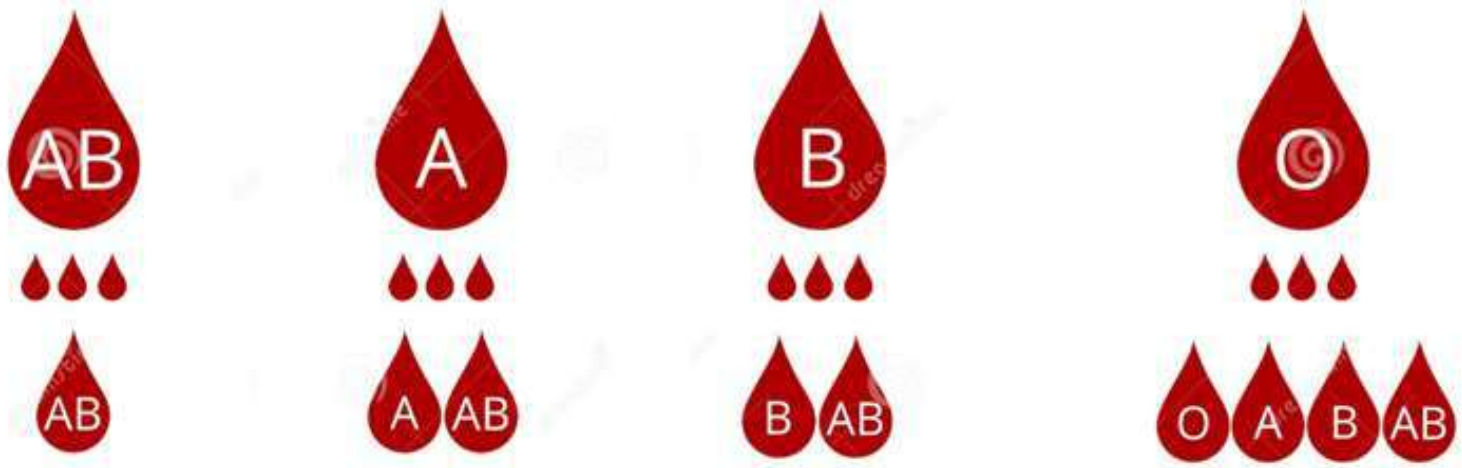

ABD Blood Group System

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ABO Blood Group System

- It is also referred to as Blood Type. The classification is based on the presence or absence of inherited antigenic substance expressed on RBCs.
- It is the most important blood grouping system discovered by Karl Landsteiner in 1901, who was awarded Nobel Prize for this work in 1930. Type AB was discovered a year later by his students Adriano Sturli and Alfred von Decastello in 1902.
- These antigens are glycoprotein complex.
- The antigens are also present on platelets, epithelium, and cells other than erythrocytes.
- Determination of BO blood groups depends upon the immunological reaction between the antigen (also called as agglutinogens)and antibody.
- ABO blood types are also present in other animals like rodents and apes, such as Chimpanzees, Bonobos, and Gorillas.

Landsteiner Rule

Landsteiner Rule states that:

- If an antigen or agglutinogen is present in the patient red blood cells (RBCs), the corresponding antibody or agglutinin will not be present in the patient under ‘normal conditions.

- If an agglutinogen is absent on the RBC cell membrane, then the corresponding agglutinin must be present in the plasma.

AB Antibodies or Agglutinin

- AB blood agglutinogen results in the presence of agglutinin or AB antibodies in the plasma of an individual.
- There are two principles of the presence of agglutinin in the plasma:
  I. Almost all normal healthy individuals above 3 – 6 months of age have naturally occurring Abs to the AB Ags that they lack. It is found in the plasma of individual without antigenic stimulation.
  II. The AB antibodies are mostly IgM class. Therefore, it effectively agglutinate low RBCs without enhancement and activate complement cascade in blood.

Blood Group

- Based on the presence or absence of agglutinogen, blood group of individual may fall into four categories; A, B, AB, and O. **— Janskỳ**
- According to the principle, blood having antigen A belongs to ‘A’ group that lacks antibody ‘A’, but antibody ‘B’ is present.
- Likewise, blood with antigen ‘B’ have antibody ‘A’, but lacks antibody ‘B’.
- If both antigens are present on the surface of RBC, no antibodies are present in the plasma; the blood group is called ‘AB’.
- But, if both antigens are absent from the RBCs, both ‘A’ and ‘B’ antibodies are present in the plasma.
- On the basis of these Ags and Abs, blood grouping is done which is based on agglutination reaction (*isoagglutinin reaction*).

