

BLOOD GROUPS AND BLOOD TRANSFUSION

Prof. Shahid Habib

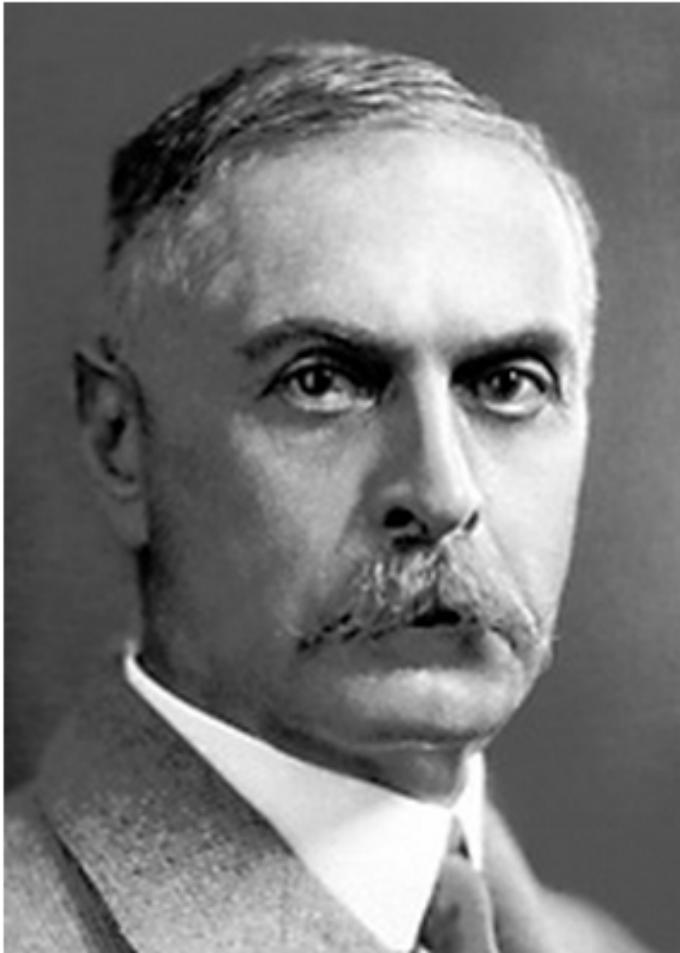
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OBJECTIVES

At the end of this lecture you should be able to:

- 1. Describe ABO blood groups types.**
- 2. Recognize Agglutinin in plasma.**
- 3. Describe genetic inheritance of Blood groups.**
- 4. Recognize transfusion reactions.**
- 5. Describe Rhesus blood groups.**
- 6. Describe causes of hemolytic disease of the newborn.**

BLOOD GROUPS



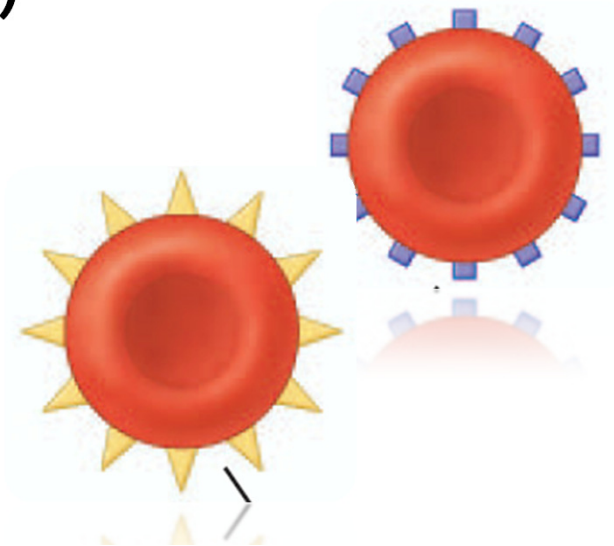
KARL LANDSTEINER
(1886-1943)

