

Haemopoiesis

(Llec.1&2)

The objectives:

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- 1. To describe the organization of the bone marrow.**
- 2. Describe the structural and functional characteristics of a hematopoietic stem cell and the life cycle of each formed element of blood, from stem cell**

Haemopoiesis :

Blood cells have limited lifespans, and need to be replaced.

Young replacing cells come, by many divisions and steps of differentiation, from stem cells.

Sites of haemopoiesis

- Embryonic haemopoietic (prenatal hemopoiesis) (at 2nd week) stem cells-mesenchymal cells in yolk sac**
- At 6th week in liver (hepatic phase) .**
- 6-8 week :spleen becomes the main site (until 8th month)(splenic phase)**
- From 12-14week : bone marrow (myeloid phase) starts to become important and by the time of birth it is the main haemopoietic organ.**

Blood cells are made in the bone marrow.

Types of bone marrow:

Red bone marrow (in new born -20 yr.) large amount of blood and hemopoietic cell).

Yellow bone marrow (accumulate large number of adipose cells and absence of hemopoietic cells).

Red bone marrow composed of:

1-Stroma: is composed of 2 types of cells embedded in a network of reticular tissue:

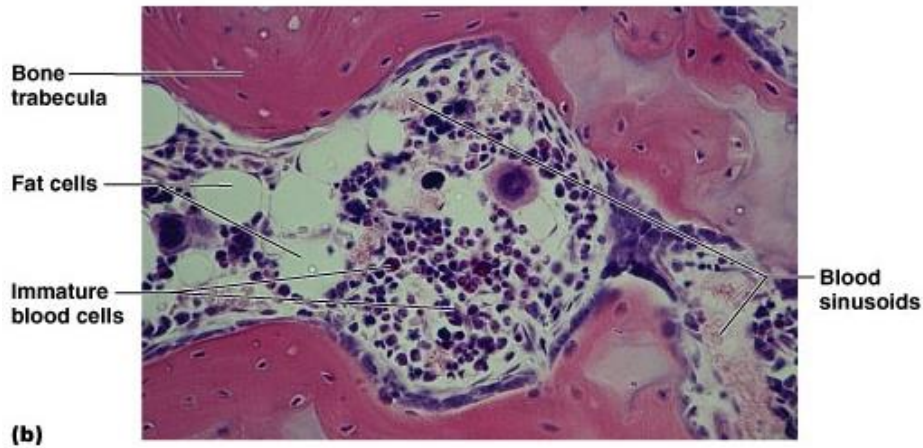
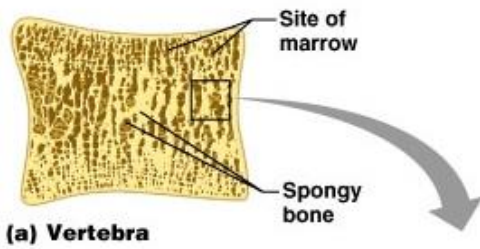
Adventitial reticular cells similar to fibroblast , secrete reticular fiber .

Macrophage: phagocyte cells .

2-Hemopoietic cords : consist of blood cells in different stages of development.

3-Sinusoidal capillaries:

- Are irregular have diameter about (45-80 um).
- Lined with thin layer of endothelial cells surrounded by reticular fiber and rest on incomplete basement membrane.
- Functions of bone marrow:
 - -Blood production : all blood cells arise from (stem) cells.
 - -Destruction of aged erythrocytes
 - -Storage of Iron
 - -Microenvironments produce specific cells Cytokines ,Growth factors
- Play a role in Immune system and phagocytosis



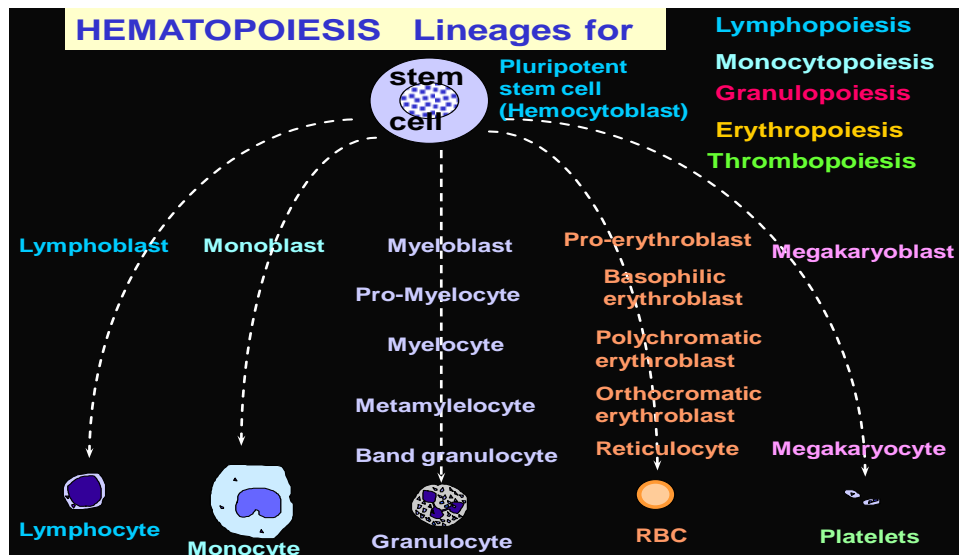
- Erythrocytes, Platelets ,granulocytes and monocytes are originated in **myeloid tissue (bone marrow)**.