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Blood Group

Blood group (ABO)	Antigen present	Antigen missing	Antibody present
A	A	B	Anti-B
B	B	A	Anti-A
AB	A & B	None	None
O	None	A & B	Anti-A & B

ABO Blood Group Typing

- The test to determine the blood group is called ABO typing. To determine the blood group, a blood sample is mixed with antibodies against type A and B blood.
- It involves both antigen typing and antibody detection. The antigen typing is called forward typing and the antibody detection is called reverse typing.
- The forward typing determines Ag on the patient's or donor's cells as:

a. Cells are tested with the antisera reagents anti-A or Anti-B
b. In the case of donor cells, antisera anti-A-B are used
c. The antisera are either made from hyperimmunized human sources or monoclonal antibodies (mAb)

Reactions of cells tested with Abs (FORWARD TYPING)		ABO Group
Anti – A	**Anti – B**	
0	**0**	**O**
+	**0**	**A**
0	**+**	**B**
+	**+**	**AB**

ABO Blood Group Typing

- The reverse typing determines antibodies in the patient's or donor's cells as;
  a. Serum tested with reagent A cells and B cells
  b. Reverse grouping is also known as back typing or serum confirmation
  c. If serum against A – cells gives positive results, the blood group will be either 'B' or 'O'.
  d. If the serum against B – cells gives negative results (no reaction), the blood group will be either 'A' or 'AB'.
  e. Likewise, If serum against B – cells gives positive results, the blood group will be either 'A' or 'O'.
  f. If the serum against B – cells gives negative results, the blood group will be either 'B' or 'AB'.

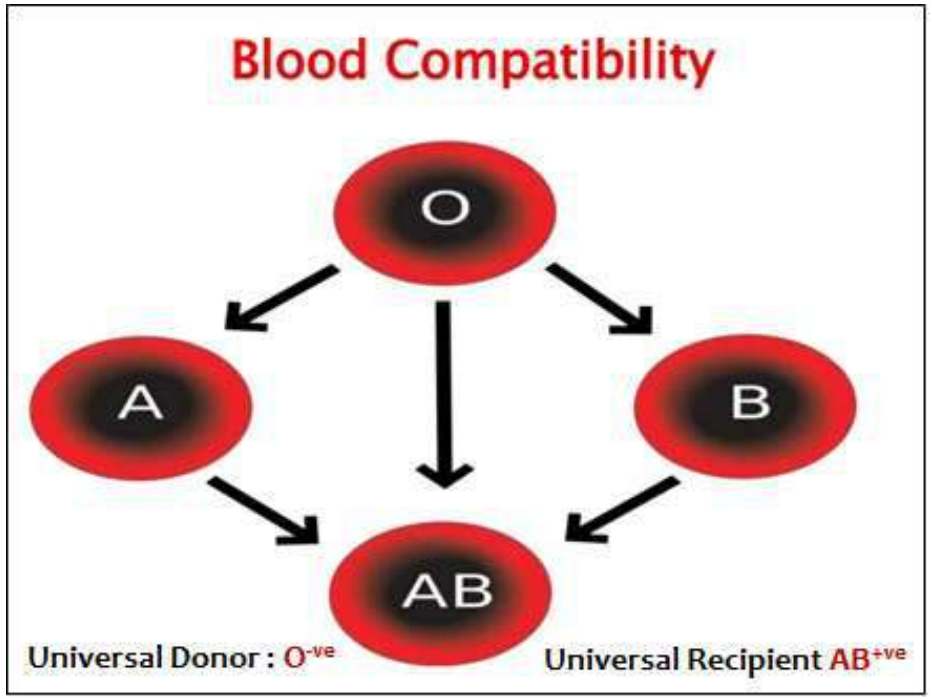
Reactions of serum tested against (REVERSE TYPING)		ABO Group
A – Cells	B – Cells	
+	+	O
0	+	A
+	0	B
0	0	AB

ABO Blood Group Compatibility

- ABO blood grouping is crucial in blood transfusion, where only compatible blood is used.
- The one who gives blood is called the "**DONOR**".
- The one who receives the blood is called "**RECIPIENT**".
- While transfusing blood, the antigen of the donor and the antibody of the recipient are considered – Forward and Reverse Blood Typing.
- RBCs of group 'O' have no antigens and so agglutination does not occur with any other group of blood. Therefore, blood group 'O' can be given to any blood group individuals, and hence persons with the 'O' group are called **UNIVERSAL DONOR**.
- RBCs of group 'AB' have both antigens (no antibodies) and so agglutination does not occur with any other group of blood. Therefore, blood group 'AB' can receive blood from any blood group individuals, and hence persons with 'AB' group are called **UNIVERSAL RECIPIENT**.

