10 White Blood Cells

ملاحظة : تم دمج محاضرتي كريات الدم البيضاء لارتباطها الوثيق ببعضها الآخر

- Very important
- Extra information
- Terms

Do something today that your future will thank you for !

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Objectives:

At the end of this lecture student should be able to:

1. **Describe different Types of WBC.**
2. **Recognize the general functions of WBC**
3. **Describe genesis and site of formation of WBC.**
4. **Describe stages of neutrophil formation**
5. **Describe the role of neutrophils in defending the body against infection .**
6. **Describe the process of phagocytosis.**

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IMMUNITY

Innate immunity
(non specific)

Examples:
- **Phagocytes**
- **Complement**
- **Barriers**

Acquired immunity
(specific, adaptive)

Cell mediated
T- lymphocytes

Humoral
Antibody mediated
B- lymphocytes

Note: Macrophages are key components of the innate immunity and activate adaptive immunity by transforming into Antigen Presenting Cells

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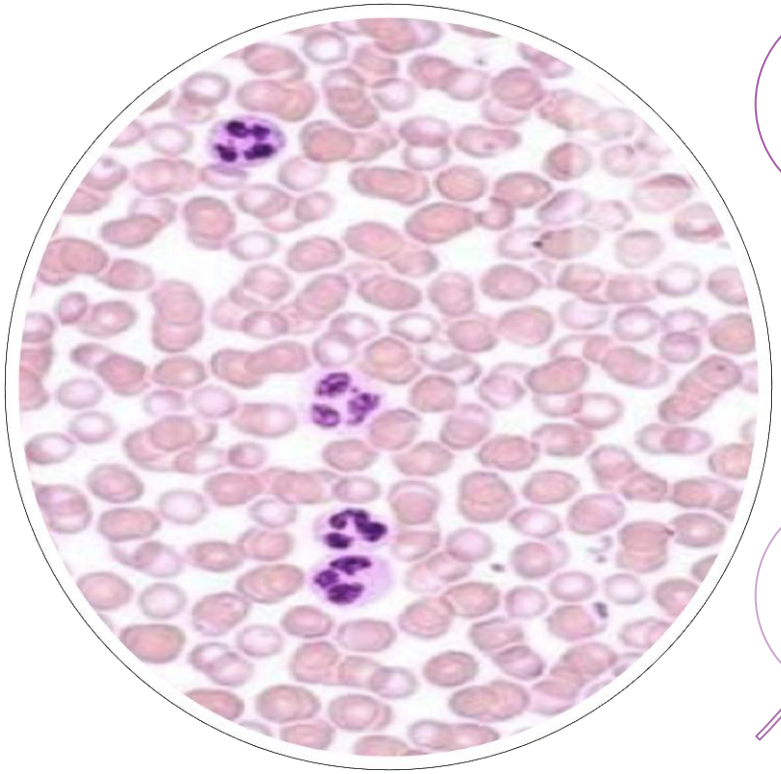
General information about WBCs



- RBCs are much more than WBCs
  " RBC: 5-6 million /ml \ WBC: 5000 ml "
- Protection against infection :
  1. Phagocytosis
  2. Secretion of antibodies
  WBC = 4000 – 11000 / ml
- WBC(Leucocytes) formed in :
  bone marrow & lymph tissue

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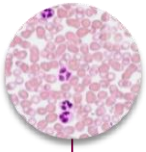
Types of WBCs



WBCs

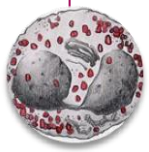
granular

Agranular

Neutrophil

62%

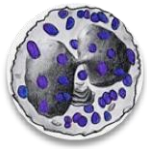
10-16um, lobulated nucleus 2-5, purple cytoplasmic granules



Eosinophil

2.3%

12-18um, 2 lobe nucleus, coarse red granules



Basophil

0.4%

10-14um, rarely segmented nucleus, nucleus hidden by large round bluish granules

Monocytes

5.3%

15-20um, kidney shape nucleus

Lymphocyte

30%

round nucleus

- small (5-8um)

- large (9-15um)

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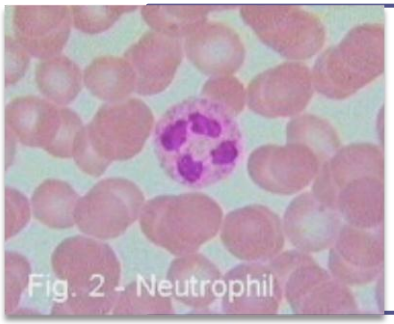
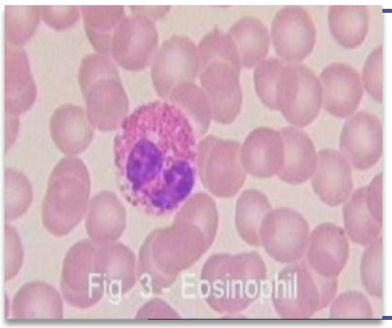
Types of WBCs



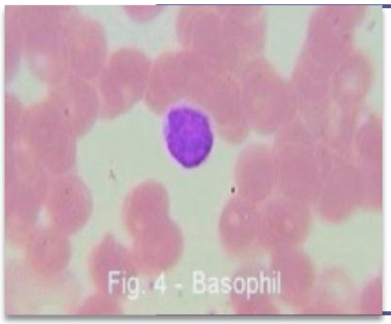
Neutrophil

لون السيتوبلازم بنفسجي
محبب والنواه صغيرة
ومجزأة لـ ٢-٥ قطع



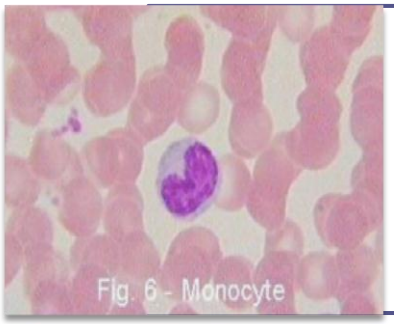
Eosinophil

السيتوبلازم أحمر محبب
والنواة لها ٢ لوب



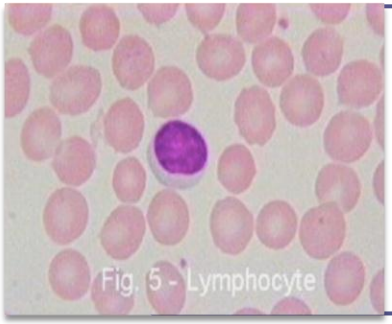
Basophil

النواة بالكاد تكون
واضحة لكثرة الحبوب
الزرقاء



Monocyte

أكبر خلية في الدم ،
ونواتها تشبه الكلية



Lymphocyte

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Life span of WBCs

Granulocytes

Normal state :
4-5 days in tissues

During infection :
Only few hours

they die after ingesting bacteria

Lymphocytes

weeks to months

according to it's type

Monocytes

In the blood :
10-20 hours

In the tissue :
life span goes up to months

they leave blood to tissues and transform into : Macrophage

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Macrophage and Neutrophil Responses During Inflammation

- **1st line of defense :**

Tissue macrophages & Physical Barriers.

- **2nd line of defense :**

Neutrophil Invasion of the inflamed area.

- **3rd line of defense :**

Monocytes –macrophage invasion of inflamed area.

- **4th line of defense :**

Increased production of granulocytes and Monocytes by Bone marrow.

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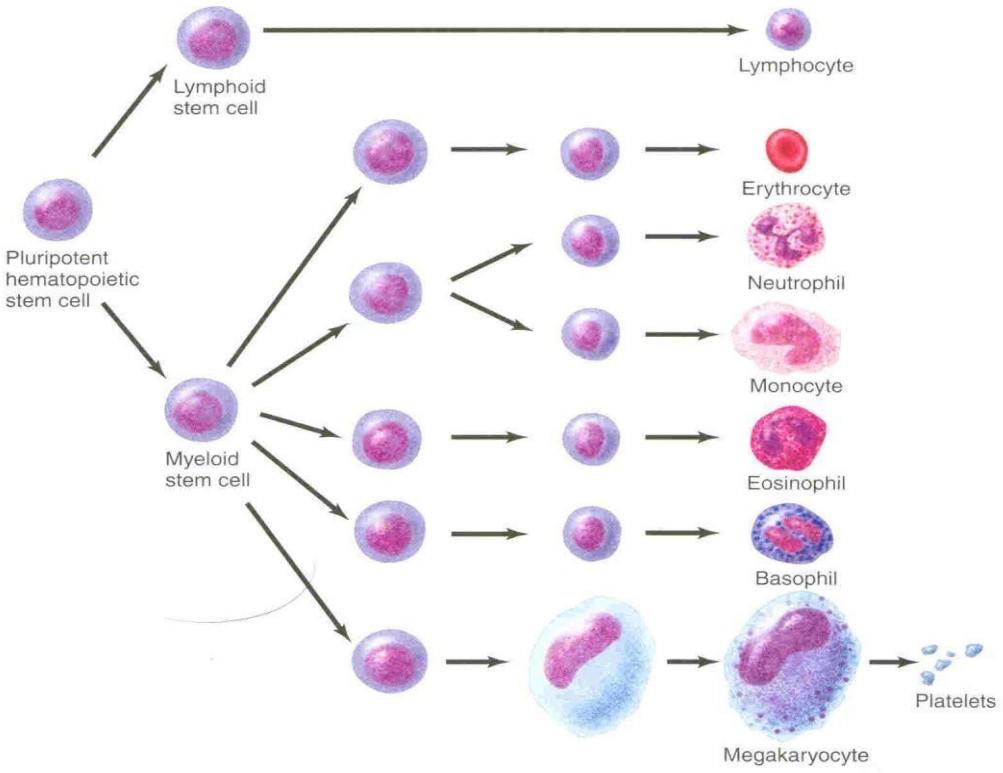
Genesis of WBCs



