Lecture Notes

UJ | SCHOOL OF MED

PHYSIOLOGY

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Blood Groups

- Blood types are a classification used for RBCs. This classification depends on the presence or absence of specific antibodies and genetically inherited antigens (A & B) on the surface of RBCs.

- Red blood cells are classified into these groups:
  1. Type A
  2. Type B
  3. Type AB
  4. Type O

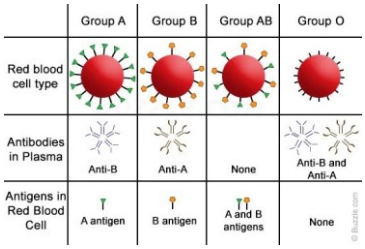
1. Type A blood:
   We have A antigens (or Agglutinogen A) on the surface of RBCs. In the plasma of individuals with Type A blood, we'll find antibodies against Antigen B (Agglutinin anti-B). It's obvious that these individuals don't have Agglutinin anti-A because that will destruct their own antigens.
2. Type B blood:
   Individuals with type B blood have B antigens (or Agglutinogen B) on the surface of RBCs. In their plasma, they have antibodies against Antigen A (Agglutinin anti-A). It's obvious that these individuals don't have Agglutinin anti-B because that will destruct their own antigens.
3. Type AB blood:

   Individuals with type AB blood have A & B antigens (or Agglutinogen A & Agglutinogen B) on the surface of RBCs. In their plasma, they have NO antibodies against Antigen A (Agglutinin anti-A) or against Antigen B (Agglutinin anti-B) .It's obvious that these individuals don't have antibodies because that will destruct their own antigens.

4. Type O blood:
   Individuals with type O blood have NO antigens on the surface of RBCs. In their plasma, they have both antibodies against Antigen A (Agglutinin anti-A) AND against Antigen B (Agglutinin anti-B). It's obvious that these individuals have antibodies because they don't have antigens, so these antibodies will work to destruct foreign antigens.

- Note that:
  1. blood donated from individuals with Type O to any other type won't be rejected because their RBCs have no antigens on their surface to be rejected.
  2. individuals with Type AB can receive blood from any donor because they have no antibodies to reject specific antigens, but the other way round doesn't work.

- A & B antigens are present and can be traced in other tissues such as (salivary glands, pancreas, kidney, liver, lungs, testes, semen, & the amniotic fluid).



- Antibodies in the plasma are not usually present in newborn babies, they start to appear naturally at the beginning of the 2nd month and their amount increases gradually till the end of the 8th month.
- Sometimes, the production of these antigens doesn't occur at all (which is not normal). These people don't develop subsequent antibodies unless they were exposed to the RBCs of other individuals .
- The plasma may contain antibodies (agglutinins) against A & B antigens; anti-A or alpha, anti-B or beta. These agglutinins are not present at birth but they appear between the 2nd and 8th month of life, most probably in response to A and/or B antigens taken in food of animal origin, especially meat, and in some bacteria. The anti-A and anti-B antibodies are describes as naturally occurring anti-bodies.

Recipient	Blood donor			
	O	A	B	AB
O	✓	x	x	x
A	✓	✓	x	x
B	✓	x	✓	x
AB	✓	✓	✓	✓

Inheritance of blood groups

- The inheritance of the A and B antigens is dictated by the A and B genes. The O gene doesn't produce any demonstrable red cell antigen. This is the reason why group A genotype can be AA (homozygous) or AO (Heterozygous). Similarly, for group B, the possible genotype is BB or BO, while for blood group O, the only possible genotype is OO. Group Ab has both A and B genes, and the only possible genotype is AB. Knowledge of these genotypes is useful in working out the probable blood group of an offspring on the basis of the knowledge of the blood genotypes of the father and mother. It is also helpful in sorting out disputed parentage of the child.

Note :

1. Genotype refers to the two alleles inherited for a particular gene. Phenotype refers to observable characteristics in organisms like their heights and eye colors.
2. O blood type antigens are recessive.

