Blood

B.Sc Second year Zoology (Honours) Paper - 4

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Blood

Functions of blood

1.Transportation: oxygen, nutrients, wastes, carbon dioxide and hormones.

2. Defense: against invasion by pathogens.

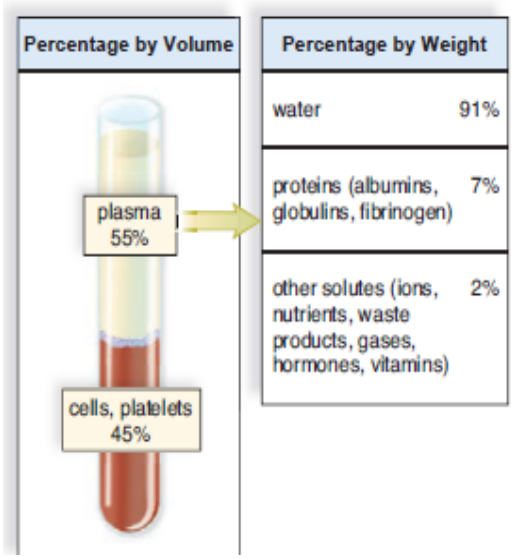
3. Regulatory functions: body temperature, water-salt balance and body pH.

Composition of blood

Blood is a fluid connective tissue

1. **Formed elements (45%):** produced in red bone marrow
   - I. Red blood cells/erythrocytes (RBC)
   - II. White blood cells/leukocytes (WBC)
   - III. Platelets
2. **Plasma (55%):**
   - I. 91% water
   - II. 9% salts (ions) and organic molecules.

Plasma proteins are the most abundant molecules.



Three major types of plasma proteins are

1. **Albumins** are the most abundant plasma proteins and contribute most to plasma's osmotic pressure.
   - They also combine with and help transport other organic molecules.
2. **Globulins** are of three types called alpha, beta, and gamma globulins.
   - Alpha and beta globulins also combine with and help transport substances in the blood such as hormones, cholesterol, and iron.
   - Gamma globulins are also known as antibodies and are produced by white blood cells called lymphocytes, not by the liver. Gamma globulins are important in fighting disease- causing pathogens.
3. **Fibrinogen** is an inactive plasma protein. Once activated, fibrinogen forms a blood clot

Where do the formed elements come from and what are they?