- **two major paths to form WBCs :**

1. Myelocytic ➡ which produce granular WBCs , monocytes

2. Lymphocytic ➡ which produce lymphocytes

- **sites of WBC formation :**

1. **Granulocytes & monocytes ➡ in bone marrow**

2. Lymphocytes ➡ in bone marrow , thymus , lymphoid tissues

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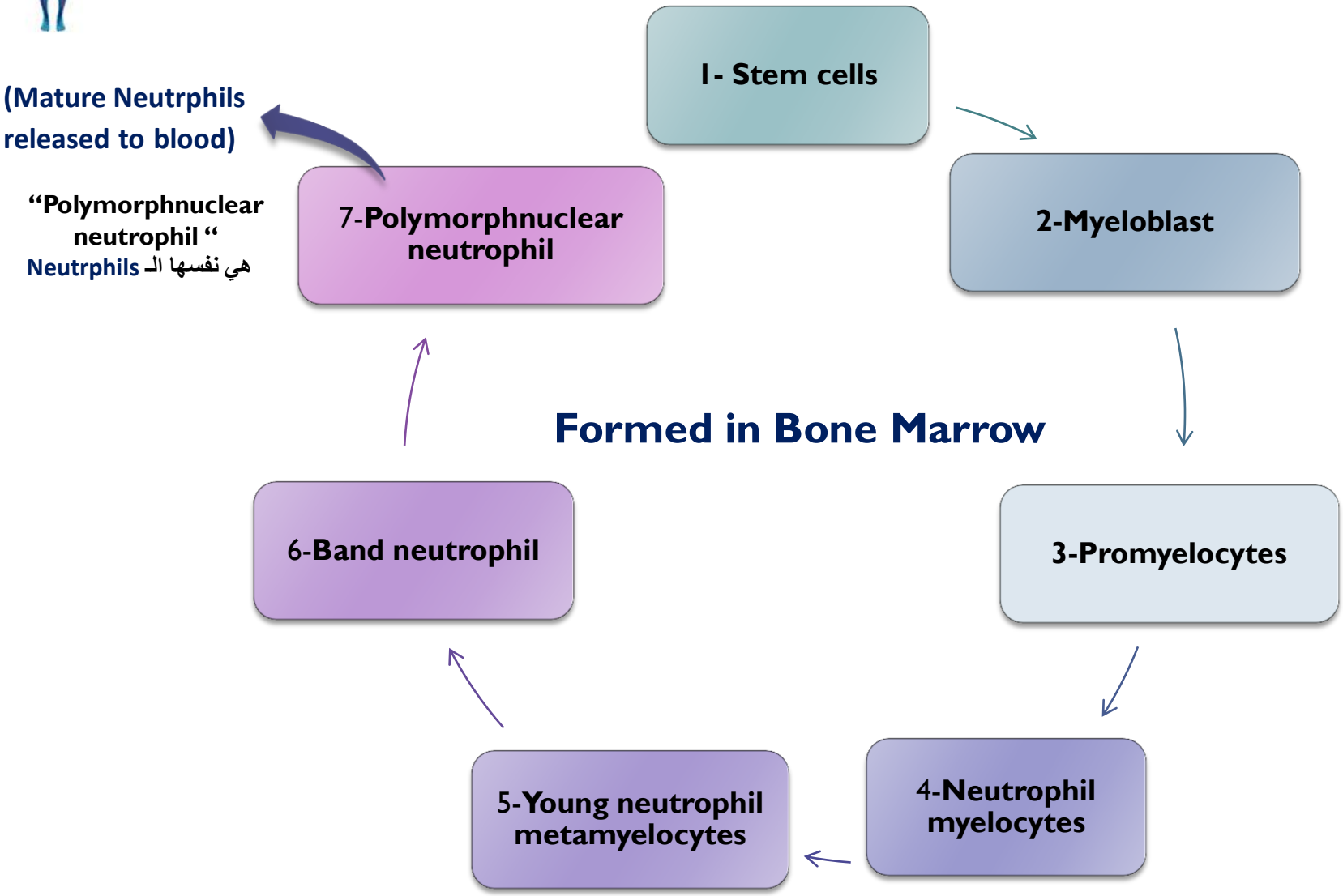
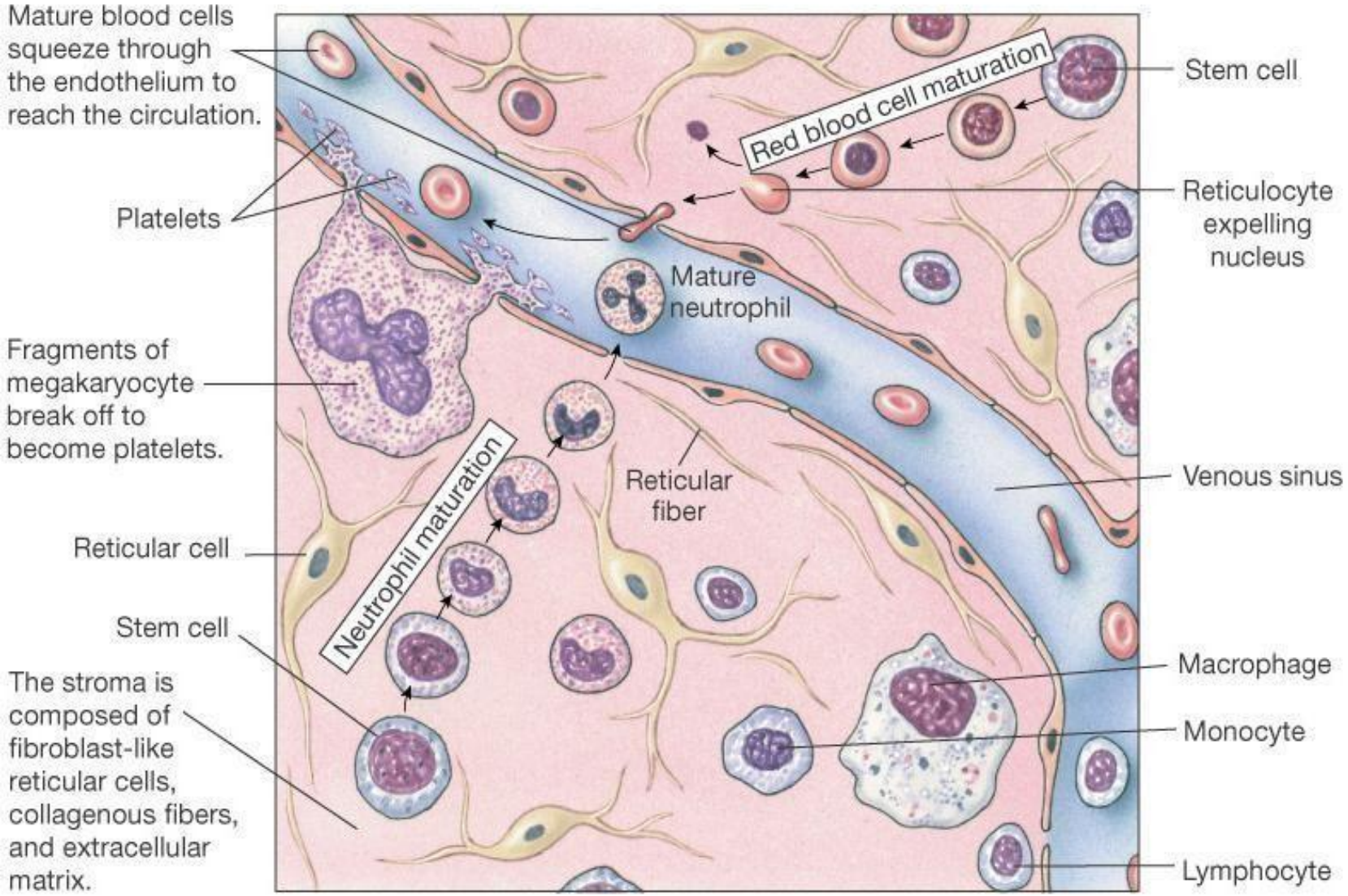
White blood cells Neutrophills



(c) Bone marrow consists of blood cells in different stages of development and supporting tissue known as the **stroma** (mattress).



Neutrophil Function

Defense against infection :

Neutrophil has the ability of engulfing bacteria or organism by a process of phyagocytosis.

