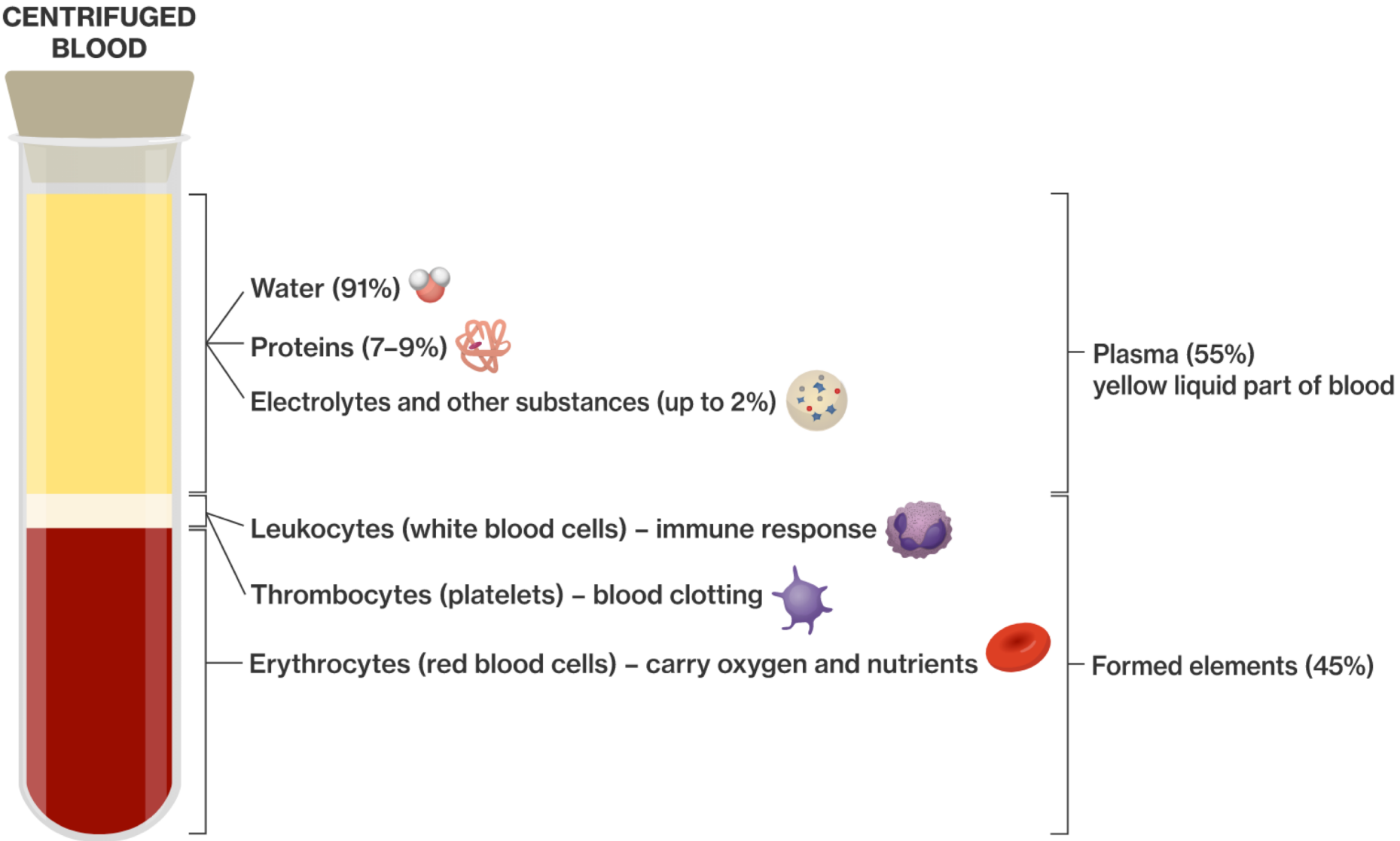
11.2 Blood: A Fluid Tissue

Blood: A Fluid Tissue

- Human body contains 4 L - 5 L of blood.
- Blood is a connective tissue
- In humans blood consists of two main components.
  - Intercellular matrix: a yellow-coloured liquid called plasma
  - Cellular component: includes red blood cells, white blood cells, and platelets.


