

# Plasma, sel darah & platelet, kontrol hormonal

dian.eurike.s@ugm.ac.id

## A Fluid Connective Tissue

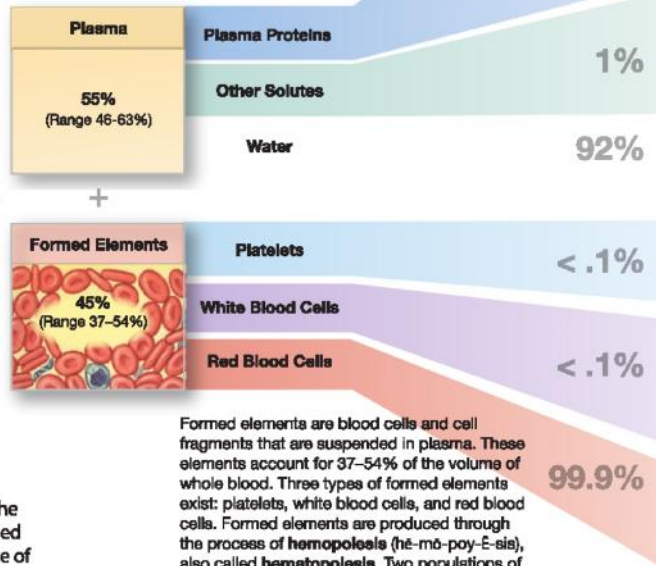
Blood is a fluid connective tissue with a unique composition. It consists of a matrix called **plasma** (PLAZ-muh) and formed elements (cells and cell fragments). The term **whole blood** refers to the combination of plasma and the formed elements. The cardiovascular system of an adult male contains 5–6 liters (5.3–6.4 quarts) of whole blood. An adult female contains 4–5 liters (4.2–5.3 quarts). The sex differences in blood volume primarily reflect differences in average body size.



The **hematocrit** (he-MAT-ō-krit) is the percentage of formed elements in a sample of blood. The normal hematocrit, or **packed cell volume (PCV)**, in adult males is 46 and in adult females is 42. The sex difference in hematocrit primarily reflects the fact that androgens (male hormones) stimulate red blood cell production, whereas estrogens (female hormones) do not.

## PLASMA

Plasma, the fluid matrix of blood, makes up 46–63% of the volume of whole blood. In many respects, the composition of plasma resembles that of interstitial fluid. This similarity exists because water, ions, and small solutes are continuously exchanged between plasma and interstitial fluids across the walls of capillaries. The primary differences between plasma and interstitial fluid involve (1) the levels of respiratory gases (oxygen and carbon dioxide, due to the respiratory activities of tissue cells), and (2) the concentrations and types of dissolved proteins (because plasma proteins cannot cross capillary walls).



Formed elements are blood cells and cell fragments that are suspended in plasma. These elements account for 37–54% of the volume of whole blood. Three types of formed elements exist: platelets, white blood cells, and red blood cells. Formed elements are produced through the process of **hemopoiesis** (he-mo-poy-ē-sis), also called **hematopoiesis**. Two populations of stem cells—myeloid stem cells and lymphoid stem cells—are responsible for the production of formed elements.

## FORMED ELEMENTS

## Komposisi darah

- Darah merupakan **jaringan ikat** terspesialisasi
- Komposisi:
  - Sel
  - Matrix extracellularis = **plasma**
- **Hematocrit**: persentase sel dalam darah (persentase erythrocytus dari volume total darah)

**TABLE 12-1**

**The composition of blood plasma.**

Plasma Component (Percentage of Plasma)	Functions
Water (~92% of plasma)	Is the solvent in which formed elements are suspended and proteins and solutes are dissolved
Plasma proteins (~7% of plasma)	All proteins serve to buffer against pH changes
Albumin (~58% of plasma proteins)	Exerts osmotic force to retain fluid within the microvasculature  Contributes to blood's viscosity  Binds and transports some fatty acids, electrolytes, hormones, and drugs
Globulins (~37% of plasma proteins)	$\alpha$ -Globulins transport lipids and some metal ions  $\beta$ -Globulins transport iron ions and lipids in bloodstream  $\gamma$ -Globulins are antibodies with various immune functions
Fibrinogen (~4% of plasma proteins)	Participates in blood coagulation (clotting); precursor of fibrin
Regulatory proteins (>1% of plasma proteins)	Consists of enzymes, proenzymes, hormones, and the complement system

## Komponen plasma darah

### Other Solutes (~1% of Blood Plasma)

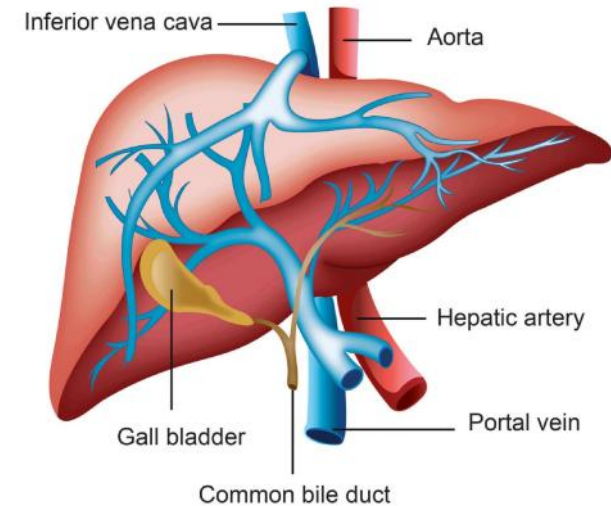
Electrolytes (eg, sodium, potassium, calcium, chloride, iron, bicarbonate, and hydrogen)	Help establish and maintain membrane potentials, maintain pH balance, and regulate osmosis (control of the percentages of water and salt in the blood)
--	--

Nutrients (eg, amino acids, glucose, cholesterol, vitamins, fatty acids)	Energy source; precursor for synthesizing other molecules
--	---

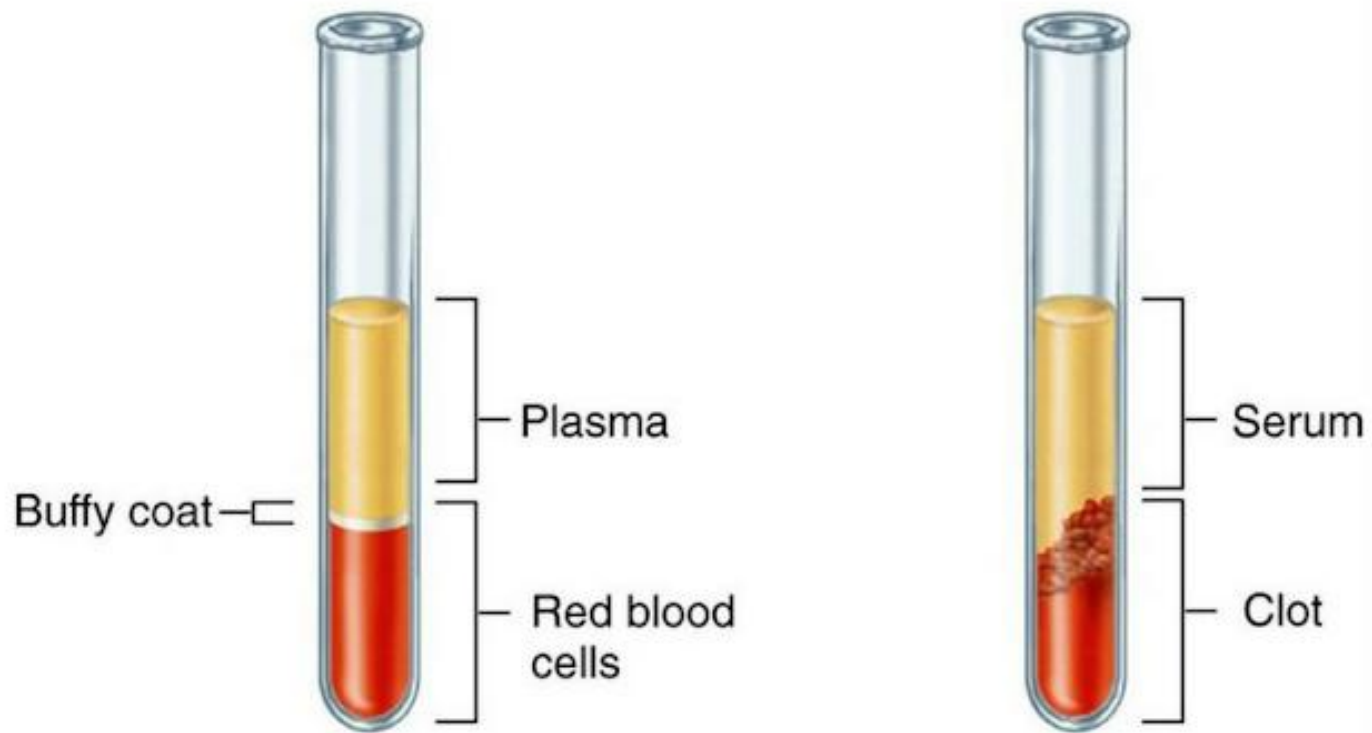
Respiratory gases (eg, oxygen: > 2% dissolved in plasma, 98% bound to hemoglobin within erythrocytes; and carbon dioxide: ~7% dissolved in plasma, ~27% bound to hemoglobin within erythrocytes, ~66% converted to $\text{HCO}_3^-$ )	Oxygen is needed for aerobic cellular respiration; carbon dioxide is a waste product produced by cells during this process
---	--

Wastes (breakdown products of metabolism) (eg, lactic acid, creatinine, urea, bilirubin, ammonia)	Waste products serve no function in the blood plasma; they are merely being transported to the liver and kidneys where they can be removed from the blood
---	---

