May be involved in signaling and adhesion. Can activate neutrophils and functions as receptor for <i>N. meningitidis</i> , <i>N. gonorrhoeae</i> .	—

CD66e	CEA, carcinoembryonic antigen, <b>CEACAM5</b>	180-200 kDa CEA family member, GPI-anchored with 6 C2-type domains and one V-type domain, heavily N-glycosylated	Epithelial cells	Capable of homophilic and heterophilic adhesion to protein cores of CD66a and CD66c. May be involved in tumor metastasis.	Serum CEA is used as a clinical marker of tumor burden
CD66f	PSG, pregnancy specific glycoprotein, Sp-1, pregnancy specific (b1) glycoprotein, <b>PSG1</b>	54-72 kDa transmembrane CEA family member with 3 C2-type and one V-type domain	Detected in serum. Produced by placental syncytiotrophoblasts, detected in fetal liver, myeloid cell lines	Essential for successful pregnancy. May protect fetus from maternal immune system.	Low levels in maternal blood predict spontaneous abortion
CD67	CD66b	See CD66b	See CD66b	See CD66b	See CD66b
<b>CD68</b>	gp110, macrophage mannose receptor	110 kDa type I transmembrane glycoprotein with mucin-like features. Extremely heavy O-linked glycosylation.	Mainly expressed in cytoplasmic granules, but also on surface, monocytes and macrophages, DC, neutrophils, basophils, eosinophils, mast cells, subset of CD34 <sup>+</sup> BM progenitors, activated T cells	Scavenger receptor which binds and internalizes LDL. Contributes to foam cell formation in atherosclerosis.	Probably best macrophage marker in immunohistochemistry
<b>CD69</b>	AIM, activation inducer molecule, MLR3, EA1, VEA	60 kDa type II transmembrane C-type lectin disulfide-linked heterodimer with variable glycosylation. Constitutively phosphorylated. Reduction leads to mol. wts. of 22 and 33kDa due to differing glycosylation.	Activated leukocytes: T cells, thymocytes, B cells, NK cells, neutrophils, eosinophils	In vitro studies suggest involvement in signal transduction and early stages of activation of cells. Induces calcium influx, synthesis of cytokines and receptors. Knockout mice demonstrate essential role for CD69 in down-regulating immune response.	Marker of early T cell activation
CD70	CD27 ligand, <b>TNFSF7</b>	50 kDa type II transmembrane protein with single TNF superfamily domain	Transiently expressed on activated T and B cells and activated NK cells. Constitutive expression on B cell CLLs and large B cell lymphomas.	Plays role in T cell activation, inducing proliferation of costimulated T cells and enhancing generation of cytolytic T cells. Involved in generation and maintenance of T cell memory.	—

continued

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD71	Transferrin receptor T9, <b>TFRC</b>	190 kDa type II transmembrane protein. Extracellular C-terminal domain containing transferrin binding site. Forms disulfide bonded homodimer, each monomer of 95 kDa.	All proliferating cells. Overexpressed in certain tumors such as glioma and colon cancer.	Mediates cellular iron uptake via internalization and recycling of transferrin. Can also bind IgA complexes and is implicated in IgA nephropathy.	Marker of proliferation, has been used to target cytotoxic molecules to proliferating cells
<b>CD72</b>	Lyb-2 (mouse homolog)	45 kDa type II transmembrane protein and member of C-type lectin family. Forms disulfide-linked homodimers, and has cytoplasmic ITIM motifs.	All B lymphocytes, not plasma cells. Expressed on macrophages and dendritic cells.	Putative ligand for CD100 and CD5. Plays role in B cell proliferation and differentiation. CD100 appears to prevent negative regulation by CD72.	Expressed on B lineage NHL and leukemias
CD73	Ecto-5'-nucleotidase, <b>NT5E</b>	69-72 kDa GPI-linked nucleotidase	Subset of T and B lymphocytes, increasing during development. Follicular dendritic cells, epithelial and endothelial cells, various lymphomas and leukemias.	Dephosphorylates ribo- and deoxyribonucleoside monophosphates to the nucleoside. Implicated in B cell-follicular dendritic cell interactions although no ligand identified.	High CD73 expression in leukemia or lymphoma is indicator of poor prognosis, low CD73 expression found in some immunodeficiency diseases
<b>CD74</b>	MHC class II associated invariant chain (Ii)	Multiple isoform type II transmembrane glycoprotein not recognized as a member of any structural family. N and O glycosylated. All isoforms are between 33 and 45 kDa in size.	MHC class II positive cells, including B cells and other antigen presenting cells and activated T cells	Regulates loading of exogenous-derived peptides onto MHC class II heterodimers. Required for normal positive selection of CD4 <sup>+</sup> T cells.	Useful in study of antigen presentation and processing and analysis of subcellular compartments. Used in phenotyping of leukemias and lymphomas.
CD75	Lactosamines	Carbohydrate, NeuAc $\alpha$ 2,6Gal $\beta$ 1,4GlcNAc, found on glycolipids and glycoproteins. CD75 and CD75s (formerly CD76) share a core carbohydrate but differ in sialylation.	Mature B cells including strong expression in germinal center cells; weak expression in extra follicular and mantle zone cells. T cell subpopulation, erythrocytes, various B cell malignancies.	No known function; may be ligand for sialic acid-binding lectins	Differentiates between malignant B cell types

CDw76/ CD75s	Sialylated lactosamines	Since HLDA 7 CDw76 was renamed CD75s; CD75 and CD75s recognize the same core carbohydrate but differ in sialylation. Carbohydrate $\alpha$ 2,6 sialylated lactosaminyl epitope, expressed on glycosphingolipids or glycoproteins.	Mature B cells in blood and lymphoid tissue, lost on germinal center and plasma cell differentiation. T cell subsets; some B cell malignancies.	Not described. May be a ligand for sialic acid-binding lectins.	Differentiates between malignant B cell types
CD77	Gb3, Pk blood group antigen, Burkitt's lymphoma associated antigen (BLA), ceramide trihexoside (CTH)	Neutral glycolipid hapten globotriaosyl ceramide (Gb3). Gal $\alpha$ 1-4Gal $\beta$ 1-4Glc $\beta$ 1-ceramide	Germinal center B cells, more strongly on centroblasts, but can be induced on extrafollicular B cells. Strongly on Burkitt's lymphoma cells. Also endothelia and epithelia.	Receptor for Shiga toxin and verotoxin, which cause dysentery and hemolytic uremic syndrome. Physiological function not known, but may bind CD19. May mark centroblasts for apoptosis unless rescued by binding antigens on FDC.	Used as a centroblast marker. Potential use as marker for cancer therapy, especially hematological malignancies such as CLL.
CDw78	Ba	Deleted from CD classification	Deleted from CD classification	Deleted from CD classification	Deleted from CD classification
<b>CD79a</b>	Immunoglobulin receptor $\alpha$ chain, MB1	32-33 kDa type I integral membrane protein and member of Ig superfamily. Contains single C2-type domain that is heavily glycosylated, and cytoplasmic ITAM motif. Forms disulfide-linked heterodimer with CD79b.	Seen early in B cell maturation with higher expression on marginal and follicular mantle B cells than germinal center cells. Intracellular expression in plasma cells.	Component of B cell receptor. Expression is essential for B cell receptor expression.	Useful in differential diagnosis of B cell neoplasms from T cell or myeloid neoplasms. Useful marker of pre-B-ALL.
<b>CD79b</b>	Immunoglobulin receptor $\beta$ chain, B29	37 kDa type I integral membrane protein and member of Ig superfamily. Contains one V-type domain that is glycosylated, and has cytoplasmic ITAM motif. Forms disulfide-linked heterodimer with CD79a.	Seen early in B cell maturation with higher expression on marginal and follicular mantle B cells than germinal center cells. Intracellular expression in plasma cells.	Component of B cell receptor. Expression is essential for B cell receptor expression, CD79b-deficient mice have block at progression from pro-B to pre-B cells.	—

continued

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
<b>CD80</b>	B7-1, BB1, CD28 ligand	60 kDa (by immunoprecipitation) type I transmembrane glycoprotein with an N-terminal V-type domain followed by a C2-type domain. Heavily glycosylated.	Activated B cells, activated T cells, macrophages, dendritic cells	Costimulation of T cells through ligation of CD28 and CD152 (CTLA-4). Coregulator of T cell activation with CD86.	CD28-CD80 complex is potential therapeutic target in treatment of rheumatoid arthritis
<b>CD81</b>	TAPA-1 (target of anti-proliferative antibody), TSPAN28	26 kDa tetraspan family member, with both termini cytoplasmic. Not glycosylated.	Widely expressed among leukocytes and also found on endothelia	Coligation of complex of CD81, CD19 and CD4 enhances BCR signaling. Knockout mice show subtle defects in B cell maturation and antibody production. Receptor for hepatitis C virus.	Research reagent
CD82	R2, IA4, 4F9, C33, <b>KAI1</b> , TSPAN27	45-90 kDa tetraspan family member with both termini cytoplasmic. Second larger loop is glycosylated. Mol. wt. depends on cell type and activation state.	Activated differential hematopoietic cells, not expressed by RBC. Epithelial cells, endothelial cells, fibroblasts.	Costimulatory for TCR/CD3 pathway	Reduced expression potentially diagnostic of metastatic cancer
<b>CD83</b>	HB15, BL15	40-45 kDa type I transmembrane protein with single V-type domain that is heavily glycosylated	Nonfollicular dendritic cells, circulating DC, interdigitating DC, Langerhans cells	Possible function in dendritic cell-cell interaction	Dendritic cell marker
<b>CD84</b>	SLAMF5, p75, GR6, Hly9- $\beta$	64-82 kDa type I integral membrane glycoprotein with one C2-type and one V-type Ig domain and a long cytoplasmic tail	Mature B cells, NK cells and monocytes, subsets of T cells (CD45RO <sup>+</sup> ); at low levels on polymorphs and platelets	Possible function in intercellular interaction and signaling	Research reagent
CD85 family	ILT (Ig-like transcript) family. Allocated CD85a, b, c etc. in centromeric-telomeric sequence, <b>LILRB1-4</b>	110 kDa transmembrane glycoprotein family of 13 members with 4 C2-type extracellular domains (except CD85k, which has 2). Contain cytoplasmic ITIM motifs (except CD85g, CD85h).	NK, dendritic cells, monocytes, plasma cells, and, at lower levels on B cells	Not known, though some CD85 members bind MHC class I and are involved in NK cell recognition of self cells	—



CD86	B7-2, B70, CD28CG2	80 kDa type I transmembrane member of Ig superfamily with single V-type domain and single C2-type domain	Interdigitating dendritic cells, Langerhans cells, DC, memory and germinal center cells	Costimulation of T cells, ligand for CD28 and CD152, binds CD152 with 20-to 100-fold higher affinity than CD28. Signaling via CD86 and CD28; CD152 is critical for induction and regulation of immune responses.	Research reagent
CD87	Urokinase-type plasminogen activator receptor (uPA-R), <b>PLAUR</b>	45-65 kDa GPI-linked protein with three Ly-6 domains and N-linked glycosylations	Monocytes, polymorphs, dendritic cells, activated T cells, fibroblasts, endothelial cells, smooth muscle	Binding of uPA induces tyrosine phosphorylation. Binds vitronectin and interacts with $\beta 1$ and $\beta 2$ integrins. Patients with LAD (lacking $\beta 2$ integrin function) show CD87 signaling deficits. KO mice show defect in uPA-mediated plasminogen activation.	Elevated expression is a poor prognostic factor in several tumors
CD88	C5a-receptor, C5aR, <b>C5R1</b>	43 kDa type III member of rhodopsin superfamily. Contains seven transmembrane domains and couples to GTP-binding proteins.	Granulocytes, monocytes, dendritic cells, astrocytes, and microglia	GPCR involved in C5a-mediated inflammation and activation of granulocytes	—
CD89	Fc $\alpha$ receptor, <b>FCAR</b>	45-100 kDa type I transmembrane glycoprotein with two C2-like Ig domains and N-linked glycosylation. Range of mol. wt. depending on cell type.	Myeloid lineage (neutrophils, monocytes), activated eosinophils	Binds IgA C $\alpha 2$ -C $\alpha 3$ domain. Binding induces phagocytosis, respiratory burst, degranulation.	Potential target for immunotherapy of infectious diseases and malignancies
CD90	<b>THY1</b>	25-35 kDa GPI-anchored member of Ig superfamily with single V-type domain	Hematopoietic stem cells, neurons, few fetal thymocytes, 10%-40% CD34 <sup>+</sup> cells in BM	Role in leukocyte adhesion and may contribute to inhibition of proliferation and differentiation	CD34 <sup>+</sup> /CD90 <sup>+</sup> cells include hematopoietic stem cells

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD91	$\alpha$ 2-macroglobulin receptor, LDL receptor-associated protein, <b>LRP1</b>	515 kDa ( $\alpha$ chain) noncovalently bound to 85 kDa ( $\beta$ chain) transmembrane chain. $\alpha$ chain contains 4 clusters of LDL receptor class A repeats, each flanked by EGF domains. Transmembrane chain has single EGF domain and LDL receptor B domain.	Monocyte lineage, erythroblasts/reticulocytes	Mediates uptake and elimination of at least 30 ligands, including $\alpha$ 2 macroglobulin-proteinase complex, plasminogen activators and various heat-shock proteins. Gene knockout is incompatible with life.	—
CD92	<b>SLC44A1</b> , <b>CHTL1</b>	70 kDa type III integral membrane protein with 10 transmembrane domains, ITIM motif and both termini intracellular. Member of choline transporter-like family.	Monocytes, granulocytes; weak on PBL, fibroblasts	Potential ligand transporter	Research reagent
<b>CD93</b>	C1qR1	126 kDa O-sialoglycoprotein with 5 EGF domains and single C-type lectin domain	Monocytes, granulocytes, AML blasts, myeloid lines, endothelial cells	Adhesion of cells. Cytoplasmic tail interacts with moesin. No longer thought to be C1q receptor.	—
CD94	<b>KLRD1</b> , kP43	30 kDa type II transmembrane glycoprotein member of the C-type lectin superfamily. Forms heterodimers with other C-type lectins, NKG2A and NKG2C.	NK cells and T cell subset	CD94-NKG2 dimers bind HLA-E, apparently suppressing NK cytotoxicity	—
CD95	APO-1, Fas, <b>TNFRSF6</b>	45 kDa type I transmembrane protein member of TNF receptor family that forms trimers. Cytoplasmic death domain and palmitoylation sites. Alternative splicing yields soluble forms.	Activated T and B cells	Mediation of apoptosis-inducing signals, lpr/lpr-mice have Fas defect and develop lymphadenopathy	Marker of apoptotic cells. Soluble CD95 increased in some autoimmune diseases.
CD95L	See CD178	See CD178	See CD178	See CD178	See CD178

<b>CD96</b>	Tactile (T cell activation increased late expression)	160 kDa type I transmembrane glycoprotein with 2 V-type domains, one C2-type domain, and one mucin-like domain with N and O glycosylation, and a proline-rich cytoplasmic domain.	Weak on T and NK cells, strongly up-regulated on activation. T cell and some acute myeloid leukemias	Possible role in NK cell adhesion to target cells through CD155 (PVR)	Useful marker for phenotyping T cell ALL and a subgroup of AML
<b>CD97</b>	TM7LN1	Class II EGF-TM7 family member protein cleaved to form dimer of extracellular subunit with three to five EGF-like domains (75-85 kDa) and seven transmembrane GPCR subunit (28kDa)	Broad expression, including activated T and B cells, monocytes/macrophages, DC, granulocytes, smooth muscle cells	Interacts with CD55 (decay accelerating factor). Possible role in cell migration.	High expression, including soluble form, at sites of inflammation in skin and lung, and in rheumatoid arthritis. Prognostic and differentiation marker for thyroid carcinomas and GI tract carcinomas.
CD98	4F2, FRP-1, <b>SLC3A2</b>	80 kDa disulfide-linked heterodimer. Type II transmembrane glycosylated heavy chain. At least 6 different light chain partners that act as amino acid transporters.	Broad on activated and transformed cells, not hematopoietic specific	Potential amino acid transporter. Associated with integrins and actin.	Up-regulated on leukocytes in inflammatory lesions; strongly expressed by neoplastic cells
<b>CD99</b>	MIC2, E2	32 kDa type I transmembrane glycoprotein. Extracellular sequence contains 5 Gly-X-Y and a high proline content, repeats as seen in collagen. Extensively O-glycosylated.	Broadly expressed in leukocytes, but subsets express different amounts, with no clear functional correlation	Adhesion molecule, mediating homotypic and heterotypic adhesion. Negative regulator of neural differentiation.	Useful for differentiating Ewing's sarcoma from neuroblastoma
CD100	<b>SEMA4D</b>	300 kDa homodimer type I integral membrane protein of semaphorin family. Each monomer contains semaphorin domain and C2-type domain.	Most hematopoietic cells, increased after activation of T or B cells. Skeletal muscle.	Binds CD72 in immune system, and binds plexin B1 in non-hematopoietic tissues. Increases PMA-induced T cell proliferation. May help guide developing neurons. Role in homotypic adhesion.	—
CD101	V7, P126, <b>IGSF2</b> , EWI-101	130 kDa type I transmembrane glycoprotein of Ig superfamily with 7 V-set extracellular domains and a short cytoplasmic sequence. Forms homodimers.	Monocytes, granulocytes, dendritic cells, activated T cells	Possible inhibitor of T cell proliferation	Expressed on Langerhans cells, histiocytosis cells

