Formation of Blood cells

Definition :- Hemopoiesis (or) Hemeatopoiesis may be defined as the process of production of formed elements of blood from undifferentiated stem cells.

* Before birth → Hemopoiesis first occurs in yolk sac of an embryo
  ↓
  later in liver, spleen, Thymus and lymph nodes of a foetus.

* 3 months before birth, after birth and throughout life.
  ↓
  Hemopoiesis primarily occurs in **Red Bone Marrow**.

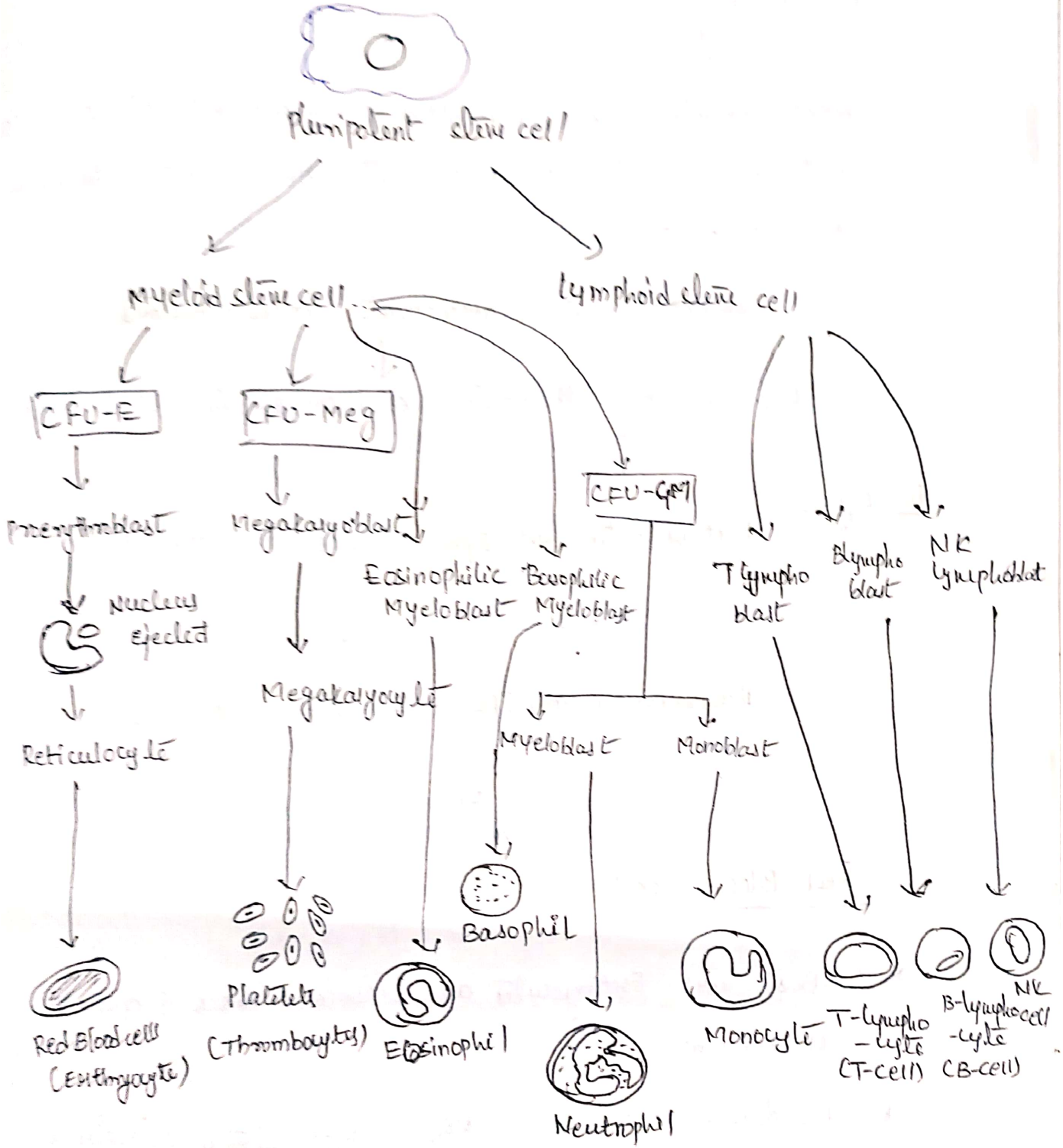
* Red Bone Marrow is a highly vascularized connective tissue.
  ↓
  located in space b/w trabeculae of spongy bone tissue.