- Kecuali  $\gamma$ -globulin, protein plasma diproduksi di hepar

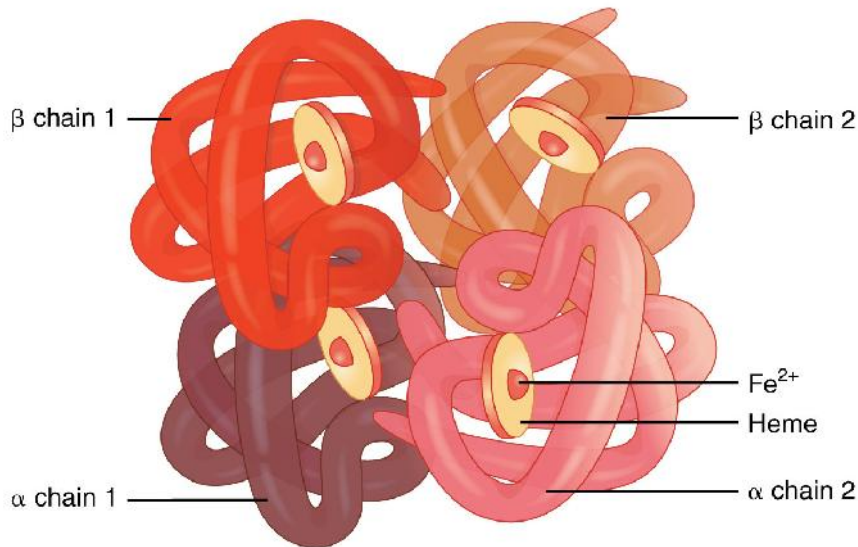
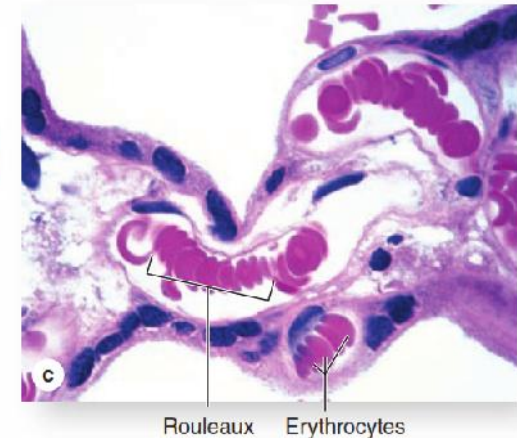
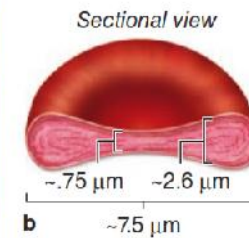
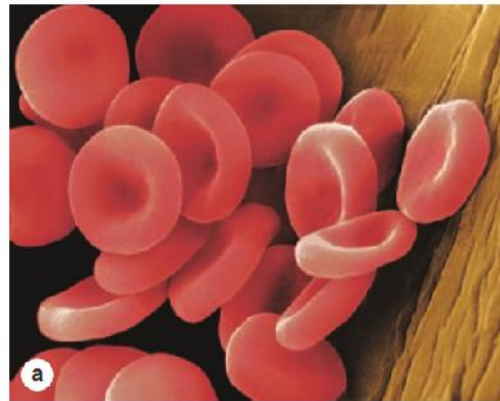
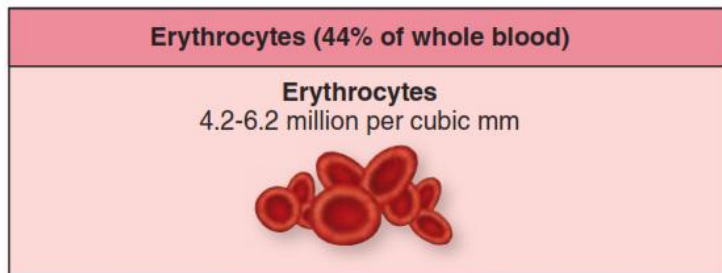


## Blood Plasma vs Blood Serum



**Serum = plasma – faktor koagulasi**

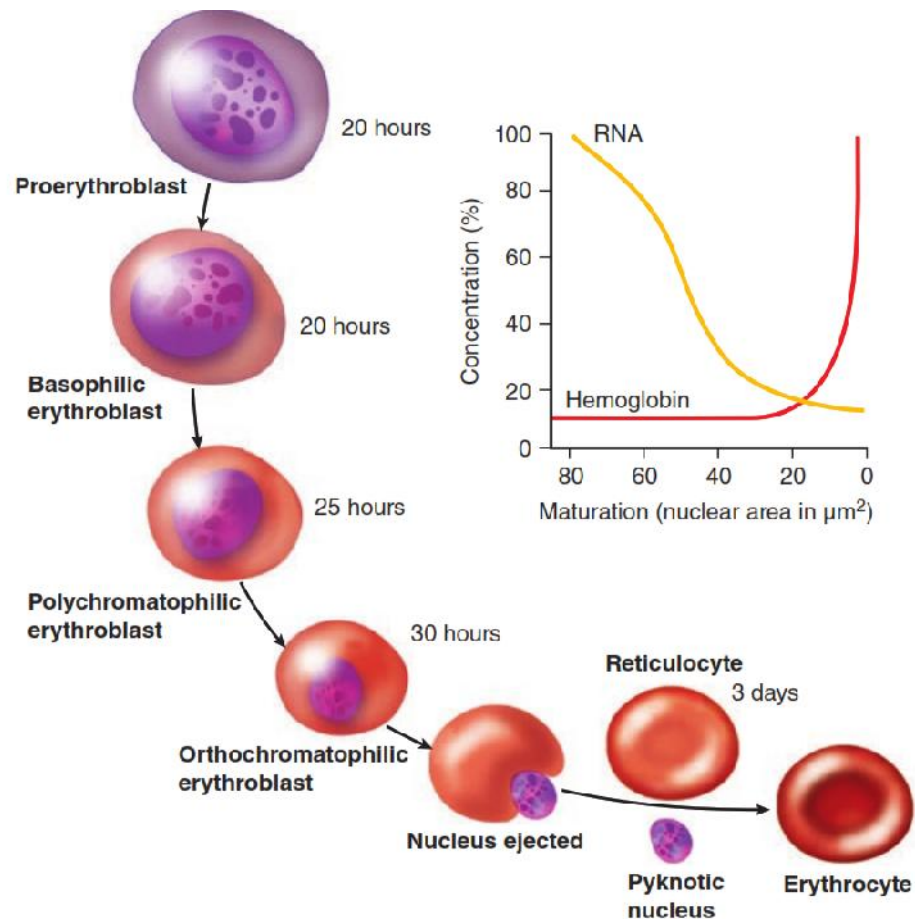
# Erythrocytus: mentranspor O<sub>2</sub>



**hemoglobin**

- **Bikonkaf:** memperluas area permukaan; mempercepat difusi O<sub>2</sub> dari erythrocytus ke plasma dan sebaliknya
- Fleksibel
- **Hemoglobin:** globin & heme (mengandung Fe<sup>2+</sup>, yang mengikat O<sub>2</sub>)
- Tidak memiliki nucleus & organella sel lainnya

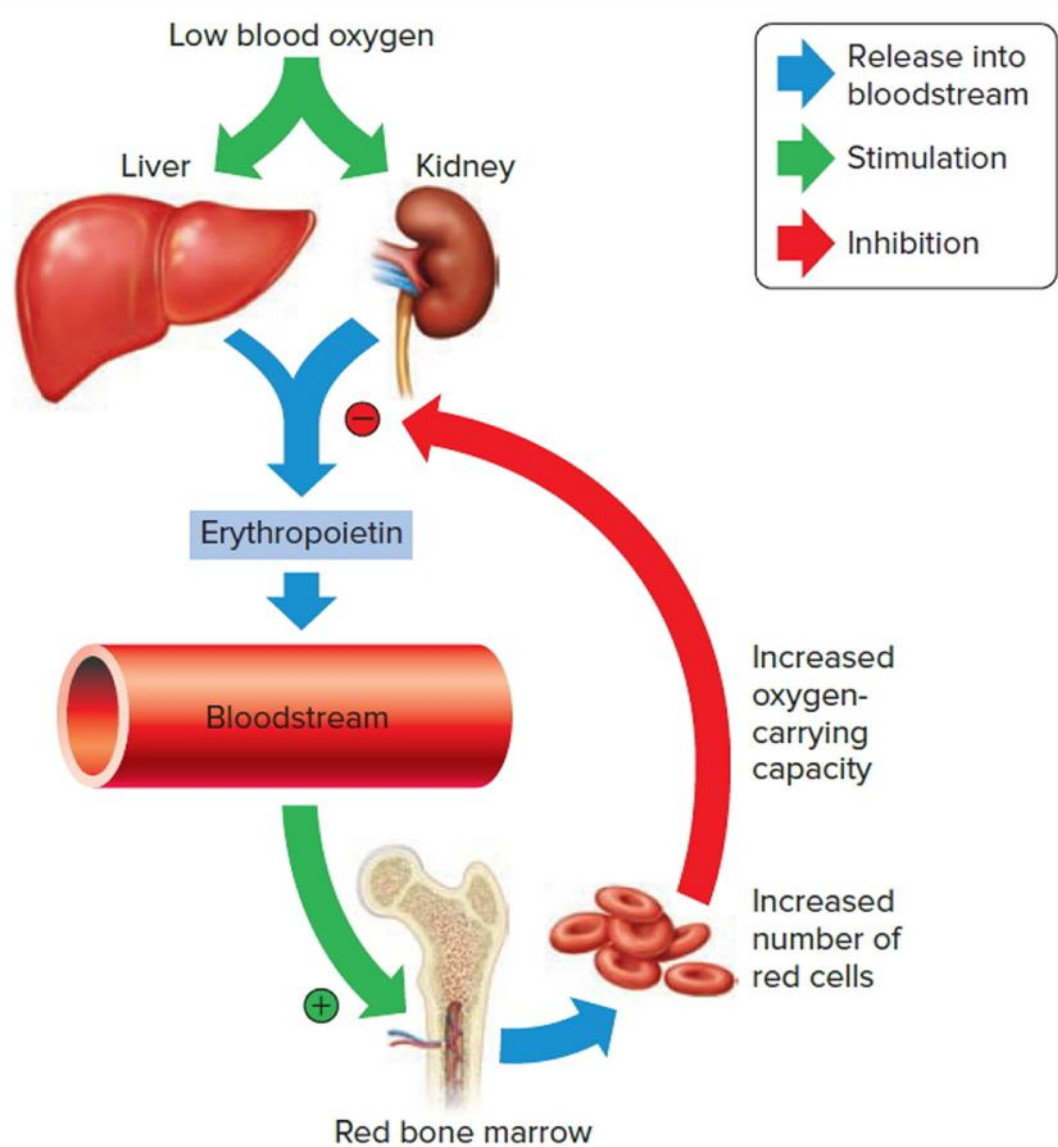
# Erythropoiesis berlangsung di sumsum tulang



