

# Blood Groups & Blood Transfusion

*Dr Ambika Jawalkar*

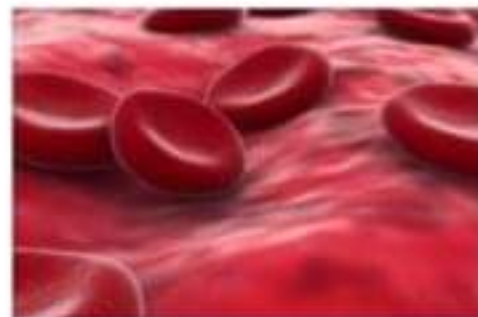


**KARL LANDSTEINER**  
**(1886-1943)**

- 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

# What are the different blood groups?

- The differences in human blood are due to the presence or absence of certain protein molecules called **antigens** and **antibodies**.
- The **antigens** are located on the **surface** of the **RBCs** and the **antibodies** are in the blood **plasma**.
- Individuals have different types and combinations of these molecules.
- The blood group you belong to depends on what you have inherited from your parents.



- There are more than 20 genetically determined blood group systems known today
- The **ABO** and **Rhesus (Rh)** systems are the most important ones used for blood transfusions.
- Not all blood groups are compatible with each other. Mixing incompatible blood groups leads to blood clumping or agglutination, which is dangerous for individuals.

# Landsteiner Law

- If an *antigen / agglutinin* is *present* on the red cell membrane of an individual, the corresponding *antibody / agglutinin* will be *absent* in the plasma.
- If an *antigen / agglutinin* is *absent* on the red cell membrane of an individual, the corresponding *antibody / agglutinin* will be *present* in the plasma.

# Blood Group systems

## MAJOR

- ABO
- Rh (Rhesus)

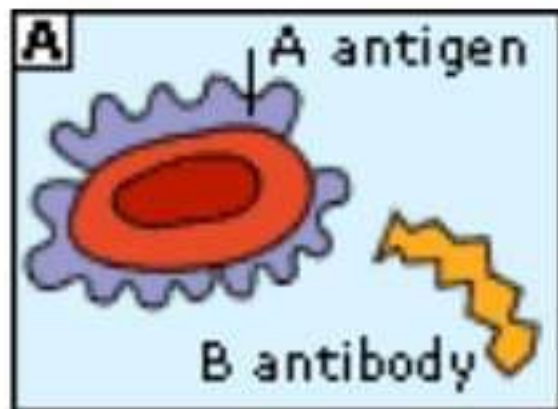
## MINOR

- MN
- Ii
- P
- Lewis
- Duffy
- Kidd
- Kell
- Lutheran



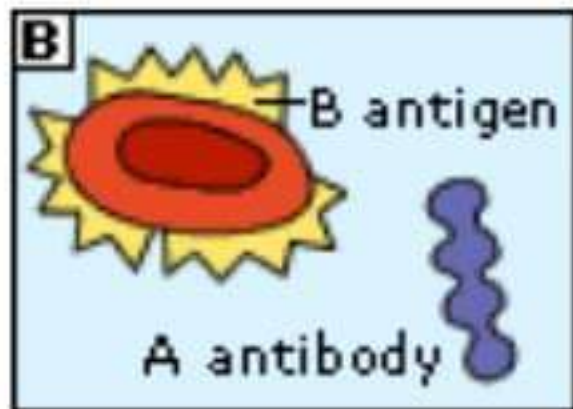
# Classical ABO Blood Grouping System

- The most important in assuring a safe blood transfusion.
- Is based on presence or absence of A & B antigens on red cell membrane.
- There are 4 blood groups according to this system
- A, B, AB & O



### **Blood group A**

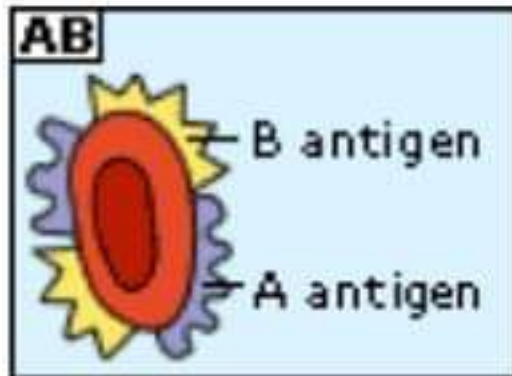
If you belong to the blood group A, you have A antigens on the surface of your RBCs and B antibodies in your blood plasma.