Steps of Phagocytosis :

- Chemotaxis
- Margination
- Diapedesis
- Ameoboid movement
- Engulfing and killing of a microbe

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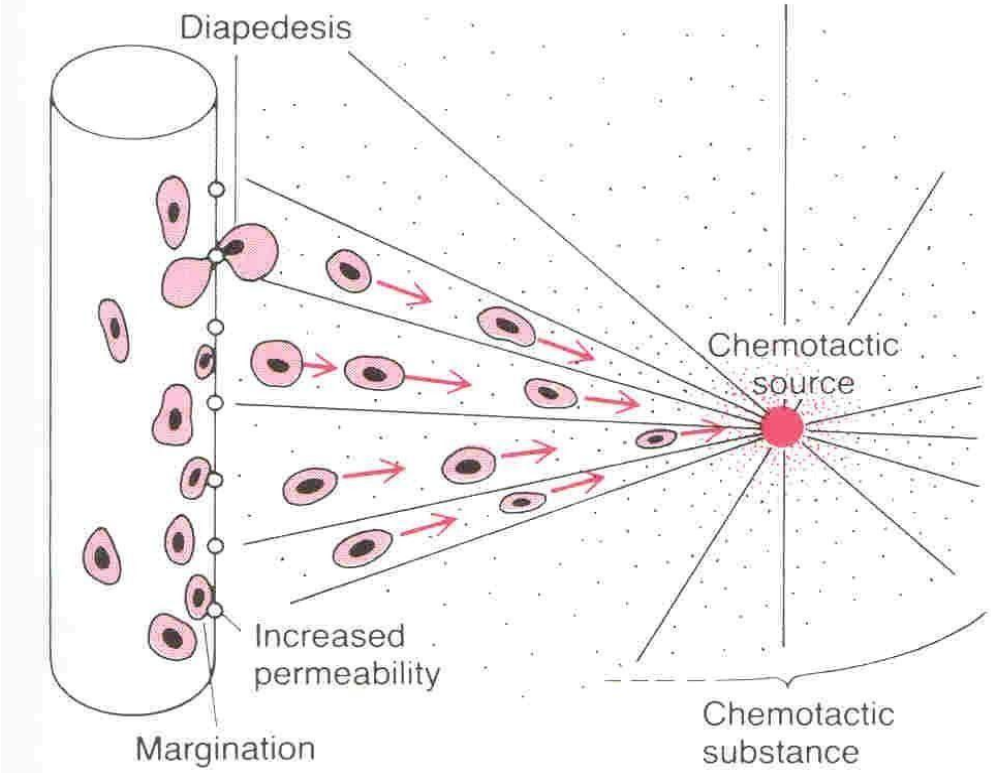
Neutrophil Function



عندما يكون هنالك جسم غريب داخل الجسم كيف تحاربه الـ **Neutrophils**؟
الجسم الغريب أو المنطقة المصابة تفرز مواد كيميائية لجذب الـ **Neutrophils** نحوه وهذه المواد تسمى بالـ **Chemotaxis**
الآن تم إبلاغ الـ عن وجود الإصابة ومكانها المحدد وهنا تبدأ المعركة !
تبدأ الـ **Neutrophils** بجلب جنودها **WBC** وتجعلها تصطف على الـ **Vessel wall**
ثم تبدأ تدخل بالدور واحدة تلو الأخرى من خلال ثقوب هذه الثقوب تسمى **Diapedesis**
وبعدها تصل إلى المنطقة المصابة ويحصل الابتلاع.

" التفاصيل موجودة في الشرائح التالية"

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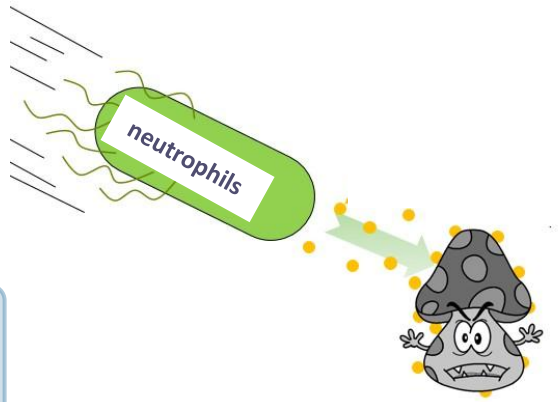
Chemotaxis :

The attraction of the neutrophils to inflamed area following chemotactic substances release from infected site.

Chemotactic substances

- Bacterial toxin "from bacteria itself"
- Degenerative products of inflamed tissue
- Complement system
- Reaction product of plasma clotting



مثل ما قلنا الـ Chemotaxis هي اللي تجذب الـ Neutrophils
"infected area release substances to attract neutrophils "

بالنسبة للنقطة الثانية فهي تعني أنه عندما يحصل التهاب للنسيج يبدأ بالتكسر ويتحلل ويفرز مواد وهذه المواد هي التي تصبح Chemotaxis

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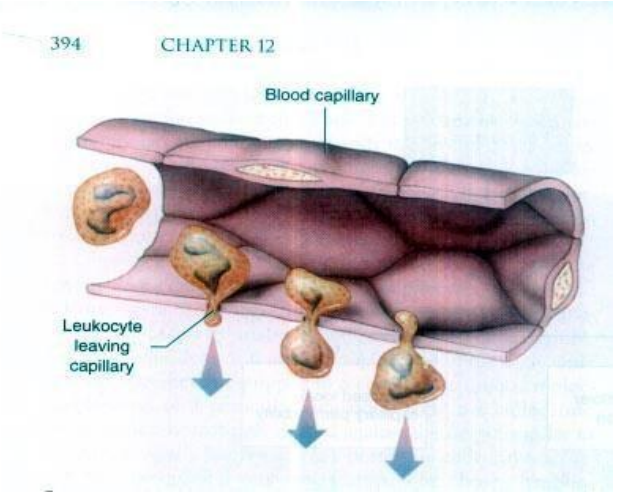
Margination & Diapedesis

Margination & Diapedesis :



1-WBC marginate along the wall of blood capillaries.

2-WBC <u>squeezes itself</u> through endothelial holes leaving blood capillaries **(Diapedesis).**

(WBC move by Amoeboid motion " moving by pseudopodia الأقدام الكاذبة" **)**

3- Towards inflammation area following **chemotactic substance** released from site of infection .

4- Upon reaching the site of infection **neutrophils** start to engulf infecting organism.

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Phagocytosis

(Selective process)

Foreign substance recognize by:

1-Rough surface.

2- No protective protein coat which prevents phagocytosis.

3-Marked by certain substance.

e.g Complement 3 or antibodies making them ready for killing a process known as "opsonization "

opsonization is the process by which a pathogen is marked for ingestion and eliminated by a phagocyte.

هي مثل الطفل إذا شاف شي غلط يركض يعلم أمه فهي تعلّم على الشي الغلط اللي هو الجسم الغريب عشان يقدر الجسم يتخلص منه

Neutrophils encircled the bacteria with pseudopodia and engulf it inside into a vacuole (phagosome) takes 3-20 bacteria.

- Phagosome :
عبارة عن Vacuole وداخله الميكروب واللي تجي لها الـ lysosomes وتفرز إنزيماتها عليها

- Phagocytosis :
عملية الابتلاع بالكامل

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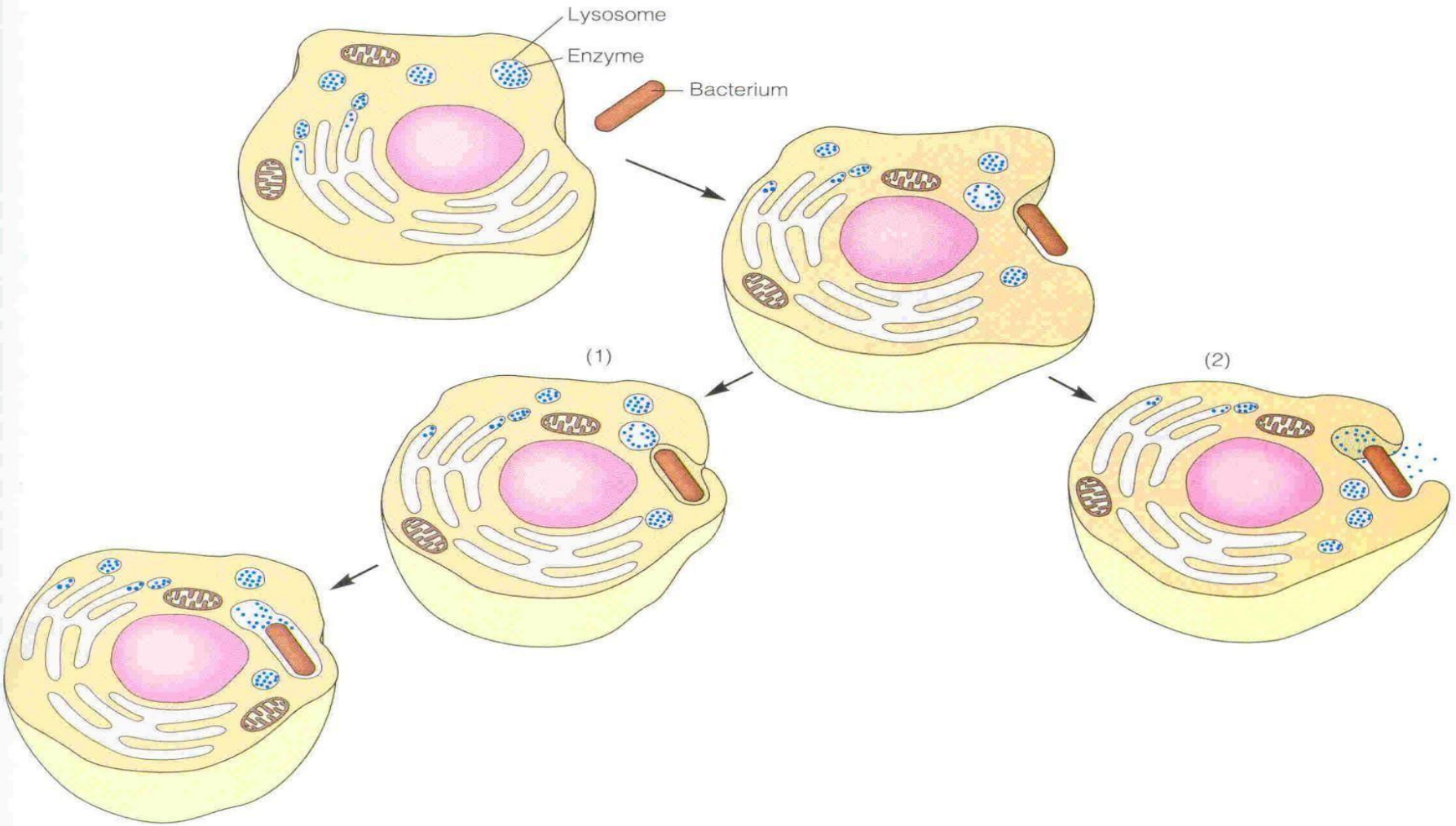


