Hematopoiesis

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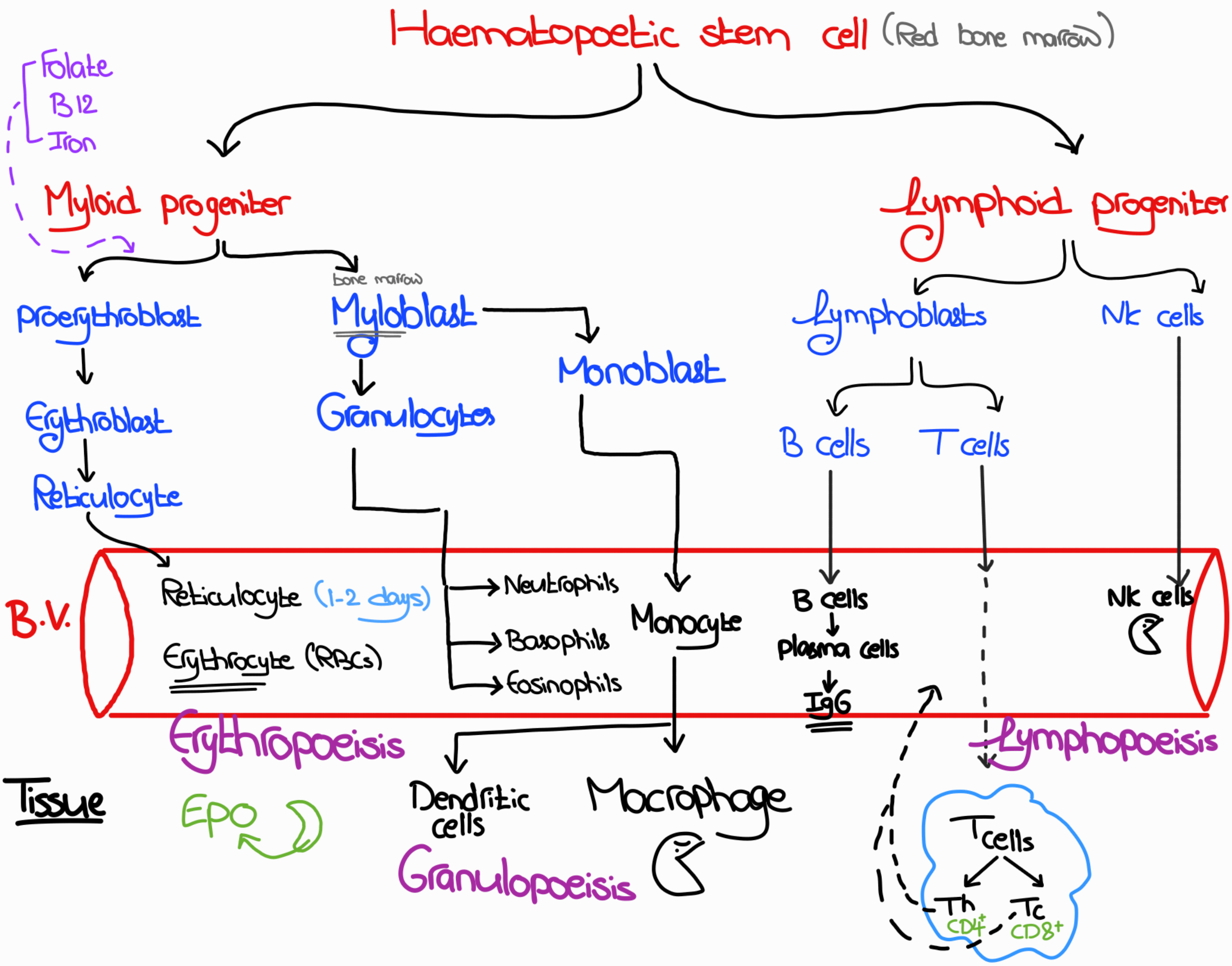
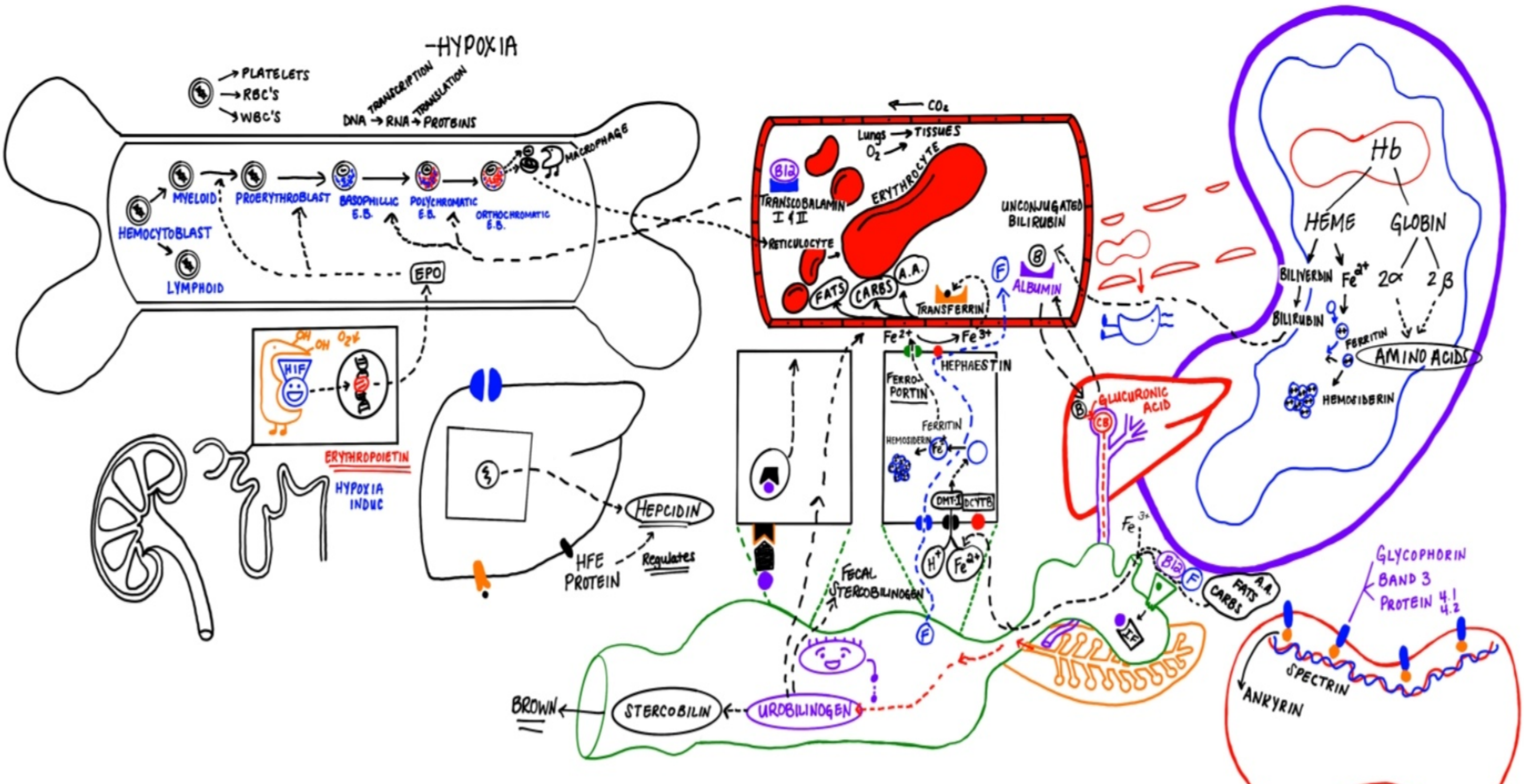

Haematopoetic stem cell (Red bone marrow)
Folate
B12
Iron
Myloid progeniter
Lymphoid progeniter
Proerythroblast
bone marrow
Myloblast
Monoblast
Lymphoblasts
NK cells
Erythroblast
Granulocytes
B cells
T cells
Reticulocyte
B.V.
Reticulocyte (1-2 days)
Erythrocyte (RBCs)
Neutrophils
Basophils
Eosinophils
Monocyte
B cells
plasma cells
IgG
NK cells
Erythropoeisis
Lymphopoeisis
Tissue
EPO
Dendritic cells
Macrophage
Granulopoeisis
T cells
Th
CD4+
Tc
CD8+

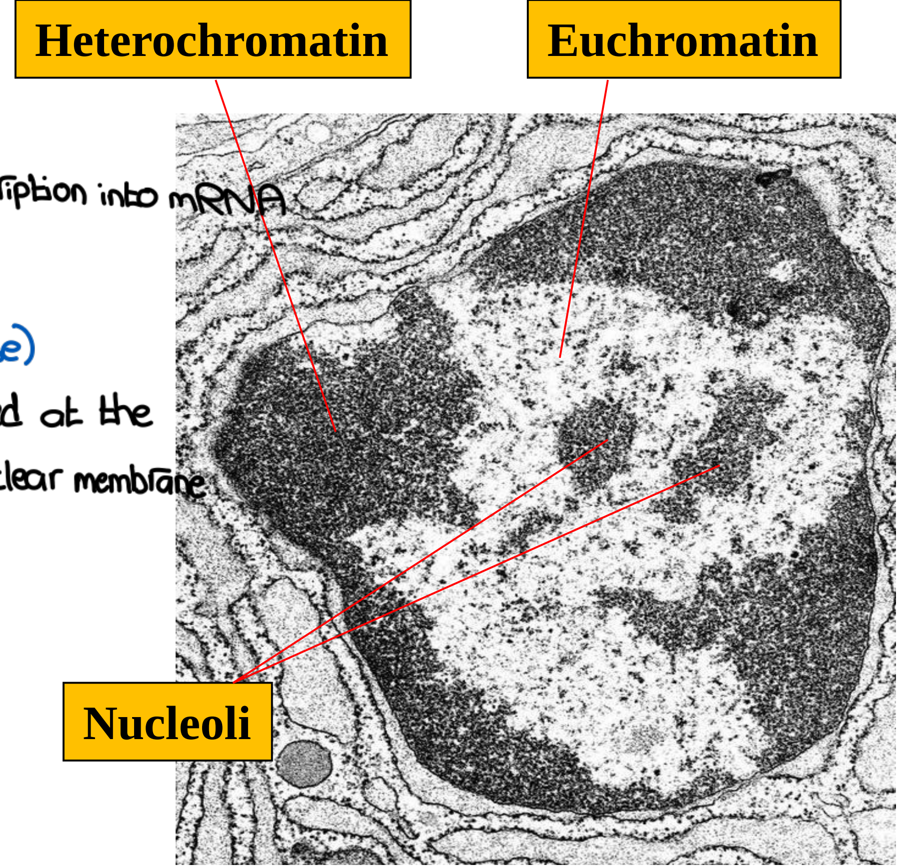

HYPOXIA
PLATELETS
RBC'S
WBC'S
DNA → RNA → PROTEINS
TRANSCRIPTION
TRANSLATION
MACROPHAGE
MYELOID
PROERYTHROBLAST
BASOPHILLIC E.B.
POLYCHROMATIC E.B.
ORTHOCHROMATIC E.B.
HEMOCYTOBLAST
LYMPHOID
EPO
HIF
ERYTHROPOIETIN
HYPOXIA INDUC
HEPCIDIN
HFE PROTEIN
Regulates
CO2
Lungs → TISSUES
O2
ERYTHROCYTE
B12
TRANSCOBALAMIN I & II
RETICULOCYTE
UNCONJUGATED BILIRUBIN
ALBUMIN
FATS
CARBS
A.A.
TRANSFERRIN
Fe2+
Fe3+
HEPHAESTIN
FERROPORTIN
FERRITIN
HEMOSIDERIN
DMT-1
DCYTB
FECAL STERCOBILINOGEN
GLUCURONIC ACID
Hb
HEME
GLOBIN
BILIVERDIN
BILIRUBIN
AMINO ACIDS
HEMOSIDERIN
BROWN
STERCOBILIN
UROBILINOGEN
GLYCOPHORIN
BAND 3
PROTEIN 4.1 4.2
SPECTRIN
ANKYRIN

Ninja Nerd

Chromatin

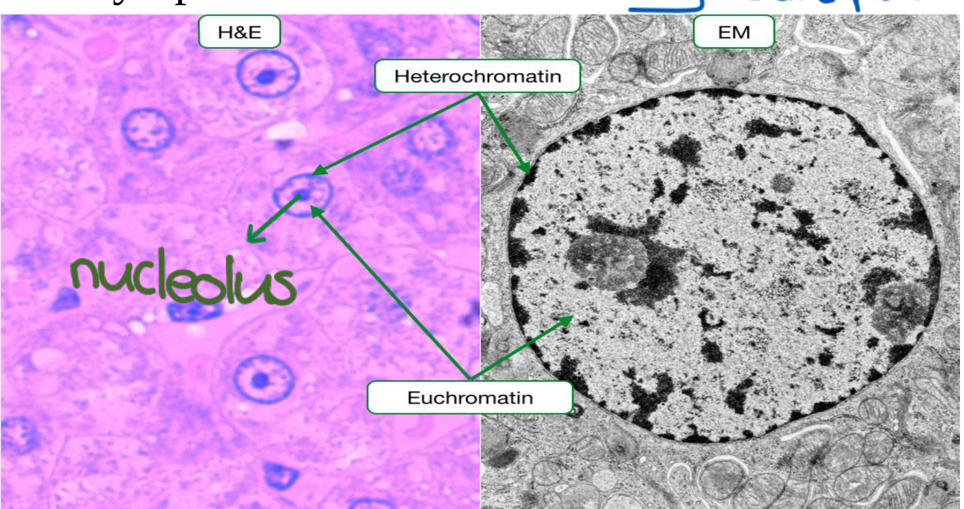
Formed of **DNA**.

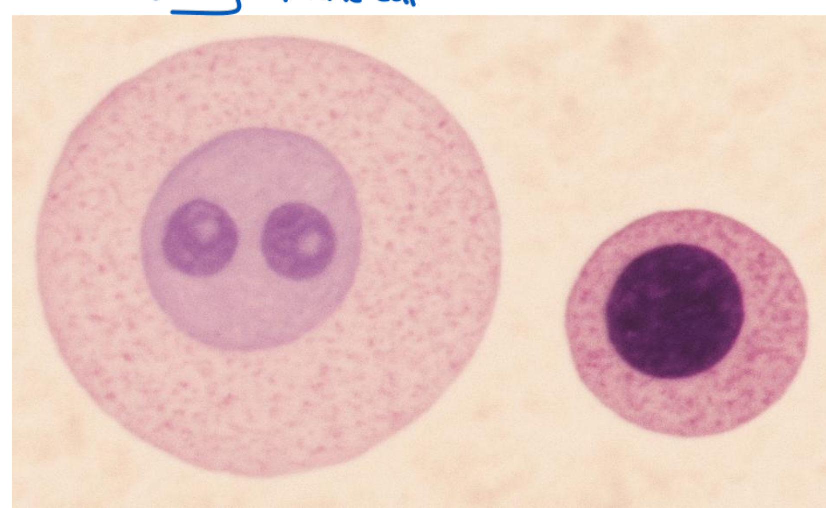
- **2 Forms:**
  - **Euchromatin**: extended active chromatin (pale). (ē leucent)
    → allows transcription into mRNA
  - **Heterochromatin:** condensed (e⁻ dense) inactive chromatin (dark) usually clumped at the inner aspect of nuclear membrane



Nucleolus

- It is a spherical dark basophilic mass not surrounded by a membrane.
- Usually one.
- **Function:** formation and assembly of ribosomal RNA (rRNA), which is responsible for protein synthesis in the cytoplasm *prominant nucleolus usually indicate protein synthetic activity of the cell