- Sintesis Hb mulai terjadi di proerythroblastus
- Normoblastus: nucleus diejeksi
- Maturasi erythrocytus perlu **vitamin B12 & asam folat**
- Erythropoiesis distimulasi oleh **erythropoietin (EPO)**

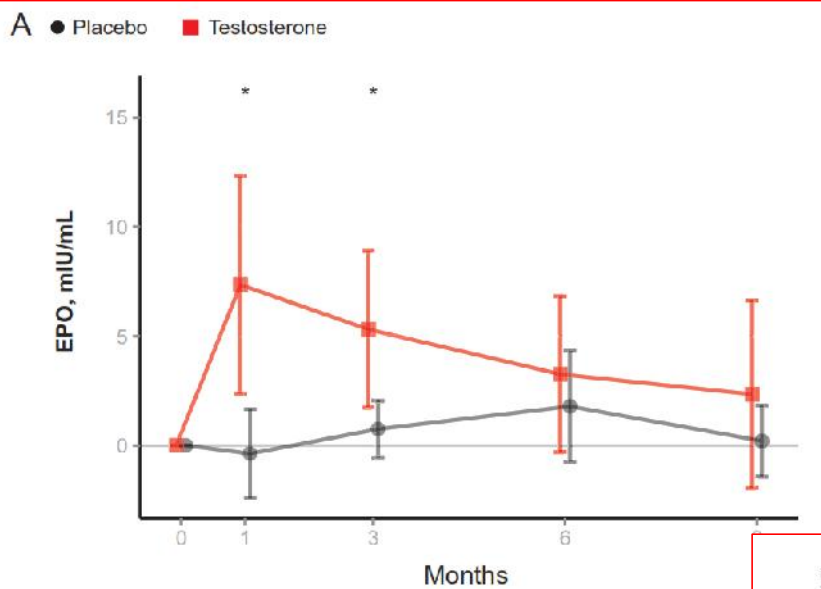
# Erythropoietin menstimulasi erythropoiesis

- Distimulasi oleh **hipoksia** yang dapat disebabkan:
  - Anemia
  - Penurunan aliran darah ke ginjal
  - Penurunan konsentrasi O<sub>2</sub> di udara pada alveolus
  - Kelainan/penyakit paru
- Fungsi: menstimulasi erythropoiesis & mempercepat maturasi erythrocytus (mempercepat sintesis Hb)

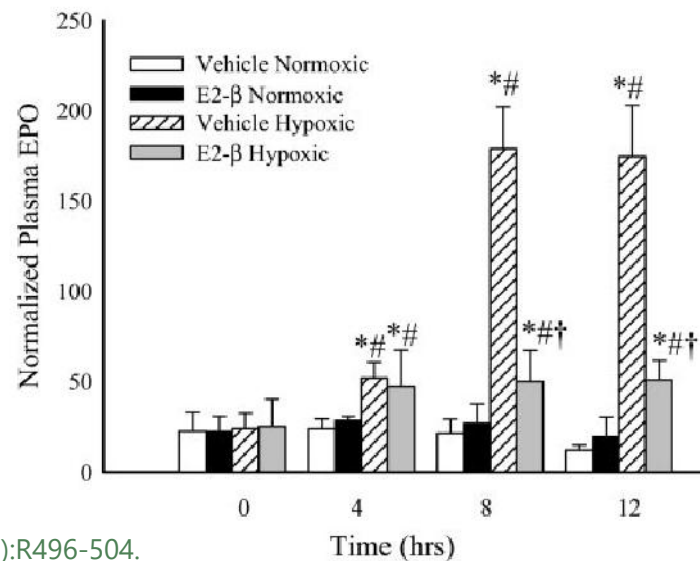


## Hormon-hormon yang meregulasi erythropoiesis

- Hormon pertumbuhan (*growth hormone*) & thyroxine menstimulasi erythropoiesis



**Testosterone meningkatkan konsentrasi EPO**

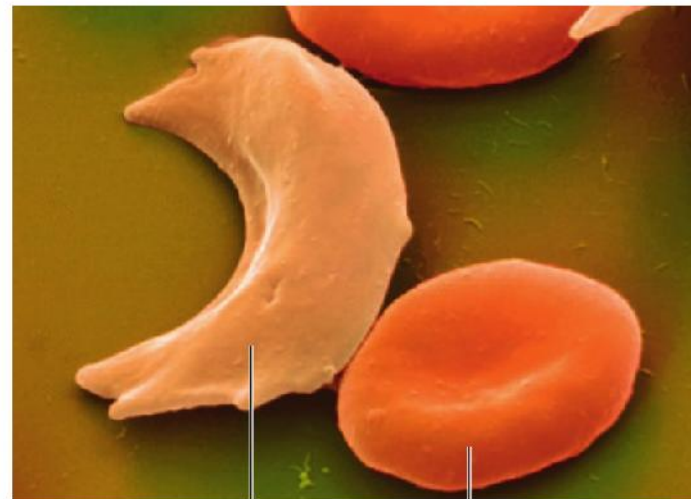
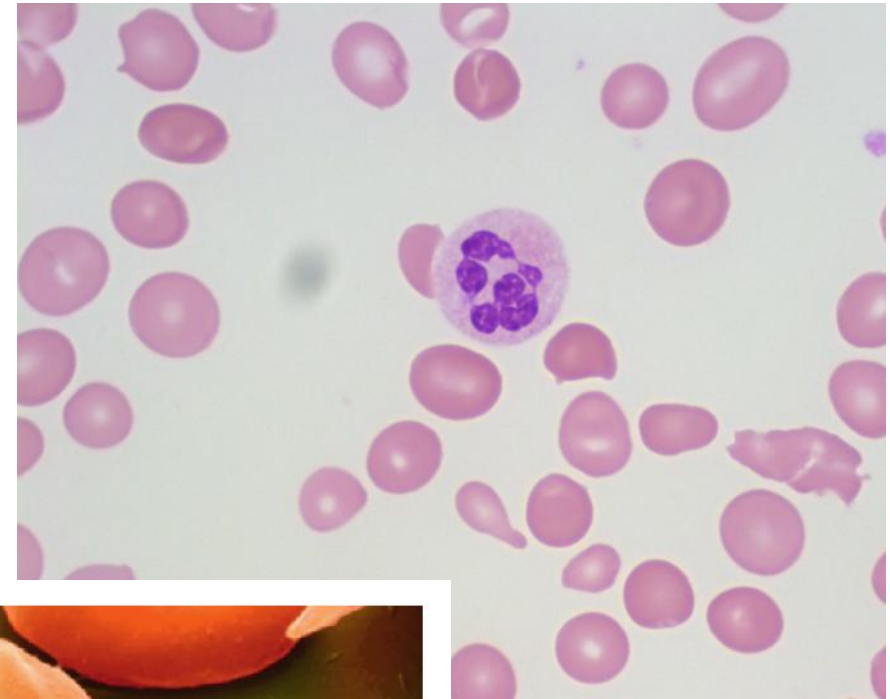


**17β - Estradiol mensupresi produksi EPO pada saat terjadi hipoksia**



**Anemia:** penurunan jumlah erythrocytus atau defisiensi Hb

- Defisiensi vit. B12 & asam folat: **anemia megaloblastik**
- Penyebab defisiensi vit . B12:
  - Kegagalan absorpsi karena defisiensi faktor instrinsik
- **Anemia aplastik**
- **Anemia hemorrhagik**
- **Anemia hemolitik**
  - Malaria
  - *Sickle cell disease*
  - Erythroblastosis fetalis