- Discovered ABO Blood group system in 1901
- Discovered Rh factor in 1930 along with Alexander S. Wiener
- Noble prize in Physiology or Medicine in 1930

Austrian scientist

BLOOD GROUP SYSTEMS

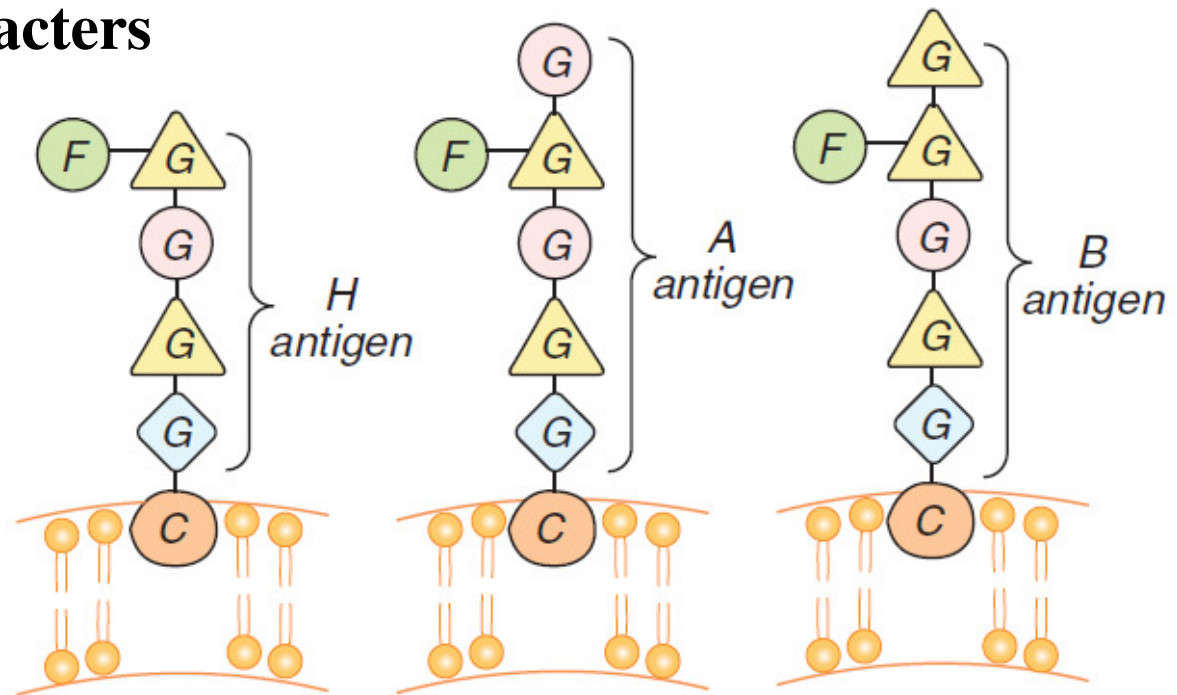
- **Blood Groups are determined by: Antigens** (glycoproteins, complex oligosaccharides that differ in their terminal sugar) **present on the surface of RBCs**
- About **20 blood group systems** are known (Eg. ABO System, Rh-System MNS System, Kell System, Lewis System, Duffy, Lutheran, KIDD)
- **Two are common**
 - ABO blood group system
 - Rh (Rhesus) blood group system



Are inherited characters

An H gene codes for a fucose transferase that adds a terminal fucose, forming the **H antigen** that is the foundation upon all blood types are formed

A and B genes code for enzymes that add a sugar to the H antigen



(F) = fucose

(G) = N-acetylgalactosamine

(G) = glucose

(G) = galactose

(C) = ceramide

(lipid bilayer) = lipid bilayer

FIGURE 31-9 Antigens of the ABO system on the surface of red blood cells.