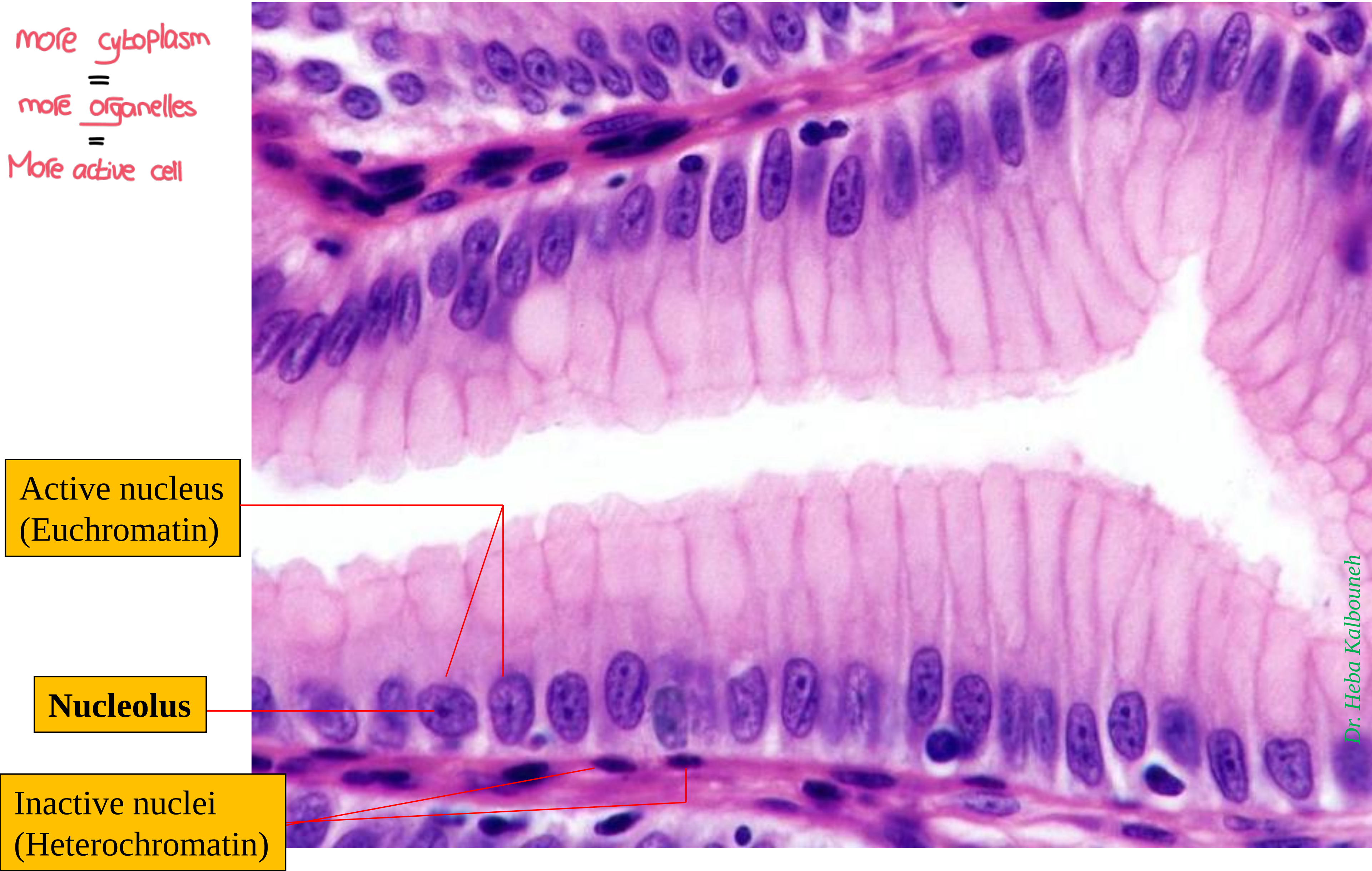
Note:

The nucleus stains **blue (basophilic)** using H&E

Lightly basophilic: active

Deeply basophilic and small: inactive

more cytoplasm
=
more organelles
=
More active cell

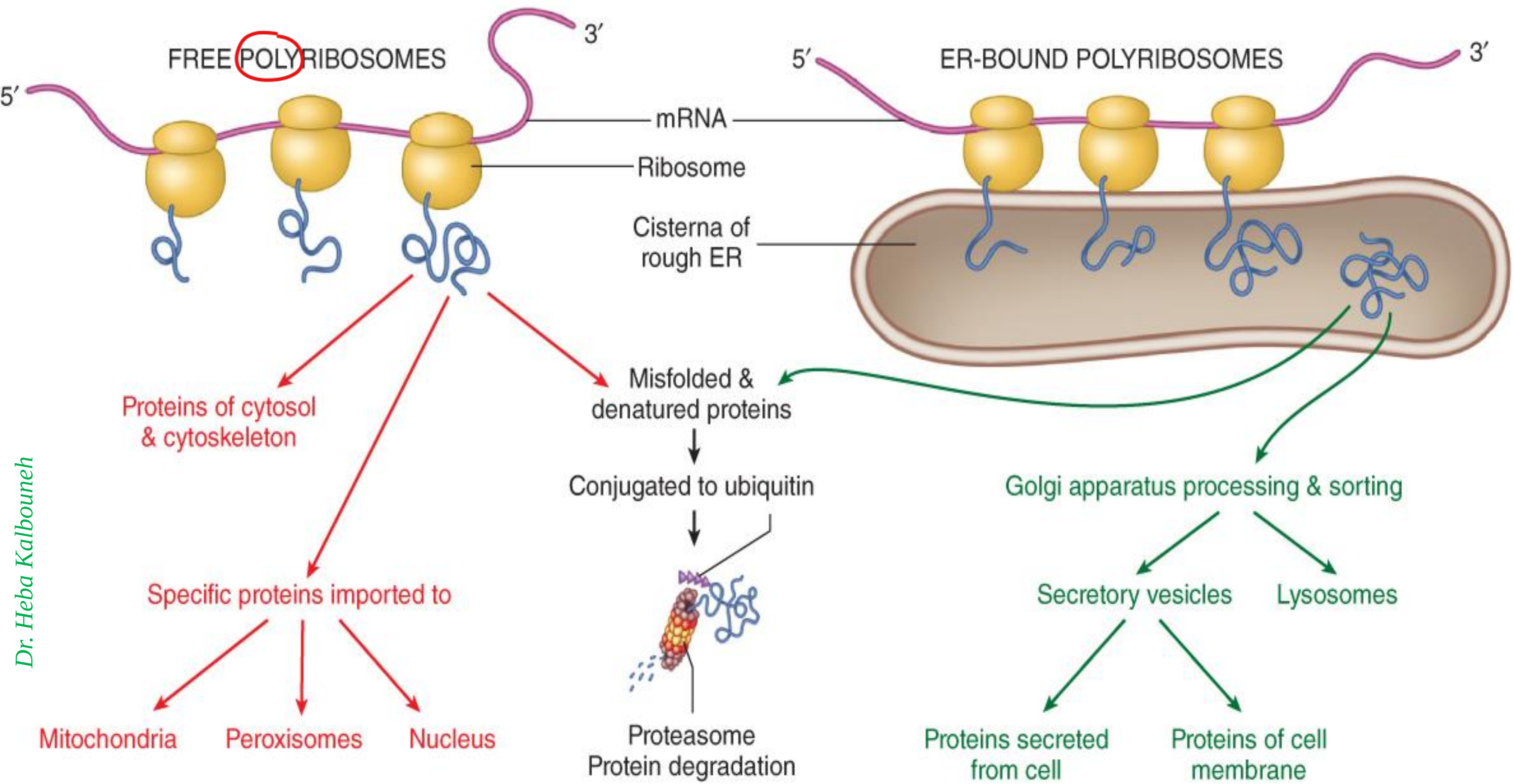


Note:

The cytoplasm stains **pink/red (acidophilic)** using H&E

The organelle (when prominent) that produces basophilia in the cytoplasm is the ribosome

Free ribosomes synthesize proteins to be used locally inside the cell. While Bound ribosomes synthesize Proteins for export.

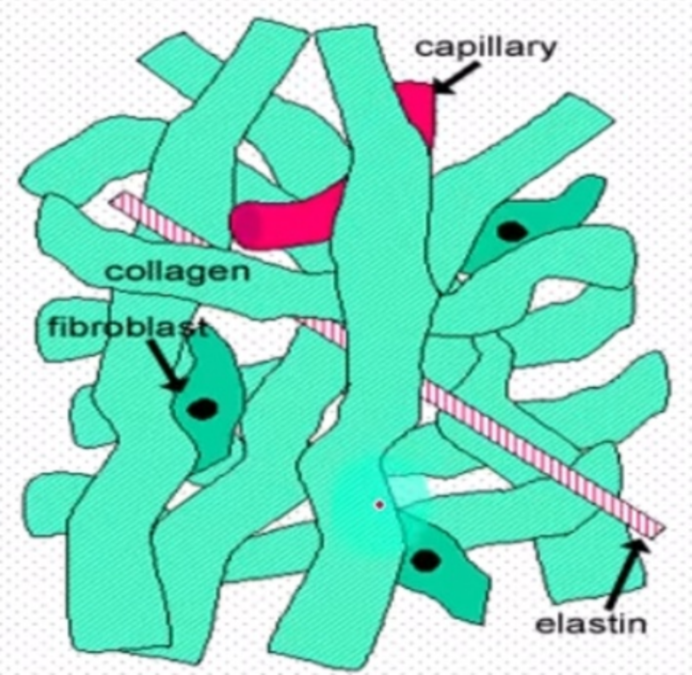


Dense irregular connective tissue

✓ Bundles of collagen fibers are randomly interwoven with no definite orientation

✓ Provides resistance to stress from all directions

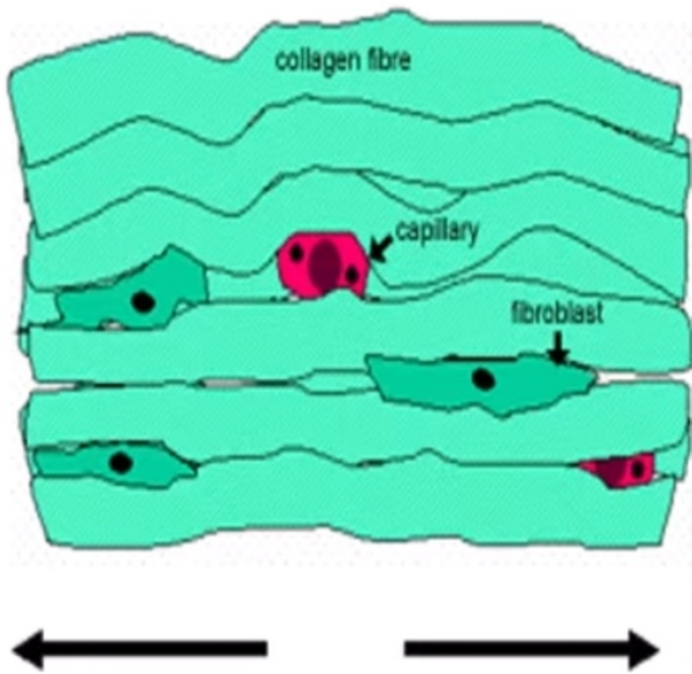
✓ Dermis of skin (deeper layer), **organ capsules**, submucosa



Loose type of CT has cells, fibers & ground substances in almost same proportion, while the dense type is mainly composed of type I collagen.

Dense regular connective tissue

✓Parallel Bundles of collagen fibers with few fibrocytes aligned with collagen and separated by very little ground substance



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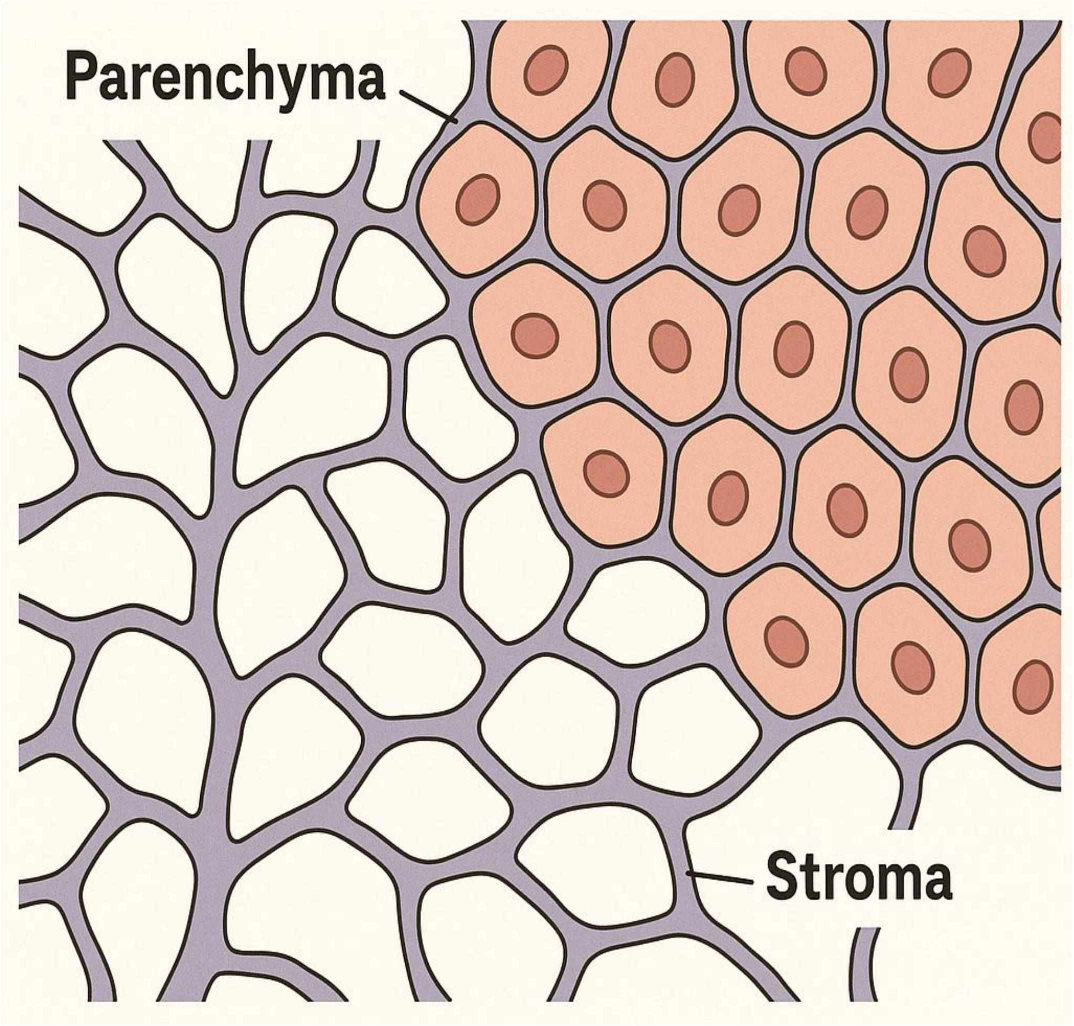
Stroma means bed

صلّ على محمد

Parenchyma / Stroma:

The **parenchyma** of an organ consists of that tissue which conducts the specific function of the organ and which usually comprises the bulk of the organ. **Stroma** is everything else -- connective tissue, blood vessels, nerves, ducts. It is made up of all the parts without specific functions of the organ

For Example:
The *parenchyma* of the heart is **muscle tissue** (cardiac muscle cells). The nerves, intrinsic blood vessels, and connective tissue of the heart comprise the *stroma*.