Sickle-shaped red blood cell

Normal-shaped red blood cell

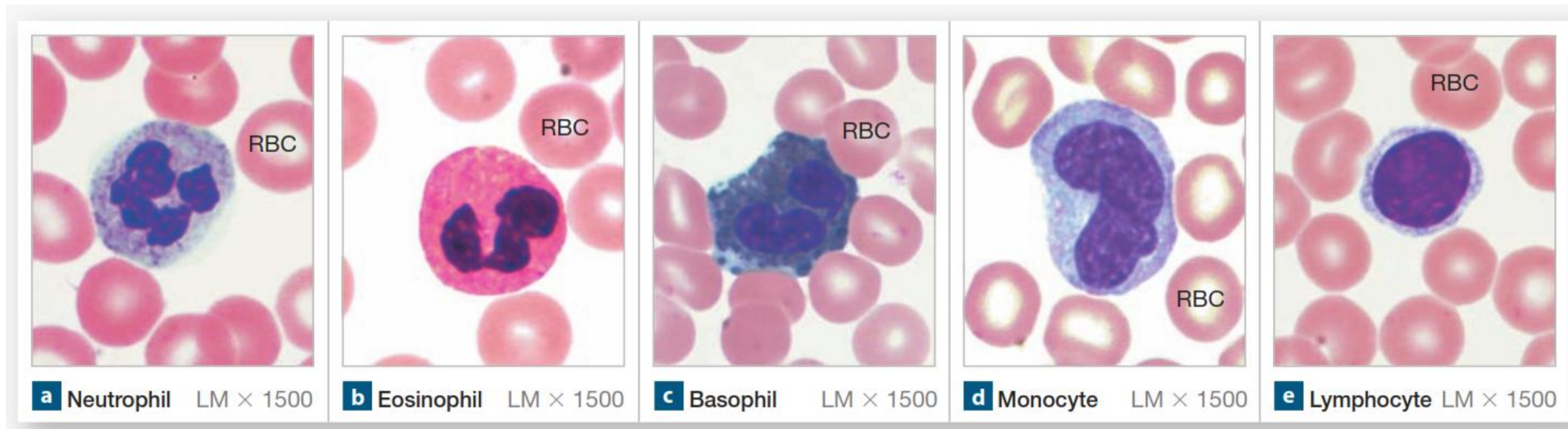
Eye of Science/Science Source

## **Polycythemia:** peningkatan jumlah erythrocytus

- Polycythemia fisiologis
- Polycythemia sekunder
- Polycythemia vera



Leukocytus: berperan dalam inflamasi & pertahanan tubuh terhadap pathogen

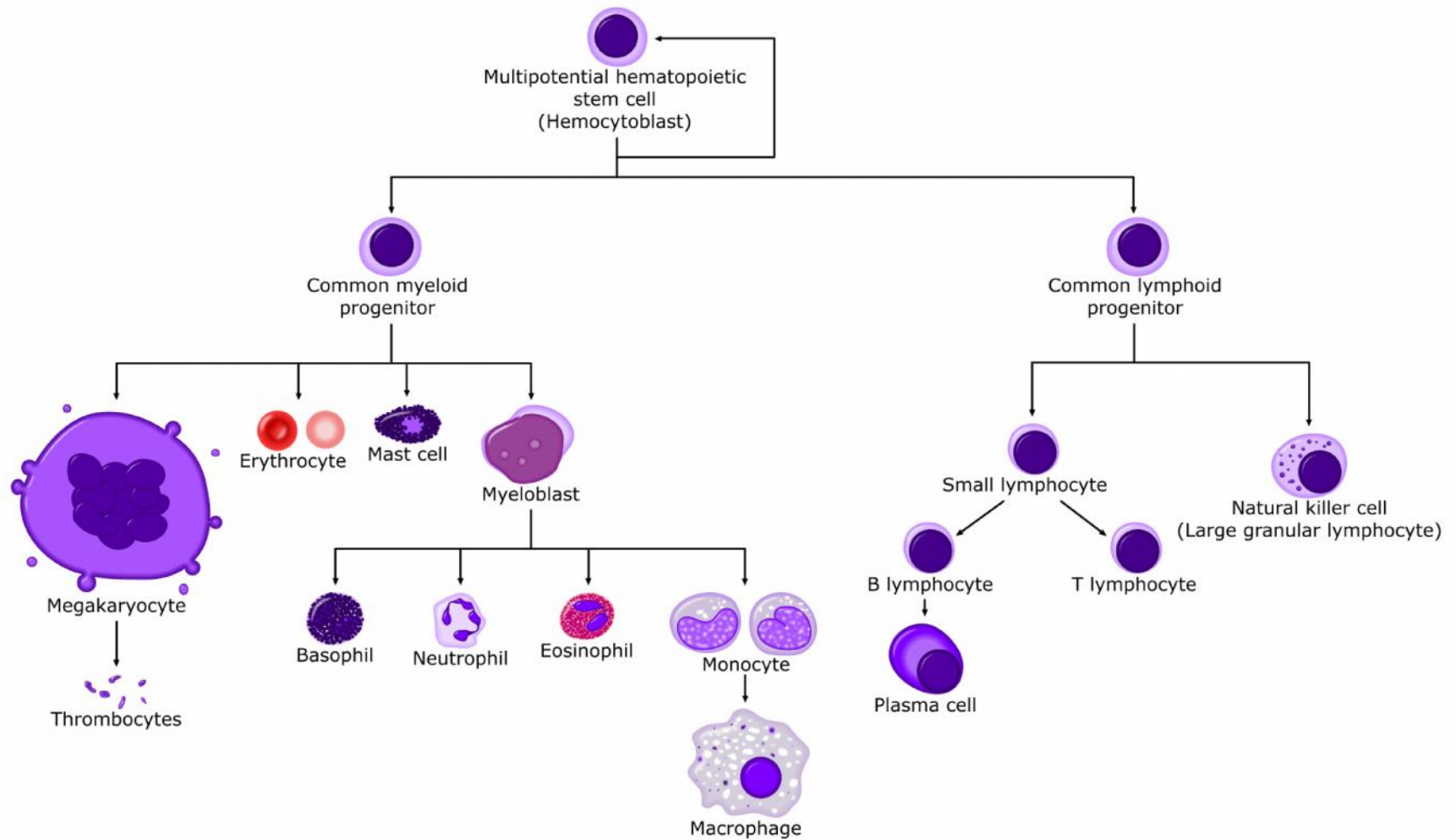


granulocytus

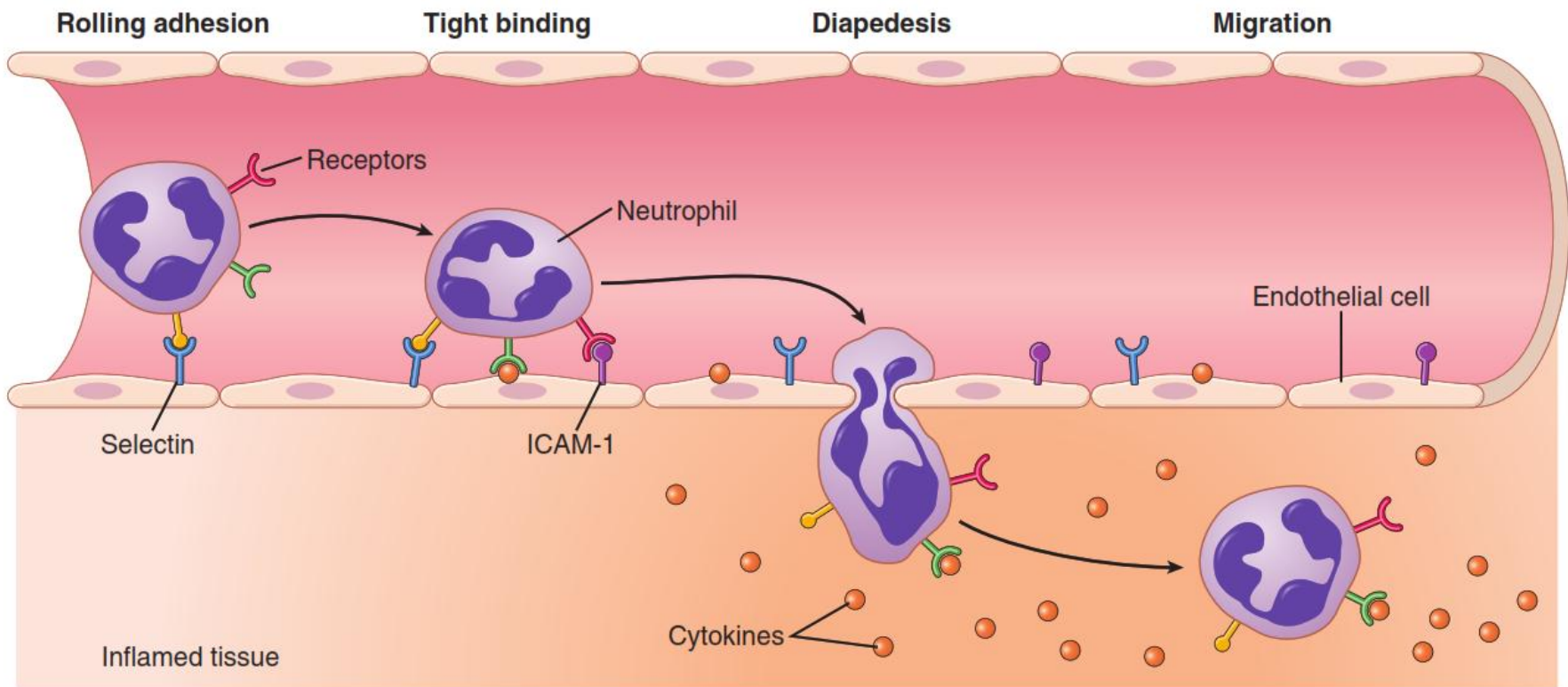
agranulocytus

Leukocytus diproduksi di sumsum tulang (lymphocytus T diproduksi di sumsum tulang kemudian mengalami maturasi di thymus), kemudian menuju sirkulasi dan jaringan untuk melakukan aksinya