ABO Blood Group Compatibility

- In mismatched transfusion, the transfusion reactions occur between donor’s RBCs and recipient's plasma.
- Reaction between incompatible (mismatched) blood types, cause transfusion reaction which may lead to mild fever and hives or in severe condition, may lead to renal failure, shock and death of the recipient.
- Sometimes, no observable agglutination reaction takes place, which is due to antibody dilution in the recipient’s blood.
- *First blood transfusion was made dog to dog by British Physician Richard Lower in 1665.*



Relative Frequency of ABO Blood Group

ABO Blood types/Relative frequency of different blood types (World data)

'O' – 47%	**'A' – 41%**	**'B' – 9%**	**'AB' – 3%**

Inheritance of ABO Blood Group System

- The ABO locus (single gene ABO) has 3 main allele forms, i.e. I^A, I^B, & ***i***. The A and B genes are found on chromosome 9 and inherited as one allele from each parent.
- The gene is located on the long arm of 9th chromosome at position 9q34.
- The I^A gives type 'A', I^B gives type 'B' and ***i*** gives type 'O' blood group.
- The gene I^A and I^B are codominant and dominant over ***i***.
- The gene encodes for glycosyltransferase.
- Genotype of blood group:
  - O group : only ***ii*** AB group : I^AI^B
  - A group : I^AI^A or I^Ai B group : I^BI^B or I^Bi
- I^AI^B people have both phenotypes due to the expression of both A and B antigens because of a special dominance relationship known as Co-dominance. It allows blood type A and B parents can have an AB child.

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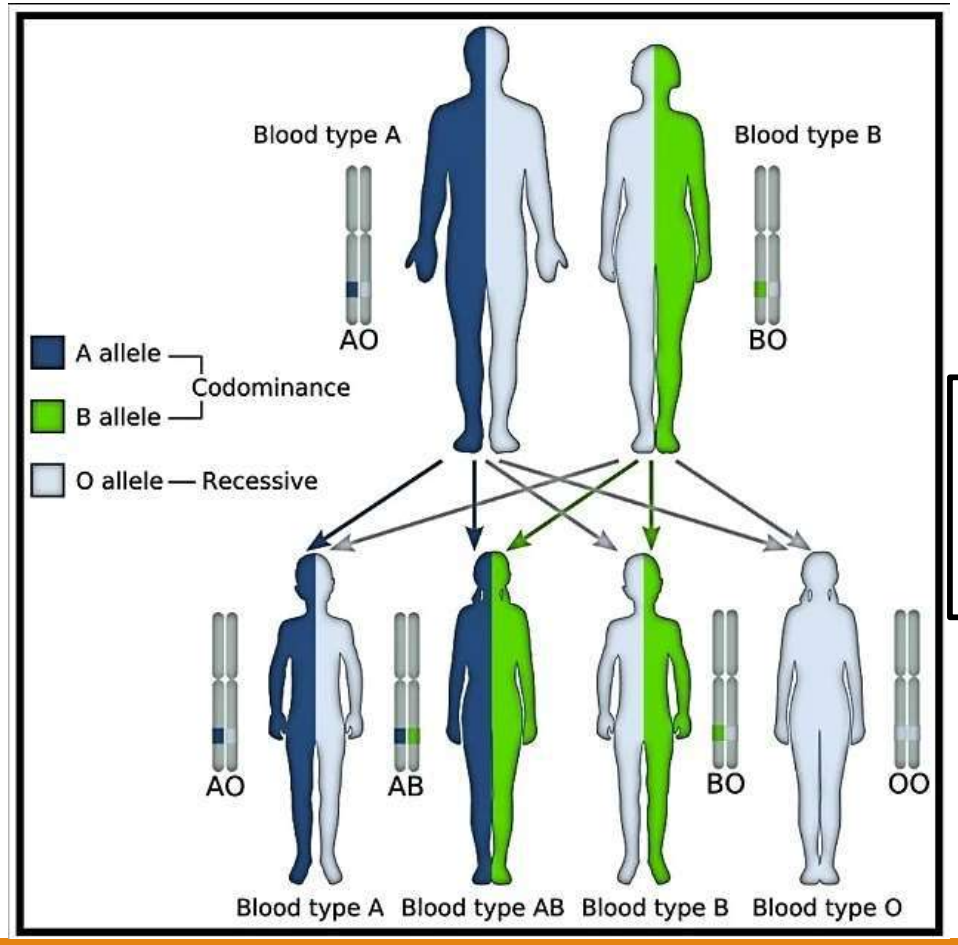
Inheritance of ABO Blood Group System