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD102	<b>ICAM-2</b>	55-65 kDa type I transmembrane glycoprotein of ICAM family, with two C2-type domains	Leukocytes but not neutrophils, strongest on vascular endothelium	Adhesion molecule. Ligand for CD11a/CD18 (LFA-1).	Potentially useful in pathology as levels reportedly up-regulated in lymph nodes with malignant infiltration
CD103	Integrin $\alpha$ E subunit, <b>ITGAE</b>	175 kDa type I transmembrane glycoprotein, cleaved into 25 kDa (N-terminal) and 150 kDa segment which remain linked by disulfide bond. Heavy N-linked glycosylation.	Intraepithelial lymphocytes and 1%-2% of circulating lymphocytes	Generally associates with integrin $\beta$ 7. Complex binds to E-cadherin on epithelial cells. Possible role in homing of intra-epithelial lymphocytes in the gut lymphoid tissues.	Marker for IELs and for lymphomas deriving from IELs. Must be interpreted conservatively.
CD104	Integrin $\beta$ 4 subunit, <b>ITGB4</b>	220 kDa type I transmembrane glycoprotein and integrin $\beta$ chain. Large cytoplasmic region with 4 fibronectin type III domains.	Complex expressed on hemidesmosomes of stratified epithelium	Associates with integrin $\alpha$ 6 subunit (CD49f), and laminin receptor. Has role in adhesion.	Mutation or loss of CD104 associated with junctional epidermolysis bullosa with pyloric atresia. Increased CD104 expression in squamous cell carcinoma and other carcinomas.
CD105	Endoglin, <b>ENG</b>	90 kDa type I transmembrane glycoproteins that form a disulfide-linked homodimer (170 kDa). Each unit has exposed RGD site.	Endothelial cells, activated macrophages, some leukemic cells and normal marrow cells	Component of multi-chain receptor for TGF- $\beta$ . Mutation in CD105 gene associated with hereditary hemorrhagic telangiectasia, vascular and bleeding disorders.	Marker for angiogenesis, good target for tumor imaging
CD106	<b>VCAM-1</b> (vascular cell adhesion molecule-1), INCAM-110	100-110 kDa type I transmembrane sialoglycoprotein with 7 C2-set Ig superfamily domains	Endothelial cells, also on some dendritic cells and follicular dendritic cells. Activated vascular endothelium secretes soluble form.	Binds to integrins VLA-4 and $\alpha$ 4 $\beta$ 7, leading to leukocyte extravasation. CD106-deficient mice have severe organogenesis defects and die as embryos.	Role in leukocyte migration

CD107a and CD107b	Lysosome-associated membrane protein 1, <b>LAMP-1</b> (CD107a) and <b>LAMP-2</b> (CD107b)	120 kDa type I transmembrane glycoproteins with 39% amino acid homology. Heavily glycosylated sialoglycoproteins.	Lysosomal proteins with low levels of expression on cell membrane. Granulocytes, activated platelets, tonsillar epithelium, and melanoma cells express both, T cells, macrophages, and endothelial cells express CD107a, while activated endothelium expresses CD107b.	Ligands for galectin, increased expression on tumors may be associated with metastasis	Potential markers for screening for lysosomal storage diseases in neonates
CD108	JMH blood group antigen, <b>SEMA7A</b>	76-80 kDa GPI-linked glycoprotein with a semaphorin domain and C2-type Ig domain	Erythrocytes, low levels on monocytes, increased with activation	Role in immunomodulatory immune function	—
<b>CD109</b>	Platelet activation factor, 8A3, E123	175 kDa GPI-linked glycoprotein that forms heterodimer. Member of $\alpha$ 2M/C3,C4,C5 superfamily.	Expressed on platelets, activated T cells, umbilical vein endothelial cells	Role in regulatory TGF- $\beta$ signaling in keratinocytes	Linked to refractoriness to platelet transfusion
CD110	Thrombopoietin receptor, <b>MPL</b>	85-92 kDa hematopoietin receptor family member with 2 fibronectin type III domains; WSXWS motif dimerizes on binding to thrombopoietin	Platelets, hematopoietic stem cells, megakaryocytes	Receptor for thrombopoietin, regulation of megakaryocyte and platelet formation	Oncogene V-mpl (murine myeloproliferative leukemia virus) can immortalize BM hematopoietic cells; mpl mutations associated with congenital thrombocytopenia
CD111	PRR1, Nectin 1, Hve C, poliovirus receptor related 1 protein, CLPED1, <b>PVRL1</b>	75 kDa type I transmembrane protein belonging to the nectin family. Has one V-set and two C-set Ig-like domains.	Broadly expressed within and outside hematopoietic lineage	Receptor for entry of HSV-1, HSV-2. Possible role in cell adhesion.	Defects cause various ectodermal dysplasias
CD112	PRR2, Nectin 2, Hve B, poliovirus receptor related 2 protein, <b>PVRL2</b>	64 and 72 kDa isoforms of a type I transmembrane glycoprotein belonging to nectin family that includes CD111 and CD155, which all have one V-set and two C-set Ig-like domains	Myelomonocytic cells and megakaryocytes as well as endothelial, epithelial and neuronal cells	Adhesion receptor; component of adherens junction. Receptor for some Herpes viruses. Interacts with CD226.	A CD112-Fc fusion protein has been shown to block infection by HSV in vitro

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD113	Nectin 3, <b>PVRL3</b> (poliovirus receptor like 3)	100 kDa type I transmembrane glycoprotein with ~30% homology to nectins 1 and 2. Contains 2 C2-type domains and one V-type domain. Extensive N-glycosylation.	Epithelial cells in gut, kidney, liver, brain, and testis	Adhesion molecule involved in adherens junctions between epithelial cells. Intracellular region binds to actin cytoskeleton.	—
CD114	G-CSFR, CSFR, granulocyte colony stimulating factor receptor, <b>CSF3R</b>	130 kDa single chain type I transmembrane molecule active as a dimer, no intrinsic kinase activity. Contains 4 fibronectin type III domains and 1 C-type Ig domain. Second fibronectin domain contains WSXWS motif.	Granulocytes, monocytes, mature platelets, endothelial cells, placenta, trophoblasts	Receptor for CSFA3, regulation of myeloid proliferation and differentiation, using JAK kinases	Target for stem cell mobilization for blood stem cell transplantation, target for enhancing recovery of myelopoiesis post chemotherapy
CD115	M-CSFR, <b>CSF-1R</b> , C-fms, FIM2	150 kDa type I integral membrane protein and member of subclass II receptor tyrosine kinase family. Contains 5 C2 type domains and cytoplasmic PTK domain.	Myeloid cells and progenitors	Receptor for M-CSF, mediates functions of M-CSF	Product of c-fms proto-oncogene; mutations in c-fms associated with hematopoietic malignancies; promotes recovery of myeloid lineage following chemotherapy
CD116	GM-CSF receptor $\alpha$ subunit, GMR $\alpha$ , <b>CSF2RA</b>	80 kDa type I integral membrane protein and class I cytokine receptor family protein. Contains one C2-type domain and one fibronectin type III repeat with WSXWS motif.	Macrophages, neutrophils, eosinophils, dendritic cells	Binds GM-CSF with low affinity, complex of CD116 and CD131 (common $\beta$ subunit) binds GM-CSF with high affinity	Specific marker of myeloid leukemias
CD117	SCFR, c-kit, stem cell factor receptor, <b>KIT</b>	145 kDa type I membrane protein with 4 C2-type and one V-type domain and cytoplasmic protein kinase domain	Hematopoietic stem and progenitor cells, tissue mast cells, melanocytes	Receptor for SCF; binding of SCF leads to dimerization, autophosphorylation, and interaction with signaling molecules	CD117 defects cause piebaldism and gastrointestinal stromal tumors

CD118	Leukemia inhibitory factor receptor ( <b>LIFR</b> )	190 kDa type I membrane glycoprotein of type 1 cytokine receptor family. Contains 6 fibronectin type III domains, one with WSXWS motif, and 19 potential N-glycosylation sites. Also present as secreted form.	Widely expressed outside immune system, but not by resting or activated lymphocytes. Secreted form levels rise during pregnancy, as LIF levels fall.	Associates with CD130 to form the receptor for LIF. Influences growth and differentiation of number of cell types, especially those in the developing embryo.	Null mutations associated with Stuve-Wiedemann Syndrome and Schwartz-Jampel type 2 syndrome
CD119	IFN- $\gamma$ receptor $\alpha$ chain, <b>IFNGR1</b>	55 kDa type I transmembrane glycoprotein and class II cytokine receptor that associates with IFN- $\gamma$ accessory factor 1 (IFN- $\gamma$ AF-1 or IFNGR1). Has three fibronectin type III domains and two C2-like Ig domains.	Ubiquitous, except RBC	Receptor for IFN- $\gamma$ ; binding of CD119/IFN $\gamma$ AF-1 complex necessary for signal transduction. Mutation of CD119 leads to susceptibility to weakly virulent mycobacterial strains, but has no effect on antibody and/or curative responses.	—
CD120a	TNF receptor 1, <b>TNFRS5</b> , <b>TNFRSF1A</b>	55 kDa type I integral membrane protein and TNFR superfamily member. Has four extracellular cysteine-rich TNF receptor domains and cytoplasmic “death domain.”	Thymus, spleen, PBL, placenta	Receptors for tumor necrosis factor; most of TNF activities are due to CD120a, signaling by CD120b confined to immune system. TNF elicits organismal and cellular responses, such as fever, shock, tumor necrosis, cell proliferation, differentiation and apoptosis.	Potential therapeutic target in treatment of type II diabetes mellitus
CD120b	TNF receptor 2, <b>TNFR80</b> , <b>TNFRSF1B</b>	75 kDa type I integral membrane protein and member of TNFR superfamily. Has four extracellular cysteine-rich TNF receptor domains but no cytoplasmic death domain.	Inducible in hematopoietic and nonhematopoietic cells. Highest on myeloid cells	High-affinity receptor for TNF- $\alpha$ and TNF- $\beta$ . Number of CD120b molecules on cell surface will be determined by level of expression induced and shedding of receptor as result of proteolytic cleavage. Cell response may be determined by ratio of CD120a to CD120b.	—
CD121a	Type I IL-1 receptor, <b>IL1R1</b> , <b>IL1RA</b>	80 kDa type 1 transmembrane glycoprotein with three C2-type domains and 6 sites for N glycosylation	Very widely expressed in hematopoietic and other tissues, at low levels (50-1000 molecules per cell)	Binds IL-1 $\alpha$ , IL-1 $\beta$ , and IL-1 receptor antagonist. KO mice are normal other than in lacking IL-1 responsiveness, delayed hypersensitivity, and contact sensitivity	Soluble CD121a is a potential anti-inflammatory agent

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD121b	Type II IL-1 receptor, <b>IL1R2</b> , <b>IL1RB</b>	60-70 kDa type I transmembrane glycoprotein with three C2-like Ig domains and 5 sites for N-glycosylation. Soluble form produced by proteolysis.	B cells, monocytes, polymorphs, some epithelia	Binds IL-1 $\beta$ well, IL1- $\alpha$ and IL-1 receptor antagonist poorly. Does not mediate IL-1 function, acting as a “decoy” receptor, reducing IL-1 action.	Potential to be used as anti-inflammatory agent and may be more effective than CD121a
CD122	IL-2 receptor $\beta$ chain, p75, <b>IL2RB</b>	75 kDa type I transmembrane glycoprotein with one fibronectin type III domain. Cytoplasmic tail is serine-rich and contains tyrosine residues.	Expressed at low levels on lymphocytes and NK cells, up-regulated by activation	Binds IL-2 jointly with CD25 and CD132. Associates with JAK tyrosine kinase in the cytoplasm to initiate activation, resulting in tyrosine phosphorylation of CD122.	Combined anti-CD122 and anti-CD25 therapy used in treatment of autoimmune disorders and allograft rejection
CD123	IL-3 receptor $\alpha$ chain, <b>IL3RA</b>	70 kDa type I transmembrane glycoprotein. Related to CD125 and CD116 with single fibronectin type III domain with WSXWS motif. Short hematopoietic receptor domain. Short cytoplasmic sequence.	Bone-marrow stem cells and more differentiated precursors, NK cells	Associates with the common $\beta$ chain (CD131) to form IL-3 receptor, which is important in growth and differentiation of erythroid, platelet, neutrophil, eosinophil, basophil, and monocyte lineages	Elevated levels in AML associated with poor prognosis
CD124	IL-4 R $\alpha$ chain, <b>IL4R</b>	140 kDa type I transmembrane glycoprotein with an N-terminal fibronectin type III domain, followed by a long cytoplasmic tail rich in serine and proline	Expressed at very low levels, but functional, on T and B lymphocytes, hematopoietic precursors, fibroblasts, endothelial cells	Associates with CD132 to form receptor for IL-4, which acts as a growth factor for B and T cells, favoring T <sub>H</sub> 2-type responses	Polymorphisms associated with allergy and atopy
CD125	IL-5 receptor $\alpha$ chain, <b>IL5RA</b>	55-60 kDa type I transmembrane glycoprotein containing a fibronectin type III domain and a short cytoplasmic sequence	Eosinophils and basophils	Associates with CD131 to form the receptor for IL-5, a cytokine which promotes the production and activation of eosinophils	Potential therapeutic target in treatment of allergic inflammatory conditions



CD126	IL-6 receptor $\alpha$ chain, <b>IL6R</b>	80 kDa type I transmembrane glycoprotein with an N-terminal C2-set Ig superfamily domain followed by two fibronectin type III domains. Also a secreted form.	B cells, at lower levels on most leukocytes and epithelial cells and in the liver	Associates with CD130 to form the receptor for IL-6, a growth factor for myelomas (including hybridomas), and a stimulus for the acute-phase response in the liver	Serum CD126 is increased in several clinical conditions, e.g., multiple myeloma, rheumatoid arthritis
CD127	IL-7 receptor $\alpha$ chain, <b>IL7R</b>	90 kDa Ig superfamily protein with a WSXWS motif in a fibronectin type III domain	B cell precursors, majority of T cells; down-regulated with T cell activation	Associates with CD132 (common $\gamma$ chain). Early lymphocyte expansion impaired in IL-7 knockout mice	CD4 <sup>+</sup> CD25 <sup>+</sup> CD127 <sup>-</sup> T cells have T regulatory function
CD128	Now CD181 (IL8RA) and CD182 (IL8RB)	—	—	—	—
CD129	IL-9 receptor $\alpha$ chain, <b>IL9R</b>	64 kDa type I transmembrane glycoprotein with N-terminal cytokine receptor domain followed by one fibronectin type III domain and a long cytoplasmic tail	Activated T cells, B cells, erythroid and myeloid precursors	Together with CD132, acts as receptor for IL-9, a growth factor for T cells and erythroid and myeloid progenitor cells	May play a role in tumorigenesis
CD130	GP 130, IL-6 receptor $\beta$ chain, <b>IL6ST</b>	130 kDa type I transmembrane glycoprotein with an N-terminal C2-set Ig superfamily domain followed by 5 fibronectin type III domains, the second with a WSXWS motif	Broadly expressed on leukocytes and other tissues	Common signaling chain for IL-6, oncostatin M, LIF, IL-11, and cardiotrophin-1. Important in the differentiation and maturation of dendritic cells. Secreted form is autoantigen in RA.	Multiple myeloma appears to involve CD130 and autocrine stimulation by IL-6 and oncostatin M
CD131	Common $\beta$ chain, <b>CSF2RB</b> , IL3RB, IL5RB	120-140 kDa type I transmembrane glycoprotein with an N-terminal cytokine receptor domain followed by 2 fibronectin type III domains and a long cytoplasmic sequence with proline-rich and serine-rich regions	Bone marrow stem cells and more differentiated precursors	Common signaling partner in 2-chain receptors for IL-3, IL-5, and GMC-SF, all important cytokines in hematopoiesis and differentiation	Mutation of CD131 can cause myeloproliferative disorders
CD132	Common $\gamma$ chain, <b>IL2RG</b>	64 kDa type I transmembrane glycoprotein with one fibronectin type III domain containing the WSXWS motif. Cytoplasmic tail has SH2 homology region.	Broadly expressed on leukocytes	Signaling component of several cytokine receptors: IL-2, 4, 7, 9, and 15	Mutation causes X-linked severe combined immunodeficiency disease, consequently target for gene therapy