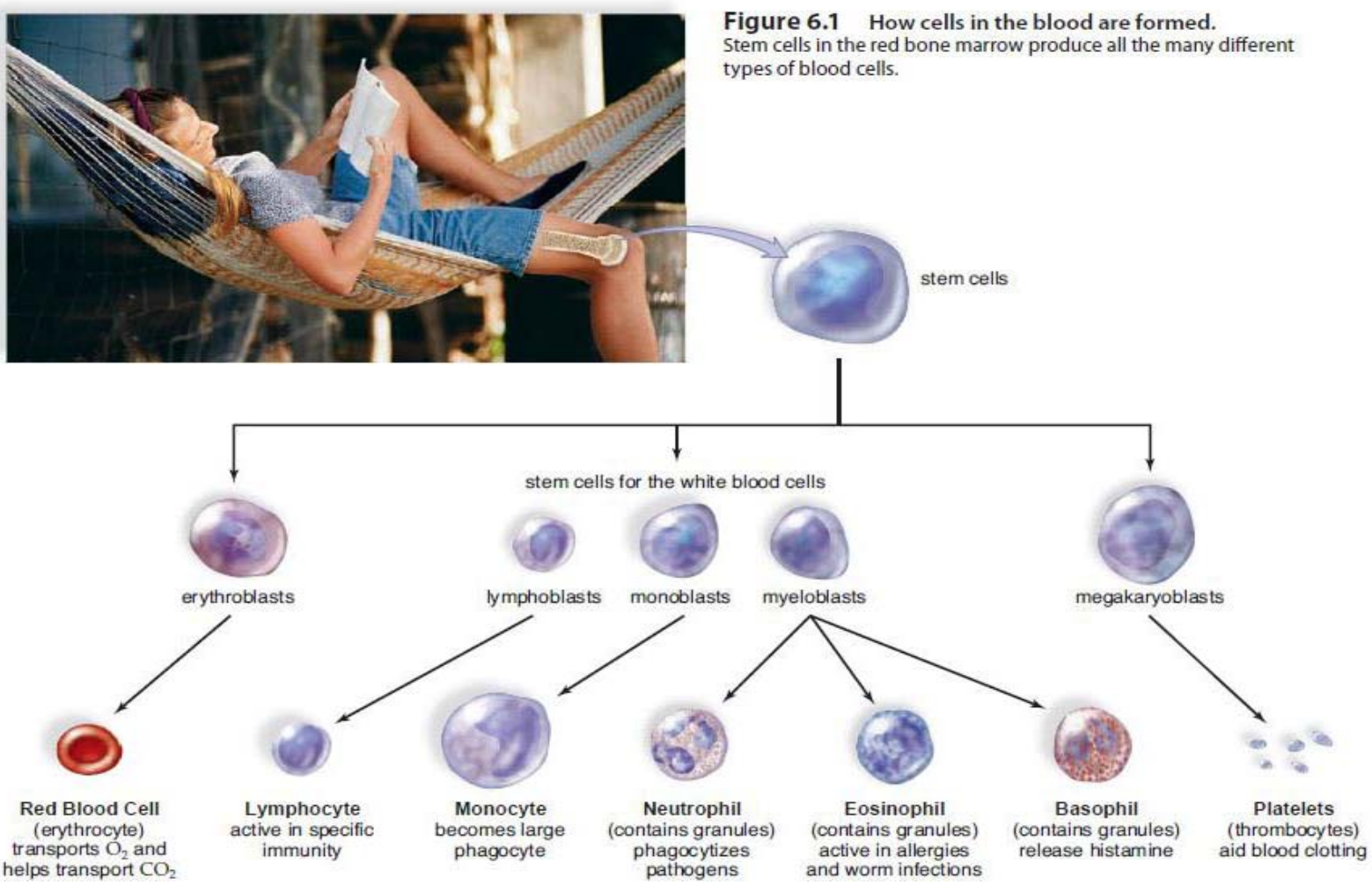


Figure 6.1 How cells in the blood are formed.
Stem cells in the red bone marrow produce all the many different types of blood cells.

Red blood cells and transport of oxygen

How Red Blood Cells Carry Oxygen

- RBC are also know as *Erythrocytes.*
- Lack a nucleus and few organelles, biconcave shape increases surface area and 4 to 6 million RBCs per mm^3 of whole blood.
- Each RBC contain about 280 million hemoglobin molecules that bind 4 molecules of O_2 each to make *oxyhemoglobin*.
- This same hemoglobin interact with CO_2 and makes carboxyhemoglobin (*carbaminohemoglobin*).