- On the surface of human red blood cells are found a series of genetically determined glycoproteins & glycolipids that act as blood group antigens. They appear early in fetal life and remain unchanged throughout life. More than 100 blood antigens have been described, out of which at least 15 well-defined red blood cells groups systems exist in most racial groups. Of these, only two are of major importance in clinical medicine, the ABO & rhesus (Rh) systems. Other blood group systems include: MM , MN , NN , PP , Pp , kell , Lewis, kid , Lutheran , Duffy & many others.

The rhesus (Rh) blood group system

- The Rh system is described on the basis of the presence or absence of the rhesus antigen (D) on the surface of red blood cells. If present, the individual is said to be D-positive or Rh- positive. 85% of Europeans , 90-95 % of Arabs and Africans & 98% of Asians are Rh- or D-positive (they have D antigens on their RBCs & they don't have antibodies against them in their plasma). If absent the individual is described as D- or Rh-negative. Thus, we can conclude that 15% of Europeans don't have the D antigen on their RBCs surfaces. Also, they do not have antibodies against the D antigen in their plasma, unless they've been exposed to D antigens.

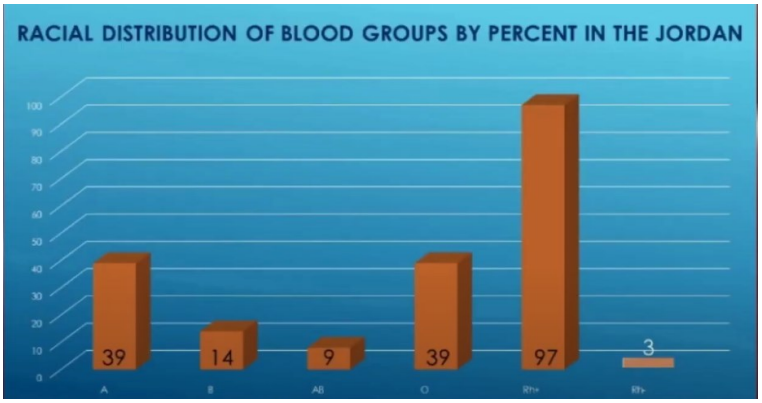
Rhesus Antigens

- There are at least 3 sets of alternative antigens in the Rh system: D or d, C or c, E or e. However, D is a strong antigen and therefore clinically more important than the others. In blood banks, Rh grouping is performed with anti-D serum.

Table 16.1 Racial Distributions of Blood Groups by Percent in the United States*

	A	B	AB	O	Rh^+	Rh^-
Whites	41	10	4	45	85	15
Blacks	28	20	5	47	90	10
Chinese	28	23	13	36	99	1
Indians (in Utah)	3	0	0	97	100	0

*Data mainly from A. S. Wiener, *Blood Groups and Transfusion*, 3d ed. Springfield, IL: Charles C. Thomas, 1943.



- In all races, O blood group has the highest percentage with variations in the Rh blood groups.
- Rh-positive blood group is either homozygous (RhRh / DD) or heterozygous (Rhrh / Dd). Rh-negative blood group is homozygous recessive (rhrh / dd).
- In case the parents had the following genotypes (DD & dd) → all children will be Rh-positive.
- In case the parents had the following genotypes (Dd & dd) → some children will be Rh-negative.
- Imagine a case where a father has a genotype of Rh-positive (RhRh / DD), a mother has a genotype of Rh-negative (rhrh / dd), and the fetus has a genotype of Rh-positive (for example → Rhrh / Dd). If some RBCs from the fetus pass into the maternal blood (which is possible during delivery), the mother is going to produce D-antibodies, because her body recognizes D-antigen as a foreign antigen. Later, in recurring pregnancies with Rh positive babies, Rh antibodies (from the mother) attack Rh-positive baby's blood cells, causing their agglutination (because antibodies bind to antigens of RBCs) and possibly hemolytic diseases.

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