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD133	AC133, PROML1, similar to mouse prominin, <b>PROM1</b>	120 kDa 5-transmembrane glycoprotein with N terminus extracellular. Founding member of prominin family.	Expression pattern similar to CD34, i.e., hematopoietic stem cells in bone marrow, cord blood and “mobilized” blood. Epithelial cells and endothelial precursor cells, but not mature endothelial cells.	Not known	Isolation of hematopoietic stem cells. CD133-positive tumor cells are highly metastatic.
CD134	<b>TNFRSF4</b> , OX40	48-50 kDa type I transmembrane glycoprotein, member of the TNF/NGF receptor family with 3 TNF receptor domains and O- and N-linked glycosylation	Activated T cells, fibroblasts, hematopoietic precursors	Activation of CD134 inhibits apoptosis	CD134 <sup>+</sup> T cells may have role in autoimmune diseases
CD135	<b>FLT3</b> , STK-1, flk2	155 kDa type I transmembrane glycoprotein with 4 extracellular C2-set and one V-set Ig superfamily domain and a cytoplasmic type III receptor tyrosine kinase family domain	Hematopoietic progenitor cells	Receptor for FLT3 ligand, important in hematopoiesis and differentiation	FLT3 mutations common in AML and ALL
CD136	<b>MST1R</b> , macrophage stimulating protein receptor, MSP-R, RON	180 kDa protein kinase (150 kDa $\alpha$ chain, 40 kDa $\beta$ chain) heterodimer with semaphorin domain and three IPT/TIG domains on $\beta$ chain. $\alpha$ and $\beta$ chains from cleavage of single gene product, extracellular $\alpha$ chain linked by disulphide bond to transmembrane $\beta$ chain	Resident macrophages, epithelial cells, monocytes, granulocytes	Receptor for macrophage stimulating protein (MSP). Ligation-induced dimerization induces migration, proliferation. Involved in regulation of blood cell production and in development of epithelial tissue. CD136 null mice fail to survive the peri-implantation period. CD136 <sup>±</sup> mice are highly susceptible to endotoxic shock.	CD136 antagonist antibody inhibits tumorigenesis

CD137	<b>TNFRSF9</b> , 4-IBB, ILA	32 kDa type I transmembrane glycoprotein with 4 TNF receptor family domains. Forms disulfide-linked homodimers.	Activated T, B cells, and monocytes	Regulator of T cell activation. Ligand is TNFSF9, CD137/TNFSF9 interaction is bidirectional. Likely to be involved in immune activation and antigen presentation.	Soluble CD137 is increased in inflammatory and autoimmune disease
CD138	Syndecan-1, heparan sulfate proteoglycan, <b>SDC1</b>	65-70 kDa core protein type I proteoglycan with two serine clusters, proximal chondroitin sulfate, distal heparan sulfate moieties	Pre-B cells, plasma cells, some epithelial tumors	Extracellular matrix receptor involved in control of cell shape in mature and developing epithelia	Used as marker of plasma cells. Possible role in tumor malignancy
<b>CD139</b>	—	209/228 kDa (by immunoprecipitation) protein as yet uncharacterized	B lymphocytes, monocytes, granulocytes, FDC, weakly on erythrocytes	Not known	CD139 <sup>+</sup> CLL may have an improved outcome
CD140	PDGF receptor type $\alpha$ (CD140a) and $\beta$ (CD140b), <b>PDGFRA</b> , <b>PDGFRB</b>	180 kDa type I transmembrane glycoprotein with 3 or 5 C2 Ig domains and type III protein kinase receptor intracellular domain	CD140a expressed by erythroid and myeloid lineage precursors and osteoblasts, fibroblasts and endothelial cells. CD140b found on endothelial and stromal cells.	Receptor for platelet-derived growth factor. Form homodimers and AB heterodimers on ligand binding.	CD140a and CD140b both fuse to numerous genes in myeloproliferative disorders. Potential target in treatment of several tumors.
CD141	<b>THBD</b> , thrombomodulin, fetomodulin	75 kDa type I transmembrane glycoprotein with extracellular C-type lectin domain and 6 EGF-like domains	Myeloid cells, platelets, endothelial cells	Receptor for thrombin, active in protein C anticoagulant pathway and may inhibit fibrinolysis. KO mice die during embryogenesis from problems unrelated to coagulation pathway.	Plasma CD141 may be useful marker of endothelial damage. Defects in CD141 may cause thromboembolic disease.
CD142	<b>F3</b> , Tissue factor, thromboplastin, coagulation factor III	45 kDa type I transmembrane glycoprotein of the class II cytokine receptor family with 2 fibronectin type III domains	Activated monocytes and endothelial cells, epithelial cells	Complexes with factor VII to form an enzyme which initiates the extrinsic coagulation cascade	Essential clotting factor
CD143	Angiotensin-converting enzyme ( <b>ACE</b> ), peptidyl dipeptidase A	170 kDa type I transmembrane member of Zn metallopeptidase family. Two forms, somatic and germinal (testicular) differ in structure, the somatic form having two catalytic sites.	Endothelial cells of arterioles, small arteries and capillaries in lung and some other organs, some epithelia	Zn metallopeptidase specific for angiotensin and bradykinin	ACE inhibitors used to treat hypertension

continued

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD144	<b>CDH5</b> , VE-cadherin, cadherin-5	135 kDa cadherin, 5 extracellular cadherin repeats, and 9 tyrosines in cytoplasmic domain	Endothelial cells	Homotypic binding; organizes adhesion junction in endothelial cells. Contact inhibition of cell growth.	Expression reduced in human angiosarcomas
CDw145	—	110, 90, 25 kDa uncharacterized proteins	HUVEC, endothelial cells in many tissues: e.g., kidney, lung, spleen, liver	Unknown	—
CD146	Muc 18, <b>MCAM</b> , Mel-CAM, s-endo	130 kDa type I transmembrane glycoprotein with 2 V-set and 3 C2-set Ig-like domains and a 63-residue cytoplasmic tail	Endothelial cells, some activated T cells, smooth muscle, melanoma	Probable adhesion function but ligand unknown	Expression is associated with melanoma progression
CD147	Basigin, M6, extracellular metalloproteinase inducer (EMMPRIN)	54 kDa type 1 N-glycoprotein of the Ig superfamily. Extracellular domain consists of C2-type and V-type Ig domains, with about half the mol. wt. being carbohydrate.	Widely expressed on leukocytes, endothelium, platelets, red blood cells	Possible adhesion function, and appears to induce metalloproteases. Knockout mice show enhanced mixed lymphocyte reaction, are infertile, and show neurological abnormalities. Ko-factor for expression of monocarboxylate transporters, associates with CD98, $\beta$ 1- and $\beta$ 2-integrins.	Increased CD147 on synoviocytes in rheumatoid arthritis. Bears high frequency blood group antigen Oka.
CD148	<b>PTPRJ</b> , DEP-1, HPTPeta	200-250 kDa member of receptor protein tyrosine phosphatase type III family. Type I transmembrane glycoprotein with 10 extracellular fibronectin type III motifs with 34 N-glycosylation sites and additional O-glycosylation sites. Cytoplasmic tail has one tyrosine phosphatase domain.	Granulocytes, monocytes, T cells NK cells, dendritic cells, platelets. Also outside hematopoietic system in nerve cells and fibroblasts.	Role in immune system unclear, but engagement with antibody leads to cytokine secretion. Natural ligand unknown. May have a role in arresting cell growth at confluence.	Negative regulator of cell proliferation
CD149	Now CD47R	Now CD47R	Now CD47R	Now CD47R	Now CD47R

CD150	<b>SLAMF1</b> , signaling lymphocyte activation molecule, IPO-3	75-95 kDa type I transmembrane molecule of Ig superfamily with one V -type and one C-type domain and three cytoplasmic SH2-binding motifs	Thymocytes, CD45RO <sup>+</sup> T cells, B cells, DC, endothelial cells	Self-ligand. Binding of CD150 to ligand(s) enhances proliferation and Ig production by activated B cells.	Potential diagnostic applications as CD150 differentially expressed on monocytes in autoimmune disease
<b>CD151</b>	PETA-3, SFA-1, TSPAN24	32 kDa tetraspan family glycoprotein with both termini cytoplasmic	Endothelium, epithelial cells, platelets and megakaryocytes, immature hematopoietic cells	May modify integrin function or signaling, coprecipitates with $\beta$ 1 integrins	Raph blood group
CD152	<b>CTLA-4</b> , cytotoxic T lymphocyte associated protein 4	33 kDa type I transmembrane Ig superfamily member with one V set Ig domain. Expressed as disulfide-linked dimer.	Activated T cells, some activated B cells, not resting T cells	High avidity receptor for CD80/CD86, provides down-regulation of T cell stimulation. CD152-deficient mice show severe lymphoproliferative disorder and die a few months after birth.	Mutation in CD152 associated with many autoimmune diseases
CD153	<b>TNFSF8</b> , CD30 Ligand	40 kDa type II transmembrane glycoprotein of TNF family. Heavily glycosylated.	Activated T cells, activated macrophages, neutrophils, eosinophils. Normal and malignant B cells.	Binds CD30; interaction associated with costimulation and with cell death	Widely expressed in hematopoietic malignancies. Expressed in bystander cells in Hodgkin's disease. Elevated in macrophages in sarcoidosis.
CD154	<b>TNFSF5</b> , TRAP, CD40 ligand	33 kDa type II transmembrane glycoprotein; member of TNF superfamily	Principally activated CD4 <sup>+</sup> T cells; at varying levels in CD8 <sup>+</sup> T cells, mast cells, NK cells, polymorphs, monocytes, activated platelets. Expression is transient upon activation of T cells.	Binds CD40, providing a survival signal to CD40 <sup>+</sup> B cells in germinal center. CD154 mutation causes hyper-IgM syndrome.	Elevated CD154 found in SLE and MS
CD155	Poliovirus receptor, <b>PVR</b> , NECL5	80-90 kDa type I transmembrane glycoprotein belonging to the poliovirus receptor family, with one V-set and two C-set Ig-like domains	Monocytes, endothelial cells, epithelial cells, CNS	Receptor for poliovirus, adhesion molecule that binds vitronectin	—

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD156a	<b>ADAM8</b> , MS 2	69 kDa type I transmembrane protein with metalloprotease domain and disintegrin domains	Neutrophils, monocytes	Possible role in leukocyte extravasation	Overexpression in lung cancer is associated with advanced disease
CD156b	TACE (tumor necrosis factor $\alpha$ -converting enzyme), <b>ADAM17</b> , snake venom like protease, CSVP	100-120 kDa type I transmembrane protein, zone-dependent metalloprotease domain, disintegrin domains	Monocytes, macrophages, PMN, T cells, endothelial cells, myocytes	Sheddase, which converts plasma membrane TNF- $\alpha$ , TNF- $\alpha$ receptor, and other cell surface proteins to soluble forms. Deletion of a catalytic domain is perinatally lethal.	Possible target for anti-inflammatory and anti-arthritis therapies
CD156c	<b>ADAM10</b>	70 kDa type I transmembrane member of ADAM family. Contains metalloprotease domain that becomes active once pro-domain is cleaved.	Broadly expressed in lymphoid and nonlymphoid tissues including liver and muscle. Also in inflamed joints and CNS.	Broadly specific endopeptidase that releases membrane proteins. Mostly localized to Golgi but does appear on surface.	Thought to be involved in myelin degradation in MS: potential therapeutic target
CD157	<b>BST-1</b> BP-3/IF7 Mo5	42-45 kDa ADP ribosyl cyclase single-chain GPI-anchored protein	Monocytes, granulocytes, lymphoid progenitors (appears prior to IgH or TCR rearrangement), BM stromal lines, HUVEC, FDC	Mediator of adhesion during inflammation	High soluble CD157 in serum of patients with severe rheumatoid arthritis
CD158	KIR (Killer Inhibitory Receptor) family. Allocated CD 158a, b, c, etc., in centromeric telomeric sequences with b1, b2 used for alleles	A family of 14 members with two (KIR2) or three (KIR3) Ig-like domains and differing cytoplasmic domains, some with and some lacking inhibitory (ITIM) motifs	NK cells and a subset of CD8 <sup>+</sup> T cells	Interact with MHC class I molecules on potential target cells, inhibiting or activating (depending on the intracellular sequence) cytotoxic function	CD158k is a phenotypic marker of Sezary cells and potential prognostic marker for Sezary syndrome

CD159a	NKG2A, <b>KLRC1</b>	43 kDa type II glycoprotein member of C-type lectin family. Has two cytoplasmic ITIM motifs and is expressed as heterodimer with CD94.	NK cells and few T cells	Complex with CD94 binds HLA-E and is inhibitory to NK cell-mediated cytotoxicity	Polymorphisms of CD159a and CD159c coding and noncoding regions have been investigated for association with arthritis
CD159c	<b>KLRC2</b> , NKG2C	36 kDa type II glycoprotein member of C-type lectin family. Expressed as heterodimer with CD94. CD159c does not contain ITIM motifs.	NK cells and few T cells	Binds MHC class I and inhibits NK cell-mediated cytotoxicity	—
<b>CD160</b>	BY55, NK1, NK28	27 kDa GPI-anchored Ig superfamily (KIR family), on surface as 80 Da disulfide-linked multimer	NK cells, cytotoxic T cells, intestinal intraepithelial lymphocytes	Broad specificity for classical and nonclassical MHC class I molecules. Role in costimulation of NK cells and CTL.	—
CD161	<b>KLRB1</b> , <b>NKR-P1A</b> , killer cell lectin-like receptor subfamily B, member 1	40 kDa type II glycoprotein, expressed as disulfide-linked homodimer	Most NK cells, subset of CD4 and CD8 T cells	Augment or inhibit NK cytotoxicity	—
CD162	<b>SELPLG</b> , P selectin glycoprotein ligand 1, PSGL-1	110-120 kDa, sialomucin, expressed as disulfide-bonded homodimer; contains 15-16 repeats of a 10-residue consensus sequence	Most peripheral blood T cells, monocytes, granulocytes, some B cells, some CD34 <sup>+</sup> BM cells	Mediates leukocyte rolling on activated endothelium, on activated platelets, and on other leukocytes at sites of inflammation	Anti-CD162L antibodies block recruitment of CD8 T cells in brain vessels from MS patients
<b>CD163</b>	GHI/61, D11, RM3/1, M130	130 kDa type I transmembrane protein with 12 scavenger receptor cysteine-rich domains	Majority of tissue macrophages, not FDC, IDC, Langerhans cells, tingible body macrophages	Role in anti-inflammatory response of monocytes	Soluble CD163 elevated in rheumatoid arthritis and celiac disease
<b>CD164</b>	MUC-24, MGC 24, multi-glycosylated core protein 24	80 kDa type I integral membrane mucin glycoprotein present as a dimer on cell surface	Bone marrow stromal cells, monocytes, epithelial tissue, bone marrow mononuclear cells	Role in adhesion of CD34 <sup>+</sup> cells to BM stroma	May be useful in analysis of gut tumors
<b>CD165</b>	AD2, gp 37	37-42 kDa membrane glycoprotein; remains uncloned	Thymocytes, thymic epithelial cells, platelets, monocytes, CNS neurons, some lymphocytes	Involved in adhesion between thymocytes and thymic epithelial cells	Highly expressed on T cell ALL