Lymphocytes are developed in **lymphatic tissue** such as:

- Thymus
- Lymph nodes
- Spleen

- **Hemopoiesis Stem cells:**
- All blood cells arise from one type of stem cells, called (hemocytoblast) which is pluripotential stem cells .

This theory is called monophyletic theory



- **-Hemocytoblast:**

Cell diameter = (15-20 μm).

Cytoplasm is deep basophilic staining, there is a lot of ribosomes .

The nucleus is rounded or oval contain (2-5) nucleoli; dense accumulation of chromatin.

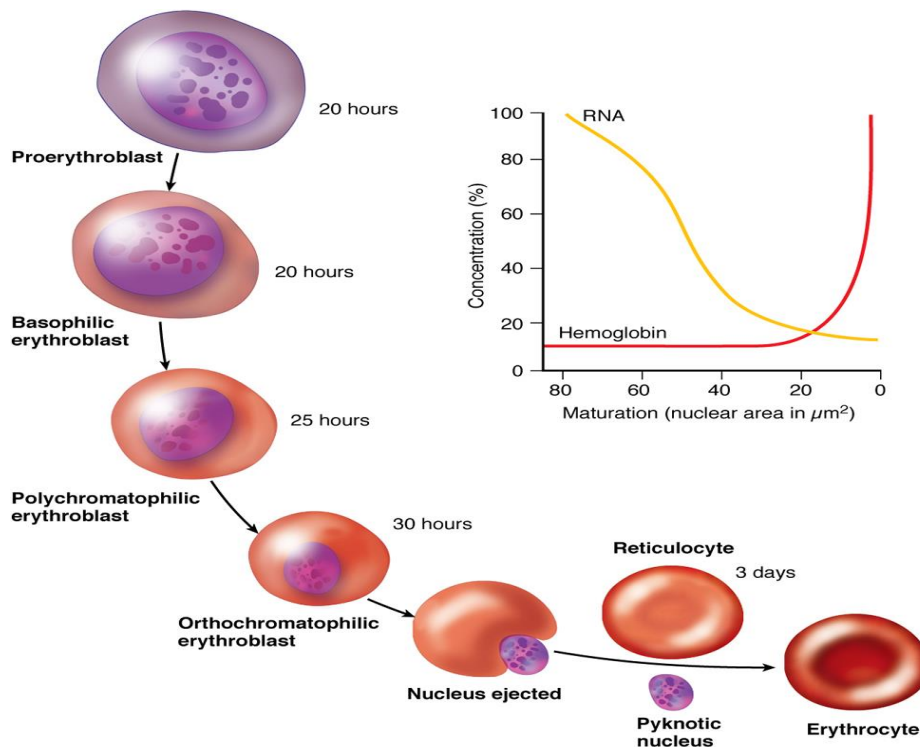
- **Erythropoiesis :**

- Lifespan of erythrocytes– 120 days
- Non nucleated ell.
- Biconcave disc .
- This process is regulated by Erythropoiten secreted from kidney.

Needs Fe, B12, folate & other elements for development

cell of erythropoiesis

Cell	Size (µm)	nucleus	nucleoli	Cytoplasm	E.m
Proerythroblast	14-19	Large (80% of cell volume) chromatin fine mitosis	3-5	Basophilic	Lots of ribosome, mitochondria
Basophilic erythroblast	12-17	Large, chromatin is coarse arranged as clock-face.	1-2	Basophilic	Some Hb is present
Polychromatophilic erythroblast	12-15	Condensed, densely staining, coarse chromatin regular arrangement as (checker-board)	Absent	Combination of basophilic and acidophilic	Reduction in number of organelles more Hb is present
Normoblast (orthochromatophilic erythroblast)	8-12	Round, small, dense chromatin, eccentric being extruded about (1/4 of cell)	Absent	Acidophilic	Few mitochondrial & polyribosome lots of Hemoglobin
Reticulocyte	7-8	None	Absent	Acidophilic	Filled with Hb, cluster of ribosomes
Mature R.B.C.	7.5	none	absent	pink	Only Hb



What are the Changes that occurred during Erythropoiesis ?