Figure 15.2

Phagocytosis by a neutrophil or macrophage. A phagocytic cell extends its pseudopods around the object to be engulfed (such as a bacterium). (Blue dots represent lysosomal enzymes.) (1) If the pseudopods fuse to form a complete food vacuole, lysosomal enzymes are restricted to the organelle formed by the lysosome and food vacuole. (2) If the lysosome fuses with the vacuole before fusion of the pseudopods is complete, lysosomal enzymes are released into the infected area of tissue.

PMNs Digestive System (Antimicrobial system)

PMN = Polymorphnuclear

- **ENZYMATIC**

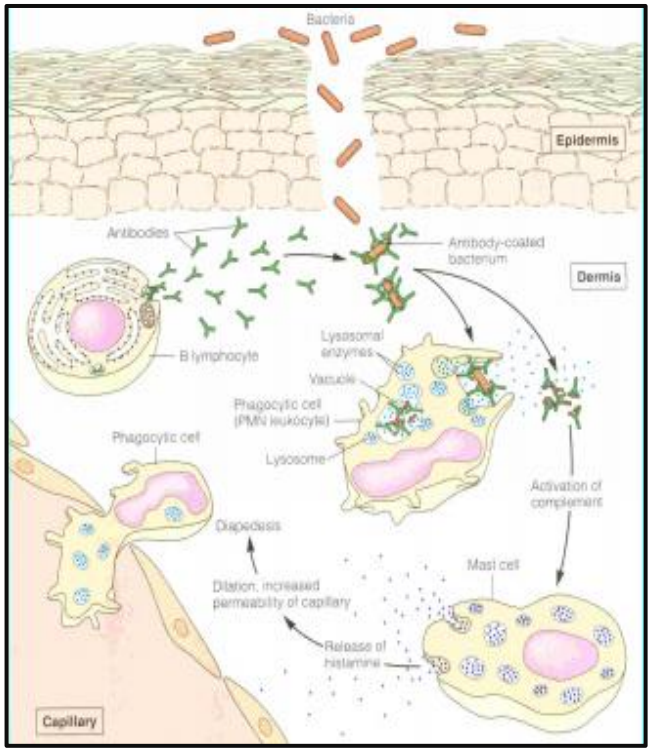
Granules :

- Heparin
- Histamine
- Bradykinin
- Serotinin
- Defensins
- Lysosomal enzymes
- Slow reacting substance of anaphylaxis

- **NON ENZYMATIC**

respiratory burst :

- O2 Free Radicals (O-2, H2O2, -OH)
- NADPH-oxidase
- Myeloperoxidase
- Cl- ⟶ HoCl
- Hypochlorous acid "very toxic"



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Microbial killing

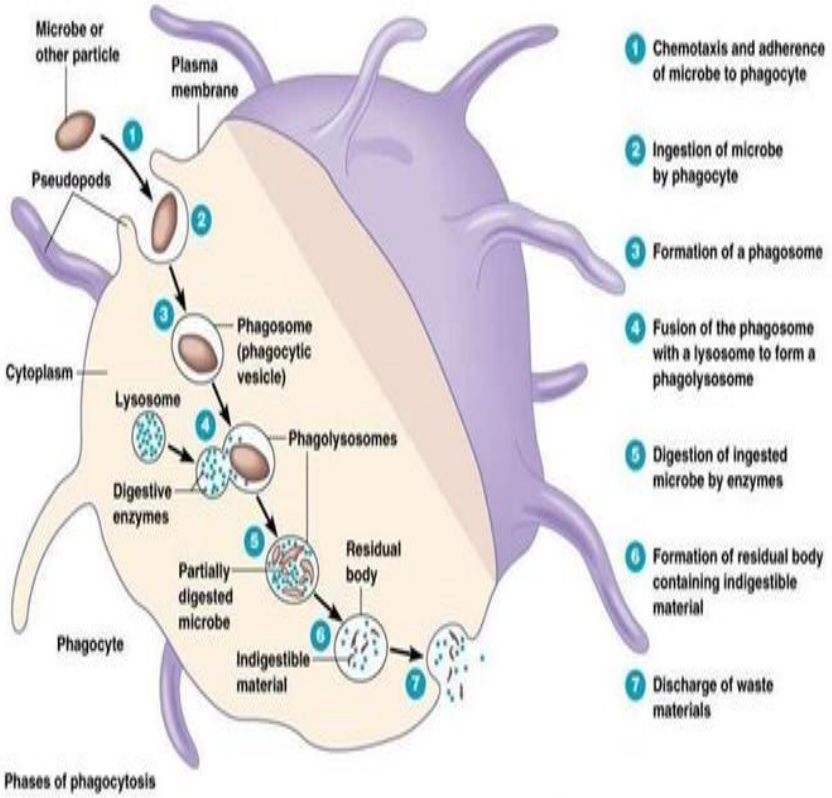
Microbial killing :

Digestion of organism inside the phagosome.

Fusion of intracellular lysosomes with phagosome vacuole

Lysosomes discharge its proteolytic enzymes such as myeloperoxidase ,catalase into the vacuole, killing and digesting the engulfed bacteria.

Release of bactericidal such as superoxide , hydrogen peroxide to kill the bacteria



bactericidal: a substance that kills bacteria.

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Mind Map

Blood physiology 3

White Blood Cells

WBC

Types of WBC

1- Granular (polymorphnuclear PMN):

a. Neutrophil 62%

10-16um, lobulated nucleus 2-5, purple cytoplasmic granules

b. Eosinophil 2.3%

12-18um, 2 lobe nucleus, coarse red granules

c.Basophil 0.4%

10-14um, rarely segmented nucleus, nucleus hidden by large round bluish granules

2- A granular

a. Monocytes 5.3%

15-20um, kidney shape nucleus

b. Lymphocyte 30%

round nucleus

Small (5-8 um)

Large (9-15 um)

red blood cells (5-6-million /ml)

white blood cells (5000/ml)

Formation

Leucocytes Formed in bone marrow & lymph tissue

Protection against infection by:

Phagocytosis

Secretion of antibodies

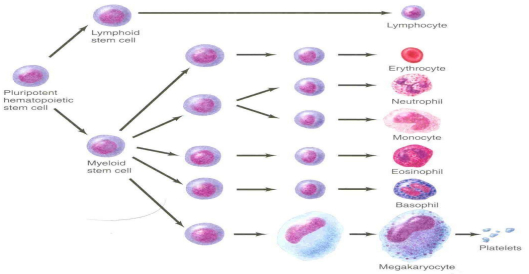
WBC = 4000—11000/ml

Genesis of WBC

Two major lineage of WBC are formed:

1- Myelocytic: granular, monocytes

2- Lymphocytic: lymphocytes



Sites of WBC Formation

Life span of WBCs

White Blood Cells

NEUTROPHILLS

formation and maturation

Neutrophil Function

Defense against infection: Neutrophil has the ability of engulfing bacteria or organism by a process of phyagocytosis

Steps of Phygocytosis

1- Chemotaxis

2-Margination

3-Diapedesis

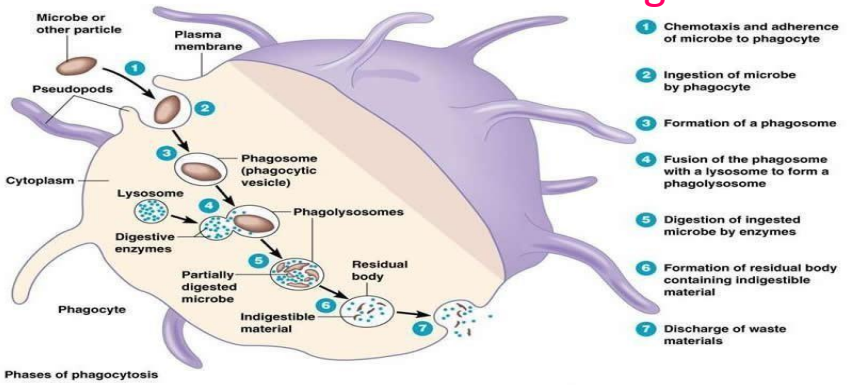
4- Ameoboid movement

5 - Engulfing and killing of a microbe

Margination & Diapedesis

WBC marginate along the wall of blood capillaries.WBC squeezes itself through endothelial holes leaving blood capillaries (diapedesis)WBC move by amoeboid motion

Microbial killing



Note : * Use it for revision not studying cuz not all the info included

PHYSIOLOGY TEAM 435

11

White Blood Cell
EOSINOPHILLS & BASOPHILS

- Very important
- Extra information
- Terms

Success does not come and find you , you have to go out and get it !