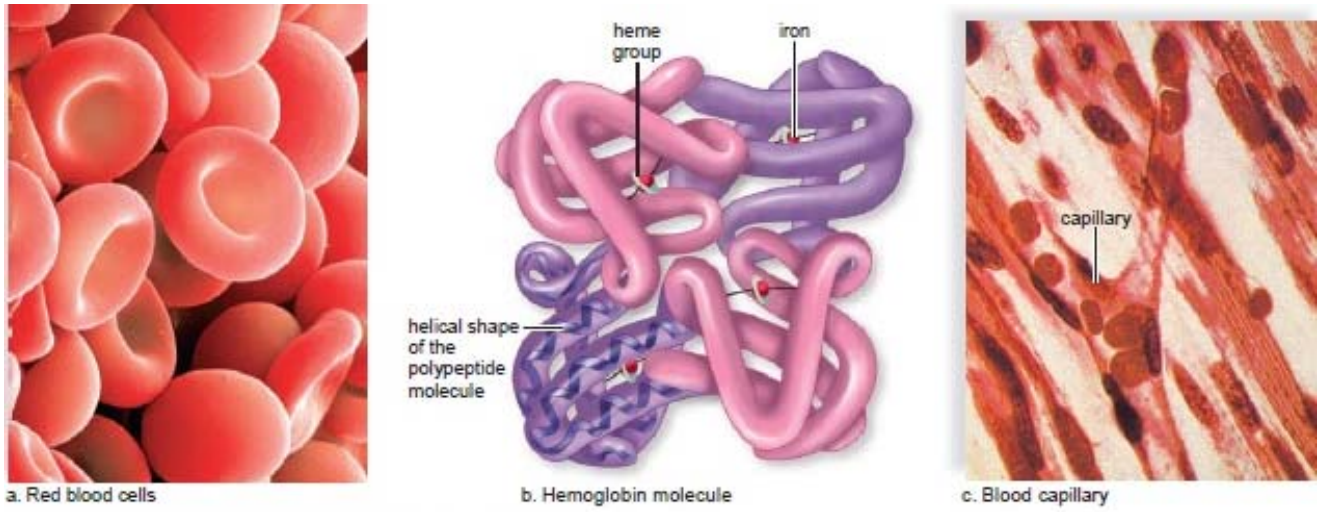
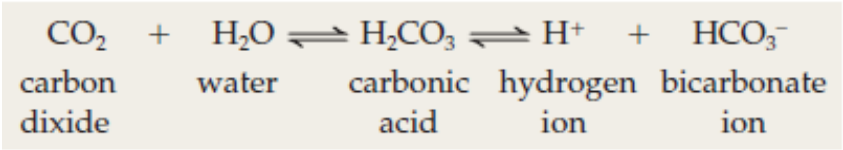


Figure 6.3 Red blood cells and the structure of hemoglobin.

How Red Blood Cells Help transport Carbon Dioxide

- 68% as a bicarbonate ion in the plasma (this conversion takes place in RBC's)



- 25% in red blood cells with hemoglobin as *Carbaminohemoglobin.*
- 7% as carbon dioxide in the plasma.

Red Blood Cells are Produced in Bone Marrow

- Produced in the red bone marrow and lifespan of about 120 days.
- When they age, red blood cells are phagocytized by white blood cells called macrophages in the liver and spleen.
- Erythropoietin (EPO) is released by kidney cells and moves to red marrow when oxygen levels are low which stimulate the stem cell in the bone marrow to produce more RBCs.

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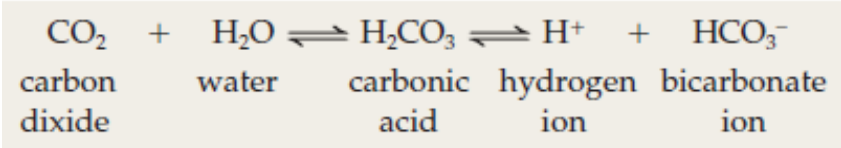

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Disorders involving Red Blood Cell's

1. Anemia – a condition from too few RBC's or hemoglobin that causes a rundown feeling.

2. Sickle-cell anemia – genetic disease that causes RBC's to be sickle shaped that tend to rupture.

3. Hemolytic disease of the newborn – a condition with incompatible blood types that leads to rupturing of blood cells in a baby before and continuing after birth.

White blood cells and defense against disease

- WBC's derived from red bone marrow and Large blood cells that have a nucleus. Its Production is regulated by colony-stimulating factor (CSF).
- There are about 5,000-11,000 per mm^3 of blood.
- They can be found in the blood as well as in tissues.
- They fight infection and an important part of the immune system some live days and others live months or years.

Types of White Blood Cells

a. Granular – contain noticeable granules, lobed nuclei

1. Eosinophil
2. Basophil
3. Neutrophil

b. Agranular – no granules, nonlobed nuclei

1. Lymphocyte
2. Monocyte

a. Granular WBCs

1. Neutrophils

- About 50-70% of all WBC's.
- Contain a multilobed nucleus .
- Upon infection they move out of circulation into tissues to phagocytosis to engulf pathogens

