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## UNIT III

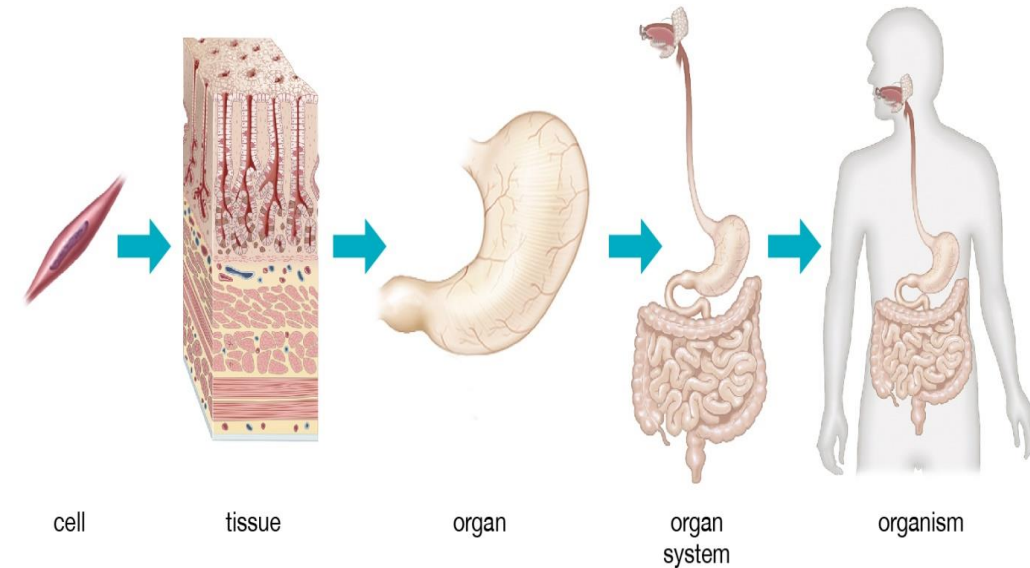
### Contents

- Organization levels of the body
- Anatomical terminology: directional term, planes of the body, body cavities
- Introduction to human body
- Blood: components, their function, and disorders
- Basic anatomy and physiology: cardiovascular, digestive, respiratory, and excretory system

### UNIT III: ORGANIZATION LEVELS OF THE BODY

- A **CELL** is the smallest independently functioning unit of a living organism. All living structures of human anatomy contain cells, and almost all functions of human physiology are performed in cells or are initiated by cells.
- A **TISSUE** is a group of many similar cells (though sometimes composed of a few related types) that work together to perform a specific function.
- An **ORGAN** is an anatomically distinct structure of the body composed of two or more tissue types that performs one or more specific functions.
- An **ORGAN SYSTEM** is a group of organs that work together to perform major functions.
- The **organism** level is the highest level of organization. An organism is a living being that has a cellular structure and that can independently perform all physiologic functions necessary for life.
- In multi-cellular organisms, including humans, all cells, tissues, organs, and organ systems of the **BODY** work together to maintain the life and health of the **organism**.

Levels of organization



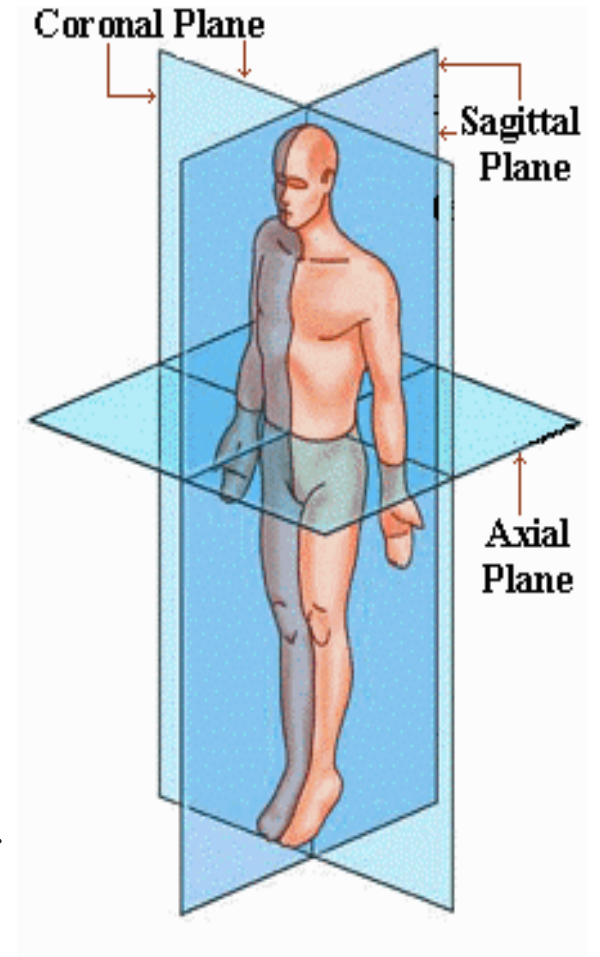
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## 2. Planes of the Body

**Coronal Plane (Frontal Plane):** A vertical plane running from side to side; divides the body or any of its parts into **anterior and posterior portions**.

**Sagittal Plane (Lateral Plane):** A vertical plane running from front to back; divides the body or any of its parts into **right and left sides**.

**Axial Plane (Transverse Plane):** A horizontal plane; divides the body or any of its parts into **upper and lower parts**.



# Introduction to Human body

- The human body is composed of several different subsystems ranging from microscopic scales to macroscopic levels.
- All the functions are controlled by one or more organ systems.

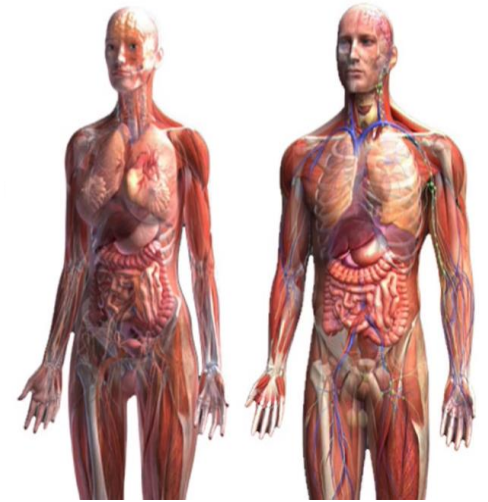
## Anatomy:

Identification and description of the body structures *i.e.* **anatomy is the study of body parts and structures.**

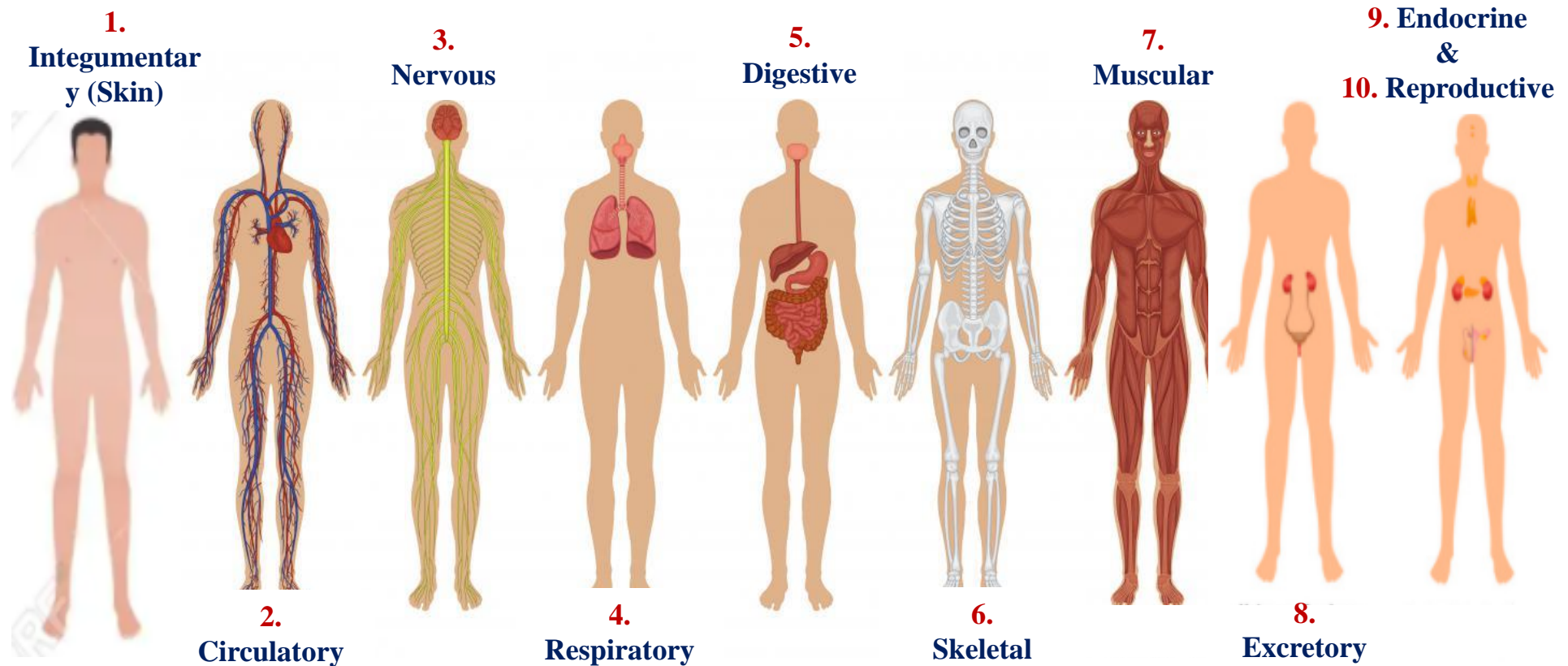
## Physiology:

Study of how body parts/structures work and function.

