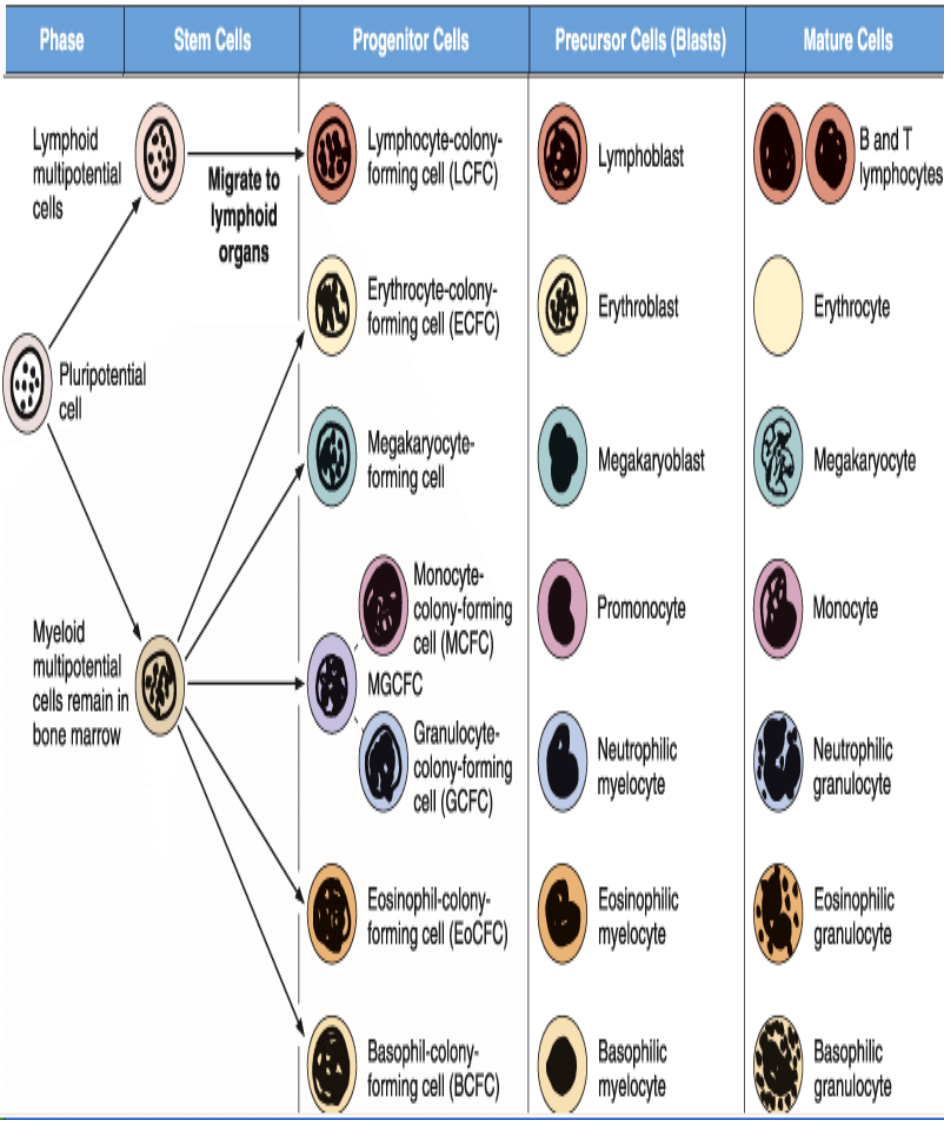
Hematopoiesis 1

Prof. Dr. Malak A. Al –yawer
Department of Anatomy/ Histology Section

At the end of this lecture, the medical student will be able to

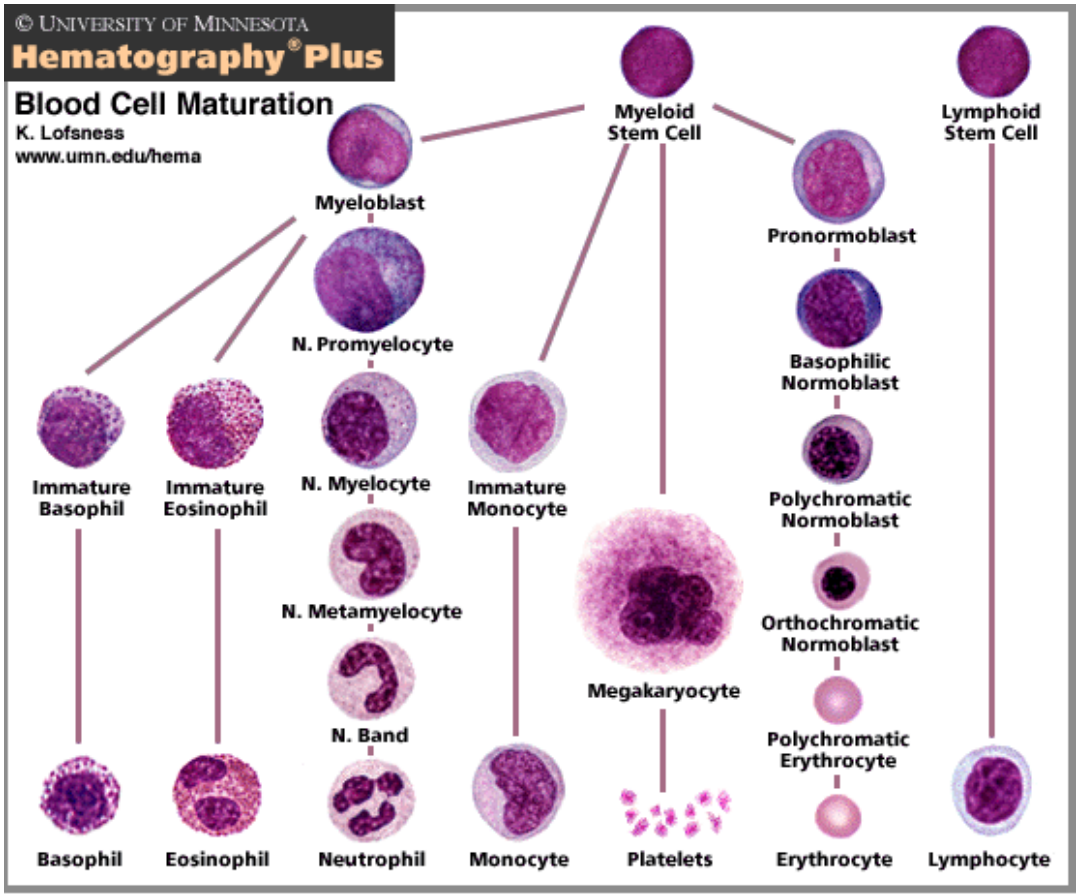
- Define stem cell theory (Monophyletic theory)of hematopoiesis.
- State the sites of hematopoiesis at different age groups
- Compare between stem cells, progenitor cells, blast cells and mature cells
- Discuss factors involved in the stimulation and regulation of hematopoietic activity.
- Discuss the term " hematopoiesis is a compartmentalized process "
- Define the ways by which various mature blood cells leave red bone marrow
- Describe the maturation stages of erythrocytes
- list the major changes that take place during maturation of erythrocyte

Hematopoiesis



- takes place in the extravascular compartment
- **Monophyletic theory:** means that a single type of stem cells gives rise to all mature blood cells in the body.