The ABO system:

- Depends on whether the red cells contain one, both or neither of the two blood antigens: A and B
- Four main ABO groups: **A, B, AB, O**

Locus of alleles responsible of ABO system is on long arm of chromosome 9 while Rh locus is on chromosome 1

Rhesus (Rh) Blood Group is Determined by:

- Presence or absence of the Rhesus antigen **(D)** on the surface of RBC:
 - –Presence of D (individual is Rh+ve) [85%]
 - –Absence of D (individual is Rh–ve) [15%]
- Rhesus antigens:
 - Dd, Cc, Ee (6 antigens)
 - Clinically most important is **D**



Landsteiner and Weiner in 1940 discovered other antigens in human R.B.Cs and named rhesus antigens or Rh-antigen because the same antigens are present in Rhesus monkey.

AGGLUTINOGENS & AGGLUTININS

Blood Group	Antigens on RBCs <u>AGGLUTINOGENS</u>	Antibodies in Serum <u>AGGLUTININS</u>	Genotype <u>O is recessive</u>
A	A	Anti-B	AA or AO
B	B	Anti-A	BB or BO
AB	A and B	Neither	AB
O	Neither	Both Anti-A and Anti-B	OO

Antibodies in ABO & Rh Systems

- Anti-A & Anti-B are: **naturally** occurring antibodies.
 - Not present at birth, appear 8 weeks after birth.
 - Triggered by A & B antigens in food and bacteria.
-
- Anti-D antibody (agglutinin):
 - Is not naturally-occurring and are **Acquired** by:
 - Transfusion of Rh-ve individual with Rh+ve blood.
 - Rh-ve pregnancy with Rh+ve fetus.

Landsteiner Law (1900) If an agglutinogen is present on the RBC of an individual, the corresponding agglutinin must be absent in the plasma of that individual and vice-versa. This law is only applicable to ABO blood grouping system.

Inheritance of ABO system

- The **ABO gene** locus is located on the **chromosome 9**
- **A** and **B** blood groups are **dominant** over the **O** blood group
- **A** and **B** group genes are **co-dominant**
- Each person has **two copies of genes** coding for their ABO blood group (one maternal and one paternal in origin)

GENETIC DETERMINATION OF AGGLUTINOGENS

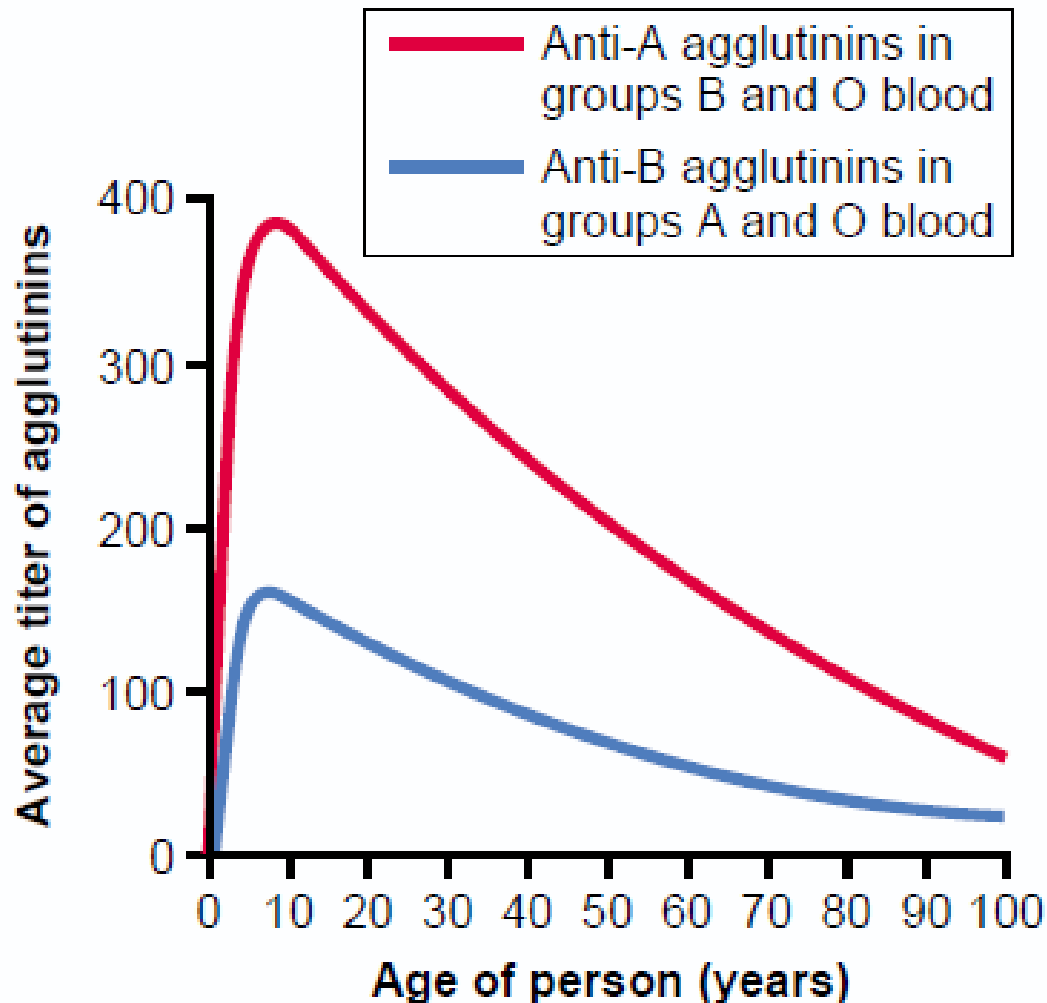
Parent Allele	A	B	O
A	AA	AB	AO
B	AB	BB	BO
O	AO	BO	OO