Thrombopoiesis

Hemocytoblast gives rise -Megakaryoblast which is:

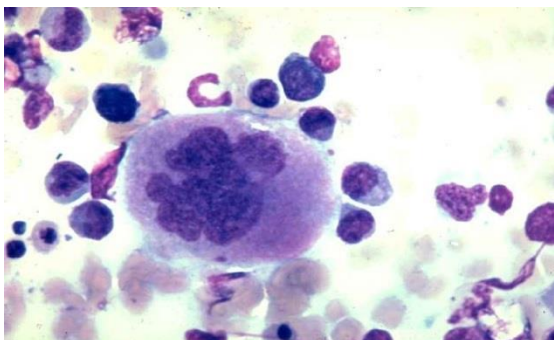
About (25-30) μm in diameter, has oval nucleus, homogenous, basophilic cytoplasm

by many mitosis division, the nucleus becomes multilobulated.

-Then megakaryocyte :

- Huge Large cell (30-100) μm in diameter . Multilobular nucleus.

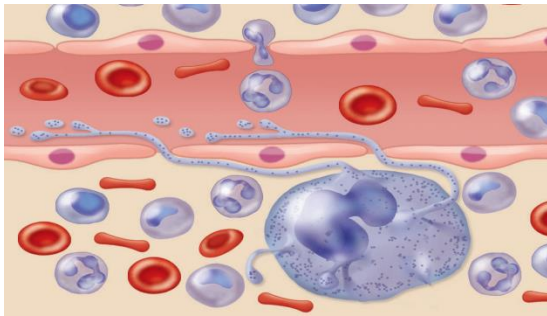
.The cytoplasm of this cell , is slightly acidophilic has fine granules, free ribosomes, smooth and R.E.R.



From the surface of megakaryocytes extend many long, branching processes called proplatelets ,which can penetrate the sinusoidal endothelium to lie within the circulating blood.

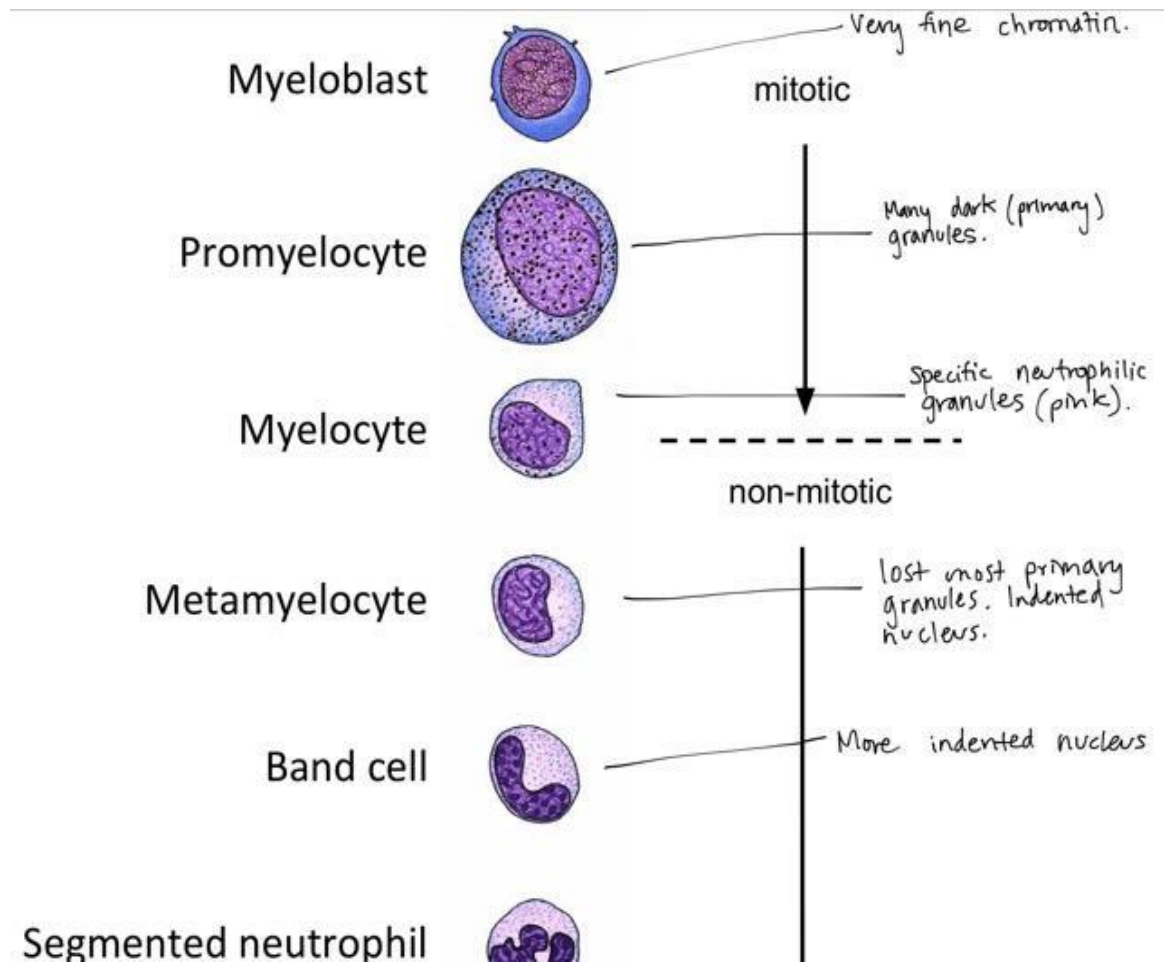
Cytoskeletal elements form a loop at the distal tip of the proplatelets and be platelet .