### **Blood group B**

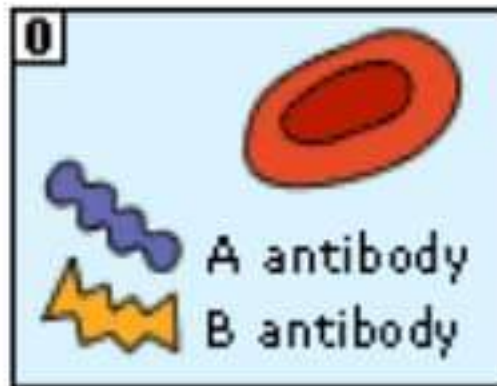
If you belong to the blood group B, you have B antigens on the surface of your RBCs and A antibodies in your blood plasma.





### **Blood group AB**

If you belong to the blood group AB, you have both A and B antigens on the surface of your RBCs and no A or B antibodies at all in your blood plasma.



### **Blood group O**

If you belong to the blood group O (null), you have neither A or B antigens on the surface of your RBCs but you have both A and B antibodies in your blood plasma.

BLOOD TYPE

TYPE A

TYPE B

TYPE AB

TYPE O

A antigen

B antigen

Both A and B antigens

Neither  
A nor B antigen

Red blood cells



Plasma



Anti-B  
antibody



Anti-A  
antibody

Neither  
antibody



Both anti-A and  
anti-B antibodies

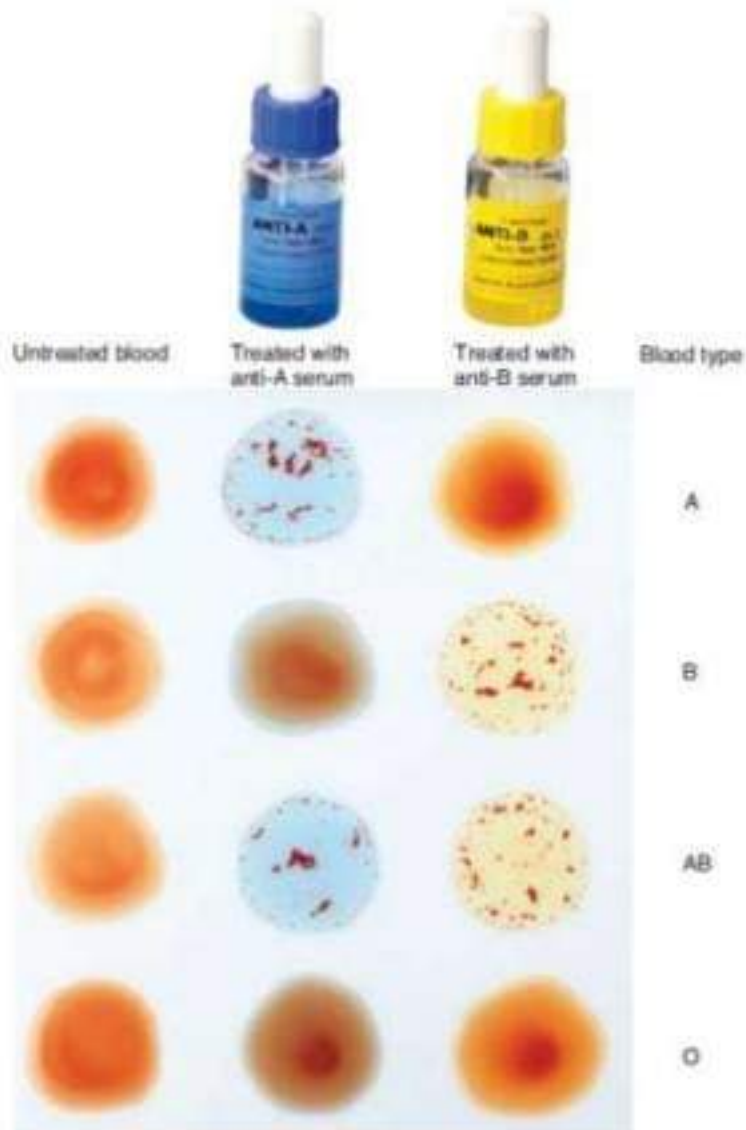
- The table shows the four ABO phenotypes ("blood groups") present in the human population and the genotypes that give rise to them.