CENTRIFUGED BLOOD
Water (91%)
Proteins (7–9%)
Electrolytes and other substances (up to 2%)
Plasma (55%)
yellow liquid part of blood
Leukocytes (white blood cells) – immune response
Thrombocytes (platelets) – blood clotting
Erythrocytes (red blood cells) – carry oxygen and nutrients
Formed elements (45%)

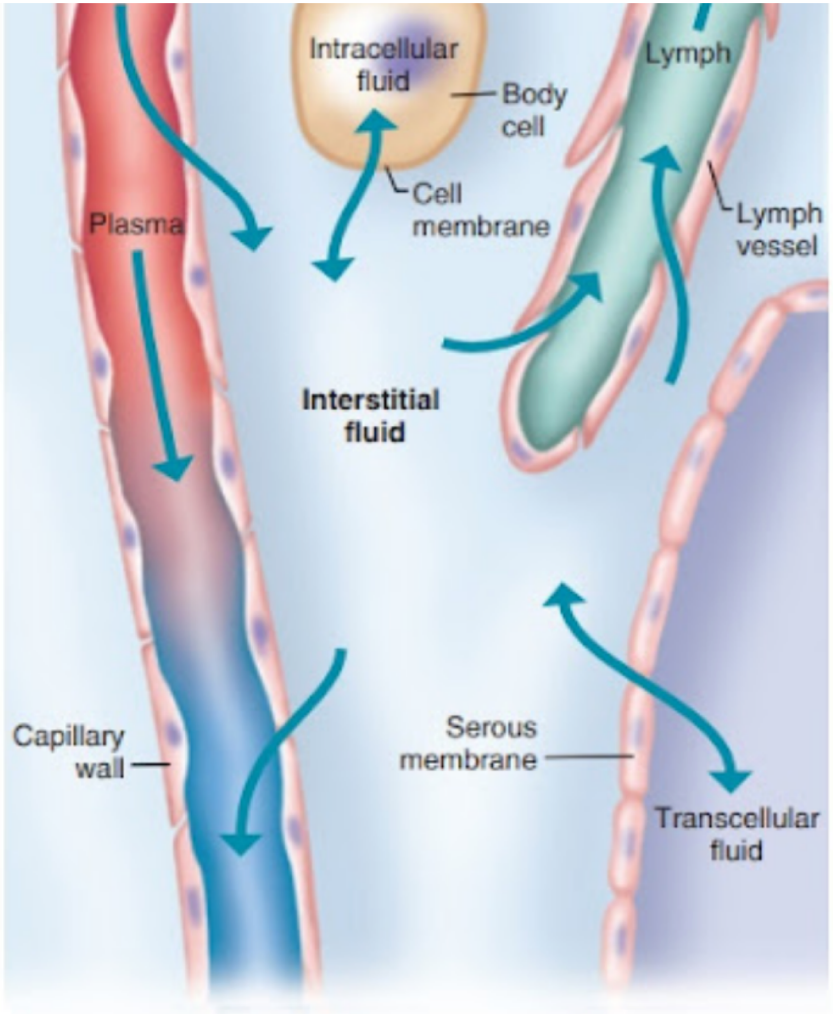
Plasma

- 90% water
- Contains dissolved oxygen, proteins, nutrients, glucose, minerals (ions of sodium, potassium, calcium, chlorine), and vitamins
- Also contains waste products of cellular respiration, CO_2

- Blood proteins
  - Albumin – maintains water balance and blood volume by osmosis
  - Globulin – transports lipids, cholesterol, fat soluble vitamins and immunoglobulins (antibodies)
  - Fibrinogen – blood clotting factors

