

Blood Composition

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Blood Physiology seminar
Dec 5th 2023

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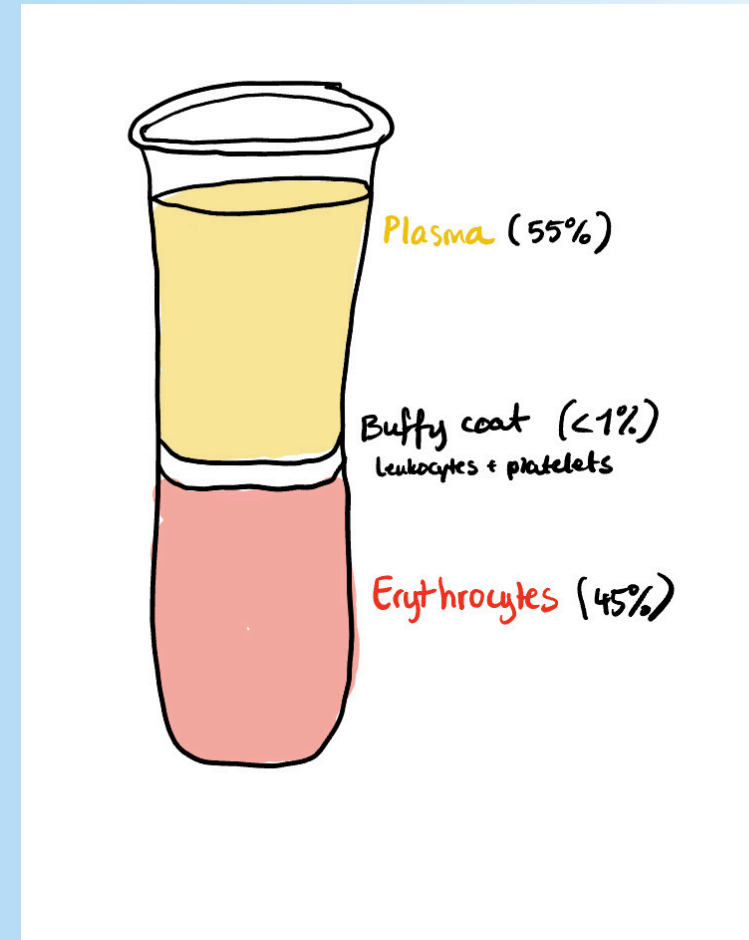
- Main components
- Hematocrit
- Albumin
- Hematopoiesis (overview)
- Erythropoiesis
- Thrombopoiesis
- Immune cells
- Wooclap



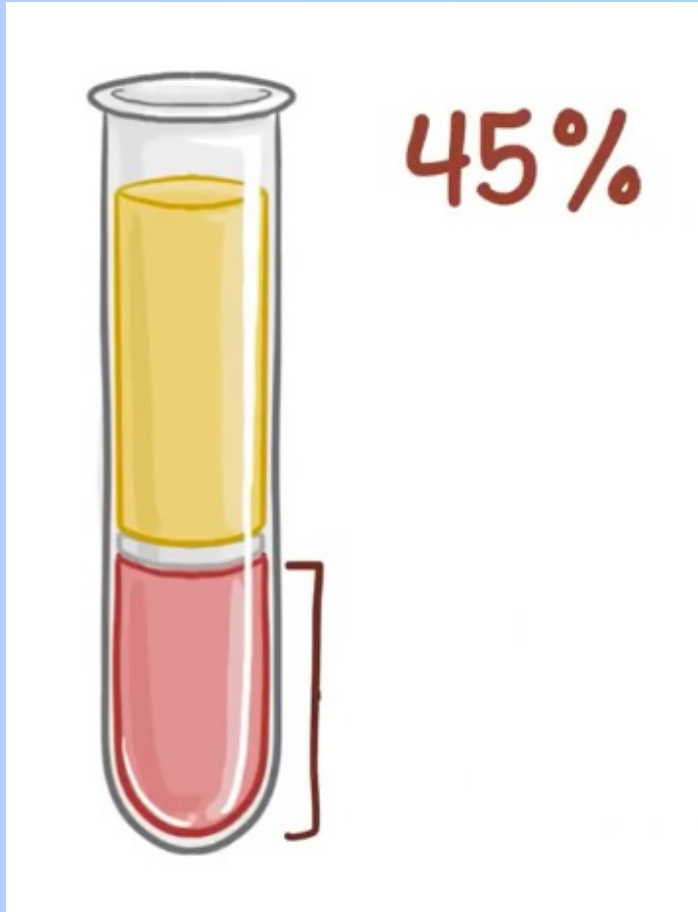
Main Components

- TBV = $\sim 3\text{L}$ (plasma) + $\sim 2,5\text{ L}$ RBC, WBC, PLT)
- 4 000 000 - 10 000 000 cells/mm³
- Main components of TBV
 1. plasma
 2. WBC + platelets
 3. RBC

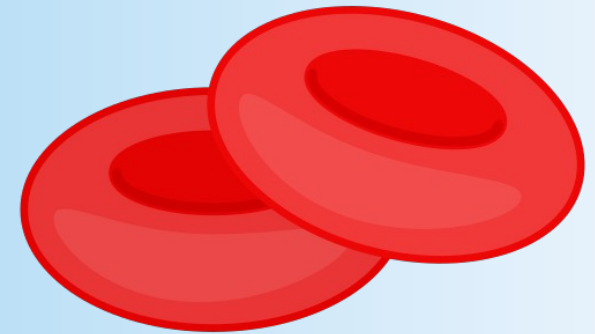
Plasma = liquid, cell free blood with clotting factors
Serum = plasma - clotting factors



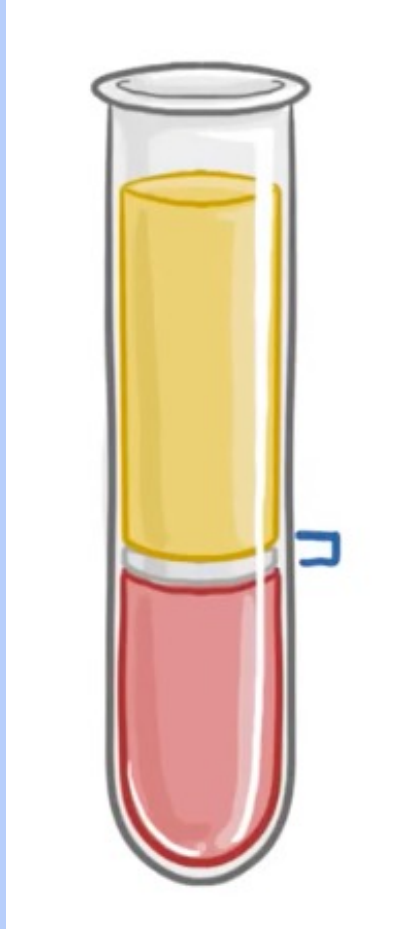
Erythrocytes



- Red blood cells
- Hematocrit
 - low: few RBC
 - high: dehydration/ too much RBC
- Carry O₂ to tissues, CO₂ to lungs
- Biconcave shape, no organelles
- 120 days lifespan