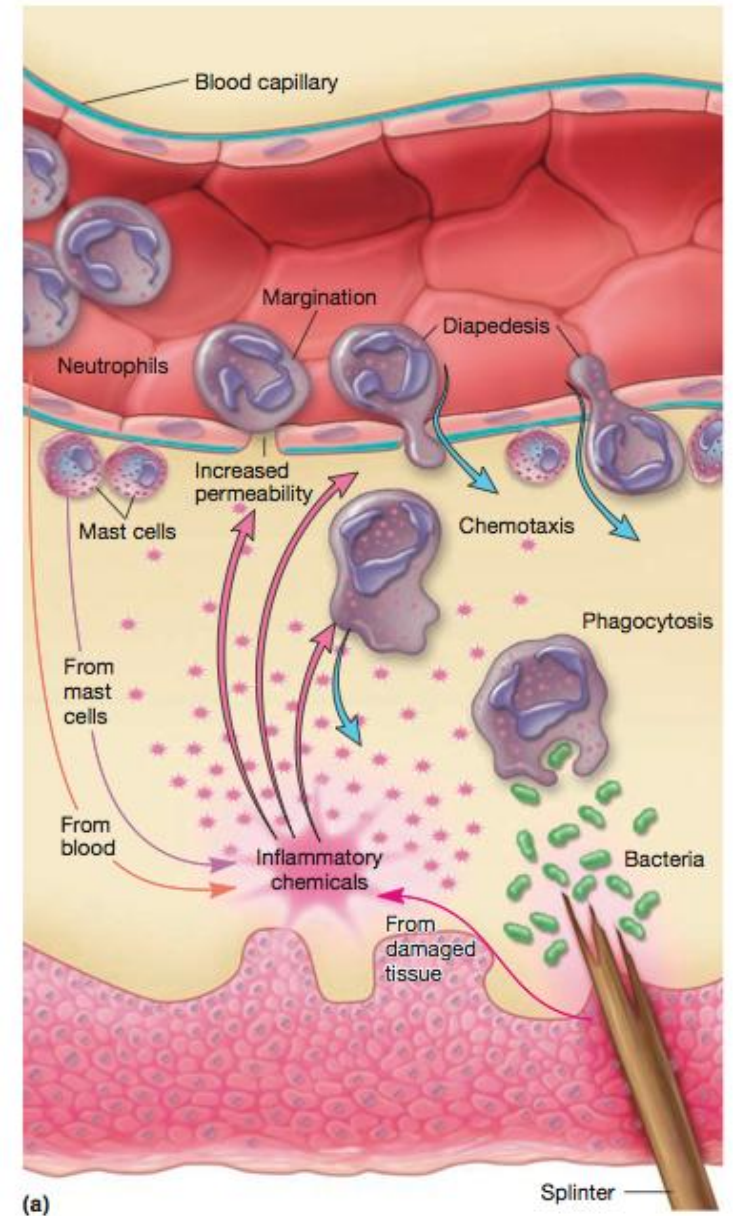
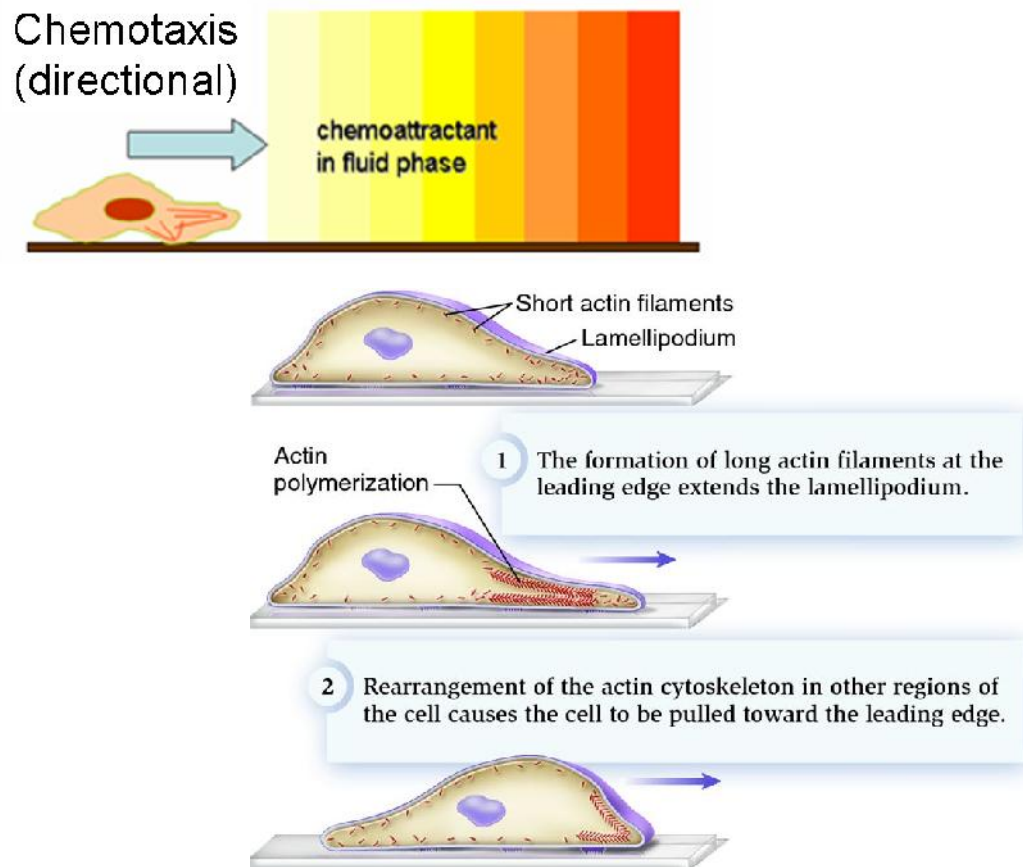
# Leukopoiesis



Leukocytus keluar dari vasa darah menuju jaringan dengan **diapedesis**

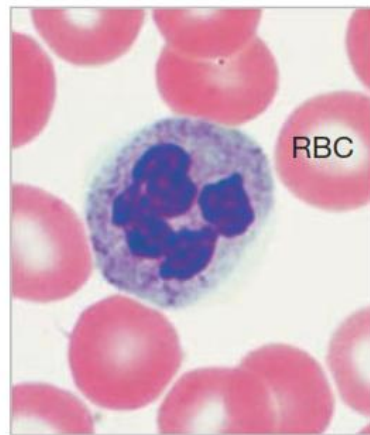


# Leukocytus melakukan **chemotaxis** dengan **gerakan ameboid**

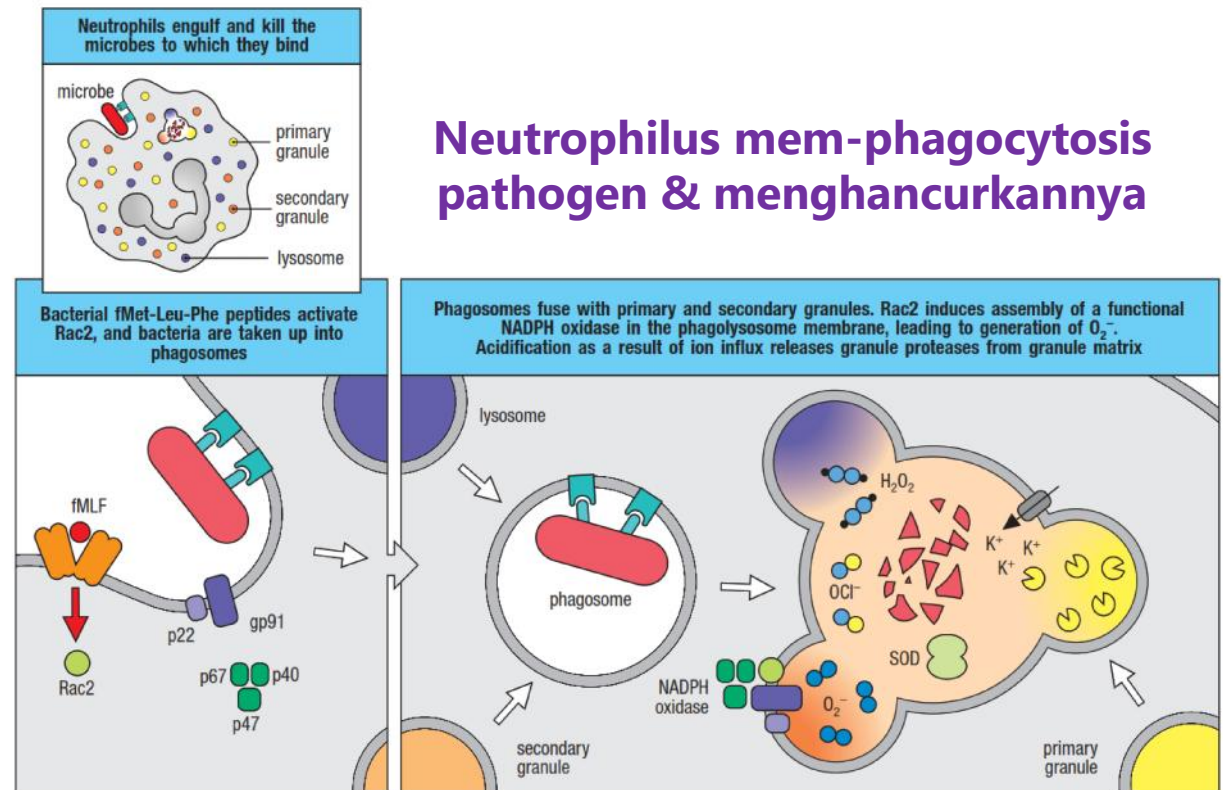


# Neutrophilus: sel yang pertama kali tiba di jaringan pada saat ada invasi pathogen

- Memproduksi **enzim antimikroba** (lysozyme, defensin, myeloperoksidase), collagenase, **sitokin**



