

Immunology Lab 5

ABO Blood Antigens

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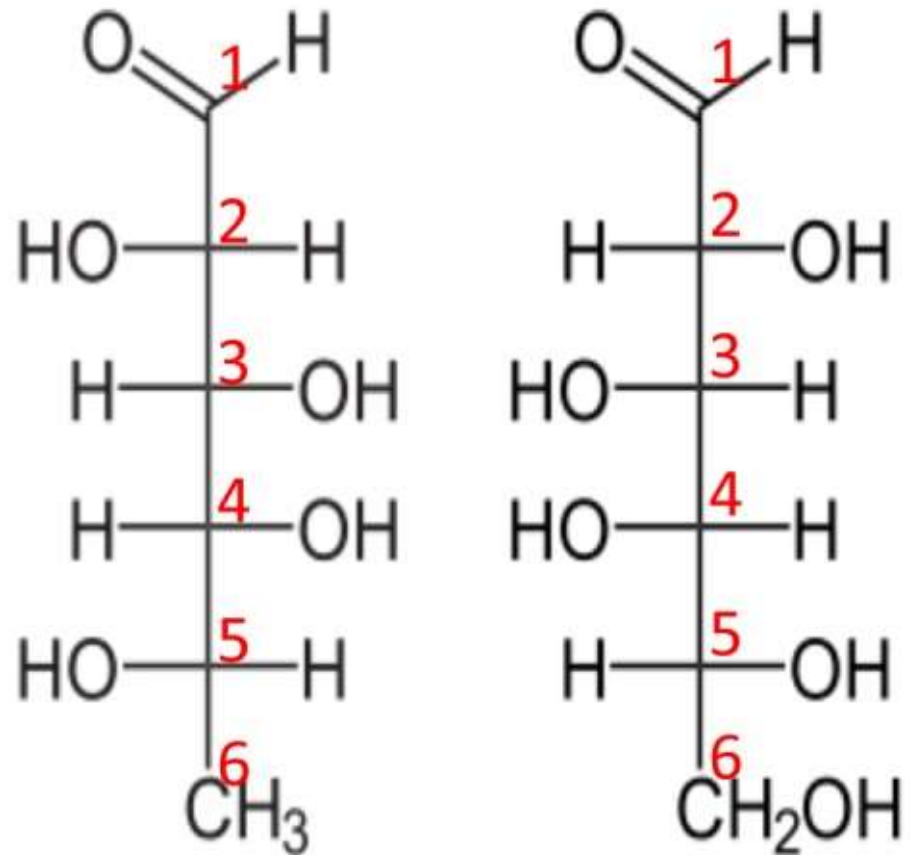
ABO blood antigens

- The ABO antigens are carbohydrates linked to cell surface proteins and lipids that are synthesized by polymorphic glycosyltransferase enzymes.
- Most individuals possess a fucosyltransferase that adds a fucose moiety to a nonterminal sugar residue of the core glycan, and the resulted fucosylated glycan is called the H antigen (O antigen).
- A single gene on chromosome 9 encodes a glycosyltransferase enzyme that may further modify the H antigen.

There are three allelic variants of this enzyme

1. **O allele gene** product: is devoid of enzymatic activity and can't attach terminal sugars to the H antigen, and express only the H antigen, the precursor of the ABO blood group antigens.
2. **A allele**– encoded enzyme (N –Acetylgalactosaminyltransferase): transfers a terminal **N-acetylgalactosamine** moiety onto the H antigen.
3. **B allele gene** product: transfers a terminal galactose moiety.

The C-6 carbon of l-fucose lacks a hydroxyl group present at the C-6 position of d-galactose. l-Fucose can also be described as **6-deoxy-l-galactose**.