The buffy coat



- <math><1\%</math>
- Platelets and leukocytes

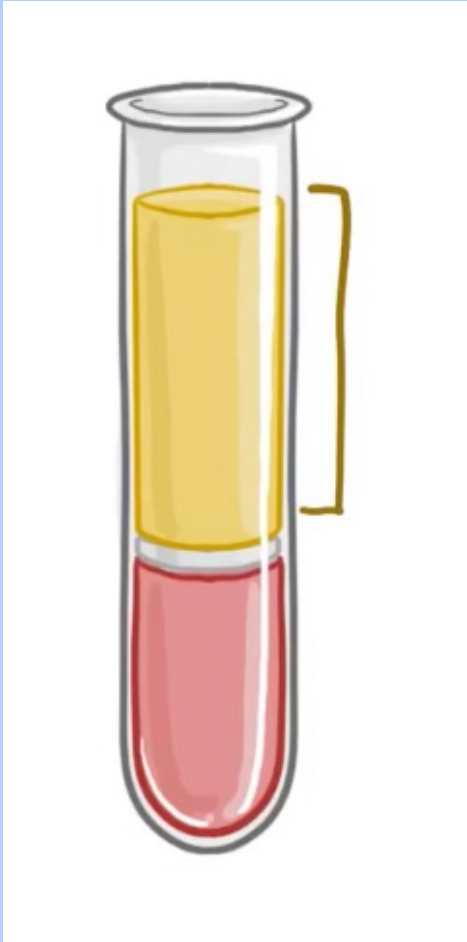
Platelets

- Form blood clots

Leukocytes (WBC/ immune cells)

- Granulocytes (neutrophils, eosinophils, basophils)
- Lymphocytes (B-cells, T-cells, NK-cells)
- Monocytes

Plasma



- 55%
- No cells
- Water (90%)
- Proteins, electrolytes, gases, hormones, nutrients, waste products (10%)

Most important protein: ALBUMIN

Other proteins:

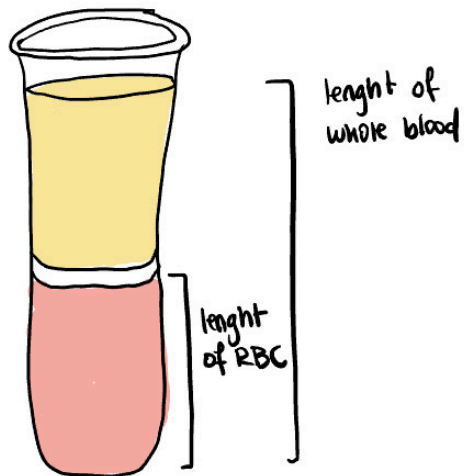
- globulins (antibodies - GAME)
- fibrinogen (clotting)

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Hematocrit



$$\text{HCT} = \frac{\text{length of packed RBC}}{\text{length of whole blood}} \times 100$$



- Females: 35-45%
- Males: 40-55%

- <45% → anemia
- >45% → polythemia

↓ HCT = ANEMIA

↓ RBC, ↑ plasma

- bleeding
- sickle cell anemia
- dysfunction of bone marrow
- kidney disease

↑ HCT = POLYCYTHEMIA

↑ RBC, ↓ plasma

- dehydration
- hypoxia
- polycythemia vera

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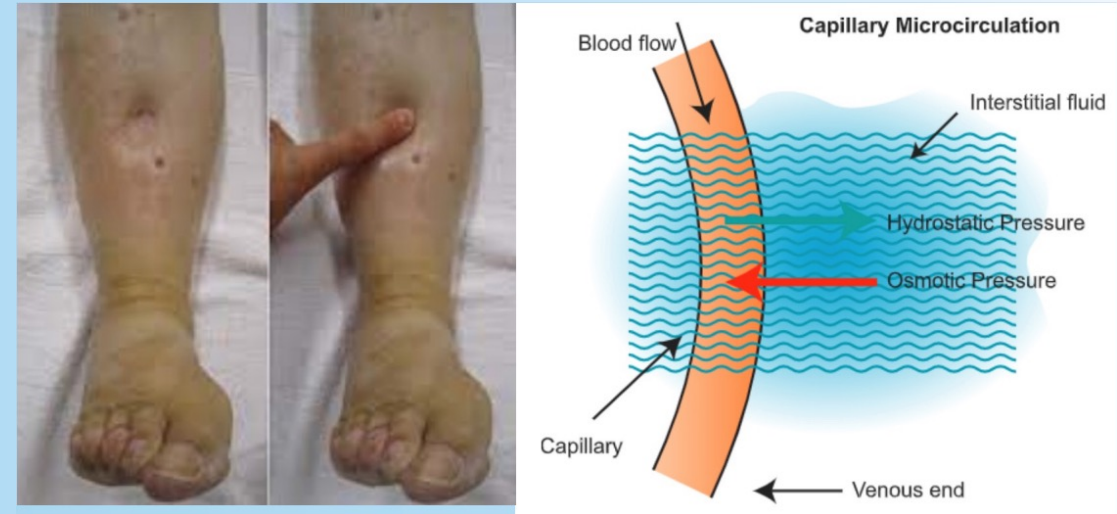
Oncotic pressure = proteins (eg. albumin) keeps fluid in the capillaries

Albumin

- Carrier/ transport protein
- Produced by liver, NOT stored in liver
- Circulating in plasma
- Most abundant protein in blood (50%)