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD166	<b>ALCAM</b> , <b>KG-CAM</b> , activated leukocyte cell adhesion molecule	100-105 kDa type 1 transmembrane protein with 2 V-type and 3 C-type Ig domains	Neurons, activated T cells, activated monocytes, epithelium, fibroblasts	Ligand for CD6, involved in neurite extension by neurons	Marker for tumor progression
CD167	Discoidin receptors <b>DDR1</b> (CD 167a) and <b>DDR2</b> (CD 167b)	125-130 kDa type I membrane glycoproteins with extracellular discoidin (F5/8) domain and intracellular receptor tyrosine kinase domain	DDR1 expressed weakly on B cells and immature dendritic cells. Widely expressed on epithelia and epithelial tumors. DDR2 widely expressed with high expression in skeletal and heart muscle.	DDR1 and DDR2 bind collagen; overexpression in epithelial tumors suggests role in tumor invasion and metastasis	—
CD168	<b>HMMR</b> , <b>RHAMM</b> (receptor for hyaluronan involved in migration and motility)	84 kDa protein, expressed on cell surface though lacking signal sequence or transmembrane domain	Thymocytes, lymphocytes, B cell malignancies	Mediates cell migration through binding of hyaluronan	Potential therapeutic target in leukemia
CD169	Sialoadhesin, <b>SN</b> , Siglec-1	175 kDa type I transmembrane glycoprotein with 1 N-terminal V-like Ig domain followed by 16 C2-like domains	Strongly on monocytes and dendritic cells, weakly on lymphocytes	Adhesion molecule, binding particularly glycolipids and glycoproteins with terminal $\alpha$ -2,3 sialic acid residues including CD43	Expressed at high levels on inflammatory macrophages in rheumatoid arthritis
CD170	<b>SIGLEC5</b> (sialic acid binding Ig-like lectin 5), <b>OB-BP2</b>	Homodimer of 70 kDa protein with one N-terminal V-like Ig domain followed by three C2-like domains. Two cytoplasmic immunoreceptor tyrosine inhibitory motif (ITIM)-like sequences.	Lymphocytes, monocytes, dendritic cells, and myeloid leukemic cells	Adhesion molecule, binds to $\alpha$ 2,3-linked and $\alpha$ 2,6-linked sialic acid. Inhibitory receptor.	—



CD171	<b>L1CAM</b> , neuronal adhesion molecule, LI	200 kDa type I transmembrane glycoprotein with 6 C2-like Ig domains followed by 5 type III fibronectin domains	Lymphocytes, monocytes, antigen-presenting cells, microvascular endothelium, neuronal tissue	Adhesion molecule, showing homotypic adhesion and also binding laminin, integrins, and proteoglycans containing chondroitin sulfate	Defects in CD171 gene cause various neurological disorders
CD172 $\alpha$ , $\beta$ , $\gamma$	<b>CD172<math>\alpha</math></b> : <b>PTPNS1</b> , SIRP $\alpha$ , SHPS-1 signal regulatory protein $\alpha$ . CD172 $\beta$ : <b>SIRB1</b> , SIRP $\beta$ 1. CD172 $\gamma$ : <b>SIRPB2</b> , SIRP $\gamma$ , SIRP $\beta$ 2	85-90 kDa type I transmembrane glycoprotein with 1 V-like and 2 C1 Ig-like domains, and an ITIM motif in the cytoplasmic region (SIRP $\alpha$ ) or no tail (SIRP $\beta$ , $\gamma$ )	Monocytes, hematopoietic precursors, neuronal tissue	Adhesion molecule. SIRP $\alpha$ delivers inhibitory signal while SIRP $\beta$ interacts with ITAM bearing molecules such as DAP-12, and is stimulatory. SIRP $\alpha$ binds CD47.	—
CD173	Blood group H2, Blood group H type 2	Carbohydrate Fuc $\alpha$ 1-2Gal $\beta$ 1-4GlcNAc. GSL or protein anchor. Product of fucosyl transferase FUT1	CD34 <sup>+</sup> precursors. Carcinomas, endothelial cells, erythrocytes.	Precursor to AB carbohydrate antigens and Lewis antigens	Blood group reagent
CD174	Lewis Y blood group, LeY, <b>FUT3</b>	Carbohydrate: Fuc $\alpha$ 1-2Gal $\beta$ 1- 4(Fuc $\alpha$ 1-3)GlcNAc $\beta$ 1. Addition catalyzed by fucosyl transferase 3	Epithelial cells, CD34 <sup>+</sup> BM precursors	Possible role as cofactor to procoagulant activity of cancer cells. Possible role in early commitment to apoptosis.	Anti-Lewis Y-conjugated doxorubicin trialled for therapy of epithelial tumors. LeY also expressed by <i>Helicobacter pylori</i> .
CD175	Tn antigen (T-antigen novelle), CD175s, sialyl-Tn	O-linked monosaccharide GalNAc $\alpha$ 1-O-Ser/Thr, GSL-linked or protein anchor. CD175s is sialylated epitope.	CD34 <sup>+</sup> BM cells, various T, B, and myeloid lineage leukemias, epithelial tumors	Precursor for ABO antigens and TF antigen	CD175 is vaccine candidate in prevention and treatment of mucin-expressing tumors. Conjugated CD175s (Theratope) is being trialled as vaccine in colorectal and non-small-cell lung cancer and has been trialled in metastatic breast cancer patients.

continued

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD176	Thomsen-Friedenreich antigen (TF)	Carbohydrate Gal $\beta$ 1-3GalNAc $\alpha$ 1-O-Ser/Thr. GSL or protein carrier.	CD34 <sup>+</sup> hematopoietic precursors, endothelial cells, erythrocytes, sialylated form ubiquitous	Implicated in induction of metastasis and invasiveness of tumors	Pan carcinoma antigen. Better prognosis for CD176 <sup>+</sup> breast cancer.
CD177	<b>PRV1</b> (polycythemia vera rubra 1), NB 1	56-64 kDa GPI-anchored glycoprotein, member of uPAR/CD59/Ly6 family	Neutrophil subset	Involved in signal transduction	NB antigens have role in alloimmune neonatal neutropenia. CD177 expression is increased in Ph-negative myeloproliferative disorders.
CD178	<b>TNFSF6</b> , FAS ligand, CD95 ligand	Trimer of 40 kDa type II transmembrane glycoproteins of TNF family. Soluble form produced by proteolysis.	T cells and NK cells; expressed more widely but shed through proteolysis	Induces apoptosis in cells expressing CD95. KO mice and humans with CD178 mutations show severe autoimmune disease.	Modulation of hematopoietic cell engraftment
CD179a	<b>VPREB1</b> , V pre- $\beta$ , pre-lymphocytes gene 1, Ig- $\iota$ chain	16-18 kDa member of Ig gene superfamily. Has IgV-like structure but lacks last $\beta$ strand of typical V domain. Associates with CD179b to form surrogate light chain; this associates with membrane IgM heavy chain and CD79a/CD79b heterodimer to form pre-B cell receptor.	Pro-B, pre-B cells	Surrogate light chain expression is essential for B cell development, pre-BCR functions as checkpoint for rearrangement of IgM heavy chain	Marker of pro-B, pre-B cells
CD179b	$\lambda$ 5, <b>IGLL1</b> , Ig $\omega$ chain	22 kDa protein with homology to Ig $\lambda$ J region and constant region. Associates with CD179a to form surrogate light chain, with membrane IgM heavy chain and CD79a/CD79b to form pre-B cell receptor.	Pro-B, pre-B cells	Surrogate light chain expression is essential for B cell development, pre-BCR functions as checkpoint for rearrangement of IgM heavy chain	Mutation in CD179b leads to agammaglobulinemia

CD180	RP105, <b>LY64</b>	95-105 kDa type I membrane protein of the toll-like receptor family with 17 leucine-rich repeats	Mantle zone B cells, marginal zone B cells, weakly on germinal center B cells	Regulates B cell recognition of LPS. CD180 null mice have impaired response to LPS-induced proliferation.	Reduced CD180 is associated with increased disease activity in SLE
CD181	CXCR1; IL-8 receptor $\alpha$ , <b>IL8RA</b> . Previously was assigned CD128A.	39 kDa (predicted) typical seven-transmembrane domain G-protein coupled receptor structure. 350 residues long with 2 N-glycosylation sites. Strong homology with CXCR2 in all regions except N-terminal tail, second loop and intracellular C-terminal, explaining ligand and signaling variations.	Neutrophils, basophils, T cell subsets, also at lower levels on monocytes and NK cells. Expressed in myeloid but not lymphoid leukemias.	High-affinity receptor for IL-8. Receptor activation leads to up-regulation of adhesion molecules, and migration up chemokine gradient towards sites of inflammation. Results in increased neutrophils at site of inflammation.	Potential marker of functional subsets of neutrophils
CD182	CXCR2; IL-8 receptor $\beta$ , <b>IL8RB</b> . Previously was assigned CD128B.	77% identical to CD181. Variations in sequence cause differing ligand specificity and signaling mechanisms.	Neutrophils, basophils, T cell subsets, monocytes, and NK cells. Also widely expressed elsewhere, including nervous system and epithelia.	High-affinity receptor for IL-8. Also binds other chemokines in addition to IL-8. Ligation leads to increased cell adhesion and migration along chemokine gradient.	Potential marker in inflammation studies
CD183	Chemokine (C-X-C motif) receptor 3, <b>CXCR3</b> , IP-10 receptor, GPR9	40 kDa (predicted) G-coupled seven pass transmembrane protein (with cytoplasmic C terminal)	T cells, activated NK cells, and transformed B cells	Receptor for chemokines Mig (CXCL 9), IP-10 (CXCL10), and I-TAC (CXCL11)	Target for small molecule antagonists for inflammatory diseases
CD184	Chemokine (C-X-C motif) receptor 4, <b>CXCR4</b>	39 kDa (predicted) G-coupled seven pass transmembrane protein (with cytoplasmic C terminal)	Widely expressed in hematopoietic cells, vascular endothelia, and neural tissue	Receptor for chemokine SDF-1 (CXCL12). Coreceptor for HIV.	High CD184 expression linked to cancer metastasis
CD185	CXCR5, <b>BLR1</b> , Burkitt lymphoma receptor 1, MDR15	39 kDa (predicted) G-coupled seven pass transmembrane protein (with cytoplasmic C terminal)	B cells and monocytes	Binding of ligand CXCL13 to CD185 induces chemotactic response, localizing B cells to primary or secondary follicles in secondary lymphoid tissues	Possible therapeutic target for Burkitt's lymphoma

continued

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD186	<b>CXCR6</b> , BONZO, STRL33, TYMSTR, chemokine (C-X-C motif) receptor 6	39 kDa (predicted) G-protein seven pass transmembrane protein of CXC receptor family.	Activated T cells	Receptor for chemokine CXCL16, and used as coreceptor by strains of HIV-1 and HIV-2	—
CD187	Not assigned	—	—	—	—
CD188	Not assigned	—	—	—	—
CD189	Not assigned	—	—	—	—
CD190	Not assigned	—	—	—	—
CD191	<b>CCR1</b> , chemokine (C-C motif) receptor 1, CKR-1, CMKBR1	41 kDa (predicted) G-protein coupled receptor member of CCR family of chemokine receptors	T lymphocytes, NK cells, and monocytes, not B cells or granulocytes. Memory T cells express higher levels.	Mediates effects of several chemokine ligands, and may be involved in stem cell proliferation	—
CD192	<b>CCR2</b> , chemokine (C-C motif) receptor 2, MCP-1-R, CKR2, CMKBR2	42 kDa G-protein coupled receptor member of CCR chemokine receptor family with 2 known isoforms	Monocytes, activated T cells and B cells	Binding of ligand MCP-1 leads to chemotactic responses. Role in localized inflammatory conditions including rheumatoid arthritis.	Coreceptor for HIV, so possible therapeutic applications
CD193	<b>CCR3</b> , eosinophil eotaxin receptor, chemokine (C-C motif) receptor 3, CKR3, CMKBR3	41 kDa G-protein coupled receptor member of CCR chemokine receptor family; no N-glycosylation site	Eosinophils and basophils, airway epithelial cells, T <sub>H</sub> 2 T cells	Binds eotaxin, which is chemoattractant for eosinophils and basophils and therefore potentially involved in allergic reactions	Potential therapeutic target for allergy

CD194	<b>CCR4</b> , chemokine (C-C motif) receptor 4, <b>CKR4</b> , <b>CMKBR4</b>	41 kDa G-protein coupled receptor member of CCR chemokine receptor family. No N-glycosylation site on first extracellular domain, 2 sites on second loop.	CLA <sup>+</sup> T cells regardless of T <sub>H</sub> phenotype, activated T <sub>H</sub> 2 lymphocytes, T <sub>reg</sub> cells, activated NK cells, basophils, macrophages	Chemoattractant homing receptor for MIP-1, RANTES, TARC, and MCP-1. Involved in skin homing of circulating memory lymphocytes. Potential role in immune reaction termination due to expression on regulatory T cells.	CD194 blockade potential therapeutic treatment of inflammation
CD195	<b>CCR5</b> , chemokine (C-C motif) receptor 5, <b>CKR5</b> , <b>CMKBR5</b>	37 kDa G-coupled seven pass transmembrane protein with sulfated tyrosine residues at N-terminal	Lymphocytes, monocytes, macrophages, dendritic cells	Receptor for chemokines MIP-1 (CCL3), MIP-1 $\beta$ (CCL4), and RANTES (CCL5). Coreceptor for some HIV isolates.	Interest in blockade of CD195 as HIV treatment
CD196	<b>CCR6</b> , chemokine (C-C motif) receptor 6, <b>LARC</b> receptor, <b>CKR6</b> , <b>CMKBR6</b>	42 kDa (predicted) G-protein-coupled receptor member of CCR chemokine receptor family, 2 N-glycosylation sites	Memory T cells, immature dendritic cells; selective expression on B cells, selective subset of non-Hodgkin's lymphoma cells	Receptor for MIP-3 $\alpha$ (CCL20). Involved in maturation of B lineage cells and dendritic cells. Particularly involved in mucosal immunity.	Potential diagnostic value for non-Hodgkin's lymphoma
CD197	<b>CCR7</b> , chemokine (C-C motif) receptor 7, <b>BLR2</b> (Burkitt lymphoma receptor 2), <b>CMKBR7</b>	43 kDa (predicted) G-coupled seven pass transmembrane protein (with cytoplasmic C terminal)	Most T cells, B cells, NK cells, activated dendritic cells	Receptor for chemokines ELC (CCL19) and SLC (CCL21). Induced by EBV.	Distinguishes central memory from effector memory T cells
CDw198	<b>CCR8</b> , chemokine (C-C motif) receptor 8, <b>CMKBR8</b>	41 kDa (predicted) G-protein coupled receptor member of CCR chemokine receptor family	Thymus, circulating NK cells, monocytes, monocyte-derived dendritic cells	Receptor for chemokine SCYA1/I-309, regulating monocyte chemotaxis and thymocyte apoptosis. Coreceptor with CD4 for HIV.	—
CDw199	<b>CCR9</b> , chemokine (C-C motif) receptor 9, <b>GPR28</b>	42 kDa (predicted) G-protein-coupled receptor member of CCR chemokine receptor family; 1 N-glycosylation site	Strong expression in thymus. Expressed on subset of memory T cells specialized for mucosal homing	Receptor for chemokine SCYA25/TECK (CCL25). Co-receptor for HIV-1.	—

continued

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
<b>CD200</b>	MRC, OX 2	33 kDa type I transmembrane protein member of Ig superfamily, with one V-type domain and one C2-type domain	B lymphocytes, neurons, some dendritic cells	Regulation of macrophage lineage. Lack of CD200 results in more rapid onset of experimental allergic encephalomyelitis (EAE)	Disruption of CD200/CD200R increases susceptibility to collagen-induced arthritis
CD201	Endothelial protein C receptor, EPCR, <b>PROCR</b>	50 kDa type I transmembrane glycoprotein of the CD1/MHC superfamily	Broadly expressed on endothelium of arteries and capillaries in skin, lung, and heart	Endothelial cell receptor for protein C, which is involved in coagulation	Presence of autoantibodies to CD201 has been shown to correlate with autoimmune fetal loss
CD202b	TIE2, <b>TEK</b>	140 kDa transmembrane protein with 2 C2-type domains, 3 EGF-like domains, and 3 fibronectin type III domains. Cytoplasmic protein tyrosine kinase domain.	Endothelial cells, subset of CD34 <sup>+</sup> hematopoietic stem cells	Membrane receptor for angiopoietins. Tyrosine kinase. CD202b-deficient mice die during embryogenesis because of defects in angiogenesis.	Useful marker of neoangiogenesis in tumors. Prognostic indicator of metastasis.
CD203c	<b>ENPP3</b> , PDNP3, PD-I $\beta$	130/150 kDa type II transmembrane protein member of ectonucleotide pyrophosphatase/phosphodiesterase (E-NNP) family. Has 2 somatin B-like domains and endonuclease and phosphodiesterase domains.	Basophils, mast cells, and their precursors	Phosphodiesterase/nucleotide pyrophosphatase, involved in hydrolysis of extracellular oligonucleotides, nucleoside phosphates, NAD	Up-regulated by allergen, IgE cross-linking
CD204	<b>MSR1</b> , SRA, macrophage scavenger receptor	220 kDa homotrimer type II transmembrane protein member of type 1 class A scavenger receptor family. Has cysteine-rich scavenger receptor domain and is N-glycosylated.	Macrophages	Mediates uptake of negatively charged macromolecules, e.g., oxidized LDL role in host defense	Rare germline mutations in <i>MSR1</i> gene possibly associated with increased risk of prostate cancer
CD205	DEC-205, lymphocyte antigen 75, <b>LY75</b> , CLEC13B	205 kDa type I transmembrane glycoprotein with a ricin B-type lectin domain, a fibronectin type II domain, and 10 C-type lectin domains	Dendritic cells, Langerhans cells, thymic epithelium, low levels on T and B lymphocytes	Probably involved in antigen uptake and presentation	Fusions of CD205 and CD302 are expressed in Hodgkin and Reed-Sternberg cells

