

THE CD SYSTEM OF LEUKOCYTE SURFACE MOLECULES

APPENDIX 4

Monoclonal Antibodies to Human Cell Surface Antigens

APPENDIX 4A

During the last 20 years, an ever-increasing number of monoclonal antibodies (mAbs) have been produced that have facilitated the purification, cloning, and functional characterization of a plethora of leukocyte surface molecules. International cooperative efforts were instrumental in coordinating this development and in studying all mAb-defined structures at the molecular level with all available techniques. This was accomplished by creating a series of international workshops, at which investigators have, up until now, defined nearly 300 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 last workshop (the 7th) was held in Harrogate, U.K., in June, 2000. The data from this workshop are summarized in the workshop proceedings published by Oxford University Press (Mason et al., 2002). The next workshop, organized by Hedly Zola, is currently underway and will be completed with a meeting in Adelaide, Australia in December 2004. Details of the 8th Workshop can be obtained from the Web site <http://www.HLDA8.org>.

CD ANTIBODIES/MOLECULES: DEFINITION

Initially, the 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; 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 (see also 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 yet characterized, but in others the number of antibodies assigned in the Workshops is considerable. In addition, remarks concerning the molecular and/or functional characteristics of CD molecules and CD mAbs are brief. 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). Protein Reviews on the Web (PROW) is a database established by Stephen Shaw accessible at <http://www.ncbi.nlm.nih.gov/PROW/>, which provides authoritative peer-reviewed summaries and links to genome and protein databases. Finally, for portable convenience, a similar compilation is available for personal digital assistant (Nicholson et al., 2002).

The CD System of
Leukocyte
Surface Molecules

A.4A.1

Contributed by Hannes Stockinger, Otto Majdic, Walter Knapp, Bernadette Swart, Ian Nicholson, and Hedly Zola

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Contributed by Hannes Stockinger, Otto Majdic, and Walter Knapp
Institute of Immunology, University of Vienna
Vienna, Austria

Bernadette Swart
Child Health Research Institute, Women's and Children's Hospital
Adelaide, Australia

Ian Nicholson and Heddy Zola
Child Health Research Institute, Women's and Children's Hospital and Cooperative Research
Centre for Diagnostics
Adelaide, Australia

Table A.4A.1 CD Molecules^{a,b}

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD1	T6 (CD1a and b)	A group of 5 genes coding 43-49 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	—
CD2	SRBC receptor, LFA-2, T11	45-88 kDa superfamily type I integral glycoprotein with one C2-like and one V-like domain. Three N-glycosylation sites accounting for 5-10 kDa. 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 and CD15. CD2 binding by ligands induces T cell activation. Knockout mice have apparently healthy immune systems.	Original T cell marker, used in typing leukemias
CD3 complex	T3	Multimolecular complex of Ig superfamily members (γ, δ, ϵ) and molecules related to FcR γ chain (ζ, η): CD3- γ , 25kDa; CD3- δ , 20 kDa; CD3- ϵ , 20 kDa; CD3- ζ , 16 kDa; CD3- η , 22kDa.	T lineage cells	Required for cell surface expression of T cell receptor and signal transduction	Best marker for cells of T lineage
CD4	OKT4, Leu3a, L3T4, T4	55 kDa Ig superfamily, 4 Ig-like domains	Thymocyte subsets, T cells that recognize peptide antigen associated with MHC class II (helper T cells), peripheral blood monocytes	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

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD5	T1, Ly1	Scavenger receptor family, 67 kDa type I transmembrane monomeric glycoprotein with 3 scavenger receptor cysteine-rich (SRCR) domains. Long cytoplasmic tail with several sites for serine, threonine, and tyrosine phosphorylation.	All T cells, low level on subset B cells including CLL and neonatal B cells	Putative ligand CD72. CD5 participates in a membrane complex with CD3 or Ig. Cytoplasmic sequence binds PTK p56lck through SH2 domain. Knockout mice healthy but show multiple subtle differences in vitro.	Widely used as a marker for B-CLL cells
CD6	T12	100-130 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 co-stimulates with signals through CD3.	Can serve as a CLL marker; mAb has been used to deplete T cells from bone marrow cells for allogeneic transplantation
CD7	Leu 9, 3A1, gp40	40 kDa Ig superfamily, membrane proximal "stalk" has four consensus repeats	T cell precursors, thymocytes, subset of peripheral T cells, pluripotent hemopoietic stem cells, up-regulated on activated T cells	May modulate cell adhesion; no ligand demonstrated	Marker for T cell ALL, pluripotential stem cell leukemia
CD8	OKT8, LeuT, LyT2, T8	Disulfide-linked heterodimer of CD8 α (32-34 kDa) and CD8 β (30-32 kDa), both Ig superfamily; CD8 α can homodimerize, CD8 β cannot	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
CD9	p24, MRP-1	24 kDa type III membrane protein, 4 transmembrane domains, 2 extracellular domains	Platelets, early B cells, activated T cells, eosinophils, basophils	CD9 mAb modulates cell adhesion and migration. Associates with precursor form of HB-EGF	Leukemia immunophenotyping, bone marrow purging, inverse correlation with metastasis

continued

A.4A.4

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD10	Common acute lymphoblastic leukemia antigen (CALLA), Neutral endopeptidase LFA1 α chain	100 kDa type II transmembrane metalloprotease with varying levels of N-glycosylation	Early B lineage cells and again on germinal center B cells; fetal thymocytes. Neutrophils, bone marrow stromal cells, some epithelia.	Peptidase activity may limit action of physiologically active peptides. Knockout mice largely normal.	Diagnostic marker for common (B lineage) acute lymphoblastic leukemia
CD11a	LFA1 α chain	180 kDa type I transmembrane glycoprotein, member of LCAM family. Extracellular sequence contains 12 N-glycosylation sites and seven tandem repeats of which three contain putative cation binding sites.	Leukocyte-restricted; highly expressed on lymphocytes, monocytes, and macrophages; lower levels on polymorphs	CD11a complexes with CD18 to form the integrin LFA-1, an adhesion and signal-transduction molecule involved in inflammation. Specific ligand is not clear. CD11a knockout mice show major deficits in immune reactions.	Useful leukocyte marker in tissue pathology; antibodies are immunosuppressive in animal models
CD11b	Mac-1 α chain	170 kDa type I transmembrane glycoprotein, member of LCAM family. Extracellular portion contains 19 N-glycosylation sites and 7 tandem repeats, 3 with cation-binding motifs	Myeloid and NK cells	CD11b-CD18 forms the integrin Mac-1, which binds multiple ligands including iC3b and several of the ICAMS. The complex forms an adhesion molecules with signaling activity. Appears to be involved in inflammation.	Used to detect monocytes and macrophages
CD11c	α chain of CR4	150 kDa type I transmembrane glycoprotein LCAM family member. 10 potential N-glycosylation sites, 7 tandem repeats with 3 putative cation-binding motifs.	Myeloid NK and dendritic 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. Appears to be involved in inflammation.	Used to detect myeloid cells in tissue studies
CD12	P90-120	150-160 kDa	Monocytes, granulocytes, NK cells	Not known	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD13	Aminopeptidase N, APN, gp150, EC 3.4.11.2	150 kDa type II transmembrane glycoprotein, homodimer	CFU-GM, granulocytes, monocytes, bone marrow stroma, osteoclasts, intestinal brush border	Zinc metalloproteinase; trims peptides bound to MHC Class II; Receptor for coronaviruses	CD13 autoantibodies associated with GVHD in bone marrow transplantation
CD14	LPS receptor	53-55 kDa GPI linked, LRG leucine-rich repeats	Monocytes, macrophages, granulocytes, microglia	LPS receptor. LPS binding activates CD14 ⁺ cells. LPS binds serum LBP, which facilitates binding to CD14.	Used as marker for monocytes
CD15	Lewis X, Le-X, X-Hapten, CD 15u indicates sulfated Lewis X. CD 15s indicates sialyl Lewis X	Carbohydrate epitope (3-fucosyl-N-acetyl lactosamine) attached to lipids or proteins	Neutrophils, eosinophils express CD15 and CD15s. Monocytes express CD 15s, which is also on high-endothelial venules and on subcapsular sinus cells in lymph nodes	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.	CD15 is a marker for mature granulocytes
CD16	Fc γ receptor type IIIb (Fc γ RIIIb)	50-80 kDa type I transmembrane glycoprotein; also occurs in GPI linked form. Two extracellular domains of the C2 set of the Ig superfamily.	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 ϵ RI γ chain. Binds antibody-antigen complexes.	Used as a marker for NK cells
CD17	LacCer, lactosylceramide	Lactosyl disaccharide group, Gal β 1-4Glc β 1-1Cer	Monocytes, granulocytes, basophils, platelets, subset of B cells	Unknown. Binds to bacteria and may function in phagocytosis.	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD18	Integrin $\beta 2$ β -chain	95 kDa type I transmembrane glycoprotein with extensive N-glycosylation	Leukocytes, broadly expressed	Interacts noncovalently with CD11a, b, c, or d to form the adhesion molecule complexes LFA-1, Mac-1, p150,95, and $\alpha D\beta 2$ respectively. Knockout mice show marked leukocyte functional defects. CD18 deficiency results in leukocyte adhesion deficiency type 1 (LAD).	Research reagent
CD19	B4	95 kDa Ig superfamily, multiple serine/threonine, and tyrosine phosphorylation sites	B lineage except plasma cells, follicular dendritic cells, malignant B cells	Signal transduction, part of B cell receptor complex with CD21 and CD81, CD19 null mice have decreased numbers of B cells, and decreased mitogenic response, and low germinal center formation	Major B lineage marker; CD19 mAb used in immunotherapy (e.g., Bexxar)
CD20	B1	35 kDa tetraspan protein	B lineage from pre-B to plasma cells	Calcium channel; CD20 null mice have normal B cell function	CD20 mAb used for immunotherapy of NHL (e.g., Rituximab)
CD21	C3d receptor, CR2	140 kD type I glycoprotein member of the complement control protein (regulators of complement activation) family. Extracellular 15-16 short consensus repeats; cytoplasmic phosphorylation sites	Mature B cells and follicular dendritic cells	Receptor for C3d, and Epstein-Barr virus. Complexes with CD19, CD81 and leu13 involved in B cell activation	Used in leukemia phenotyping and in immunohistology