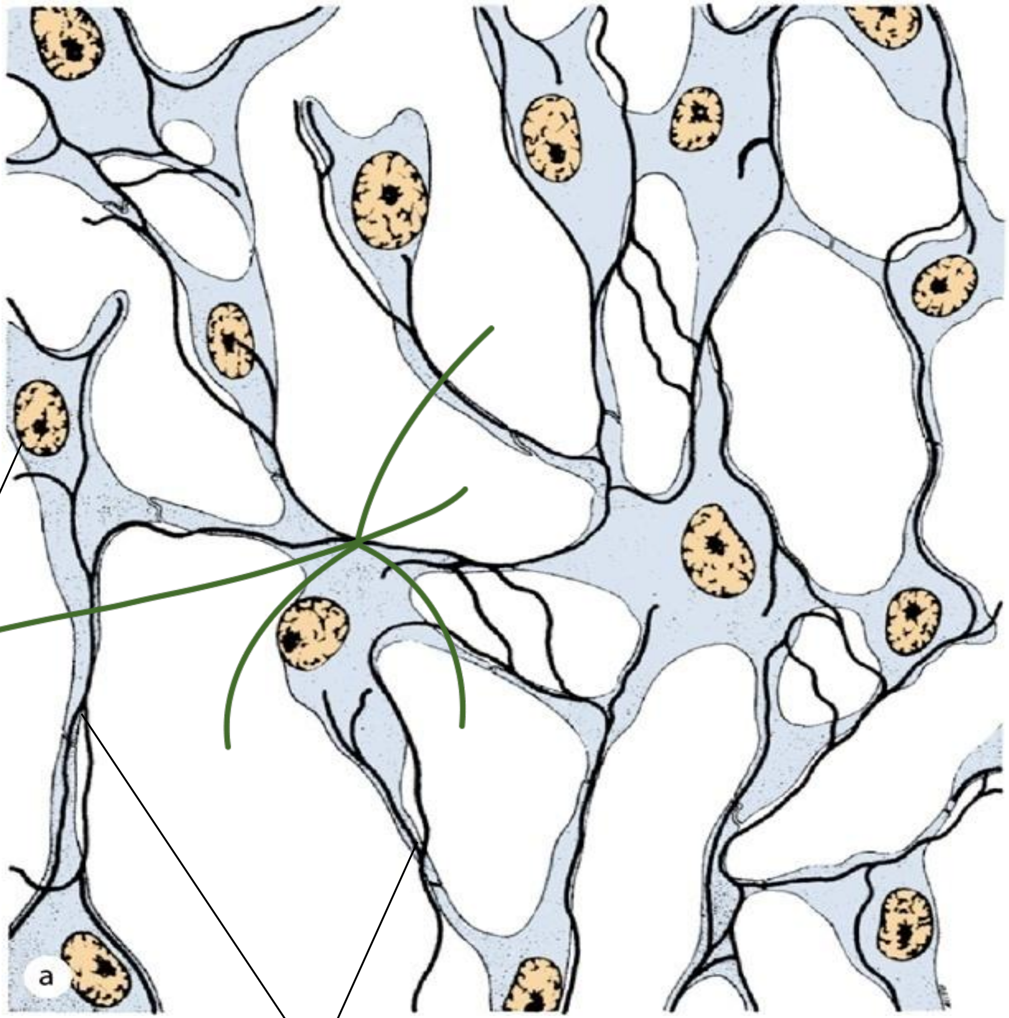


Remember Reticular fibers are type III collagen fibers.

Reticular connective tissue

- Consists of reticular cells (modified fibroblasts) and the network of reticular fibers formed by them
- Forms the structural framework (stroma) in which the cells of the organ are suspended
- In the **liver, bone marrow, lymph nodes and spleen** **(Reticulo-Endothelial organs)**

large spaces to Permit movement of large substances



Types of capillaries

: The smallest capillaries were fluid exchange takes place
A single layer of endothelial cells supplied by basement membrane

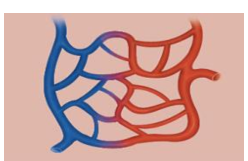
Continuous capillaries
- Are most common
- Endothelium forms solid lining
- Adjacent cells are held together with tight junctions
- Found in most organs

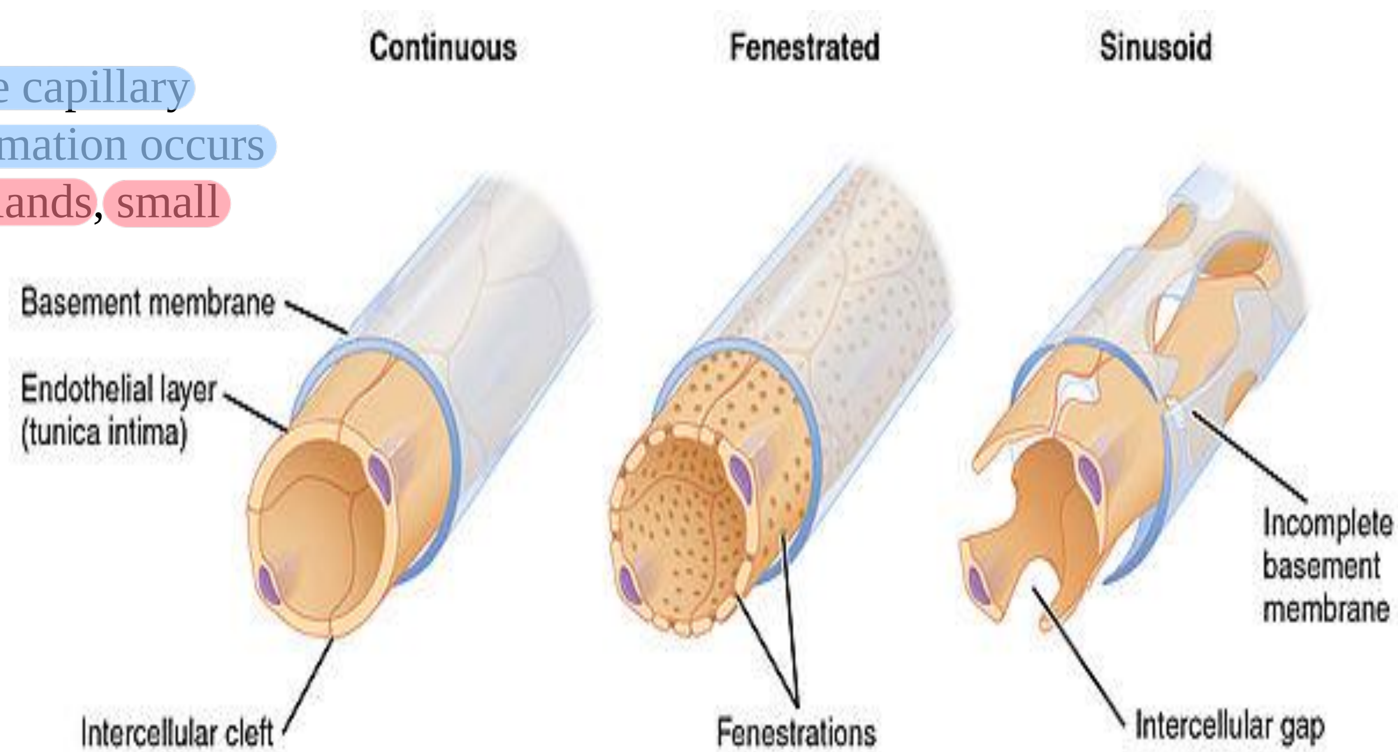
Fenestrated capillaries
- Endothelium contains pores (fenestrations)
- Found wherever active capillary absorption or filtrate formation occurs
- Found in endocrine glands, small intestine, and kidney

Sinusoidal capillaries

(No smooth muscles inside)

- Exhibit wide diameters with wide gaps between endothelial cells
- Basement membrane incomplete or absent
- Allow large molecules (proteins and blood cells) to pass between the blood and surrounding tissues
- Found in liver, spleen, and bone marrow





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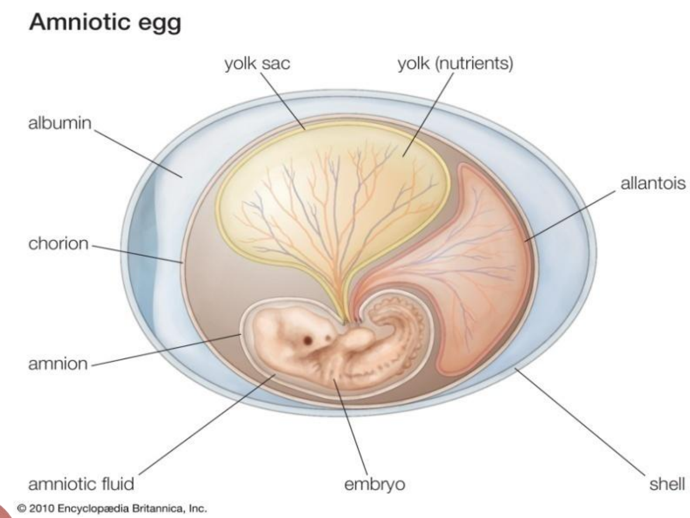
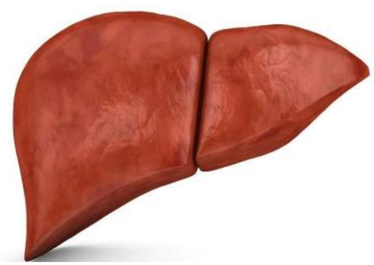
Blood Cell Formation (Hematopoiesis)

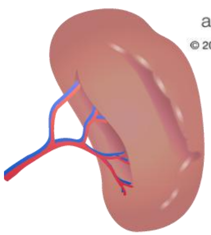
Mature blood cells have a relatively short life span and must be continuously replaced with new cells from precursors developing during hemopoiesis/ hematopoiesis (Gr. haima, blood + poiesis, a making).



Early embryo
Yolk sac mesoderm

Second trimester
Developing liver and spleen





Third trimester
Bone marrow

After birth, all blood cells originate in bone marrow
Medullary hematopoiesis

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Bone marrow

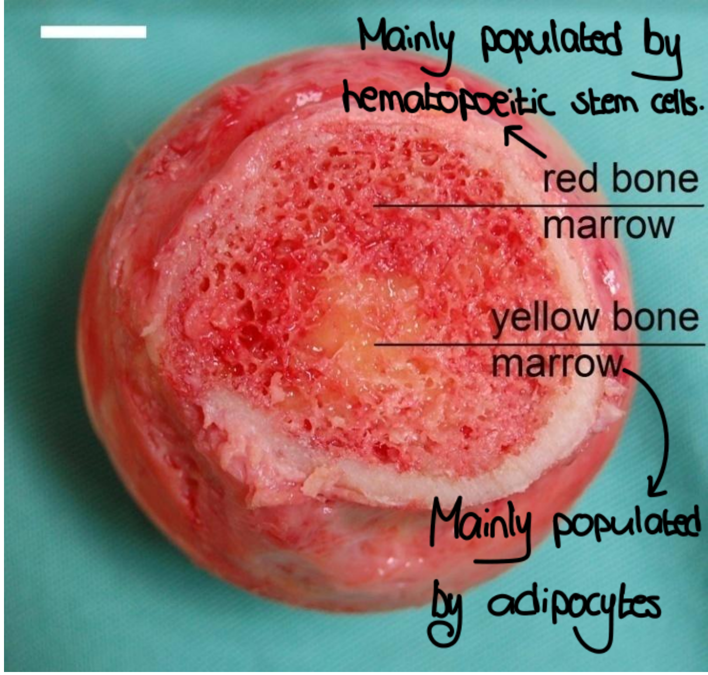
The red bone marrow is a highly cellular structure that is located in the medullary cavities of the bone

It consists of:

1 Hemopoietic stem cells (the origin of different blood cells) surrounded by 2 numerous macrophages and 3 sinusoidal capillaries and supported by 4 a reticular tissue.

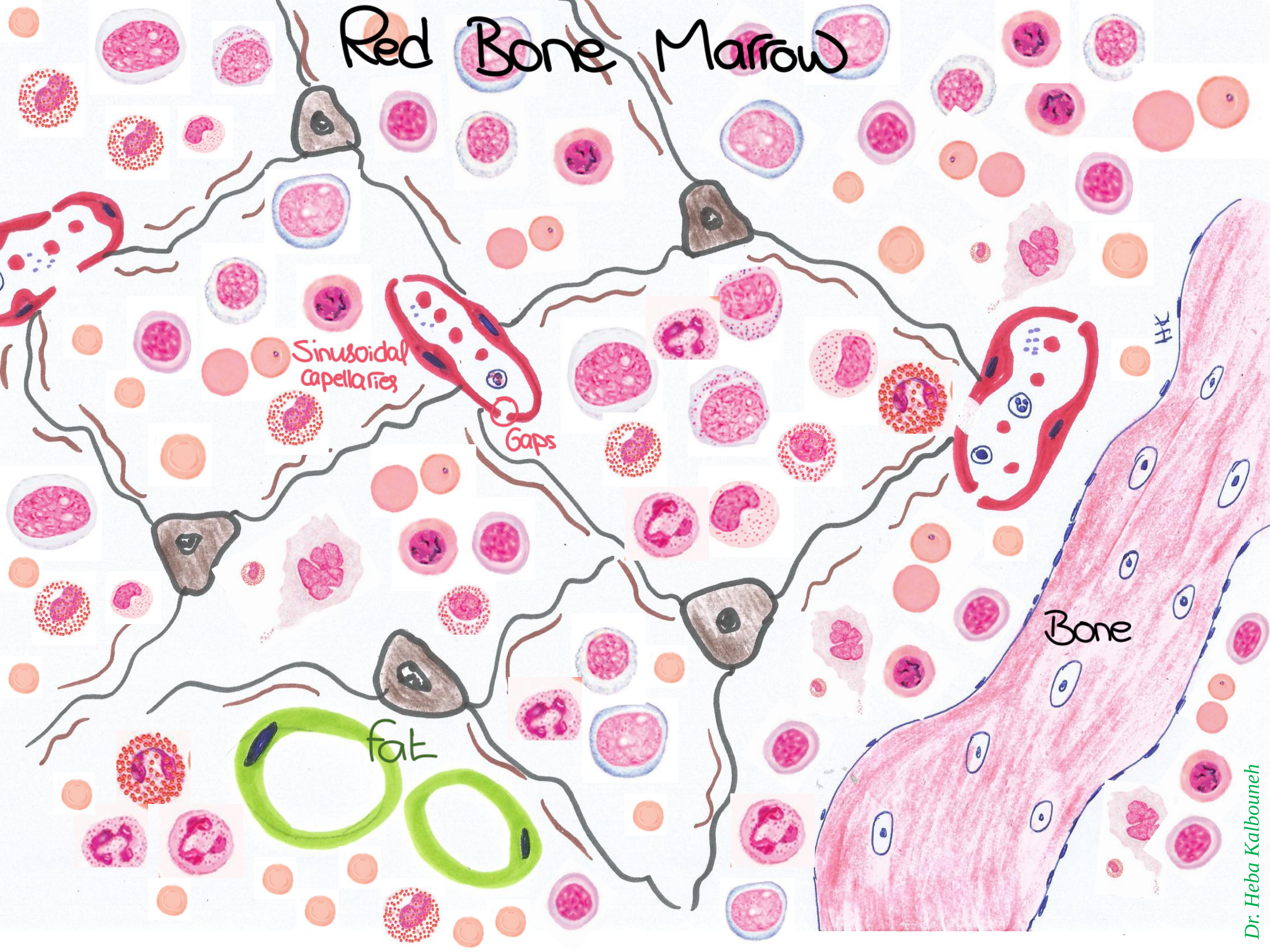
As the individual ages and becomes an adult, the red marrow is found primarily in the axial skeleton (flat bones of the skull, sternum and ribs, vertebrae, and pelvic bones). The remaining bones, primarily the long bones in the limbs of the body, gradually accumulate fat, and their marrow becomes yellow. Consequently, they lose the hemopoietic functions.