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Objectives

At the end of this lecture student should be able to:

1- Describe Esinophils formation and functions.
2- Describe Basophils formation and functions.
3- Describe Monocytes and macrophage formation and functions.
4- Describe Reticuloendothelial components and functions.
5- Describe lymphocytes formation and maturation.
6- Describe the functions of the different types of lymphocytes.
7- Recognize leucocytosis and leucopenia.
8- Recognize type of leukaemia.

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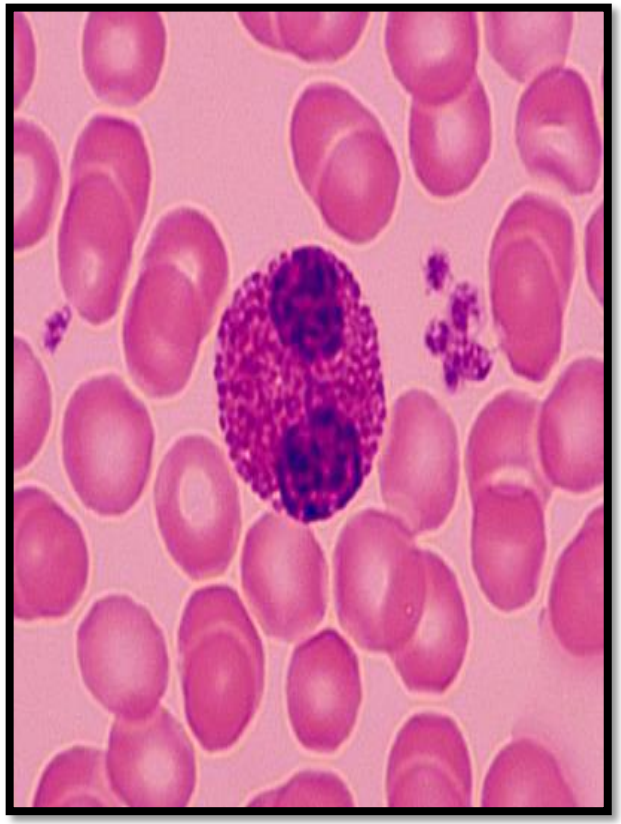
Formation and Maturation of Eosinophils



Stem cells

↓

Myeloblast

↓

Promyelocytes

↓

Eosinophil myelocytes

↓

Eosinophil metamyelocytes

↓

Polymorphnuclear eosinophil
(Mature Eosinophil released to blood)

Formed in Bone Marrow

Eosinophils = full of red granules

Polymorphnuclear الخلية ذات النواة متعددة الأشكال

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Eosinophil Functions

- **Phagocytosis**
- **High Eosinophil count :**

a. **Parasitic (hook worm, ascaris, bilharzia).**

b. **Allergic (asthma, rhinitis, drug reaction).**

- **Eosinophil attach themselves to parasites and releases substances (hydrolytic enzymes, superoxide) to kill it.**

الخلية تربط نفسها بالـ parasiteوتحرر مكوناتها (إنزيمات محللة + سوبر أوكسايد) لقتل الميكروب

عدد عالي من الـ Eosinophil = High eosinophil count
نكتشفها من خلال FBC (Full blood count)
تزيد من عدد الـEosinophilووقتها نفكر بمسببين رئيسيين : (الطفيليات + جميع أنواع الحساسية)

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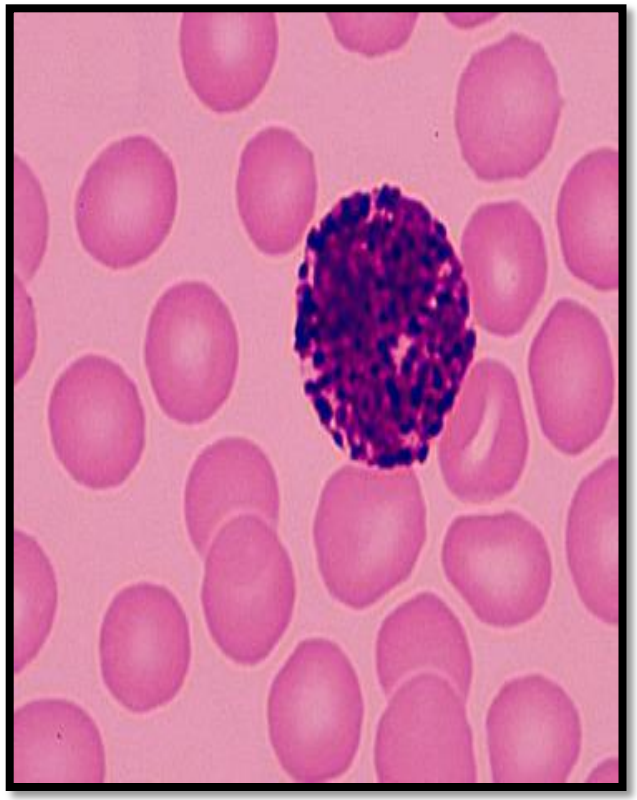
Formation and Maturation of Basophils



Basophils = full of blue granules
النواة بالكاد تُرى لكثرة الحبوب التي تغطيها

Stem cells

↓

Myeloblast

↓

Promyelocytes

↓

Basophil myelocytes

↓

Polymorphnuclear Basophil
(Mature Basophils released to blood)

Formed in Bone Marrow

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Basophils Functions

Similar to mast cells, both secrets :

1- Heparin to prevent clotting.

2- Histamine , bradykinin & serotinin contribute to inflammation response.

3- The release of those substances cause local and vascular reactions characteristic of allergic manifestation.

Heparin is an anticoagulant (blood thinner) that prevents the formation of blood clots.

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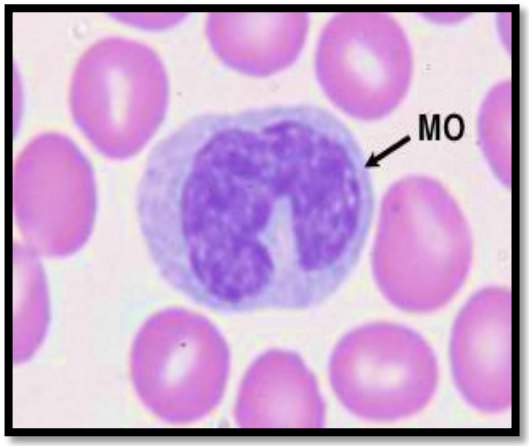
Monocytes and Macrophages

- **No Granules but Vacoules**
- **Stay for 10-20 hours in circulation then leave blood to tissues transforming into larger cells macrophage.**

تخرج من الدم للأنسجة لتتحول إلى : Macrophage ينتظر إشارة من الخلية ليبدأ الابتلاع

- **Macrophage life span is longer up to few <u>months</u> .**
- **Two types: Mobile & Fixed**

Formed in Bone Marrow



Stem cells

↓

Monoblast

↓

Promonocyte

↓

Mature monocytes released into blood

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Function of Monocytes and Macrophages

Macrophages :
are a powerful phagocytic cell and first line of defense

- **Ingest up to 100 bacteria.**
- **Ingest larger particles as old RBC.**
- **Get rid of waste and survive .**

monocytes transfer to macrophages that are also called (scavenging cells)

الـ Macrophages وظيفتها : "عامل النظافة"

Functions :

Anti-inflamatory

Directly

phygocytosis of bacteria and dead cells

"تبتلع الميكروب بنفسها"

Indirectly

cooperating with lymphocytes by recognizing foreign body (take in foreign body process it and present it to lymphocytes)

تمسك الجسم الغريب عشان توجّه الـ lymphocytes نحوه واللي بدوره يقضي عليه " يفزعون لبعض "