Blood Group	Antigens on RBCs	Antibodies in Serum	Genotypes
A	A	Anti-B	AA or AO
B	B	Anti-A	BB or BO
AB	A and B	Neither	AB
O	Neither	Anti-A and anti-B	OO

## Why do individuals produce antibodies to antigens they do not have?

- The "A" and "B" antigens are also produced by some other plants and microorganisms. Thus, individuals who do not recognize one or more of these antigens as "self" will produce antibodies against the plant or microbial antigens.
- These antibodies will also react with human antigens of the same kind whether introduced via a blood transfusion or a tissue graft.

# Detremination of blood groups



# Genetics & 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)



# AUTOSOMAL CHROMOSOME



MOTHER




The alleles for Blood group are in the same place on the chromosome 9. However the genes have a different code giving the different blood group



FATHER

one alleles from Mother and one from Father.

## Possible Blood group Genotypes

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

# Rhesus (Rh) Blood grouping system

*Rh antigen – C, D, E, c, d & e*

- Some of us have it, some of us don't.

If it is present, the blood is RhD positive, if not it's RhD negative.

So, for example, some people in group A will have it, and will therefore be classed as A+ (or A positive).

While the ones that don't, are A- (or A negative).

And so it goes for groups B, AB and O.

## *Rh antibodies*

- No natural antibodies
- But are produced only when Rh+ blood is given to a Rh- person
- Once produced they persist for years & can produce serious reactions during 2<sup>nd</sup> transfusion
- 85% of the population is Rh positive, the other 15% of the population is Rh negative

# Clinical Application of Blood Grouping

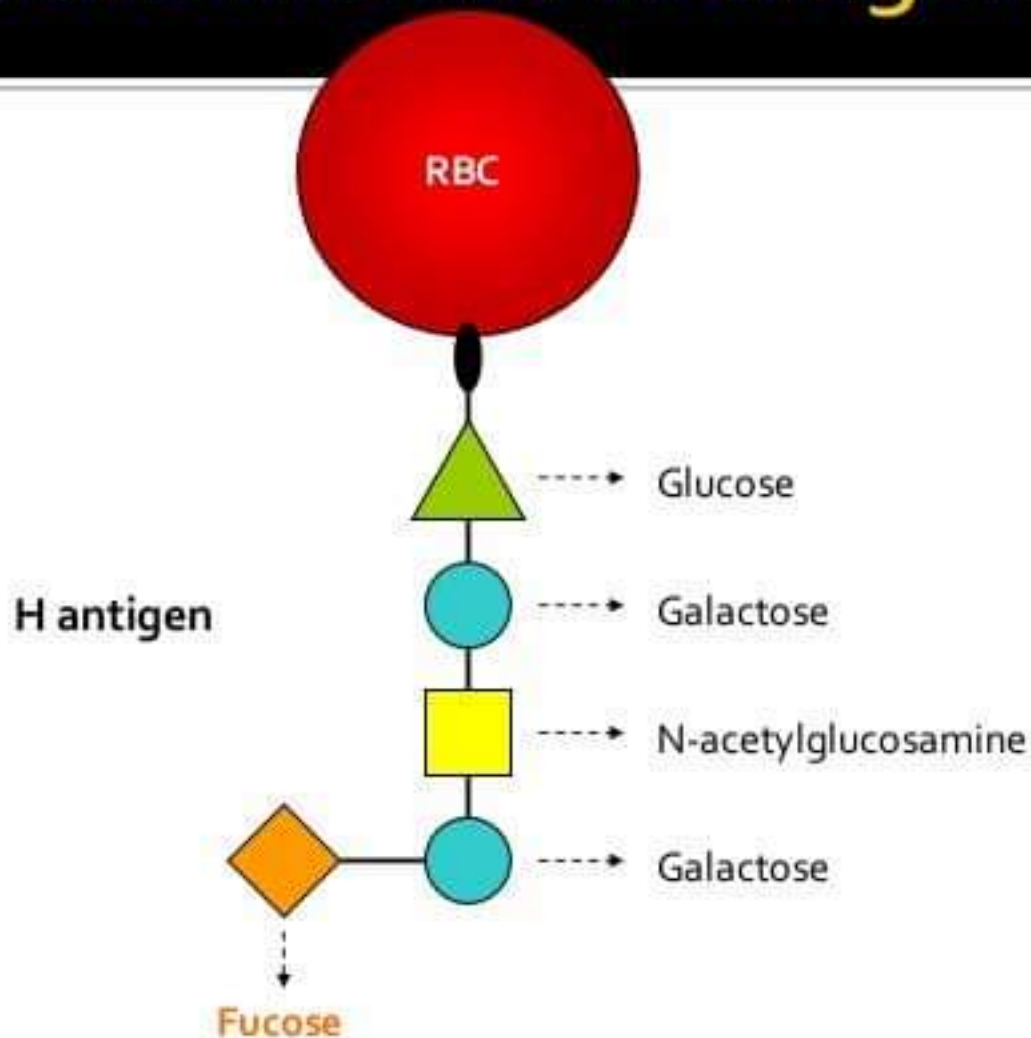
- In Blood transfusion
- In preventing hemolytic disease
- In paternity disputes
- In medicolegal cases
- In knowing susceptibility to disease
  - Group O- duodenal cancer
  - Group A- Carcinoma of stomach, pancreas & salivary glands