L-Fucose

D-Galactose

FUT2 as a genetic marker

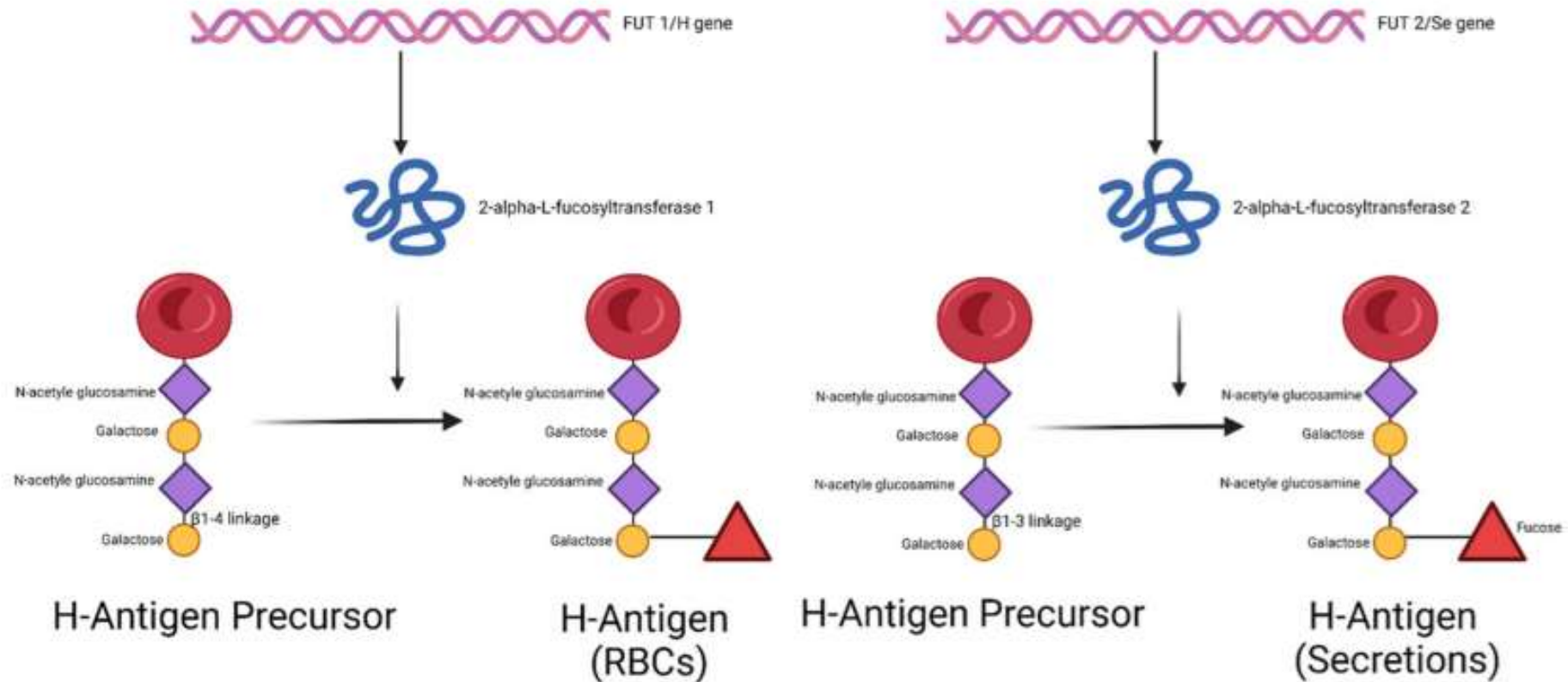


Figure 1. Role of FUT1 and FUT2. Fucosyltransferase enzymes H (FUT1) add fucose to the alpha (1, 2) binding of type 2 glycoproteins on RBCs to form H antigen, whereas FUT2 adds fucose to the alpha (1, 2) binding of type 1 glycoprotein chains to make ABH antigens in other body fluids (secretor phenotype).