AGGLUTININS / ANTIBODIES

- Immunoglobulins Are proteins which appear in the plasma or body fluids in response to administration of antigens
 - IgM & IgG

anti-A or anti-B antibodies are of the IgM class (large molecules) and these do not cross the placenta
Rh antibodies are IgG type & can cross placenta

TITER OF ANTI-A& B AGGLUTININS AT DIFFERENT AGES



Two to 8 months after birth, an infant begins to produce agglutinins.

A maximum titer is usually reached at 8 to 10 years of age, and this gradually declines throughout the remaining years of life.

THE Rh IMMUNE RESPONSE

- Formation of anti-Rh agglutinins

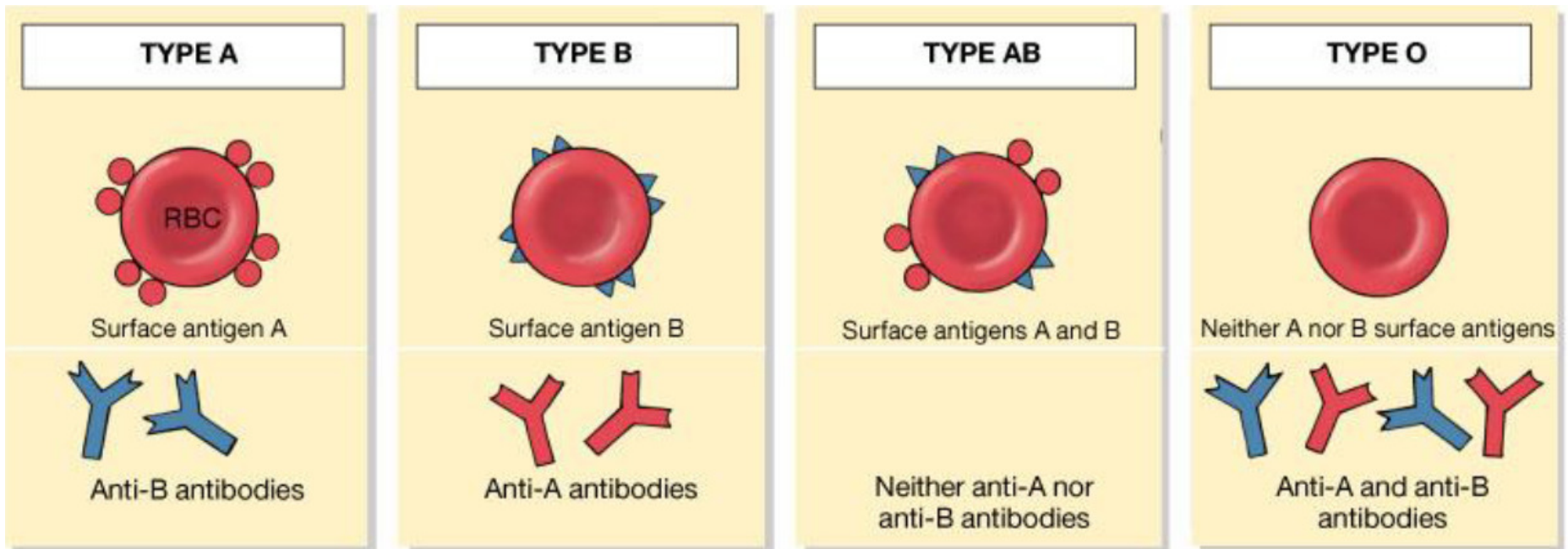
If Rh +ve blood is transfused for the first time to