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD22	BL-CAM	Ig superfamily/type I transmembrane glycoprotein with 6 C2-like and one V domain, mol. wt. 140 kDa. 130 kDa isoform, with one C2-domain fewer, coexpressed at lower levels. Cytoplasmic tail contains 6 tyrosines.	Mature B cells and their malignancies. Cytoplasmic in early B cells.	Adhesion and signaling molecule. Sialic acid binding lectin (generically called Siglec). Binds numerous glycoproteins, including CD45. Cytoplasmic region contains ITAM and ITIM sequences. Knockout mice have fewer mature B cells, less surface Ig and are more sensitive to triggering, through B cell receptor	Diagnosis and experimental therapy of mature B cell malignancies
CD23	BLAST-2 low affinity IgE receptor B6, FcεRII, Leu-20	45 kDa type II integral membrane protein, C-type lectin	B cells, monocytes, follicular dendritic cells, 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 a poor prognostic indicator
CD24	BA-1, HAS	35-45 kDa GPI-linked glycoprotein	All B lineage except plasma cells, mature granulocytes	Not known	Marker for staging B cell development
CD25	TAC, IL-2 receptor α chain	55 kDa type I transmembrane glycoprotein member of complement control protein (CCP) family. Proteolytic fragment found in serum.	Activated T cells, B cells, and monocytes. Low level on subset of resting T cells.	Component of the three-chain receptor for IL-2. Has short cytoplasmic tail and is involved in ligand binding rather than signaling	Membrane-bound and soluble CD25 are used to monitor cell activation in immune response
CD26	Dipeptidyl peptidase (DPPIV), adenosine deaminase (ADA)-binding protein	110 kDa type II transmembrane glycoprotein, lacking homology to other protein families	Activated T and B cells and monocytes, epithelial cells and 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.	—

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD27	None	TNF/NGF receptor family, mol. wt., 55 kDa. Glycosylated type I transmembrane protein, expressed as cysteine-linked homodimer. N and extensive O-glycosylation; intracellular serine phosphorylation site but lacks the death domain.	Restricted to lymphocytes. Soluble form found in serum.	Ligand for CD70. Knockout mice have apparently normal numbers and distribution of T and B cells. CD70-CD27 interaction appears important in primary T cell responses.	Marker for naive T cells and increased soluble CD27 in inflammatory conditions
CD28	Tp44, T44	44 kDa Ig superfamily type I transmembrane glycoprotein, expressed as homodimer	T cell subset, activated B cells	Ligand for CD80/CD86 (B7-1, B7-2), 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, structurally related to CD152 (CTLA4) but functionally distinct.	—
CD29	Integrin β 1 chain, VLA-beta chain, platelet GPIIa	110 kDa integrin; forms heterodimer with any integrin α 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 hemopoietic stem cell differentiation.	—
CD30	Ki-1, Ber H2	105 kDa TNFR family type I transmembrane glycoprotein	Reed-Sternberg cells in Hodgkin's lymphoma, activated B, T, and NK cells, monocytes	Involved in negative selection of T cells in thymus; CD30 null mice have increased number of thymocytes	Elevated soluble CD30 correlates with activity of hepatitis B infection; CD30 ⁺ lymphomas have better prognosis

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD31	PECAM-1 (platelet/endothelial cell adhesion molecule-1), endocam, platelet GPIIb	130-140 kDa Ig superfamily type I glycoprotein with 6 C2-type domains and a 118 cytoplasmic tail with ITIM-like sequence. N-linked carbohydrate comprises ~40% of molecular weight	Vascular endothelium, polymorphs, platelets, B cells, T cell subsets; soluble forms in serum	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). Knockout mice show defective transendothelial leukocyte migration.	Research reagent
CD32	FcγRII	40-kDa Ig superfamily protein with three isoforms (FcγRIIa, b, and c) and multiple splice variants. Two Ig C-like extracellular domains. Intracellular region has ITAM (a, c isoforms) or ITIM (b isoforms).	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; binds IgG2 preferentially. The b isoform mediates feedback inhibition of B cell responses, while ITAM-bearing 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
CD33	My9; gP67	67 kDa Ig superfamily type I transmembrane glycoprotein. One extracellular C2 and one V domain, with 5 sites for N-glycosylation	Principally restricted to myeloid cells; strong on monocytes, macrophages, mast cells, Langerhans cells; weak on polymorphs. 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, particularly types M1-5 (FAB classification)
CD34	None	105-120 kDa sialomucin-like type I transmembrane glycoprotein. Heavily glycosylated.	Hematopoietic precursor cells, bone marrow stromal cells, capillary endothelium	Ligand for CD62L (L-selectin)	Marker for stem cells

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD35	Complement Receptor type 1, CR1, C3b/C4b receptor, immune adherence receptor	220 kDa type I transmembrane glycoprotein; extracellular domain consists of tandemly repeated complement control protein repeats	Erythrocytes, neutrophils, monocytes, eosinophils, B lymphocytes, 10%-15% 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.	—
CD36	GPIV, OKM-5, GPIIb, PASIV	88-113 kDa transmembrane glycoprotein	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	—
CD37	None	40-52 kDa tetraspan glycoprotein, with 2-3 N-linked carbohydrates and protein core of 26 kDa	High density on B 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
CD38	T10	45 kDa type II transmembrane glycoprotein. 4 N-glycosylation sites. Soluble form found in serum.	Early B and T cells, activated T cells, germinal center B cells, plasma cells. Hematopoietic progenitor at a restricted differentiation stage.	Adhesion molecule, binding to CD31. Ligation induces cell activation and proliferation or death. Has NAD ⁺ glycohydrolase, ADP-ribosyl cyclase, and ADP-ribose hydrolase activities; Knockout mice show deficiencies in these enzyme activities.	Phenotypic marker in leukemia and HIV-1; used to purify bone marrow and germinal center subsets
CD39	None	80 kDa ecto-apyrase glycoprotein with both amino- and carboxy-termini cytoplasmic	Mantle zone B cells, activated T cells, NK cells, macrophages, Langerhans cells, dendritic cells	Mediates homotypic adhesion and ecto-apyrase activity	Research reagent

A.4A.11

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD40	None	50 kDa TNF/NGF receptor superfamily type I integral membrane glycoprotein with 4 cysteine-rich repeats	B cells, monocytes, dendritic cells	Receptor for co-stimulatory signal to B cells, binding CD154 (CD40L). Mutations in the ligand are associated with the immune deficiency disorder Hyper-IgM syndrome. See CD154, below	CD40 antibody can substitute for CD40 ligand in activating B cells
CD40L	CD40 ligand; see CD154, below	See CD154, below	See CD154, below	See CD154, below	See CD154, below
CD41	Glycoprotein IIb, α II β integrin	135 kDa heterodimer integrin family β chain transmembrane protein, disulfide linked to α chain	Platelets and platelet precursors	CD41/CD61 complex involved in platelet activation and aggregation	Research reagent
CD42 (a-d)	CD42a, platelet glycoprotein IX (GPIX); CD42b, GPIIb- α ; CD42c, GPIIb- β ; CD42d, GPV	23 kDa (CD42a); 135/22 kDa heterodimer (CD42b/c); 85 kDa (CD42d): membrane glycoproteins which together form the CD42 complex	Platelets and megakaryocytes	Complex is essential for platelet adhesion to sites of injury. CD42b binds von Willebrand factor	Research reagent
CD43	Leukosialin, sialophorin	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 adhesion and inhibition of adhesion. Possible ligands are CD54 and hyaluronic acid. Knockout mice show increased T cell adhesion and easier activation.	CD43 expression is defective in Wiskott-Aldrich syndrome. HIV-infected cells express modified CD43 glycosylation pattern.
CD44	pgp1	80-95 kDa type I transmembrane glycoprotein with a cartilage link protein (hyaladherin) module. Alternative splicing leads to multiple variant (CD44v) forms with differential expression and function.	Leukocytes and erythrocytes. Variant forms widely expressed on endothelia and epithelia.	Adhesion and signaling. Binds hyaluronic acid. CD44v isoforms possibly involved in tumor metastasis.	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD45	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	All hemopoietic cells; isoform expression can change with activation	Tyrosine phosphatase (EC 3.1.34)	Isoforms are used to discriminate naive and memory (RA/RO) cells
CD45RA	None	205-220 kDa isoform of CD45	Naive T cells, B cells	As for CD45	Used as a marker of "naive" lymphocytes
CD45RO	None	Isoforms of CD45 (see CD45 entry) with no insertion at the splice insertion point	T cell subset, described as memory T cells. CD45RA ⁺ 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, MCP	Four N-terminal short consensus repeat modules. Single-chain type I transmembrane molecule. 4 isoforms generated by alternate splicing plus glycosylation 56-76 kDa.	Lymphocytes, tumor cells, placental trophoblasts, sperm cells, fibroblasts	Cofactor for factor I proteolytic cleavage of C3b and C4b. No CD46 mutations or deficiencies have been identified.	Research reagent
CD47	Integrin-associated protein (IAP), ovarian carcinoma antigen OA3	45-60 kDa Ig superfamily member	Broad: hemopoietic cells, epithelial and endothelial cells, fibroblasts	CD47 null mice have defect in host defense	Research reagent
CD48	BLAST-1, Hulym3, OX45, BCM1	GPI-linked. 2 Ig like domains, 45 kDa	Pan-leukocyte; not neutrophils, not platelets	CD2 binding	Fewer CD48 ⁺ lymphocytes in paroxysmal nocturnal hemoglobinuria
CD49a	α 1, very late antigen, VLA 1 α chain	200 kDa integrin type I transmembrane molecule, long type I transmembrane glycoprotein	Activated T cells, monocytes, cultured neuronal cells, melanoma cells	Adhesion receptor for collagen and laminin-1	Up-regulated in several inflammatory diseases of human intestine

