Human blood group systems

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The term **human blood group systems** is defined by International Society of Blood Transfusion as systems in the human species where cell-surface antigens—in particular, those on blood cells—are "controlled at a single gene locus or by two or more very closely linked homologous genes with little or no observable recombination between them",[1] and include the common ABO and Rh- (Rhesus) antigen systems, as well as many others; thirty-five major human systems are identified as of November 2014.[2] In addition to the ABO and Rh systems, the antigens expressed on blood cell membrane surfaces include 346 red blood cell antigens and 33 platelet antigens, as defined serologically.[3] The genetic basis for most of these antigens lie in 45 red blood cell and 6 platelet genes. An individual, for example, can be AB RhD positive, and at the same time M and N positive in the MNS system, K positive in the Kell system, and Le^a or Le^b positive in the Lewis system, where these and many of the systems are named for patients in whom the corresponding antibodies were first detected.

Contents

Blood grouping postulates

Blood is composed of cells suspended in a liquid called plasma. Suspended in the plasma are three types of cells:

- **Red blood cells** carry oxygen
- **White blood cells** fight infection
- **Platelets** stop bleeding in injuries

The most common type of grouping is the ABO (either uppercase or lowercase) grouping. The varieties of glycoprotein coating on red blood cells divides blood into four groups:

- A (A oligosaccharide is present)
- B (B oligosaccharide is present)
- AB (A and B oligosaccharides are present)
- O (neither A nor B, only their precursor H oligosaccharide present)

There are subtypes under this grouping (listed as A1, A2, A1B or A2B…) some of which are quite rare. Apart from this there is a protein which plays an important part in the grouping of blood. This is called the Rh factor. If this is present, the particular blood type is called positive. If it is absent, it is called negative. Thus we have the following broad categories:[4]

- A1 Negative (A1 −ve)
- A1 Positive (A1 +ve)
- A1B Negative (A1B −ve)
- A1B Positive (A1B +ve)
- A2 Negative (A2 −ve)
- A2 Positive (A2 +ve)
- A2B Negative (A2B −ve)
- A2B Positive (A2B +ve)
- B Negative (B −ve)
- B Positive (B +ve)
- B1 Positive (B1 +ve)
- O Negative (O −ve)
- O Positive (O +ve)

Rare blood types

In the "ABO" system, (and Rhesus D system) all blood belongs to one of four major groups: A+/−, B+/−, AB+/−, or O+/−. The presence (+) or absence (−) of the RhD (Rhesus D) antigen is indicated by the plus or minus following the ABO type. But there are more than two hundred minor blood groups that can complicate blood transfusions. These are known as rare blood types. Whereas common blood types are expressed in a letter or two, which may be a plus or a minus, a smaller number of people express their blood type in an extensive series of letters in addition to their 'AB-' type designation. The h/h blood group, also known as Oh or the Bombay blood group, is a rare blood type.[5]

Blood group systems

This table was borrowed in significant part from a tabular ISBT document available via the web (columns 1, 2, 3 and 5),[2] with column 4, regarding epitopes and entry notes, being largely unsourced (and therefore suspect material not in compliance with Wikipedia policies).[6] That and other unsourced information—i.e., not appearing in the ISBT table cited, or new to the table since publication of the ISBT table—should be considered as currently unverifiable by this encyclopedia's standards.

ISBT №[2]	System name	System symbol	Epitope or carrier, notes	Chromosome
001	ABO	ABO	Carbohydrate (N-Acetylgalactosamine, galactose). A, B and H antigens mainly elicit IgM antibody reactions, although anti-H is very rare, see the Hh antigen system (Bombay phenotype, ISBT #18).	9q34.2
002	MNS	MNS	GPA / GPB (glycophorins A and B). Main antigens M, N, S, s.	4q31.21
003	P	P	Glycolipid. Three antigens: P_1, P, and P^k	22q13.2
004	Rh	RH	Protein. C, c, D, E, e antigens (there is no "d" antigen; lowercase "d" indicates the absence of D).	1p36.11
005	Lutheran	LU	Protein (member of the immunoglobulin superfamily). Set of 21 antigens.	19q13.32
006	Kell	KEL	Glycoprotein. K_1 can cause hemolytic disease of the newborn (anti-Kell), which can be severe.	7q34
007	Lewis	LE	Carbohydrate (fucose residue). Main antigens Le^a and Le^b — associated with tissue ABH antigen secretion.	19p13.3
008	Duffy	FY	Protein (chemokine receptor). Main antigens Fy^a and Fy^b. Individuals lacking Duffy antigens altogether are immune to malaria caused by *Plasmodium vivax* and *Plasmodium knowlesi*.	1q23.2
009	Kidd	JK	Protein (urea transporter). Main antigens Jk^a and Jk^b.	18q12.3
010	Diego	DI	Glycoprotein (band 3, AE 1, or anion exchange). Positive blood is found only among East Asians and Native Americans.	17q21.31
011	Yt	YT	Protein (AChE, acetylcholinesterase).	7q22.1
012	XG	XG	Glycoprotein.	Xp22.33
013	Scianna	SC	Glycoprotein.	1p34.2
014	Dombrock	DO	Glycoprotein (fixed to cell membrane by GPI, or glycosyl-phosphatidyl-inositol).	12p12.3
015	Colton	CO	Aquaporin 1. Main antigens Co(a) and Co(b).	7p14.3
016	Landsteiner-Wiener	LW	Protein (member of the immunoglobulin superfamily).	19p13.2
017	Chido	CH	C4A C4B (complement fractions).	6p21.3
018	Hh	H	Carbohydrate (fucose residue).	19q13.33
019	XK	XK	Glycoprotein.	Xp21.1

