AL-mustaqbal university

College Of Health and Medical Techniques

Department of kidney dialysis techniques

Hematology

2nd stage

Lec.3

Erythropoiesis

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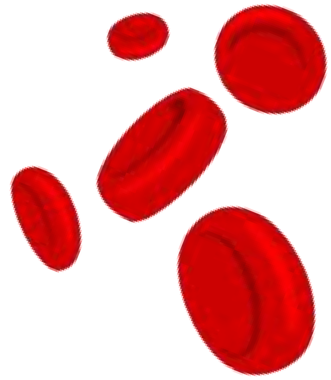
Introduction



The red blood cells (RBCs), also known as erythrocytes, are the most abundant cells in the human blood. Their primary function is to transport oxygen from the lungs to tissues and to carry carbon dioxide back to the lungs for exhalation. This lecture will cover: Erythropoiesis, RBC morphology, RBC cell membrane, and RBC metabolism.

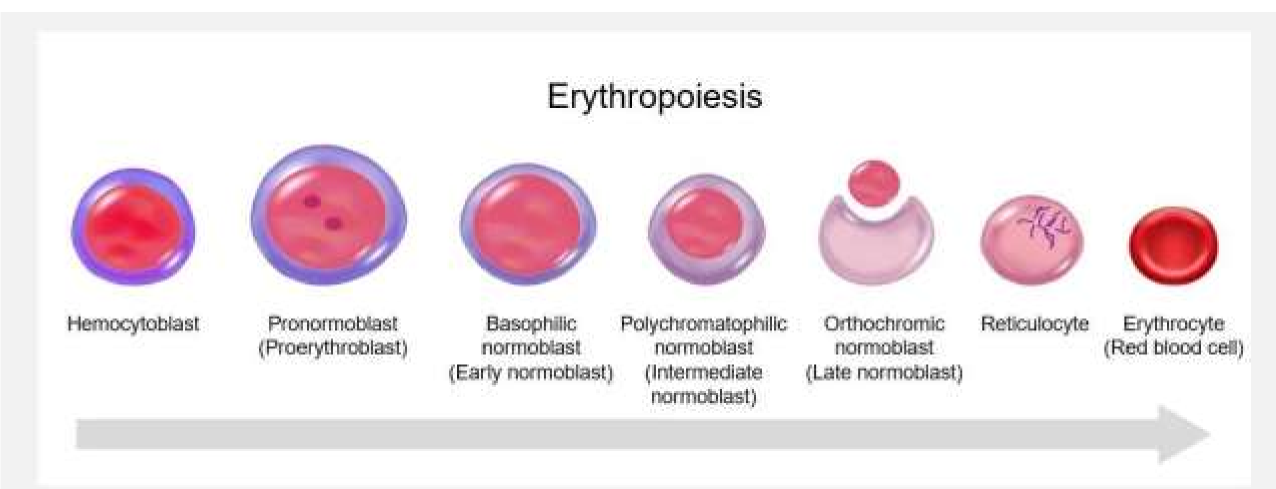
Erythropoiesis (Definition)

Erythropoiesis is the process of red blood cell production. It occurs mainly in the bone marrow in adults. The process is regulated by the hormone erythropoietin (EPO), which is produced by the kidneys in response to low oxygen levels (hypoxia).