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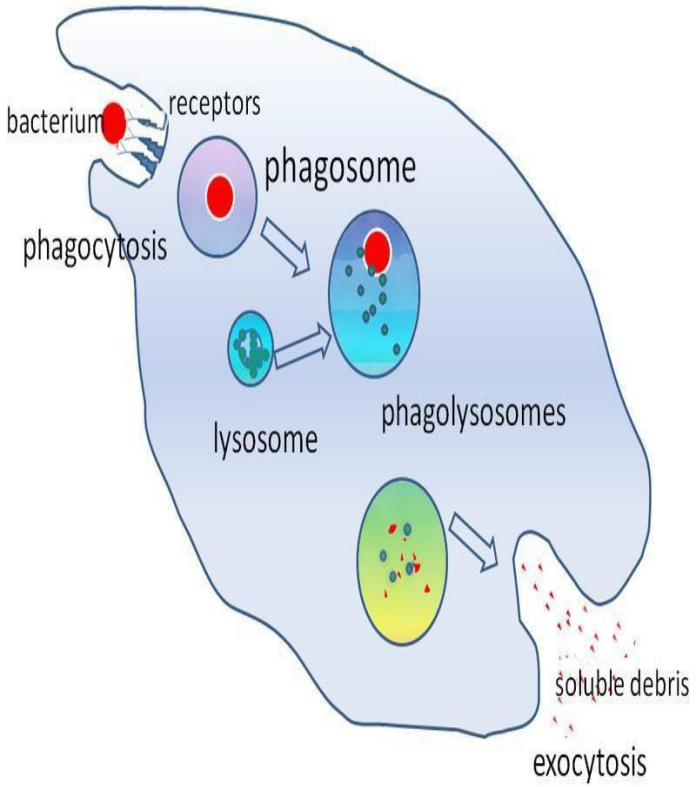
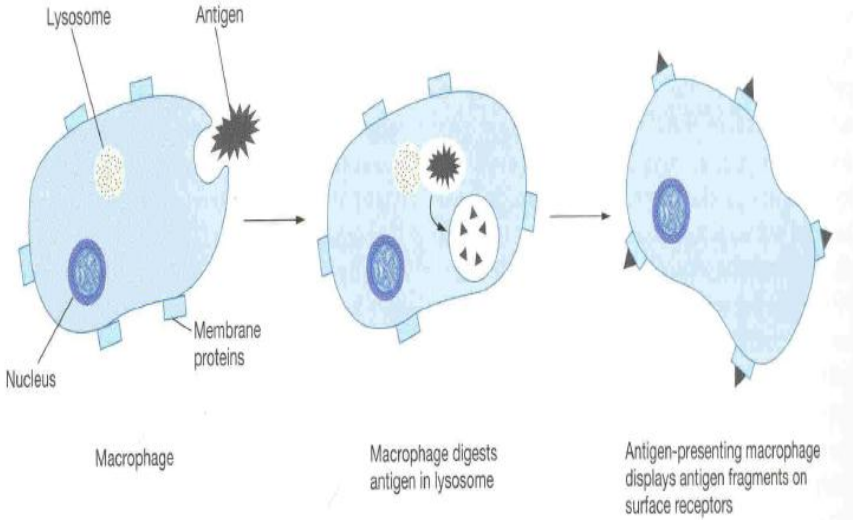
Directly



Indirectly



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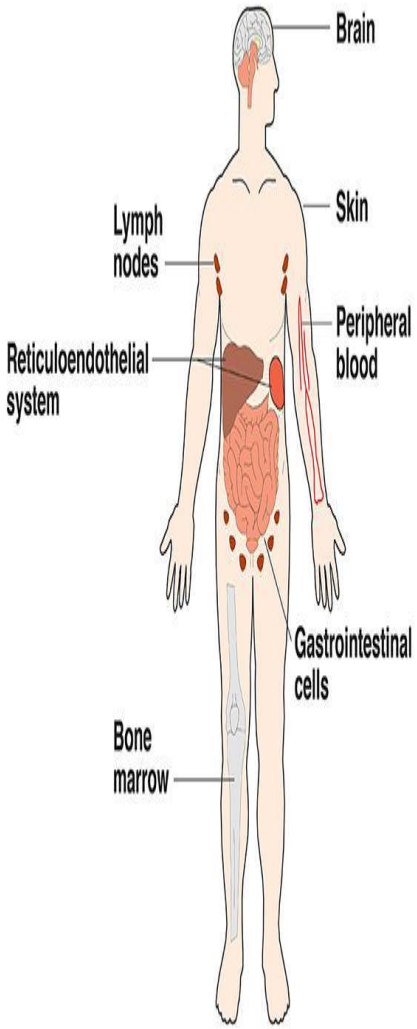
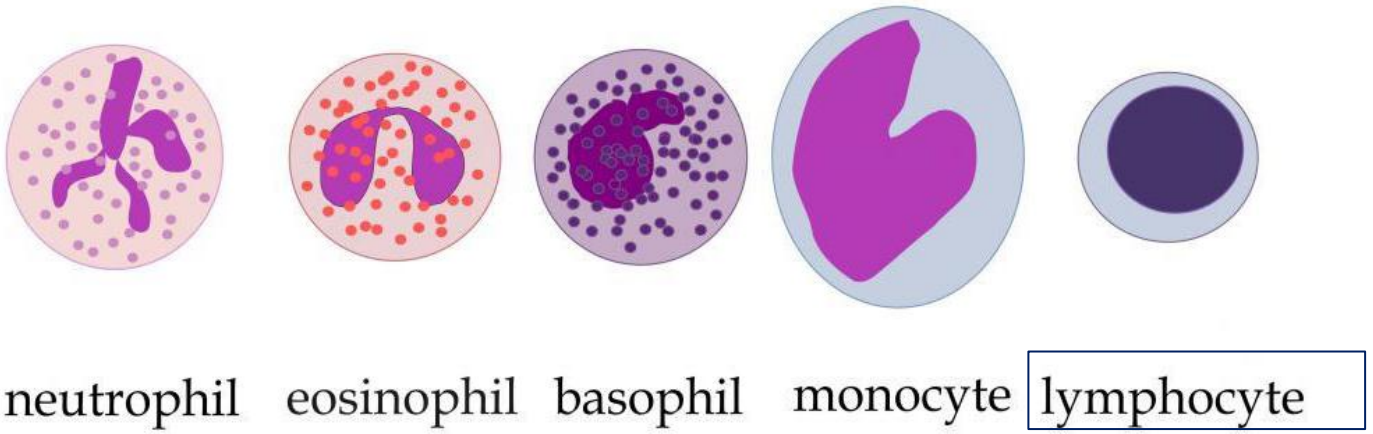
Reticuloendothelial System



Consist of	Located in	Functions of Reticuloendothelial system
• **Monocytes** • **Macrophage** • **Endothelial cells (bone marrow, spleen, lymph node)**	• **All tissues especially: skin (histocytes), liver (kupffer),bone marrow, lymph nodes, lung , spleen**	• **Phagocytosis: Bacterial, foreign particles , dead cells** • **Breakdown of hemoglobin** • **Immune function: processing antigen and antibodies (indirect) production** • **Storage of iron**

Lymphocytes



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Lymphocytes Formation and Maturation

Stem cells
(thymus, lymphoid tissue & bone marrow)

↓

Lymphoblast

↓

intermediate pyronophilic blast cell

↓

lymphocytes

Formed in bone marrow, thymus, lymphoid tissues

Life Span Of Lymphocytes range from weeks to months according to its type

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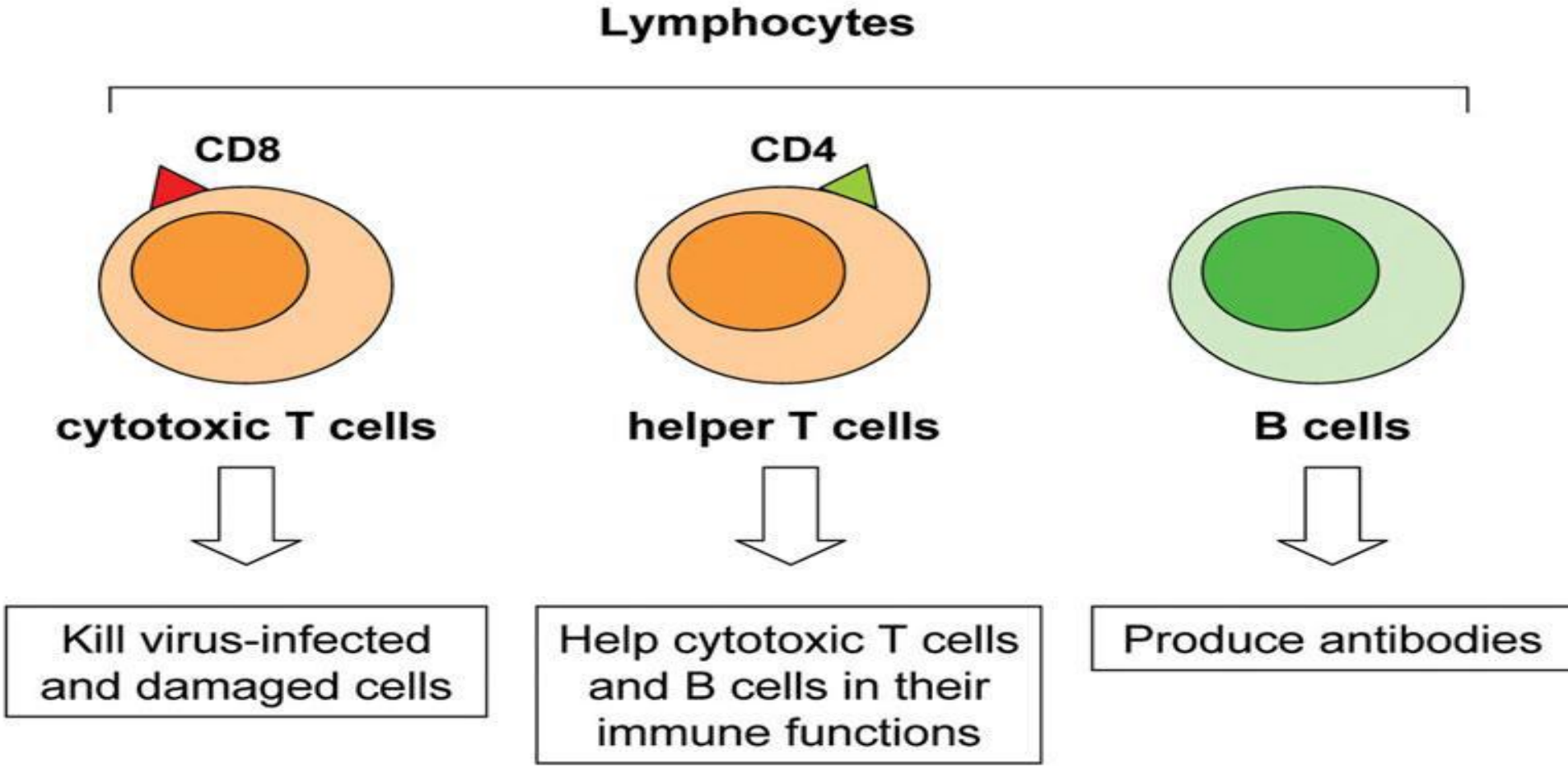
Lymphocytes Functions



CD8 , CD4 : antigens in the surface of cells.