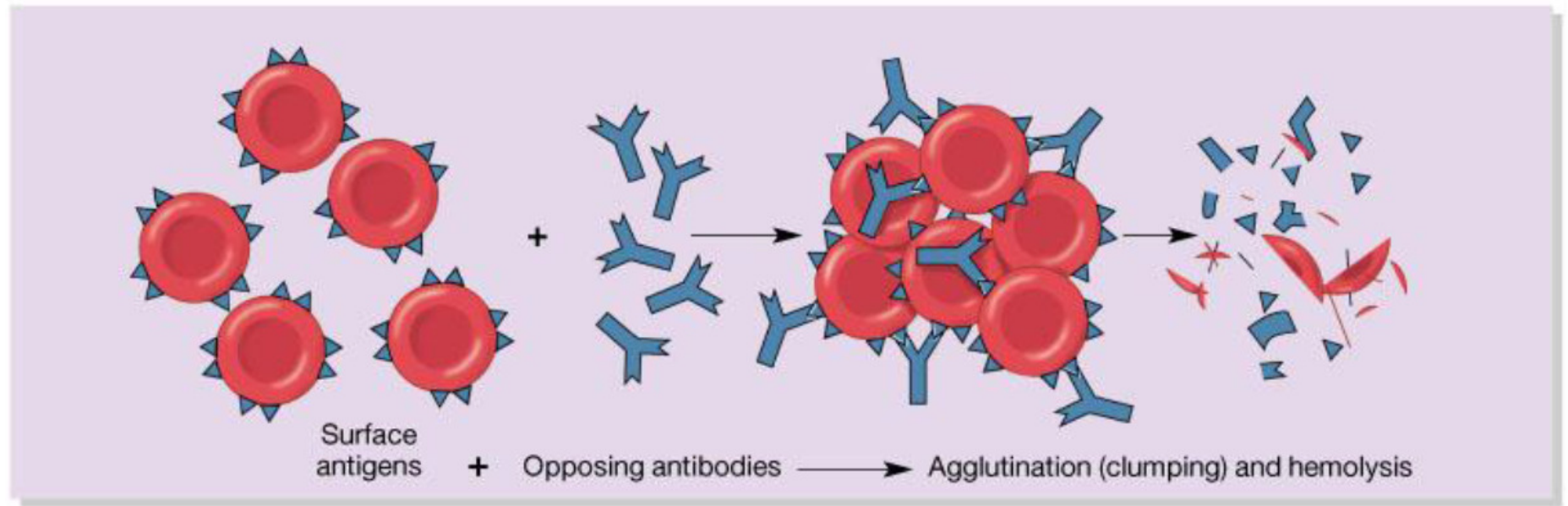
Rh -ve person



Anti-Rh agglutinins develop slowly (2-4 months)
Once produced they persist for years & can produce
serious reactions during 2nd transfusion