So platelets are formed from invaginations of the cytoplasm of this cell ,that separated as Proplatelets then be platelets.



Granulopoiesis : Cell of granulopoiesis

Cell	Size (μ m)	Nucleus	Nucleoli	Cytoplasm	Granules	E.m.
Myeloblast	12-14	Round, blue, fine chromatin, mitosis	2-3	Basophilic	None	R.E.R; Golgi; mitochondria; ribosome
Promyelocyte	Same size or larger than above	Round to oval; reddish-blue coarse chromatin, mitosis'	1-2	Basophilic bluish cytoplasm	Azurophilic granules	R.E.R; Golgi; mitochondria; ribosome
Myelocyte	10-12	Kidney-shaped; coarse chromatin, mitosis	0-1	Pale –blue cytoplasm	Azurophilic & specific granules	Same as above
Metamyelocyte	10-12	Kidney shaped as horse – shoe; dense coarse chromatin; no mitosis	None	Pale-blue	As above	Organelles are reduce in number
Band form	9-12	Curved rode; very coarse chromatin, no mitosis	None	Pale – blue	As above	As above
Mature granular W.B.C.	9-12	Lobed, coarse chromatin	None	Pale bluish-pink	As above	As above



Monopoiesis:

Monoblast: similar to myeloblast

Promonocyte: Diameter about (16-18) μm

Nucleus is oval or kidney shaped eccentrically located.

Cytoplasm = basophilic, no specific granules, large amount of R.E.R. Golgi complex;

numerous mitochondria.

Monocyte : mature cells

Lymphopoiesis :

Lymphoblast : Large rounded cell , Cytoplasm is basophilic, without granules granules,

Nucleus is rounded, dense chromatin ,(2-3) nucleoli

The cell is divided (2-3) times to produce

Prolymphocyte : Smaller than lymphoblast, has basophilic Cytoplasm .

Nucleoli can't be seen, chromatin is condensed .

Lymphocytes: the mature are 2 types :

T- lymphocytes and B- lymphocytes .

About 20% of the leukocytes in circulation are lymphocytes.

They are functional unit of immune system.

They can recognize foreign antigen , can distinguish self from non-self by their surface antigen receptors through two types of Immunity ,which is a term used to describe the protective response and defense mechanism against foreign bodies.1-cellular Immunity 2- humeral – Immunity.

T-lymphocytes:

About 75% of circulating lymphocytes(6-15 mm) in diameter .Thymus-derived lymphocyte. Their stem cells originate in bone marrow as Immature and undifferentiated, they complete their maturation in thymus, proliferate and recognize as T- lymphocytes(thymus- depended lymphocytes).They are carried through blood stream to the spleen lymph node and responsible for cellular Immunity .

B- lymphocytes :are Originated and completed their maturation in bone marrow, then reach (lymph node, spleen) through blood circulation. They are responsible for humeral – Immunity through which it stimulated and produce plasma cells that secret antibodies (Immunoglobulin) (A,G,D,E,M) into body fluid.

Note: see the related figures in your text book.