Anatomy knowledge is essential for studying physiology.



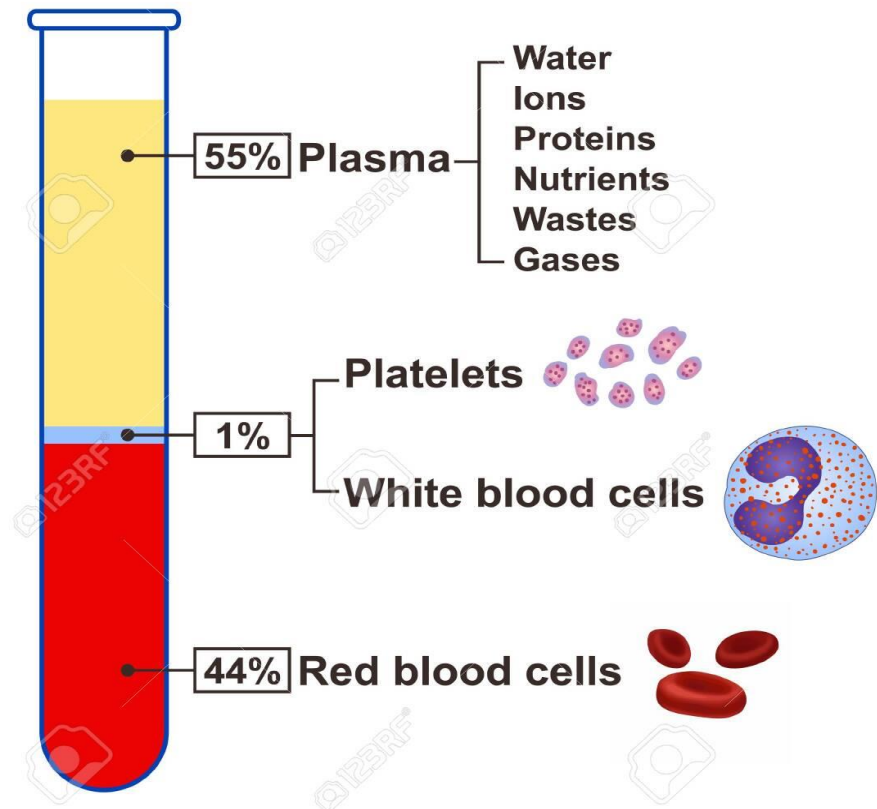
Ten major systems include the Integumentary (Skin), Cardiovascular (circulatory), Nervous, Respiratory, Digestive, Skeletal, Muscular, Excretory, Endocrine and the Reproductive system.



# BLOOD CELLS

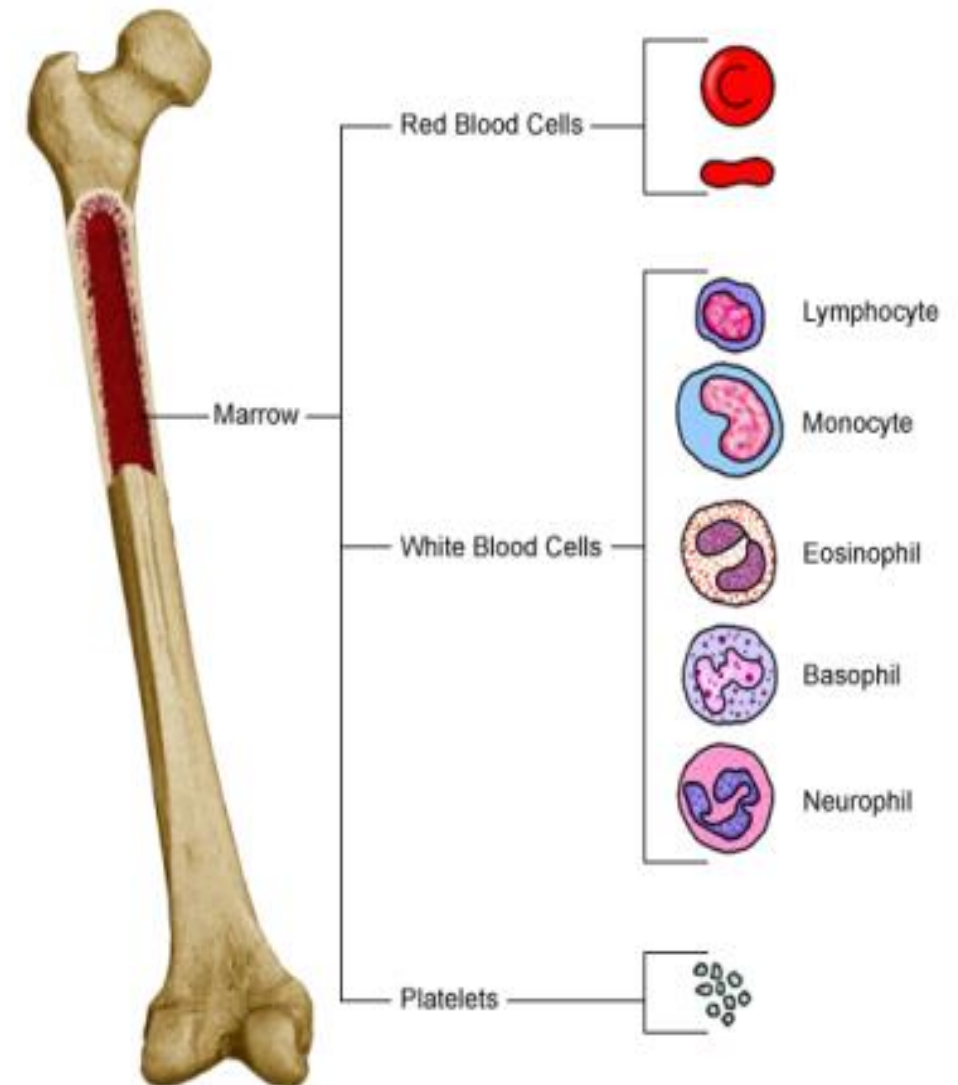
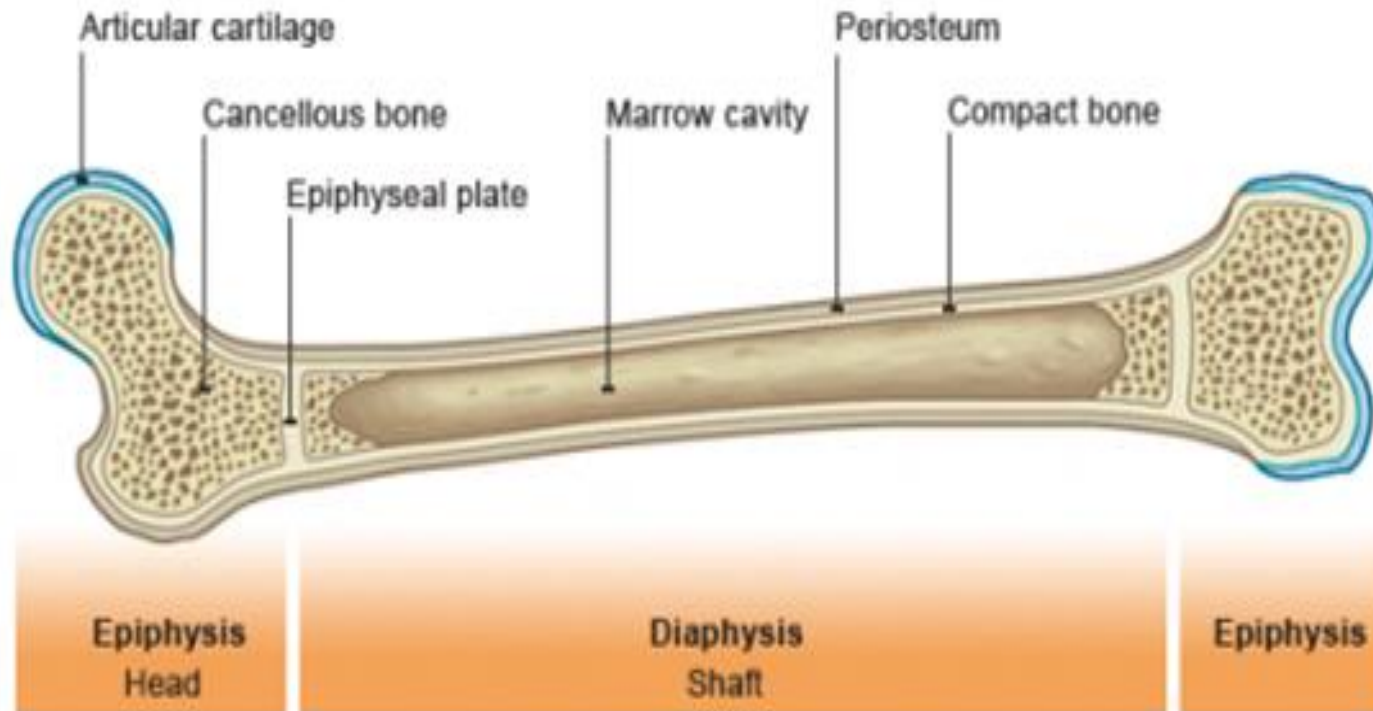
- These are the cells which are produced during **haematopoiesis** and found mainly in the blood.
- Blood is composed of blood cells which account for **45%** of the blood tissue by volume, with the remaining **55%** of the volume composed of plasma, the liquid portion of the blood.
- It transports everything that must be carried from one place to another within the body- nutrients, wastes (headed for elimination from the body), and body heat through blood vessels.
- Average amount: 8% body weight (70 kg man- 5.6L)
- Specific gravity: 1055-1065 (viscosity is 5 times that of water)
- pH: 7.35-7.45
- Salinity: 0.9%
- Colour: Bright red to deep red