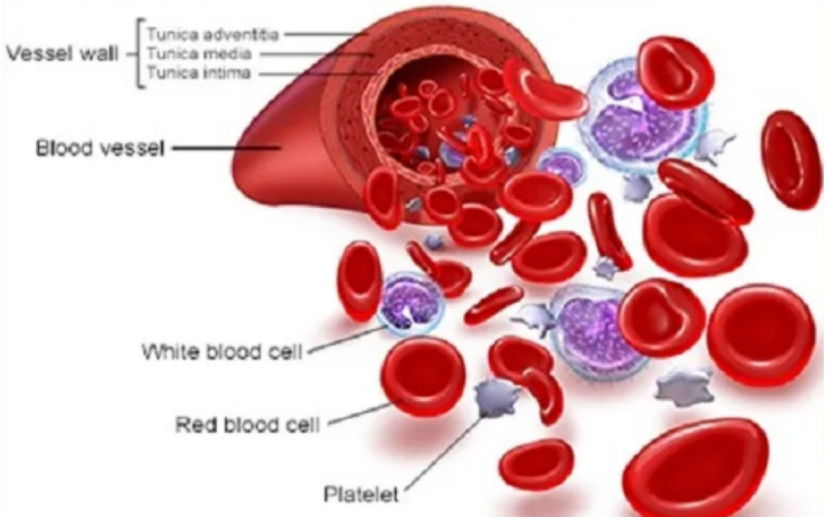
Blood Pressure and Sodium

- A high concentration of sodium ions in plasma creates an osmotic pressure gradient and causes water to enter the bloodstream
- As more water enters blood, blood volume increases
- Increased blood volume may lead to hypertension (high blood pressure)
- Arteries is wrapped by a thick layer of muscles to prevent too much water flow in, and control blood volume.



Cellular Component

- Red Blood Cells (Erythrocytes)
  - Contain hemoglobin to transport oxygen
  - Tiny biconcave disks with no nucleus to provide larger S.A and space
  - Formed from stem cells in bone marrow
  - Last about 120 days in the body



Cellular Component

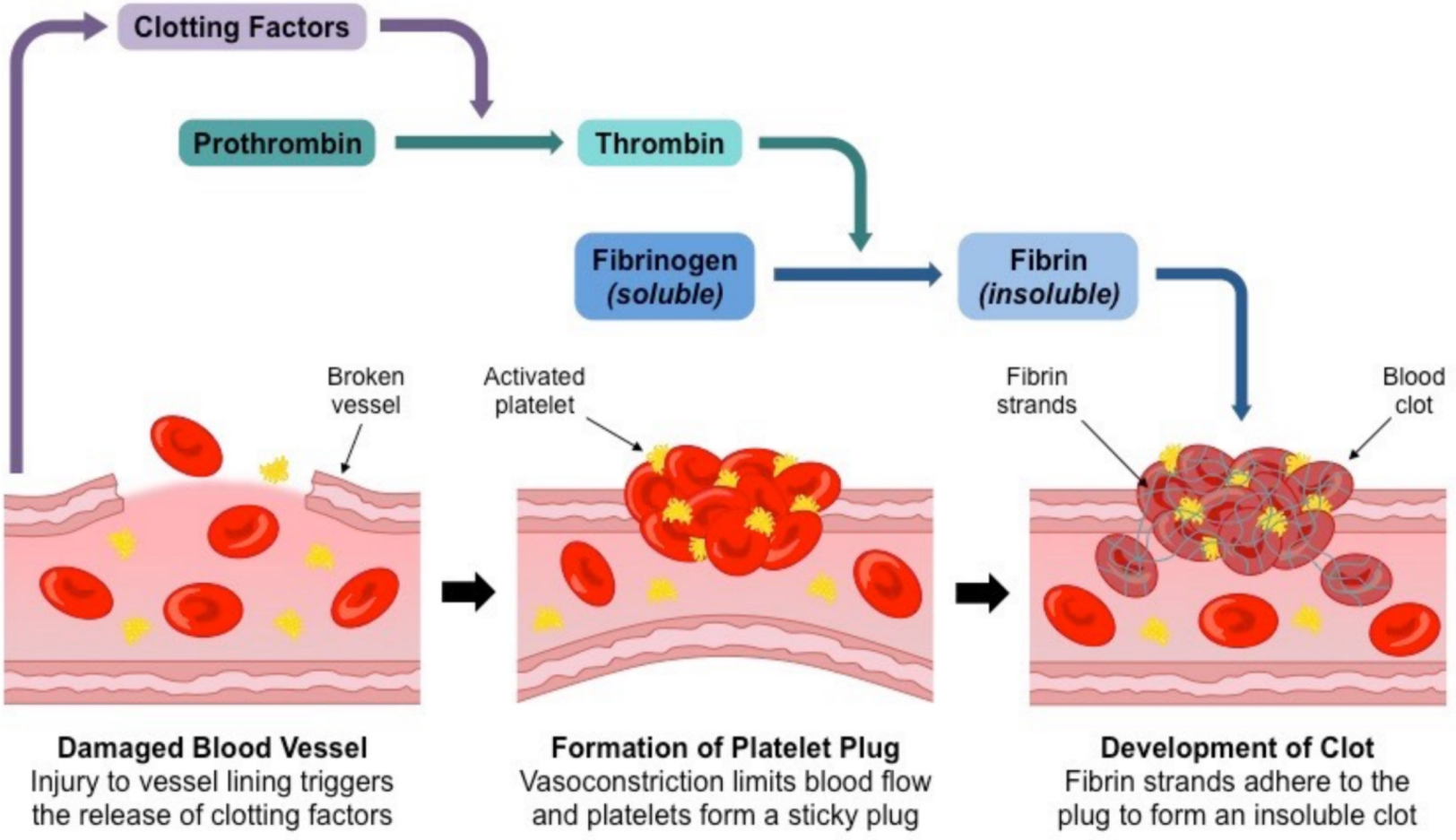
- White Blood Cells (Leukocytes)
  - Formed in bone marrow
  - Have a nucleus
  - Line of defense against disease caused by microorganisms and viruses