CD206	Macrophage mannose receptor (MMR), <b>MRC1</b> , <b>CLEC13D</b>	175-180 kDa type I transmembrane glycoprotein with a ricin B-type lectin domain, a fibronectin type II domain, and 8 C-type lectin domains	Macrophages, endothelium	Binds oligomannose-containing molecules and mediates phagocytosis by macrophages of microorganisms bearing these carbohydrates	—
<b>CD207</b>	Langerin, <b>CLEC4K</b>	40 kDa type II transmembrane protein member of C-type lectin family, with single C-type lectin domain	Langerhans cells	Carbohydrate-binding molecule which may bind carbohydrate-bearing antigens for internalization, processing, and presentation	Specific marker for Birbeck granules of Langerhans cells
CD208	DC-LAMP, <b>LAMP3</b>	70-79 kDa type I integral glycoprotein member of lysosomal associated membrane protein family	Activated dendritic cells	Lysosome associated, transiently expressed in MHC-II compartment	LAMP3 overexpression may be associated with enhanced metastatic potential in cervical cancer
<b>CD209</b>	DC-SIGN, <b>CLEC4L</b>	44 kDa type II transmembrane protein with a C-type lectin domain and 7 repeats of an 11-residue sequence that may mediate formation of tetramers	Dendritic cells	High-affinity receptor for CD102 (ICAM-2) and CD50 (ICAM-3). Component of DC-T cell interaction.	Binds viral surface glycoproteins, including HIV gp120. Therefore potential target for prevention and treatment of pathogen-induced infection.
CDw210a and CDw210b	CDw210a: <b>IL10RA</b> . CDw210b: <b>IL10RB</b> , <b>CRFB4</b> , <b>IL10R2</b>	CDw210a is 63 kDa type I membrane glycoprotein with two fibronectin type III domains and a 318 residue cytoplasmic tail. CDw210b is 37 Da (predicted) type I membrane glycoprotein with similar structure. Both are members of type II cytokine receptor family.	T and B cells, NK cells, monocytes, macrophages	CDw210a is functional receptor for IL-10, CDw210b is accessory chain	CMV and EBV make IL-10 analogs that bind to IL-10 receptor; therefore possible target for treatment of viral infection
CD211	Not assigned	—	—	—	—
CD212	IL-12 receptor $\beta$ chain, <b>IL12RB1</b>	85/110 kDa type I transmembrane protein of the cytokine receptor family, with 5 fibronectin type III-like domains. Strong homology to CD130.	Expressed on 72% of blood lymphocytes, indicating majority T cell expression. NK cells, some B cell lines	Dimerizes with IL12RB2 to form the IL-12 receptor. IL-12 directs immune responses preferentially towards $T_H1$ -type responses. Also pairs with IL23R to form IL23/IL23A receptor.	Identification of $T_H1$ cells

continued

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD213a1 and CD213a2	CD213a: <b>IL13RA1</b> . CD213b: <b>IL13RA2</b> , IL13BP	Both proteins are 49 kDa (predicted) type I transmembrane protein members of hematopoietin family, with one fibronectin type III domain. Proteins show 27% homology to each other.	Broadly expressed in hematopoietic tissue, nervous system and other tissues	CD213a binds IL-13 with low affinity, in a complex with the IL-4 R $\alpha$ chain (CD124). CD213a2 binds IL-13 with high affinity but lacks signaling function.	Potential therapeutic target for glioma. Possible role in psoriasis and atopic dermatitis.
CD214	Not assigned	—	—	—	—
CD215	Not assigned	—	—	—	—
CD216	Not assigned	—	—	—	—
CD217	IL-17 receptor, <b>IL17R</b>	130 kDa type I transmembrane glycoprotein. Member of family without homology to other cytokine receptor families.	Broad tissue distribution. Cord blood lymphocytes, peripheral blood lymphocytes, thymocytes.	One of a family of receptors for IL-17 and related cytokines	IL17R signaling enhances inflammation in animal models of IBD
CD218a and CD218b	CD218a: IL-18 receptor $\alpha$ , <b>IL18R1</b> . CD218b: IL-18 receptor $\beta$ , <b>IL18RAP</b>	CD218a is 62 kDa type 1 membrane glycoprotein with 3 C2-type domains and cytoplasmic toll interleukin receptor domain. CD218b is a 68 kDa type 1 membrane glycoprotein with only 2 C2-type domains and toll interleukin receptor domain	CD218a broadly expressed on most cells in immune system, and in other tissues. CD218b expression more selective, seen on activated but not resting helper T cells.	Two receptors together bind IL-18 and mediate actions through activation of NF $\kappa$ B	—
CD219	Not assigned	—	—	—	—



CD220	Insulin receptor, <b>INSR</b>	135 kDa ( $\alpha$ subunit), 95 kDa ( $\beta$ subunit) dimeric transmembrane protein cleaved from product of single gene. $\alpha$ subunit has ligand-binding domain and 2 fibronectin type III domains, and is covalently linked by disulfide bond to the $\beta$ subunit transmembrane tyrosine kinase that also has 2 fibronectin type III domains and a cytoplasmic receptor tyrosine kinase domain.	Ubiquitous: erythrocytes, liver, muscle, adipose tissue	Cellular receptor for insulin. Autophosphorylated on insulin binding	Mutation in CD220 leads to insulin-resistant diabetes mellitus
CD221	IGF 1 Receptor, type 1 IGF receptor, <b>IGF1R</b>	Pre-protein cleaved into 135 kDa ligand-binding $\alpha$ subunit and 95 kDa tyrosine kinase $\beta$ subunit. Expressed as tetramer of two heterodimers. $\alpha$ subunit has ligand-binding domain and 2 fibronectin type III domains, and is covalently linked by disulfide bond to the transmembrane $\beta$ subunit that has 2 fibronectin type III domains and a cytoplasmic receptor tyrosine kinase domain.	Ubiquitous	Receptor for insulin-like growth factors IGF1 and IGF2. Autophosphorylated on IGF1 binding.	Receptor gene is subject to imprinting. Biallelic expression associated with Beckwith-Wiedemann syndrome.
CD222	Man-6p receptor, mannose-6-phosphate receptor, insulin-like growth factor II receptor, <b>IGF2R</b>	250 kDa type I transmembrane protein with 15 homologous C-type lectin domains and a fibronectin type II domain	Ubiquitous	Internalization of IGF2, internalization of lysosomal enzymes, regulation of TGF- $\beta$ activity	Reduced CD222 expression is associated with increased cell proliferation. CD222 null mice exhibit organ and skeletal abnormalities and die at birth.
CD223	<b>LAG-3</b> , lymphocyte activation gene 3	70 kDa type I transmembrane protein with one modified V-set Ig superfamily domain followed by 3 C2-set Ig domains. Has homology with CD4.	Activated T and NK cells, expressed at higher levels on CD8 than CD4 cells	Binds MHC class II. Regulates the expansion of antigen-specific immune responses.	Soluble CD223 enhances in vitro induction of CTL

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD224	$\gamma$ -glutamyl transferase, GGT, $\gamma$ -glutamyl transpeptidase, <b>GGT1</b>	100 kDa heterodimeric type II transmembrane protein member of threonine peptidase family. 21-30 kDa light chain subunit covalently attached to 55-60 kDa heavy subunit, originating from single polypeptide precursor	Subpopulations of leukocytes, hematopoietic precursors, some cell lines, e.g., K562, CGM, HL60	E.C.2.3.2.2. Catalyses transfer of $\gamma$ -glutamyl residue from glutathione to amino acids or peptides.	GGT activity increased in liver disease
CD225	Leu-13, interferon-induced transmembrane protein 1, IFI17, <b>IFITM1</b>	17 kDa membrane protein which coprecipitates with CD81 (TAPA-1)/CD19/CD21 complex. Has two transmembrane domains, and both termini are cytoplasmic	Leukocytes, endothelial cells	Component of the CD81/CD19/CD21 complex. Involved in B cell activation.	Low CD225 expression is associated with poor prognosis in CML. Also useful as pan-endothelial cell marker.
<b>CD226</b>	DNAM-1, PTA-1	65 kDa Ig superfamily glycoprotein with two V-set domains	Induced by activation on NK cells, platelets, monocytes, T cell subset	Adhesion molecule. Interacts with CD155 (PVR) and CD112 (nectin 2)	Expression increased in patients with some autoimmune diseases and viral infections
CD227	<b>MUC 1</b> , episialin, EMA	Protein core of very large heterogenous glycoprotein-mucin. 220-700 kDa integral membrane protein consisting of a highly variable number of tandem repeats of 20 residues	Widely expressed on leukocytes and epithelia of glands and ducts	Mucins generally have protective and lubricating functions	Prognostic marker in adenocarcinoma
CD228	Melanotransferrin, <b>MF12</b> , MAP97	97 kDa transferrin-like molecule with 2 nonfunctional peptidase domains	Melanoma	Presumed iron transport function	Role in melanoma proliferation and tumorigenesis
CD229	<b>Ly9</b> , SLAMF7	20 kDa type I transmembrane glycoprotein of SLAM family with two V-set and two C2-set Ig superfamily domains	T and B lymphocytes, thymocytes	Self-ligand, localizes to immune synapses	May inhibit T cell activation

CD230	Prion protein, PrP(c), PrP(sc) abnormal form, <b>PRNP</b> , PrP27-30	30-40 kDa GPI-anchored protein. $\alpha$ -helical structure and N-terminal repeat sequences. Glycosylation different in PBMC to brain. PrP(c) has $\alpha$ -helical structure PrP(sc) has $\beta$ -sheet structure and tends to polymerize.	T cells, B cells, monocytes, dendritic cells, brain. Not red blood cells.	PrP(c) may bind copper. Normal function unknown. PrP(sc) aggregates bind cholesterol-rich phospholipid membranes and are cytotoxic.	Infective agent in bovine spongiform encephalopathy and human CJD. Mutations in Prp gene associated with familial CJD-like disorders.
CD231	TALLA-1, TM4SF2, <b>TSPAN7</b>	150 kDa tetraspanin family member with larger second extracellular loop. Both termini are cytoplasmic.	Neuronal tissue, neuroblastoma, T type acute lymphoblastic leukemia	Not known, although used as specific marker of T cell ALL	Involved in X-linked mental retardation
CD232	VESPR, <b>PLXNC1</b> , Plexin C1	200 kDa membrane protein member of plexin family with a semaphorin-like domain and cysteine-rich region	Monocytes, some B cells. Not fully described.	Receptor for virally encoded semaphorin	—
CD233	<b>SLC4A1</b> , B and 3, AE1, anion exchanger 1, Diego blood group antigen	95 kDa integral membrane protein. 12 to 14 transmembrane helices. Both termini are cytoplasmic. Fourth loop carries ABO blood group antigen.	Erythrocytes (over $10^6$ copies per cell)	N-terminal cytoplasmic domain links membrane to underlying spectrin-based membrane skeleton, C-terminal membrane domain mediates exchange of chloride and bicarbonate anions across plasma membrane	Diego blood group antigen. Defects lead to various hematological and ion-transport disorders
CD234	<b>DARC</b> , Fy-glycoprotein, Duffy blood group antigen	35 kDa, 7-transmembrane domain acidic glycoprotein member of chemokine receptor superfamily	Erythrocytes, capillary endothelial cells	Binds multiple inflammatory cytokines, acting as chemokine “sink.” Also receptor for <i>Plasmodium vivax</i> invasion.	Possible target for modulating inflammation
CD235a and CD235b	CD235a: <b>GYPA</b> , Glycophorin A, PAS-2, MN sialoglycoprotein. CD235b: <b>GYPB</b> , Glycophorin B, PAS-3, ss-active sialoglycoprotein	Type I membrane proteins, both are highly glycosylated. CD235a forms homodimers, monomeric, mol. wt. 28-31 kDa. CD235b, mol. wt. 20 kDa	Erythrocytes	Major glycoproteins of erythrocytes	MN blood group (CD245a), SS blood group (CD235b). Glycophorin A RBC are resistant to falciparum malaria.

continued

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD236	<b>GYPC</b> , Glycophorin C/D (CD236), Glycophorin C (CD236R), Gerbich blood group antigen	40 kDa sialoglycoprotein type III membrane protein, linked to membrane via band 4.1. Glycophorin D (30 kDa) is truncated at N-terminus.	High CD236 levels on erythrocytes, lower CD236R on erythrocytes. Both detectable on wide range of other tissues.	Regulation of mechanical stability of erythrocytes. Also receptor for <i>Plasmodium falciparum</i> merozoites.	Blood group antigen (Gerbich)
CD237	Not assigned	—	—	—	—
CD238	<b>KEL</b> , Kell blood group antigen	93 kDa type II transmembrane zinc endopeptidase, disulfide-linked to XK protein	Erythroid cells, testis; low levels in brain, heart, skeletal muscle	Cleavage of endothelin 3 to bioactive form, absence of XK protein associated with late-onset muscular dystrophy	Kell blood group
CD239	<b>LU</b> , B-CAM, Lutheran glycoprotein	78/85 kDa type I transmembrane glycoprotein member of Ig superfamily with 2 V-type and 3 C-type domains	Erythrocytes, broad range of cells; not on lymphocytes, granulocytes, monocytes, or platelets	Role in cell-cell and cell-substrate adhesion. Binds laminin	Lutheran blood group, also Auberger blood group
CD240CE	<b>RHCE</b> , Rh blood group system, Rh 30CE,	30 kDa glycoprotein member of Rh blood group system. Contains 12 transmembrane domains; palmitoylated on extracellular loops. Forms are polymorphism based.	Erythroid cells	Role in erythrocyte membrane integrity; may function as ammonium transporter	Rh incompatibility is the leading cause of hemolytic disease of the newborn; Rh-incompatible transfusion may result in death
CD240D	<b>RHD</b> , Rh blood group system, Rh 30D (CD240D)	30 kDa glycoprotein member of Rh blood group system. Contains 12 transmembrane domains; palmitoylated on extracellular loops. Forms are polymorphism based.	Erythroid cells	Role in erythrocyte membrane integrity; may function as ammonium transporter	Rh incompatibility is the leading cause of hemolytic disease of the newborn; Rh-incompatible transfusion may result in death

<b>CD240 DCE</b>	Rh30D/CE	30 kDa glycoprotein member of Rh blood group system. Contains 12 transmembrane domains; palmitoylated on extracellular loops. Product of hybrid gene formed when section of CD240D gene is replaced with equivalent section of CD240CE. Protein stable but lacks many D epitopes.	Erythroid cells	Role in erythrocyte membrane integrity; may function as ammonium transporter	Rh incompatibility is the leading cause of hemolytic disease of the newborn; Rh-incompatible transfusion may result in death
CD241	<b>RHAG</b> , RhAg, Rh50, Rh-associated antigen	50 kDa glycoprotein; 12 transmembrane domains; single N-glycosylation	Erythroid cells	May function as ammonium transporter	Formation of a complex with Rh50 is essential for expression of Rh blood group antigens
CD242	<b>ICAM 4</b> , LW blood group, Landsteiner-Wiener blood group antigens	42 kDa type I transmembrane glycoprotein with 2 C-type domains	Erythrocytes, expression associated with Rh antigens (CD240)	Binds CD11a/CD18 integrin; role in adhesion of erythrocytes to leukocytes	LW blood group antigens, LW antigens may be depressed in pregnancy
CD243	<b>ABCBI</b> , MDR-1, P-glycoprotein, pgp 170, multidrug resistance protein I	170 kDa glycoprotein which spans the membrane 12 times. Member of ABC family of transport proteins.	Kidney, liver, gut tissue; low levels in hematopoietic cells but higher on bone marrow stem cells and some malignant cells	ATP-dependent efflux pump that removes small molecules (including drugs) out of the cell	Marker in evaluating potential drug resistance of tumors
<b>CD244</b>	2B4, NAIL, SLAMF4	70 kDa type I transmembrane glycoprotein with one V-set and one C2-set Ig superfamily domain. Phosphorylated on ligation.	NK cells, $\gamma\delta$ T cells, monocytes, basophils, eosinophils	Expression suggests involvement in non-MHC restricted cytotoxicity. Binds CD48. NK activating receptor in human, inhibitory receptor in mice.	—
CD245	p220/240, DY12, DY35	220-240 kDa transmembrane protein; structure unknown, but with weak phosphatase activity	All resting PBI, monocytes. Weak on granulocytes, platelets. Negative on erythrocytes, weak on T cell lines, thymocytes. IL-2-dependent T cell clones positive.	Signal transduction. Costimulation of T and NK cells.	—