Can the yellow bone marrow be reconverted into red one ?
Yes it can, e.g. severe bleeding



Extramedullary hematopoiesis refers to the hematopoiesis that occurs in organs other than bone marrow.
(fetal development, normal immune responses, and pathological circumstances)

Under certain conditions (severe bleeding or hypoxia), yellow marrow reverts to red


Red Bone Marrow
Sinusoidal capellaries
Gaps
Bone
fat
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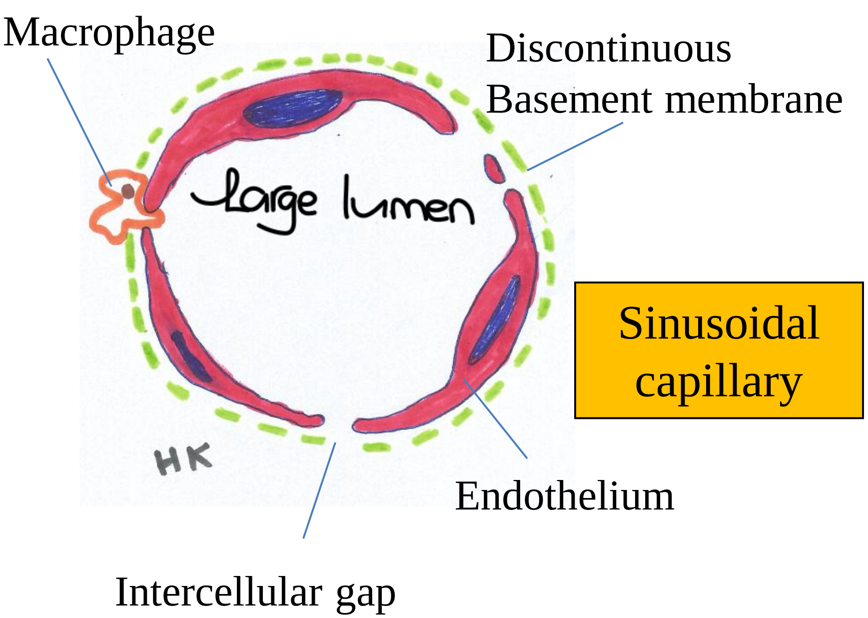
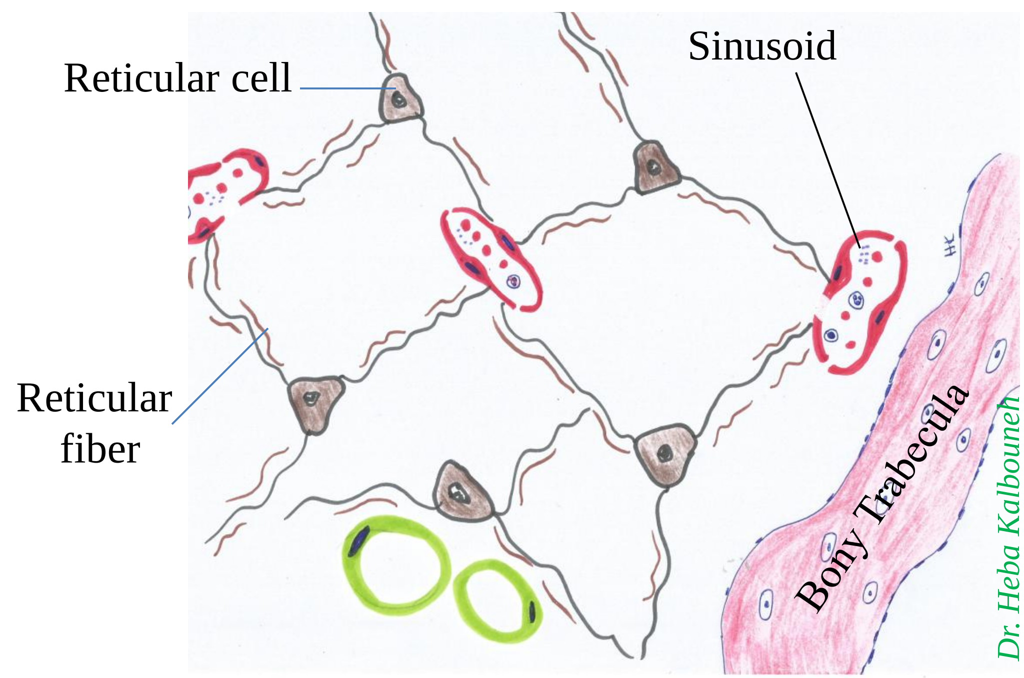
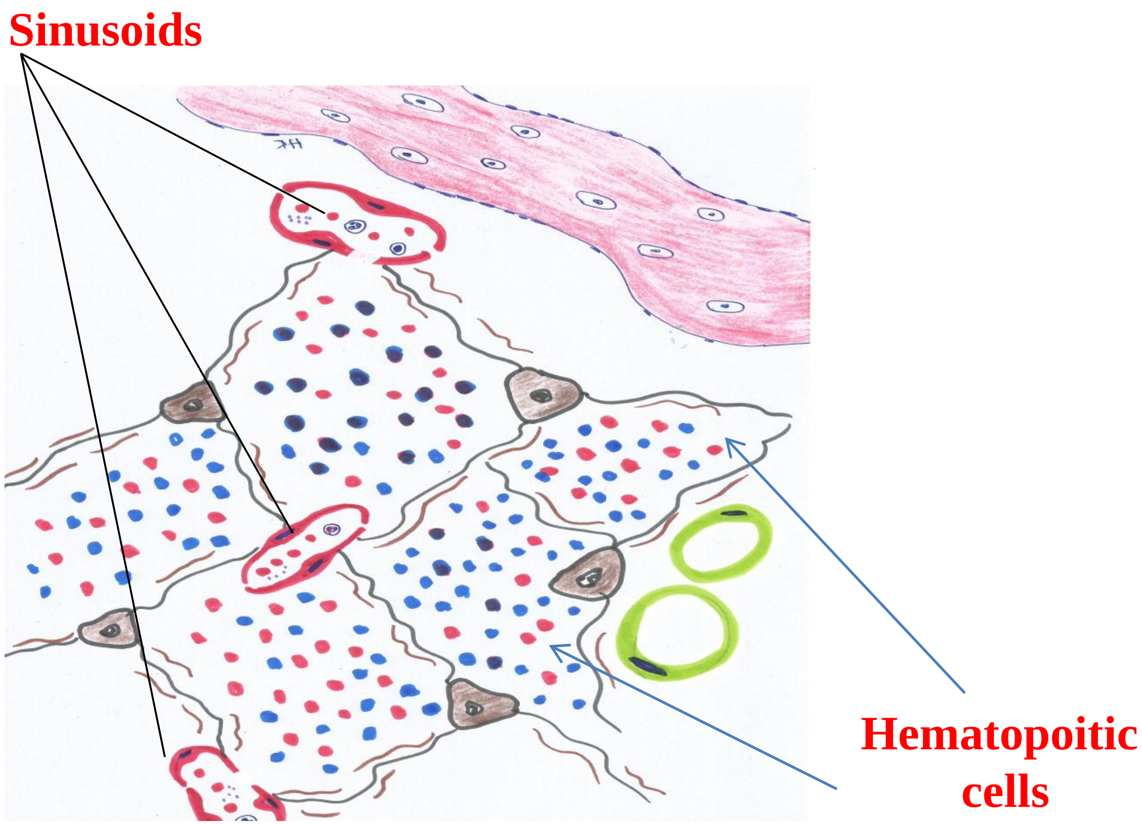
* All capillaries are surrounded by loose CT
* Hb is a basic protein.



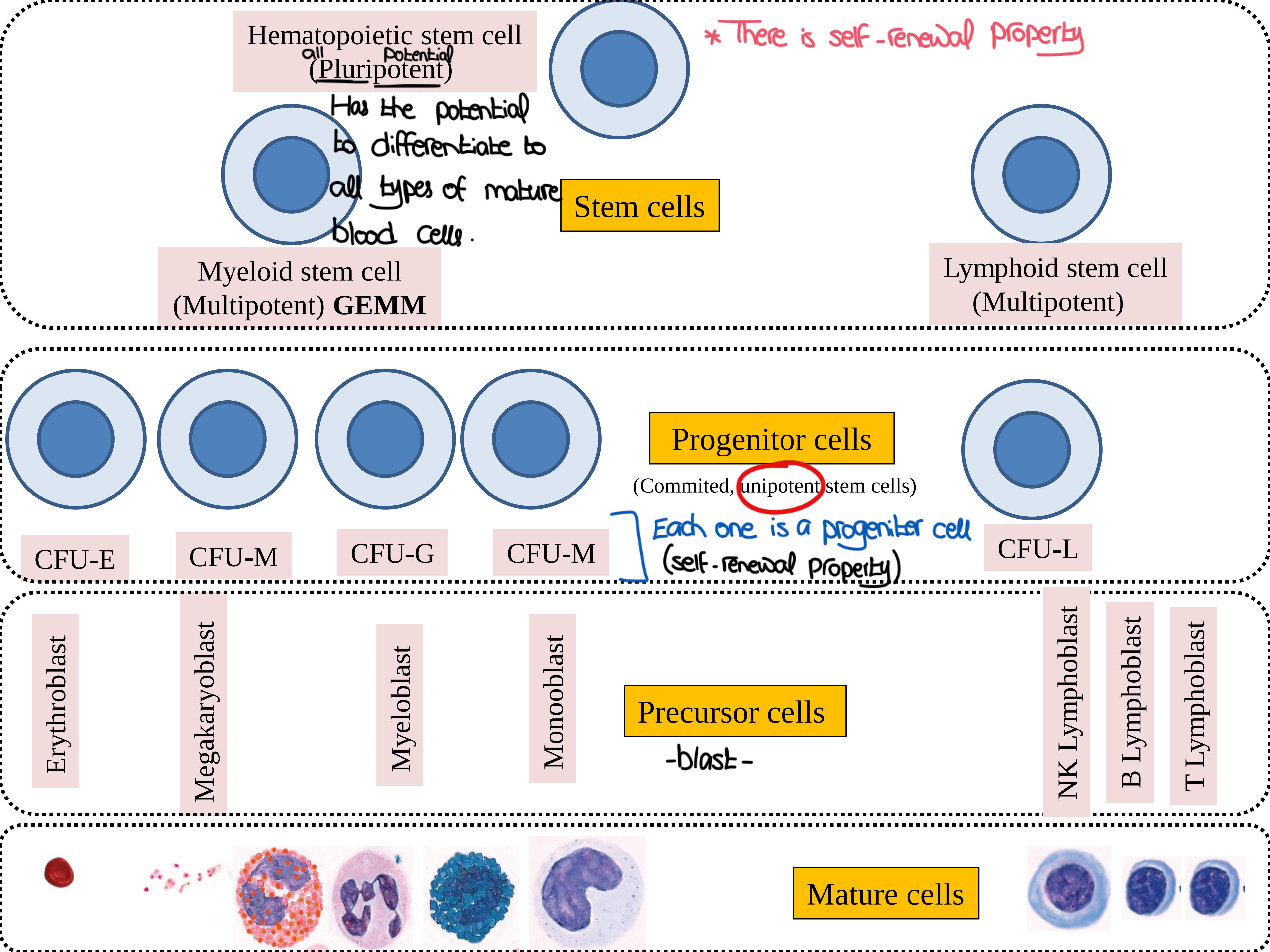
Reticular tissue forming the stroma of the bone marrow



Between the hematopoitetic cells run the **sinusoids,** which have discontinuous endothelium, through which newly differentiated blood cells and platelets enter the circulation



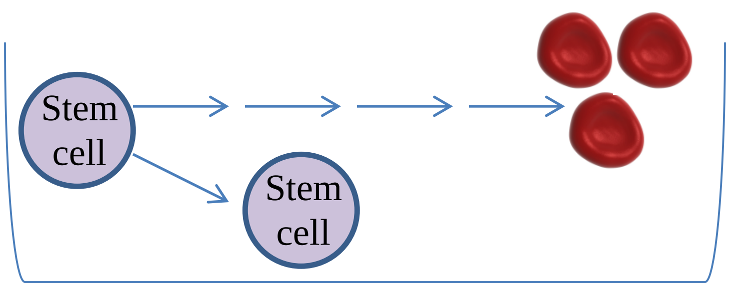
Red marrow is also a site where older, defective erythrocytes undergo phagocytosis by macrophages, which then reprocess heme-bound iron for delivery to the differentiating erythrocytes.


Hematopoietic stem cell
all Potential
(Pluripotent)
* There is self-renewal property
Has the potential to differentiate to all types of mature blood cells.
Stem cells
Myeloid stem cell
(Multipotent) **GEMM**
Lymphoid stem cell
(Multipotent)
Progenitor cells
(Commited, unipotent stem cells)
Each one is a progenitor cell (self-renewal property)
CFU-E
CFU-M
CFU-G
CFU-M
CFU-L
Erythroblast
Megakaryoblast
Myeloblast
Monooblast
Precursor cells
-blast-
NK Lymphoblast
B Lymphoblast
T Lymphoblast
Mature cells

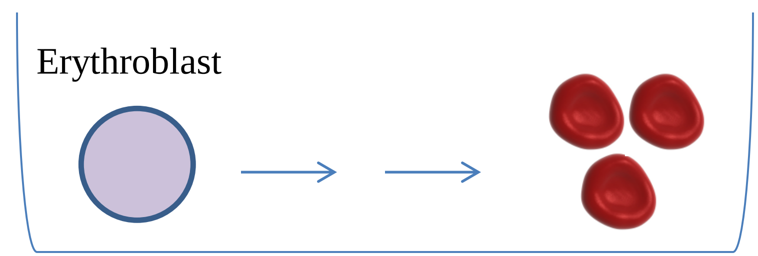
Stem cells are capable of asymmetric division and self-renewal.

Stem cells can maintain the original population

Precursor cells produce only mature blood cells



Erythroblasts are precursor cells



Every time the stem cell multiplies, it will give two cells, one differentiate into mature RBCs and the other cell add to the original population

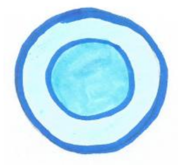
All Erythroblasts multiply and differentiate into mature RBCs (erythrocytes) and **no** erythroblasts are left in the end

Hematopoietic pluripotent stem cells

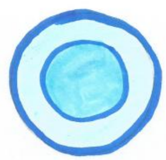
Note:

Stem cells and progenitor cells cannot be morphologically distinguished and resemble **large lymphocytes**

Myeloid stem cells

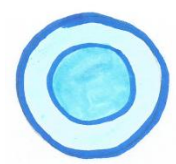


Lymphoid stem cells



Rate of cell division:
Slow in **Stem cells**
Rapid in **progenitor and precursor cells**

Progenitor cells/ CFUs



All progenitor cells (CFUs) produce precursor cells (or blasts)

Precursor cells/ Blasts

Selected precursors of different blood cells

Precursor cells gradually assume the morphologic characteristics of the mature, functional cell types they will become

Pluripotent hematopoietic stem cells

All blood cells arise from a single type of stem cell in the bone marrow called pluripotent stem cell
It can produce ALL BLOOD CELL TYPES

It proliferates and forms two major cell linages

Myeloid stem cells

Progenitor and precursor cells

Granulocytes
-Neutrophils
-Basophils
-Eosinophils
Erythrocytes
Megakaryocytes
Monocytes

Lymphoid stem cells

Progenitor and precursor cells

T lymphocyte
B lymphocyte
Natural killer cells

Note: pre T-cells (precursor T cells, T lymphoblasts) migrate to the thymus where they proliferate and differentiate.

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Pluripotent hematopoietic stem cells

Myeloid stem cells

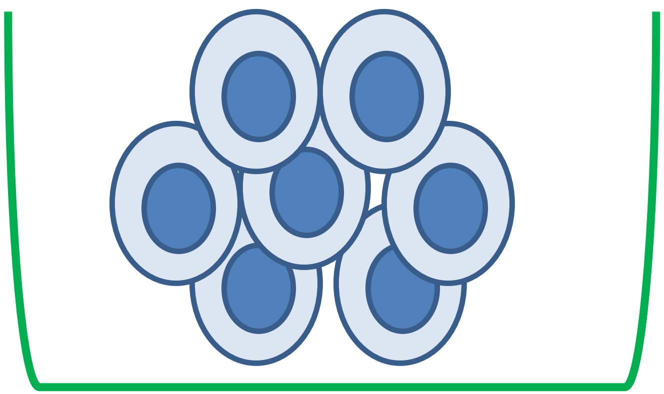
Progenitor cells/ CFUs

- CFU Erythrocyte
  CFU-E
- CFU Granulocyte-Monocyte
  CFU-GM
  - CFU Monocyte
    CFU-M
  - CFU Granulocyte
    CFU-G
- CFU Megakaryocyte
  CFU-M

Lymphoid stem cells

- CFU Lymphocyte
  CFU-L

The progenitor cells for blood cells are often called **colony-forming units** (CFUs), because they give rise to colonies of only one cell type when cultured in vitro or injected into a spleen.