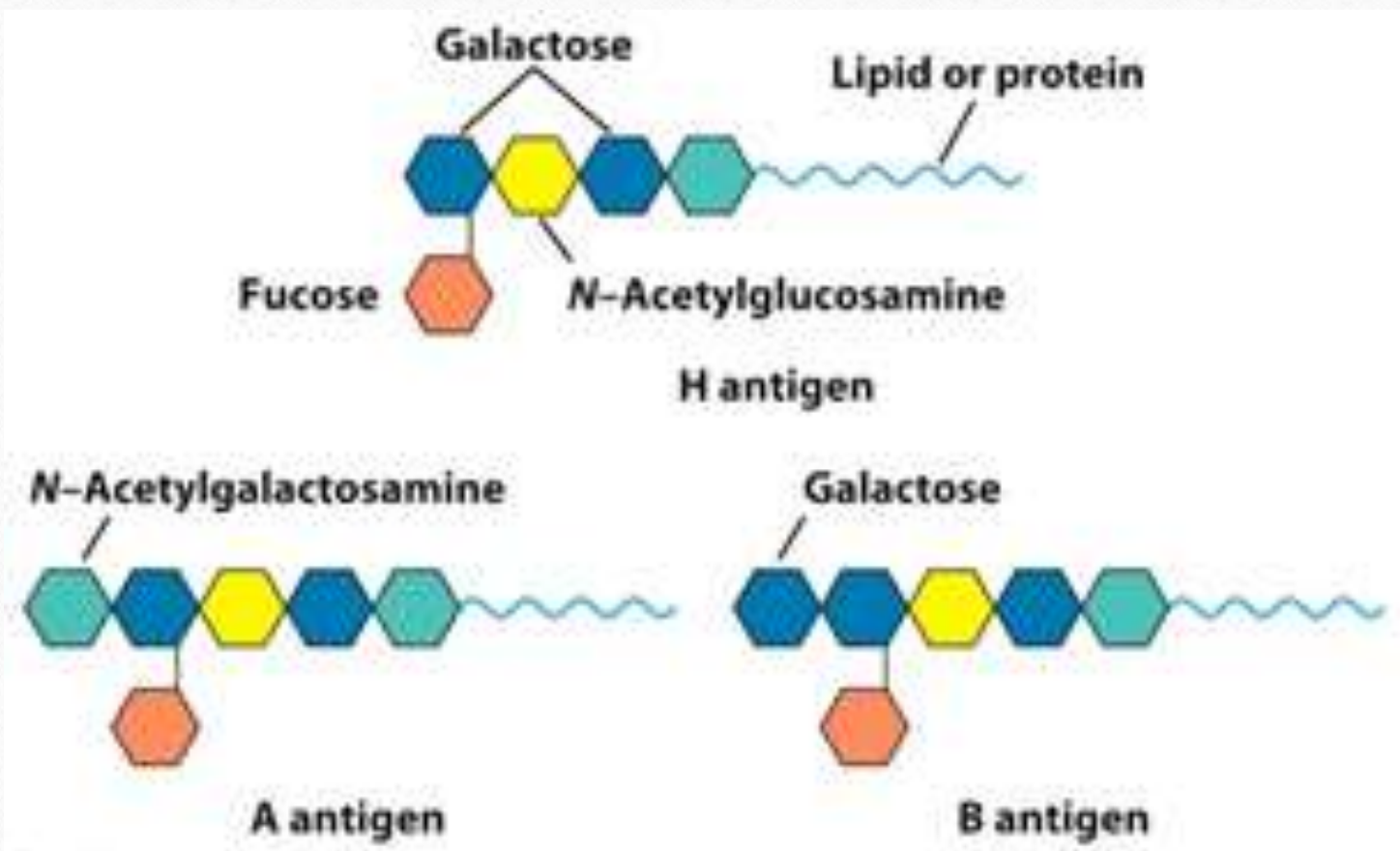
