# PHYSIOLOGY

**Q1 – Erythropoiesis**

**Ans : 1 – Answer**

## *Introduction*

Erythropoiesis is the physiological process by which red blood cells are continuously produced to compensate for senescent and destroyed erythrocytes. Since erythrocytes contain hemoglobin, they are essential for transport of oxygen from the lungs to peripheral tissues and for removal of carbon dioxide from tissues to the lungs. Adequate erythropoiesis is therefore vital for cellular respiration, oxidative metabolism, and maintenance of normal tissue function.

## *Definition*

Erythropoiesis is defined as the process of formation, development, differentiation, and maturation of red blood cells from pluripotent hematopoietic stem cells in the bone marrow, ultimately resulting in the release of mature, anucleate erythrocytes into the circulation.

## *Sites of Erythropoiesis*

The site of erythropoiesis varies with age. In early embryonic life, red blood cells are formed in the yolk sac. During mid■gestation, the liver becomes the principal site, followed by the spleen. After birth and throughout adult life, erythropoiesis is confined to the red bone marrow, particularly of the vertebrae, sternum, ribs, pelvis, and proximal ends of long bones such as the femur and humerus. In pathological conditions, extramedullary erythropoiesis may occur in the liver and spleen.

## *Stages of Erythropoiesis*

Erythropoiesis proceeds through a series of morphologically distinct stages. The process begins with the proerythroblast, a large cell with a prominent nucleus and deeply basophilic cytoplasm. This is followed by the basophilic erythroblast, in which active ribosomal RNA synthesis occurs. The polychromatophilic erythroblast shows mixed staining due to increasing hemoglobin content. The orthochromatic erythroblast exhibits marked nuclear condensation and extrusion of the nucleus. The reticulocyte, containing residual ribosomal material, enters the circulation and matures into a fully functional erythrocyte within one to two days.

## *Role of Erythropoietin*

Erythropoietin is a glycoprotein hormone secreted mainly by the peritubular interstitial cells of the kidneys in response to reduced oxygen tension in blood. Hypoxia acts as the primary stimulus for erythropoietin release. The hormone acts on erythroid progenitor cells in the bone marrow, enhancing their proliferation, differentiation, and maturation, thereby increasing the total red blood cell mass.

## *Factors Required for Erythropoiesis*

Normal erythropoiesis requires several essential factors. Iron is necessary for hemoglobin synthesis, while vitamin B12 and folic acid are required for DNA synthesis and nuclear maturation. Adequate proteins are essential for globin chain formation. Hormones such as erythropoietin, thyroxine, testosterone, and growth hormone further stimulate erythropoietic activity.

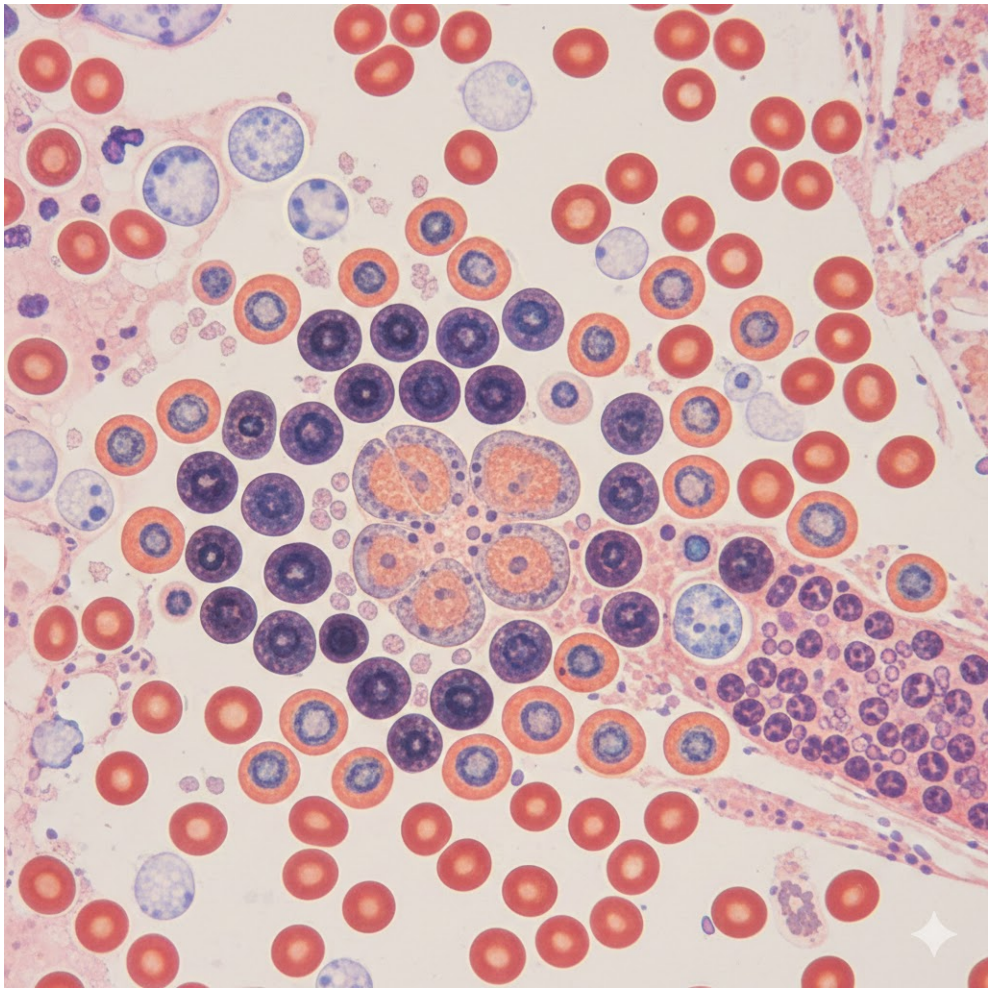
## *Regulation of Erythropoiesis*

Erythropoiesis is regulated primarily by tissue oxygen tension. A fall in oxygen delivery to tissues increases erythropoietin secretion, which in turn enhances red blood cell production. Adequate renal function and intact bone marrow are therefore essential for normal regulation of erythropoiesis.

## *Clinical Importance*

Defective erythropoiesis results in anemia, a condition characterized by reduced oxygen■carrying capacity of blood. Common causes include iron deficiency anemia, megaloblastic anemia due to vitamin B12 or folate deficiency, aplastic anemia due to bone marrow failure, and anemia of chronic kidney disease resulting from decreased erythropoietin secretion.

## Diagram – Stages of Erythropoiesis



### *Conclusion*

Erythropoiesis is a continuous, finely regulated physiological process essential for maintaining normal red blood cell count and efficient oxygen delivery to tissues. Proper functioning of bone marrow, kidneys, and adequate nutritional support are critical for normal erythropoiesis. Any disturbance in this process leads to clinically significant hematological disorders.