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD49b	Integrin $\alpha 2$ chain, VLA-2 α chain, platelet GPIa	150 kDa integrin, long type I transmembrane glycoprotein	Platelets, megakaryocytes, activated T cells, B lymphocytes, monocytes, epithelial cells, endothelial cells, fibroblasts	Covalently associated with integrin $\beta 1$ chain to form VLA-2. Mediates cell adhesion to collagen, laminin. Promotes wound healing by collagen contraction.	Research reagent
CD49c	$\alpha 3$, VLA-3 α chain	145-150 kDa integrin, long type I transmembrane glycoprotein. Cleaved into heavy and light chains and expressed as disulfide linked.	B cells, adherent cell lines	Component of adhesion receptor for laminin-5, fibronectin, invasin, laminin-1, collagen, entactin	Research reagent
CD49d	$\alpha 4$ integrin, VLA-4 α chain	145 kDa integrin, long type I transmembrane glycoprotein. Cleaved into heavy and light chains and expressed as disulfide linked.	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, cell adhesion to VCAM-1, MAAdCAM-1, fibronectin, thrombospondin. Involved in multiple inflammatory responses, essential to differentiation and migration of hemopoietic stem cells, role in tumor progression and metastasis.	Research reagent
CD49e	$\alpha 5$, VLA-5 α chain	160 kDa integrin, long type I transmembrane glycoprotein. Cleaved into heavy and light chains and expressed as disulfide linked.	Variety of adherent and nonadherent cells, monocytes, NK cells, dendritic cells, osteoblasts	Adhesion to fibronectin. Null mutation is embryonic lethal	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD49f	$\alpha 6$, VLA-6 α chain, platelet GPIc	150 kDa integrin, 125 + 25 kDa disulfide linked domain, long type I transmembrane glycoprotein. Cleaved into heavy and light chains and expressed as disulfide linked.	Platelets, megakaryocytes, monocytes, T cells, thymocytes, many cultured adherent cell lines	Heterodimer $\alpha 6\beta 1$, adhesion to laminins, invasins, merosin. Interaction between epithelial cells and basement membrane during wound healing. Involved in tumour metastasis	Research reagent
CD50	ICAM-3, intercellular adhesion molecule 3	120-140 kDa Ig superfamily, five Ig-like domains	Leukocytes, Langerhans cells	Regulates LFA/ICAM1 and integrin $\beta 1$ -dependent adhesion; provides costimulatory signal during immune response	Research reagent
CD51	Integrin α chain, vitronectin receptor	Disulfide linked 125 kDa and 24 kDa molecule. Integrin α chain family	Endothelial cells; cultured/activated monocytes and macrophages, platelets, activated T cells, some B cells osteoclasts	Complex of CD51/CD61 binds RGD motifs in ECM proteins vitronectin, van Willebrand factor. Adhesion to cell matrix.	Research reagent
CD52	Campath-1	21-28 kDa GPI anchored membrane glycopeptide, consisting of 12 amino acid residues bearing a complex N-linked carbohydrate structure	Lymphocytes, monocytes, eosinophils; male reproductive tract epithelium and mature sperm (absorbed from seminal fluid)	Not known, but present at high concentrations (500,000 molecules per lymphocyte). CD52- cells (in patients treated with anti-CD52 antibody) appear to function normally.	Murine and humanized antibodies used in treatment of leukemia and to reduce lymphocyte numbers and function in autoimmune disease and organ or bone marrow transplantation
CD53	MRC OX-44	35-42 kDa tetraspan superfamily member	Thymocytes, T cells, B cells, monocytes, granulocytes, osteoblasts, osteoclasts. Not in erythrocytes.	CD53 cross-linking induces calcium mobilization	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD54	ICAM-1, intercellular adhesion molecule 1	90 kDa type I transmembrane glycoprotein member of Ig superfamily with 5 Ig like domains and extensive glycosylation. Soluble form in serum.	Absent from resting leukocytes but expressed on activated T, B cells, and monocytes. Low levels on endothelin, increased in inflammatory states.	Adhesion molecule binding to LFA-1, Mac-1, 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 potentially useful indicator of inflammation
CD55	DAF, decay accelerating factor	70 kDa GPI-anchored glycoprotein. Four complement control protein repeats.	Wide expression on lymphocytes, erythrocytes	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. Expression may be related to tumorigenesis.
CD56	NKHI	Ig superfamily member in 3 forms and 20-30 splice variants. Hemopoietic form is 140 kD. 5 C-2 set Ig like domains and 2 fibronectin III domains. Variable glycosylation, which includes the CD57 epitope.	Isoforms on neural cells (NCAM), muscle cells, and embryonic tissue and tumors. In hemopoietic 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.	NK cells marker; NK subsets "split" according to level of CD56 expression. Identification of various solid tumors.
CD57	HNK1	Sulfated trisaccharide epitope SO ₄ -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 auto-antibodies in peripheral neuropathy. Expressed on some solid tumors.

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD58	LFA-3, lymphocyte function associated antigen-3	55-70 kDa, Ig superfamily member of CD2 family alternate transmembrane or GPI anchored forms	Leukocytes, erythrocytes, endothelial and epithelial cells, fibroblasts	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
CD59	MACIF, MIRL, P-18	18-25 kDa GPI anchored protein, Ly6 superfamily, structurally related to snake venom neurotoxins	Widely expressed, 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.	Research reagent
CD60	CD60a, CD60b, CD60c	GD3 (CD60a), 9-O-acetyl GD3 (CD60b), 7-O-acetyl GD3 (CD60c)	Subset of activated T cells, platelets, thymic epithelium, smooth muscle cells, IL-13-activated keratinocytes	CD60a,b are costimulatory, GD3 may be involved in apoptosis induction	High frequency of CD60 ⁺ T cells in synovial fluid of normal and arthritic patients and in cutaneous psoriatic lesions. CD60 expression may correlate with CD4 T _H 2 type cytokine profile. Research reagent
CD61	Glycoprotein IIIa, β3 integrin	90 kDa integrin	Platelets and megakaryocytes, endothelium, smooth muscle, some B cells, monocytes, macrophages	Common β subunit of CD41/61 and CD51/61, CD41/61 mediates attachment to matrix proteins	

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD62E	E-selectin, LECAM-2, ELAM-1	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	Binds sialyl Lewis-X (CD15s) through the C-type lectin domain, ligands include ESL-1 and PSGL-1. Adhesion molecule involved in leukocyte extravasation. Mice deficient in CD62E and CD62P have reduced leukocyte recruitment to inflammatory sites.	Research reagent
CD62L	L-selectin, LAM-1, Mel-14	75-95 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.	Binds glycoproteins bearing CD155 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.	Research reagent
CD62P	P-selectin	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.	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD63	LIMP, gp55, LAMP-3, neuroglanular antigen, melanoma-associated antigen ME491, PTLGP40, granulophysin FcR1, FcγR1, high-affinity Fcγ receptor	40-55 kDa tetraspan superfamily, Intracellular lysosomal protein. Major extracellular domain between transmembrane segments 3 and 4 heavily glycosylated.	All T cells; low level on subset of B cells including CLL and neonatal B cells	Activated platelets, degranulated neutrophils, monocytes, macrophages, endothelium	Marker of platelet activation; marker for primary melanoma
CD64		72 kDa, Ig superfamily protein	Monocytes, macrophages, subset of blood and germinal center dendritic cells	Receptor mediated phagocytosis of immune complexes, ADCC	Research reagent
CD65	Ceramide dodecasaccharide 4c	Ceramide oligosaccharide. Some antibodies recognize a sialylated form, CD65S	Granulocytes, monocytes	Unknown, possible ligand for CD62P and CD62E	Research reagent
CD66a	BGP, biliary glycoprotein, NCA-160	140-180 kDa CEA family, Ig superfamily glycoprotein	Granulocytes, epithelial cells	Capable of homophilic and heterophilic adhesion, capable of activating neutrophils; receptor for <i>N. meningitis</i> , <i>N. gonorrhoeae</i>	Research reagent
CD66b	Previously CD67; CGM6, NCA-95	95-100 kDa CEA family, GPI linked, Ig superfamily glycoprotein	Granulocytes	Capable of heterophilic adhesion with CD66c, capable of activating neutrophils. Released during granulocyte activation.	Research reagent
CD66c	NCA, nonspecific cross-reaction antigen, NCA-50/90	90 kDa CEA family, GPI linked, Ig superfamily glycoprotein	Granulocytes and epithelial cells	Capable of homophilic adhesion, capable of activating neutrophils	Research reagent
CD66d	CGM1	35 kDa CEA family, Ig superfamily glycoprotein	Granulocytes	May be involved in signaling and adhesion	Research reagent