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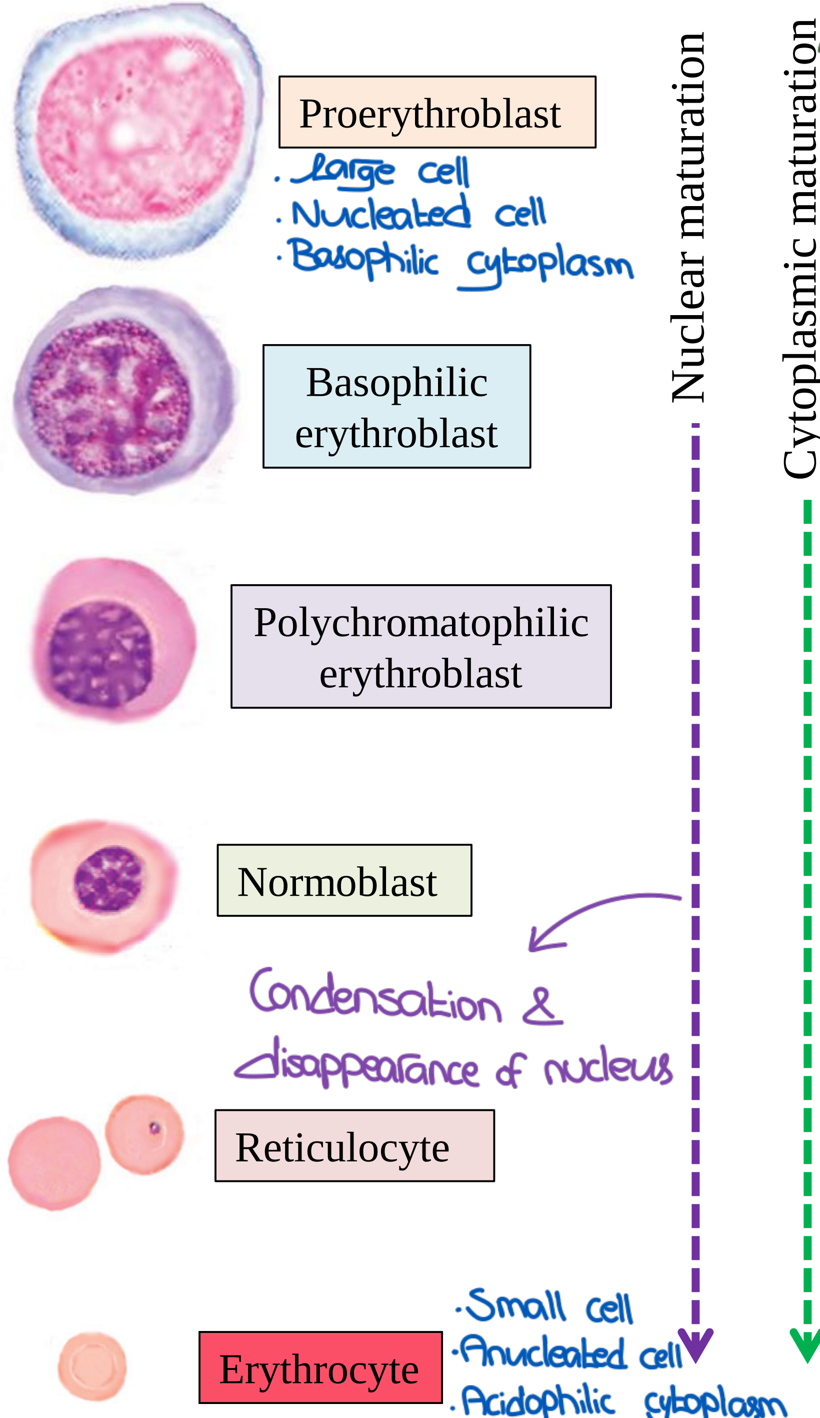
Blood Cell Formation (Hematopoiesis)

Throughout childhood and adult life, erythrocytes, granulocytes, monocytes, and platelets continue to form from stem cells located in bone marrow

Important & required

Erythropoiesis: the process which produces erythrocytes
Granulopoiesis: the process which produces granulocytes
Thrombopoiesis: the process which produces thrombocytes
Lymphopoiesis: the process which produces lymphocytes
Monocytopoiesis: the process which produces monocytes

Remember
Lymphopoiesis occurs in the marrow and in the lymphoid organs to which precursor cells migrate from marrow.



→ Basophilic cytoplasm has to be converted into acidophilic one by synthesis of Hb.

Erythropoiesis (red cell formation)

✓ Takes about 1 week

✓ Rate is controled by the hormone erythropoietin (secreted by the kidney cells) and the availability of iron, folic acid, vitamen B12, protein precursors

Purple → imp. for nuclear maturation
Green → imp. for cytoplasmic maturation.

Stages of differentiation are characterized by:

1- Decreasing cell size

2- Progressive loss of organelles

Presence of free ribosomes at early stages

⇩

Accounts for the marked cytoplasmic basophilia **(blue)**

3- Progressive increase in hemoglobin content

⇩

Accounts for increasing eosinophilia **(pink/red)**

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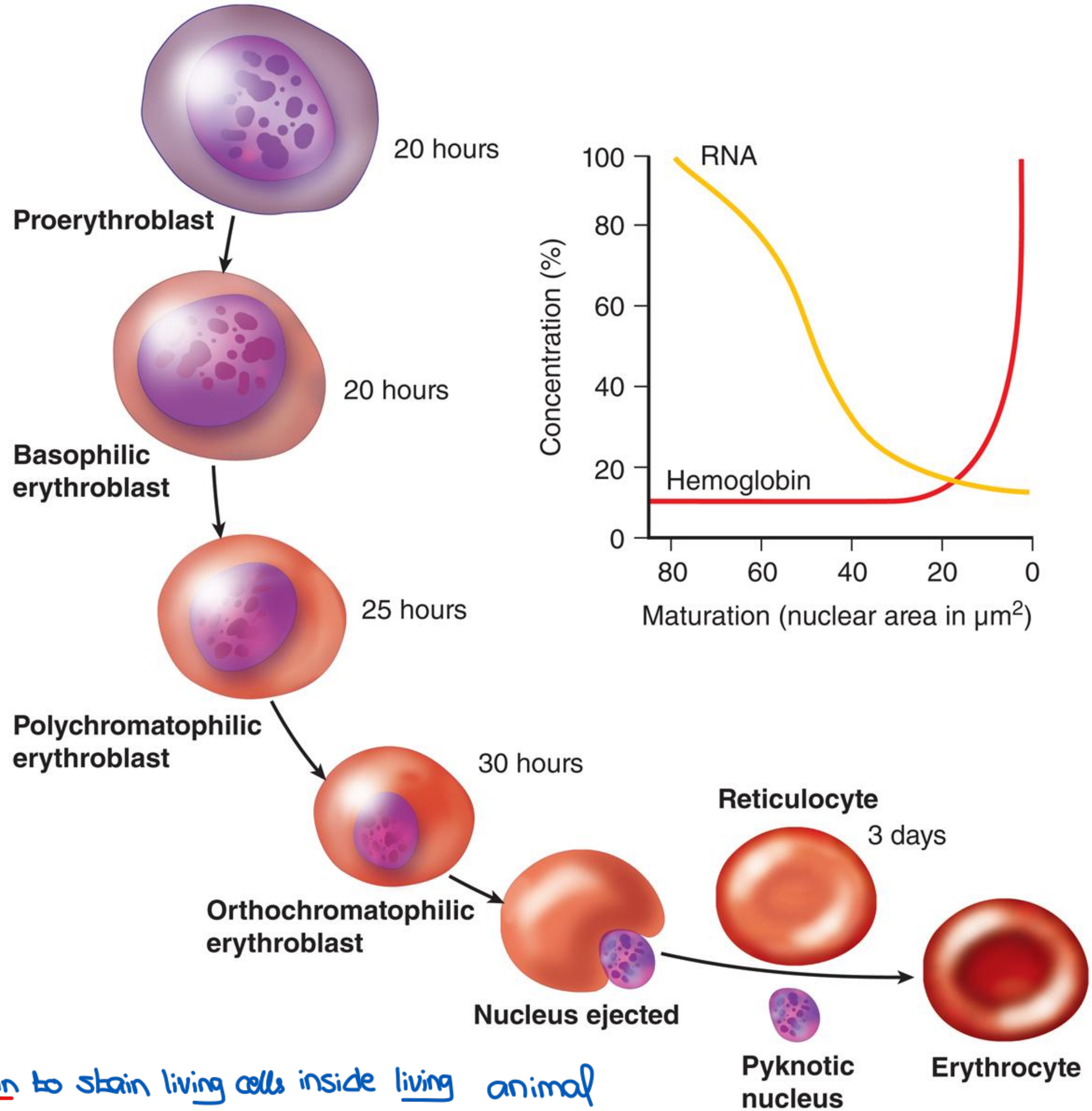
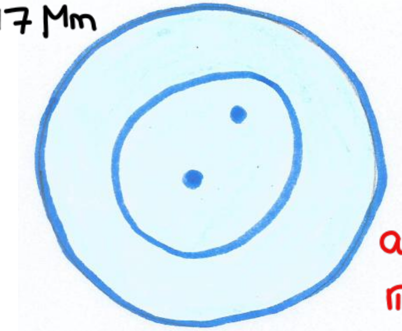


we use vital stain to stain living cells inside living animal

and we use supravital stain to stain living cells outside the body (Brilliant cresyl blue)

17 Mm

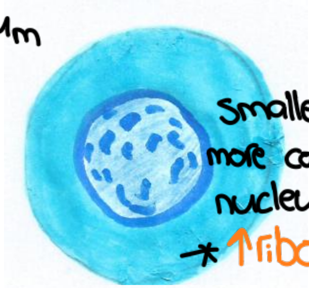


Proerythroblast

as it matures, it has ↓ # of ribosomes and ↑ Hb

- ✓The first recognizable erythrocyte precursor
- ✓Largest cell (17um)
- ✓Large pale nucleus with prominent nucleolus
- ✓Pale basophilic cytoplasm

15 Mm



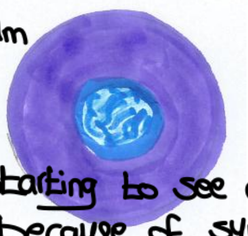
Basophilic erythroblast

smaller and more condensed nucleus

↑ribosomes

- ✓The cell becomes smaller (15um)
- ✓Nucleus: smaller and darker
- ✓Deeply basophilic cytoplasm (high in ribosomes)

13 Mm



Polychromatophilic erythroblast

starting to see acidophilia in cytoplasm because of synthesized Hb.

- ✓The cell becomes smaller (13um)
- ✓Nucleus: smaller and darker
- ✓Cytoplasm becomes violet
- ✓Takes basic (ribosomes) and acidic stains (Hb)

11 Mm

Normoblast

= Orthochromatophilic erythroblast.

- ✓The cell becomes smaller (11um)
- ✓Nucleus: smaller, darker and eccentric to be expelled outside
- ✓Cytoplasm is acidophilic (Hb)

The nucleus is extruded at this stage

9 Mm

Reticulocyte

1-2 %

→ basophilic reticulum

represents the remnant ribosomes within the cytoplasm.

- ✓Immature erythrocyte but slightly larger (9um)
- ✓No nucleus
- ✓Cytoplasm is acidophilic (Hb) but contains remnants of ribosomes forming reticulum
- ✓Can be stained by supravital stains (brilliant cresyl blue)

7 Mm

Erythrocyte

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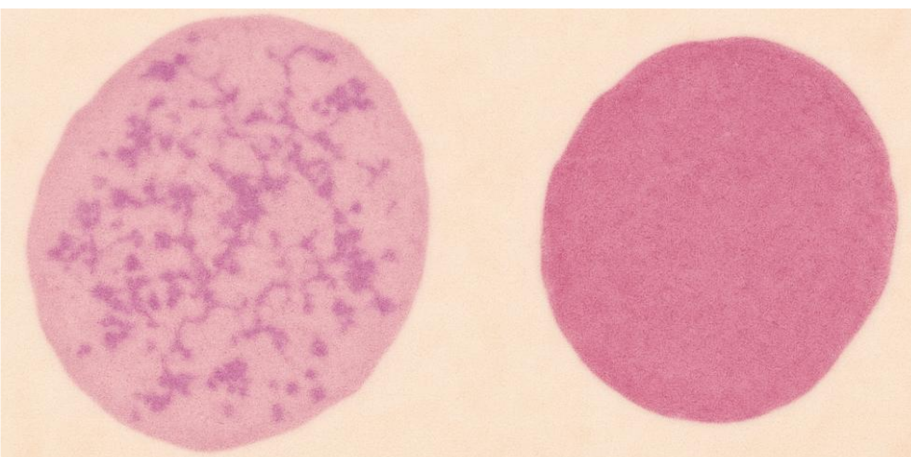
Reticulocytes

Very important CLINICALLY

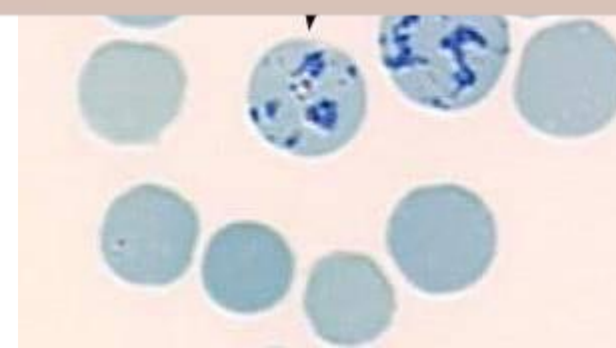
- ➢ Are immature red blood cells (last stage)
- ➢ The cell has extruded its nucleus, but is still capable of producing hemoglobin. ***WHY??***
- ➢ Supravital dye: precipitation of reticulum in the cytoplasm (brilliant cresyl blue)
- ➢ Normally, only about 1% of all red blood cells in the bloodstream are reticulocytes
- ➢ They circulate for about 1-2 days before developing into mature red blood cells
- ➢ An increase in reticulocytes ---- blood loss (hemorrhage)

<u>Because:</u>

1. Hemoglobin synthesis doesn't need DNA directly — it needs mRNA and ribosomes. Even after the nucleus is gone, some mRNA and ribosomes remain temporarily in the cytoplasm.
2. These remaining ribosomes can continue translating mRNA into hemoglobin for a short period.
3. Eventually, those ribosomes and organelles degenerate, leaving a mature erythrocyte that's just a flexible, hemoglobin-filled bag.



Reticulocyte Mature Erythrocyte



Granulopoiesis (Neutrophils, Eosinophils and Basophils formation)

✓ Takes about 2 weeks

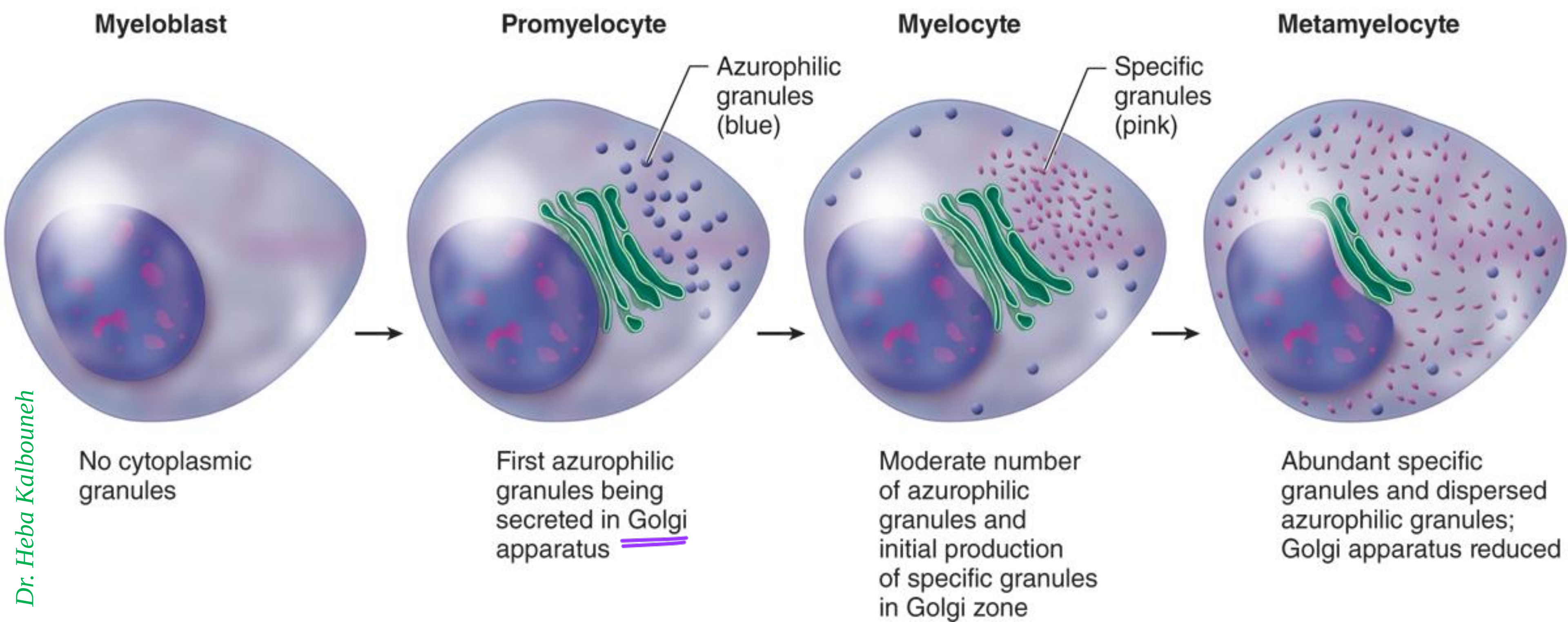
Stages of differentiation are characterized by:

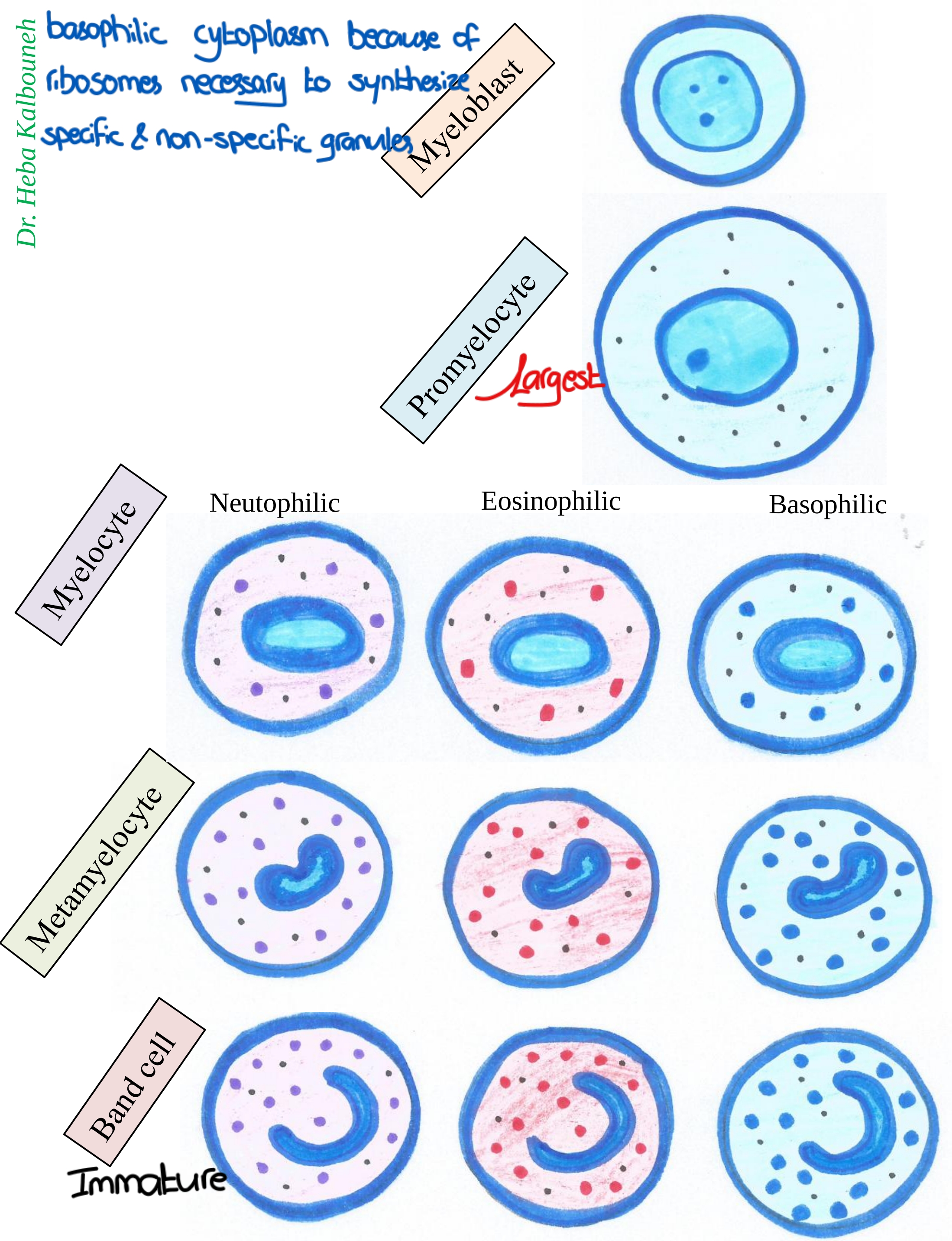
1- Cytoplasmic changes dominated by synthesis of azurophilic granules and specific granules.

First, formation of the azurophilic granules (similar in all three types of granulocytes)

Second, formation of the specific granules (differ in each of the three types of granulocytes)

2- Condensation, indentation and segmentation of the nucleus =Nuclear maturation





Myeloblast

. Large nucleus
. Little cytoplasm
. No granules.

✓The first recognizable precursor

Promyelocyte

✓The largest (20um)
✓Azurophilic granules start to appear

Myelocyte

. Nuclear condensation: more heterochromatin & less euch.
. The last stage were cells can divide

✓3 types
✓The cell becomes smaller
✓ The nucleus becomes smaller and darker
✓ Specific granules start to appear

Metamyelocyte

✓3 types
✓Cannot divide it only matures (differentiates)
✓Undergoes metamorphosis
✓Nucleus becomes indented (kidney shaped)
✓Specific granules increase in number

Band cell (stab cell)

more curved and indented nucleus

✓3 types No segmentation nor lobulation
✓Nucleus becomes curved rod in shape

Neutrophilic band cells (important CLINICALLY)

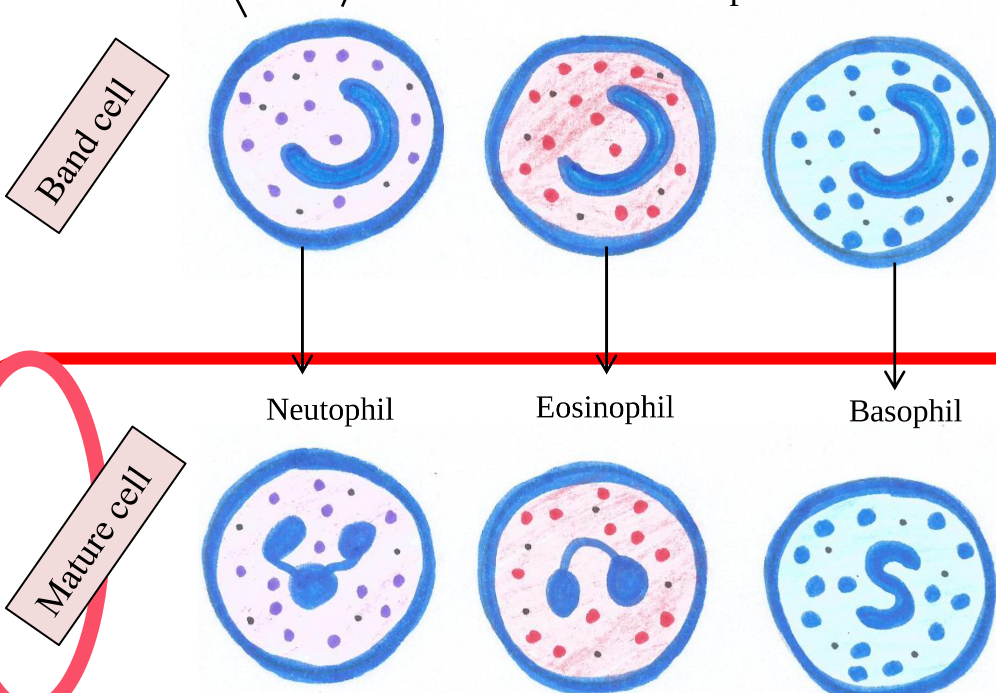
Their percentage does not exceed 5% in peripheral blood

The appearance of large numbers of immature neutrophils (band cells) in the blood, sometimes called a "shift to the left," is clinically significant, usually indicating **a bacterial infection**.

It's normal to have band cells inside the peripheral blood, there they complete maturation

Band cell is **almost** a mature neutrophil, just doesn't have a segmented nucleus yet

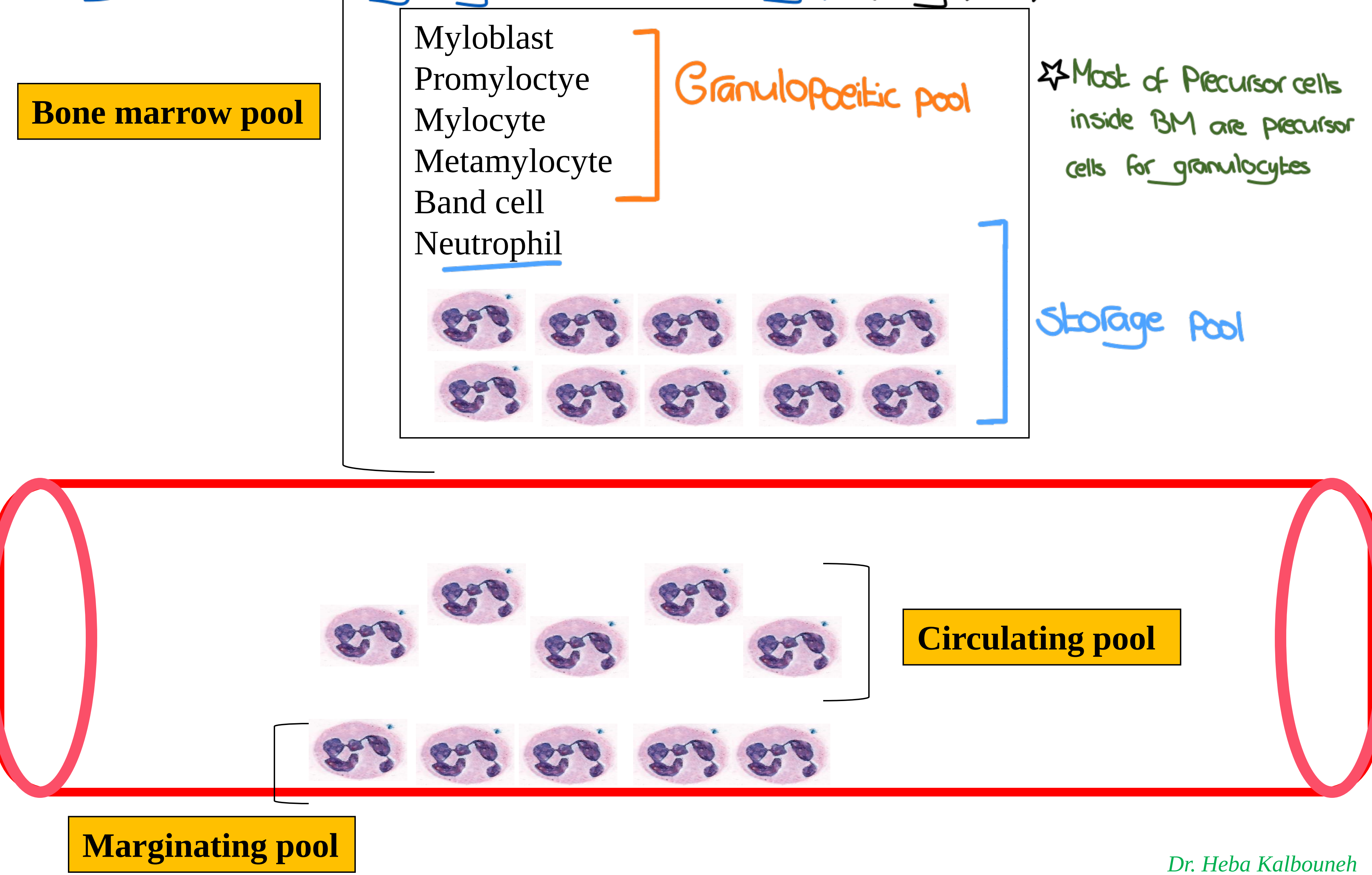
This means that the bone marrow has been signaled to release more neutrophils and increase production of neutrophils



• Stem cells, Progeniter cells & Precursor cells cannot be be found in the blood. ONLY inside the BM.

* Reticulocytes & band cells can, but in very small percentages.

The cause of nutrophilia is not necessarily always the ↑ in granulopoeisis.
It can be caused by the movement of mature neutrophils from storage pool to circulating pool, or movement of margenating neutrophils to circulating pool (during exercise).



Developing and mature neutrophils exist in four functionally and anatomically defined compartments:

(1) The granulopoietic compartment in active marrow
(2) Storage as mature cells in marrow until release
(3) The circulating population
(4) A population undergoing margination

Margination is a process in which neutrophils adhere loosely and accumulate transiently along the endothelial surface in venules and small veins.

Note: Margination of neutrophils in some organs can persist for several hours and is not always followed by the cells' emigration from the microvasculature.

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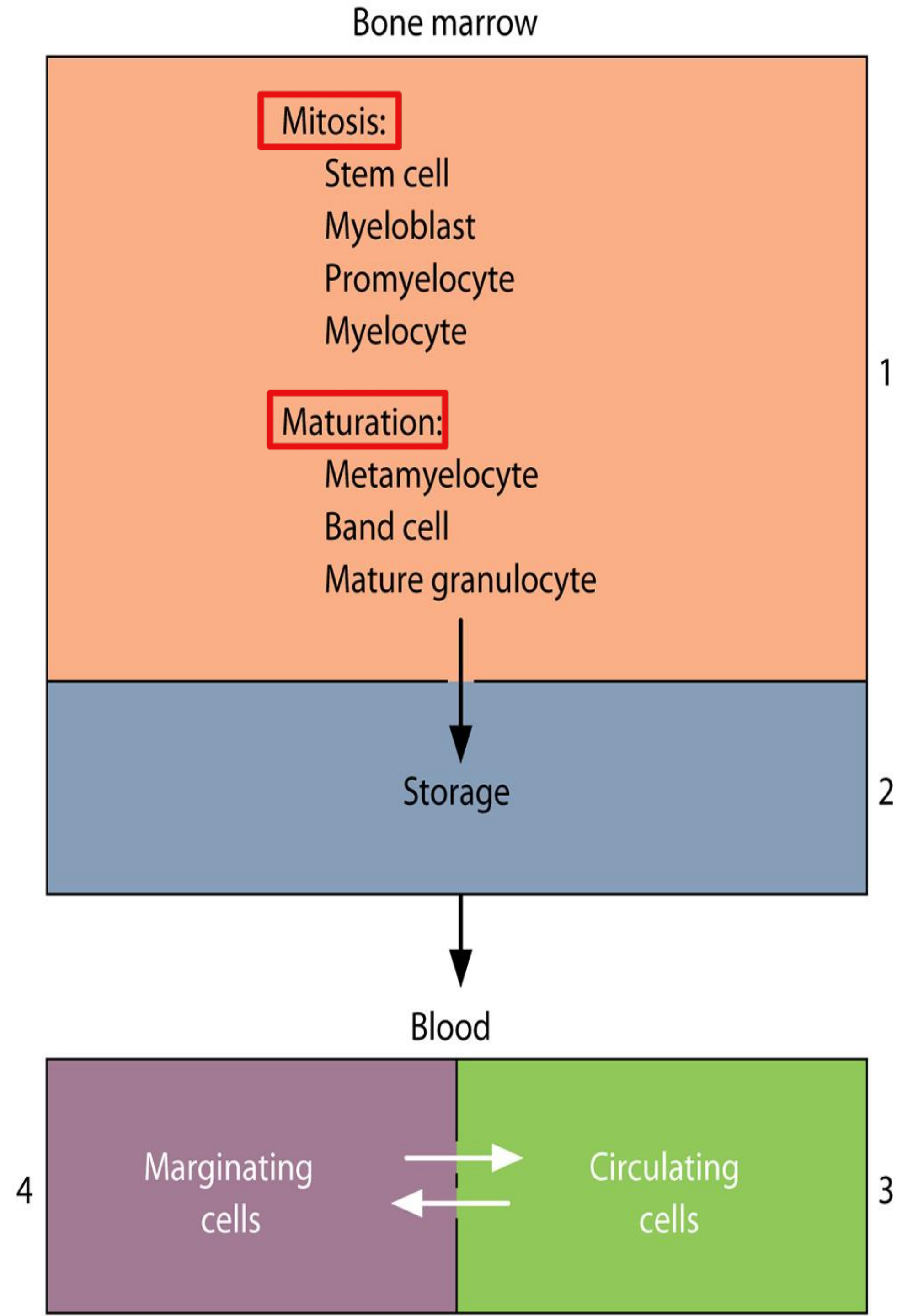

At sites of injury or infection, neutrophils and other granulocytes enter the connective tissues by migrating through intercellular junctions between endothelial cells of postcapillary venules in diapedesis.