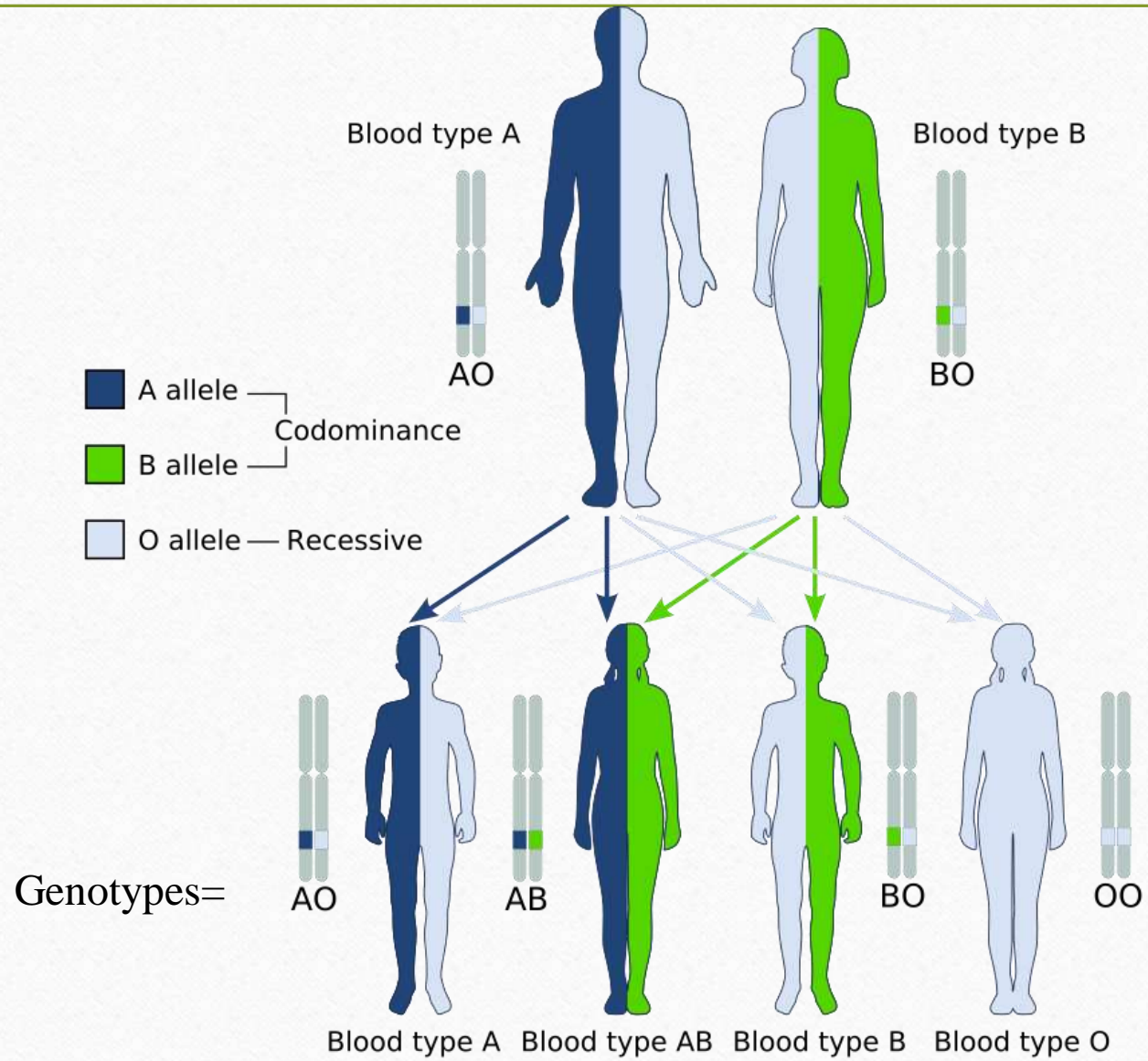