continued

A.4A.19

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD66e	CEA, carcinoembryonic antigen	180-200 kDa, CEA family (Ig superfamily), GPI linked, Ig superfamily glycoprotein	Epithelial cells	Capable of homophilic and heterophilic adhesion. 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 β 1 glycoprotein	54-72 kDa CEA family, Ig superfamily glycoprotein	Detected in serum. Produced by placental syncytiotrophoblasts, fetal liver, myeloid cell lines	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
CD68	gp110, macrosialin	110 kDa type I transmembrane glycoprotein	Mainly expressed in cytoplasmic granules, but also on surface; monocytes and macrophages, DC, neutrophils, basophils, eosinophils, mast cells, subset of CD34 ⁺ bone marrow progenitors	—	Research reagent
CD69	AIM, activation inducer molecule, MLR3, EA1, VEA	60 kDa type II transmembrane C-type lectin disulfide linked heterodimer (28+32) kDa. Constitutively phosphorylated.	Activated leukocytes: T cells, thymocytes, B cells, NK cells, neutrophils, eosinophils	Involved in signal transduction, calcium influx	Marker of early T cell activation
CD70	CD27 ligand	29 kDa type II transmembrane protein, TNF family	Activated T and B cells	Costimulation of T and B cells	Research reagent
CD71	Transferrin receptor, T9	190 kDa disulfide bonded homodimer type II transmembrane protein	All proliferating cells	Binds transferrin and mediates iron uptake	Marker of proliferation, has been used to target cytotoxic molecules to proliferating cells
CD72	Lyb-2	42 kDa reduced, 86 kDa unreduced homodimer; C-type lectin family	All B lymphocytes, not plasma cells. Weak on tissue macrophages; not monocytes	Ligand for CD5	Expressed on B lineage NHL and leukemias

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD73	Ecto-5'-nucleotidase	69-72 kDa GPI anchored enzyme	Subset of T and B lymphocytes, FDC, epithelial and endothelial cells	Dephosphorylates ribo and deoxyribonucleoside monophosphates to the nucleoside	High CD73 expression in leukemia or lymphoma is a poor prognostic indicator; low CD73 expression found in some immunodeficiency diseases
CD74	MHC Class II-associated invariant chain (Ii)	Isoforms, mol. wt. 33, 35, 41, 42. Type II transmembrane glycoprotein not recognized as a member of a structural family. N and O-glycosylated.	MHC class II positive cells, including B cells and other antigen-presenting cells and activated T cells	Function in transport and expression of MHC class II is well characterized; cell surface function not known	Research reagent
CD75	None	Carbohydrate, NeuAc α 2,6Gal β 1,4GlcNAc, found on glycolipids and glycoproteins. CD75 and CD75s (formerly CD76) share a core carbohydrate but differ in sialylation	Mature B cells including germinal center cells strongly; extrafollicular and mantle zone cells weakly. T cell subpopulation, erythrocytes, various B cell malignancies	No known function; may be ligand for sialic acid-binding lectins	Used in analysis of leukemia cells
CDw76/CD75s	None	At the seventh HLDA conference, CDw76 was renamed CD75s. CD75 and CD75s recognize the same core carbohydrate but differ in sialylation. Carbohydrate α 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

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD77	Gb3, Pk blood group antigen, BCA	Neutral glycolipid hapten globotriaosyl ceramide (Gb3). Gal α 1-4Gal β 1-4Glc β 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
CDw78	Ba	Deleted from CD classification	Deleted from CD classification	Deleted from CD classification	Deleted from CD classification
CD79a	Immunoglobulin receptor α chain, MB1	40-45 kDa Ig superfamily, disulfide linked heterodimer with CD79b cytoplasmic ITIM motif	B lymphocytes, marginal zone and follicular mantle stronger than germinal center. Plasma cells.	Component of B cell receptor. Expression is essential for B cell receptor expression.	Research reagent
CD79b	Immunoglobulin receptor β chain, B29	37 kDa Ig superfamily, disulfide linked heterodimer with CD79a	B lymphocytes, marginal zone and follicular mantle stronger than germinal center. Not on 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.	—
CD80	B7.1	60 kDa type I transmembrane glycoprotein with an N-terminal V-set Ig superfamily domain followed by a C2-set domain	B cells, monocytes, dendritic cells, activated T cells	Costimulation of T cells through ligation of CD28 and CTLA-4 (CD152)	Research reagent
CD81	TAPA-I (target of anti-proliferative antibody)	26 kDa tetraspan, with both termini intra-cytoplasmic. No N-glycosylation	Widely expressed among leukocytes and also found on endothelia	Involved in a signal transduction complex with CD19 and CD21. Knockout mice show subtle defects in B cell maturation and antibody production	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD82	R2, IA4, 4F9, C33, KAI1	45-90 kDa (depends on cell type) tetraspan	Activated differential hemopoietic cells, not expressed by RBC. Epithelial cells, endothelial cells, fibroblasts	Not known	Research reagent
CD83	HB15	43 kDa Ig superfamily-single-V-like domain, heavily glycosylated	Nonfollicular dendritic cells, circulating DC, interdigitating DC, Langerhans cells	Unknown	Dendritic cell marker
CD84	None	73 kDa type I integral membrane glycoprotein with one C2-type and one V-type Ig domain and an 83 residue cytoplasmic chain with 5 tyrosines and putative SH2 binding motifs	Mature B cells, NK cells and monocytes, subsets of T cells (CD45RO positive); at low levels on polymorphs and platelets	Not known, but structural similarities to CD2 and CD48 suggest a function in intercellular interaction and signaling	Research reagent
CD85	ILT (Ig-like transcript) family. Allocated CD85a, b, c etc. in centromeric-telomeric sequence	Family of 13 members with Ig-like extracellular domains. Mol. wt. 110 kDa, details of structure still emerging.	NK, dendritic cells, monocytes, plasma cells; 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	Research reagent
CD86	B7-2, B70	80 kDa Ig superfamily, single V-like domain, single C2-like domain	Interdigitating dendritic cells, Langerhans cells, DC, memory, and germinal center cells	Costimulation of T cells, ligand for CD28/CD152, binds CD152 with 20-to 100-fold higher affinity. Signaling of CD80/CD86 and CD28/CD152 is critical for induction and regulation of immune responses.	—

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD87	Urokinase-type plasminogen activator receptor (UPA-R)	45-65 kDa N-glycosylated GPI-linked protein with three Ly-6 domains	Monocytes, polymorphs, dendritic cells, activated T cells, fibroblasts, endothelial cells, smooth muscle	Binding of UPA induces tyrosinase phosphorylation. Binds vitronectin and interacts with $\beta 1$ and $\beta 2$ integrins. Patients with LAD (lacking $\beta 2$ integrin function) show CD87 signaling deficits. Knockout mice show defect in UPA mediated plasminogen activation.	Elevated expression is a poor prognostic factor in several tumors
CD89	Fc α receptor	Ig superfamily type I transmembrane glycoprotein, 45-70 or 70-100 kDa (eosinophil)	Myeloid lineage (neutrophils, monocytes) activated eosinophils	Binds IgA C $\alpha 2$ -C $\alpha 3$ domain. Binding induces phagocytosis, respiratory burst, degranulation	Research reagent
CD90	Thy1	25-35 kDa Ig superfamily, GPI anchored	Hemopoietic stem cells, neurons, few fetal thymocytes; 10%-40% CD34 ⁺ cells in bone marrow	May contribute to inhibition of proliferation and differentiation	CD34 ⁺ /CD90 ⁺ cells include hemapoietic stem cells
CD91	$\alpha 2$ -macroglobulin receptor, LDL receptor-associated protein	600 kDa dimer, 85 kDa β subunit has TM segment and signal regions, 515 kDa α subunit has 4 LDL receptor class A repeats	Monocyte lineage, erythroblasts/reticulocytes	Gene knockout is incompatible with life	Research reagent
CD92	None	70 kDa protein of unknown structure	Monocytes, granulocytes weak on PBL, fibroblasts	Not known	Research reagent
CD93	None	110 kDa O-sialoglycoprotein	Monocytes, granulocytes AML blasts, myeloid lines endothelial cells	Not known	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD94	kP43	43 kDa type II transmembrane glycoprotein member of the C-type lectin superfamily. Heterodimer with other C-type lectins, NKG2A and NKG2C. Cytoplasmic ITIM sequence	NK cells and T cell subset	CD94-NKG2 dimers bind HL-A-E, apparently suppressing NK cytotoxicity	Research reagent
CD95	APO-1, Fas	45 kDa reduced; TNF receptor family, type I transmembrane protein; alternative splicing yields soluble forms; two serine/threonine glycosylation sites	Activated T and B cells	Mediation of apoptosis-inducing signals, Ipr/Ipr-mice have Fas defect and develop lymphadenopathy	Marker of apoptotic cells
CD95L	See CD178	See CD178	See CD178	See CD178	See CD178
CD96	Tactile (T cell activation increased late expression)	160 kDa type I transmembrane glycoprotein with 3 Ig-like and one mucin-like domain with N and O glycosylation, and a proline-rich cytoplasmic domain. Soluble form also occurs.	Weak on T and NK cells, strongly up-regulated on acute myeloid leukemias	No known function	Research reagent
CD97	None	75-85 kDa EGF-TM7 superfamily class II, G-protein coupled receptor with scheduled EC domain	Activated T and B cells, monocytes/macrophages, DC, granulocytes	Ligand for CD55 (decay accelerating factor)	High expression at sites of inflammation in skin and lung, and in rheumatoid arthritis. Also soluble CD97.
CD98	4F2, FRP-1	125 kDa heterodimer: 80 kDa + 45 kDa. Glycosylated heavy chain has transmembrane domain.	Broad on activated and transformed cells, not hemopoietic specific	Potential amino acid transporter, strongly associated with actin	Up-regulated on leukocytes in inflammatory lesions; strongly expressed by neoplastic cells
CD99	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.	Broadly expressed in leukocytes but subsets express different amounts, with no clear functional correlation	Adhesion molecule, mediating homotypic and heterotypic adhesion	Research reagent