Stages of Erythropoiesis

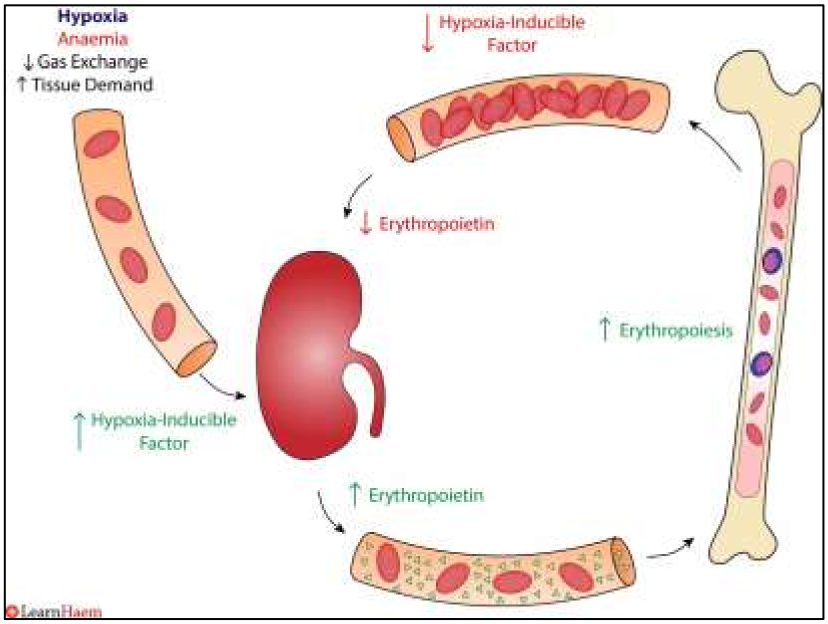
1. Stem Cell (Pluripotent Hematopoietic Stem Cell)
2. Proerythroblast
3. Basophilic Erythroblast
4. Polychromatic Erythroblast
5. Orthochromatic Erythroblast (Normoblast)
6. Reticulocyte
7. Mature Erythrocyte

As cells mature, the nucleus is condensed and eventually lost, and hemoglobin accumulates in the cytoplasm.



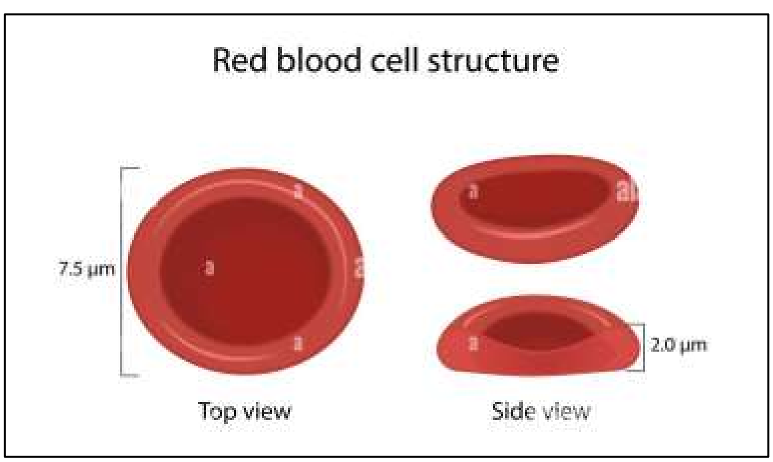
Regulation of Erythropoiesis

Erythropoietin (EPO) stimulates bone marrow to increase RBC production.
Nutrients required: Iron, Vitamin B12, and folic acid.
Feedback mechanism: Low oxygen → kidney releases EPO → stimulates bone marrow → increased RBCs → normal oxygen level → decreased EPO.



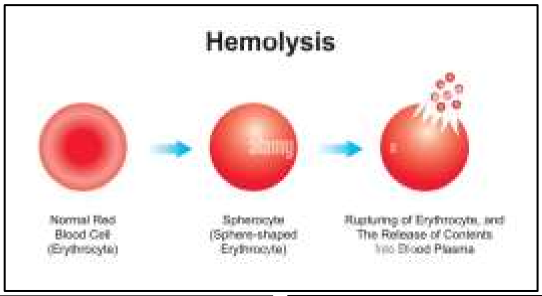
RBC Morphology (Structure and Shape)

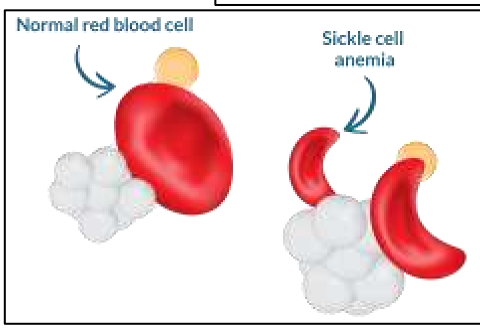
Normal shape: Biconcave disc (7.5 µm diameter, 2 µm thick).
Advantages: increased surface area for gas exchange and flexibility to pass through narrow capillaries. Lack of nucleus and mitochondria allows more space for hemoglobin.