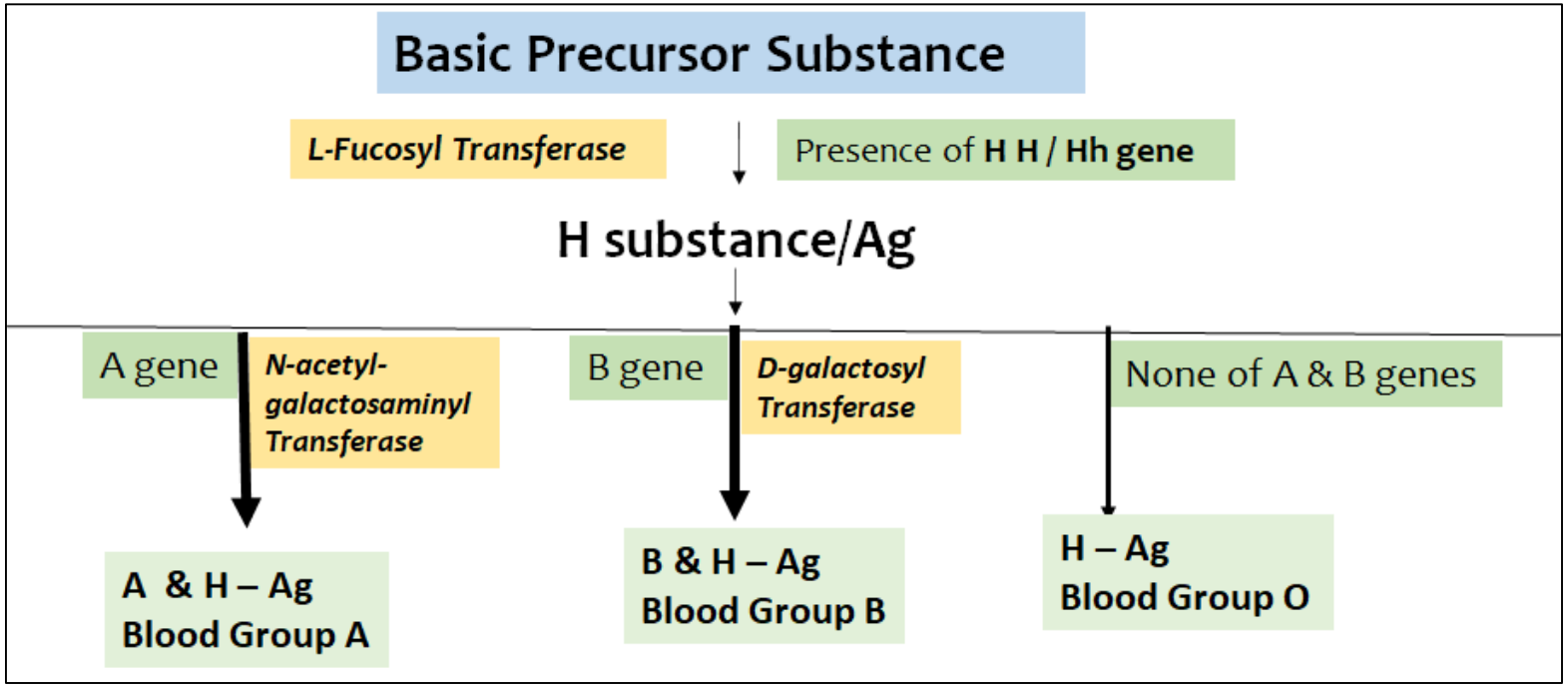
Blood types ‘A’ and ‘B’ are co-dominant giving the ‘AB’ phenotype.