continued

A.4A.25

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD100	None	300 kDa (150 kDa reduced), semaphorin, protein tyrosine phosphatase	Most hemopoietic cells, increased after activation of T or B cells	Associates with CD45, role in homotypic adhesion	Research reagent
CD101	V7, P126	240 kDa (unreduced) type I transmembrane glycoprotein with 7 V-set Ig superfamily extracellular domains and a short cytoplasmic sequence	Monocytes, granulocytes, dendritic cells, activated T cells	Possible costimulator of T cells	Research reagent
CD102	ICAM-2	55-65 kDa type I transmembrane glycoprotein with two C-2 set Ig superfamily domains	Leukocytes but not neutrophils; strongest on vascular endothelium	Adhesion molecule. Ligand for CD11a/CD18 (LFA-1).	Research reagent
CD103	Integrin α E subunit	175 kDa glycoprotein, cleaved into 25 kDa (N-terminal) and 150 kDa segment which remain linked by disulfide bond	Intraepithelial lymphocytes and 1%-2% of circulating lymphocytes	Generally associates with integrin β 7. Complex binds to E-cadherin on epithelial cells. Possible role in homing of intraepithelial lymphocytes in the gut lymphoid tissues.	Research reagent
CD104	Integrin β 4 subunit	220 kDa type I transmembrane glycoprotein. Large cytoplasmic region with 4 fibronectin type 3 domains.	Complex expressed on hemidesmosomes of stratified epithelium	Associates with integrin α 6 subunit (CD49f) to form an adhesion molecule with a role in epithelial structure	Research reagent
CD105	Endoglin	170 kDa disulfide-linked homodimer; each unit forms a type II transmembrane glycoprotein	Endothelial cells, activated macrophages, some leukemic cells, and normal marrow cells	Component of multi-chain receptor for TGF- β . Mutation in CD105 gene associated with hereditary hemorrhagic telangiectasia, vascular and bleeding disorders.	—

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD106	VCAM-1 (vascular cell adhesion molecule-1), INCAM-110	100-110 kDa type I transmembrane glycoprotein with 6 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 leucocyte extravasation. CD106-deficient mice have severe organogenesis defects and die as embryos.	—
CD107a/b	Lysosome-associated membrane protein 1 (LAMP-1, CD107a) and LAMP-2 (CD107b)	120 kDa type I transmembrane glycoproteins with 39% amino acid identity. 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	Research reagent
CD108	JMH blood group antigen	76-80 kDa GPI linked glycoprotein	Erythrocytes	Not known	Research reagent
CD109	Platelet activation factor; Gov a/b alloantigen	175 kDa GPI-linked glycoprotein	Expressed on platelets, activated T cells, umbilical vein endothelial cells	Not known	Research reagent
CD110	Thrombopoietin receptor mpl	85-92 kDa hematopoietin receptor family	Platelets, hematopoietic stem cells, megakaryocytes	Receptor for thrombopoietin, regulation of megakaryocyte and platelet formation	Oncogene V-mpl (murine myeloproliferative leukemia virus) can immortalize bone marrow hematopoietic cells; mpl mutations associated with congenital thrombocytopenia

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD111	PRR1, Nectin 1, Hve C1, poliovirus receptor related 1 protein	Type I transmembrane protein belonging to the polio virus receptor family and consisting of one V-set and two C-set Ig like domains	Broadly expressed within and outside hemopoietic lineage	Receptor for entry of HSV-1, HSV-2	Research reagent
CD112	PRR2, Nectin 2, Hve B, poliovirus receptor related 2 protein	64 and 72 kDa isoforms of a type I transmembrane glycoprotein belonging to a family (poliovirus receptor family) that includes C111 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 adherence junction. Receptor for some herpes viruses.	Research reagent
CD113	Not assigned	CD113 not assigned	CD113 not assigned	CD113 not assigned	Research reagent
CD114	G-CSFR, CSFR3, HG-CSFR, CSFR3, granulocyte colony stimulating factor receptor	130 kDa single chain type I transmembrane molecule, no intrinsic kinase activity	Granulocytes, monocytes, mature platelets, endothelial cells, placenta, trophoblasts	Cytokine receptor, regulation of myeloid proliferation and differentiation	Target for stem cell mobilization for blood stem cell transplantation, target for enhancing recovery of myelopoiesis post chemotherapy
CD115	M-CSFR, CSF-1, C-fms	150 kDa subclass II receptor tyrosine kinase, EC region has ligand binding domain and five Ig domains	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 hemopoietic malignances, promotes recovery of myeloid lineage following chemotherapy
CD116	GM-CSF receptor α subunit, GMR α	80 kDa class I cytokine receptor family protein	Macrophages, neutrophils, eosinophils, dendritic cells	Binds GM-CSF with low affinity, complex of CD116 and CD131 (common β subunit) binds GM-CSF with high affinity	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD117	SCFR, c-kit, stem cell factor receptor	145 kDa Ig superfamily protein	Hemopoietic stem and progenitor cells, tissue mast cells, melanocytes	Receptor for SCF; binding of SCF leads to dimerization, autophosphorylation, and interaction with signaling molecules	Research reagent
CD118	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD119	IFN γ receptor α chain	55 kDa class II cytokine receptor associates with IFN- γ accessory factor 1 (IFN- γ AF-1)	Ubiquitous, except RBC	Receptor for IFN- γ ; binding of CD119/IFN- γ 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.	Research reagent
CD120	CD120a, TNF receptor 1; CD120b, TNF receptor 2	55 kDa (CD120a) or 75 kDa (CD120b) TNFR superfamily; four extracellular cysteine-rich ligand-binding c-terminal regions (“death domain”)	Thymus, spleen, PBL, placenta	Receptor 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, tumour necrosis, cell proliferation, differentiation, and apoptosis.	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD121a	Type I IL-1 receptor	80 kDa Ig superfamily type I 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 α , IL-1 β , and IL-1 receptor antagonist. Knockout mice are normal aside from lacking IL-1 responsiveness, delayed hypersensitivity, and contact sensitivity.	Soluble CD121a is a potential anti-inflammatory agent
CD121b	Type II IL-1 receptor	60-70 kDa Ig superfamily 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 β well binds IL1 α and IL-1 receptor antagonist poorly. Does not mediate IL-1 function, acting as a “decoy” receptor, reducing IL-1 action.	—
CD122	IL-2 receptor β chain, p75	75 kDa type I transmembrane glycoprotein with one cytokine receptor domain and 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 Lck tyrosine kinase in the cytoplasm to initiate activation, resulting in tyrosine phosphorylation of CD122.	—
CD123	IL-3 receptor α chain	70 kDa type I transmembrane glycoprotein. N-terminal domain has not been allocated to a family but resembles domain on CD125 and CD116, and is followed by a cytokine receptor domain and a fibronectin type III domain. Short cytoplasmic sequence.	Bone-marrow stem cells and more differentiated precursors, NK cells	Associates with the common β chain (CD131) to form IL-3 receptor, which is important in growth and differentiation of erythroid, platelet, neutrophil, eosinophil, basophil, and monocyte lineages	—

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD124	IL-4 receptor α chain	140 kDa type I transmembrane glycoprotein with an N-terminal cytokine receptor domain and a 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 _H 2-type responses	Research reagent
CD125	IL-5 receptor α chain	55-60 kDa type I transmembrane glycoprotein containing N-terminal domain similar to those on CD123 and CD116, followed by a cytokine receptor domain and 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	Research reagent
CD126	IL-6 receptor α chain	80 kDa type I transmembrane glycoprotein with an N-terminal C2-set Ig superfamily domain followed by a cytokine receptor domain and a fibronectin type III domain	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	—
CD127	IL-7 receptor α chain	90 kDa Ig superfamily protein with two conserved WSXWS motifs in EC domain	B cell precursors majority of T cells; down-regulated with T cell activation	Associates with CD132 (common γ chain). Early lymphocyte expansion impaired in IL-7 knockout mice	Research reagent
CD128	IL-8 receptor	58-67 kDa 7-pass transmembrane glycoprotein with extracellular N-terminus; member of G-protein-coupled receptor superfamily	Neutrophils, basophils, T cell subsets	Receptor for IL-8, a chemotactic factor	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD129	IL-9 receptor α chain	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	Research reagent
CD130	GP 130, IL-6 receptor β chain	130 kDa type I transmembrane glycoprotein with an N-terminal C2-set Ig superfamily domain followed by a cytokine receptor domain and 4 fibronectin type III domains	Broadly expressed on leukocytes and other tissues	Common and signaling chain for IL-6, oncostatin M, LIF, IL-11 and cardiotrophin-1	Research reagent
CD131	Common β chain	120-140 kDa type I transmembrane glycoprotein with an N-terminal cytokine receptor domain followed by a fibronectin type III domain, a second cytokine receptor domain, a second fibronectin type III domain, 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	—
CD132	Common γ chain	64 kDa type I transmembrane glycoprotein with one cytokine receptor domain and one fibronectin type III domain. Cytoplasmic tail has SH2 homology region	Broadly expressed on leukocytes	Essential component of several cytokine receptors: IL-2, 4, 7, 9 and 15. Mutation causes X-linked severe combined immunodeficiency disease	—
CD133	AC133, PROML1, similar to mouse prominin	120 kDa 5-transmembrane protein	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