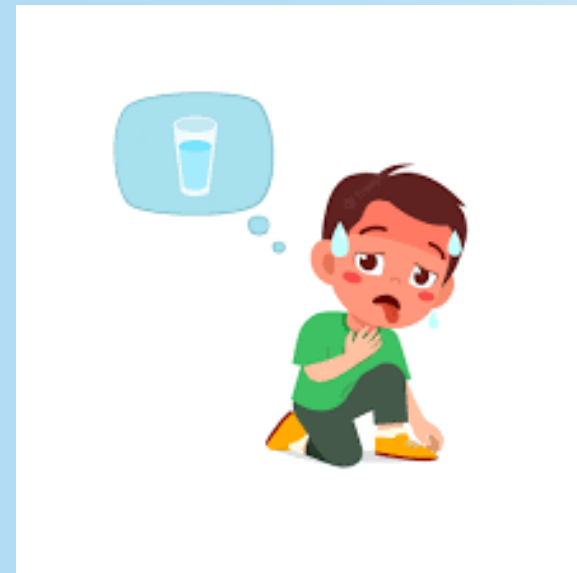
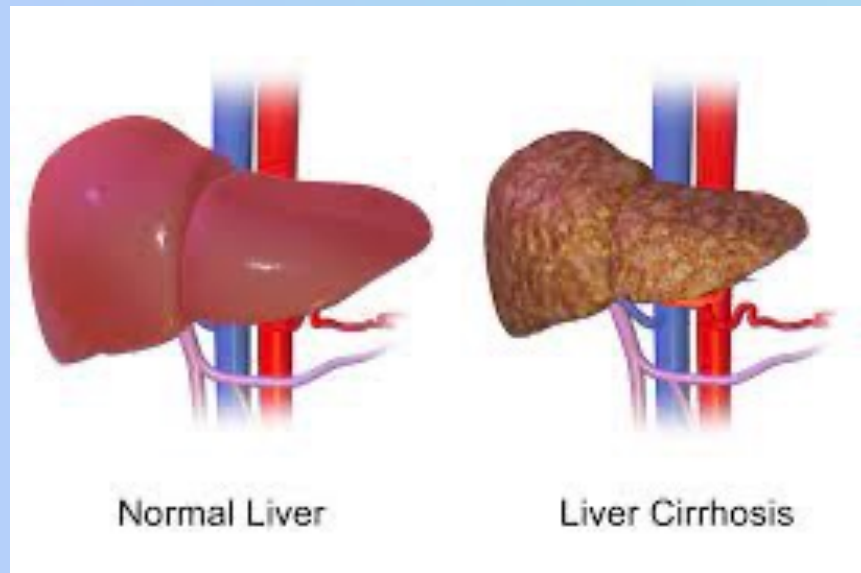
Functions

- Maintains **oncotic pressure**
- Transports **hydrophobic** components (drugs, nutrients, hormones)



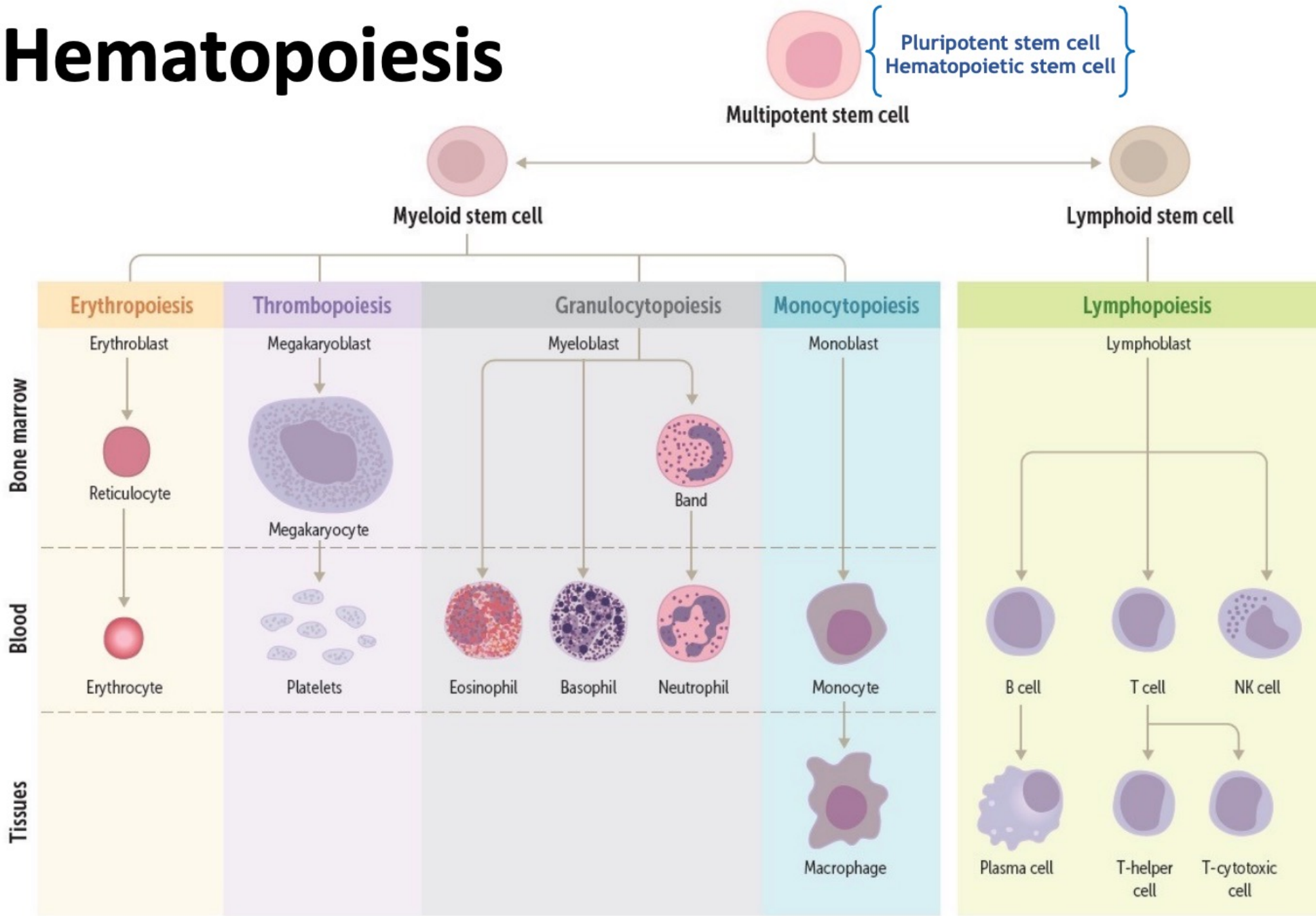
Hyper/ hypoalbuminemia

- Low albumin (hypoalbuminemia) can be caused by: malnutrition, liver disease, inflammatory disease
- High albumin (hyperalbuminemia) can be caused by: dehydration