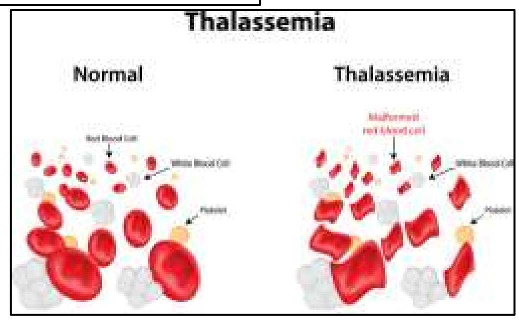


Abnormal RBC Morphology

Anisocytosis: variation in cell size. **Poikilocytosis**: variation in cell shape. Examples: Sickle cells in sickle cell anemia, **Spherocytes** in hereditary spherocytosis, **Target cells** in liver disease or thalassemia.







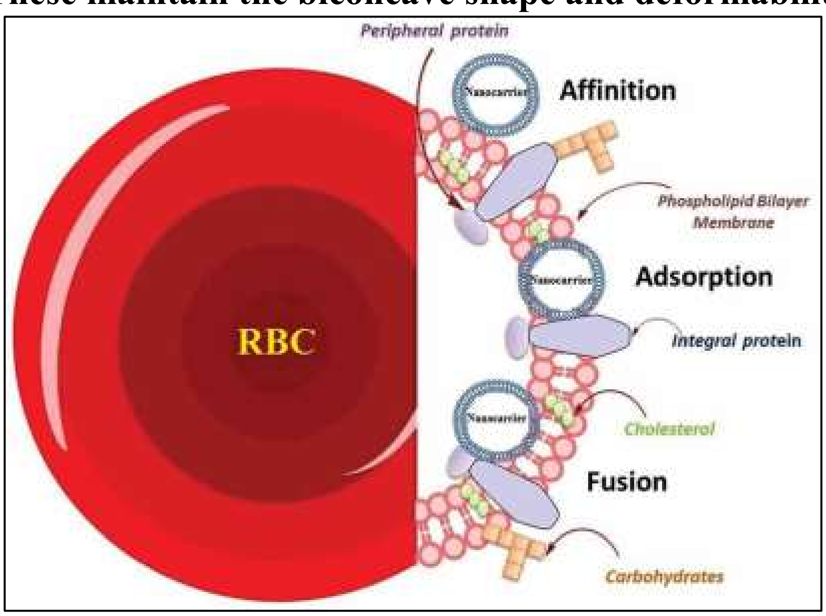
The RBC Cell Membrane

Provides shape, flexibility, and stability.

Composition:

1. lipid bilayer (phospholipids, cholesterol)
2. integral proteins (Band 3, glycophorin)
3. peripheral proteins (spectrin, ankyrin, actin).

These maintain the biconcave shape and deformability.



Membrane Functions

1. Maintains osmotic balance and ion exchange.
2. Provides antigenic sites (ABO and Rh antigens).
3. Maintains cell integrity during circulation.
4. Defects cause hemolytic anemias.

RBC Metabolism

RBCs lack mitochondria; energy is produced by anaerobic glycolysis. Main pathways:

1. Embden–Meyerhof pathway – produces ATP for membrane pumps.
2. Hexose Monophosphate shunt – generates NADPH for oxidative protection.
3. Methemoglobin reductase pathway – keeps iron in Fe^{2+} state.
4. Leubering–Rapaport shunt – regulates 2,3-BPG levels.

RBC Lifespan and Destruction

Average lifespan: 120 days. Aging RBCs lose flexibility and are removed by macrophages in the spleen and liver.

Hemoglobin breakdown: Globin → amino acids, Heme → iron (recycled) + bilirubin (excreted in bile).