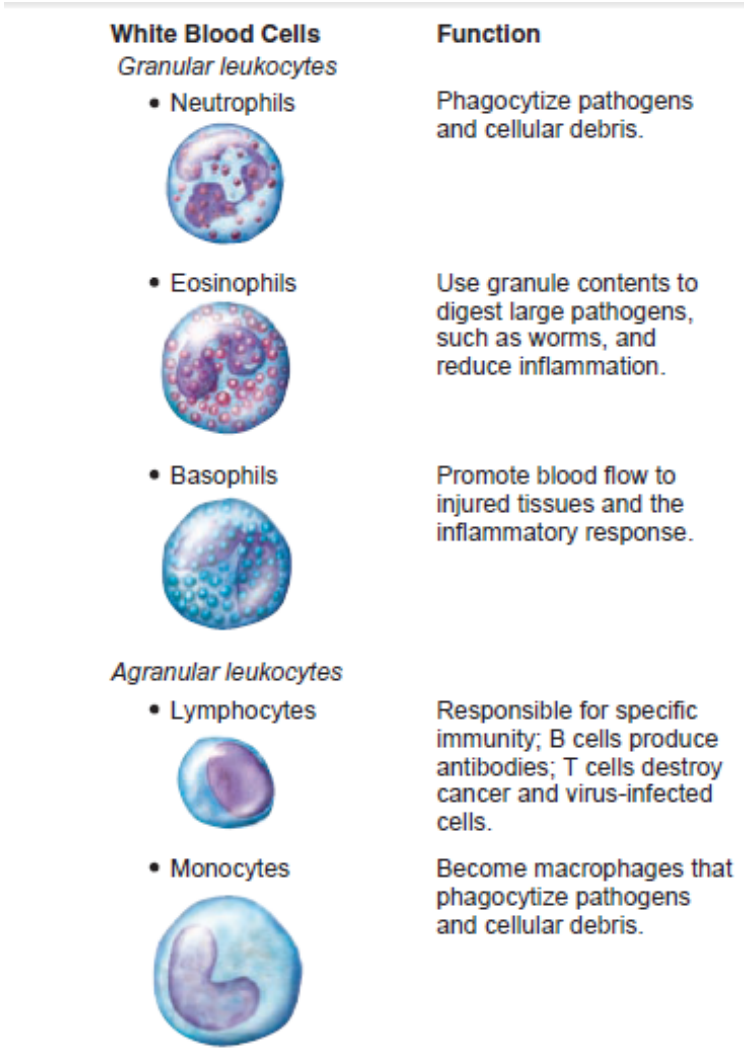

Figure 6.5 Some examples of white blood cells.
Neutrophils, eosinophils, and basophils are granular leukocytes. Lymphocytes and monocytes have few, if any, granules (agranular).

2. Eosinophils

- Small percentage of WBC's.
- Contain a bilobed nucleus.
- Many large granules function in large parasitic infections and play a role in allergies .

3. Basophil

- Small percentage of WBC's.
- Contain a U-shaped or lobed nucleus.
- Release histamine related to allergic reaction.

b. Agranular WBCs

1. Lymphocyte

- About 25-35% of all WBC's.
- Large nucleus that takes up most of the
- Develop into B and T cells that are imp immune system.

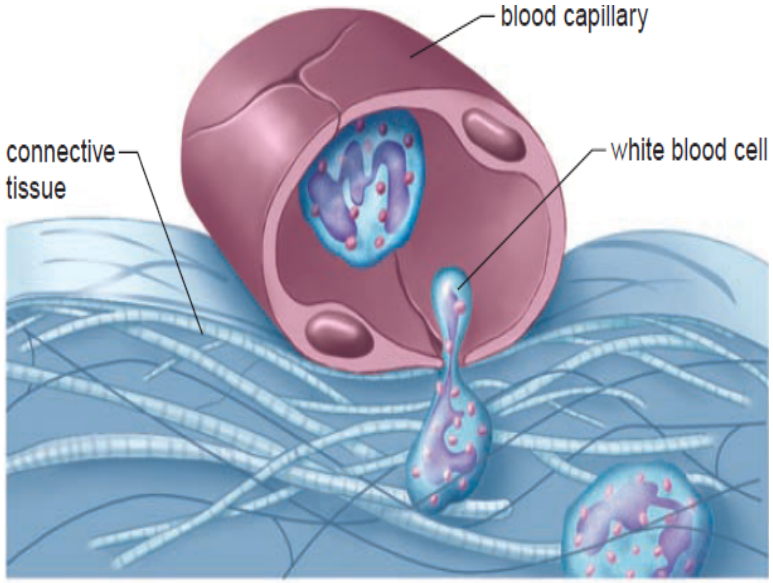

Figure 6.6 Movement of white blood cells into the tissue. White blood cells can squeeze between the cells of a capillary wall and enter body tissues.