(a)



(b)

BLOOD TYPING

Anti-A

Anti-B

Anti-D serum determines
Rh+ and Rh-

A drop of
patient
RBC

Anti-A

Anti-B

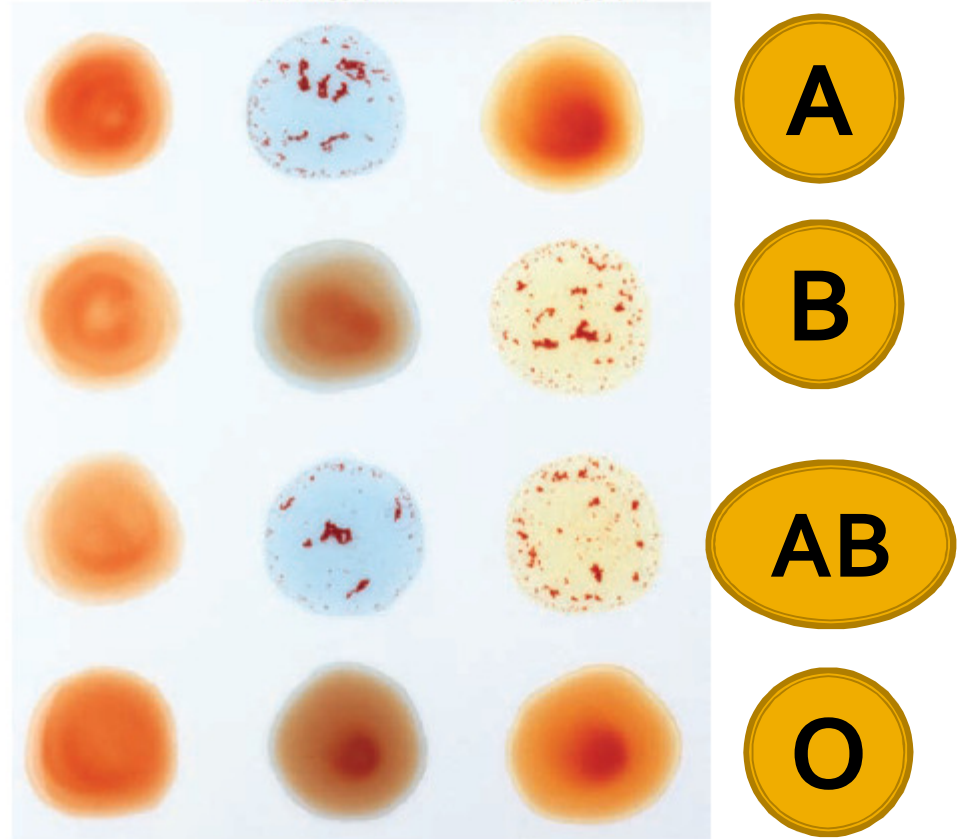
Anti-D

Untreated blood

Treated with
anti-A serum

Treated with
anti-B serum

Blood type



Importance of blood groups

- In Blood transfusion
- In preventing hemolytic disease (Rh incompatibility)
- In paternity disputes
- In medicolegal cases
- In knowing susceptibility to disease
 - Group O- duodenal cancer
 - Group A- Carcinoma of stomach, pancreas & salivary glands

Agglutination in transfusion reaction

- If a person with blood group A transfused with blood of group B (contains anti-A in plasma)
 - The anti-A in plasma of recipient blood group B will agglutinate the transfused cell (A)
 - The clumped cells plug small blood vessels
 - Sometimes causes immediate hemolysis
- **Transfusion reaction**