* It is present chiefly in bones of Axial skeleton, Pectoral and Pelvic girdle & proximal epiphyses of Humerus & Femur.

* About 0.5 to 0.1% of Red bone Marrow cells are derived from → Mesenchyme and are called pluripotent stem cells (or) hemocytoblasts.

* In New borns all bone marrow is red so active in Blood cell production
  ↓
  As Individual grows and in adulthood red bone Marrow in long bones becomes inactive - replaced by yellow Bone Marrow (fat cells).

origin, development and structure of Blood cells



CFU-E → colony- forming unit Erythrocyte

CFU-meg → colony forming unit Megakaryocyte

CFU-GM → colony forming unit granulocyte Macrophage.

* During hemopoiesis some of the myeloid stem cells differentiate into progenitor cells.

↓

Next generation cells are called precursor cells also known as blasts. over several cell divisions they develop into Actual formed elements of Blood.

* several hormones called Hemopoietic Growth factors

↓

Regulate the differentiation and proliferation of particular progenitor cells.

For E.g's :-

Erythropoietin (or) EPO produced in kidneys cell.

↓

↑ the No. of RBC precursors.

Thrombopoietin (or) TPO produced by liver

↓

Stimulate Formation of platelets.

Red Blood cells

* (RBCs) (or) Erythrocytes are biconcave discs & a diameter of 7-8 μm.

* The plasma membrane of RBC is both strong and flexible allows them to deform without rupturing and pass through narrow capillaries.

* RBCs contains oxygen carrying protein Hemoglobin pigment that give red color to Blood.

→ A Healthy adult male has about 5.4 million RBCs per microliter (μL) of blood.

→ A healthy adult female has about 4.8 million RBCs (a lone drop of blood is about 50μL)

* some glycolipids in PM of RBCs are antigens that form various Blood groups.

↓

ABO and Rh groups

* RBCs lack a Nucleus and other organelles and can neither reproduce nor carry out Extensive Metabolic Activity.

* cytosol of RBCs contain Hemoglobin Molecules (33% of cell's weight)

↓

Synthesized before loss of Nucleus, during RBC production

RBC physiology :-

* RBCs are highly specialized for their oxygen Transport function
* As RBCs lack Mitochondria and generate ATP Anaerobically (Without oxygen)

↓

They do not use any of the oxygen they transport.

* Each RBC contains about 280 million hemoglobin molecules.
* Hemoglobin Molecule consists of

↙ ↘

A protein called Globulin

↓

composed of four polypeptide chains (2 alpha and 2 beta chains)

A Non protein pigment called Heme

↓

Bound to Each of four chains an Iron ion (Fe^{2+}) is at center of each heme ring.

* As each heme group combine reversibly with one oxygen molecule So, each hemoglobin molecule bind to 4 oxygen molecules.
* Hemoglobin also transports about 23% of total CO_2.

RBC life cycle:-

- RBCs live only about 120 days.

(1) Macrophages in spleen, liver (or) Red Bone Marrow phagocytize ruptured and worn out RBCs

(2) Globin and heme portions are split Apart.

(3) Globin is break down into Amino Acids (Reused to synthesize other proteins)

(4) Iron is removed from heme portion in the form of Fe^{3+} which Associates with plasma protein (Transferrin)

↓

Transporter of Fe^{3+} in the Blood Stream.

↓

In Muscle Fibers, liver cells, and Macrophages of the spleen Fe^{3+} detaches from transferrin and Attached to an Iron storage protein Ferritin.

↓

upon release from storage site (or) Absorption from GIT Fe^{3+} reattaches to transferrin.

↓

Fe^{3+} transferrin complex is then carried to Red Bone Marrow where RBC precursor cells take it up for use in Hemoglobin synthesis.

→ Iron is Needed for Heme portion.

→ Amino Acid are needed for globin portion.

→ Vitamin B_{12} is also needed for synthesis of hemoglobin.

↓

Erythropoiesis in Red Bone Marrow results in production of RBCs which enter in circulation.

↓

Where Iron is removed from heme → The non Iron portion of heme is converted to biliverdin (A green pigment) and then into bilirubin (A yellow orange pigment)

↓

Bilirubin enter the blood and transported to the liver.

↓

From liver, bilirubin released into bile and passes into small Intestine and then into large Intestine

↓

In large Intestine bacteria convert bilirubin into urobilinogen

↓

Some of the urobilinogen is Absorbed back into Blood converted into yellow pigment urobilin and excreted in urine.

↓

Most urobilinogen is eliminated in feces in the form of a brown pigment called stercobilin. (gives feces its characteristic color)