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD134	OX 40	48-50 kDa type I transmembrane glycoprotein, member of the TNF/NGF receptor family with 3 cysteine-rich repeats	Activated T cells, fibroblasts, hematopoietic precursors	Binds OX 40 ligand and is involved in T cell interaction with antigen-presenting cells including B cells	Research reagent
CD135	FLT3, STK-1	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	Research reagent
CD136	Macrophage stimulating protein receptor, MSP-R, Ron	180 kDa protein kinase (150 kDa α chain, 40 kDa β chain) heterodimer; α and β chains from cleavage of single gene product, α chain extracellular, β chain transmembrane	Resident macrophages, epithelial cells	Ligation-induced dimerization induces migration, proliferation. CD136 null mice fail to survive the peri-implantation period. CD136 ^{+/-} mice are highly susceptible to endotoxic shock	—
CD137	4-1BB; ILA	Disulfide-linked dimer of 32 kDa type I transmembrane glycoprotein with 4 TNF receptor family domains	Activated T cells, B cells, and monocytes	Function unknown. Ligand is TNF family member leading to T cell activation. Likely to be involved in immune activation and antigen presentation.	—
CD138	Syndecan-1, heparan sulfate proteoglycan	65-70 kDa core protein membrane intercalated type I receptor, two serine clusters, proximal hosts chondroitin sulfate, distal hosts heparan sulfate	Pre-B cells, plasma cells	Extracellular matrix receptor	Used as marker of plasma cells
CD139	None	209/228 kDa protein as yet uncharacterized	B lymphocytes, monocyte, granulocytes, FDC, weakly on erythrocytes	Not known	CD139 ⁺ CLL may have an improved outcome

continued

A.4A.33

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD140	PDGF receptor type α (CD140a) and β (CD140b)	180 kDa type I transmembrane glycoprotein with Ig superfamily, cytoplasmic domain, and type III protein kinase receptor intracellular domain	CD140a expression not detected, CD140b found on endothelial and stromal cells	Receptor for platelet-derived growth factor	Research reagent
CD141	Thrombomodulin, fetomodulin	75-105 kDa type I transmembrane glycoprotein with C-type lectin extracellular domain	Myeloid cells, platelets, endothelial cells	Receptor for thrombin, active in protein C anticoagulant pathway and may inhibit fibrinolysis. Knockout mice die during embryogenesis from problems unrelated to coagulation pathway	Plasma CD141 may be useful marker of endothelial damage
CD142	Tissue factor, thromboplastin, coagulation factor III	45 kDa type I transmembrane glycoprotein of the class II cytokine receptor family	Activated monocytes and endothelial cells, epithelial cells	Complexes with factor VII to form an enzyme which initiates the extrinsic coagulation cascade	Research reagent
CD143	Angiotensin-converting enzyme (ACE), peptidyl dipeptidase A	170 kDa member of Zn metalloproteinase family. Exists as type I transmembrane protein. 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 metalloproteinase specific for angiotensin and bradykinin. Knockout mice show reduced male fertility (i.e. function).	Research reagent
CD144	VE-cadherin, cadherin-5	135 kDa cadherin, 5 EC cadherin repeats, 9 tyrosine in cytoplasmic domain	Endothelial cells	Homotypic binding; organizes adhesion junction in endothelial cells. Contact inhibition of cell growth.	Expression reduced in human angiosarcomas
CDw145	None	Main immunoprecipitation band at 251 kDa; weak bands at 90 and 110 kDa	HUVEC; endothelial cells in many tissues, e.g., kidney, lung, spleen, liver	Unknown	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD146	Muc 18, MCAM, 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 I N-glycoprotein of the Ig superfamily. Extracellular domain consists of one V and one C2 type domain, with about half the mol. wt. being carbohydrate	Widely expressed on leukocytes, endothelium, platelets, red blood cells	Possible adhesion function, and appears to induce metalloproteinases. Knockout mice show enhanced mixed lymphocyte reaction, are infertile, and show neurological abnormalities	None demonstrated
CD148	DEP-1, HPTP- η	200-160 kDa member of receptor protein tyrosine phosphatase type III family. Type I transmembrane glycoprotein with 8 extra cellular fibonectin 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 hemopoietic 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.	Research reagent
CD149	Now CD47R	Now CD47R	Now CD47R	Now CD47R	Now CD47R
CD150	SLAM, signaling lymphocyte activation molecule, IPO-3	75-95 kDa type I transmembrane molecule, Ig superfamily	Thymocytes, CD45RO T cells, B cells, DC, endothelial cells	Binding of CD150 to ligand(s) enhances proliferation and Ig production by activated B cells	Research reagent
CD151	PETA-3, SFA-1	32 kDa tetraspan family glycoprotein	Endothelium, epithelial cells, platelets and megakaryocytes, immature hematopoietic cells	May modify integrin function or signaling, coprecipitates with β 1 integrins	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD152	CTLA-4, cytotoxic T lymphocyte associated protein 4	33 kDa reduced 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. Binds CD30, interaction associated with costimulation and with cell death	—
CD153	CD30 ligand	Heavily glycosylated 40 kDa TNF family type II transmembrane glycoprotein	Activated T cells, activated macrophages, neutrophils, eosinophils; normal and malignant B cells	Widely expressed in hematopoietic malignancies. Expressed in bystander cells in Hodgkin's disease. Elevated in macrophages in sarcoidosis	
CD154	CD40 ligand	33 kDa type II transmembrane glycoprotein member of TNF superfamily	Principally activated CD4 ⁺ T cells; at varying levels in CD8 ⁺ 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 ⁺ B cells in germinal center. CD154 mutation causes hyper-IgM syndrome.	Elevated CD154 found in systemic lupus erythematosus and multiple sclerosis
CD155	Poliovirus receptor, PVR	80-90 kDa type I transmembrane glycoprotein belonging to the poliovirus receptor family, with one V-set and two C-set Ig-like superfamily	Monocytes	Receptor for poliovirus; may have role in regulation of CD44 binding to hyaluronan	Research reagent
CD156a	ADAM 8, MS 2	69 kDa type I transmembrane protein, metalloprotease domains, disintegrin domains	Neutrophils, monocytes	Possible role in leukocyte extravasation	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD156b	TACE (tumor necrosis factor α -converting enzyme), ADAM 17 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	Shedase which converts plasma membrane TNF- α , TNF- α receptor to soluble forms. Deletion of a catalytic domain is perinatally lethal.	Research reagent
CD157	BST-1 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), bone marrow stromal lines, HUVEC, FDC	Not known	High soluble CD157 in serum of severe rheumatoid arthritis
CD158	KIR (killer inhibitory receptor) family. Allocated CD158a, 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 ⁺ T cells	Interact with MHC Class I molecules on potential target cells, inhibiting or activating (depending on the intracellular sequence) cytotoxic function	Research reagent
CD159a	NKG2a	43 kDa glycoprotein, C-type lectin family, two cytoplasmic ITIM motifs, expressed as heterodimer with CD94	NK cells	Complex with CD94 binds HL-A-E and is inhibitory to NK cell mediated cytotoxicity	Research reagent
CD160	BY55	27 kDa Ig superfamily (KIR family), on surface as 80 kDa disulfide-linked multimer	NK cells, cytotoxic T cells, intestinal intraepithelial lymphocytes	Role in costimulation of NK cells and CTL	Research reagent
CD161	NKR-P1A, killer cell lectin-like receptor subfamily B, member 1	40 kDa type II glycoprotein, expressed as disulfide-bonded homodimer	Most NK cells, subset of CD4 and CD8 T cells	Costimulation	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD162	P selectin glycoprotein ligand 1, PSGL-1	110-120 kDa, sialomucin, expressed as disulfide-bonded homodimer, 15-16 repeats of a 10 residue consensus sequence	Most peripheral blood T cells, monocytes, granulocytes, some B cells, some CD34 ⁺ bone marrow cells	Mediates leukocyte rolling on activated endothelium, on activated platelets and on other leukocytes at sites of inflammation	Research reagent
CD163	GHI/61, D11, RM3/1, M130	130 kDa type I transmembrane protein, scavenger receptor SF	Majority of tissue macrophages, not FDC, IDC, Langerhans cells, tingible body macrophages	Role in anti-inflammatory response of monocytes	Research reagent
CD164	MUC-24, MGC 24, multi-glycosylated core protein 24	80 kDa type I integral membrane mucin glycoprotein	Bone marrow stromal cells, monocytes, epithelial tissue, bone marrow mononuclear cells	Role in adhesion of CD34 ⁺ cells to bone marrow stroma	Research reagent
CD165	AD2, gp 37	37-42 kDa membrane glycoprotein	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
CD166	ALCAM, KG-CAM, neurolin (zebra fish), BEN (chicken), DM-GRASP (chicken), activated leukocyte cell adhesion molecule	100-105 kDa, Ig superfamily, 5 Ig-like domains	Neurons, activated T cells, activated monocytes, epithelium, fibroblasts	Ligand for CD6, involved in neurite extension by neurons	Marker for tumor progression
CD167	Discooidin receptor DDR1 (CD167a) and DDR2 (CD167b)	Membrane glycoprotein with extracellular discoidin 1 motif; intracellular receptor tyrosine kinase motif	DDR1 expressed weakly on B cells and immature dendritic cells. Widely expressed on epithelia and epithelial tumors.	Binds collagen (DDR1); overexpression in epithelial tumors, suggests role in tumor invasion and metastasis	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD168	RHAMM (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	Adhesion molecule, through binding of hyaluronan. Oncogene, regulating signaling through rats.	Research reagent
CD169	Sialodhesin, Siglec-1	175 kDa type I transmembrane glycoprotein with 1 N-terminal V-like Ig domain followed by 16 C2-like domains	Weakly on lymphocytes, strongly on monocytes and dendritic cells	Adhesion molecule, binding particularly glycolipids and glycoproteins with terminal α -2 sialyl residues	Research reagent
CD170	Siglec 5 (sialic acid binding Ig-like lectin 5)	Homodimer of 70 kDa protein with N-terminal V-like Ig domain followed by C2 like domains. Two cytoplasmic immunoreceptor tyrosine inhibitory motif (ITIM)-like sequences.	Lymphocytes, monocytes, dendritic cells, and myeloid leukemic cells	Adhesion molecule	Research reagent
CD171	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. Mutation of CD171 gene causes neurological disease.	—
CD172	Member of SIRP (signal inhibitory regulatory protein) family	Ig family member with 1 V-like and 3 C-2 like domains, and an ITIM motif in the cytoplasmic region (SIRP- α) or no tail (SIRP- β)	Monocytes, hematopoietic precursors, neuronal tissue	Adhesion molecule, SIRP- α delivers inhibitory signal while SIRP- β interacts with ITAM-bearing molecules and is stimulatory. SIRP- α binds CD47	—
CD173	Blood group H2, blood group H type 2	Carbohydrate: Fuc α 1-2Gal β 1-4GlcNAc. GSL or protein anchor. Product of fucosyl transferase FUT 1	CD34 ⁺ precursors. Carcinomas, endothelial cells, erythrocytes	Precursor to AB carbohydrate antigens and Lewis antigens	Blood group reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD174	Lewis Y blood group, LeY	Carbohydrate: Fuc α 1-2Gal β 1-4(Fuc α 1-3)GlcNAc β 1	Epithelial CD43 ⁺ bone marrow precursors	Possible role as cofactor to procoagulant activity of cancer cells. Possible role in early commitment to apoptosis.	Anti-Lewis Y conjugated doxorubicin used in trials for therapy of epithelial tumors. Lewis Y also expressed by <i>Helicobacter pylori</i> . Research reagent
CD175	Tn antigen (T-antigen nouvelle)	O-linked monosaccharide: GalNAc α 1-O-R; GSL linked or protein anchor	CD34 ⁺ bone marrow cells, various T-, B-, and myeloid lineage leukemias, epithelial tumors	Precursor for ABO antigens and TF antigen	Research reagent
CD176	Thomsen-Friedenreich antigen (TF)	Carbohydrate Gal β 1-3GalNAc α 1-O-R; GSL or protein carrier	CD34 ⁺ hematopoietic precursors, endothelial cells, erythrocytes, sialylated form ubiquitous	Not known	Pancreatic carcinoma antigen
CD177	NB1	56-64 kDa GPI-anchored glycoprotein	Neutrophil subset	Up-regulated in response to fMLP	NB antigens have role in alloimmune neonatal neutropenia Research reagent
CD178	FAS ligand, CD95 ligand	Trimer of 40 kDa type II transmembrane glycoprotein 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. Knockout mice and humans with CD95L mutation show severe autoimmune disease.	Research reagent
CD179a	V pre- β	16-18 kDa, Ig V-like structure, lacks last β strand of typical V domain	Pro-B, pre-B cells; associates with CD179b to form surrogate light chain; this associates with membrane Ig μ heavy chain and CD79a/CD79b to form pre-B cell receptor	Surrogate light chain expression is essential for early B cell development	Marker of pro-B, pre-B cells