  - 2 categories:

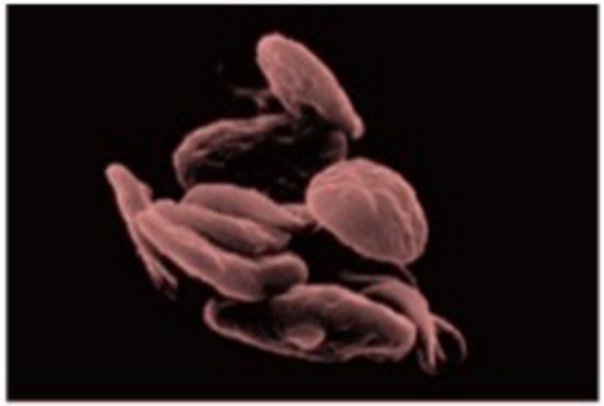
    - Granular (neutrophils, eosinophils and basophils): use chemicals to attack foreign pathogens
    - Agranular (lymphocytes and monocytes): engulfing and killing pathogens, also clean up dead cells and debris.

Cellular Component

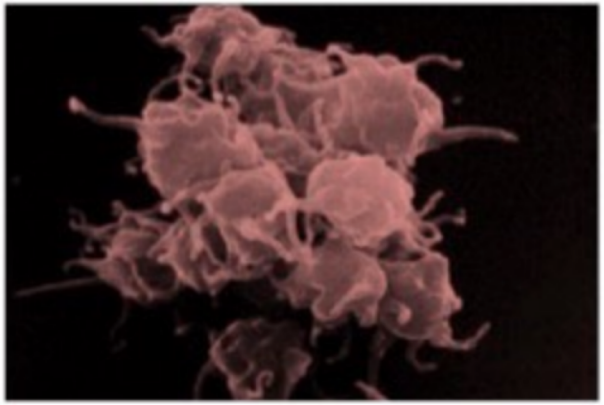
- Platelets
  - Small cell fragments produced from bone marrow
  - Important for clotting of blood