Figure 15-15a
 Basic Immunology, Seventh Edition
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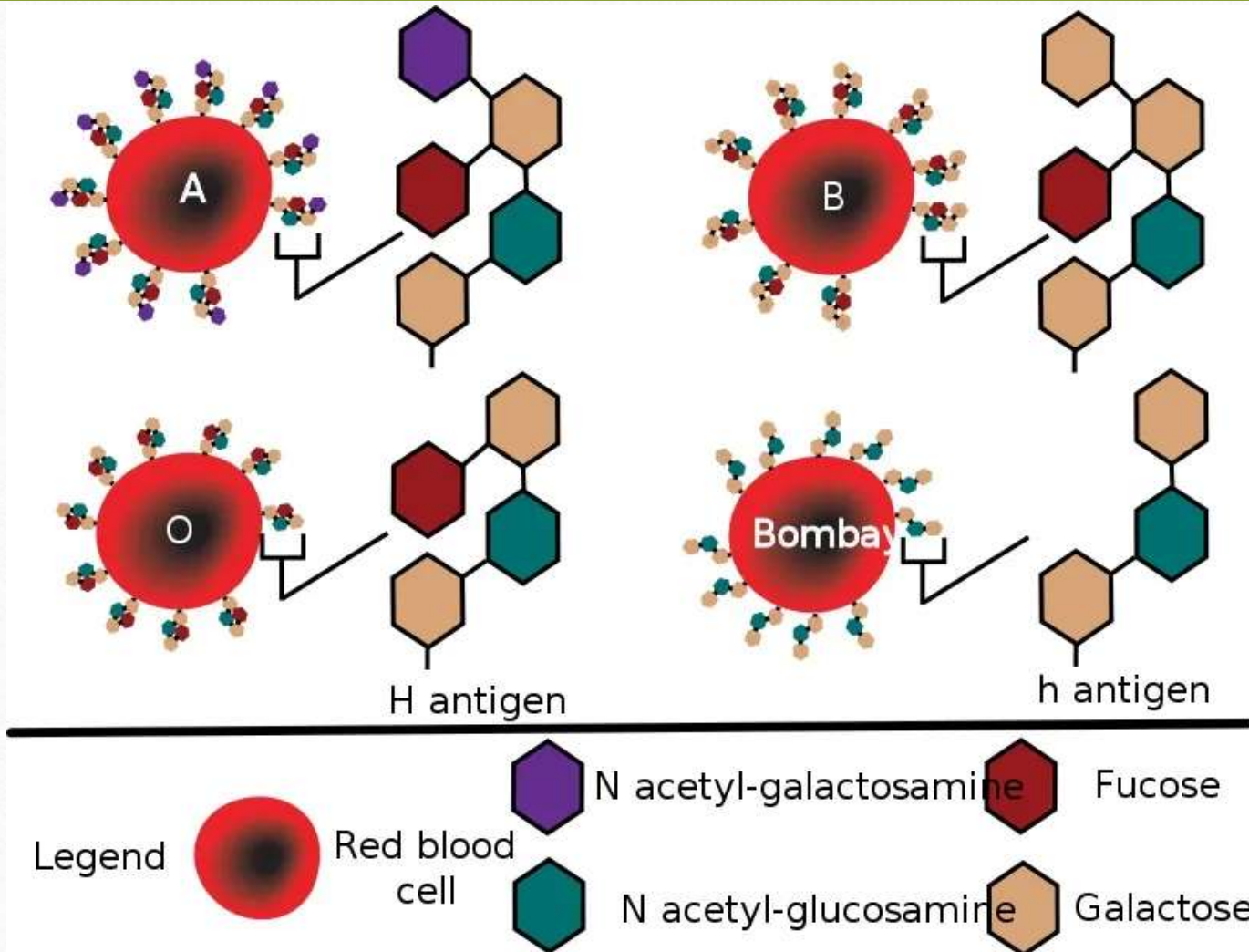