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Hematopoiesis

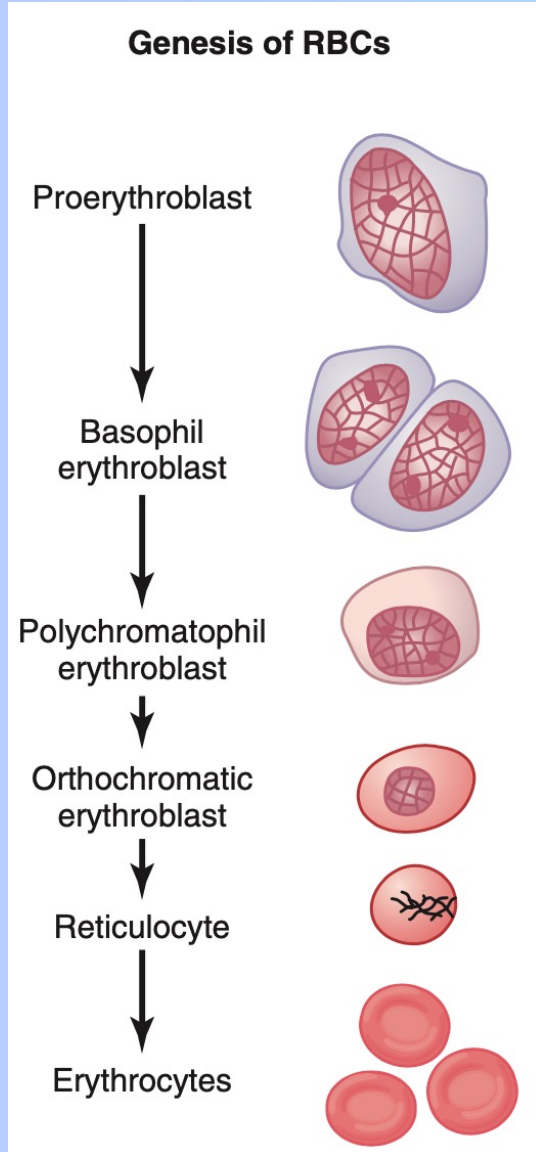


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Erythropoiesis = production of RBC

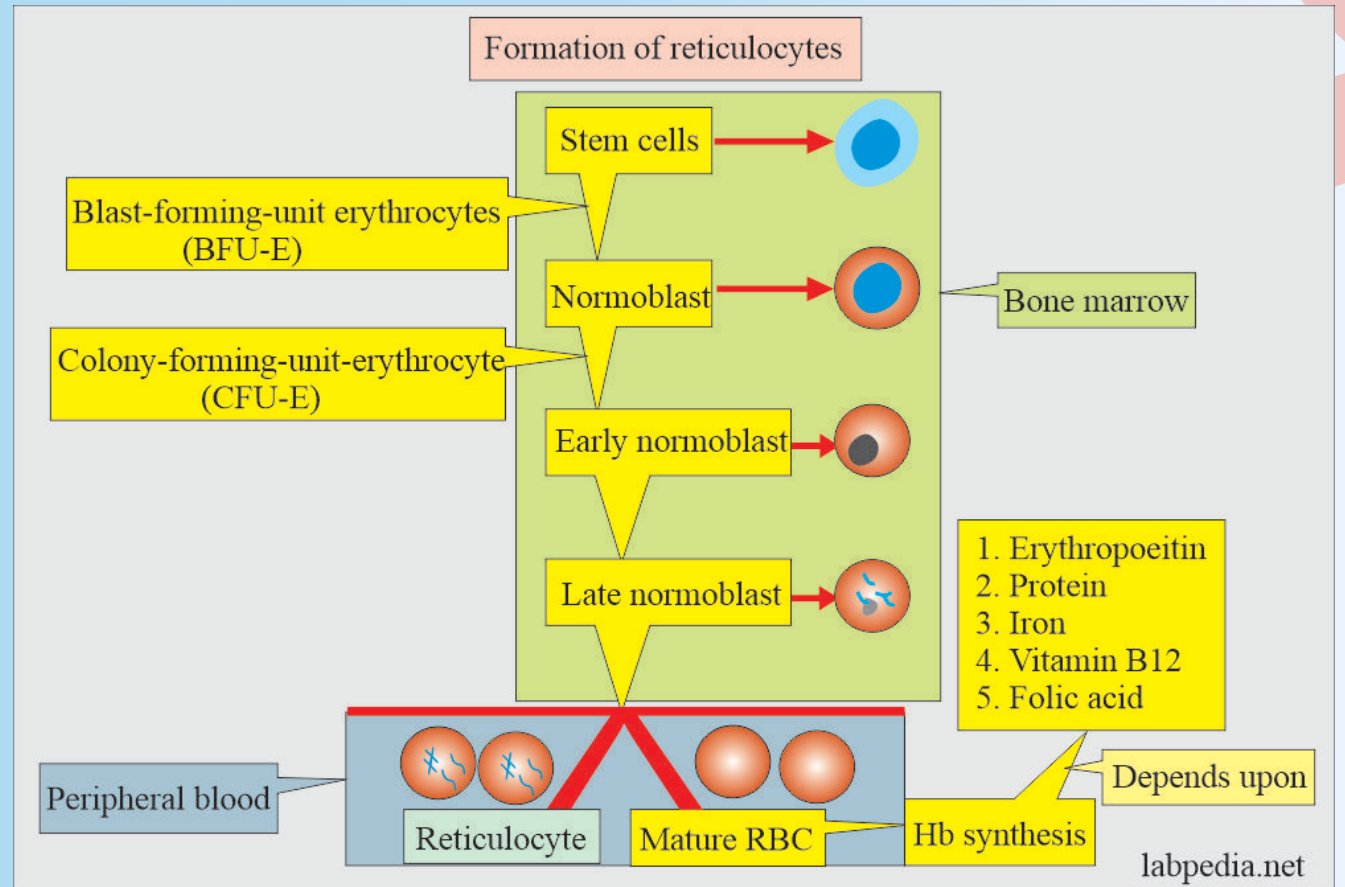
- ♂: 4.3-5.9 million/mm³, ♀: 3.5-5.5 million/mm³
- Before birth → liver, spleen
- After birth → bone marrow

- Stimulated by EPO secreted by kidneys
- Requires: iron (Fe²⁺), vitamin B12 (cobalamin), folic acid (vit B9) → thymidine triphosphate
→ Deficiency leads to anemia