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD179b	Lambda 5	22 kDa, homology to Ig lambda J region and constant region	Pro-B, pre-B cells; associates with CD179a to form surrogate light chain, with membrane Ig μ heavy chain and CD79a/CD79b to form pre-B cell receptor	Surrogate light chain expression is essential for B cell development, pre-BCR functions as checkpoint for rearrangement of IgM heavy chain	Research reagent
CD180	RP105	95-105 kDa type I membrane protein, leucine rich repeats, Toll-like receptor family	Mantle zone B cells, marginal zone B cells, weakly on germinal center B cells	Regulates B cell recognition of LPS, ligation of CD180 by mAb leads to up-regulation of CD80/CD86 and increase in cell size. CD180 null mice have impaired response to LPS-induced proliferation.	Research reagent
CD181	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD182	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD183	CXCR3 chemokine receptor	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)	Research reagent
CD184	CXCR4 chemokine receptor	G-coupled seven pass transmembrane protein (with cytoplasmic C terminal)	Widely expressed in hematopoietic cells, vascular endothelial, and neural tissue	Receptor for chemokine SDF-1 (CXCL12)	Research reagent
CD185	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD186	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD187	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD188	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD189	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD190	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD191	Not Assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD192	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent

A.4A.41

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD193	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD194	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD195	CCR5 chemokine receptor	G-coupled seven pass transmembrane protein (with cytoplasmic C terminal)	Lymphocytes, monocytes, macrophages, dendritic cells	Receptor for chemokines MIP-1 (CCL3), MIP-1 β (CCL4), and RANTES (CCL5)	Research reagent
CD196	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CDw197	CCR7 chemokine receptor	G-coupled seven pass transmembrane protein (with cytoplasmic C terminal)	Memory T cells, activated dendritic cells	Receptor for chemokines ELC (CCL19) and SLC (CCL21)	Research reagent
CD198	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD199	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD200	MRC OX 2	41-47 kDa type I transmembrane glycoprotein Ig superfamily	B lymphocytes, neurons, some dendritic cells	Regulation of macrophage lineage. Lack of CD200 results in more rapid onset of experimental autoimmune encephalitis. Disruption of CD200/CD200 receptor increases susceptibility to collagen-induced arthritis.	—
CD201	Endothelial protein C receptor (EPCR)	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	Research reagent
CD202	TIE2, TEK	140 kDa transmembrane protein with 3 fibronectin type III domains, 2 Ig-like domains and EGF-like domains	Endothelial cells, subset of CD34 ⁺ hematopoietic stem cells	Membrane receptor for angiopoietins, tyrosine kinase. CD212-deficient mice die during embryogenesis because of defects in angiogenesis.	—