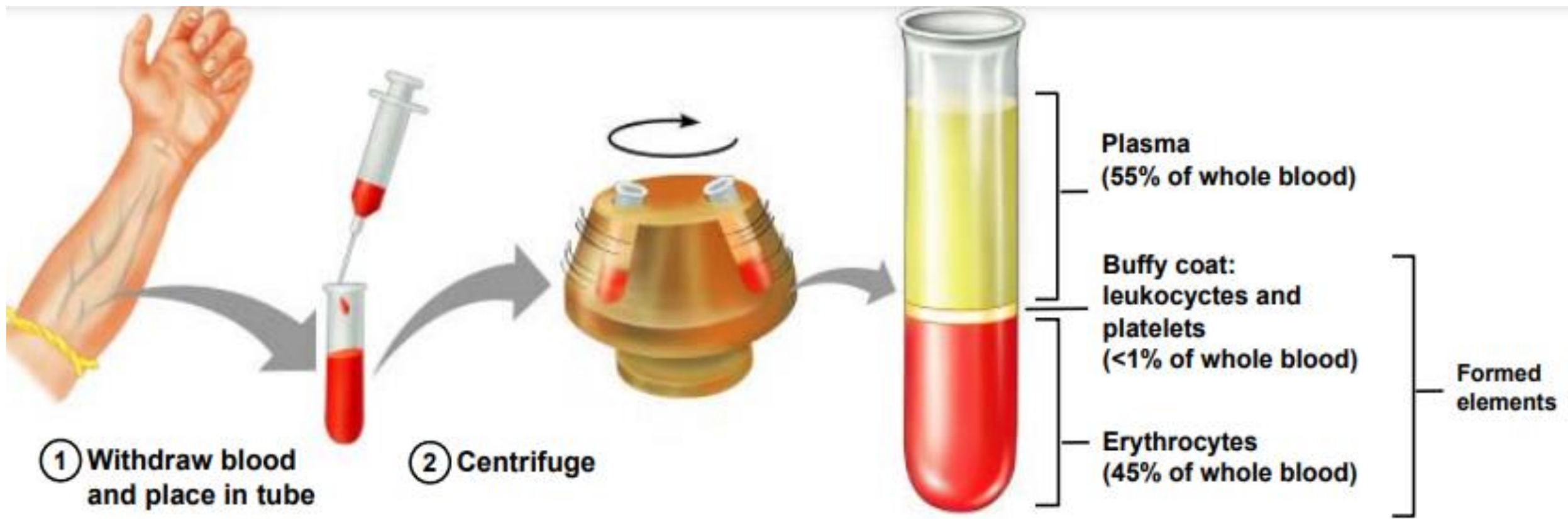
## Components of Blood





# Red bone marrow



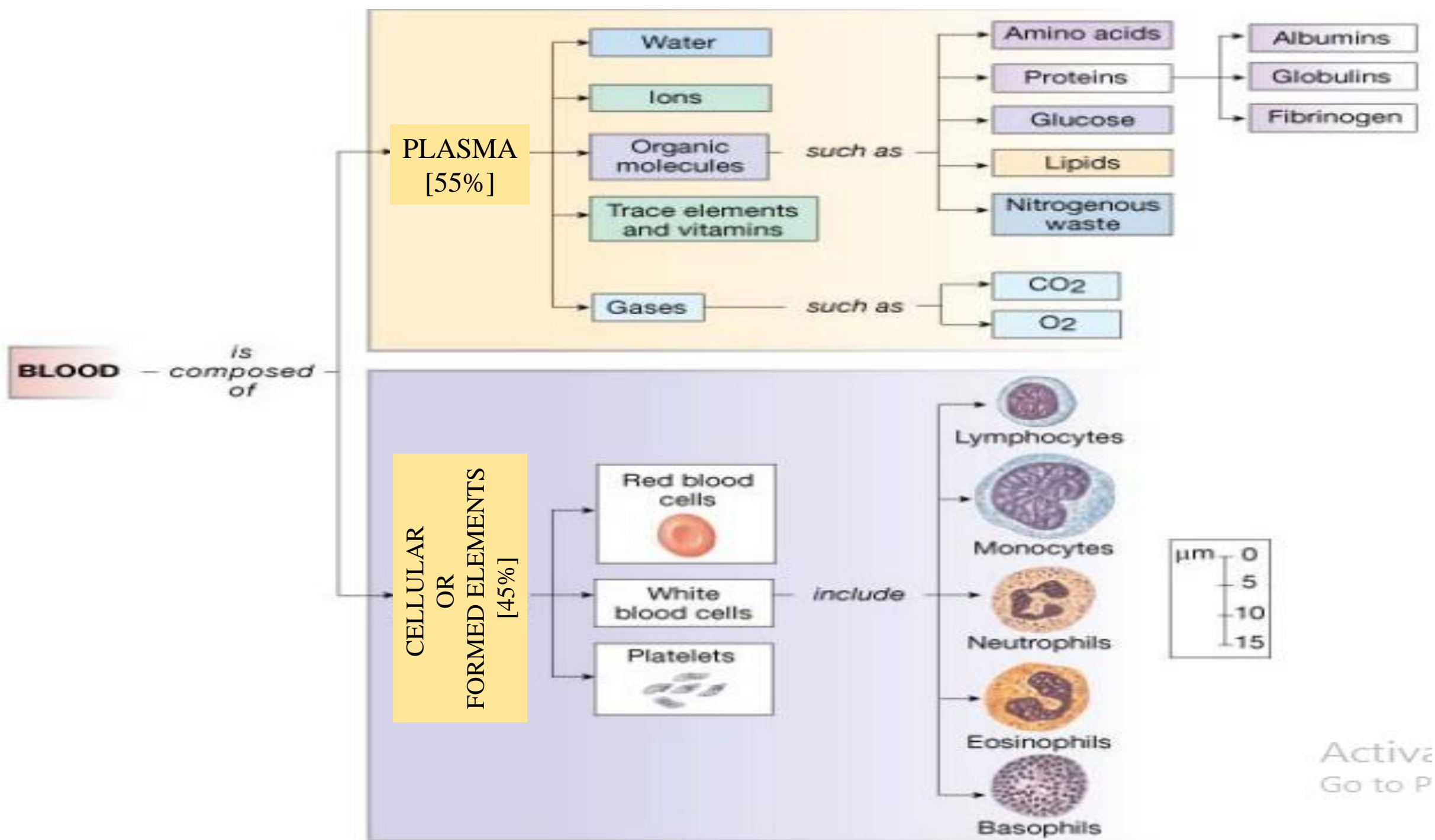


- **Hematocrit**

- Males:  $47\% \pm 5\%$
- Females:  $42\% \pm 5\%$

- The haematocrit (Ht or HCT), is the **volume percentage (vol%) of red blood cells (RBC) in blood**, measured as part of a blood test.

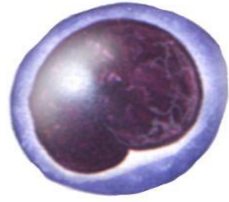




# Blood Cells



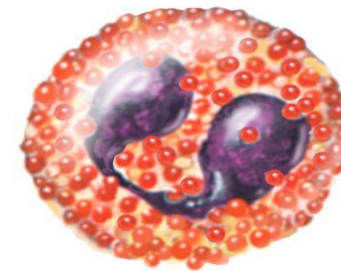
**Monocyte**



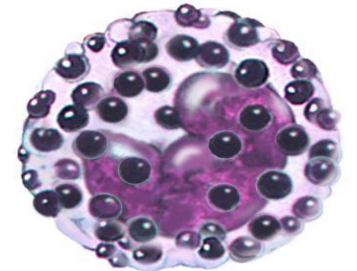
**Lymphocyte**



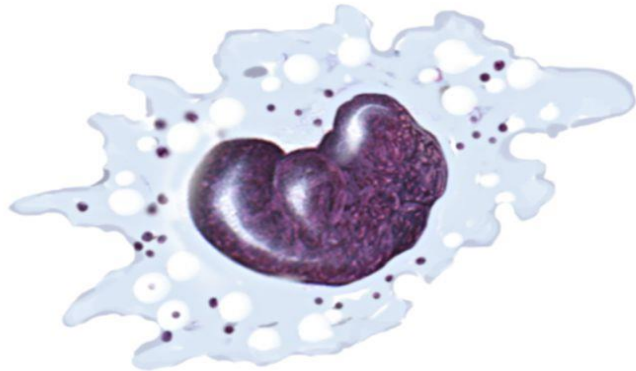
**Neutrophil**



**Eosinophil**



**Basophil**



**Macrophage**



**Erythrocyte**



**Platelets**

# Blood Group

- There are 4 main **blood groups** (types of blood) – A, B, AB, and O.