Inheritance of ABO Blood Group System

		Father's Blood Type				
		A	B	AB	O	
Mother's Blood Type	A	A or O	A, B, AB, or O	A, B, or AB	A or O	Child's Blood Type
	B	A, B, AB, or O	B or O	A, B, or AB	B or O	
	AB	A, B, or AB	A, B, or AB	A, B, or AB	A or B	
	O	A or O	B or O	A or B	O	

Inheritance of ABO Blood Group System

- The presence or absence of the ABH antigens on the membrane of RBCs is controlled by the H gene.
- The presence or absence of the ABH antigens in secretions is indirectly controlled by the Se gene.
  - *H gene – H and h alleles (h is an amorph).*
  - *Se gene – Se and se alleles (se is an amorph).*



Biochemistry of ABO Blood Group System

Precursor of ABH antigen: Paragloboside / Glycan

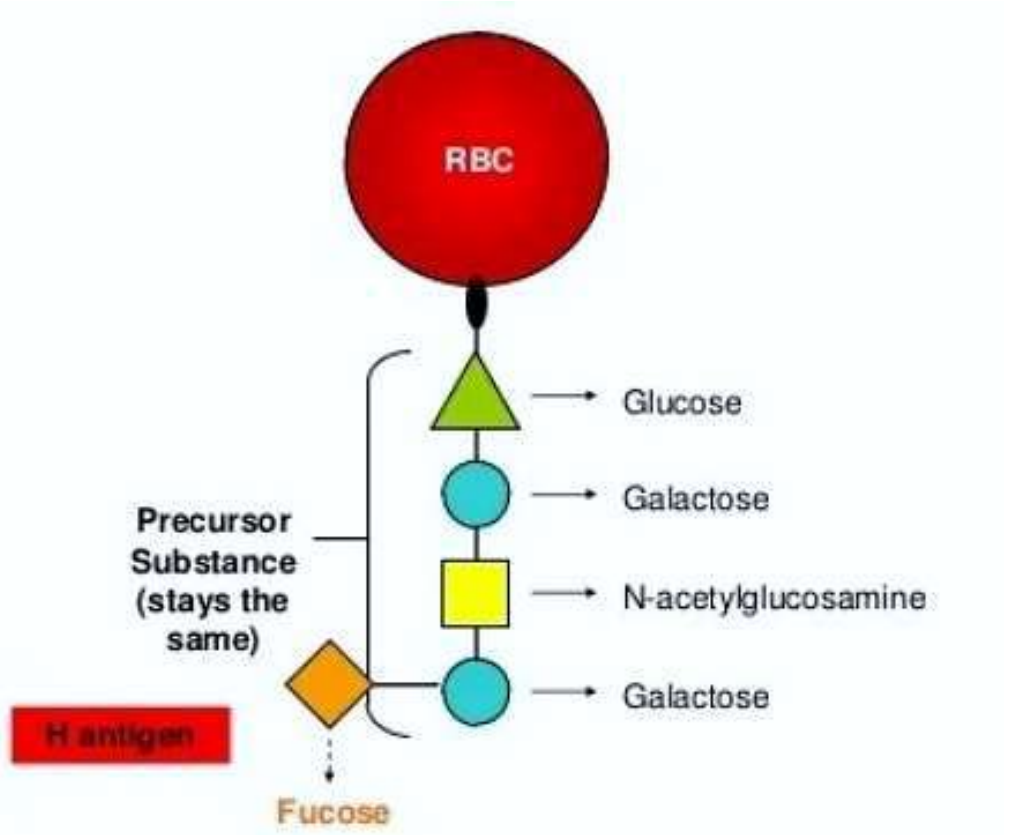
- Type I precursor: Terminal galactose linked to a subterminal N-acetylglucosamine in a 1-3 linkage
- Type II precursor: Same sugars combine in a 1-4 linkage
- ABH antigens on RBC are derived from type II chains.
- Blood group substances in secretion are made from both types I and II precursors.

Source: slideshare.com

Biochemistry of ABO Blood Group System

H Substance

- H gene (FUT1 gene) leads to the production of an enzyme α-2-L-fucosyl transferase, which transfers fucose to the terminal galactose of the precursor Glucose galactose N-acetylglucosamine.

