

Organs and Cells of the Immune System

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Lee 2

التعرض من تشريح الدكتور
أيام الأون لاين

كما نسوا زصيلنا لهم
الله يرحمهم من دى نكم

vit C يزيد ال T cell production
وهذا الاشى الي يساعد بتعزيز المناعة

Objectives

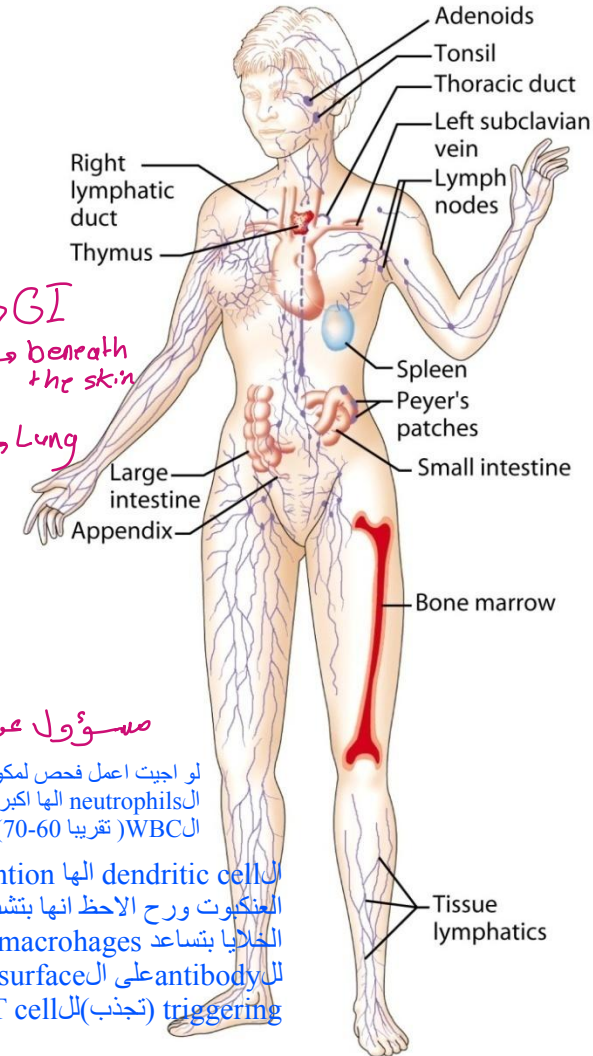
- The organs and tissues of the immune system
- Haematopoiesis and formation of blood cells
- Immune cells classes, functions and circulation
- Immune cells development and maturation