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD246	Anaplastic lymphoma kinase ( <b>ALK</b> )	200 kDa type I transmembrane receptor protein-tyrosine kinase with extracellular LDL receptor and cysteine-rich MAM domains	Neuronal tissue. A fusion protein arising from a 2;5 chromosomal translocation with <i>NPM1</i> is found in 5%-10% of NHL.	Important role in brain development	Diagnosis of anaplastic large-cell lymphomas. ALK inhibitors may have therapeutic applications.
CD247	<b>CD3Z</b> , T cell receptor $\zeta$ chain, CD3 $\zeta$	16 kDa type I transmembrane protein, not glycosylated. Has three cytoplasmic ITAM motifs. Expressed in complex with CD3 $\gamma$ , $\delta$ , and $\epsilon$ , and T cell receptor $\alpha/\beta$ or $\gamma/\delta$ heterodimers.	All T cells	Part of CD3 complex, couples antigen recognition to intracellular signal transduction pathways	Immunodeficiencies due to <i>Q70X</i> mutations have been reported
<b>CD248</b>	TEM1, endosialin, CD164-sialomucin-like protein (CD164L1)	175 kDa type I membrane protein. Contains single C-type lectin domain, three EGF domains, and a mucin-like region. Heavy O-glycosylation.	Tumor endothelial cell marker also expressed on some fibroblastic cells and smooth muscle cells. Some dispute about precise expression.	Possible role in cell-cell interactions, particularly during tumor angiogenesis and metastasis	Expression correlates with high-grade tumors and aggressive progression of disease
CD249	Aminopeptidase A, glutamyl aminopeptidase, <b>ENPEP</b>	160 kDa type II membrane protein and member of M1 peptidase family. Multiple N-glycosylation sites. Forms disulfide-linked homodimers.	Endothelial and epithelial cells in renal proximal tubules and nephron glomerulus	Ectoenzyme catalyzing release of N-terminal glutamate from a peptide. Plays regulatory role in angiogenesis	Potential therapeutic target in treatment of hypertension and in prevention of tumor angiogenesis
CD250	Not assigned	—	—	—	—
CD251	Not assigned	—	—	—	—
CD252	<b>OX40L</b> , <b>TNSF4</b> , CD134L	34 kDa type II transmembrane glycoprotein member of TNF superfamily. Probably forms homotrimer. Each monomer contains single TNF superfamily domain.	Antigen-presenting cells, including B cells, dendritic cells, endothelium	Membrane expressed cytokine that acts as costimulator via interaction with ligand on T cells	Potential target for psoriasis and asthma

CD253	TRAIL, APO-2 ligand, <b>TNFSF10</b>	32 kDa (predicted) type II transmembrane glycoprotein member of TNF superfamily. Contains single TNF superfamily domain. Extracellular domain shed to form 19 kDa soluble protein that forms dimers and trimers.	Widely expressed in lymphoid and nonlymphoid tissues by activated T cells, NK cells, and dendritic cells	Induces apoptosis. Multiple receptors. Possibly mediates interferon $\gamma$ -dependent NK cell function.	—
CD254	TRANCE, <b>TNFSF11</b> , RANK ligand	35 kDa (predicted) type II transmembrane glycoprotein member of TNF superfamily. Contains single TNF superfamily domain and cleavage site. Probably forms homotrimer.	Induced on T cells by activation. Expressed in secondary lymphoid tissue.	Stimulates osteoclast activation and differentiation. May be involved in apoptosis regulation.	Potential diagnostic and therapeutic target in bone and immune systems
CD255	TWEAK, TNFSF12, APO3 ligand, <b>TNFSF12</b>	30-35 kDa (membrane) 18 kDa (soluble) type II transmembrane glycoprotein member of TNF superfamily. Contains single TNF superfamily domain. Soluble form containing receptor-binding region of ectodomain is produced by furin cleavage.	IFN- $\gamma$ -stimulated PBLs and monocytes, endothelial cells, smooth muscle cells, and fibroblasts. Also expressed in many other tissues.	Weakly induces apoptosis in many tissues and cell lines. Can induce NF $\kappa$ B activation and proliferation of endothelial cells. Promotes angiogenesis and induces pro-inflammatory cytokine secretion.	—
CD256	APRIL, <b>TNFSF13</b>	28 kDa (predicted) glycoprotein member of TNF superfamily. Contains single TNF superfamily domain and cleavage site. Predicted to form homotrimers and heterotrimers with CD257.	Secreted after proteolysis, so rarely seen as membrane protein. Soluble form at high levels in multiple myeloma. CD257 heterotrimer in serum associated with inflammatory autoimmune disease.	Role in B cell development, and may induce apoptosis through interaction with other TNFRSF members. Acts as growth factor for neuroblastoma cell lines, hence role in nervous system.	—

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD257	BlyS, BAFF, <b>TNFSF13B</b>	31 kDa (membrane) 17kDa (soluble) type II transmembrane glycoprotein member of TNF superfamily. Contains single TNF superfamily domain and cleavage site. Predicted to form homotrimers and heterotrimers with CD256.	B lymphocytes and monocytes/macrophages. Up-regulated by interferon $\gamma$ . Soluble form seen in autoimmune inflammatory conditions.	B cell survival, activation, and differentiation factor. Confers apoptotic resistance to some B cell tumors.	Possible target therapeutic for B cell tumors
CD258	LIGHT, <b>TNFSF14</b>	29 kDa type II transmembrane glycoprotein member of TNF superfamily. Contains single TNF superfamily domain and cleavage site that results in soluble molecule.	Low levels in resting blood and tissue leukocytes, up-regulated on activation.	Can trigger apoptosis as well as cell activation, including dendritic cells. Costimulator for T cell proliferation.	Research reagent
CD259	Not assigned	—	—	—	—
CD260	Not assigned	—	—	—	—
CD261	TRAIL-R1, DR4, <b>TNFRSF10A</b>	50 kDa (predicted) type I transmembrane protein member of TNF receptor superfamily. Contains 3 TNF receptor domains and a cytoplasmic death domain.	Wide expression on lymphocytes, gut tissue	On interaction with ligand CD261 initiates a cell death cascade	CD261 polymorphism associated with increased bladder cancer risk
CD262	TRAIL-R2, DR5, <b>TNFRSF10B</b>	48 kDa (predicted) type I transmembrane protein member of TNF receptor superfamily. Contains 3 TNF receptor domains and a cytoplasmic death domain.	Wide expression on lymphocytes, lung, and prostate tissue. Induced by tumor suppressor p53.	On interaction with ligand CD262 initiates a cell death cascade	Defective CD262 function appears associated with head and neck carcinoma



CD263	TRAIL-R3, DcR1, LIT, TRID, <b>TNFRSF10C</b>	65 kDa GPI-anchored membrane receptor protein and member of TNF receptor superfamily. Has 3 TNF receptor domains, followed by 5 tandem TAPE repeats.	T and B lymphocytes, NK cells, macrophages, monocytes, granulocytes. Also in many other tissues	Membrane receptor for CD253, thought to act as decoy receptor, inhibiting CD253-induced apoptosis. Cannot transmit apoptotic signal. Role in malignant tissues unclear.	—
CD264	TRAIL-R4, TRUNDD, DcR2, <b>TNFRSF10D</b>	35 kDa type I membrane protein member of TNF receptor superfamily. Has 3 TNF receptor domains and truncated cytoplasmic death domain.	T and B lymphocytes, NK cells, macrophages, monocytes, granulocytes. Also in many other tissues.	Membrane receptor for CD253, thought to act as decoy receptor, inhibiting CD253-induced apoptosis. Cannot transmit apoptotic signal. Role in malignant tissues unclear.	—
CD265	RANK, TRANCE-R, EOF, <b>TNFRSF11A</b>	97 kDa type I membrane protein member of TNF receptor superfamily. Contains 4 TNF receptor domains and long cytoplasmic domain.	Broadly expressed in human tissues	Functional receptor for CD254, both proteins required for osteoclastic differentiation, activation, and bone homeostasis	Variants of CD265 responsible for bone remodeling disorders
CD266	TWEAK-R, <b>TNFRSF12A</b>	14 kDa type I membrane protein member of TNF receptor superfamily. Smallest member of TNFR family, containing single, incomplete TNF receptor domain.	mRNA detected in wide variety of human tissues. Higher protein levels in liver and brain tumors than in normal tissues.	Mediates CD255-induced proliferation and migration of epithelial cells. No apparent connection to apoptotic effects of CD255.	—
CD267	TACI, <b>TNFRSF13B</b>	32 kDa type III membrane protein member of TNF receptor superfamily. Contains 2 TNF receptor domains.	Memory B cells; detected on multiple myeloma and B cell CLL	Negative regulator of B cell activation. Essential costimulatory signal for T independent humoral responses.	Agonistic anti-CD267 is potential therapeutic agent for treatment of B cell lymphoproliferative disorders
CD268	BAFF receptor, <b>TNFRSF13C</b>	18 kDa (unprocessed precursor) type III transmembrane protein member of TNF receptor superfamily. Contains single, incomplete TNF receptor domain.	Lymphoid tissue and circulating blood leukocytes. Down-regulated on activation of resting B cells and CD4 <sup>+</sup> T cells.	Physiological function not yet clear; possibly associated with mature B cell survival	Potential therapeutic target for autoimmune disorders
CD269	BCMA, BCM, <b>TNFRSF17</b>	27 kDa type III membrane protein member of TNF receptor superfamily. Contains single TNF receptor domain.	Plasma cells, plasma blasts, tonsillar germinal center cells. Mostly intracellular.	Essential for long term survival of bone marrow plasma cells	Potential therapeutic target for selective elimination of plasma cells in treatment of antibody-mediated autoimmunity

*continued*

Table A.4A.1 CD Molecules<sup>a,b</sup>, continued

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
(CD270)	LIGHT-R, HVEM, <b>TNFRSF14</b>	30 kDa type I transmembrane protein, member of TNF-TNFR superfamily. Contains 4 TNF receptor domains.	Resting T cells, monocytes, immature dendritic cells. T cell activation down-regulates expression.	Interaction with ligand (CD258) on T cells provides costimulatory signal. Signaling implicated in development of macrophage-derived atherosclerotic lesions.	—
CD271	<b>NGFR</b> (p75), TNFRSF16, NTR, LNGFR	75 kDa (long form) type I membrane protein, member of TNFR superfamily. Contains 4 TNF receptor domains and an intracellular death domain.	Neurons, stromal cells, and follicular dendritic cells	Diverse and opposing actions due to ability to bind variety of ligands and act as coreceptor with a number of different signaling molecules	Expression levels of CD271 and NGF may aid in determining prognosis of patients with invasive ductal carcinoma
CD272	<b>BTLA</b>	33 kDa type I membrane protein, member of CD28/B7 family of costimulator molecules in Ig superfamily. Contains single V-type domain and two intracellular ITIM motifs.	All mature lymphocytes and developing B and T cells, splenic macrophages, BM-derived dendritic cells	Induction of CD272 signaling results in attenuation of T cell activation	—
CD273	B7-DC, PD-L2, <b>PDCD1LG2</b> , PDCG1L2	25 kDa type I membrane protein, member of B7 regulatory protein family within Ig gene superfamily. Contains one C2-type and one V-type domain.	Dendritic cells, activated monocytes, and T cells. Expressed in numerous other tissues by nonimmune cells.	Costimulates proliferation of T cells, mediates IFN- $\gamma$ production. Augments DC stimulation of T cell responses.	Marker for distinguishing primary mediastinal B cell lymphoma from other diffuse large B cell lymphomas
<b>CD274</b>	B7-H1, PD-L1, PDCD1LG1	40 kDa type I membrane protein, member of B7 regulatory protein family within Ig gene superfamily. Contains one C2-type and one V-type domain.	Dendritic cells, activated T cells, activated monocytes. Expressed in numerous other tissues by nonimmune cells, and by numerous tumors.	Acts as both costimulatory and coinhibitory molecule for T cells. Pathogens may exploit CD274 to evade immune response.	Blockade of CD274 may be useful tool in cancer immunotherapy
CD275	ICOS ligand, <b>ICOSLG</b>	33 kDa (unprocessed precursor) type I transmembrane glycoprotein, homolog of CD80 and CD86. Contains one C2-type and one V-type domain.	B cells, monocytes, macrophages, dendritic cells, and endothelial cells	CD275 binds only ICOS, not homologs CD28 or CD152. Binding of ligand on activated T cells increases cytokine secretion.	Target for therapeutic intervention in graft rejection and allergic airway inflammation

<b>CD276</b>	B7-H3 (long), 4Ig-B7-H3	110 kDa (long), 45 kDa (short) type I transmembrane protein member of B7 regulatory proteins within Ig gene superfamily. Contains 2 V-type and 2 C-type domains. Short form has only one of each domain type.	On activation of monocytes, NK cells, dendritic cells, T cells, B cells	CD276 acts as inhibitor of T cell function. May provide some tumors with protection against NK cell-mediated killing.	Potential tool for detecting neuroblastoma cells in bone marrow
CD277	BT3.1, BTF5	56 kDa type I transmembrane protein member of BT-related subfamily of B7 family within Ig superfamily. Contains 2 V-type domains and intracellular B30.2-like globular domain.	T cells, B cells, NK cells, monocytes, dendritic cells, subset of stem cells. mRNA expression in number of other tissues.	Member of family of proteins that regulate T cell activation, however, precise function remains unclear	—
CD278	<b>ICOS</b> (inducible costimulator)	55-60 kDa type I transmembrane protein. Forms disulfide-linked dimer, each monomer having a single V-type domain with cysteine residues close to membrane at residue 136.	T cells after 12-48 hr activation. Thymic medulla and T cell zones of lymph nodes.	Costimulatory signals for T cell proliferation, cytokine synthesis, and cognate interaction with B cells	Potential target for immunotherapy for allergic airway inflammation and graft rejection
CD279	PD1, PDC1, hPD1, SLEB2, <b>PDCD1</b>	55 kDa type I transmembrane protein belonging to CD28 subfamily within Ig superfamily. Contains single V-type domain.	During thymic development by CD4 <sup>-</sup> CD8 <sup>-</sup> cells, by activated T and B cells, activated monocytes	May indirectly induce cell death by inhibiting cell survival gene expression. Also maintains peripheral self tolerance.	SNP analysis of CD279 may be useful for prognosis of susceptibility to autoimmune diseases
CD280	Endo180, TEM22, <b>MRC2</b> , UPARAP, KIAA0709	180 kDa type I transmembrane protein and endocytosis receptor of macrophage mannose receptor (MMR) family. Has 8 C-type lectin domains, a fibronectin type III domain, and a Ricin B-type lectin domain at the N-terminus.	Myeloid progenitors, fibroblasts, subset of endothelial cells, subset of macrophages. Highly expressed at sites of active tissue remodeling.	Constitutively recycled cell surface adhesion molecule that mediates uptake and degradation of ECM proteins	Potential therapeutic target in treatment of carcinomas by limiting ECM degradation