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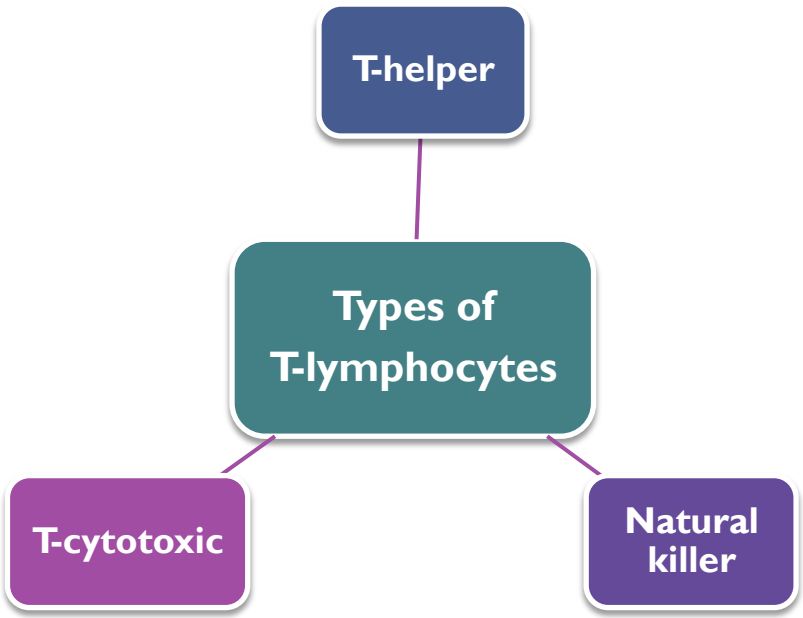
Lymphocytes Types

T-Lymphocytes (Thymus dependent)

- Formed in bone marrow or lymphoid tissue migrate to thymus for maturation.
- Life spans 100-130 days. "ممكن أكثر"
- Circulate between blood, tissues, lymph.

Functions :

- Cellular immunity (graft rejection delayed hypersensitivity)
- Role in antibody secretion



- على سبيل المثال لما تحدث عملية نقل لكلية أو أي عضو والجسم يرفض هذا العضو وتصير مضاعفات مين اللي رفض العضو ؟ الـ T-Lymphocytes
- (Memory cells :T-lymphocytes)

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Lymphocytes Types

B- Lymphocytes (Thymus-independents)

- First discovered in Bird Bursa (ومن هنا جاءت التسمية)
- Formed in : Bone marrow, germinal layer of lymph node, red pulp of spleen .
- Life span 2-7 days.
- It transforms into large plasma cell (produce antibody).
- Function : Humoral immunity. "Humoral , NOT Hormonal ! "
- Stimulated by antigen transforming.

- **Humoral immunity.**
  The component of the immune response involving the transformation of B cells into plasma cells that produce and secrete antibodies to a specific antigen.
- antigen is any substance that causes an immune system to produce antibodies against it.
- plasma cells إلى B-lymphocytes الـ يحول الـ antigen
  اللي بدورها تنتج الـ antibody

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Leucocytosis

(Increased WBC) ↑

Physiological

- Morning (Decrease)
- Evening (Increase)
- After physical exercise (WBC increase)
- Stress or Adrenaline injection Disease

Disease

- Bacterial infection (tonsillitis , Appendicitis)
- Worm infection

More Explanation : Vedio

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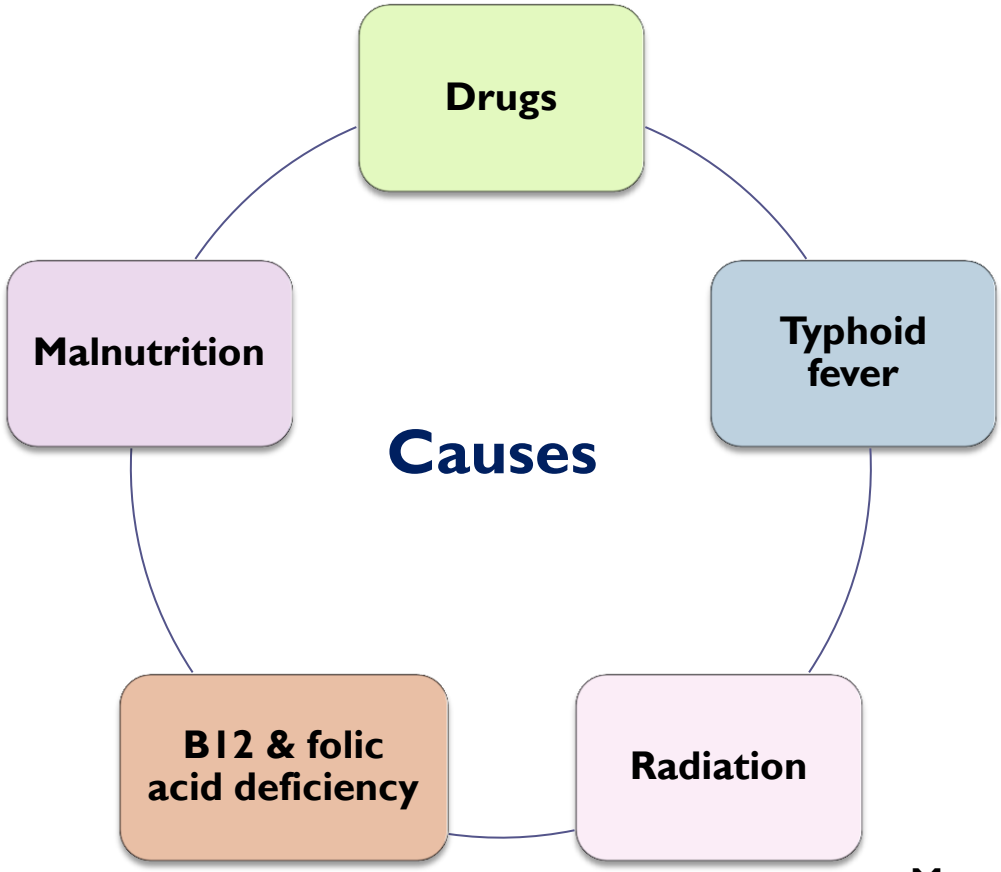
Leucopenia

(Decreased WBC) ↓



العدد الطبيعي لكريات الدم البيضاء :
(4000 – 11000)
أي زيادة :
Leucocytosis
أي نقصان :
Leucopenia

More Explanation :Vedio

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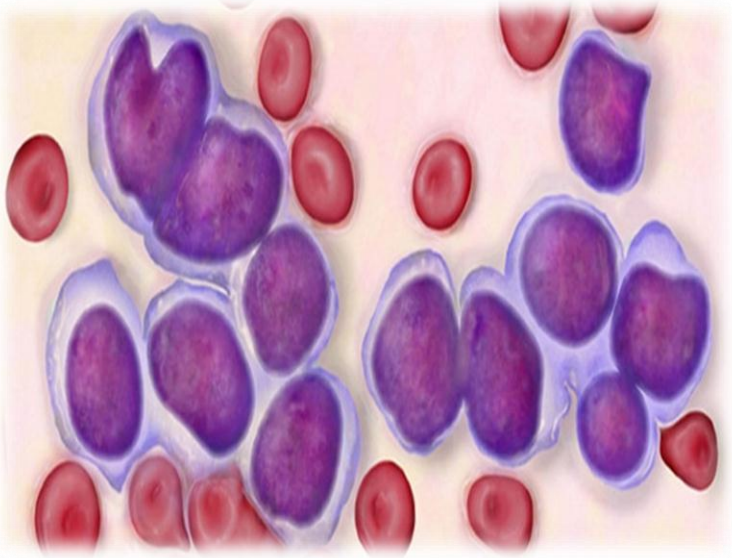
Leukaemia

❖ Leukaemia :

Cancer of white blood cells due to chromosomal abnormality caused by chemicals, radiation, and viruses.