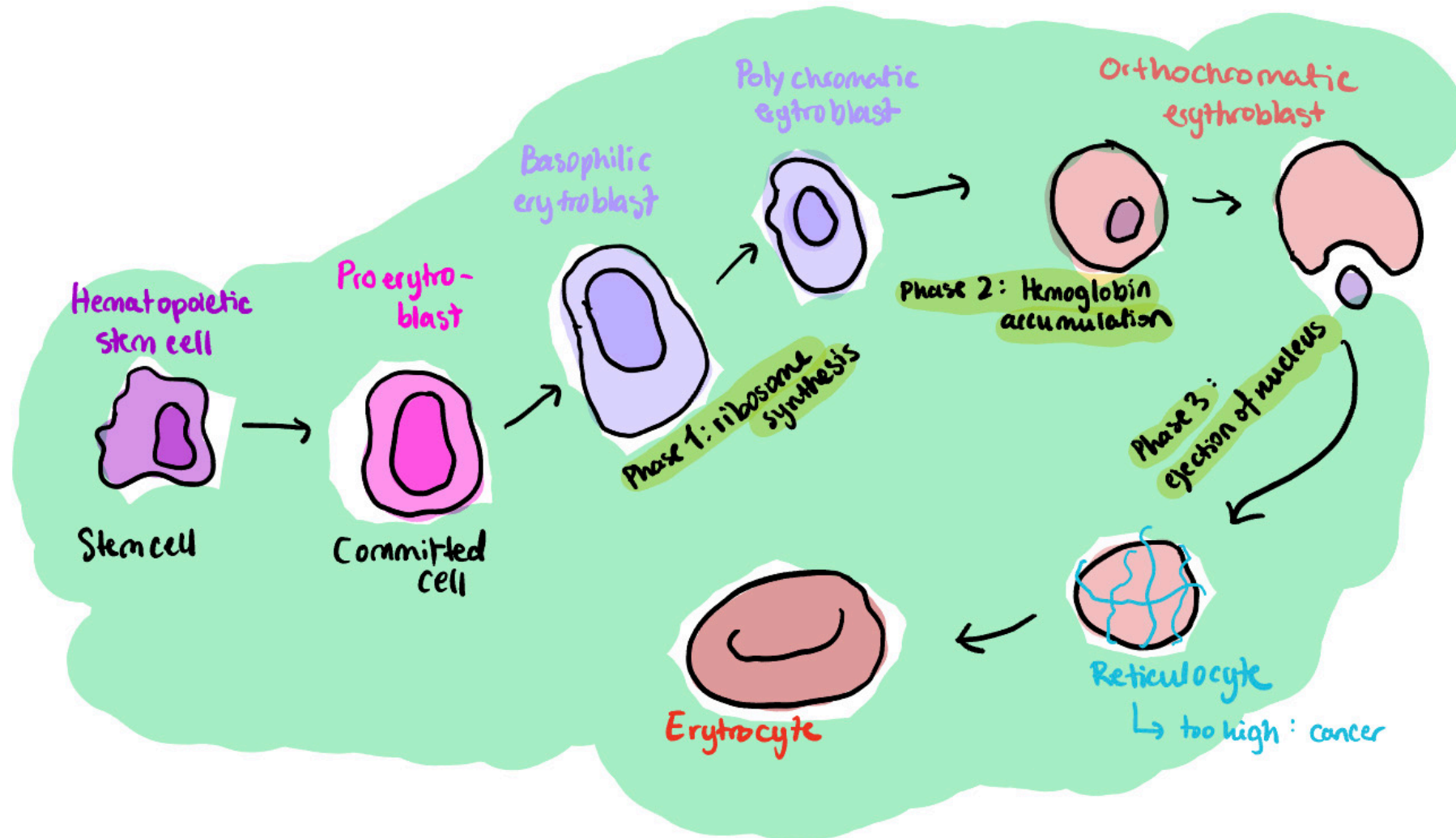


Erythropoiesis = production of RBC

- Reticulocytes → RBC
- ~0.5-2.5% of total RBC count
- High levels → pathology
(hemolytic anemia, bleeding, kidney disease, cancer)



Erythropoiesis

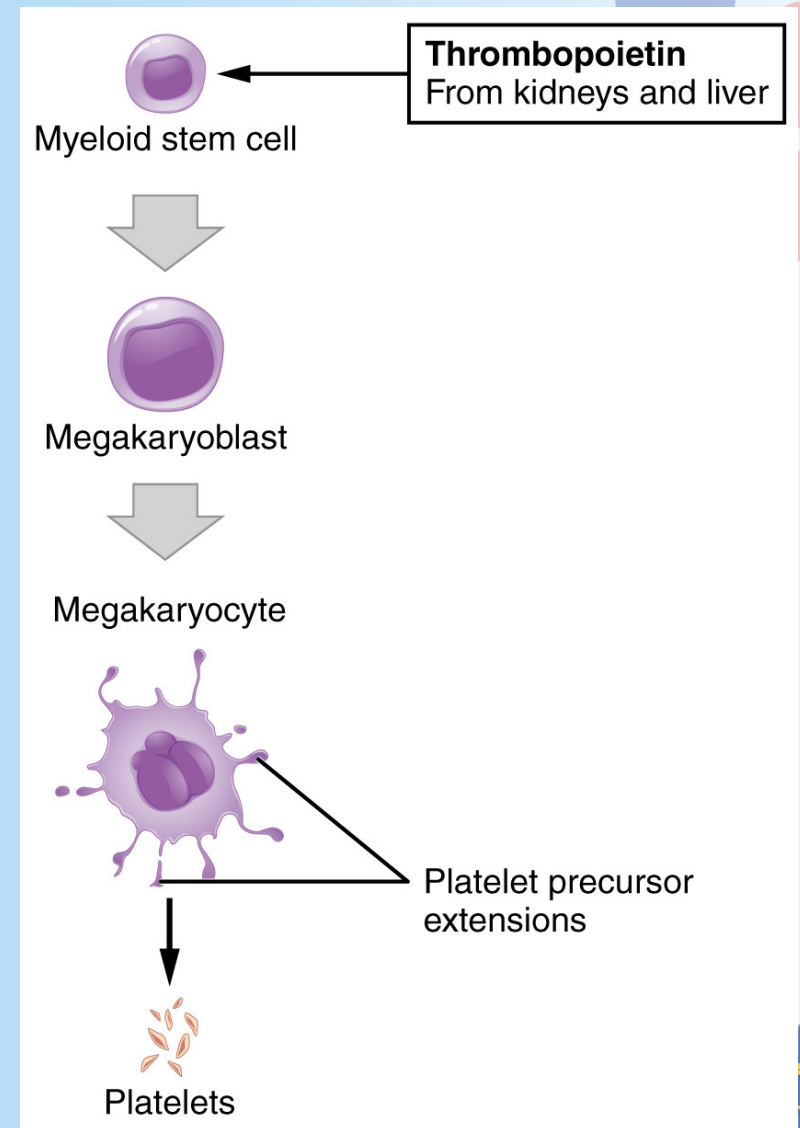
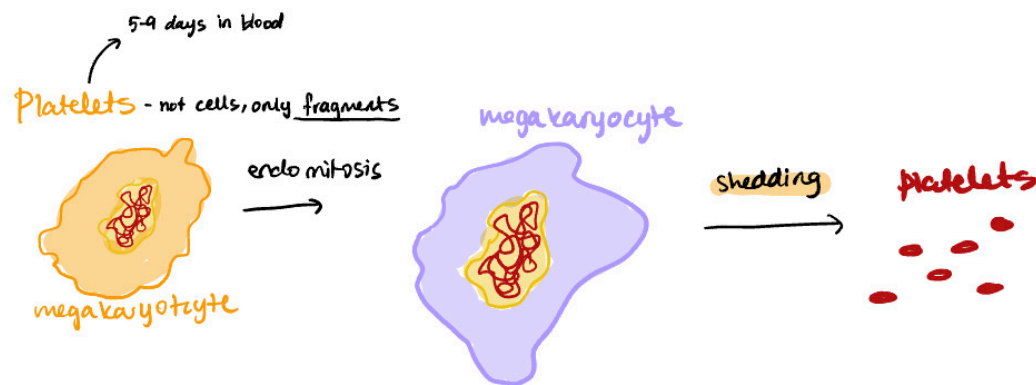