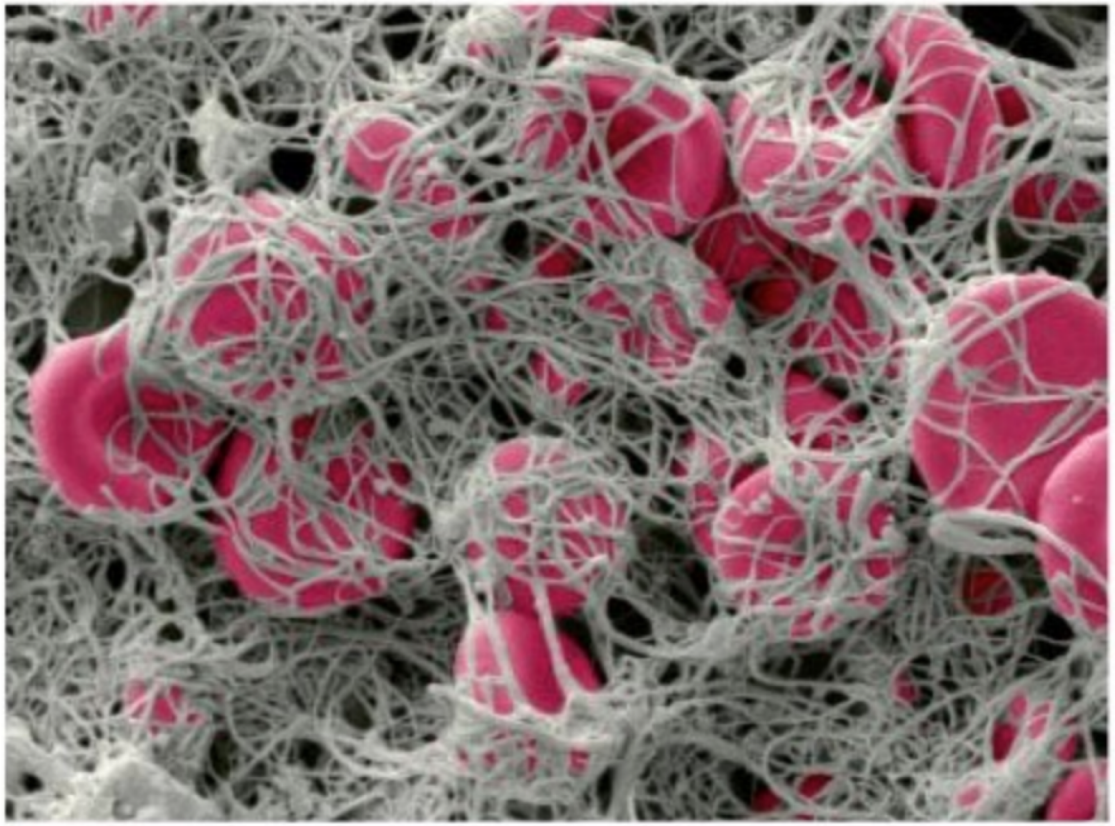
RESTING



ACTIVATED



Isolated Platelets



Fibrin Strands in a Blood Clot

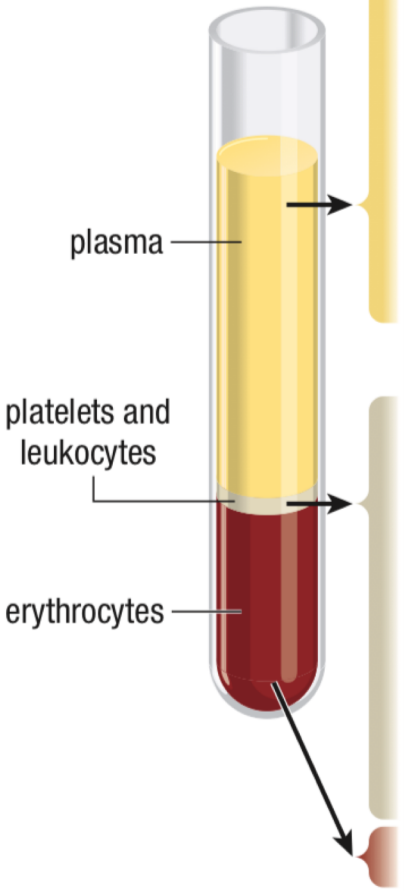
Coagulation Cascade

The process by which blood clots are formed involves a complex set of reactions collectively called the coagulation cascade

- This cascade is stimulated by clotting factors released from damaged cells (extrinsic pathway) and platelets (intrinsic pathway)

The coagulation cascade involves many intermediary steps, however the principal events are as follows:

- Clotting factors cause platelets to become sticky and adhere to the damaged region to form a solid plug
- These factors also initiate localised vasoconstriction to reduce blood flow through the damaged region
- Additionally, clotting factors trigger the conversion of the inactive zymogen *prothrombin* into the activated enzyme **thrombin**
- Thrombin in turn catalyses the conversion of the soluble plasma protein *fibrinogen* into an insolube fibrous form called **fibrin**
- The fibrin strands form a mesh of fibres around the platelet plug and traps blood cells to form a temporary clot
- When the damaged region is completely repaired, an enzyme (*plasmin*) is activated to dissolve the clot



Components	Relative amounts	Functions
Plasma portion (55 %–58 % of total volume):		
Water	91 %–92 % of plasma volume	Solvent
Plasma proteins (albumin, globulins, fibrinogen, and so on)	7 %–8 %	Defence, clotting, lipid transport, roles in extracellular fluid volume, and so on
Ions, sugars, lipids, amino acids, hormones, vitamins, dissolved gases, urea and uric acid (metabolic wastes)	1 %–2 %	Roles in extracellular fluid volume, pH, eliminating waste products, and so on
Cellular portion (42 %–45 % of total volume):		
Platelets	250 000–300 000 per microlitre	Roles in clotting
Leukocytes (white blood cells) Neutrophils Lymphocytes Monocytes/macrophages Eosinophils Basophils	 3000–6750 1000–2700 150–720 100–360 25–90	 Phagocytosis during inflammation Immune response Phagocytosis in all defence responses Defence against parasitic worms Secrete substances for inflammatory response and for fat removal from blood
Erythrocytes (red blood cells)	4 800 000–5 400 000	Oxygen, carbon dioxide transport

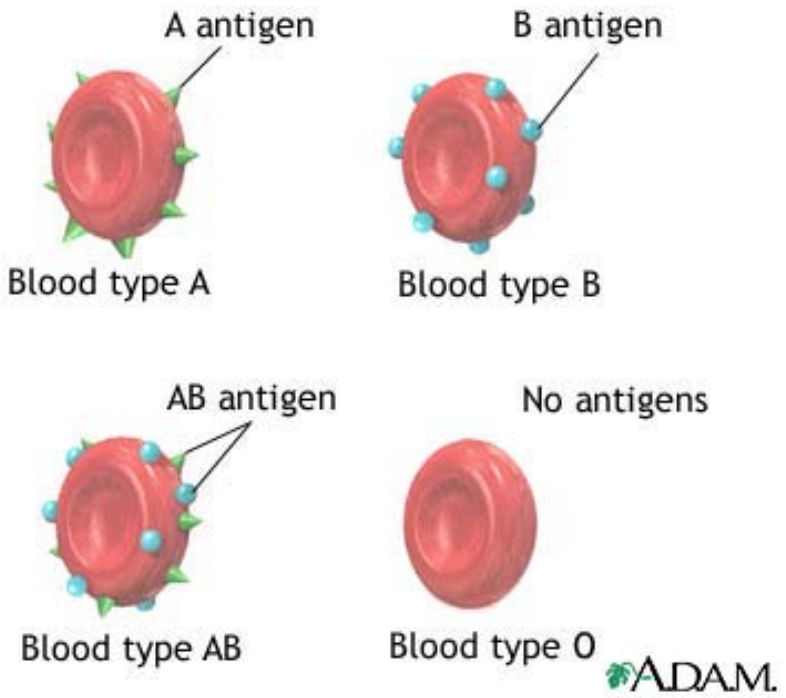
Blood Types – Recall…

- Four blood types:

  A, B, AB, and O.

- Blood types are determined by the presence (or absence) of different sugars, called markers, on the cell membranes of erythrocytes.

- Incompatibility occurs because the markers act as antigens, which are considered as foreign material.



- When the immune system detects antigens, it produces antibodies that attach to the antigens, causing the blood cells to clump together, blocking blood vessels and preventing the circulation of blood and delivery of oxygen.

- For example, if type A blood is given to a person with type B blood, the recipient will develop antibodies in response to the type A marker. Type A blood can be given to a person with type A or type AB blood because their blood already has the A marker and will not produce antibodies against it.

- Also there is another antigen - the Rh factor on erythrocyte membranes that produces an antibody reaction. This is not as severe as the antibody reaction to blood type markers. The Rh antigen is present in approximately 85 % of the population, and these individuals are said to be Rh-positive. 15% are Rh- negative.