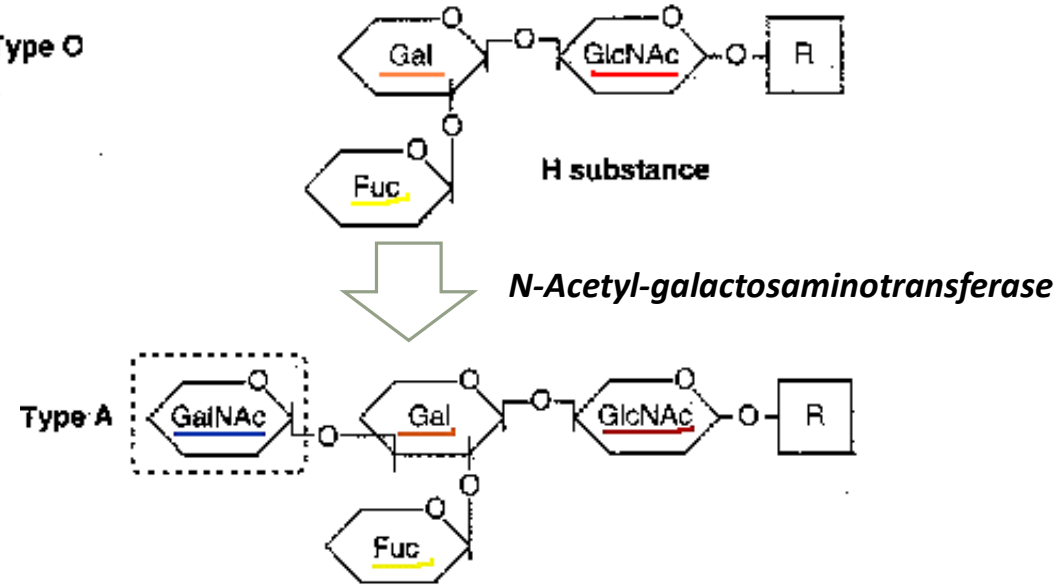


Source: slideshare.com

Biochemistry of ABO Blood Group System

Formation of A Antigen

- A gene codes for an enzyme that adds GalNAc (N-Acetyl-D-galactosamine) to the terminal H antigen.