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD281	TOLL-like receptor 1, <b>TLR1</b> , TIL	90 kDa type I transmembrane protein member of TLR family. Contains 8 leucine-rich repeat sequences and the intracellular Toll Interleukin Receptor Domain. Forms heterodimer with CD282.	Monocytes and neutrophils; detectable in breast milk	Plays role in innate immunity by recognizing outer surface protein A lipoprotein of <i>Borrelia burgdorferi</i> , mycobacterial lipoprotein, and triacylated lipopeptides. Induction of signal cascade leads to pro-inflammatory cytokine release.	—
CD282	TOLL-like receptor 2, <b>TLR2</b> , TIL4	84 kDa type I transmembrane protein member of TLR family. Contains many leucine-rich repeat sequences and the intracellular Toll Interleukin Receptor Domain. Forms heterodimer with CD281 and CD286.	Peripheral blood leukocytes, high expression in monocytes in bone marrow, lymph nodes, and spleen. Detectable in other tissues.	Recognizes molecular patterns of fungi, protozoan pathogens, and bacteria, and stimulates pro-inflammatory cytokines as part of innate immunity	—
CD283	TOLL-like receptor 3, <b>TLR3</b>	100 kDa type I transmembrane protein member of TLR family. Contains many leucine-rich repeat sequences and the intracellular Toll Interleukin Receptor Domain.	Fibroblasts, myeloid dendritic cells, microglia, and astrocytes; mostly intracellular	Has role in host response to double-stranded RNA viral infection; activation leads to initiation of caspase-dependent apoptotic cascade	—
CD284	TOLL-like receptor 4, <b>TLR4</b>	85 kDa type I transmembrane protein member of TLR family. Contains many leucine-rich repeat sequences and the intracellular Toll Interleukin Receptor Domain.	Monocytes, macrophages, granulocytes, dendritic cells, activated CD4 <sup>+</sup> T cells	Activation of signaling pathways by binding to LPS ligand results in inflammatory cytokine production favoring a T <sub>H</sub> 1 response	—
(CD285)	TOLL-like receptor 5, <b>TLR5</b>	91 kDa type I transmembrane protein member of TLR family. Contains many leucine-rich repeat sequences and the intracellular Toll Interleukin Receptor Domain.	Highly expressed in mucosal epithelium and peripheral blood leukocytes, especially monocytes. Moderate expression in immature dendritic cells. Also in other tissues.	Receptor for bacterial flagellin. On binding, inflammatory cytokine release and immune cell activation occurs. Polymorphism in stop codon present in 10% of population leads to susceptibility to lung infections by bacterial pathogens.	—

CD286	TOLL-like receptor 6, <b>TLR6</b>	91 kDa type I transmembrane protein member of TLR family. Contains many leucine-rich repeat sequences and the intracellular Toll Interleukin Receptor Domain. Forms heterodimers with CD282.	Monocytes, immature dendritic cells, plasmacytoid pre-dendritic cells, microvessel endothelium	Heterodimer with CD282 recognizes microbial diacyl-lipopeptides	—
(CD287)	TOLL-like receptor 7, <b>TLR7</b>	121 kDa (predicted) type I transmembrane protein member of TLR family. Contains many leucine-rich repeat sequences and the intracellular Toll Interleukin Receptor Domain.	Endosomes of plasmacytoid dendritic cells, B cells, myeloid dendritic cells. Also detectable in other tissues.	Receptor for single-stranded GU-rich viral RNA, and forms part of innate defense mechanism against RNA viruses	—
CD288	TOLL-like receptor 8, <b>TLR8</b>	120 kDa type I transmembrane protein member of TLR family. Contains many leucine rich repeat sequences and the intracellular Toll Interleukin Receptor Domain.	Endosomal compartments of macrophages and subsets of dendritic cells	Part of innate defense against RNA viruses. Ligation to single-stranded GU-rich RNA triggers secretion of inflammatory and regulatory cytokines.	—
CD289	TOLL-like receptor 9, <b>TLR9</b>	116 kDa type I transmembrane protein member of TLR family. Contains many leucine-rich repeat sequences and the intracellular Toll Interleukin Receptor Domain.	High level expression by plasmacytoid dendritic cells, primary and secondary lymph organs, and at low levels by peripheral blood leukocytes	Binds unmethylated CpG DNA motifs, and is therefore a receptor for DNA present in endosomes during bacterial and viral infection. Triggers T <sub>H</sub> 1-skewed adaptive response.	—
CD290	TOLL-like receptor 10, <b>TLR10</b>	95 kDa type I transmembrane protein member of TLR family. Contains multiple leucine-rich repeat domains and intracellular Toll Interleukin Receptor Domain. Highly polymorphic.	Normal and neoplastic B cells, with expression level increasing with maturation. Highest in activated B cells. Detectable in other tissues.	Function unclear due to lack of a murine model for study of CD290. Possible link between CD290 polymorphisms and asthma. Ligand currently unknown.	—
(CD291)	TOLL-like receptor 11, <b>TLR11</b>	97 kDa type I transmembrane protein member of TLR family. Human gene contains multiple stop codons and does not encode a full length protein.	Murine CD291 expressed by macrophages and renal and bladder epithelium	Ligand in mouse is protozoan profilin and protects animals from urinary tract infections. No role found in humans, possible compensation by other TLRs.	—

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD292	<b>BMPRI1A</b> , ALK3	50-58 kDa type I transmembrane protein member of bone morphogenetic protein receptor (BMPR) family of serine/threonine kinases within TGF- $\beta$ receptor superfamily. Heterodimerizes with BMPRII. Contains activin receptor domain and protein tyrosine kinase receptor domain.	Bone progenitor cells, chondrocytes, epithelial cells of epidermis, hair follicles, intestine, and skeletal muscle.	Plays role in embryonic development, inducing proliferation and differentiation of a number of tissues, especially osteogenesis and chondrogenesis	—
CDw293	<b>BMPRI1B</b> , ALK6	50-58 kDa type I transmembrane protein member of BMP receptor family. Has activin receptor domain and intracellular protein tyrosine kinase domain. Forms heterodimer with BMPRII.	Bone progenitor cells, chondrocytes, and several embryonic tissues	Regulates cell proliferation and differentiation of bones and cartilage during embryonic development	—
CD294	<b>CRTH2</b> , <b>GPR44</b>	43 kDa (predicted) G protein coupled receptor family member, with seven pass transmembrane domain. Two potential glycosylation sites, and potential intracellular phosphorylation sites.	Widely expressed outside immune system. Expressed by subset of T cells with T <sub>H</sub> 2 response.	Resembles chemokine receptors, but physiological role remains unclear. Ligand is prostaglandin D2, which has various effects.	Potentially a marker for T <sub>H</sub> 2 cells
CD295	Leptin R, <b>LEPR</b> , OBR, B219	130-150 kDa type I membrane protein member of type 2 subfamily of type 1 cytokine receptor family. Contains 4 fibronectin type III domains and a C2-type Ig domain. Heavily glycosylated. Forms homodimer upon ligand binding.	Ubiquitously expressed	Mediates effects of hormone leptin. Regulates food intake, lipid metabolism, immune function, fertility, angiogenesis, and bone formation among numerous other effects.	—

CD296	<b>ART1</b>	37 kDa arginine-specific mono-ADP ribosyltransferase anchored to cell via GPI-anchor. Extracellular region contains $\alpha$ helices.	Epithelial cells, subset of T cells, heart, and skeletal muscle	Catalyzes transfer of ADP-ribose group to arginine of target protein, reversibly modifying function. Activity associated with monocyte differentiation, inflammatory responses, and inhibition of proliferation, and cytotoxicity by cytotoxic T cells.	—
CD297	ART4, DOK1, <b>DO</b> , Dombrock blood group	38 kDa arginine-specific mono-ADP ribosyltransferase anchored to cell via GPI anchor	Erythrocytes, erythroblasts, and activated monocytes. Detectable in gynecological tumors but not in normal tissue.	Catalyzes transfer of ADP-ribose group to arginine of target protein, reversibly modifying function	DO blood group markers are useful genetic markers, sometimes associated with severe hemolytic transfusion reactions. Potential target for gynecologic cancer treatment.
CD298	Na/K ATPase $\beta$ 3-subunit, <b>ATP1B3</b>	32 kDa (predicted) type II transmembrane protein. Whole molecule consists of 3 subunits, of which $\alpha$ is catalytic component.	All leukocytes, probably also in many other tissues	Membrane localized enzyme involved in Na/K transport. Expression induced upon cellular activation. Specific role of noncatalytic $\beta$ chain unknown.	—
CD299	DC-SIGN2, DC-SIGNR, L-SIGN, CD209L, <b>CLEC4M</b>	40 kDa Type II transmembrane protein and member of C-type lectin family. Highly homologous to CD209. Contains a single C-type lectin domain and 7 23-amino-acid repeat sequences.	Liver sinusoidal endothelial cells, endothelial cells in lymph nodes, placental endothelium, lung endothelium	Pathogen recognition receptor involved in peripheral immune surveillance in liver. Receptor probably not recycled after endocytosis.	—
CD300 family	CD300a: CMRF35H, IRC1, IRC2; CD300c: CMRF35A, LIR; CD300e: CMRL35L1	All are type I transmembrane proteins and members of CMRF family within Ig gene superfamily. All contain a single V-type domain. CD300a has three intracellular ITIM motifs. Mol. wt. CD300a 60kDa, CD300c 23kDa (predicted).	CD300a: expressed among subsets of most leukocyte populations; CD300c: broadly expressed by many leukocyte populations; CD300e: monocytes, macrophages and dendritic cells	CD300a acts as a receptor that may contribute to down-regulation of cytolytic activity of NK cells	—

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD301	MGL, <b>CLECSF14</b> , HMGL, HML	38 kDa type II transmembrane glycoprotein and member of C-type lectin superfamily. Contains single C-type lectin domain and predicted $\alpha$ -helical coil that is involved in trimer formation.	Immature dendritic cells and macrophages	Involved in receptor-mediated endocytosis of glycosylated proteins. Possible contributor to anti-tumor immunity.	Marker for immature dendritic cells
<b>CD302</b>	DCL1	30 kDa type I transmembrane protein with single C-type lectin domain. Minimal structural information available.	Granulocytes, macrophages, monocytes, dendritic cells	Endocytic receptor for glycosylated antigens	Fusion protein between CD205 and CD302 expressed by Hodgkin's lymphoma cell lines
CD303	BDCA-2, CLECSF11, DLEC, HECL, <b>CLECSF7</b>	38 kDa type II transmembrane protein and member of C-type lectin family. No known signaling motifs in cytoplasmic domain, single glycosylated C-type lectin domain in extracellular region.	Plasmacytoid dendritic cells	Dual function of both capturing and targeting antigen for processing and presentation to T cells	Specific plasmacytoid dendritic cell marker. MAbs are potential therapy for SLE
CD304	BDCA-4, neuropilin, neuropilin-1, VEGF165R, <b>NRP1</b>	90 kDa (soluble) and 140kDa (membrane) type I transmembrane glycoprotein receptor of VEGF-A. Contains 2 complement binding domains, followed by 2 coagulation factor V/VIII homology domains and a receptor tyrosine phosphatase MU domain. Variable splicing results in a soluble form containing only complement and coagulation factor domains.	Endothelial cells, neurons, several carcinomas. Also on subset of plasmacytoid dendritic cells and some T cells.	Plays major role in angiogenesis by enhancing VEGF-A-mediated endothelial cell chemotaxis. Soluble form has anti-angiogenic properties, probably by sequestering VEGF-A. Role on plasmacytoid dendritic cells unclear.	Marker for plasmacytoid dendritic cells. Overexpression correlates with metastatic disease and poor prognosis for prostate cancer patients.
CD305	<b>LAIR1</b>	31 kDa (predicted) type I transmembrane protein with single N terminal Ig superfamily C2 domain and two intracellular ITIM motifs	Majority of lymphocytes, NK cells, monocytes, and dendritic cells. Germinal center B cells are negative.	Inhibition of cellular activation seen in vitro. Ligand not identified so physiological function unclear.	—



CD306	<b>LAIR2</b>	16 kDa (predicted) type I transmembrane protein with similar structure to CD305, encoded by separate gene. Contains single C2-type domain and intracellular ITIM motif. Two probably soluble splice variants identified.	Monocytes	Physiological function not yet clear	—
CD307	IRTA2, FcRH5, BXMAS1, <b>FCRL5</b>	100 kDa type I transmembrane glycoprotein and member of Ig gene superfamily. Significant sequence and structural similarity to Fc receptors. Contains 8 C2-type domains and two intracellular ITIM motifs.	Selectively expressed on B lymphocytes, especially centrocytes of germinal center light zone and interfollicular B cells	Likely involved in regulating normal B cell activation; however, function not yet fully demonstrated. Deregulated expression may be linked to lymphomagenesis.	Potential marker for immunotherapy in treatment of B cell lymphomas and hairy cell leukemia
CD308	VEGFR1, <b>FLT1</b>	152 kDa (predicted) type I transmembrane glycoprotein member of the CSF-1/PDGF receptor family of type III tyrosine kinase receptors. Contains 7 C2-type domains that are glycosylated. Splicing gives membrane and soluble forms.	Most vascular endothelium and peripheral blood monocytes, osteoblasts, and trophoblasts	Important mediator of stem cell recruitment and mobilization, angiogenesis, and inflammation	Potential target in treatment of inflammation and atherosclerotic plaque growth
CD309	VEGFR2, <b>KDR</b> , Flk-1	230 kDa type I transmembrane glycoprotein member of the CSF-1/PDGF receptor family of type III tyrosine kinase receptors. Contains 7 C2-type domains and is highly glycosylated.	Most embryonic tissues, decreasing before birth. Increased adult levels associated with pathogenic angiogenesis. Expressed by vascular endothelial cells, megakaryocytes, retinal progenitors, smooth muscle cells, and pancreatic duct cells.	Regulation of angiogenesis. Ligand binding leads to receptor dimerization, stimulating endothelial cell proliferation and migration.	Major therapeutic target for treatment of tumors and diabetic retinopathy

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
(CD310)	VEGFR3, <b>FLT4</b>	146 kDa (predicted) type I transmembrane glycoprotein member of the CSF-1/PDGF receptor family of type III tyrosine kinase receptors. Contains 7 C2-type domains, all with N-linked glycosylations. Also has intracellular tyrosine kinase domain.	Lymphatic endothelium of normal and malignant tissues	Plays important role in angiogenesis and lymphangiogenesis in adults. Likely to have central role in promoting metastasis of tumors to regional lymph nodes.	Specific marker of lymphatic endothelium. Potential target for treatment of metastatic tumors such as prostate cancer and melanoma.
(CD311)	<b>EMR1</b>	98 kDa (predicted) integral membrane protein of EGF-TM7 family. Contains 7 membrane spanning domains and 6 EGF domains with multiple N-linked glycosylations.	Peripheral blood monocytes and macrophage cell lines	Precise function unknown. Mouse homolog, F4-80, may play a role in terminal differentiation of macrophages.	—
CD312	<b>EMR2</b>	90 kDa integral membrane protein of EGF-TM7 family. Contains 7 membrane spanning domains and 5 EGF domains.	Myeloid cells and activated lymphocytes	May contribute to interaction of activated T cells, dendritic cells, and macrophages with B cells	—
(CD313)	<b>EMR3</b>	72 kDa (unprocessed) integral membrane protein of EGF-TM7 family. Contains 7 membrane-spanning domains and 2 EGF domains. Likely cleaved into 2 subunits that remain non-covalently linked via spacer region.	Strong in neutrophils, weaker in monocytes and macrophages. Low-level expression in other tissues.	Currently unknown	—
CD314	<b>NKG2D</b> , <b>KLRK1</b>	42 kDa type II transmembrane protein with single C-type lectin domain	Constitutive expression on NK cells, CD8 <sup>+</sup> T cells, some CD4 <sup>+</sup> T cells.	Recognizes transformed or virus-infected cells expressing CD314 ligands and activates cell-mediated killing	Used in studies of cytotoxicity

CD315	CD9P1, SMAP6, <b>PTGFRN</b> , prostaglandin F2 negative regulator, FPRP, KIAA1436	135 kDa type I membrane protein and member of Ig-like protein subfamily EWI within Ig gene superfamily. Contains 6 V-type domains with multiple N-linked glycosylation sites.	Keratinocytes, subset of B cells and activated monocytes. High level expression in colon cancer cell lines.	Associates with tetraspanin molecules CD9 and CD81. Involved in regulating cell motility and polarity.	—
CD316	EWI-2, <b>IGSF8</b> , PGRL, CD81P3	63 kDa type I membrane protein and member of Ig-like protein subfamily EWI within Ig gene superfamily. Contains 4 V-type Ig-like domains.	B and T lymphocytes, NK cells, broad range of other tissues	Associates with tetraspanin molecules CD9 and CD81. Involved in tumor cell metastasis, nervous system development, cell proliferation, and myogenesis. Also involved in cell motility and polarity.	—
CD317	<b>BST2</b> , HM1.24	29-32 kDa type II transmembrane protein with two possible N-linked glycosylation sites	Mature Ig-secreting B cells, T cells, monocytes, NK cells. Dendritic cells and neoplastic plasma cells from multiple myeloma patients.	Precise function unknown but may have role in interaction between lymphocytes and bone stromal cells	Marker of late stage B cell maturation. Potential target for multiple myeloma therapy.
CD318	<b>CDCP1</b> , SIMA135	140 kDa type I transmembrane protein containing three glycosylated complement binding domains	CD34 <sup>+</sup> CD134 <sup>+</sup> bone marrow cells, keratinocytes. Overexpressed in colorectal cancers.	Plays role in early hematopoiesis. Possible role in wound healing of the epidermis.	Marker of hematopoietic progenitor cell subsets
CD319	CRACC, <b>SLAMF7</b> , 19A, 19A24, CS1	66 kDa type I transmembrane protein and member of CD2 family of receptors within Ig superfamily. Single glycosylated C2-type domain, two intracellular ITSM motifs.	Cytotoxic lymphocytes, activated B cells, NK cells, mature dendritic cells	Triggers NK cell-mediated cytotoxicity	—
<b>CD320</b>	8D6	29 kDa (predicted) type I transmembrane protein related to low density lipoprotein receptor family, as determined by presence of two LDLRA domains	Follicular dendritic cells	Involved in follicular dendritic cell-mediated proliferation of CD27 <sup>+</sup> plasma cells in germinal centers	Potential target in treatment of lymphomas