Inflamed connective tissues thus form a fifth terminal compartment for neutrophils, where the cells reside for a few days and then die by apoptosis, regardless of whether they have performed their major function of bacterial phagocytosis.

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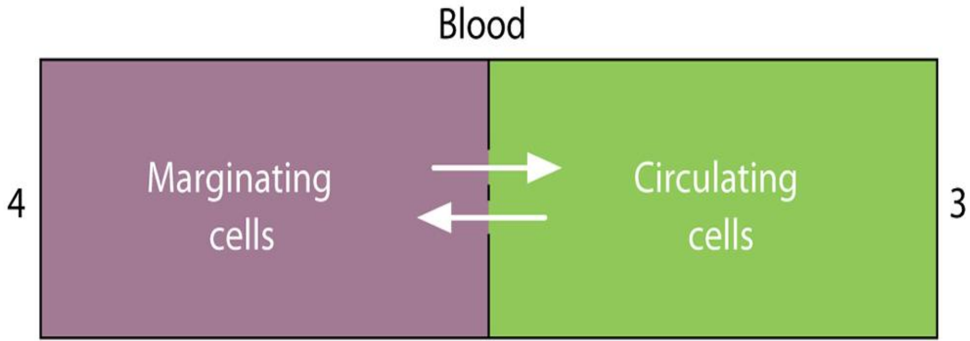
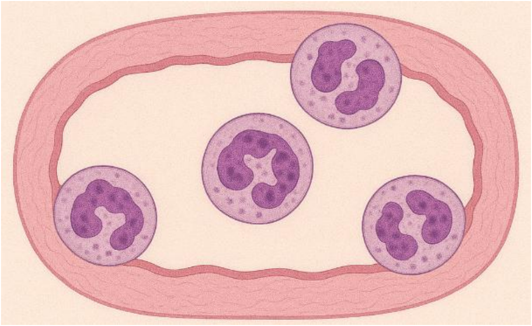
Changes in the number of neutrophils in the blood must be evaluated by taking all their compartments into consideration.

Thus, neutrophilia (an increase in the number of circulating neutrophils) does not necessarily imply an increase in granulopoiesis.

Intense muscular activity or the administration of epinephrine can cause neutrophils in the marginating compartment to move into the circulating compartment, producing neutrophilia even though granulopoiesis has not increased. However, glucocorticoids (adrenal hormones) such as cortisone increase the mitotic activity of neutrophil precursors and this also increases the blood count of neutrophils.





How many RBCs are in 1 ul of peripheral blood?

5 million/ul

How many WBCs are in 1 ul of peripheral blood?

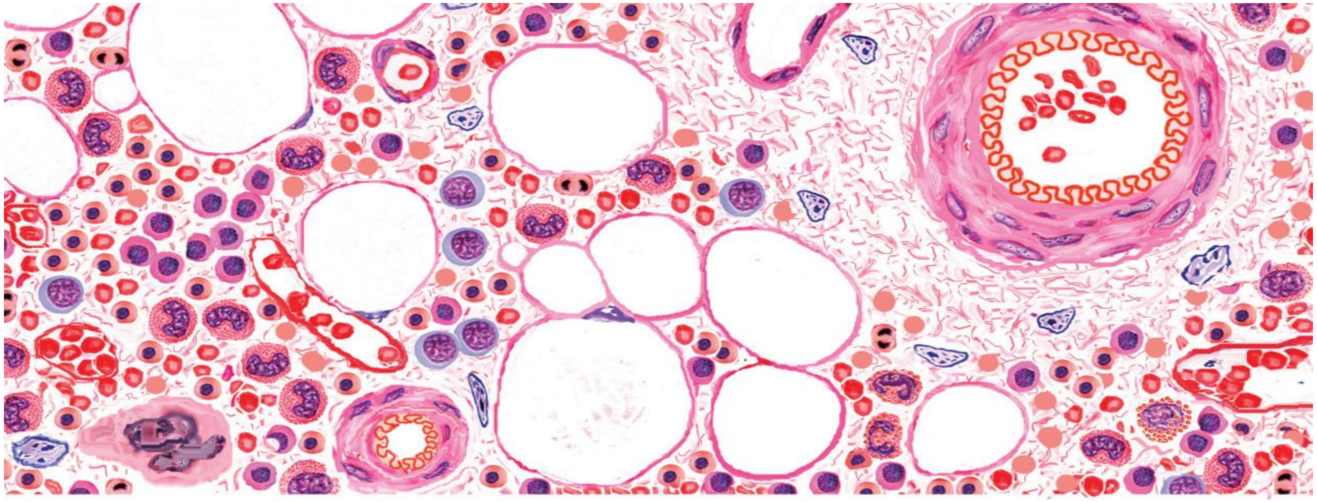
4500-11000/ul

But in the bone marrow (myeloid tissue)!!!

Myeloid: Erythroid

3:1

Remember the life span!!!!!



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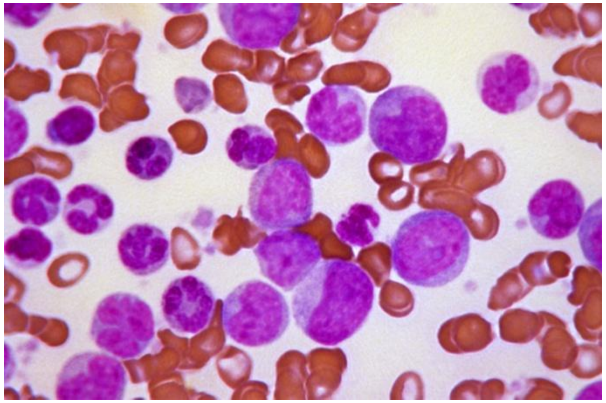
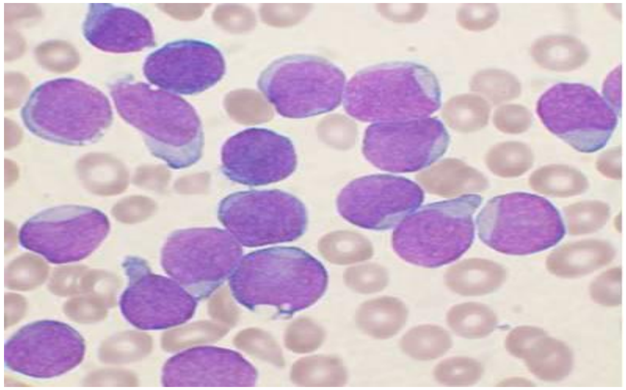
White blood cell abnormalities

Increased numbers of white cells appear in the peripheral blood in a variety of disorders and provide a useful clue to the underlying disease.

A considerable and sustained increase of circulating **neutrophils** in **bacterial infection**

An increase of circulating **eosinophils** **in parasitic infection and some allergies**





Leukemia is a malignant proliferation of white cell precursors in the bone marrow

Vast number of white cells and their precursors (many of which spell over into the blood)

Leukemia is classified according to the cell line involved (granulocytic, monocytic, lymphocytic)

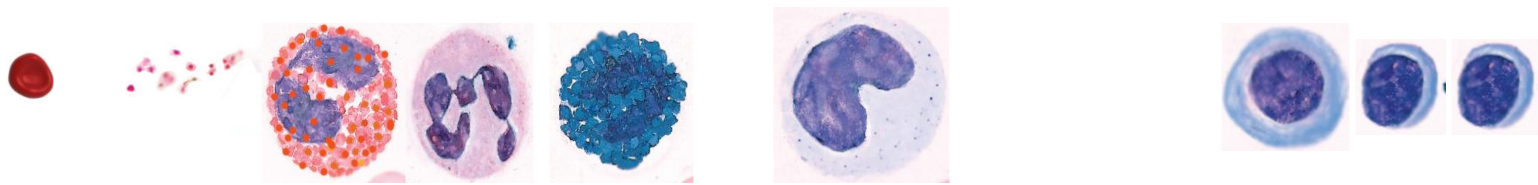
Stem cells

Progenitor cells

Precursor cells

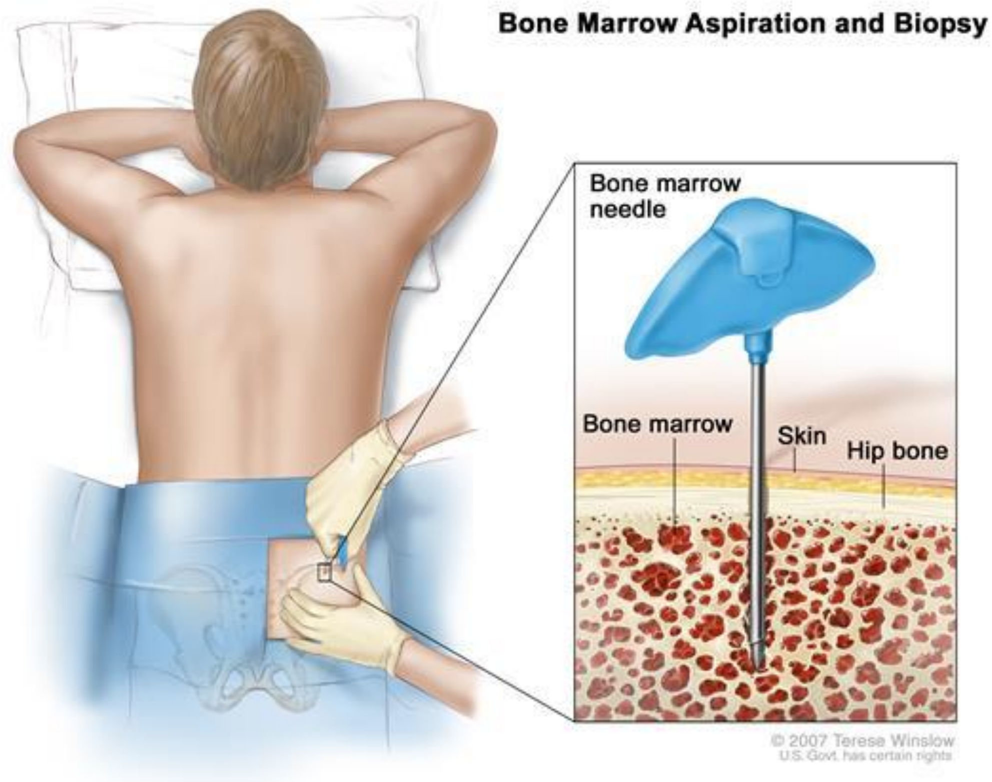
Bone marrow

Peripheral blood



Blood film/ smear

Bone marrow Apirate or biobsy
Needed to diagnose disorders like aplastic anemia or leukemia



Bone marrow transplantation
In bone marrow diseases like leukemia, hematopoietic stem cells taken from a donor are infused into the same or another person

Thrombopoiesis

Hematopoietic pluripotent stem cell

↓

Myeloid stem cells

↓

Colony forming unit- megakaryocyte

↓

Megakaryoblast

↓

Promegakaryocyte

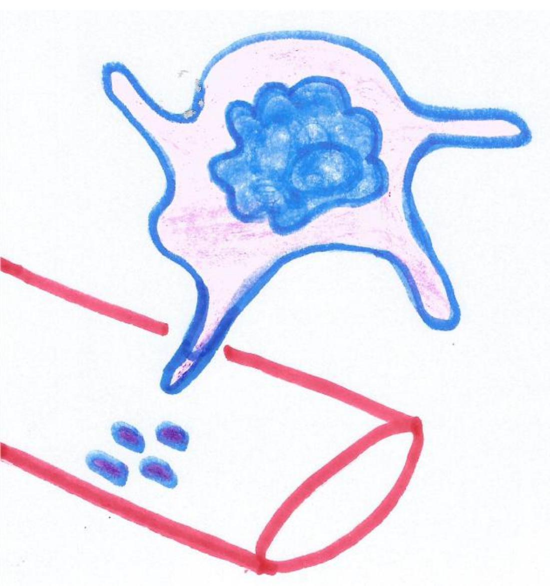
Polyploid nucleus

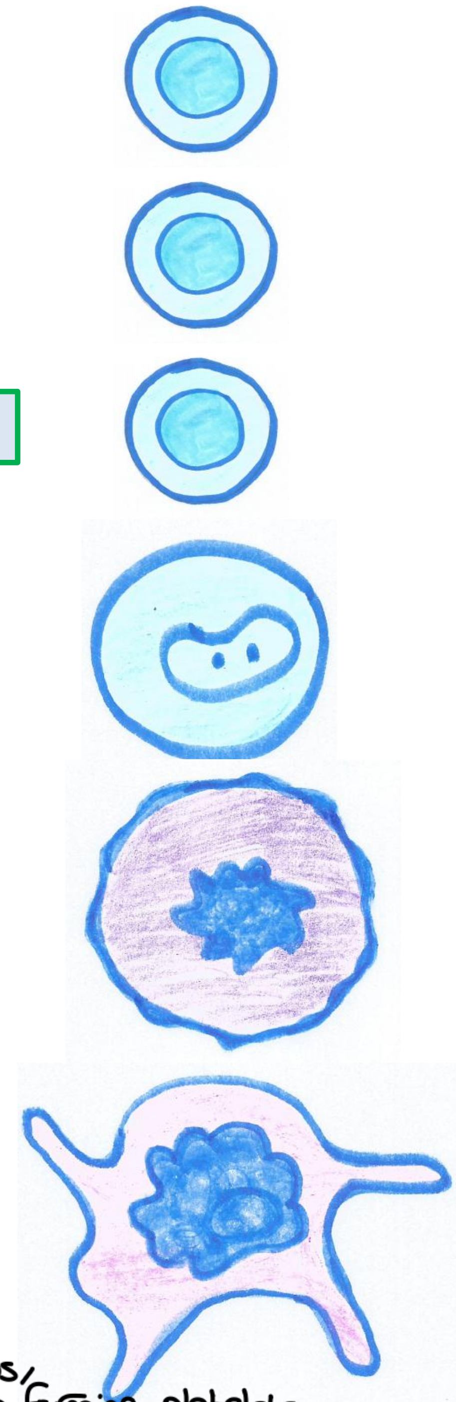
large nucleus because it undergoes many rounds of DNA replication without division of the nucleus

↓

Megakaryocyte

extends its processes to the bloodstream, and as the blood flows, the tips of these processes breakdown forming platelets