# Bombay blood group

- H antigen / H substance is absent
- first discovered in Bombay, now known as Mumbai by Dr. Y.M. Bhende
- present in about 0.0004%



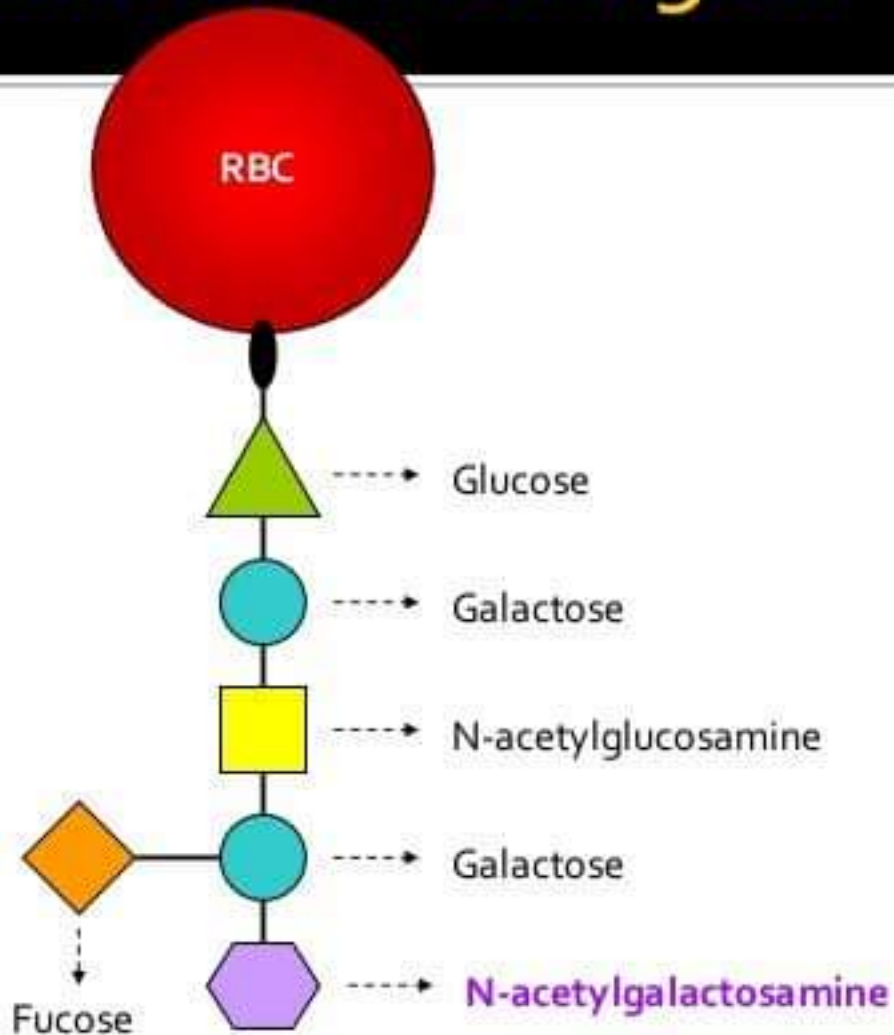
# Formation of the H antigen



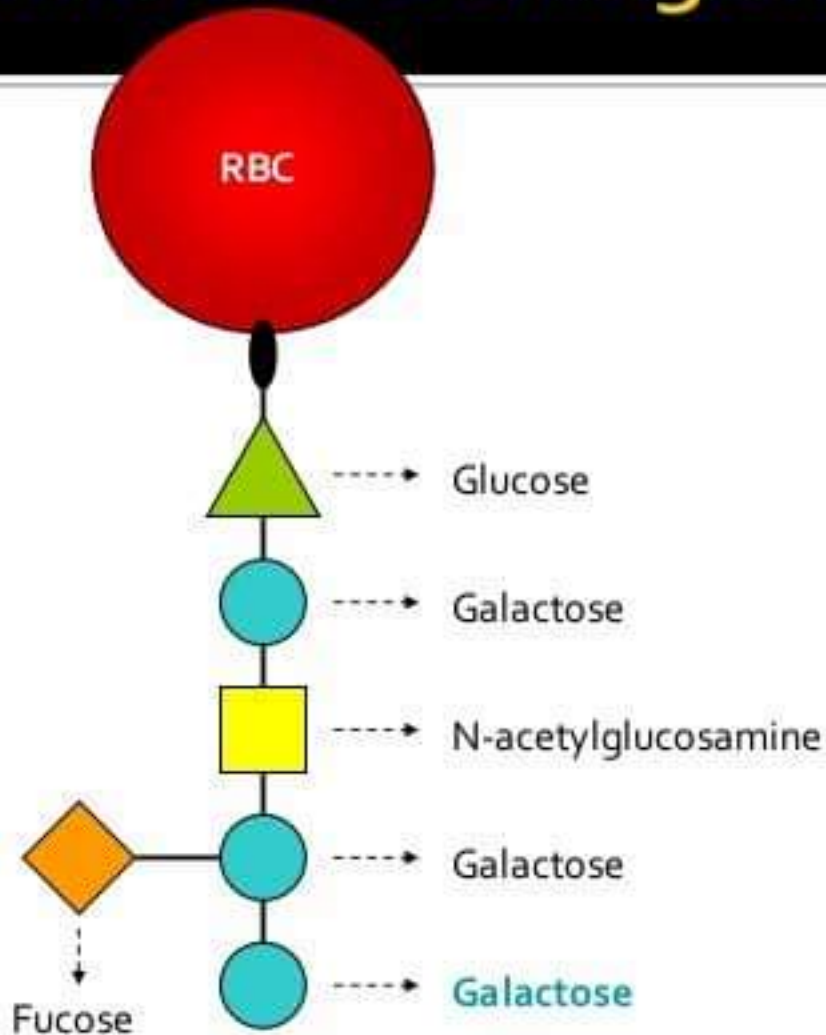
# H antigen

- The H antigen is the foundation upon which A and B antigens are built
- A and B genes code for enzymes that add a sugar to the H antigen
  - **Immunodominant sugars** are present at the terminal ends of the chains and confer the ABO antigen specificity

# Formation of the A antigen



# Formation of the B antigen



# Bombay

- RBCs with no H, A, or B antigen (patient types as O)
- Bombay RBCs are NOT agglutinated with anti-A, anti-B, or anti-H (no antigens present)
- Bombay serum has strong anti-A, anti-B and anti-H, agglutinating ALL ABO blood groups
- What blood group would you use to transfuse this patient??