pleuripotential stem cell

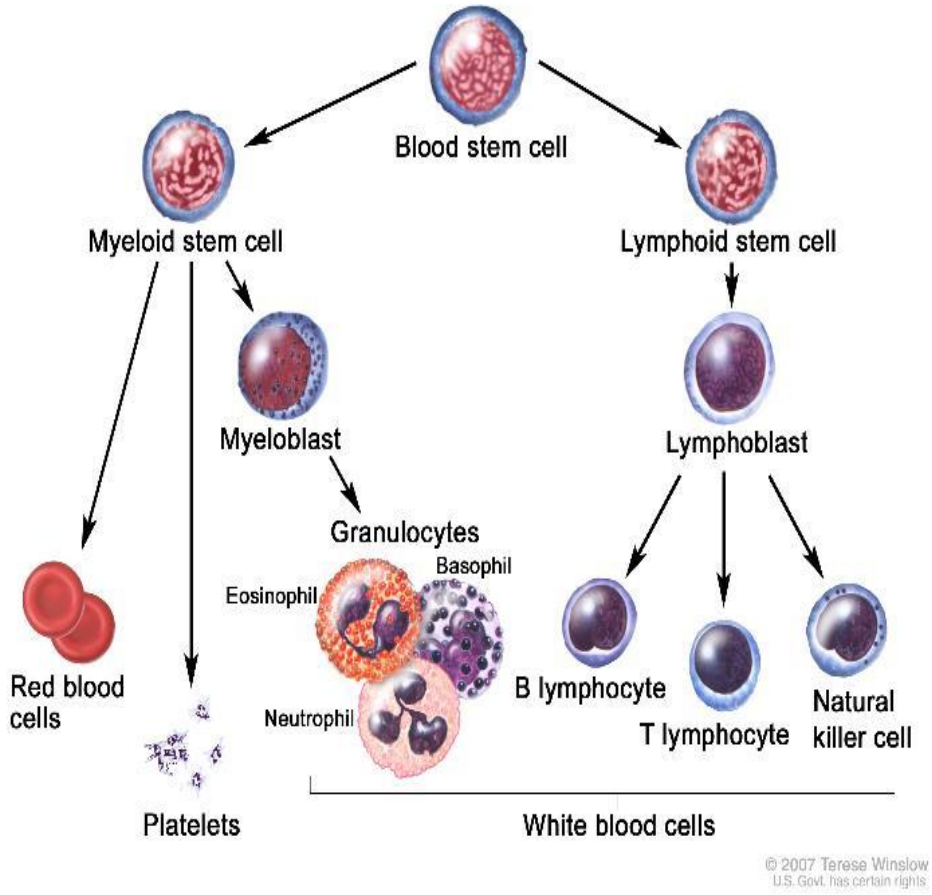


- it can porduce all blood cell types .

Pleuripotential stem cell

- proliferate and form

1. **Lymphoid multipotentia cells**
2. **Myeloid multipotential cells**



SITES OF HEMATOPOIESIS

Age	Site of hematopoiesis
Embryo	yolk sac then liver
3rd to 7th month	Spleen
4th and 5th months	marrow cavity - esp. granulocytes and platelets
7th month	marrow cavity - erythrocytes
Birth	mostly bone marrow; spleen and liver when needed
Birth to maturity	number of active sites in bone marrow decreases but retain ability for hematopoiesis
Adult	bone marrow of skull, ribs, sternum, vertebral column, pelvis, proximal ends of femurs

stem cells:

1. can produce all blood cell types
2. Low mitotic activity
3. Self renewing
4. Scarce in the bone marrow
5. Cannot be morphologically distinguished (resemble large lymphocyte)

Progenitor cells :

1. Could be unipotential or bipotential
2. High mitotic activity
3. Self renewing
4. Common in marrow and lymphoid organs
5. Cannot be morphologically distinguished (resemble large lymphocyte)

Precursor cells(blast):

1. Monopotential cells
2. High mitotic activity
3. Not self renewing
4. Common in marrow and lymphoid organs
5. Beginning of morphologic differentiation

Mature cells :

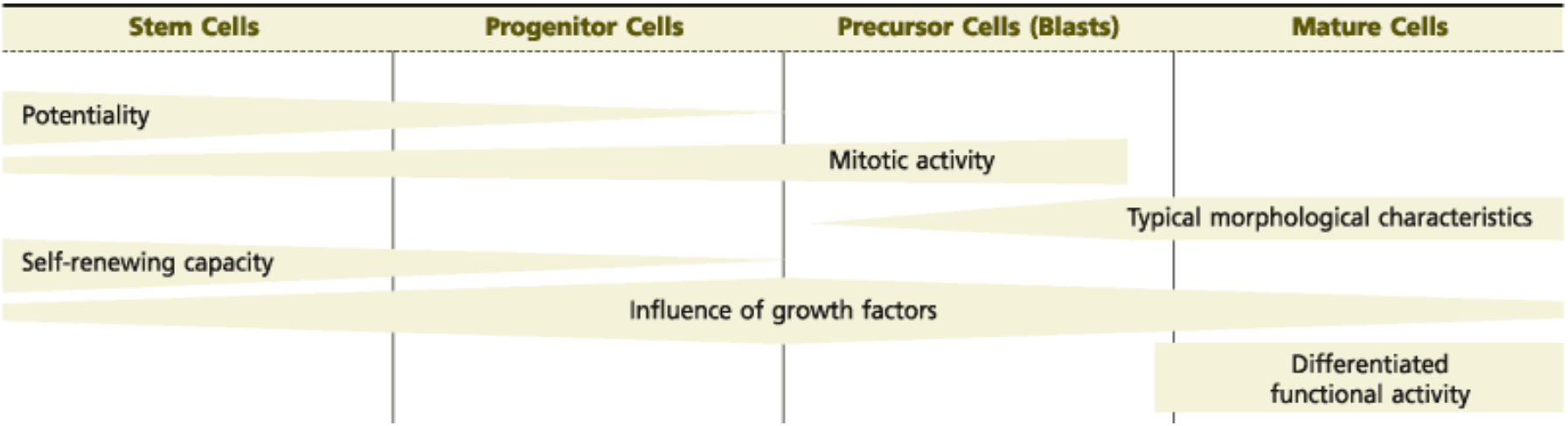
1. No mitotic activity
2. Abundant in the blood and haematopoietic organs
3. Clear morphologic differentiation