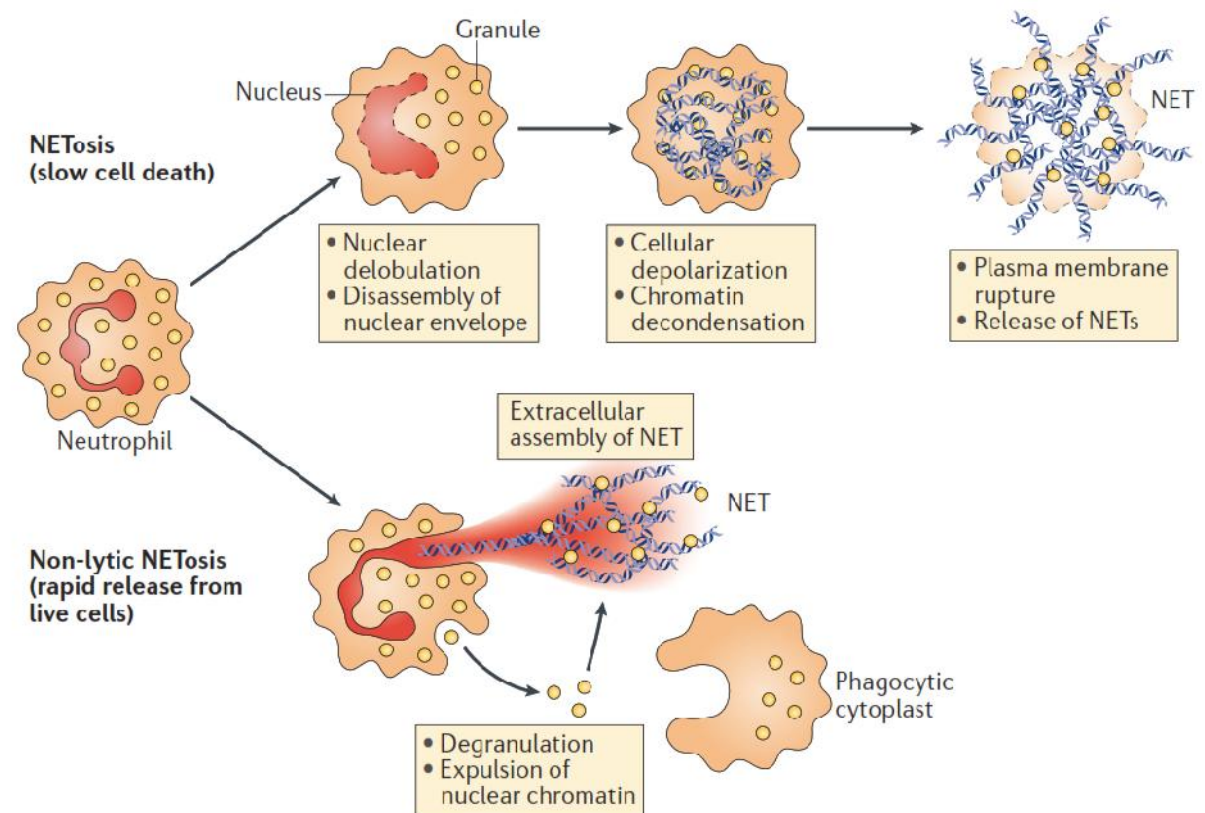
**a** Neutrophil LM × 1500



**Neutrophilus mem-phagocytosis pathogen & menghancurkannya**

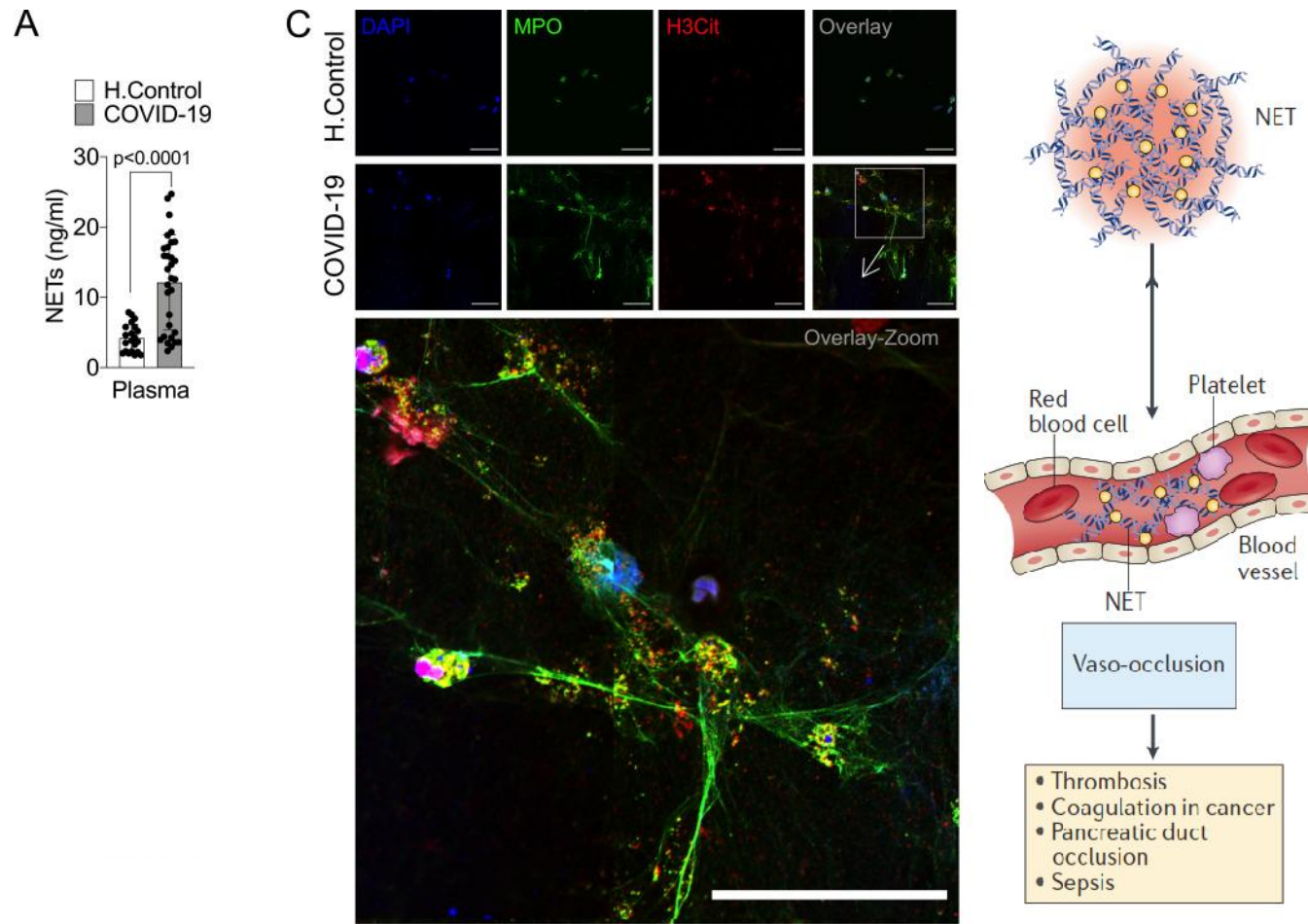
# Neutrophil extracellular traps (NET)

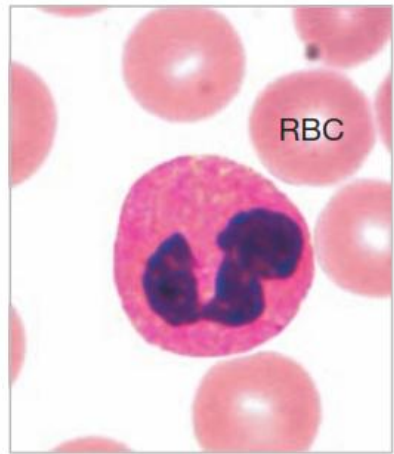
- Struktur ekstraseluler seperti jala yang tersusun atas chromatin & granula protein (myeloperoxidase, elastase)
- Berfungsi untuk memerangkap, menetralkan, & membunuh pathogen (mencegah penyebaran pathogen)





# Infeksi SARS-CoV-2 menginduksi produksi NET. Kadar NET pada pasien COVID-19 lebih tinggi dibandingkan orang sehat



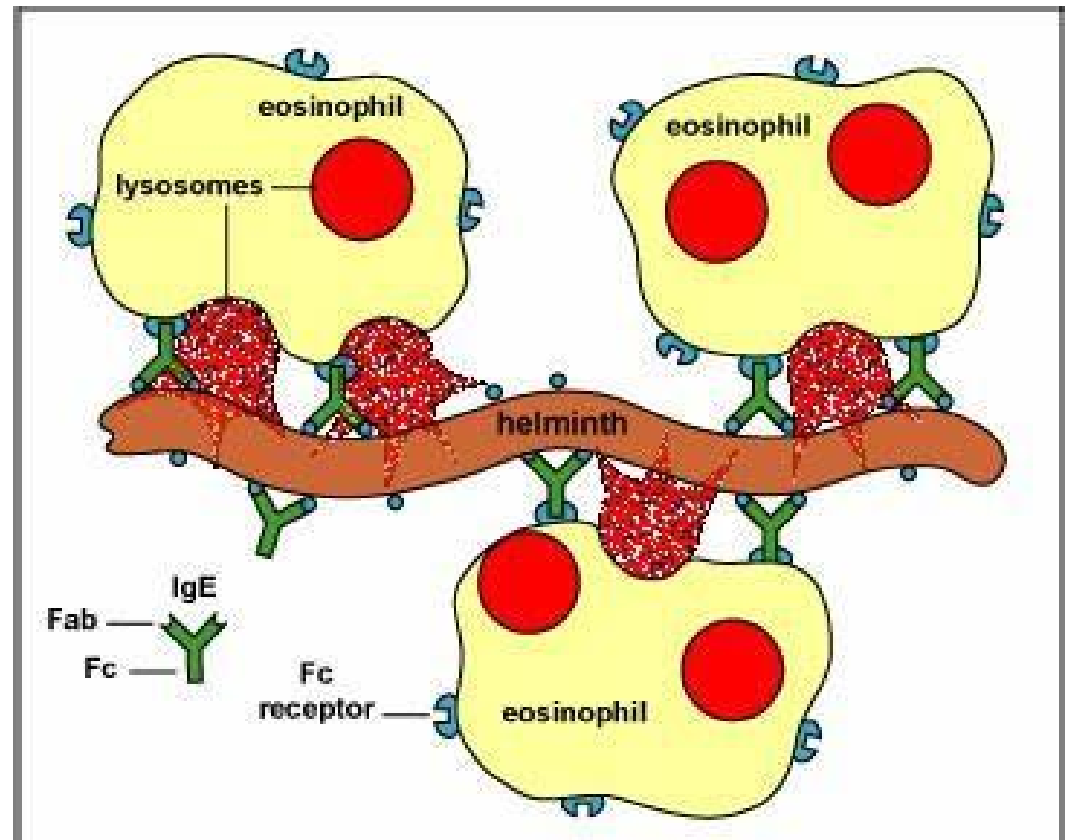


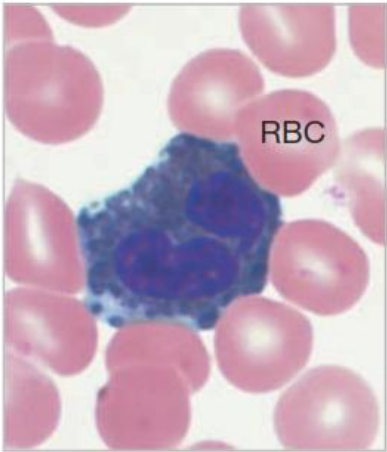
**b** Eosinophil LM × 1500

## Eosinophilus memiliki reseptor IgE

Eosinophilia:

- **Infeksi parasit**
- **Reaksi alergi**

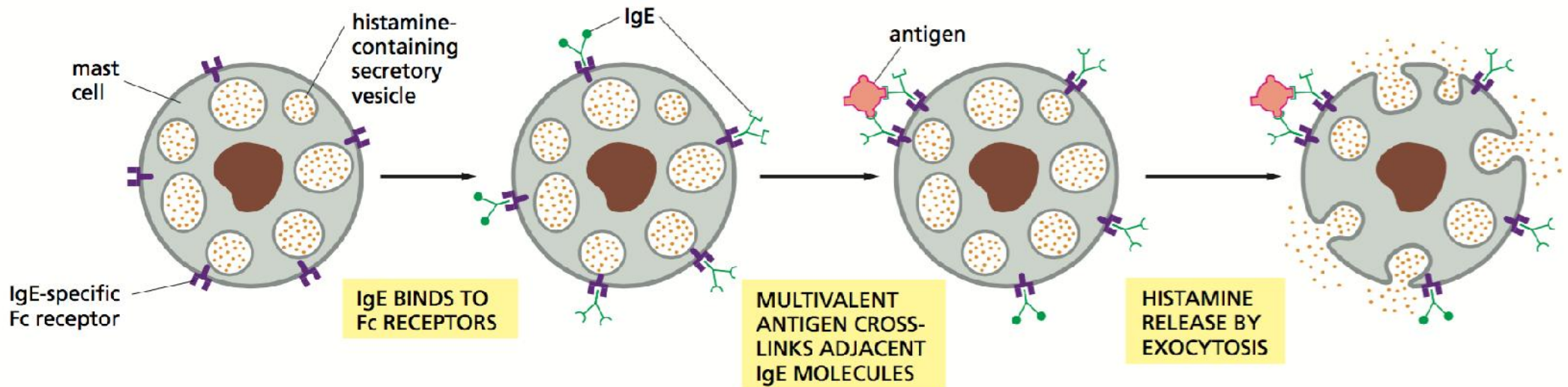


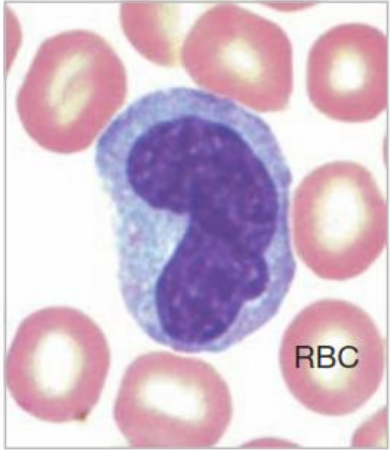


## Basophilus berperan dalam reaksi alergi

- Memiliki reseptor IgE
- Mensintesis **histamin & heparin**

**c** Basophil LM × 1500



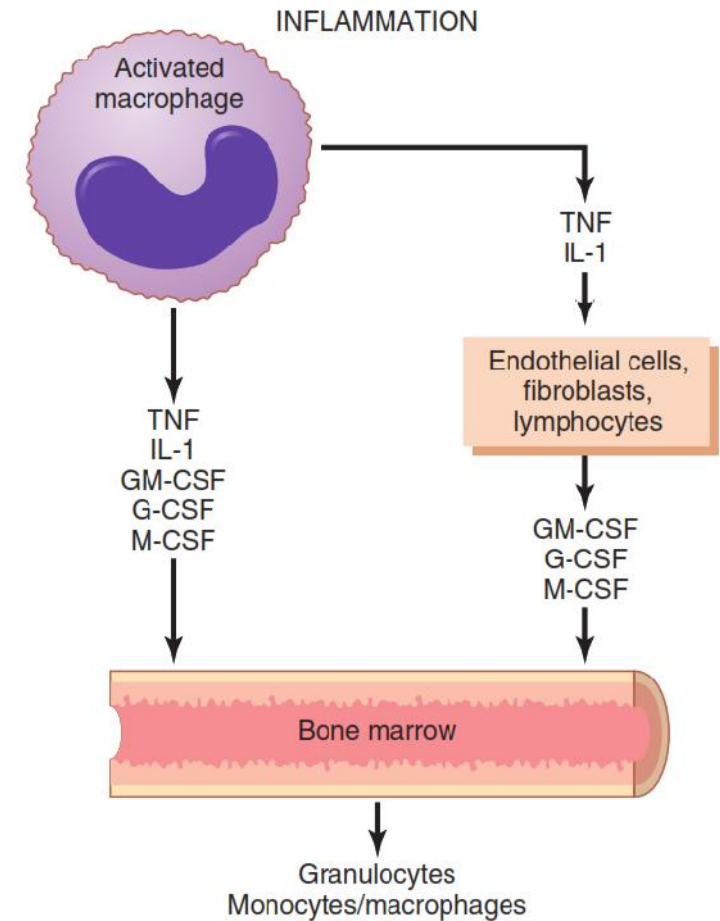
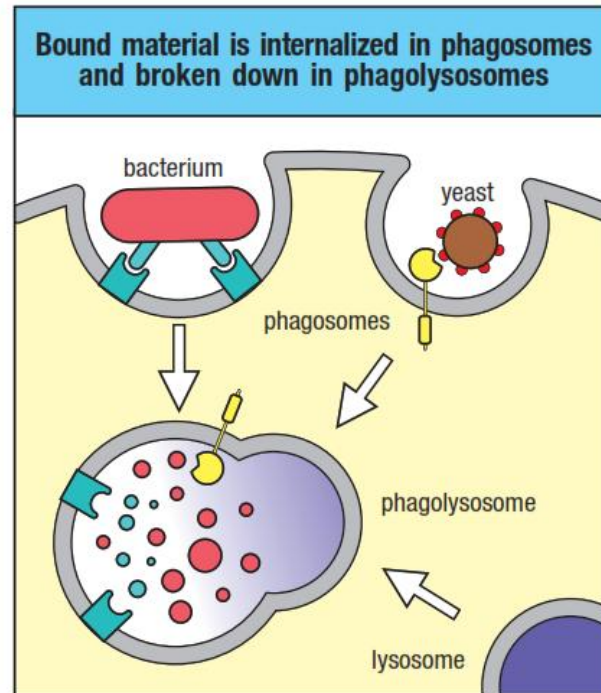
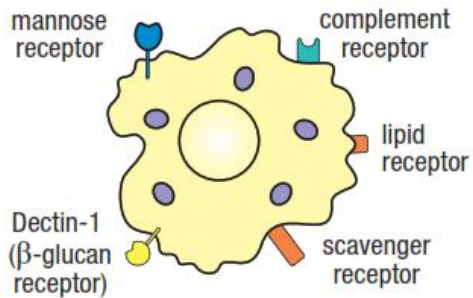


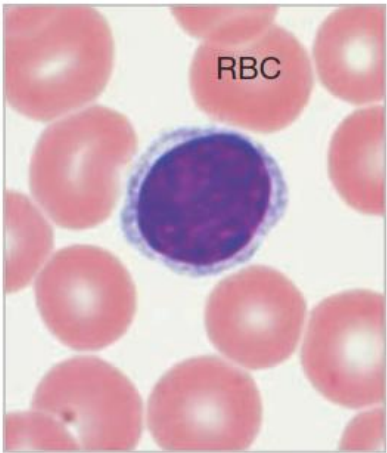
**d** Monocyte LM × 1500

## Monocytus merupakan precursor **macrophagocytus**

- Macrophagocytus: mem-phagocytosis dan mendestruksi pathogen, sel yang apoptosis
- Memproduksi sitokin & faktor pertumbuhan

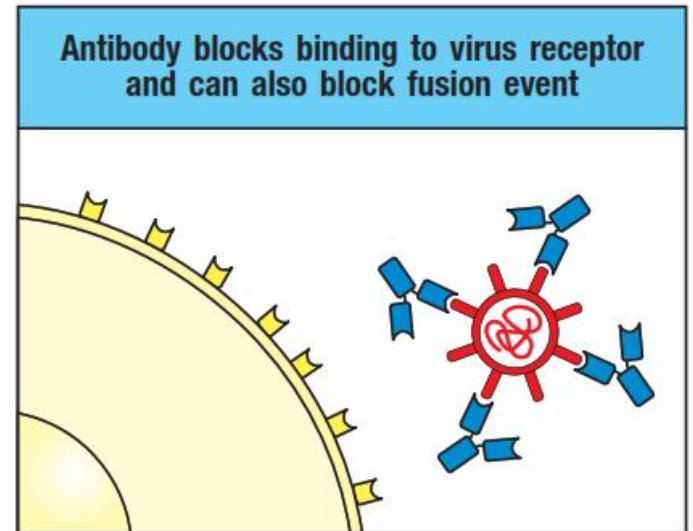
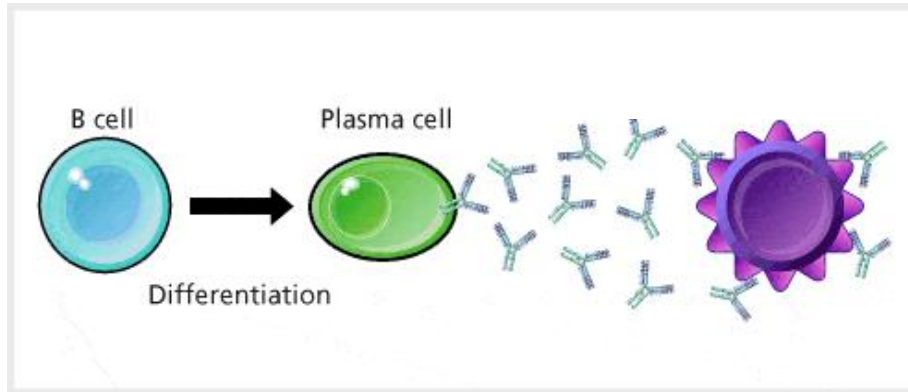
### Macrophages have phagocytic receptors that bind microbes and their components