Anatomy of the Immune System

- **Lymphoid organs:**

1. Primary or central lymphoid organs:
bone marrow and thymus

2. Secondary or peripheral lymphoid organs: lymph nodes, spleen, and mucosal and cutaneous immune system



- **Blood cells in the immune sys:**

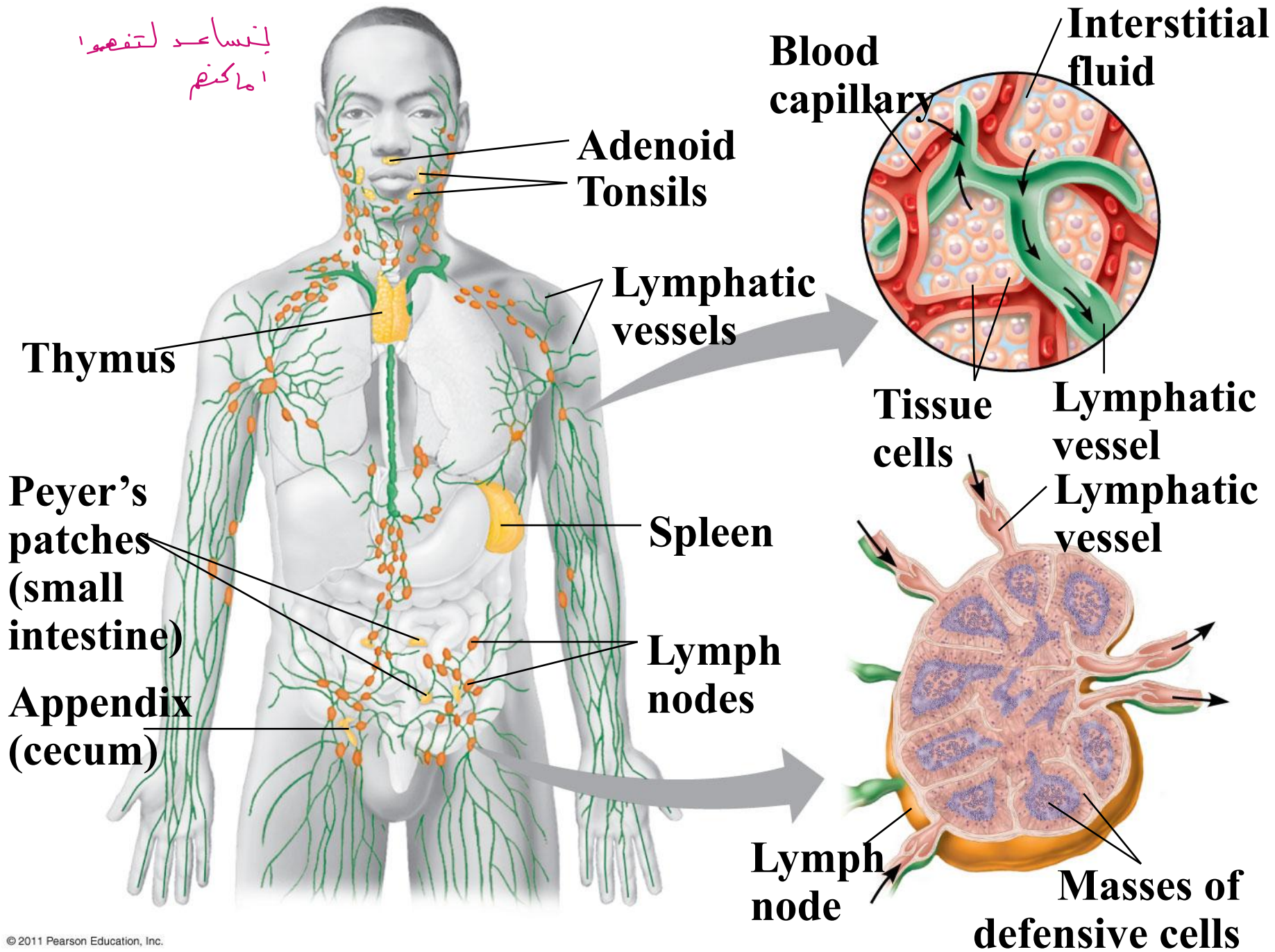
1. Innate immune cells:
“phagocytes” macrophage, neutrophils, dendritic cells

2. Adaptive immune cells:
“lymphocytes” T cells, B cells

- **Lymphatic and blood circulation**

مسؤول عن ال phagocytosis
 لو اجبت عمل فحص لمكونات الدم روح الاظ انه
 ال neutrophils لها اكبر نسبة من نسبه
 ال WBC (تقريبا 60-70%)
 ال dendritic cell لها exption في شبكة
 العنكبوت وروح الاظ انها بتشبه خلايا ال CNS وهاي
 الخايا بتساعد macrohages وبتعمل presentation
 للantibody على ال surfaced عشان تعمل
 triggering (تجذب) لل T cell لتشتغل

لنساعد لتفصوا
اماكنهم



هنا ال cell تقضي معظم الوقت بال lymphoid organ واصلا هي بصير
الها من ال central

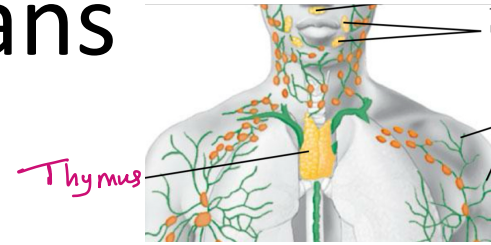
هنا ال lymph node بده يدخله lymph اصح؟ طيب من وين رح يجي ال lymph؟ بجي معلي ال filtration للدم من
الخلايا وال tissue الموجودين بال capillary فيروح لل lymph vessle فال lymph بكون فيه antigen و cell
ال lymph node اجواتها في immun cell فلما يدخلها ال lymph رح تعمل ال dcapture لل antigen الي اجا من ال
tissue

اما ال spleen ما بدخله lymph، بدخله blood وعشان هيك رح ياخذ ال antigen الي من ال blood

- The cells of the immune system spend much of their time in lymphoid organs. They develop (arise) in primary lymphoid organs, and they interact with antigens in secondary lymphoid organs.
 - Thymus: primary lymphoid organ for T cell development
 - Bone marrow: primary lymphoid organ for B cell development
 - Lymph nodes: collect antigens from tissues
 - Spleen: collects antigens from blood stream