Hematopoiesis depends on

1. **microenvironmental conditions**
2. **growth factors**.

- The microenvironmental conditions are furnished by cells which produce an adequate extracellular matrix.

A general view of hematopoiesis shows that

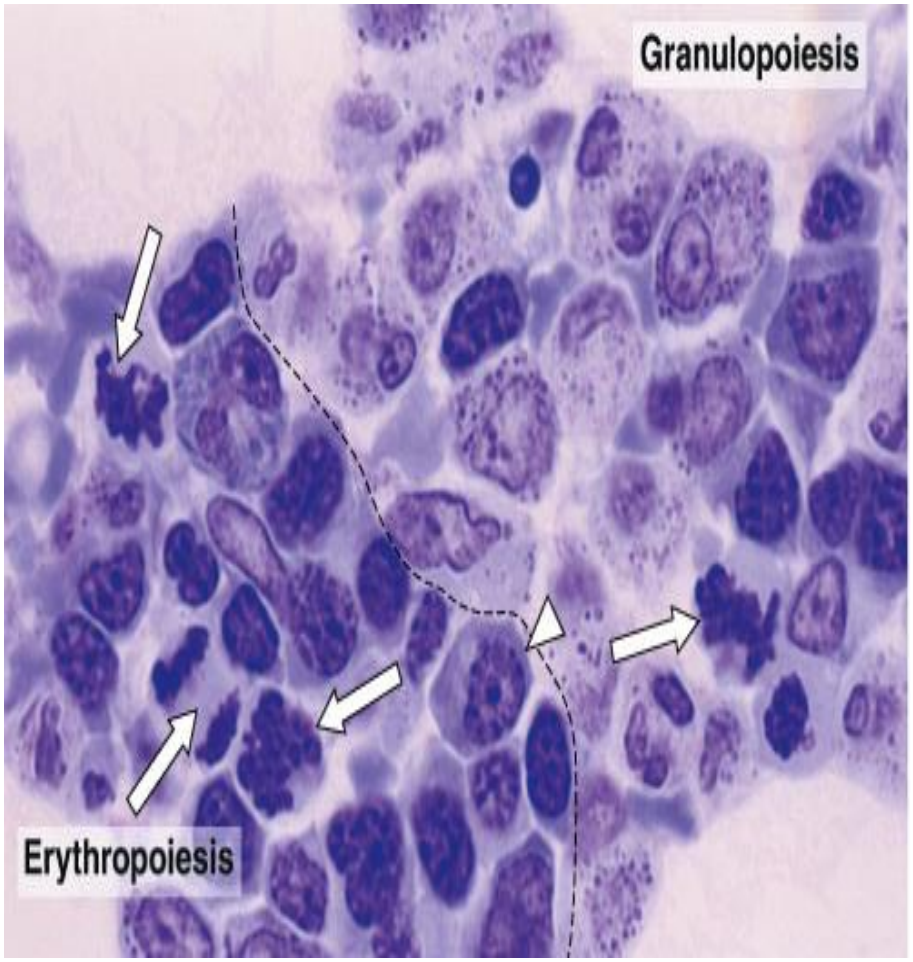


- **The potential for differentiation and the self-renewing capacity of the initial cells gradually decrease.**
- **The mitotic response to growth factors gradually increases**