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Thrombopoiesis = production of platelets

- Bone marrow
- Normal range: **150,000 - 450,000** cells / mm³
- Stimulated by: TPO
- Rupture of megakaryocyte → platelets

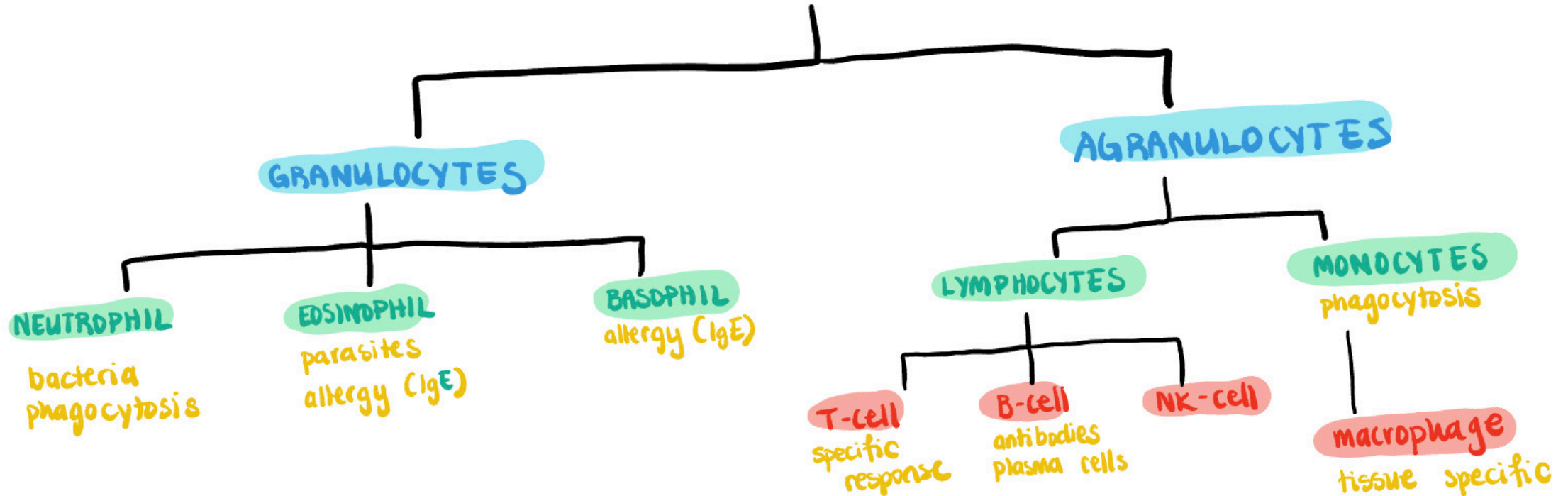
- Megakaryocytes: **NOT** in the blood
- **Primary hemostasis**
- Deficiency (thrombocytopenia) → Bleeding!



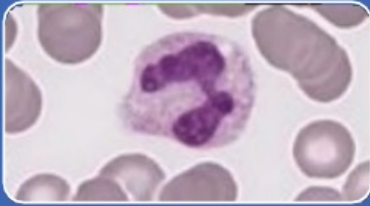
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4000 - 10 000 cells / mm³

TYPES OF WBC (leukocytes)

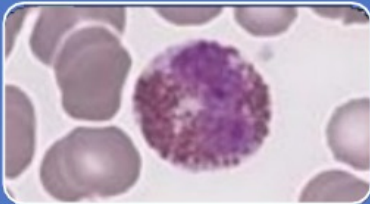


Granulocytes



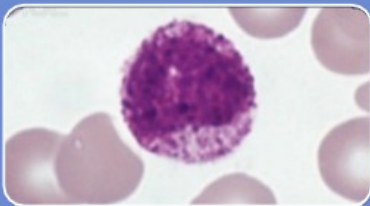
Neutrophils

- **Most abundant WBC (50-60%)**
- **"Front line"**
- Particularly effective against extracellular bacteria