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD203c	E-NPP3, PDNP3, PD-1 β	Type II TM protein, 270 kDa unreduced, 130 and 150 kDa reduced	Basophils, mast cells and their precursors	Phosphodiesterase/nucleotide pyrophosphatase, hydrolysis of oligonucleotides, nucleoside phosphates, NAD	Research reagent
CD204	MSR, SRA, macrophage scavenger receptor	Not assigned	Macrophages	Mediates uptake of negatively charged macromolecules, e.g., oxidized low-density lipoprotein role in host defense.	Research reagent
CD205	DEC-205	205 kDa type I transmembrane glycoprotein with an N-proximal fibronectin type II domain followed by 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	Research reagent
CD206	Macrophage mannose receptor (MMR)	175-180 kDa type I transmembrane glycoprotein with one fibronectin type II domain and 8 C-type lectin domains	Macrophages, endothelium	Binds oligomannose-containing molecules and mediates phagocytosis of microorganisms bearing these carbohydrates by macrophages	—
CD207	Langerin	C-type lectin	Activated dendritic cells, Langerhans cells	Carbohydrate-binding molecule which may bind carbohydrate-bearing antigens for internalization, processing, and presentation	Research reagent
CD208	DC-LAMP	70-90 kDa glycoprotein, C-type lectin	Activated dendritic cells	Lysosome associated, transiently expressed in MHC-II compartment	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD209	DC-SIGN	44 kDa type II transmembrane protein with a C-type lectin domain and 7 repeats of an II-residue sequence	Dendritic cells	Binds ICAM-3 (CD50) and this interaction appears to be an important component of DC-T cell interaction. Binds HIV gp120.	Research reagent
CDw210	IL-10 receptor	Two fibronectin type III domains and a 318-residue cytoplasmic tail	T and B cells, NK cells, monocytes, macrophages	Receptor for IL-10	Research reagent
CD211	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD212	IL-12 receptor β chain	Type I transmembrane protein of the cytokine receptor family, with 5 fibronectin type III-like domain. Strong homology to CD130	Reportedly expressed by T _H 1 but not T _H 2 cells. However, also reported on 72% of blood lymphocytes, indicating majority T cell expression. NK cells, some B cell lines.	Dimerizes and associates with an unknown chain to form the IL-12 receptor. IL-12 directs immune responses preferentially towards T _H 1-type responses.	Identification of T _H 1 cells
CD213a1 and CD213a2	IL-13 receptor α 1 and α 2	Type I transmembrane molecule with one cytokine receptor domain and one membrane proximal fibronectin type III domain	Broadly expressed in hematopoietic tissue, nervous system, and other tissues	Binds IL-13 with low affinity. Complex with the IL-4 R α chain (CD124). Binds IL-13 with high affinity.	Potential therapeutic target for glioma
CD214	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD215	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD216	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CDw217	IL-17 receptor	130 kDa type I transmembrane glycoprotein with no homology with other cytokine receptors	Broad tissue distribution. Cord blood lymphocytes, peripheral blood lymphocytes, thymocytes.	Binds IL-17 with low affinity	Research reagent
CD218	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD219	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD220	Insulin receptor	α -subunit ligand-binding domain, 95 kDa β subunit transmembrane tyrosine kinase expressed as disulfide-linked dimer of $\alpha\beta$ heterodimer, Tyrosine kinase receptor family	Ubiquitous; erythrocytes, liver, muscle, adipose tissue	Cellular receptor for insulin. Mutation in CD220 leads to insulin resistant diabetes mellitus.	Research reagent
CD221	IGF I Receptor, type I IGF receptor	α subunit, 135 kDa ligand binding domain; β subunit 90 kDa transmembrane tyrosine kinase expressed as disulfide linked dimer of $\alpha\beta$ heterodimer; α and β subunits are cleaved from a single gene product	Ubiquitous	Receptor for insulin-like growth factors IGF1 and IGF2	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, IGF2R	250 kDa type I transmembrane protein, 15 homologous domains, fibronectin-like collagen-binding domain	Ubiquitous	Internalization of IGFII, internalization of lysosomal enzymes, regulation of TGF- β activity. CD222 null mice exhibit organ and skeletal abnormalities and die at birth	—
CD223	LAG-3 (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, stronger on CD8 than CD4 cells	Binds MHC class II. LAG-3-deficient mice show normal immune responses	Research reagent
CD224	γ -glutamyl transferase, GGT, γ -glutamyl transpeptidase	Heterodimeric ectoenzyme, 55-60 kDa heavy subunit, 21-30 kDa light 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 γ -glutamyl residue from glutathione to amino acids or peptides	GGT activity increased in liver disease
CD225	Leu-13, interferon-induced transmembrane protein 1	17 kDa membrane protein which coprecipitates with TAPA-1	Leukocytes, endothelial cells	Component of the CD21/CD19/TAPA-1 complex involved in B cell activation	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD226	DNAM-1, DTA-1	65 kDa Ig superfamily glycoprotein with two V-set domains	Induced by activation on NK cells, platelets, monocytes, T cell subset	Adhesion molecule. Ligand unknown	Research reagent
CD227	MUC1	Protein core of very large heterogenous glycoproteins-mucins. MUC1 is an integral-membrane protein consisting of a 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	97 kDa transferrin-like molecule	Melanoma	Presumed iron transport function	Research reagent
CD229	Ly9	90-120 kDa type I transmembrane glycoprotein with two V-set and 2 C2-set Ig superfamily domains, arranged (N)-V-C2-V-C2	T and B lymphocytes, thymocytes	Unknown, but similarity to CD2 and CD48 suggest an adhesion function	Research reagent
CD230	Prion protein, PrP(c), PrP(sc) abnormal form	27-30 kDa glycolipid anchored protein. Glycosylation different from PBMC to brain PrP(c) has α -helical structure; PrP(sc) has β -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 Creutzfeld-Jakob disease (CJD). Mutations in Prp gene associated with familial CJD-like disorders.
CD231	TALLA-1, TM4SF2	150 kDa (28-45 kDa when reduced) tetraspanin	Neuronal tissue, neuroblastoma, T-type acute lymphoblastic leukemia	Not known	CD231 (TM4SF2) is involved in X-linked mental retardation
CD232	VESPR	Member of plexin family with a semaphorin-like domain	Monocytes, some B cells. Not fully described	Receptor for virally encoded semaphorin	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD233	Band 3, AE1, anion exchanger 1, Diego blood group antigen	95 kDa integral membrane protein. 12 to 14 transmembrane helices; glycan chain on fourth loop carries ABO blood group antigen	Erythrocytes (>1,000,000 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. Implicated in formation of senescent antigens in aging red blood cells; role in attachment of malaria parasites to red cell.	—
CD234	DARC, Fy-glycoprotein, Duffy blood group antigen	35 kDa, 7 transmembrane domains, acidic glycoprotein, chemokine receptor superfamily	Erythrocytes, capillary endothelial cells	Role in inflammation and malaria infection	Research reagent
CD235	Glycophorin A (CD235a), glycophorin B (CD235b)	Type I membrane proteins highly glycosylated	Erythrocytes	Major glycoproteins of erythrocytes	MNS blood group antigens, glycophorin A RBC are resistant to Falciparum malaria
CD236	Glycophorin CD (CD236), glycophorin C (CD236R), Gerbich blood group antigen	13 kDa sialoglycoprotein type III membrane protein, linked to membrane via band 4.1, glycophorin D is truncated at N-terminal	Erythrocytes (CD236R), glycophorin D is ubiquitous	Regulation of mechanical stability of erythrocytes receptor for <i>Plasmodium falciparum</i> merozoites	Blood group antigen (Gerbich)
CD237	Not assigned	Not assigned	Not assigned	Not assigned	Research reagent
CD238	Kell blood group antigen	93 kDa type II transmembrane glycoprotein, disulfide linked to XK protein, zinc endopeptidase	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	Research reagent

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD239	B-CAM, Lutheran glycoprotein	78/85 kDa type I TM glycoprotein, Ig superfamily	Erythrocytes, broad range of cells; not on lymphocytes, granulocytes, monocytes, or platelets	Role in cell-cell and cell-substrate adhesion	Research reagent
CD240	Rh blood group system, Rh 30CE (CD240CE), Rh 30D (CD240D)	30 kDa glycoprotein; 12 transmembrane domains; palmitoylated on extracellular loops	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	RhAg, Rh50, Rh associated antigen	50 kDa glycoprotein; 12 transmembrane domains; single N-glycosylation	Erythroid cells	Formation of a complex with Rh50 is essential for expression of Rh blood group antigens; may function as ammonium transporter	—
CD242	ICAM 4, LW blood group, Landsteiner-Wiener blood group antigens	42 kDa type I transmembrane glycoprotein of Ig superfamily	Erythrocytes; expression associated with Rh antigens (CD240)	Bind CD11a/CD18 integrin; role in adhesion of erythrocytes to leukocytes	LW blood group antigens, LW antigens may be depressed in pregnancy
CD243	MDR-1, P-glycoprotein, pgp 170, multidrug resistance protein I	170 kDa glycoprotein which spans the membrane 12 times. Member of ABC family of ATP-binding transport proteins	Kidney, liver, gut tissue, low levels in hemopoietic cells but higher on bone marrow stem cells and some malignant cells	Pumps small molecules (including drugs) out of the cell, ATP-dependent activity	Marker in evaluating potential drug resistance of tumors
CD244	2B4	66 kDa type I transmembrane glycoprotein with one V-set and one C2-set Ig superfamily domain	In mice, on NK cells and T cells, capable of non-MHC restricted cytotoxicity	Expression suggests involvement in non-MHC restricted cytotoxicity	Research reagent

continued

Table A.4A.1 CD Molecules^{a,b}, continued

Index	Other names	Molecular properties	Cellular expression	Function	Usefulness
CD245	p220/240, DY12, DY35	220-240 kDa transmembrane protein, weak phosphate activity	All resting PBL, 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	Research reagent
CD246	Anaplastic lymphoma kinase (ALK)	Receptor protein-tyrosine kinase with putative transmembrane and extracellular domains	Neuronal tissue. A fusion protein arising from a 2;5 chromosomal translocation is found in anaplastic large cell lymphomas.	Important role in brain development	Diagnosis of anaplastic large cell lymphomas
CD247	T cell receptor ζ chain, CD3 ζ	16 kDa type I transmembrane protein, not glycosylated. Expressed in complex with CD3 γ , δ , and ϵ and T cell receptor α/β or γ/δ heterodimers.	All T cells	Part of CD3 complex, couples antigen recognition to intracellular signal transduction pathways	—

^aAdapted, with permission, from BioMedicalPDA (<http://www.biomedicalpda.com>), Professional PDA Publishing, LLC, Larchmont, N.Y.

^bAbbreviations: ADCC, antibody-dependent cell-mediated cytotoxicity; ALL, acute lymphocytic leukemia; APC, antigen-presenting cells; B-CLL, chronic lymphocytic leukemia, B cell type; BCR, B cell receptor; CLL, chronic lymphocytic leukemia; CNS, central nervous system; DC, dendritic cells; EC, extracellular; FAB, French-American-British Cooperative Group; FDC, follicular dendritic cells; GM-CSF, granulocyte-macrophage colony stimulating factor; GPI, glycosyl phosphatidylinositol; GSL, glycosphingolipid; GVHD, graft-versus-host disease; HB-EGF, heparin-binding epidermal growth factor–like growth factor; HUVEC, human umbilical vein endothelial cells; IL, interleukin; LDL, low-density lipoprotein; LIF, leukemia inhibitory factor; LPS, lipopolysaccharide; MCF, macrophage colony stimulating factor; MHC, major histocompatibility complex; NGF, nerve growth factor; NHL, non-Hodgkin's lymphoma; NK, natural killer; PBL, peripheral blood lymphocytes; PBMC, peripheral blood mononuclear cells; PMN, polymorphonuclear lymphocytes; PTK, protein tyrosine kinase; RBC, red blood cells; SCF, stem cell factor; SRBC, sheep red blood cell; TCR, T cell receptor; TM, transmembrane; TNF, tumor necrosis factor; TNFR, tumor necrosis factor receptor.