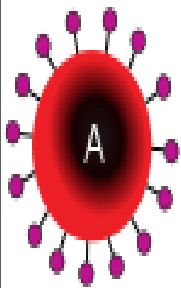
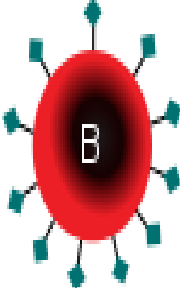
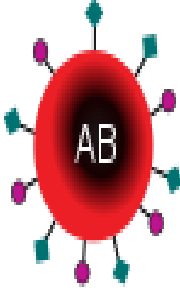
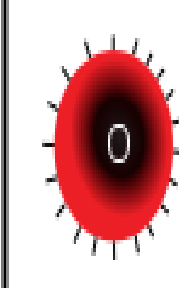
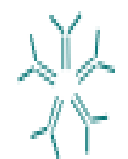
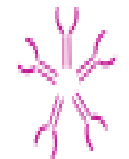
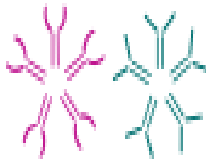



Your **blood group** is determined by the genes you inherit from your parents.

**Group A:** The surface of the red blood cells contains A antigen, and the plasma has anti-B antibody. Anti-B antibody would attack blood cells that contain B antigen.

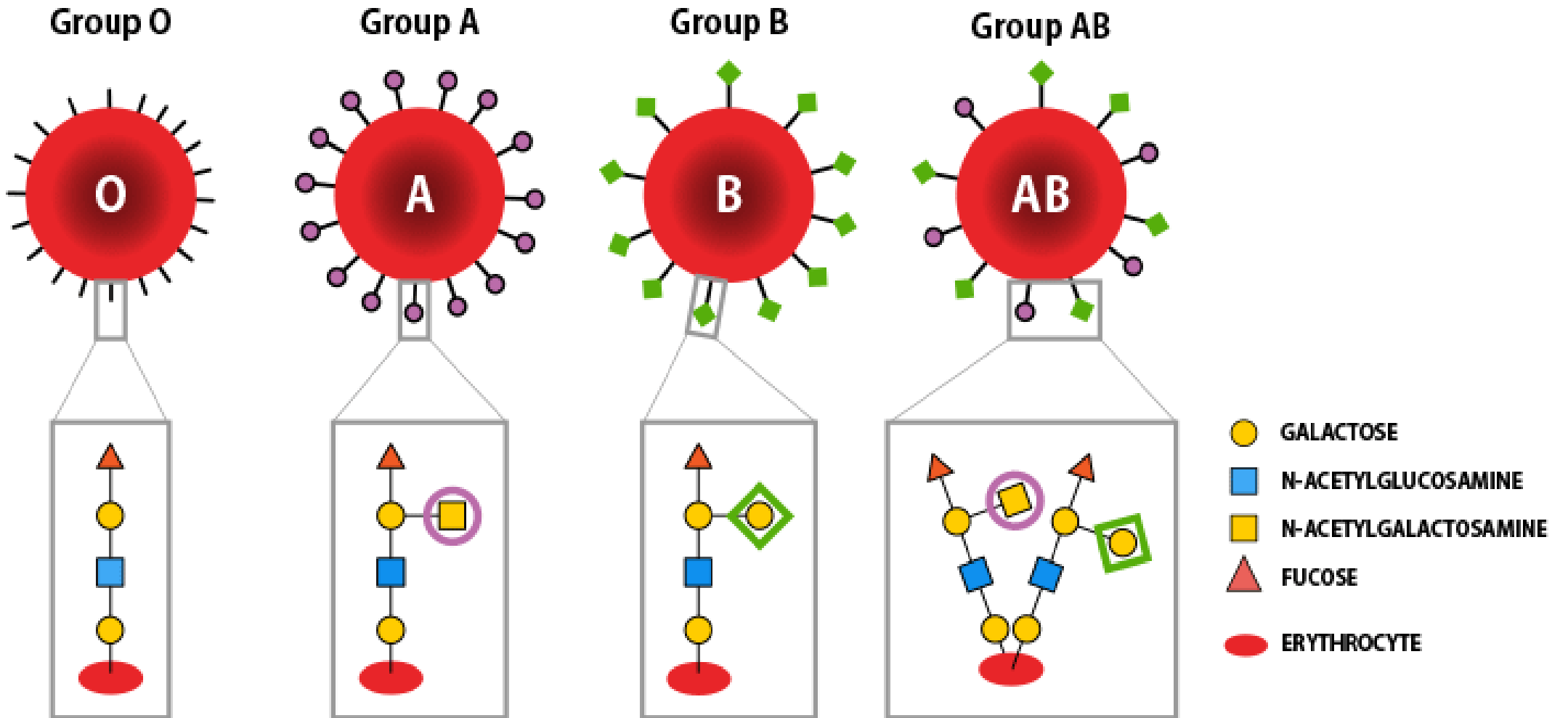
**Group B:** The surface of the red blood cells contains B antigen, and the plasma has anti-A antibody. Anti-A antibody would attack blood cells that contain A antigen.

**Group AB:** The red blood cells have both A and B antigens, but the plasma does not contain anti-A or anti-B antibodies. Individuals with type AB can receive any ABO blood type.

**Group O:** The plasma contains both anti-A and anti-B antibodies, but the surface of the red blood cells does not contain any A or B antigens. Since these antigens are not present, a person with any ABO blood type can receive this type of blood

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in red blood cell	 A antigen	 B antigen	 A and B antigens	None

# Red blood cell types

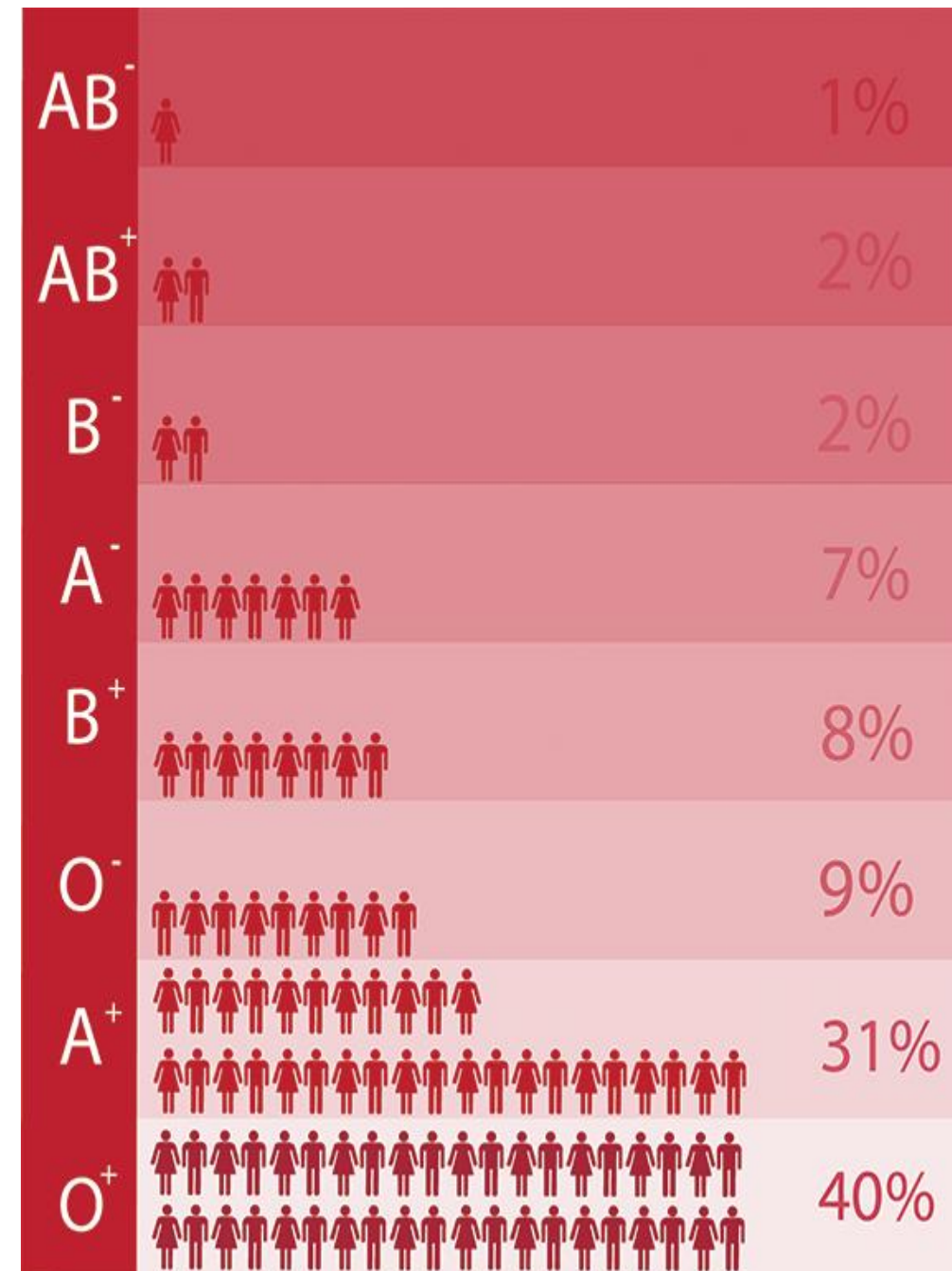


- There are eight main blood types, but some are rarer than others. The list below shows the percentage of donors with each blood type:

- ❖ O positive: 40%
- ❖ O negative: 9%
- ❖ A positive: 31%
- ❖ A negative: 7%
- ❖ B positive: 8%
- ❖ B negative: 2%
- ❖ AB positive: 2%
- ❖ AB negative: 1%