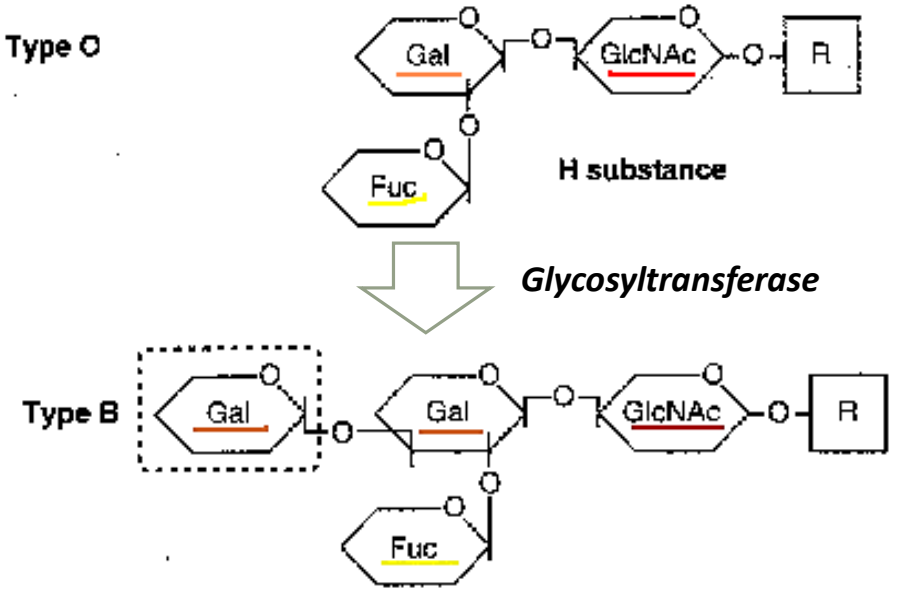
Biochemical structure of A antigen

Source: slideshare.com

Biochemistry of ABO Blood Group System

Formation of B Antigen

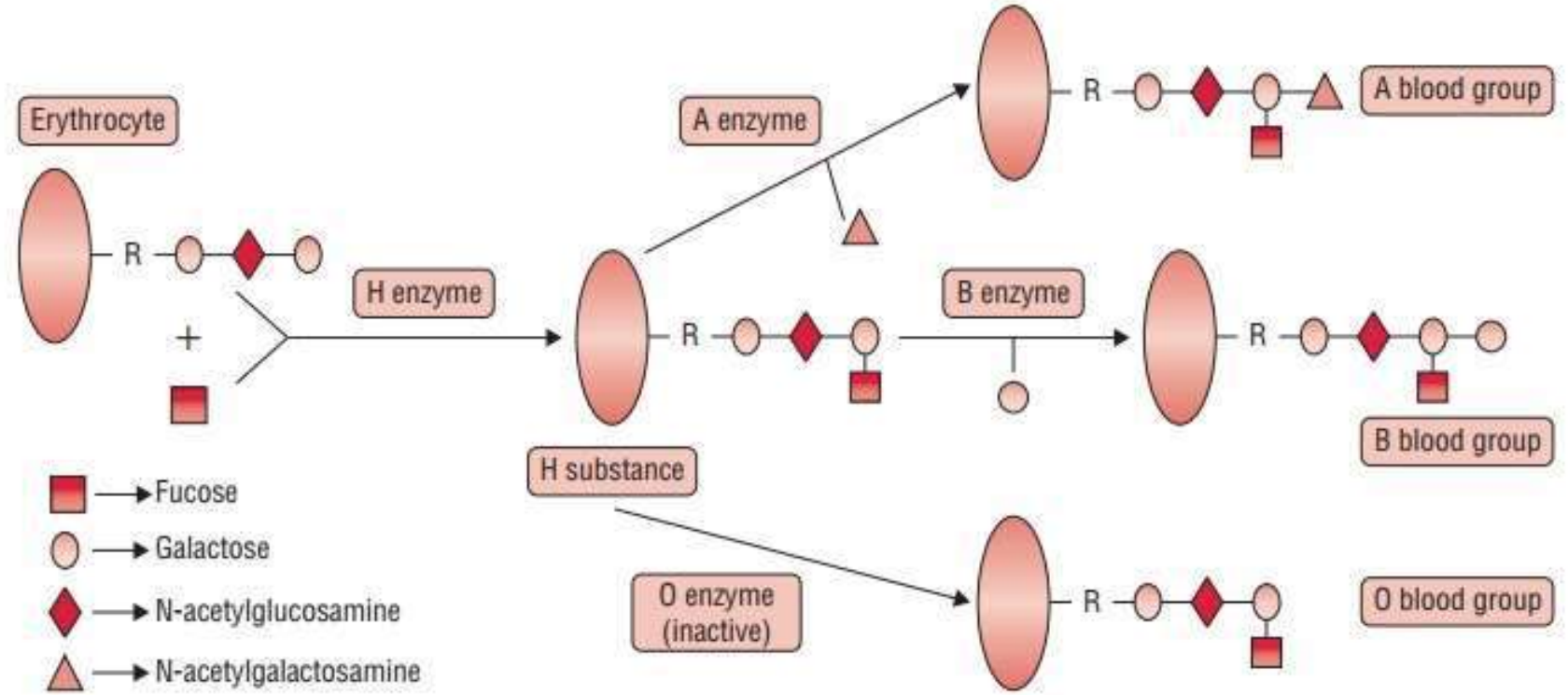
- B gene codes for an enzyme a different glycosyltransferase that adds D-galactose to the terminal H antigen.



Biochemical structure of A antigen

Source: slideshare.com

Biochemistry of ABO Blood Group System



ABO blood group system.

https://www.brainkart.com/article/ABO-Blood-Group-System-and-Antigens_17998/

Rh Blood Group System

- It is second most important blood group system after ABO blood group system.
- It is one of 36 current human blood group system.
- It was discovered by Karl Landsteiner and Alexander Wiener in 1940 in *Rhesus macaque*, hence it is known as **'Rh factor'**.
- It consists of 50 well defined blood group antigens.
- Among 50 antigens, there are 6 common types of Rh antigens, which are C, D, E, c, d, and e. Each antigen is specifically referred to as Rh factor.
- The 'D' Rh factor is widely prevalent in the population and considerably more antigenic than the other Rh factors.
- Anyone who has 'D' antigen is said to be Rh positive **(Rh^+)**, whereas a person who does not possess type 'D' antigen is said to be Rh negative **(Rh^-)**.

Manifestation of Rh Blood Group

Erythroblastosis fetalis

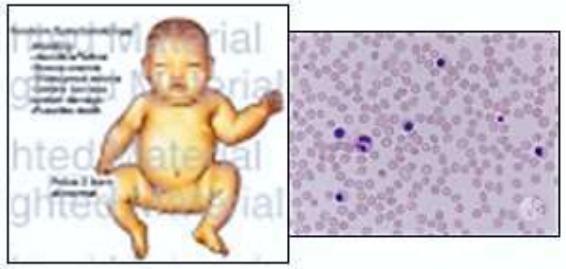
- It is the hemolytic disease of newborns.
- It is the disease of the fetus and newborn child characterized by agglutination and phagocytosis of the fetus's RBCs.
- It occurs when the mother is Rh-negative **(Rh^-)**, and the father is Rh-positive **(Rh^+)**.
- Baby is inherited with **Rh^+** antigen, while mother develops anti-Rh antibody.
- Anti-Rh antibody of mother diffuse through the placenta into the fetus and cause RBC agglutination.
- Symptoms observed are enlarged liver, spleen, or heart, fluid build-up in the fetus's abdomen, etc.