Hematopoiesis

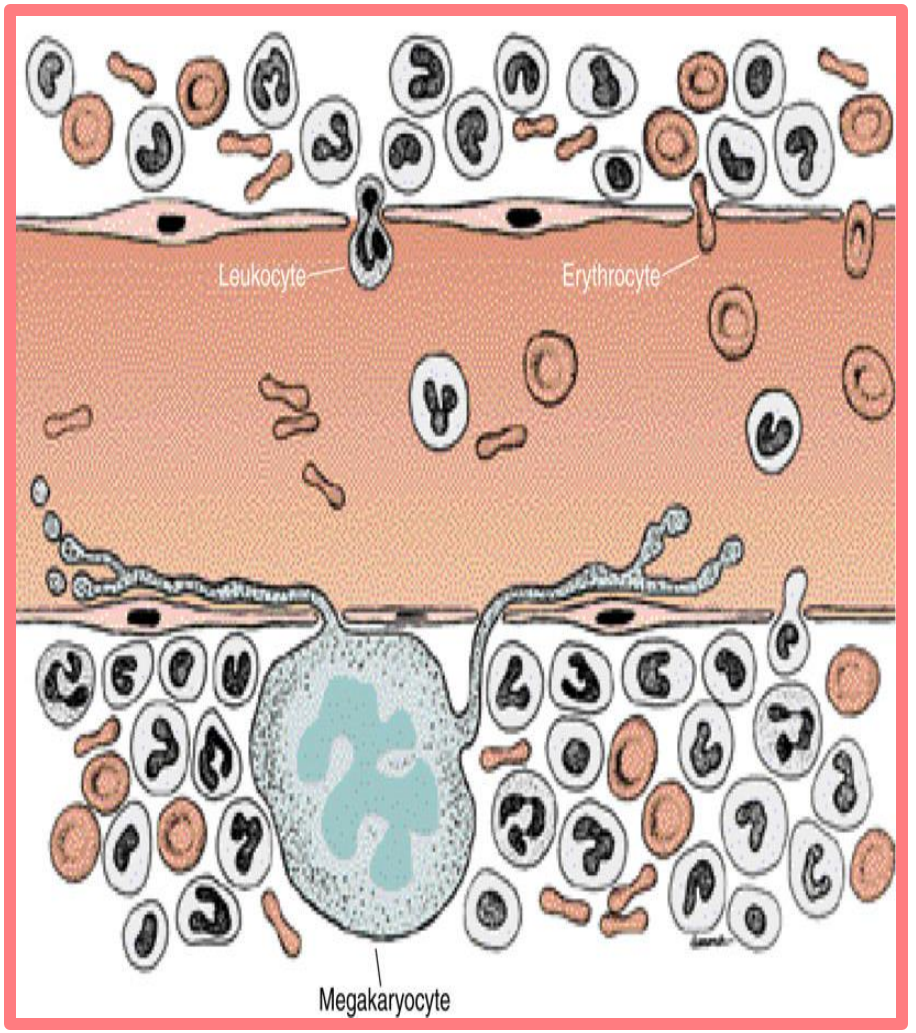
is a compartmentalized process within the hematopoietic tissue

- **Erythropoiesis - (erythroblastic islands)**
- **Granulopoiesis** occurs in less distinct foci
- **Megakaryopoiesis** occurs adjacent to the sinus endothelium .