Diagram showing the carbohydrate chains that determine the ABO blood group

- Mutations in the gene encoding the fucosyltransferase that produces the H antigen without fucose are rare.
- People who are homozygous for such a mutation are said to have the **Bombay blood group** (h/h, also known as Oh).
- And cannot produce H, A, or B antigens. And can't receive type O, A, B, or AB blood.

Blood Groups (Antigens and Antibodies)

Blood Group	Antigens	Antibodies
A	A,H	B
B	B,H	A
AB	A,B,H	-
O	H	A,B
Bombay Blood Group	-	A,B,H

Called (O, hh, Oh)

Percentages of the 8 blood groups

AB-negative (0.6 percent)

B-negative (1.5 percent)

AB-positive (3.4 percent)


A-negative (6.3 percent)

O-negative (6.6 percent)

B-positive (8.5 percent)

A-positive (35.7 percent)

O-positive (37.4 percent)



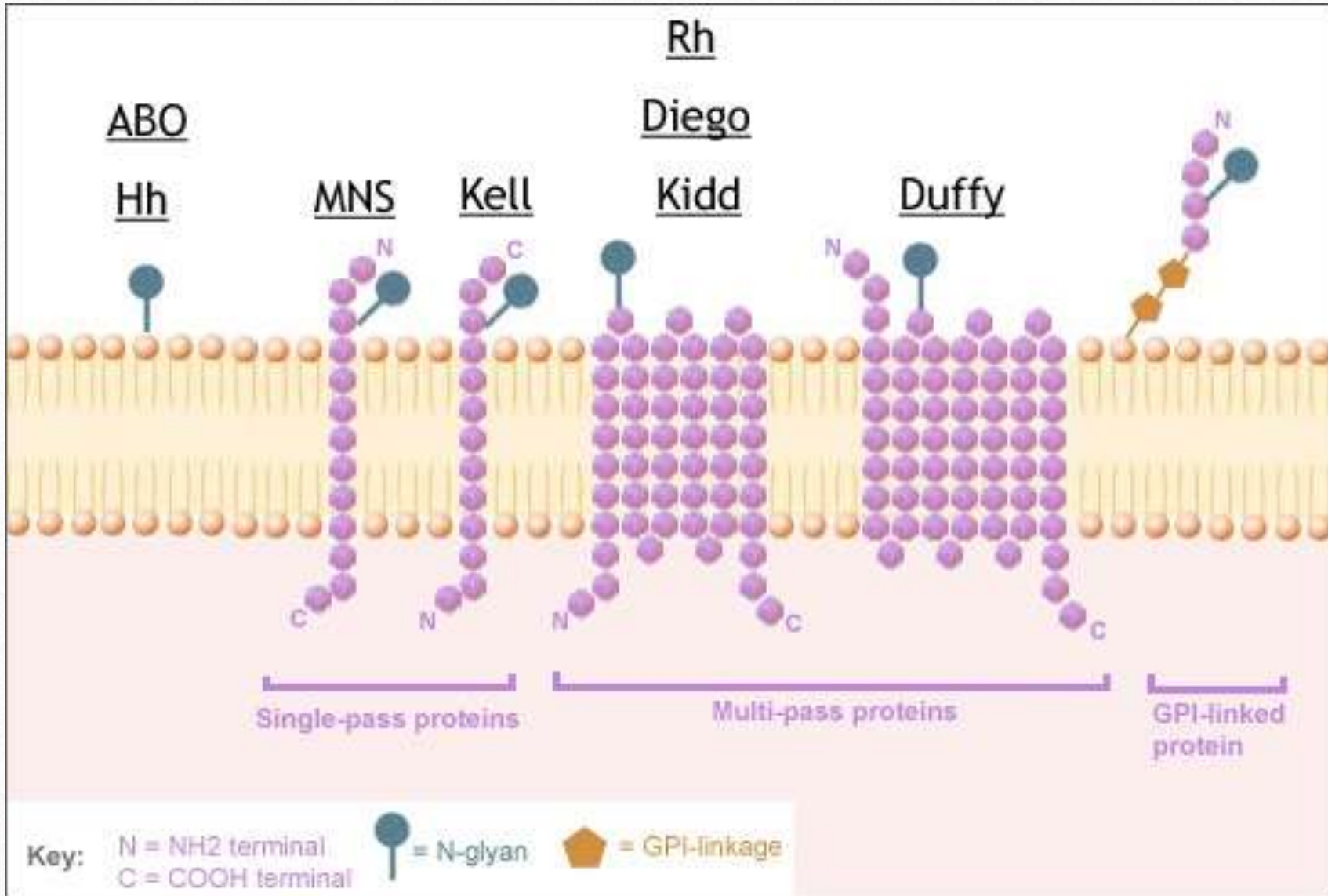
44%

Most Common Transplantation -Blood Transfusion-

		Donor's Blood Type							
		O-	O+	B-	B+	A-	A+	AB-	AB+
Patient's Blood Type	AB+	✓	✓	✓	✓	✓	✓	✓	✓
	AB-	✓		✓		✓		✓	
	A+	✓	✓			✓	✓		
	A-	✓				✓			
	B+	✓	✓	✓	✓				
	B-	✓		✓					
	O+	✓	✓						
	O-	✓							

- ✓ O-negative is the **universal blood type**, meaning any other blood type may receive it (see our blood type compatibility chart here).
- ✓ This can quickly deplete the stores of O-negative that blood centers have on the shelves.
- ✓ While 44% of the population is type O, less than 7% is O-negative. So as you can see, the most needed type of blood is also the hardest to collect.
- ✓ AB negative is the rarest of the eight main blood types - just 1% of our donors have it. Despite being rare, demand for AB negative blood is low