# ANSWER:

- Another Bombay
  - Group O RBCs cannot be given because they still have the H antigen
  - You have to transfuse the patient with blood that contains **NO** H antigen



# HAEMOLYTIC DISEASE OF NEWBORN

- Occurs due to Rh incompatibility between mother & fetus
- 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

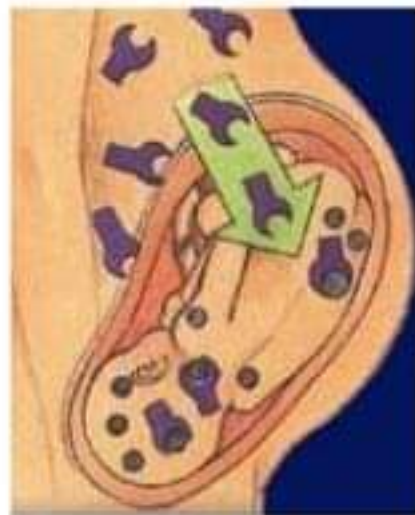
First pregnancy



Anti-Rh<sup>+</sup>  
antibodies



Possible  
subsequent  
pregnancies



*This happens when Rh- mother carries an Rh+ baby*

# Manifestations of Haemolytic disease

- Erythroblastosis fetalis
- Icterus gravis neonatorum
- Kernicterus
- Hydrops fetalis

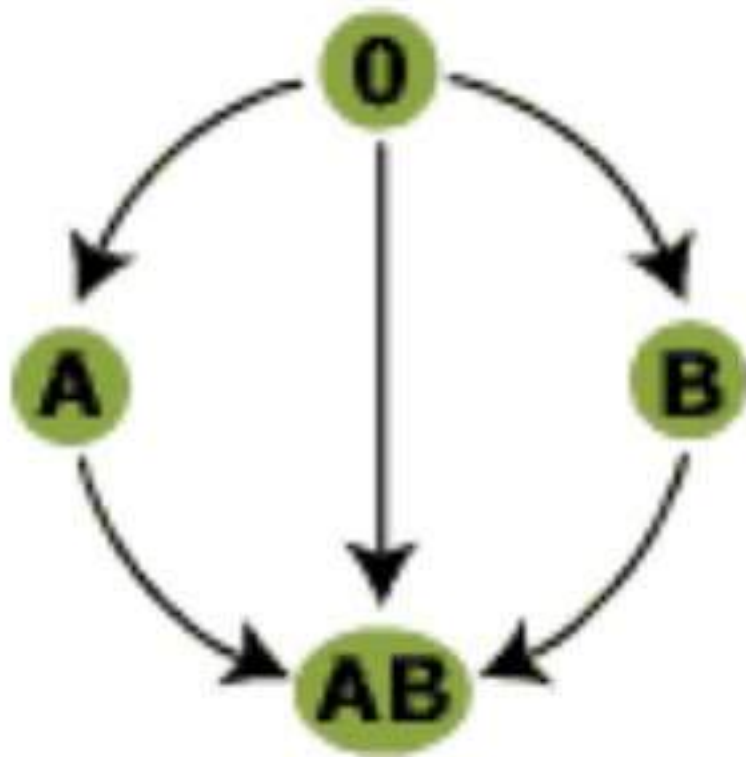
## Prevention & Treatment:

- Injecting single dose of Rh antibodies (Anti-D) to the mother soon after delivery
- Exchange transfusion

# BLOOD TRANSFUSION

## Blood transfusions – who can receive blood from whom?

People with blood group O are called "**universal donors**" and people with blood group AB are called "**universal receivers**."



# Indications

- Blood Loss
- For quick restoration of haemoglobin
- Exchange transfusion
- Blood diseases

***DONOR***

**RECIPIENT**



# Precautions

- Absolute indication
- Cross matching
- Rh+ blood should never be given to Rh- person
- Donor's blood should always be screened
- Bloodbg/bottle should be checked
- Should be given at slow rate
- Proper aseptic measures should be followed
- Careful watch on recipient's condition