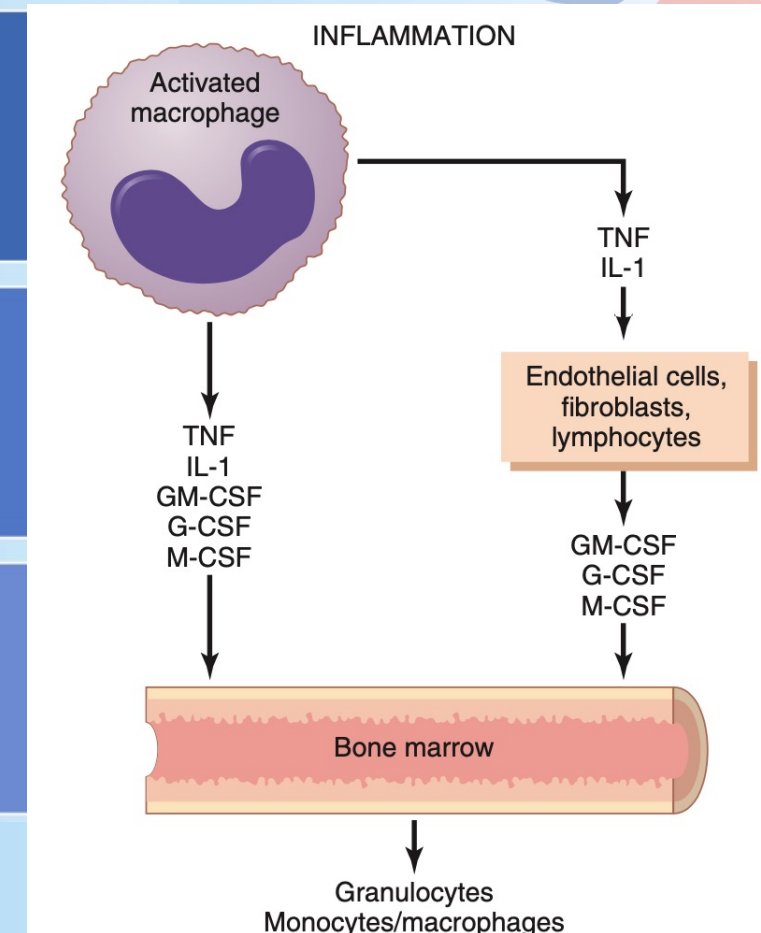
Eosinophils

- **Immune defense against parasites** - too large for phagocytosis
- Participate in allergic reactions
- Activated by IgE antibodies (IgE for Eosinophils)



Basophils

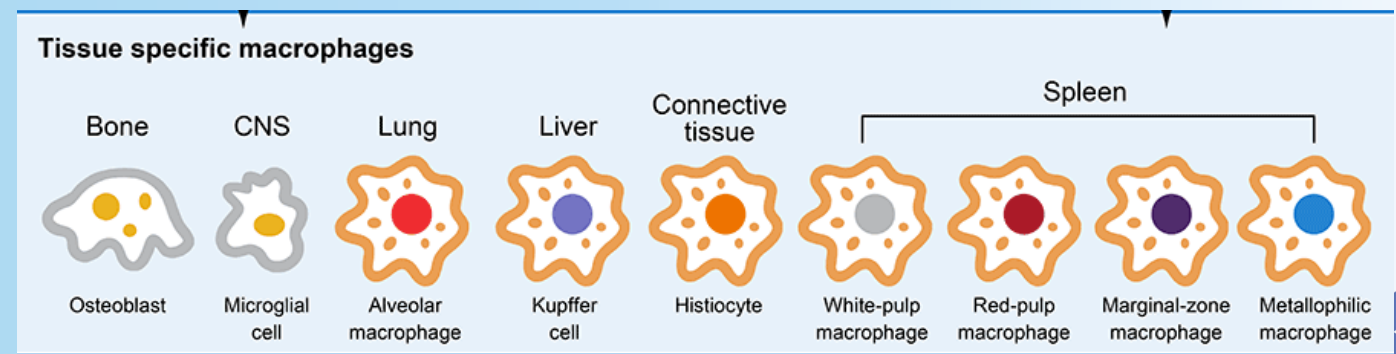
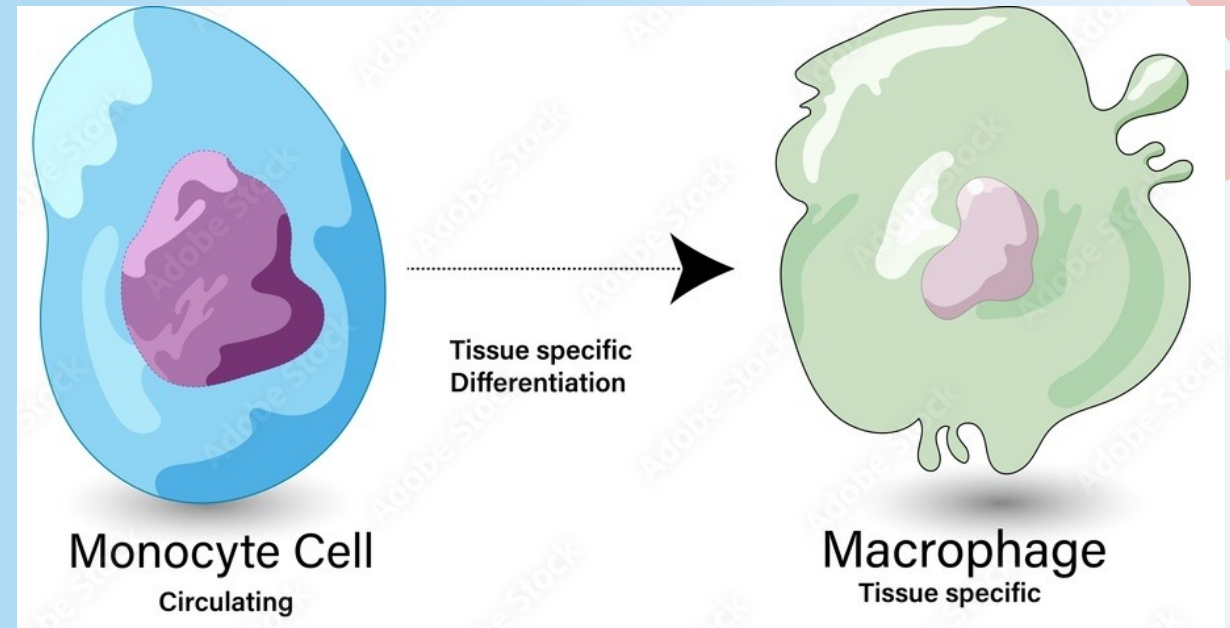
- Participate in **allergic and inflammatory reactions**
- Activated by IgE antibodies (IgE for allerg-E)



Macrophage production

- Production in bone marrow (monocytes)
- Colony stimulating factors (CSF's)
- Monocytes → macrophage (in the tissues)
- Phagocytosis
- Antigen-presentation