ISBT №[2]	System name	System symbol	Epitope or carrier, notes	Chromosome
020	Gerbich	GE	GPC / GPD (Glycophorins C and D).	2q14.3
021	Cromer	CROM	Glycoprotein (DAF or CD55, regulates complement fractions C3 and C5, attached to the membrane by GPI).	1q32.2
022	Knops	KN	Glycoprotein (CR1 or CD35, immune complex receptor).	1q32.2
023	Indian	IN	Glycoprotein (CD44 adhesion function?).	11p13
024	Ok	OK	Glycoprotein (CD147).	19p13.3
025	Raph	RAPH	Transmembrane glycoprotein.	11p15.5
026	JMH	JMH	Protein (fixed to cell membrane by GPI). Also known as Semaphorin 7A or CD108.	15q24.1
027	Ii	I	Branched (I) / unbranched (i) polysaccharide.	6p24.2
028	Globoside	GLOB	Glycolipid. Antigen P.	3q26.1
029	GIL	GIL	Aquaporin 3.	9p13.3
030	Rh-associated glycoprotein	RHAg	Rh-associated glycoprotein.	6p21-qter
031	Forssman	FORS	Globoside alpha-1,3-N-acetylgalactosaminyltransferase 1 (GBGT1)	9q34.13
032	Langereis[7]	LAN	ABCB6, human ATP-binding cassette (ABC) transporter, mitochondrial porphyrin transporter.[7]	2q36
033	Junior	JR	ABCG2. Multi-drug transporter protein.	4q22
034	Vel	Vel	Human red cell antigens	1p36.32
035	CD59	CD59	—	11p13

References

1. ISBT (2016). "International Society for Blood Transfusion (ISBT) Committee on Terminology for Red Cell Surface Antigens, Terminology Home Page". Retrieved 20 February 2016.
2. ISBT (2014). "Table of Blood Group Systems v4.0 (November)" (PDF). International Society of Blood Transfusion. Retrieved 19 February 2016.
3. Lane, W.J.; Westhoff, C.M.; Uy, J.M.; Aguad, M.; Smeland-Wagman, R.; Kaufman, R.M.; Rehm, H.L.; Green, R.C.; Silberstein, L.E. (2015). "Comprehensive Red Blood Cell and Platelet Antigen Prediction from Whole Genome Sequencing: Proof of Principle". *Transfusion*. **56** (3): 743–54. doi:10.1111/trf.13416. PMID 26634332.
4. Indian Red Cross Society, Tamil Nadu Branch.
5. This blood phenotype was first discovered in Bombay, now known as Mumbai, in India, by Dr. Y. M. Bhende in 1952.
6. See WP:VERIFY and WP:OR.
7. Helias, V.; Saison, C.; Ballif, B.A.; Peyrard, T.; Takahashi, J.; Takahashi, H.; Tanaka, M.; Deybach, J.C.; Puy, H.; Le Gall, M.; Sureau, C.; Pham, B.N.; Le Pennec, P.Y.; Tani, Y.; Cartron, J.P. & Arnaud, L. (2012). "ABCB6 is Dispensable for Erythropoiesis and Specifies the New Blood Group System Langereis" (PDF). *Nature Genetics*. **44**

(2, January 15): 170–173. doi:10.1038/ng.1069. PMC 3664204. PMID 22246506. "[Quoting Abstract: The human ATP-binding cassette (ABC) transporter ABCB6 has been described as a mitochondrial porphyrin transporter essential for heme biosynthesis, but it is also suspected to contribute to anticancer drug resistance, as do other ABC transporters located at the plasma membrane. We identified ABCB6 as the genetic basis of the Lan blood group antigen expressed on red blood cells but also at the plasma membrane of hepatocellular carcinoma (HCC) cells, and we established that ABCB6 encodes a new blood group system (Langereis, Lan). Targeted sequencing of ABCB6 in 12 unrelated individuals of the Lan(-) blood type identified 10 different ABCB6 null mutations. This is the first report of deficient alleles of this human ABC transporter gene. Of note, Lan(-) (ABCB6(-/-)) individuals do not suffer any clinical consequences, although their deficiency in ABCB6 may place them at risk when determining drug dosage.]"

External links

- Dean, Laura (2005). *Blood Groups and Red Cell Antigens*. Bethesda, MD, USA: National Center for Biotechnology Information (NCBI), National Library of Medicine, National Institutes of Health. Retrieved 19 February 2016.
- SIB-EBI-PIR (2016). "Blood group Antigen Proteins: List of Entries, 17 February version". *Swiss-Prot Protein Knowledgebase*. Geneva, CHE: Swiss Institute of Bioinformatic (SIB), in cooperation with the European Bioinformatics Institute (EBI, Hinxton, ENG), and the Protein Information Resource (PIR, Washington DC, USA). Retrieved 19 February 2016.
- ISBT Table of blood group antigens within systems (http://ibgrl.blood.co.uk/ISBT%20Pages/ISBT%20Terminology%20Pages/Table%20of%20blood%20group%20antigens%20within%20systems.htm), updated August 2008.
- BGMUT Blood Group Antigen Gene Mutation Database (http://www.ncbi.nlm.nih.gov/gv/mhc/xslcgi.cgi?cmd=bgmut/home) at NCBI, NIH.