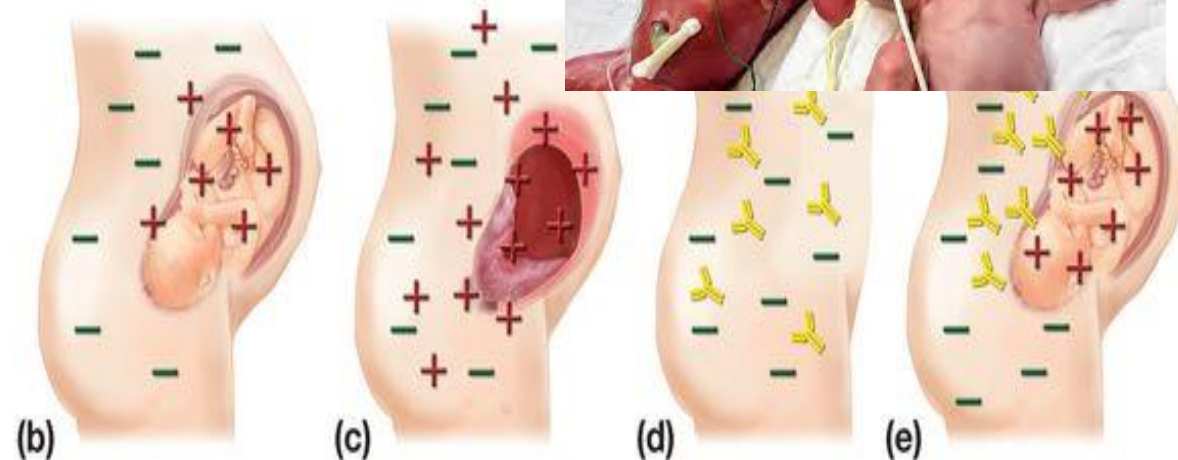
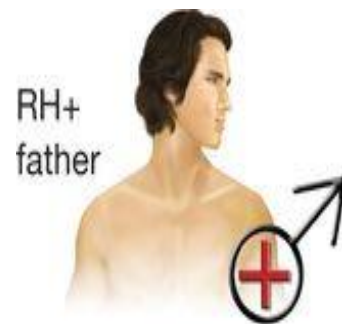
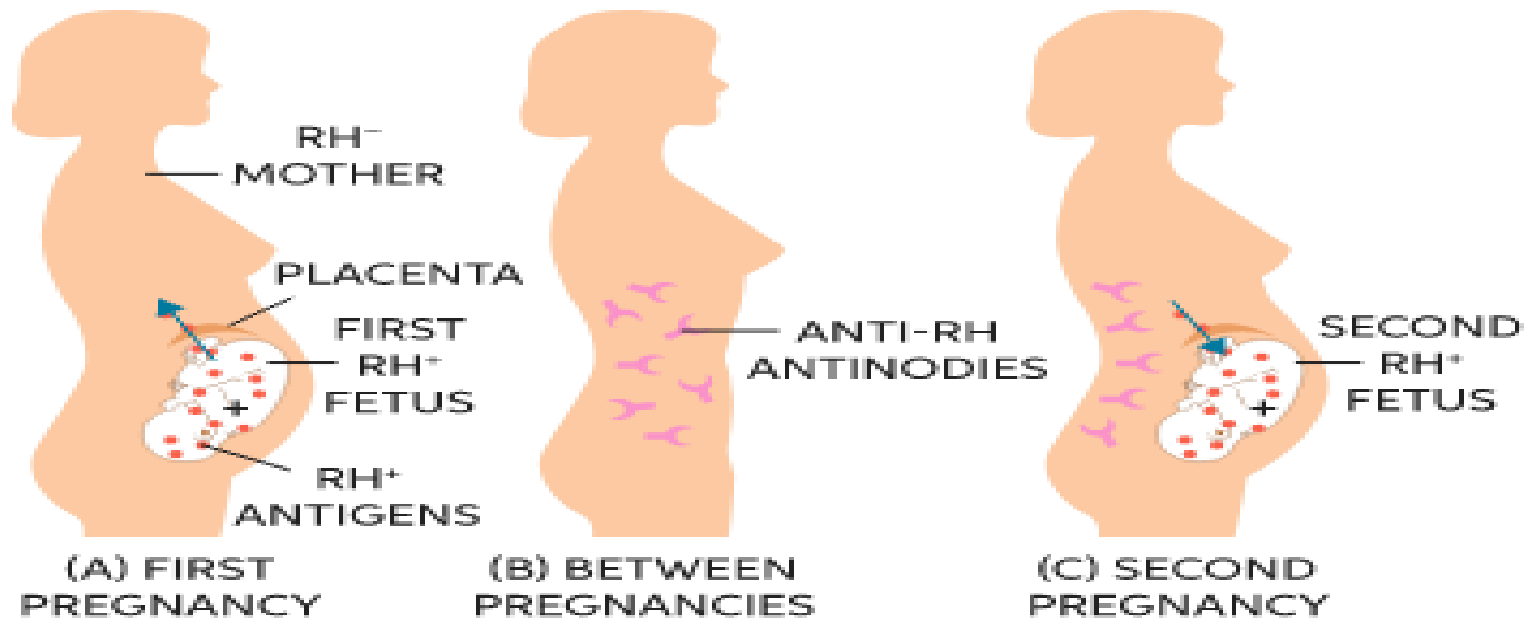
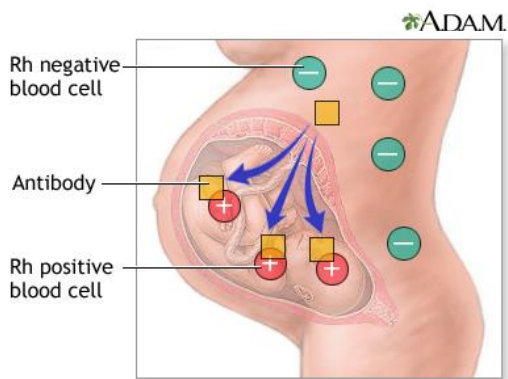
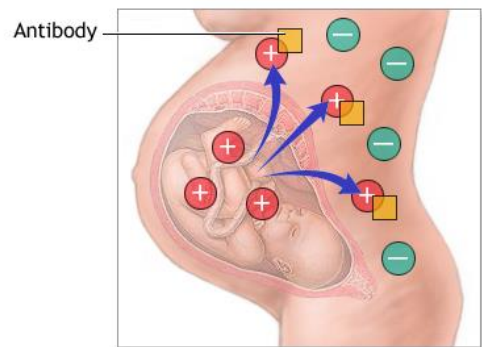
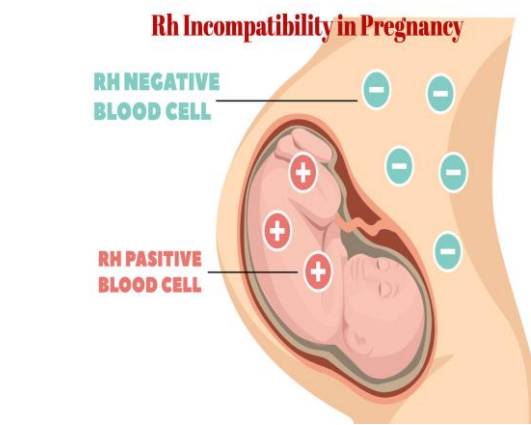
- **Rhesus factor**

- ❖ Some red blood cells have Rh factor, also known as the RhD antigen. Rhesus grouping adds another dimension.
- ❖ If the red blood cells contain the RhD antigen, they are RhD positive. If they do not, they are RhD negative.





# ERYTHROBLASTOSIS FETALIS



## Routine Rh sensitization prevention

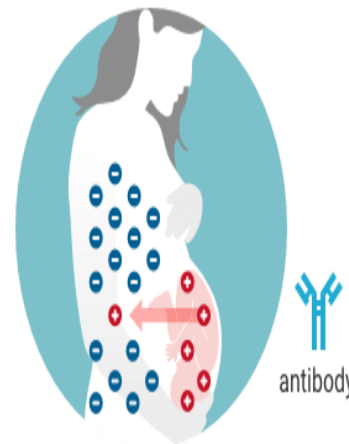
If the father or baby is not conclusively shown to be Rh-negative, RhoGAM should be given to an Rh-negative mother in these situations to prevent Rh sensitization:

- At 26 to 28 weeks of pregnancy
- After delivery of an Rh-positive baby

## How RhoGAM works

RhoGAM helps prevent the production of antibodies (Rh sensitization). Rh sensitization of the Rh-negative mother during pregnancy can lead to hemolytic disease of the fetus and newborn (HDFN) in future pregnancies.