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Monocytopoiesis

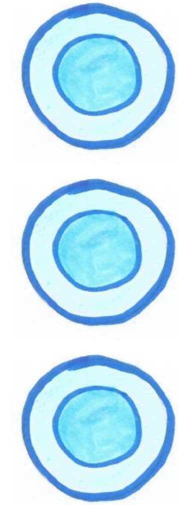
Hematopoietic pluripotent stem cell

↓

Myeloid stem cell

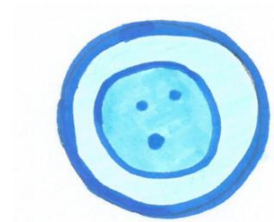
↓

Colony forming unit- monocyte



↓

Monoblast



The earliest precursor cell

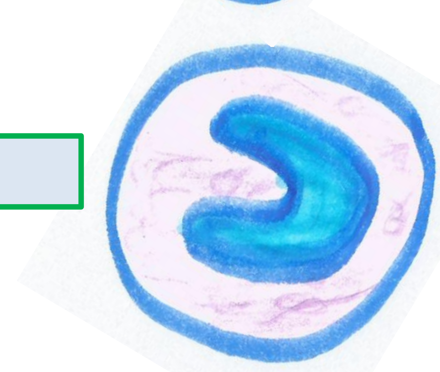
↓

Promonocyte

Smaller and more condensed and indented nucleus

↓

Monocyte



More condensed C-shaped or horseshoe nucleus

Lymphopoiesis

Hematopoietic pluripotent stem cell

↓

Lymphoid stem cells

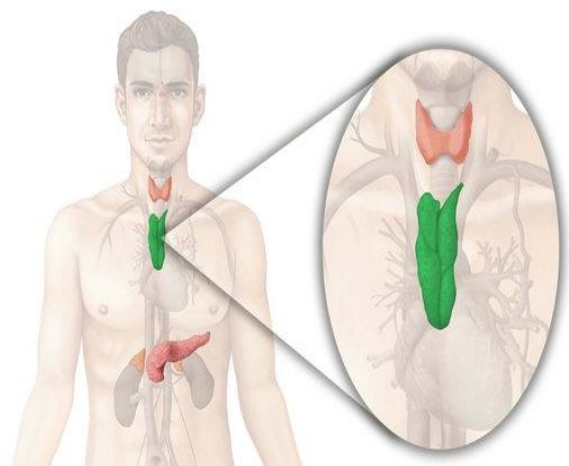
↓

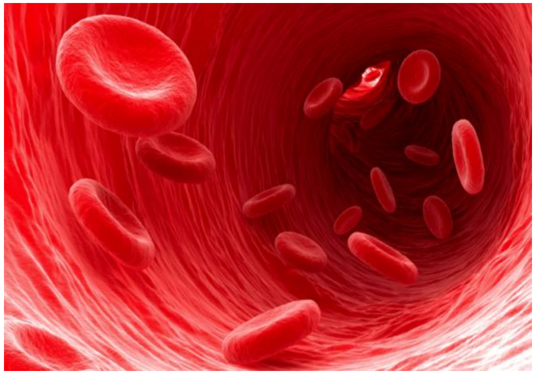
Lymphocyte colony forming cell

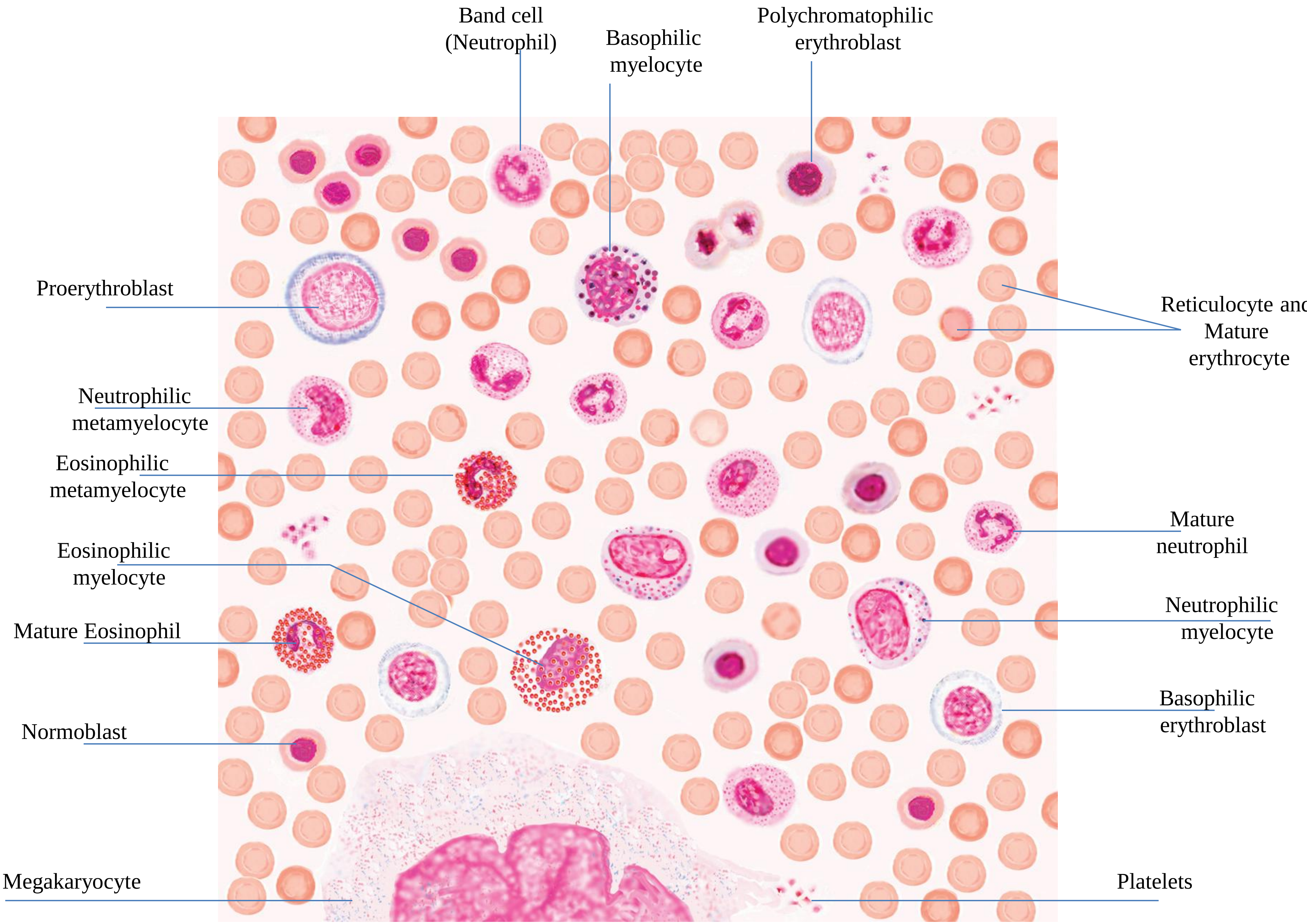
↓

Lymphoblast

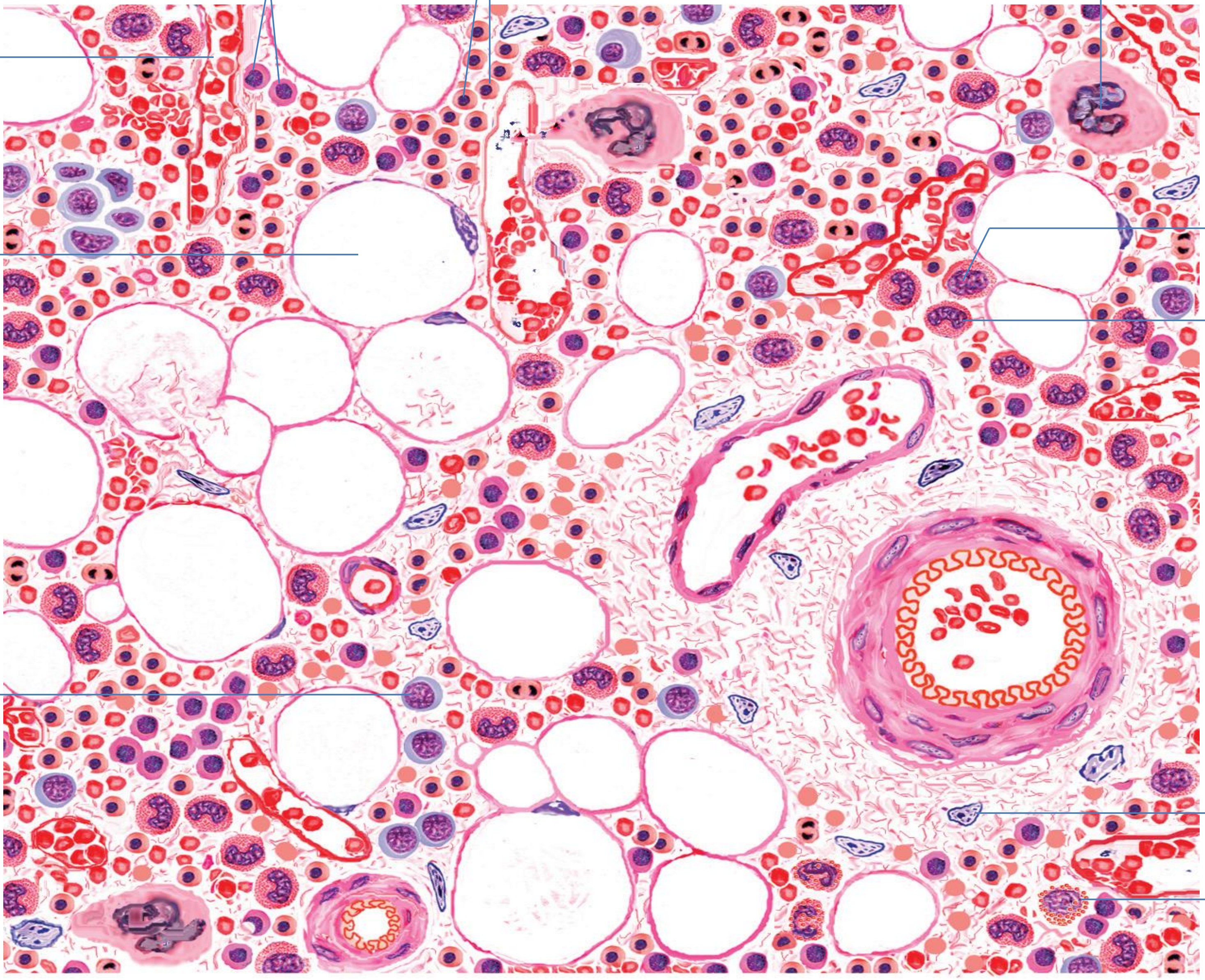
- Thymus → T Lymphocyte
- BM → B Lymphocyte
- Directly into blood → Natural killer lymphocyte







Bone marrow (Giemsa stain)



Bone marrow (H&E)

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Hemopoietic growth factors (colony-stimulating factors (CSF) or cytokines) are glycoproteins that stimulate proliferation of progenitor and precursor cells and promote cell differentiation and maturation within specific lineages.

Erythropoiten
Thrombopoiten
CSF-G

available in the market

Cloning of the genes for several important hematopoietic growth factors has significantly advanced study of blood formation and permitted the production of clinically useful factors for patients with hemopoietic disorders.

In which of the following cells involved in erythropoiesis does hemoglobin synthesis begin?

a. Orthochromatic erythroblast
b. Polychromatophilic erythroblast
c. Reticulocyte
d. Basophilic erythroblast
e. Proerythroblast

According to chatgpt, Hb synthesis begins in basophilic erythroblast but in very little amounts that does not cause color change. Although Dr. Ebaa (in physiology) said " Hb starts to appear in polychromatophilic erythroblast. So we will ask for this Inshallah.

Probably
Ans : d

Which of the following can be used to describe megakaryocytes?

a. Multinucleated
b. Formed by fusion of haploid cells
c. Precursors to bone marrow macrophages
d. A minor but normal formed element found in the circulation
e. Possess dynamic cell projections from which one type of formed element is released

Option	Analysis
a. Multinucleated	❌ Incorrect — the nucleus is **single but multilobed (polyploid)**, not multiple separate nuclei.
b. Formed by fusion of haploid cells	❌ No — their polyploid nucleus results from **endomitosis**, not cell fusion.
c. Precursors to bone marrow macrophages	❌ No — **monocytes** give rise to macrophages, not megakaryocytes.
d. A minor but normal formed element found in the circulation	❌ No — **megakaryocytes remain in the bone marrow;** only **platelets** enter the circulation.
e. Possess dynamic cell projections from which one type of formed element is released	✅ **Correct!** — megakaryocytes extend **proplatelet processes** into marrow sinusoids, and these fragments break off as **platelets**.

Which cytoplasmic components are the main constituents of the dark precipitate that forms in reticulocytes upon staining with the dye cresyl blue?

a. Golgi complexes
b. Hemoglobin
c. Nucleoli
d. Nuclear fragments
e. Polyribosomes

✅ **Answer: (e) Polyribosomes**

Explanation:
The dark reticular pattern in cresyl blue-stained reticulocytes corresponds to **residual ribosomes and polyribosomes**, which are still capable of translating hemoglobin mRNA.

Which process occurs during granulopoiesis but not during erythropoiesis?

a. Cells lose their capacity for mitosis
b. Euchromatin content increases
c. Nucleus becomes increasingly lobulated
d. Overall cell diameter decreases
e. Overall nuclear diameter decreases

Feature	Granulopoiesis	Erythropoiesis
Mitosis	Stops at metamyelocyte	Stops at orthochromatic erythroblast
Nuclear changes	Nucleus becomes lobulated/segmented	Nucleus becomes **pyknotic**, then extruded
Cytoplasm	Develops specific granules	Becomes acidophilic due to hemoglobin
Cell size	Decreases slightly	Decreases gradually
Euchromatin content	Decreases as nucleus condenses	Also decreases before extrusion

🔹 **Analyze the options:**

a. Cells lose their capacity for mitosis → ❌ Happens in **both** processes.

b. Euchromatin content increases → ❌ Actually **decreases** as cells mature in both lineages.

c. Nucleus becomes increasingly lobulated → ✅ **Unique to granulopoiesis** (neutrophils, eosinophils, basophils develop segmented nuclei).

d. Overall cell diameter decreases → ❌ Happens in **both** lineages.

e. Overall nuclear diameter decreases → ❌ Happens in **both** lineages.

What fate often awaits granulocytes that have entered the marginating compartment?

a. Undergo mitosis
b. Crossing the wall of a venule to enter connective tissue
c. Cannot reenter the circulation
d. Differentiate into functional macrophages
e. Begin to release platelets

Ans : b

What is the earliest stage at which specific granulocyte types can be distinguished from one another?

a. Myelocyte
b. Band form
c. Reticulocyte
d. Metamyelocyte
e. Promyelocyte

Ans : a

Which cell type is capable of further mitosis after leaving the hemopoietic organ in which it is formed?

a. Basophil
b. Eosinophil
c. Reticulocyte
d. Lymphocyte
e. Neutrophil

✅ **Answer: (d) Lymphocyte**

Explanation:

- **Granulocytes and erythroid cells** complete their differentiation and **cannot divide** after leaving the bone marrow.
- **Lymphocytes** retain the ability to **proliferate** when they encounter an antigen in **secondary lymphoid tissues**.

Shortly after her birth a baby is diagnosed with a mutation in the erythropoietin receptor gene which leads to familial erythrocytosis (familial polycythemia). During the seventh to ninth months of fetal development, the primary effect on her red blood cell production was in which of the following?

a. Liver
b. Yolk sac
c. Spleen
d. Thymus
e. Bone marrow

Ans : a

A 54-year-old man presents with recurrent breathlessness and chronic fatigue. After routine tests followed by a bone marrow biopsy he is diagnosed with lymphocytic leukemia. Chemotherapy is administered to remove the cancerous cells, which also destroys the precursor cells of erythrocytes. To reestablish the erythrocytic lineage, which of the following cells should be transplanted?

a. Reticulocytes
b. Orthochromatophilic erythroblasts
c. Megakaryoblasts
d. Basophilic erythroblasts
e. Metamyelocytes

Option	Analysis
a. Reticulocytes	❌ Already enucleated; cannot divide; only mature into RBCs.
b. Orthochromatophilic erythroblasts	❌ Late precursor; nucleus is pyknotic; limited proliferative potential.
c. Megakaryoblasts	❌ Precursors to platelets, not RBCs.
d. Basophilic erythroblasts	✅ **Correct — early erythroid precursor**; still capable of proliferation and hemoglobin synthesis; can repopulate the erythrocytic lineage.
e. Metamyelocytes	❌ Granulocyte precursor; irrelevant for RBCs.

A smear of blood from a 70-year-old leukemia patient reveals a larger than normal population of cells that have large, round nuclei with 1 or 2 nucleoli. The cytoplasm of these cells shows azurophilic granules. Which of the following forms of leukemia would you suspect?

=promyelocytes

a. Promyelocytic leukemia
b. Basophilic leukemia
c. Lymphoblastic leukemia
d. Stem cell leukemia
e. Eosinophilic leukemia

Option	Analysis
a. Promyelocytic leukemia	✅ Correct — promyelocytes have **large round nuclei, nucleoli,** and **azurophilic granules;** typical of acute promyelocytic leukemia (APL).
b. Basophilic leukemia	❌ Basophils are mature granulocytes with **basophilic granules;** nuclei are usually **lobulated,** not large and round.
c. Lymphoblastic leukemia	❌ Lymphoblasts have **scant cytoplasm** and usually **no granules.**
d. Stem cell leukemia	❌ Not a standard classification; stem cells are **very immature** and usually not seen in large numbers in circulation.
e. Eosinophilic leukemia	❌ Eosinophils have **orange/red granules** and are **more mature;** nuclei are lobulated.

سُورَةُ الأَحزَابِ

إِنَّ ٱللَّهَ وَمَلَٰٓئِكَتَهُۥ يُصَلُّونَ عَلَى ٱلنَّبِيِّۚ يَٰٓأَيُّهَا ٱلَّذِينَ
ءَامَنُواْ صَلُّواْ عَلَيۡهِ وَسَلِّمُواْ تَسۡلِيمًا ٥٦