- *2. Monocyte*
- Relatively uncommon. They are Largest WBC with horseshoe-shaped nucleus.
- Take residence in tissues and develop into macrophages.
- Macrophages use phagocytosis to engulf pathogens.

Disorders Involving White Blood Cells

1. Severe combined immunodeficiency disease (SCID) – an inherited disease in which stem cells of WBC's lack an enzyme that allows them to fight any infection.

2. Leukemia – groups of cancers that affect white blood cells in which cells proliferate without control.

3. Infectious mononucleosis – also known as the "kissing disease " occurs when the Epstein-Barr virus (EBV) infects lymphocytes resulting in fatigue, sore throat and swollen lymph nodes.

Platelets and Blood Clotting

Platelets

- Platelets are made of fragments of large cells called megakaryocytes made in the red bone marrow.
- About 200 billion are produced per day.
- They function in blood clotting.
- Blood proteins named thrombin, prothrombin and fibrinogen are important for blood clotting by leading to fibrin threads that catch RBC's.
- Vitamin K is necessary for the production of prothrombin.

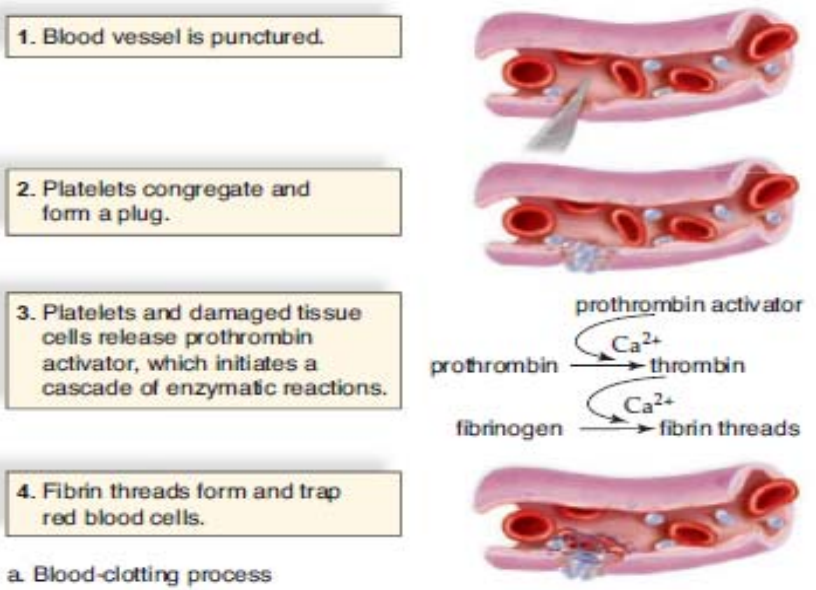

Figure 6.7 **The steps in the formation of a blood clot.**
a. Platelets and damaged tissue cells release prothrombin activator, which acts on prothrombin in the presence of Ca^{2+} (calcium ions) to produce thrombin. Thrombin acts on fibrinogen in the presence of Ca^{2+} to form fibrin threads.
b. A scanning electron micrograph of a blood clot shows red blood cells caught in the fibrin threads.

Disorders Related to Blood Clotting

1. Thrombocytopenia – a disorder in which the number of platelets is too low due to not enough being made in the bone marrow or the increased breakdown outside the marrow.
2. Thromboembolism – when a clot forms and breaks off from its site of origin and plugs another vessel.
3. Hemophilia – a genetic disorder that results in a deficiency of a clotting factor so that when a person damages a blood vessel they are unable to properly clot their blood both internally and externally.