### HOW HDFN DEVELOPS



Sometimes a baby's Rh-positive red blood cells enter the Rh-negative mother's bloodstream

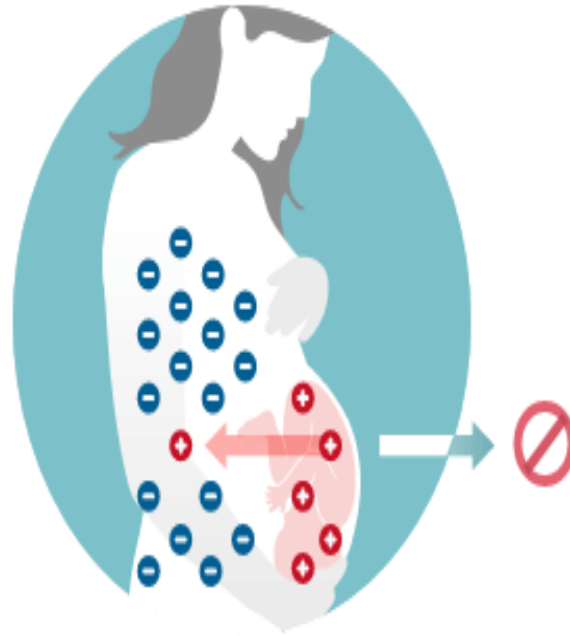


The mother produces antibodies against the baby's red blood cells. Usually, these antibodies do not affect her first baby, but future Rh-positive babies are at risk

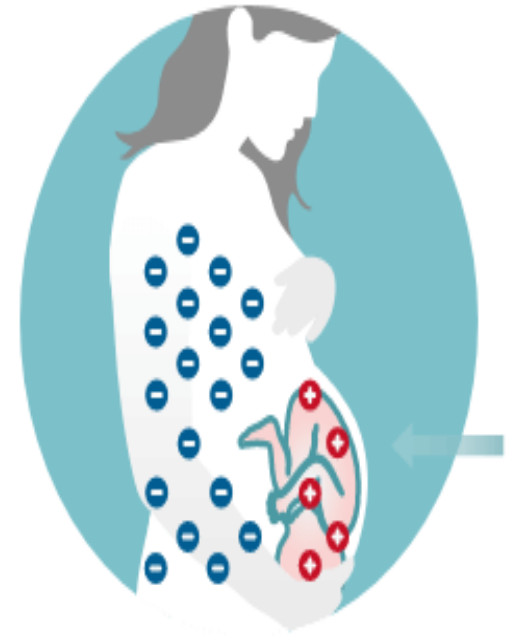


If the second baby is Rh-positive, the mother's antibodies will destroy the baby's red blood cells, putting the baby at risk for HDFN

## HOW RHOGAM WORKS



RhoGAM prevents the Rh-negative expectant mother from making antibodies during pregnancy that could cause HDFN in future pregnancies



As long as the Rh-negative mother receives RhoGAM appropriately during every pregnancy, her babies are at very low risk of developing HDFN

## Blood Group









- In humans, there are 4 blood types (phenotypes): A, B, AB, and O
- Blood type is controlled by **3 alleles**:  $I^A$ ,  $I^B$ ,  $I^O$  (the base letter = I stands for immunoglobulin). The ABO blood types were discovered by Karl Landsteiner in 1901; he received the **Nobel Prize in Physiology or Medicine** in 1930 for this discovery,
- $I^O$  is **recessive**, two  $I^O$  alleles must be present for the person to have type O blood

Blood type	Genotype	
<b>A</b>	$I^A, I^O$	<b>AO</b>
	$I^A, I^A$	<b>AA</b>
<b>B</b>	$I^B, I^O$	<b>BO</b>
	$I^B, I^B$	<b>BB</b>
<b>AB</b>	$I^A, I^B$	<b>AB</b>
<b>O</b>	$I^O, I^O$	<b>OO</b>

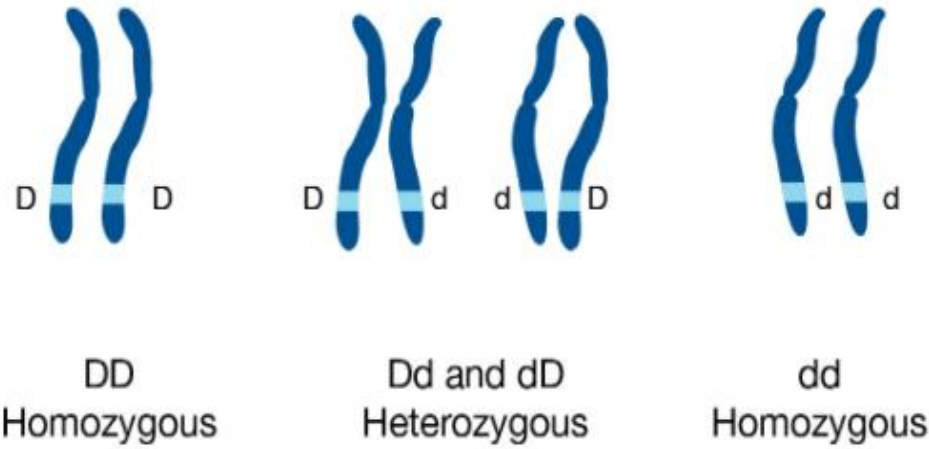
- $I^A$  and  $I^B$  are **codominant** but both are dominant to  $I^O$ . If a person receives an  $I^A$  allele and a  $I^B$  allele, their blood type is type AB, in which characteristics of both A and B antigens are expressed.
- Because  $I^O$  is dominated by both  $I^A$  and  $I^B$  alleles, a person with blood group A could have the genotype  $I^A I^O$  or  $I^A I^A$ . This has implication when having children because, if both parents carry the  $I^O$  allele, a child could be born with the genotype  $I^O I^O$  (blood group O), even though neither of the parents have this phenotype



**B** = Allele  
**b** = Allele









		Mother	
		B 	b 
Father	B 	 <b>BB</b>	 <b>Bb</b>
	b 	 <b>Bb</b>	 <b>bb</b>

Genotypes



Phenotypes



		b  b	
B 	b 	 <b>Bb</b>	 <b>Bb</b>
	b 	 <b>bb</b>	 <b>bb</b>



***Determine the offspring's blood types from a cross between a person who is type B het. and a person who is type A het.***

**$I^B i^o \times I^A i^o$**

	<b><math>I^B</math></b>	<b><math>i^o</math></b>
<b><math>I^A</math></b>	<b><math>I^A I^B</math></b>	<b><math>I^A i^o</math></b>
<b><math>i^o</math></b>	<b><math>I^B i^o</math></b>	<b><math>i^o i^o</math></b>

***25% AB***  
***25% A - Het.***  
***25% B - Het.***  
***25% O***



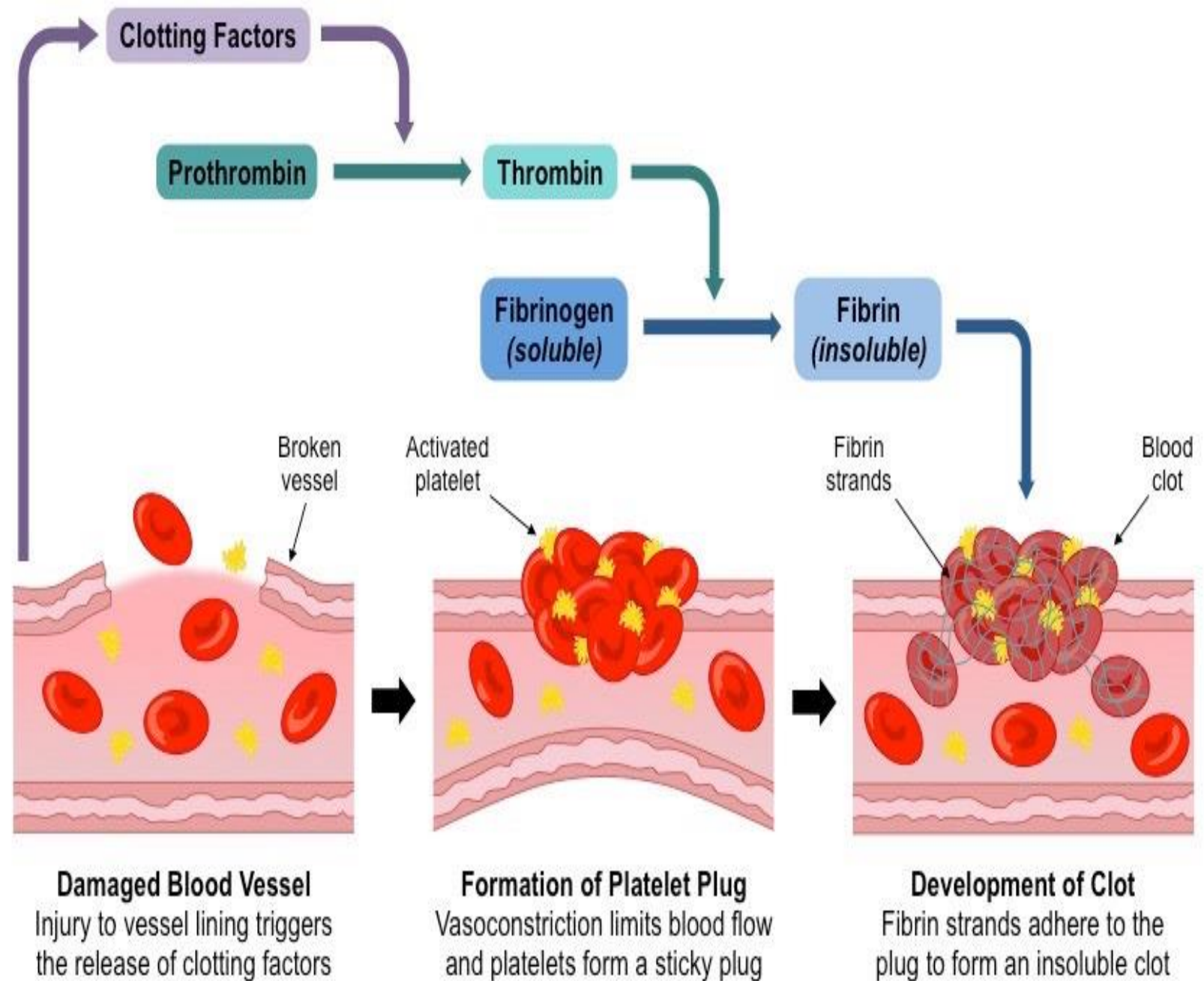
A vertical purple bar with the letter 'A' to its right.	A vertical purple bar with the letter 'B' to its right.
A vertical purple bar with the letter 'A' to its right.	A vertical purple bar with the letter 'B' to its right.