Blood grouping System	System symbol	<u>Epitope</u> or carrier, notes	<u>Chromosome</u>
<u>ABO</u>	ABO	Carbohydrate) <u>N-Acetylgalactosamine</u> , <u>galactose</u> .(A, B and H antigens	<u>9</u>
<u>MNS</u>	MNS	Main antigens M, N, S, s. carried on sugar-bearing proteins called glycoporphins.	<u>4</u>
<u>Rh</u>	RH	Protein. C, c, D, E, e antigens (there is no "d" antigen; lowercase "d" indicates the absence of D	<u>1</u>
<u>Kell</u>	KEL	Glycoprotein. K ₁ can cause <u>hemolytic disease of the newborn (anti-Kell</u> ,(which can be severe.	<u>7</u>
LI	Li	Polysaccharide	6
<u>Duffy</u>	FY	Protein) <u>chemokine receptor</u> .(Main antigens Fy ^a and Fy ^b .Individuals lacking Duffy antigens altogether are immune to <u>malaria</u> caused by <u>Plasmodium vivax</u> and <u>Plasmodium knowlesi</u> .	<u>1</u>



RH blood antigen

- Rh antigens are non-glycosylated, hydrophobic cell surface proteins found in red blood cell membranes.
- 15% of the population has a deletion or other alteration of the RhD allele.
- Rh status is inherited from our parents, separately from our blood type.
- If you inherit the dominant Rhesus D antigen from one or both of your parents, then you are Rh-positive (85% of us). If you do not inherit the Rhesus D antigen from either parent, then you are Rh-negative (15% of us).

Rh System

Rh Antigens and Encoding Genes

- Subsequently it was confirmed that the RH locus is on chromosome 1 and comprises two highly homologous, very closely linked genes, RHD and RHCE.
- The Rh blood group system consists of 49 defined blood group antigens, among which the five antigens (D, C, c, E, and e) are the most important.
- There is no d antigen. D antigen is the main that its presence or absence mean Rh+ or Rh- respectively.
- The main antigens are D, C, E, c and e, which are encoded by two adjacent gene loci, the RHD gene which encodes the RhD protein with the D antigen and the RHCE gene which encodes the RhCE protein with the C, E, c and e antigens
- The RHCE gene has four main alleles; CE, Ce, ce and cE.
- This concept of D and CcEe genes linked closely and transmitted together is consistent with the Fisher nomenclature.

Examples on antigens in Rh+ and Rh -

D- C+ E+ c- e+ (RhD-)

D+ C+ E- c- e+ (RhD+)

- ✓ Each locus has its own set of alleles which are Dd , Cc , and Ee . The D gene is dominant to the d gene, but Cc and Ee are co-dominant (meaning that all of the inherited alleles lead to expression of the coded antigens).
- ✓ Antibodies to Rh antigens can be involved in hemolytic transfusion reactions and antibodies to the Rh(D) antigens confer significant risk of hemolytic disease of the fetus and newborn.