Rh incompatibility between mother and fetus

- Mother is Rh-ve and first baby is Rh+ve:
- At delivery
 - Fetal Rh+ve RBC cross to maternal blood
 - The mother will develop Anti-D after delivery.
 - First child escapes & is safe

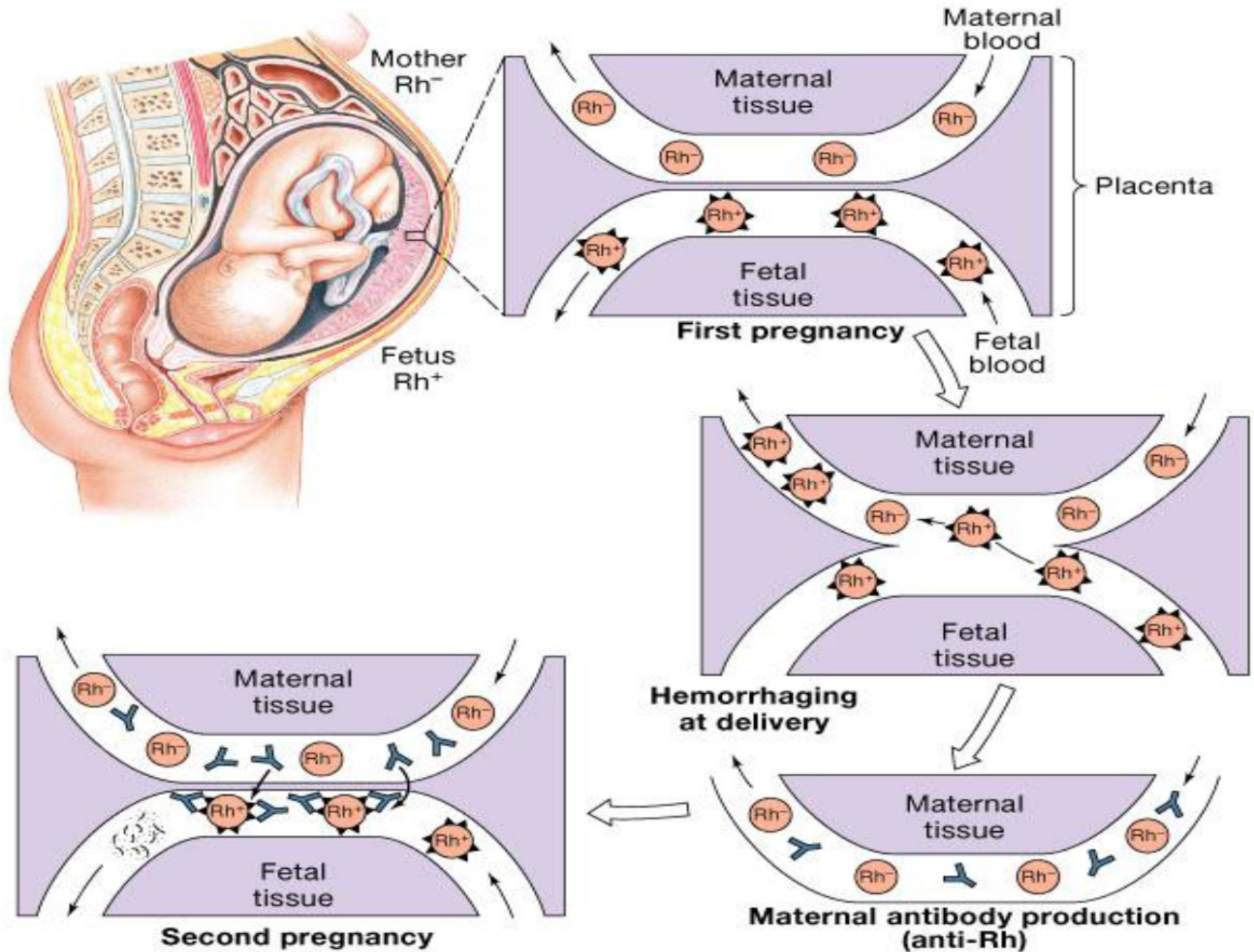
If the mother was transfused before with Rh+ve blood before, first child will also be affected

Rh incompatibility between mother and fetus

- Second fetus
 - If Rh+ve
 - Anti-D crosses placenta and destroys fetal Rh+ve RBCs

Outcome?