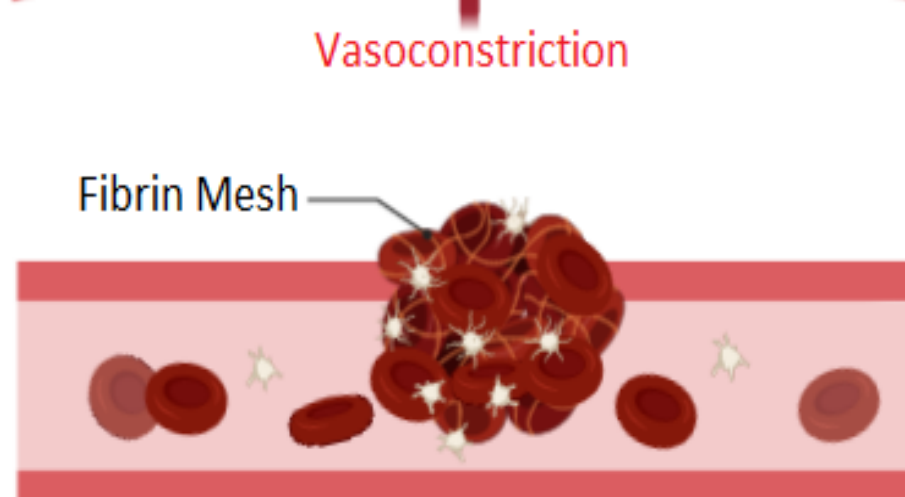
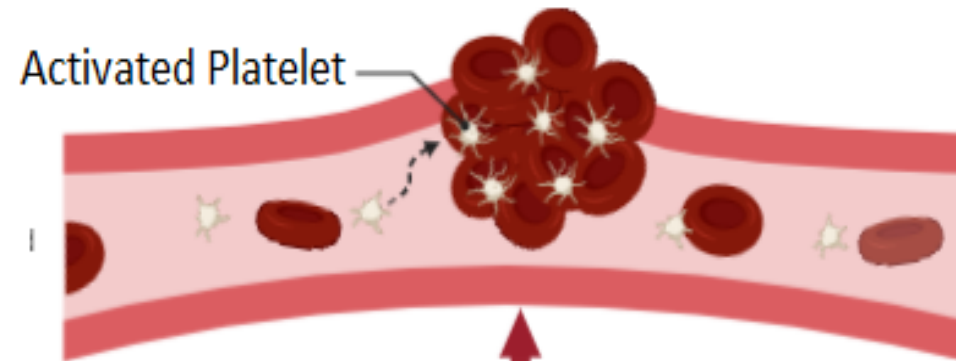
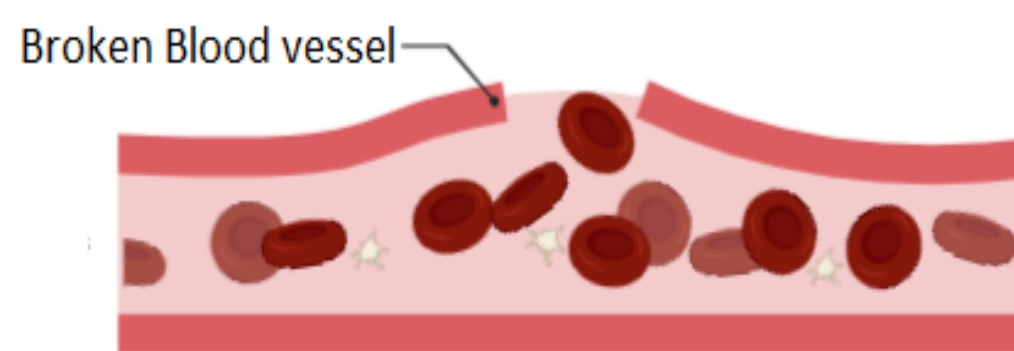
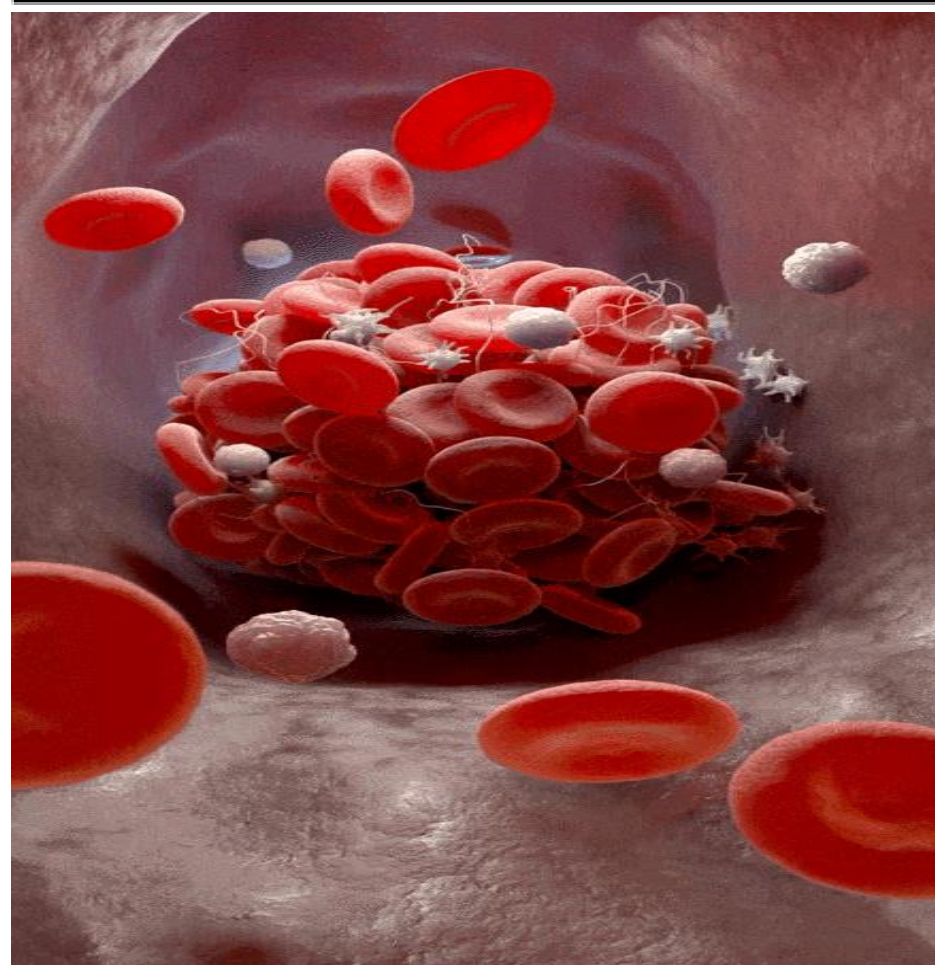
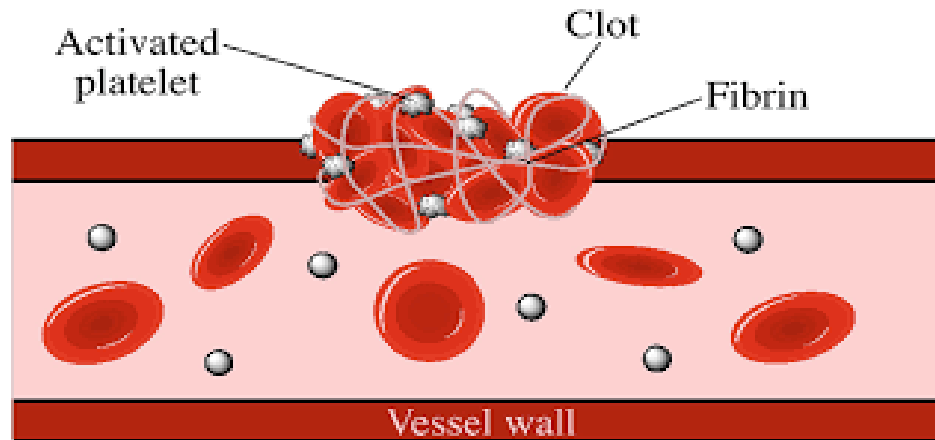




## Blood Clotting (haemostasis) Process

- Clotting is the mechanism by which broken blood vessels are repaired when damaged
- Clotting functions to prevent blood loss from the body and limit pathogenic access to the bloodstream when the skin is broken
- There are two key components of a blood clot – platelets and insoluble fibrin strands
- Platelets undergo a structural change when activated to form a sticky plug at the damaged region (primary haemostasis)
- Fibrin strands form an insoluble mesh of fibres that trap blood cells at the site of damage (secondary haemostasis)