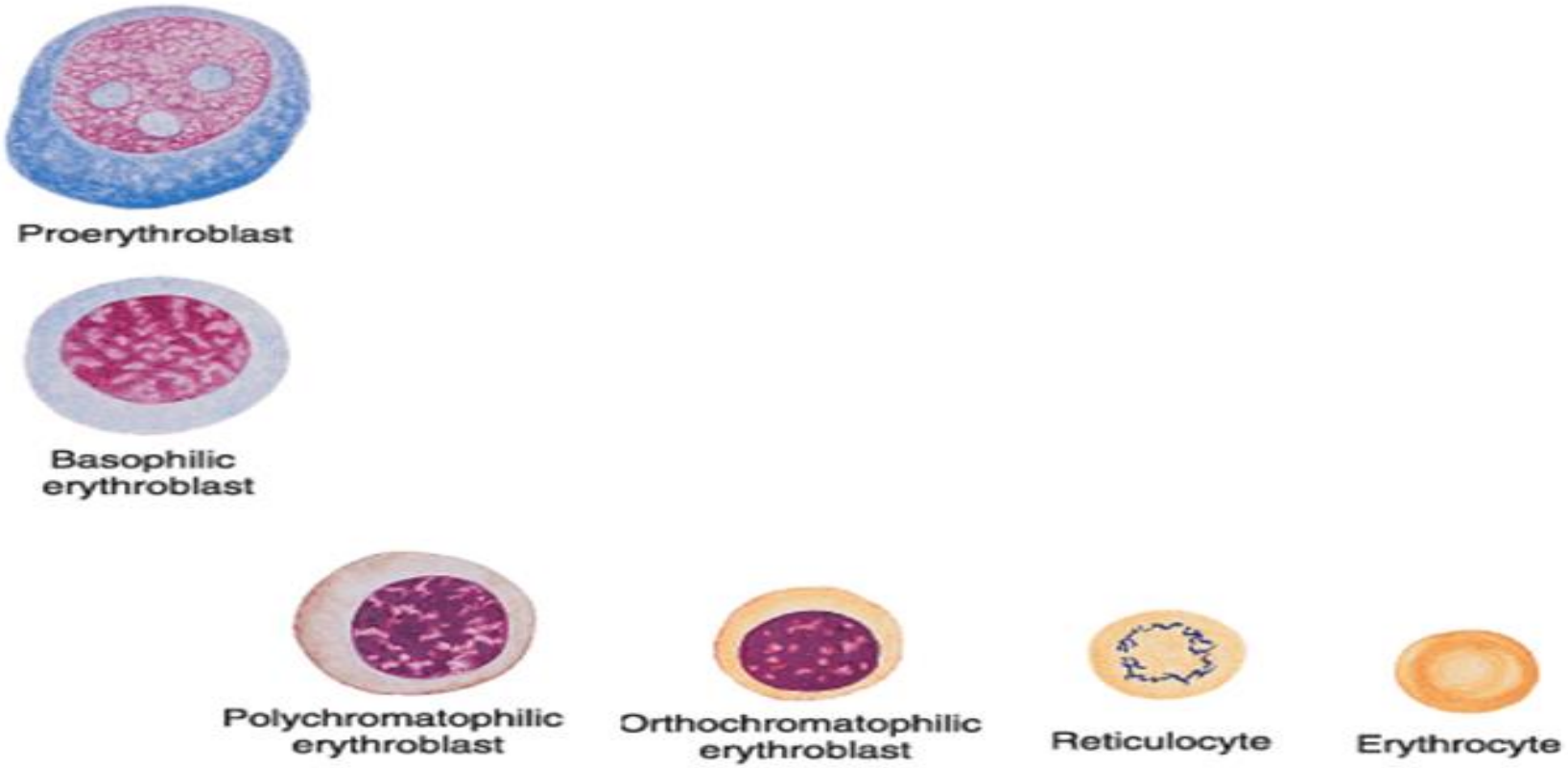
Upon maturation, the hematopoietic cells, regulated by the reticular cells, traverse the wall of the venous sinuses to enter the bloodstream

- **Leukocytes** cross the wall of the sinusoid by their **own activity.**
- **Erythrocytes** are believed to enter the sinusoid by a **pressure gradient that exists across its wall.**
- **Megakaryocytes** form thin processes (**proplatelet processes**) that cross the wall of the sinusoid and **fragment at their tips**, liberating the platelets.



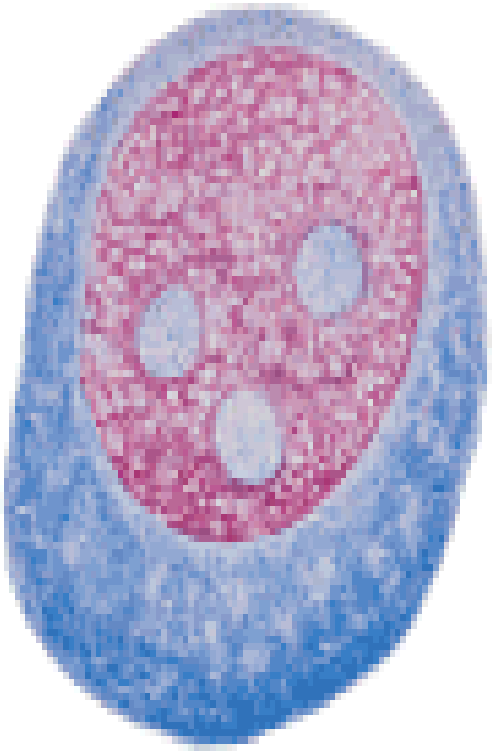
Maturation of erythrocytes

- Regulated mainly by **erythropoietin** released by the kidneys
- influenced by **androgens**