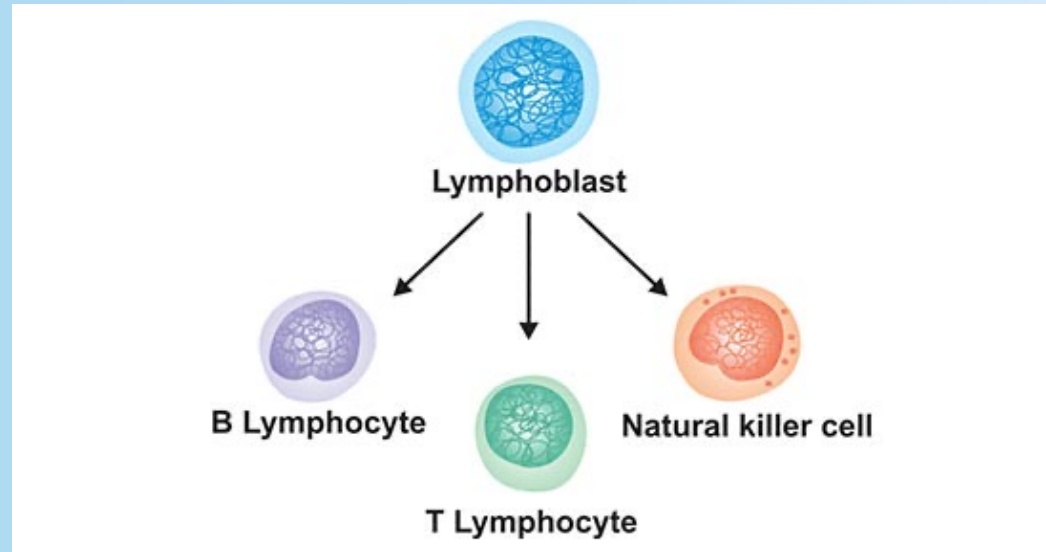
- Migrates into inflammatory sites, eats necrotic tissue



Lymphatic tissues:
SPLEEN; THYMUS;
TONSILS

Lymphocytes production

- Agranulocytes
- Lymphocytes = B-cells, T-cells, NK-cells
- Circulate in blood or in lymphatic tissues
- Highly antigen-specific
- B-cells are produced by AND mature in Bone marrow
- T-cells production = bone marrow
maturation = Thymus



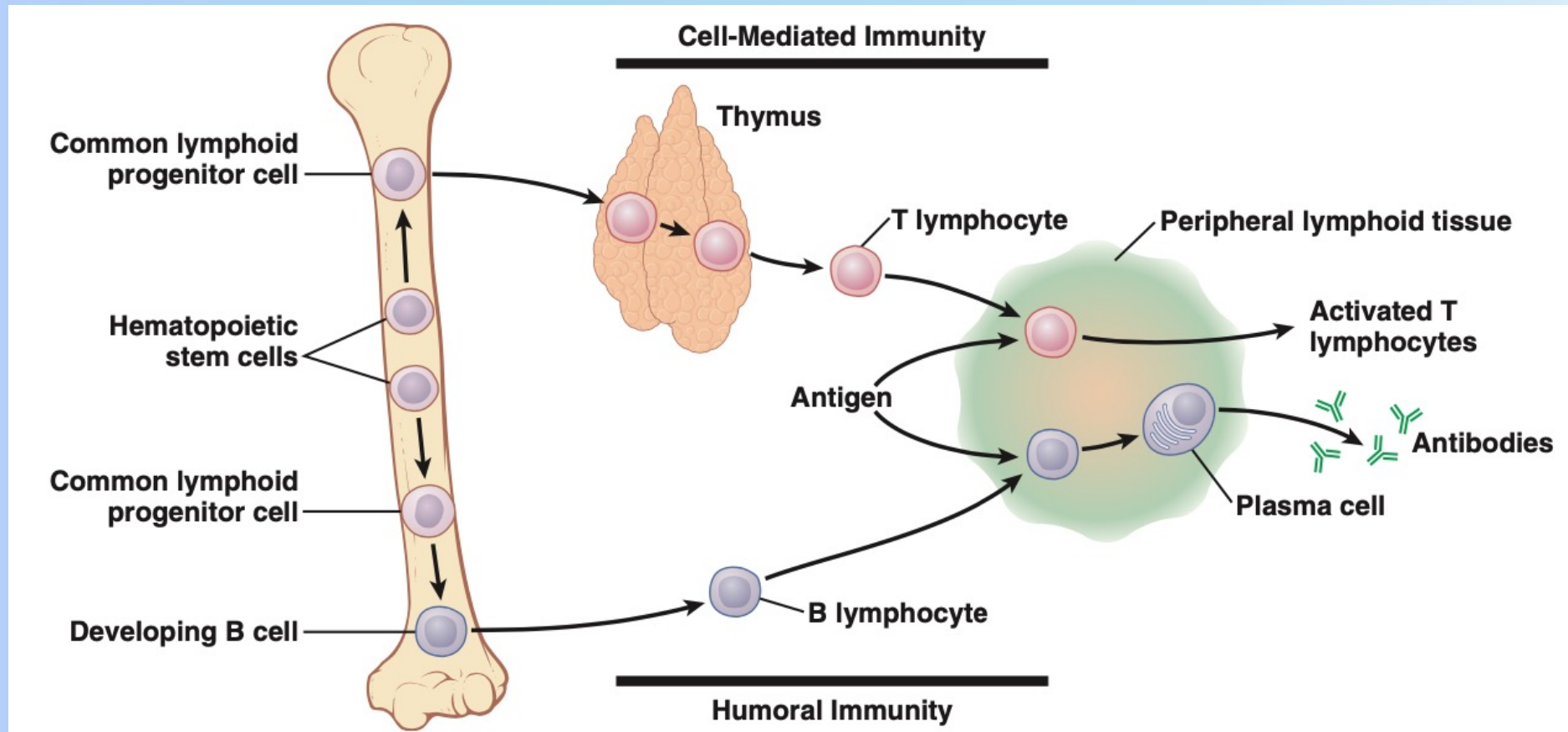
Lymphocytes functions

B-cells → humoral immunity

“plasma cells produce antibodies

T-cells → cell-mediated immunity

Cytotoxic T-cells (CD8+); Helper T-cells (CD4+)



	RBC	WBC	Platelets
Function	Transport O ₂ and CO ₂	Immune defense	Primary hemostasis
Normal range	4,000,000 – 10,000,000 cells/mm ³	4,000 – 10,000 cells/mm ³	150,000 – 400,000 cells/mm ³
% distribution	93%	>1 %	6-7%
Relative size	Medium	Large	Small
Life span	~ 120 days	Variable	8-9 days
Origin	Before birth – liver, spleen After birth - bone marrow	Bone marrow (mature in lymph organs)	Bone marrow
Stimulated by	EPO	Colony stimulating factors (CSF)	TPO

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Thank you!



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