Blood clotting Process

Clotting Factors

Prothrombin

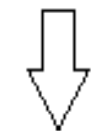


Thrombin

Fibrinogen



Fibrin



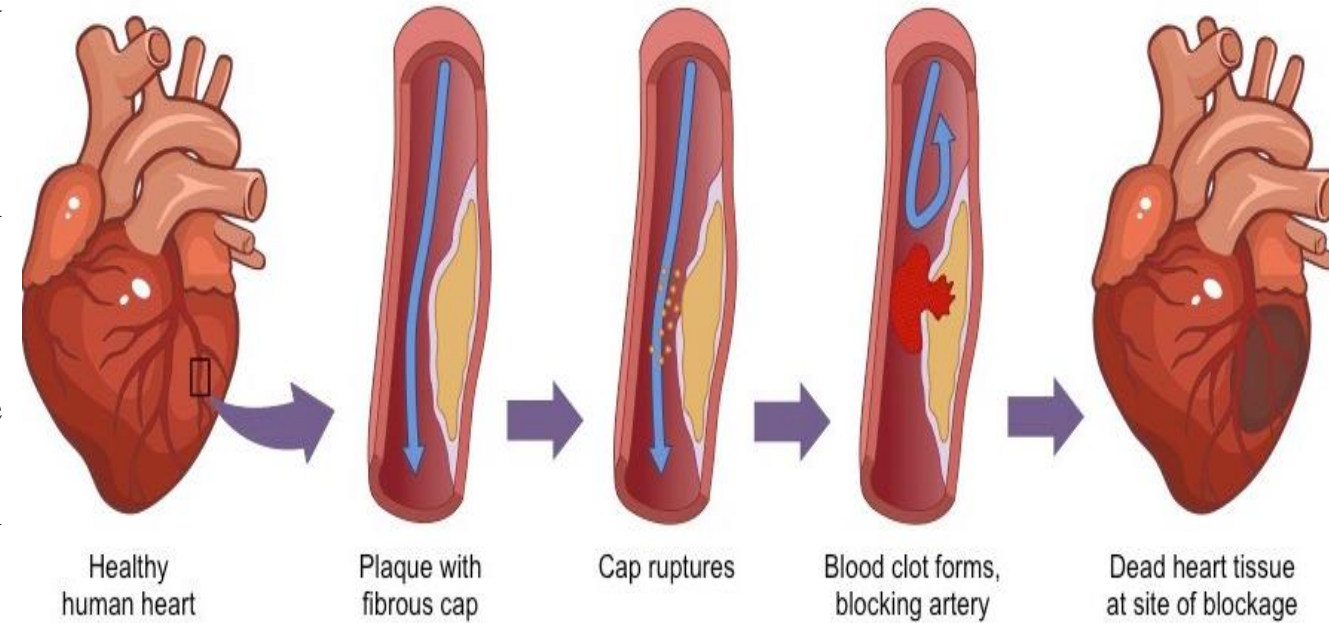
Blood clot



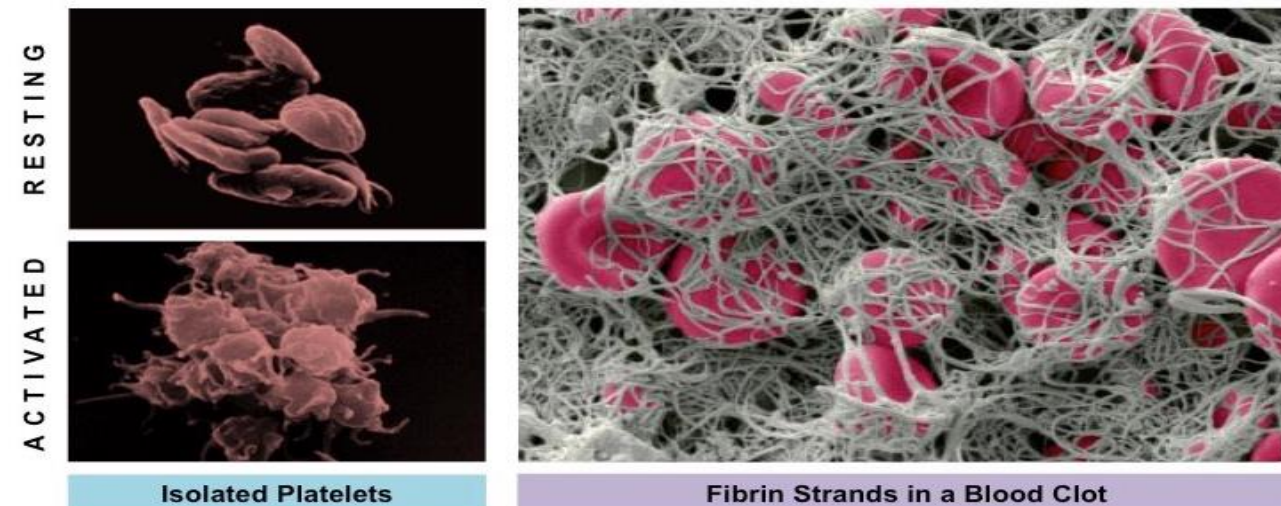
# Coronary Thrombosis

- Coronary thrombosis is the formation of a clot within the blood vessels that supply and sustain the heart tissue (coronary arteries)
- Occlusion of a coronary artery by a blood clot may lead to an acute myocardial infarction (heart attack)
- Blood clots form in coronary arteries when the vessels are damaged as a result of the deposition of cholesterol (atherosclerosis)
- Fatty deposits develop in the arteries and significantly reduce the diameter of the lumen.
- The restricted blood flow increases pressure in the artery, leading to damage to the arterial wall.
- If the plaque ruptures, blood clotting is triggered, forming a *thrombus* that restricts blood flow

## Causes and Consequences of Coronary Thrombosis



## Components of a Blood Clot (Scanning Electron Microscopy)





# Quiz

Q. Which of the following statements is true regarding the ABO blood system?

- A. People who have the A antigen normally would not produce the anti-A antibody.
- B. People who are type AB normally produce both anti-A and anti-B antibodies.
- C. The only ABO type blood that normally does not have either A or B antigens is AB.
- D. None

The universal blood donors for the ABO system are type:

- A. A
- B. B
- C. O
- D. AB

**In the ABO system, blood group 'O' is characterized by the:**

- (a) presence of antigen O
- (b) presence of both antigen A and antigen B
- (c) absence of both antigen A and antigen B
- (d) presence of antigen A and absence of antigen B

**If a blood type ends in + (positive) that means**

- (a) your attitude is positive
- (b) you are positive for an Rh protein
- (c) you are positive you know your blood type
- (d) + sign at the end is insignificant

**Human blood types in the ABO blood group are identified by**

- (a) clotting factors in plasma
- (b) microscopic examination of white blood cells
- (c) antigen-antibody reactions
- (d) series of enzyme controlled reactions

**Red blood cells that do not contain either A or B antigens on their surface are normally found in the person with blood type**

(a) A   (b) O   (c) B   (d) AB

Which of the following blood group is considered a universal donor?

a) A      b) B      c) AB      d) O

The probability of having a girl child with blood group O when the parents have blood group A and B is

A. 0%      B. At least 50%      C. At most 25%      D. Exactly 75%

Q. In a family, father has a blood group 'A' and mother has a blood group 'B', Children show 50 % probability for a blood group "AB" indicate that -

A. Father is heterozygous

B. Mother is heterozygous

C. Either of parent is heterozygous

D. Mother is homozygous

**The possible blood groups of children born to parents having A and AB groups are:**

- A). O, A**
- B). A, B, AB**
- C). O, A, B**
- D). O, A, B, AB**

**A man of blood group O marries a woman of blood group AB, which type of progeny would indicate that man is homozygous?**

- (a) O**
- (b) A and B**
- (c) A**
- (d) AB**

**A child with mother of 'A' blood group and father of 'AB' blood group will have a blood group**

- (a) O**
- (b) A and B**
- (c) A**
- (d) A, B &AB**

In the first case (considering a person with A blood group has  $I^A I^O$  genotype):

$I^A I^O$  (A blood group)  $\times$   $I^A I^B$  (AB blood group).

Gametes	$I^A$	$I^O$
$I^A$	$I^A I^A$ A blood group	$I^A I^O$ A blood group
$I^B$	$I^A I^B$ AB blood group	$I^B I^O$ B blood group

So, the possible  $I^B$  blood groups of children born in this case are A, B, and AB blood groups.

In the second case (considering a person with A blood group has  $I^A I^A$  genotype):

$I^A I^A$  (A blood group)  $\times$   $I^A I^B$  (AB blood group).

Gametes	$I^A$	$I^A$
$I^A$	$I^A I^A$ A blood group	$I^A I^A$ A blood group
$I^B$	$I^A I^B$ AB blood group	$I^A I^B$ AB blood group

So, the possible blood groups of children born in this case are A and AB blood groups.



A child of a mother with blood group A and a father with blood group AB may have any one of the following blood groups except

- (a) A
- (b) B
- (c) AB
- (d) O

A child having blood group B has a father with blood group A. What could be the blood group of the mother?

- (a) A
- (b) B
- (c) B or AB
- (d) O

If one child in the family has blood group AB and another child has O, what will be the genotypes of their parents?

- A.  $I^A I^B$  and  $I^o I^o$
- B.  $I^A I^A$  and  $I^B I^B$
- C.  $I^A I^o$  and  $I^B I^o$
- D.  $I^A I^B$  and  $I^A I^B$

Mother-fetus Rh blood type incompatibility problems can occur if the mother is \_\_\_\_\_ and her fetus is \_\_\_\_\_ .

- a) Rh positive; Rh positive
- b) Rh positive; Rh negative
- c) Rh negative; Rh positive
- d) Rh negative; Rh negative

When a fetus' blood is agglutinated by its mother's Rh antibodies, the severe anemia that results is called:

- a) immunization
- b) ectopic pregnancy
- c) erythroblastosis fetalis

If the mother is Rh<sup>-ve</sup> and father is Rh<sup>+ve</sup>, which of the following Rh<sup>+ve</sup> child is normally not affected?

1. First
2. 2<sup>nd</sup>
3. 3<sup>rd</sup>
4. 4<sup>th</sup>

If the husband is Rh<sup>+</sup> and the wife is Rh<sup>-</sup> then

- A The couple cannot get children.
- B The couple's first child may be born but they are not likely to have their second child without medical intervention.
- C Their first fetus will not survive but the subsequent ones will.
- D The couple's reproductive life will be normal.