## Cross matching

### ❖ **Major Cross matching –**

*mixing of donor's cells with recipient's  
plasma*

### ❖ **Minor crossmatching -**

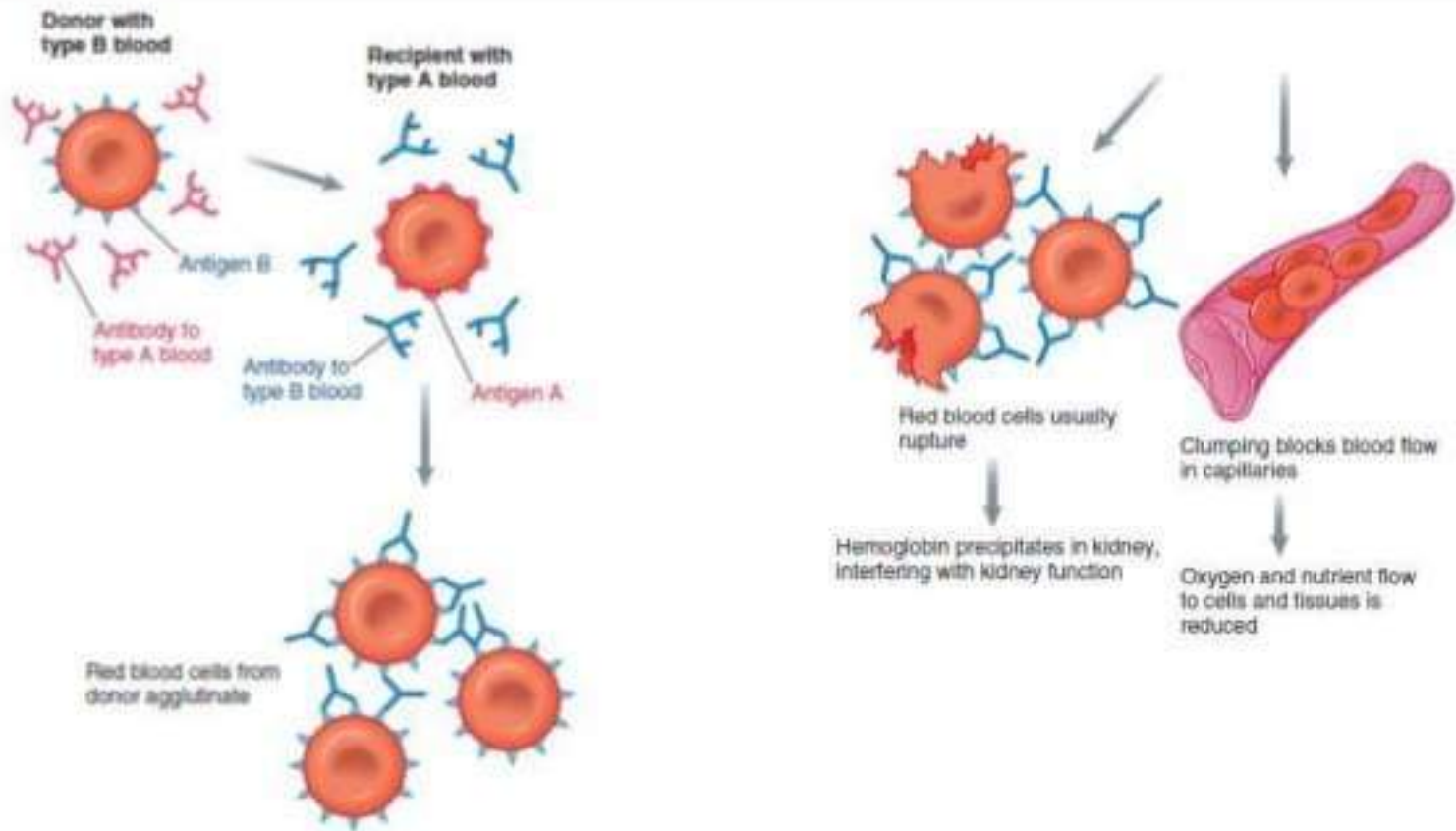
*mixing of recipient's cells with donor's  
plasma*

# Hazards of Blood Transfusion

## 1. *Mismatch transfusion reactions*

- \* Agglutination
- \* Tissue ischemia
- \* Haemolysis
- \* Haemolytic jaundice
- \* Circulatory shock
- \* Renal vasoconstriction
- \* Haemoglobinuria
- \* Renal tubular damage
- \* Acute renal shutdown
- \* Uremia

# Transfusion Reaction



2. *Circulatory overload*
3. *Transmission of blood-borne infections*
4. *Pyrogenic reaction*
5. *Allergic reactions*
6. *Hyperkalemia*
7. *Hypocalcemia*
8. *Reduced tissue oxygenation*
9. *Haemosiderosis*
10. *Thrombophlebitis*
11. *Air embolism*