Maturation of erythrocytes

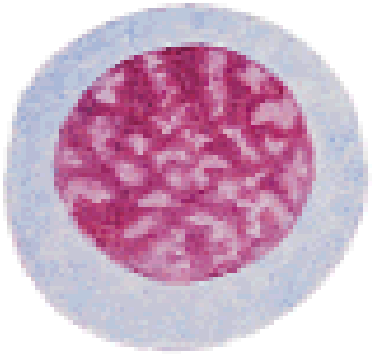
1. **pluripotential cell**
2. **Myeloid multipotential cell**
3. **Erythrocyte – colony forming cell**
4. **Proerythroblast (pronormoblasts)**



Proerythroblast

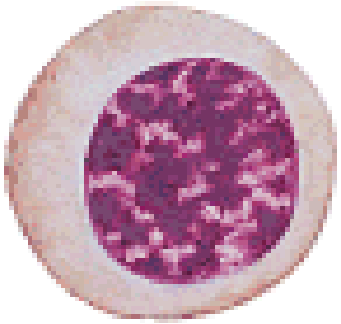
Maturation of erythrocytes

5. **Basophilic erythroblast (basophilic normoblasts)**
strongly basophilic cytoplasm because of free ribosomes and polyribosomes.



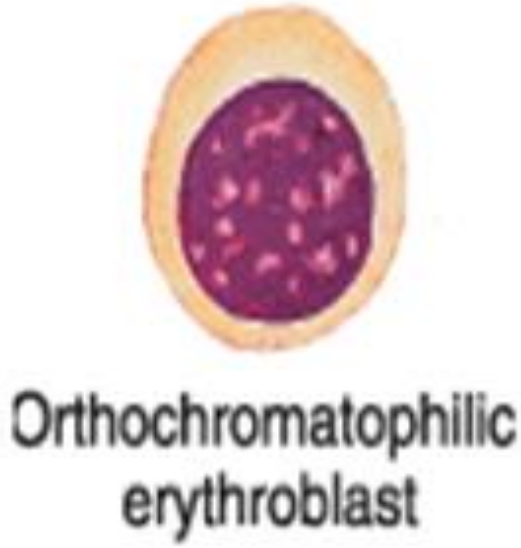
Basophilic erythroblast

6. **Polychromatophilic erythroblast (polychromatophilic normoblasts)**
mixed color cytoplasm purplish blue to grey



Polychromatophilic erythroblast

Maturation of erythrocytes



Orthochromatophilic erythroblast

7. **Orthochromatophilic erythroblast :**

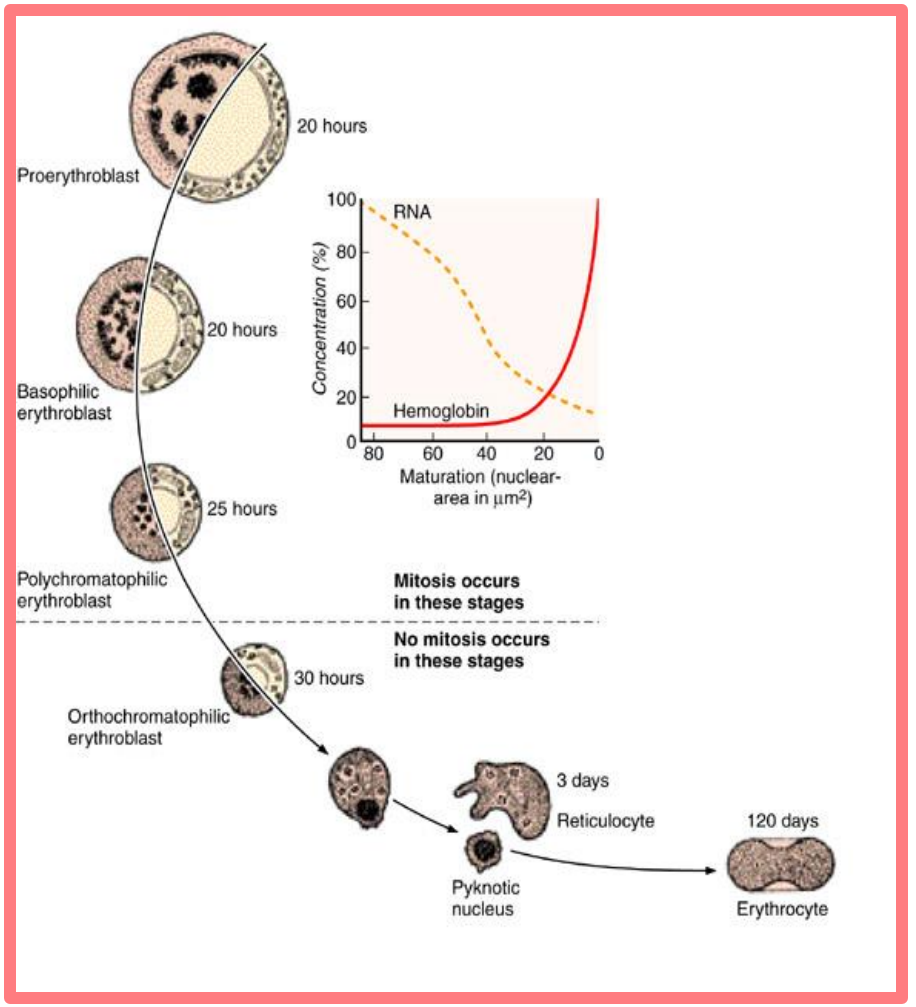
- the amount of haemoglobin is the same as that of erythrocyte
- Nucleus ---pyknotic ---- extruded from the cell