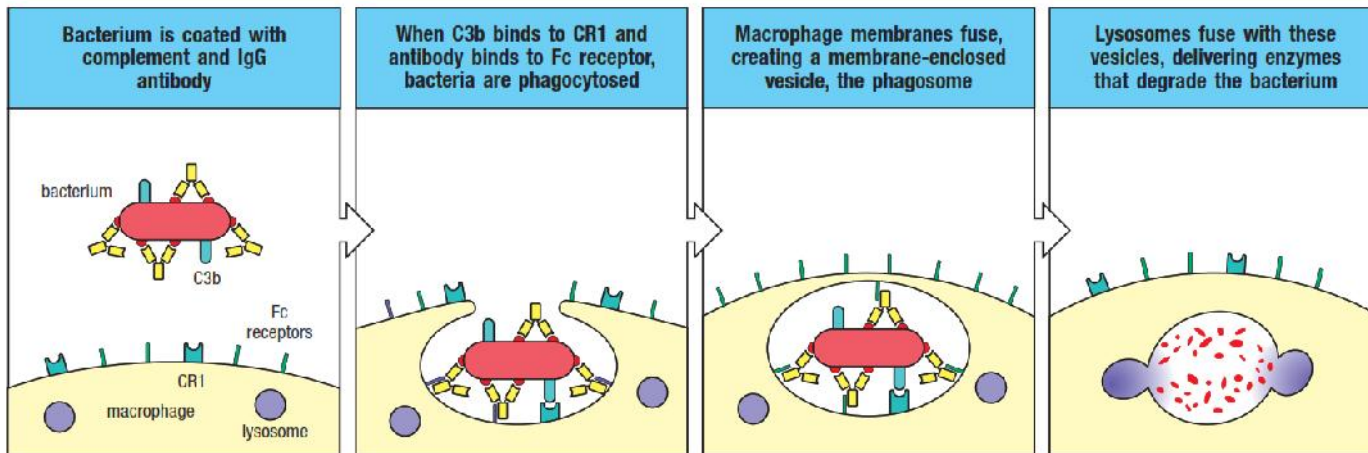


e Lymphocyte LM × 1500

Lymphocytus B berdiferensiasi menjadi **sel plasma (plasmocytus)** & menghasilkan **antibodi**

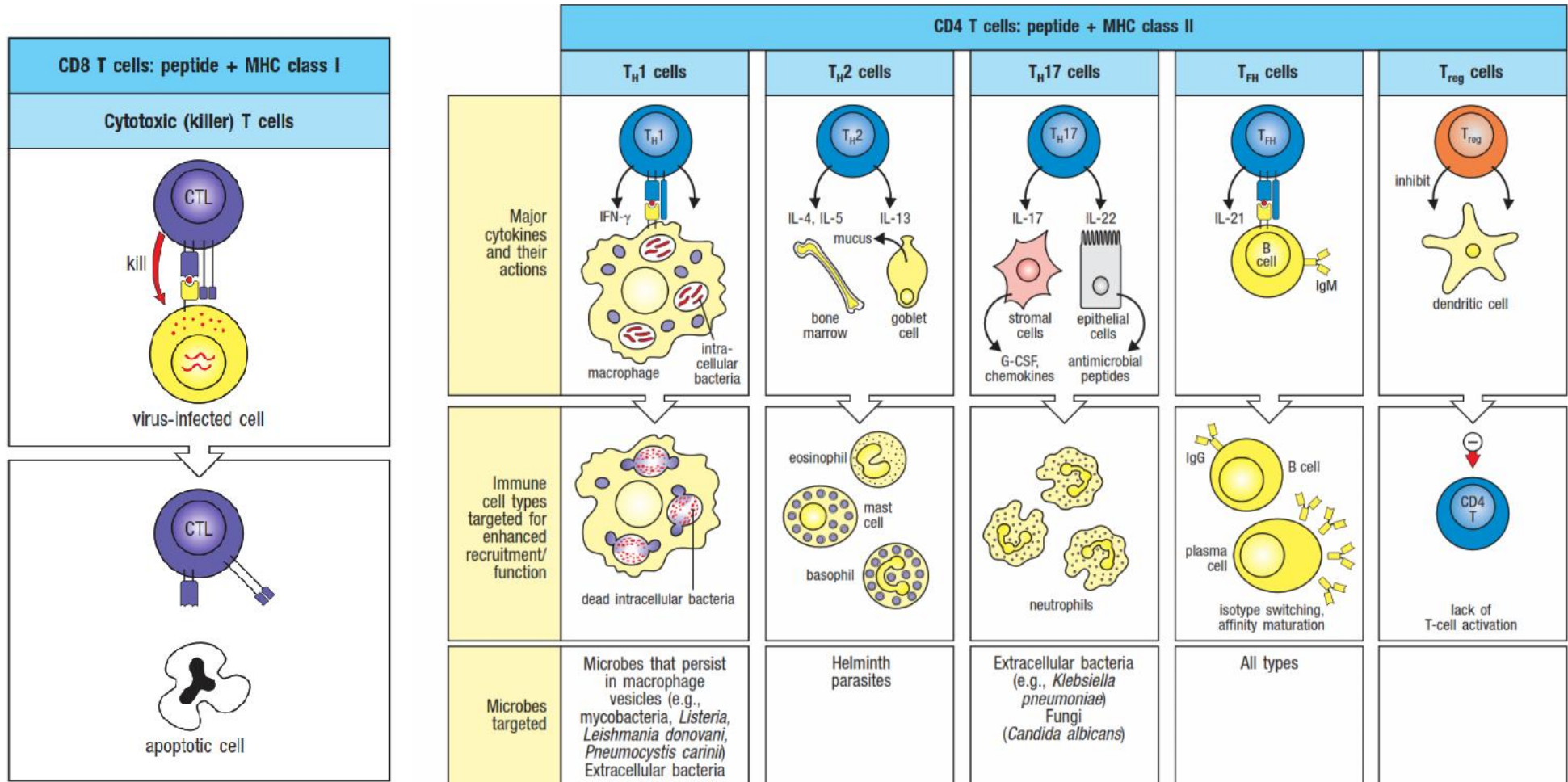


antibodi menetralisasi virus/ toksin



pathogen/ toksin yang diopsonisasi Ab-spesifik dapat diphagocytosis macrophagocytus untuk dihancurkan

# Lymphocytus T berdiferensiasi menjadi berbagai sel T efektor dengan fungsi yang bervariasi



## Leukopenia

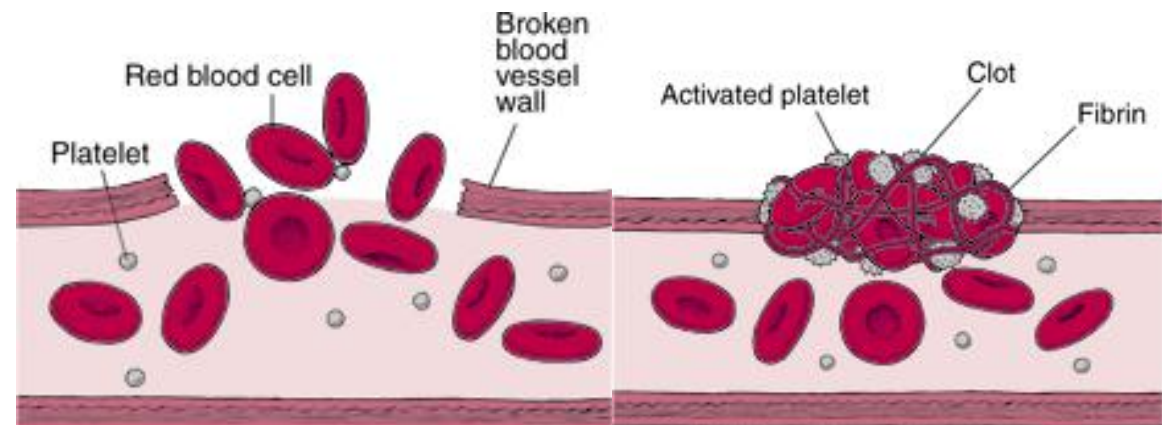
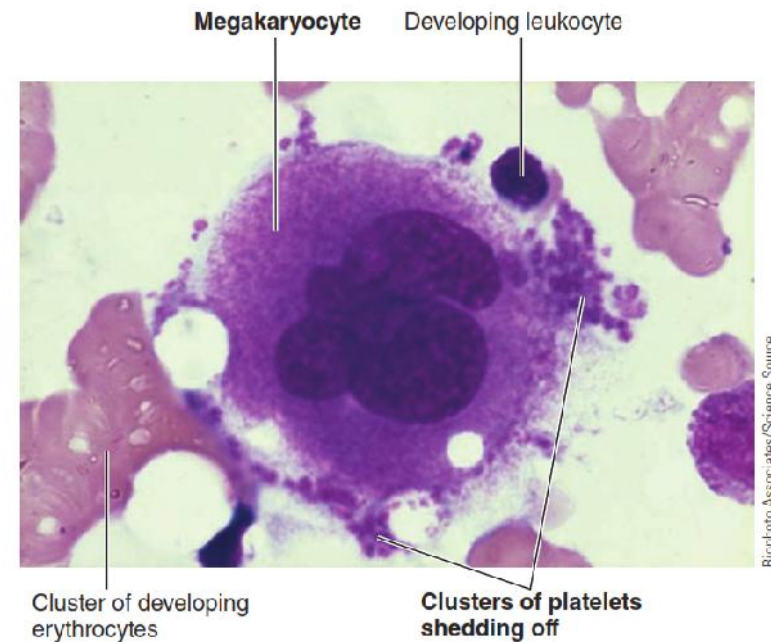
- radiasi
- kemoterapi
- konsumsi obat
- HIV/AIDS

- infeksi bakteri
- inflamasi
- alergi
- kanker

## Leukocytosis

# Thrombocytus berperan dalam koagulasi darah

- Merupakan fragmen **megakaryocytus**
- **Thrombopoietin, IL-6, CSF:** menstimulasi produksi thrombocytus
- Mengandung actin & myosin sehingga dapat berkontraksi
- Fungsi thrombocytus
  - Membentuk **sumbat thrombocytus (platelet plug)**
  - Memproduksi molekul yang berperan dalam koagulasi darah







THANK YOU  
THANK YOU  
**THANK YOU**  
THANK YOU  
THANK YOU  
THANK YOU

**Have A Nice Day**