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD321	<b>JAM1</b>	32-35 kDa type I transmembrane protein member of junctional adhesion molecule subfamily within Ig superfamily. Has two C2-type domains. Forms dimers between CD321 molecules on interacting cells.	Neutrophils, monocytes, lymphocytes, platelets, lung, kidney, placenta	Adhesion molecule involved in tight junctions between cells. Role in extravasation of leukocytes.	Potential value in immunophenotypic analysis
CD322	<b>JAM2</b>	45 kDa type I transmembrane protein and member of junctional adhesion molecule (JAM) subfamily within Ig superfamily. Contains single C2-type and single V-type domains. Intracellular region has potential phosphorylation sites.	Endothelial cells, monocytes, B cells, activated and memory T cells. Strongly expressed during embryogenesis, less abundant in adult.	Associates with CD321 and CD323 during formation and maintenance of tight junctions. May promote transmigration of lymphocytes across endothelium.	—
(CD323)	JAM-C, <b>JAM-3</b> , VE-JAM, FLJ14529	43 kDa type I transmembrane protein and member of JAM subfamily within Ig superfamily. Has single C2-type and single V-type domains. Potential phosphorylation sites on intracellular domain.	T cells, NK cells, platelets. Widely expressed by endothelial cells in many tissues, especially placenta, kidney, and brain.	Localizes to interendothelial tight junctions	Potential treatment target for inflammatory vascular pathologies
CD324	E-cadherin, cadherin-1, <b>CDHE</b> , <b>CDH1</b> , uvomorulin, ECAD, Arc1	120 kDa type I transmembrane protein and member of classical cadherin family. Contains 5 cadherin domains and forms disulfide-linked homodimers.	Non-neural epithelial cells, stem cells, erythroblasts	Cell-cell adhesion molecule, especially important for interepithelial cell adhesion. Contributes to cell differentiation and polarity, and is a suppressor of tumor development and progression.	Lack of CD324 usually correlated with poor prognosis for carcinoma patients

CD325	N-cadherin, cadherin-2, NCAD, CDHM, <b>CDH2</b>	140 kDa type I transmembrane protein and member of classical cadherin family. Contains 5 cadherin domains.	Neurons, endothelial cells, osteoblasts, stem cells. Mostly present on cells that do not express CD324 and P cadherin.	Forms a complex with catenins that links to actin cytoskeleton. Complex important for synaptic development and function of neurons. Plays role in adhesion of malignant T cells to epithelia, promoting metastasis.	—
CD326	Ep-CAM, EGP40, MIC18, TROP1, EGP, hEGP-2, KSA, M4S1, <b>TACSTD1</b> , GA733-2	40 kDa type I transmembrane adhesion protein without homology to any other known adhesion molecule. Contains two EGF domains.	Most epithelial cells. Only seen in cancers of epithelial origin.	Mediates calcium-dependent homotypic cell-cell adhesion. Thought to maintain cells in position during proliferation. Expression levels inversely correlate with E-cadherin levels and cellular differentiation state.	Marker of epithelial cells and can be used to distinguish tumors of epithelial origin
CD327	<b>SIGLEC6</b> , OB-BP1, CD33L, CD33L1, sialic-acid-binding Ig-like lectin 6	49 kDa (predicted) type I transmembrane protein and member of sialic acid-binding Ig superfamily lectin. Contains 2 C2-type domains and single V-type domain. Intracellular region contains one ITIM motif.	Placental cells, spleen, and small intestinal B cells	Predicted to mediate cell-cell recognition events between specific cell populations in placenta, spleen, and small intestine. Possible role in signal transduction.	—
CD328	<b>SIGLEC7</b> , sialic acid-binding Ig-like lectin 7, AIRM1, p75	75 kDa (predicted) type I transmembrane protein and member of sialic acid-binding Ig superfamily lectin. Contains 2 C2-type domains and a single V-type domain. Intracellular region contains one ITIM motif.	NK cells, and at lower levels by granulocytes, monocytes and subsets of T cells. High-level expression in placenta, liver, lung, and spleen.	Mediates sialic acid-dependent cell-cell binding and functions as inhibitory receptor of NK cells. Inhibits proliferation of leukemic cells in vitro.	—
CD329	<b>SIGLEC9</b> , sialic acid-binding Ig-like lectin 9	50 kDa type I transmembrane protein and member of sialic acid-binding Ig superfamily lectin. Contains two C2-type domains and single V-type domain. Intracellular region contains single ITIM motif.	Monocytes, neutrophils. Weaker expression in 50% of B cells, NK cells, and subset of T cells.	Reduces TCR signaling. Can initiate pro- and anti-apoptotic signaling in neutrophils depending on cytokine environment.	—

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
(CD330)	<b>SIGLEC10</b> , sialic acid-binding Ig-like lectin 10	90-120 kDa type I transmembrane protein and member of sialic acid-binding Ig superfamily lectin. Closely related to Siglec 5. Contains 3 C2-type domains and one V-type domain. Intracellular region has two ITIM motifs. Multiple isoforms.	Long isoform strongly expressed by eosinophils, neutrophils, and monocytes in bone marrow, spleen, and spinal cord. Sv2 isoform expressed in lymph node, lung, ovary, and appendix.	Likely to be inhibitory receptor, and may modulate eosinophil activity during allergic reaction	—
CD331	<b>FGFR1</b> , FLT2, FLG	130 kDa type I transmembrane protein and a receptor tyrosine kinase of the FGF receptor family. Contains 3 C2-type domains and multiple N-linked glycosylation sites. Binding of FGF ligand induces receptor dimerization.	Fibroblasts, epithelial cells, endothelial cells	Mediates responses to fibroblast growth factors, regulating cell proliferation, differentiation, and migration during embryogenesis. Also involved in adult wound repair.	Potential target of tyrosine kinase inhibitors for use in treatment of various cancers
CD332	<b>FGFR2</b> , KGFR, TK14, BEK, KSAM-1	115-135 kDa type I membrane protein and receptor tyrosine kinase of the FGF receptor family. Contains 3 C2-type domains and multiple N-linked glycosylations. Ligand binding induces dimerization. Multiple isoforms.	Isoform FGFR2b exclusively expressed by epithelial cells; FGFR2c exclusively expressed by mesenchymal cells	Mediates responses to FGFs, especially during embryogenesis, adult tissue repair, and tumor angiogenesis	—
CD333	<b>FGFR3</b> , JTK4	115-135 kDa type I membrane protein and receptor tyrosine kinase of the FGF receptor family. Contains 3 C2-type domains with multiple N-linked glycosylations. Ligand binding induces dimerization. Multiple isoforms.	Fibroblasts and epithelial cells	FGF-induced CD333-mediated signaling plays critical role in growth and development of the skeleton. Abnormal expression of CD333 linked to papillary bladder tumors, multiple myeloma, peripheral T cell lymphoma, thyroid, cervical, and colorectal carcinoma.	—

CD334	<b>FGFR4, JTK2, TKF</b>	110 kDa type I membrane protein and receptor tyrosine kinase of the FGF receptor family. Has three C2-type domains, the membrane-proximal one with multiple N-linked glycosylation sites. Ligand binding induces dimerization.	Epithelial cells, fibroblasts, skeletal muscle cells	Plays role in differentiation of skeletal muscle cells. Mutations associated with breast, colon, prostate cancers, head and neck squamous carcinoma, lung adenocarcinoma.	CD334 expression level prognostic indicator for number of cancers. Potential therapeutic target for cancer treatment.
CD335	<b>NKp46, NCR1, Ly94</b>	46 kDa type I membrane protein and member of natural cytotoxicity receptor (NCR) family within Ig superfamily. Contains two C2-type domains and O- and N-linked glycosylation sites.	Resting and activated NK cells	Major lysis receptor for NK cells and mediates direct lysis of virus infected cells and tumor cells. Surface expression density correlates with magnitude of NK cell cytolytic activity against target cells.	Specific marker for NK cells
CD336	<b>NKp44, NCR2, Ly95</b>	44 kDa type I membrane protein and member of NCR family. Contains single C2-type domain.	IL-2 activated NK cells and minor T cell subset	May contribute to increased efficiency of activated NK cells to mediate lysis of virus-infected cells and tumor cells. Surface density correlates with cytolytic magnitude.	—
CD337	<b>NKp30, NCR3, Ly117, 1C7</b>	30 kDa type I membrane protein and member of NCR family. Contains single C2-type domain.	Resting and activated NK cells	Main receptor involved in killing immature dendritic cells. Surface density correlates with cytolytic magnitude.	Specific marker for NK cells
CD338	<b>ABCG2, BCRP, BCRP1, ABCP, MRX, MXR, MXR1, BMDP, ABC15</b>	72 kDa integral membrane protein and member of ABC transporter superfamily. Contains 6 membrane-spanning domains, with both termini cytoplasmic. Probably forms disulfide-linked homodimers or homotetramers.	Subpopulation of hematopoietic stem cells as well as stem cells from other tissues. Expressed by large variety of other cells.	Efflux transport protein using ATP hydrolysis to drive efflux of numerous molecules including chemotherapy drugs against concentration gradient. Role in stem cells unclear, but may protect cells against exogenous cytotoxic substrates.	Marker for stem cells. Inhibitors to CD338 used in conjunction with chemotherapeutic agents

*continued*

**Table A.4A.1** CD Molecules<sup>a,b</sup>, *continued*

Index	Other names	Mol. wt./family/molecular structure	Cellular expression	Function	Usefulness
CD339	Jagged1, <b>JAG1</b> , JAGL1, hJ1	150 kDa Type I transmembrane protein and member of jagged ligands family. Single DSL domain followed by fifteen EGF domains and cysteine-rich juxtamembrane domain.	Stromal and epithelial cells	Acts as ligand for some Notch receptors. Involved in cell fate decisions during hematopoiesis and cardiovascular system development.	—
CD340	HER2/neu, <b>ERBB2</b> , p185HER2	185 kDa Type I transmembrane protein and member of the ERBB family of receptor tyrosine kinases. Contains two cysteine-rich extracellular domains, but does not bind any known ERBB ligand on its own.	Bone marrow mesenchymal stem cells, subsets of c-ALL blasts and in B cell lymphoblastic leukemia. Overexpression seen in many cancers.	Forms heterodimers with ligand-bound ERBB family members. Heterodimerization may stabilize ligand binding and contribute to kinase-mediated activation of downstream signaling. When overexpressed, homodimerization occurs as seen in many cancers.	Therapeutic target in treatment of HER2-positive breast cancers. Prognostic marker for carcinoma.
CD344	Frizzled-4, FZ-4, <b>FZD4</b> , hFz-4, FzE4	60 kDa (unprocessed precursor) integral membrane protein and member of Frizzled family of G protein-coupled receptors. May form heterodimers. Contains intracellular Wnt/ $\beta$ -catenin pathway activation motif.	Kidney, brain, lung, liver. Expressed by fetal neuronal progenitor cells and neuronal intestinal cells.	Essential for regulation of tissue and cell polarity, embryonic development, regulation of proliferation, and many other developmental processes. Receptor for Wnt proteins.	Marker for neuronal stem cells
CD349	Frizzled-9, FZ9, <b>FZD9</b> , FzE6	65 kDa (unprocessed precursor) integral membrane protein and member of Frizzled family of G protein-coupled receptors. May form heterodimers. Contains intracellular Wnt/ $\beta$ -catenin pathway activation motif.	Adult and fetal brain, testis, eye, skeletal muscle, kidney. CFU-F-forming mesenchymal stem cells of bone marrow and placenta	Essential for regulation of tissue and cell polarity, embryonic development, regulation of proliferation, and many other developmental processes. Receptor for Wnt proteins. Important factor for development of nervous system and critical for hippocampal development.	Marker for bone marrow and placental mesenchymal stem cells



CD350	Frizzled-10, <b>FZD10</b> , FZ10, hFz10, FzE7	65 kDa (unprocessed precursor) integral membrane protein and member of Frizzled family of G protein-coupled receptors. May form heterodimers. Contains intracellular Wnt/ $\beta$ -catenin pathway activation motif.	Placenta, fetal kidney, fetal lung, fetal brain. Also seen in a number of cancer cell lines.	Essential for regulation of tissue and cell polarity, embryonic development, regulation of proliferation, and many other developmental processes. Receptor for Wnt proteins.	—
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<sup>a</sup>Entries in bold signify the gene name as listed by the U.S. National Center for Biotechnology Information (NCBI; <http://www.ncbi.nlm.nih.gov/>). Entries in parentheses signify CD numbers allocated to known molecules, but where no antibodies have been formally assigned in the course of HLDA Workshops.

<sup>b</sup>Abbreviations: ADA, adenosine deaminase; ADCC, antibody-dependent cell-mediated cytotoxicity; ALL, acute lymphocytic leukemia; AML, acute myelogenous leukemia; APC, antigen-presenting cells; B-CLL, chronic lymphocytic leukemia, B cell type; BCR, B cell receptor; BM, bone marrow; CFU-GM, colony-forming unit, granulocyte-monocyte; CJD, Creutzfeldt-Jakob disease; CLL, chronic lymphocytic leukemia; CNS, central nervous system; DC, dendritic cells; EBV, Epstein-Barr virus; EC, extracellular; ECM, extracellular matrix; EGF, epidermal growth factor; ELC, Epstein-Barr virus-induced molecule-1 ligand chemokine; FDC, follicular dendritic cells; FGF, fibroblast growth factor; GM-CSF, granulocyte-macrophage colony stimulating factor; GPCR, G protein-coupled receptor; GPI, glycosyl phosphatidylinositol; GSL, glycosphingolipid; GVHD, graft-versus-host disease; HepB, hepatitis B; HLA, human leukocyte antigen; HSC, hematopoietic stem cells; HSV, herpes simplex virus; HUVEC, human umbilical vein endothelial cells; ICAM, intercellular adhesion molecule; IDC, interdigitating cells; IEL, intraepithelial lymphocytes; IFN, interferon; Ig, immunoglobulin; IL, interleukin; ITAM, immunoreceptor tyrosine-based activation motif; ITIM, immunoreceptor tyrosine-based inhibitory motif; ITSM, immunoreceptor tyrosine-based switch motif; JAK, Janus kinase; KO, knockout; LDL, low-density lipoprotein; LIF, leukemia inhibitory factor; LFA, lymphocyte function-associated antigen; LPS, lipopolysaccharide; MAb, monoclonal antibody; MAdCAM, mucosal addressin cell adhesion molecule; M-CSF, macrophage colony stimulating factor; MHC, major histocompatibility complex; MIP, macrophage inflammatory protein; NCAM, neural cell adhesion molecule; NGF, nerve growth factor; NHL, non-Hodgkin's lymphoma; NK, natural killer; PB, peripheral blood; PBL, peripheral blood lymphocytes; PBMC, peripheral blood mononuclear cells; PDGF, platelet-derived growth factor; PMA, phorbol myristate acetate; PMN, polymorphonuclear lymphocytes; PTK, protein tyrosine kinase; RANTES, regulated upon activation, normal T cell expressed and secreted; RBC, red blood cells; RGD, single-letter code for arginine-glycine-aspartate motif; SCF, stem cell factor; SLAM, signaling lymphocytic activation molecule; SLC, secondary lymphoid organ chemokine (or, when part of a gene name, e.g., *SLC3A2*, solute carrier family member); SRBC, sheep red blood cell; TAPE, threonine-, alanine-, proline-, and glutamine-rich repeats; TARC, thymus and activation regulated chemokine; TCR, T cell receptor; TLR, toll-like receptor; T<sub>H</sub>, helper T cells; TNF, tumor necrosis factor; TNFR, tumor necrosis factor receptor; VCAM, vascular cell adhesion molecule; VEGF, vascular endothelial growth factor; VLA, very late antigen.