		MOTHER	
		D	d
FATHER	D	DD	Dd
	d	Dd	dd

Rh System

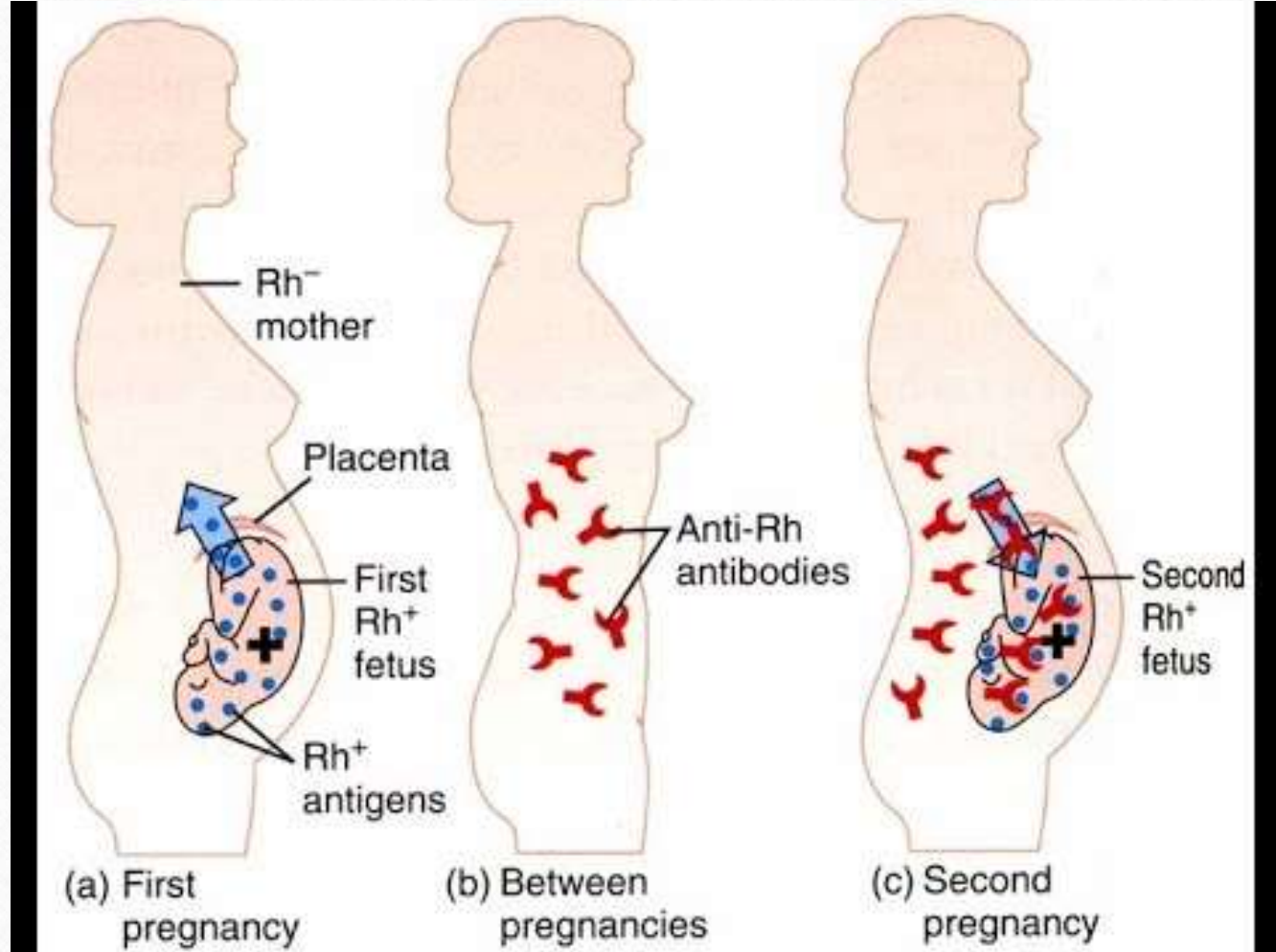
- **Antibodies**
 - ✓ Antibodies directed against all Rh antigens, except d, have been described: anti-D, anti-C, anti-c, anti-E and anti-e.
 - ✓ Rh antigens are restricted to red cells and Rh antibodies result from previous alloimmunization by previous pregnancy or transfusion.
 - ✓ Immune Rh antibodies are predominantly IgG.

...Rh Antibodies

- ✓ Anti-D is clinically the most important antibody.
- ✓ It may cause hemolytic transfusion reactions and was a common cause of fetal death resulting from hemolytic disease of the newborn before the introduction of anti-D prophylaxis.

hemolytic disease of the newborn

- When the condition is caused by the RhD antigen-antibody incompatibility, it is called Rh D Hemolytic disease of the newborn.
- The major clinical significance of anti-Rh antibodies is related to hemolytic reactions associated with pregnancy that are similar to transfusion reactions.
- (**Rh-negative mothers**) carrying an Rh-positive fetus can be sensitized by fetal red blood cells that enter the maternal circulation, usually during childbirth. IgG antibodies are generated in Rh-negative mothers.
- Subsequent pregnancies in which the fetus is Rh positive are at risk because the maternal (anti-Rh D) IgG antibodies can cross the placenta and mediate the destruction of the fetal red blood cells. This causes anemia, dyspnea, jaundice and erythroblastosis fetalis.



Erythroblastosis Fetalis

Kernicterus: is a type of brain damage that can result from high levels of bilirubin in a baby's blood.