8. Reticulocyte: youngest erythrocyte containing a delicate reticulum

9. Erythrocyte : anucleated and biconcave in peripheral blood

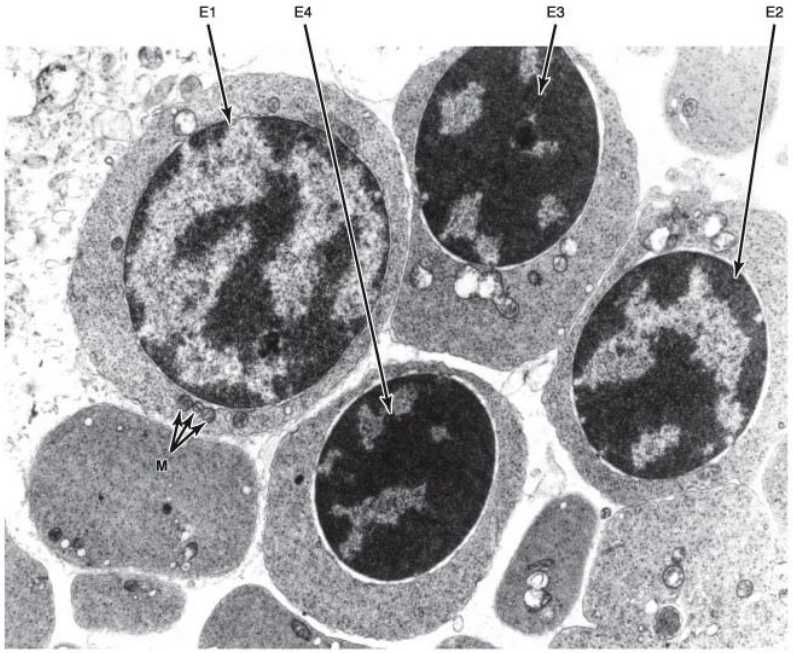
Several major changes take place during maturation of erythrocyte

1. **C**ell volume
2. **N**ucleoli
3. **N**uclear diameter and chromatin
4. **B**asophilia **&** acidophilic protein
5. **M**itochondria and other organelles



Electron micrograph of Red bone marrow

- **Four erythroblasts** in successive stages of maturation are seen (E1, E2, E3, and E4).
- As the cell matures, its chromatin becomes gradually condensed, the accumulation of hemoglobin increases the electron density of the cytoplasm, and the mitochondria (M) decrease in number.



Summary

- Hematopoiesis takes place in the extravascular compartment
- a single type of stem cells gives rise to all mature blood cells in the body.
- Pleuripotential stem cell form Lymphoid multipotential cells & Myeloid multipotential cells
- Sites of hematopoiesis varies with age
- Stem cells , progenitor cells, blast cells & mature cells are different types of cells present in the bone marrow
- Hematopoiesis depends on microenvironmental conditions & growth factors
- Several major changes take place during maturation of erythrocyte

Thank you