❖ **WBC MORE than $50x10^3$**
(ارتفاع في عدد كريات الدم البيضاء الغير طبيعية)

❖ **Acute or chronic onset.**

❖ **Accompanied with anemia and bleeding.**

Video

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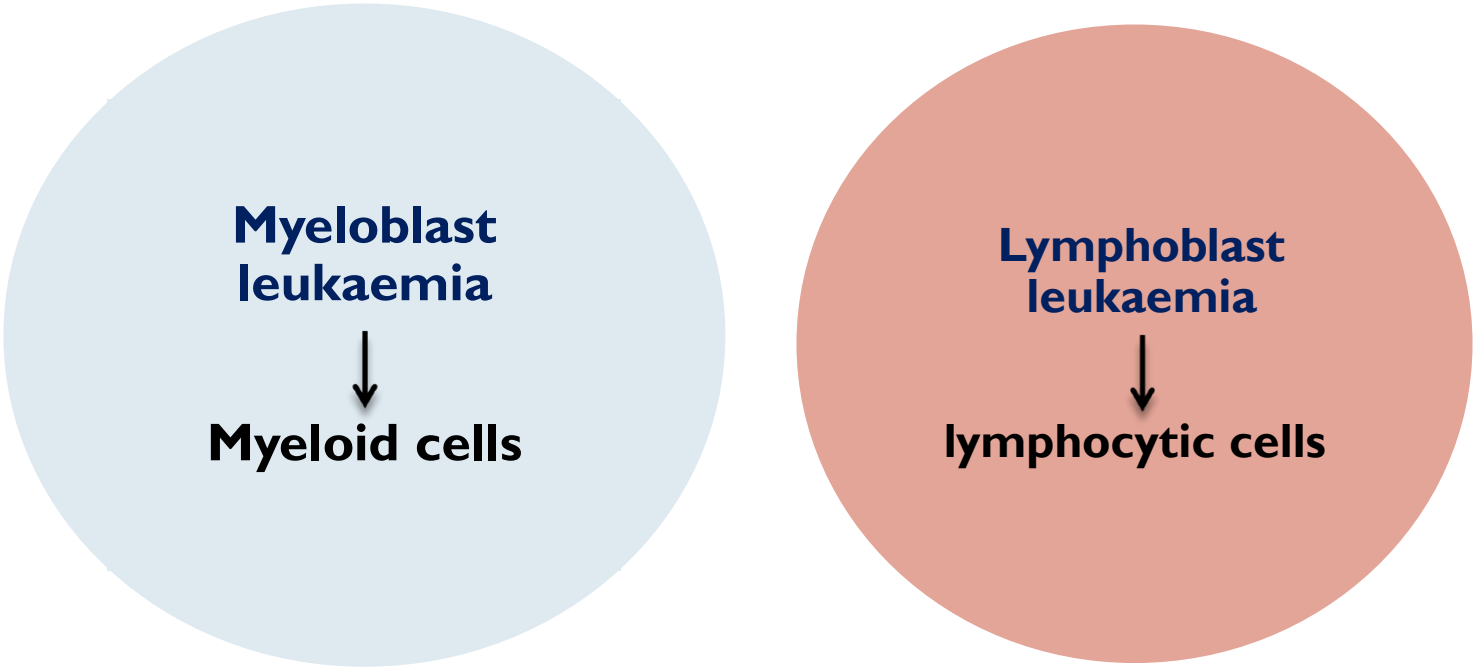
Types of Leukaemia



More Explanation : Vedio

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- QUIZ

- 3 Videos that explain every thing about blood : 1 & 2 & 3
" the third one is about WBCs"

- Origin of WBCs click here

click here : لازم تشوفونه!

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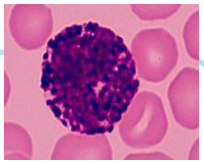
A

Mind Map

Basophils
White Blood Cells

Formation and Maturation of Basophils



Formed in Bone Marrow

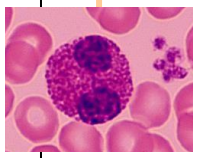
1- Stem cells → Myeloblast→ Promyelocytes →
2- Basophil myelocytes →
3- Polymorphnuclear Basophil *(*Mature Basophils released to blood*)*

- **Similar to mast cells both secrets :**

1- Heparin to prevent clotting
2- Histamine , bradykinin & serotinin contribute to inflammation response
3- The release of those substances cause local and vascular reactions characteristic of allergic manifestation

White Blood Cells
EOSINOPHILLS

Formation and Maturation of Eosinophils

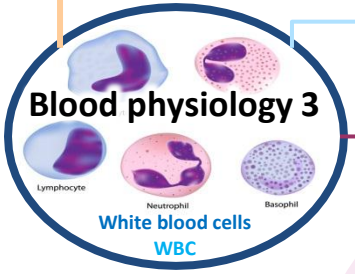


Formed in Bone Marrow

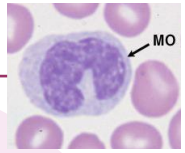
1.Stem cells → Myeloblast→ Promyelocytes →
2. Eosinophil myelocytes →
3. Eosinophil metamyelocytes →
4. polymorphnuclear eosinophil (Mature Eosinophil released to blood)

Function
- **Phagocytosis**
- **High eosinophil count** — Parasitic, Allergic

Eosinophil attach themselves to parasites and releases substances (hydrolytic anzymes, superoxide*)* to kill it



MONOCYTES
White Blood Cells
MACROPHAGES &
Formation



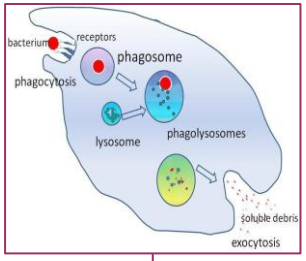
Formed in Bone Marrow

1- Stem cell → monoblast → promonocyte → mature monocytes released into blood
2- Stay for 10-20 hours in circulation
3-Then leave blood to tissues transforming into larger cells macrophage
4- Macrophage life span is longer upto few months

Function of Monocytes and Macrophages

Macrophages are a powerful phagocytic cells*;* first line of defense

Direct anti Inflammatory

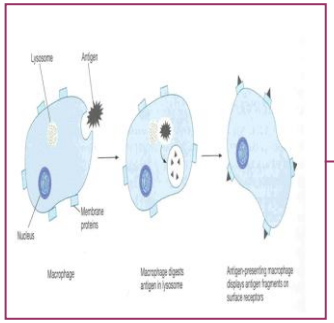


❖ **Functions: anti-inflamatory**

–Directly: phygocytosis of bacteria, dead cells

–Indirectly cooperating with lymphocytes by recognizing foreign body (take in foreign body process it and present it to lymphocytes)

Indirect anti-inflammatory



Note :

*** use this mind map for revision not studying cuz not all the info included !**
*** This mind map includes slides 1-12**

B

Mind Map

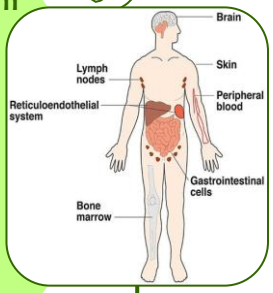
Reticuloendothelial system

Consist of:

Monocytes ,Macrophage

And **Endothelial cells** (bone marrow, spleen, lymph node)

Located in all tissues especially: skin (histocytes), liver (kupffer), spleen, bone marrow, lymph nodes, lung



Functions of Reticuloendothelial system

1.Phagocytosis: Bacterial, dead cells, foreign particles

2.Breakdown of Hb

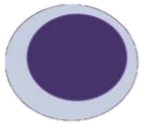
3.Immune function: processing antigen and antibodies production (indirect)

4.Storage of iron

Note :

*** use this mind map for revision not studying cuz not all the info included !**
*** This mind map includes slides 13-24**

White Blood Cells



LYMPHOCYTES

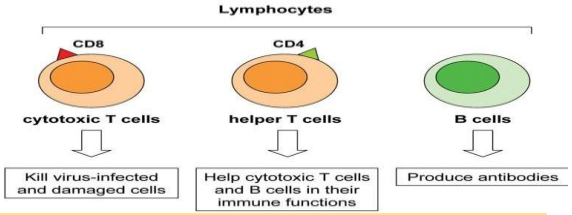
Lymphocytes Formation and Maturation

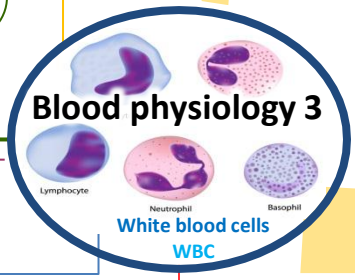
1- Formed in bone marrow, thymus, lymphoid tissues

2- Stem cell (thymus, lymphoid tissue & bone marrow) → lymphoblast → intermediate pyronophilic blast cell → lymphocytes

3- Life Span Of Lymphocytes range from weeks to months according to its type

LYMPHOCYTES Function and types





Leukaemia

Cancer of white cells due to chromosomal abnormality caused by chemicals, radiation, and viruses.
WBC more than 50x103

Leucopenia

decreased WBC

causes :
1- malnutrition
2- drugs
3- typhoid fever
4- radiation

Leucocytosis

Increased WBC

- Physiological → After physical exercise
- Disease → Bacterial infection (tonsillitis,appendicitis)

GOOD LUCK!

Physiology team

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- منيرة الحسيني
- منيرة السلولي
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