Hemolytic Disease of the newborn



ERYTHROBLASTOSIS FETALIS / HEMOLYTIC DISEASE OF NEW BORN

1. Hemolytic anemia:

- If severe: is treated with exchange transfusion:
- Replace baby's blood with Rh-ve RBC (several times)

2. Hydrops fetalis (death in utero)

3. Kernicterus

Prevalence of Disease

1st Pregnancy ----- 0%

2nd Pregnancy ----- 3%

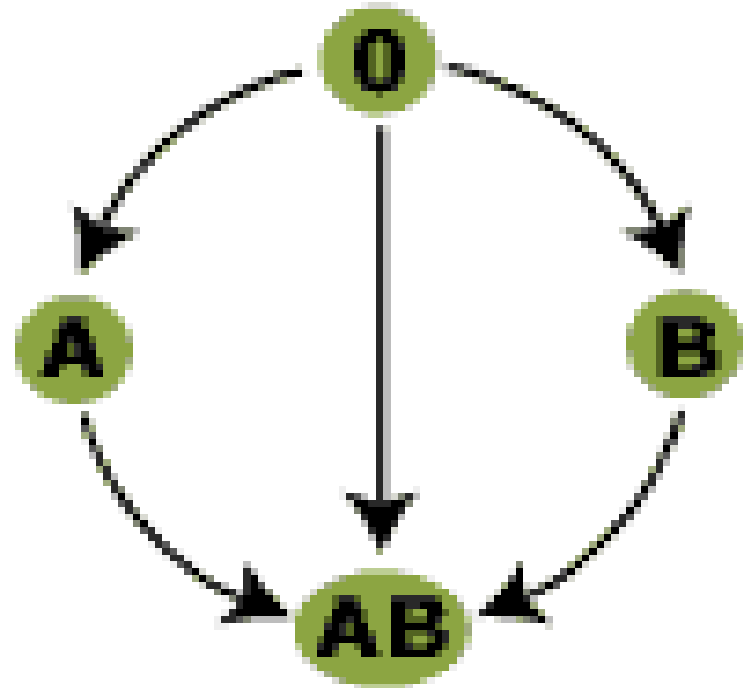
3rd Pregnancy ----- 10%

Prevention:

Injecting the mother with anti-D immediately after 1st childbirth
Antenatal (during pregnancy) prophylaxis

DONORS AND RECIPIENTS

- People with blood group o are called "universal donors" and people with blood group AB are called "universal receivers."



Complications of blood transfusion

- 1. Immune reaction: Incompatible blood transfusion leading to immediate or delayed reaction, fever, haemolysis, allergic reaction**
- 2. Transmission of diseases; malaria, syphilis, viral hepatitis & Aids**
- 3. Iron overload due to multi-transfusion in case of sickle cell anemia and thalassemia.**

Hazards of mismatched transfusion

■ 2 Types

■ Immediate

- Agglutination
- Hemolysis
- Fever
- Allergic reaction
- Acute renal shutdown
 - Renal vasoconstriction
 - Circulatory shock
 - Tubular blockage

■ Delayed

- Sensitization
- Thrombo Phlebitis

If You Have You Can Receive

O+	O+	O-		
O-	O-			
A+	A+	A-	O+	O-
A-	A-	O-		
B+	B+	B-	O+	O-
B-	B-	O-		
AB+	AB+	AB-	O+	O-
	A+	A-	B+	B-
AB-	AB-	O-	A-	B-