Manifestation of Rh Blood Group

Erythroblastosis fetalis

1. **Hydrops fetalis**-baby may die in utero.

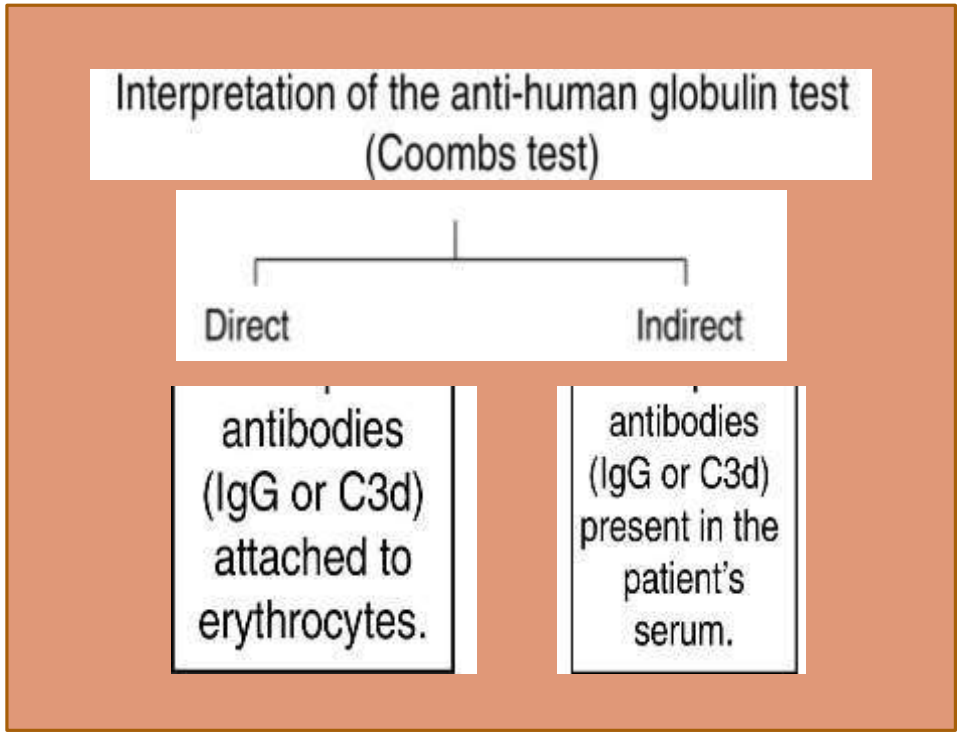
2. **Erythroblastosis fetalis**

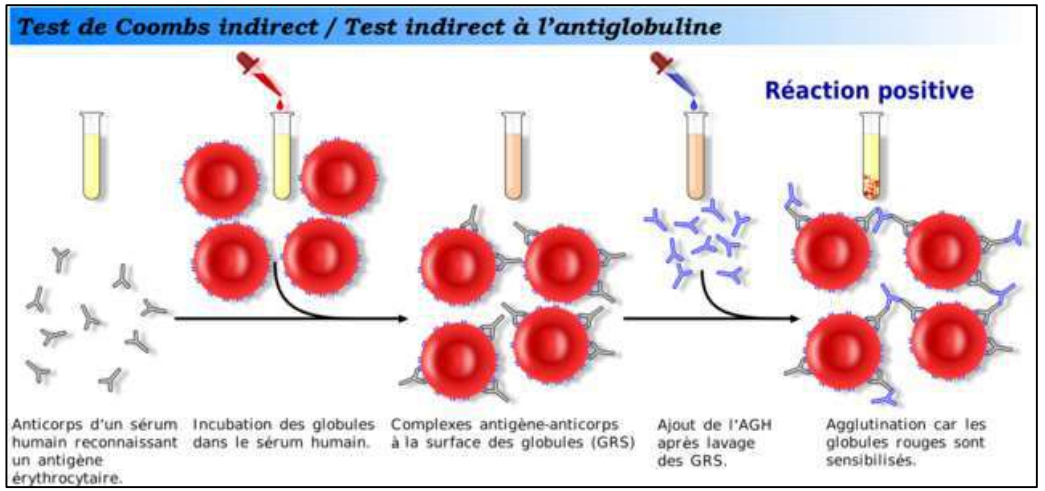


3. If mother has received **anti D abs** injection at time of Ist delivery, this causes neutralization of baby's Rh+ve RBCs, and immune system does not activate to produce abs.

Manifestation of Rh Blood Group

Erythroblastosis fetalis – <u>Indirect Coomb's Test</u>





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Thank you