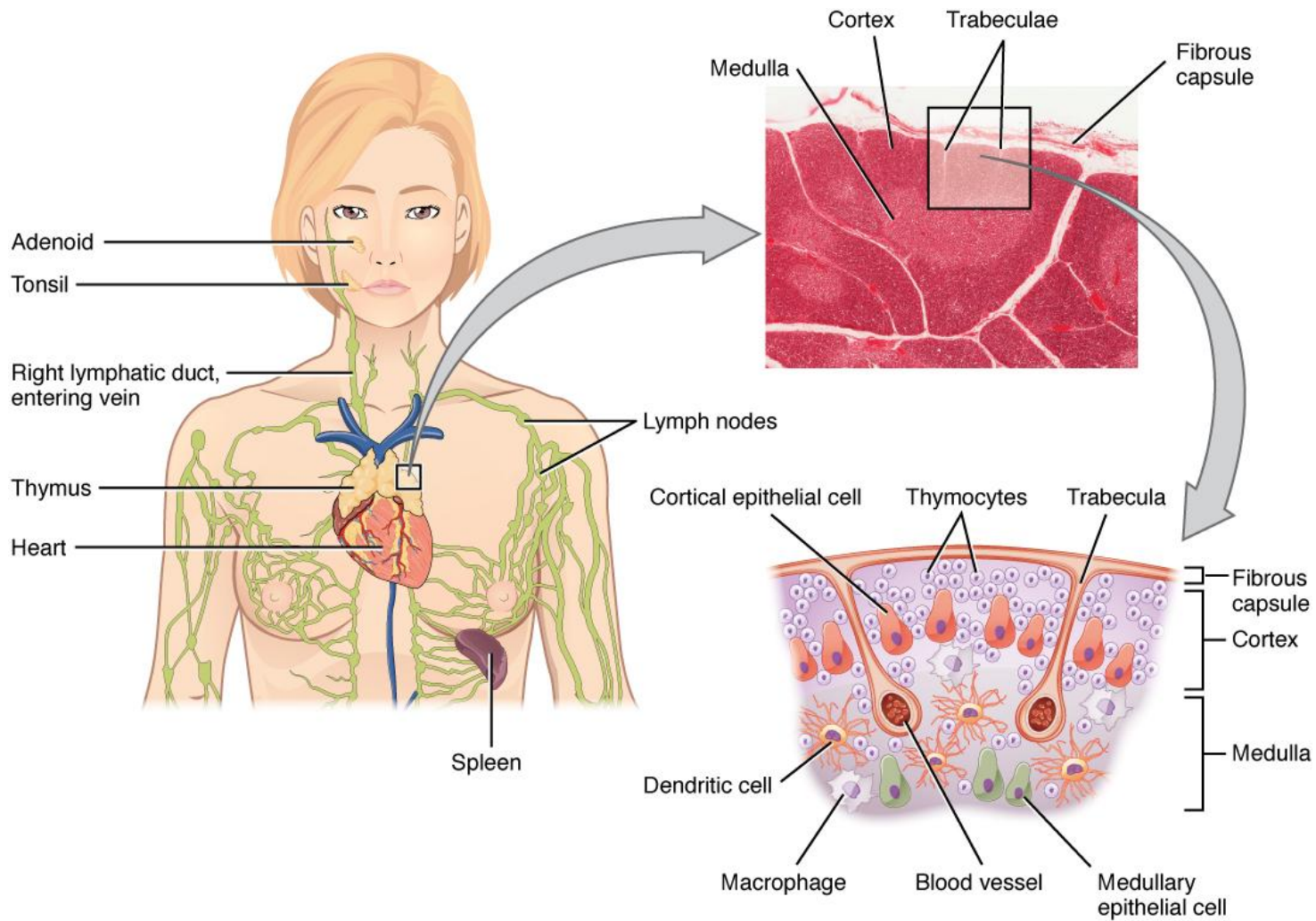
Lymphoid Organs

1. Thymus



يعني مقسوم الي قسمين (فصين)

- Flat **bilobed** organ situated above the heart
- Each lobe is surrounded by a capsule and divided into lobules separated by connective tissues called trabiculae هذول ال 2lobes بكونو مفصولين بالtrabacula
- The thymus reach its maximum size at puberty and then atrophies. اكبر حجم بيوصله ال Thymuse بكون في مرحله الpuberty (مرحلة الرشد) وبعد هيك يضمحل (atrophies) حكيئا فوق انه thymus مسؤول عن تصنيع ال T cell صح فبتوقع انه ال Tcell production تقل مع الوقت (drop)
- The thymus generation of T cells drop with time. By the age of 35 thymus generation of T cells drop to 20% and by the age of 65 it drop to 2% of newborn levels
- Play critical role in formation and maturation of T cells



2. Bone Marrow

موجود في bone

- Bone marrow is the flexible tissue in the interior of bones
- On average, bone marrow constitutes 4% of the total body mass of humans
- There are two types of bone marrow: red marrow (also known as myeloid tissue) and yellow marrow.
- Bone marrow is the site of haematopoiesis and the origin of B cells in human
- The hematopoietic component of bone marrow produces approximately 500 billion blood cells per day

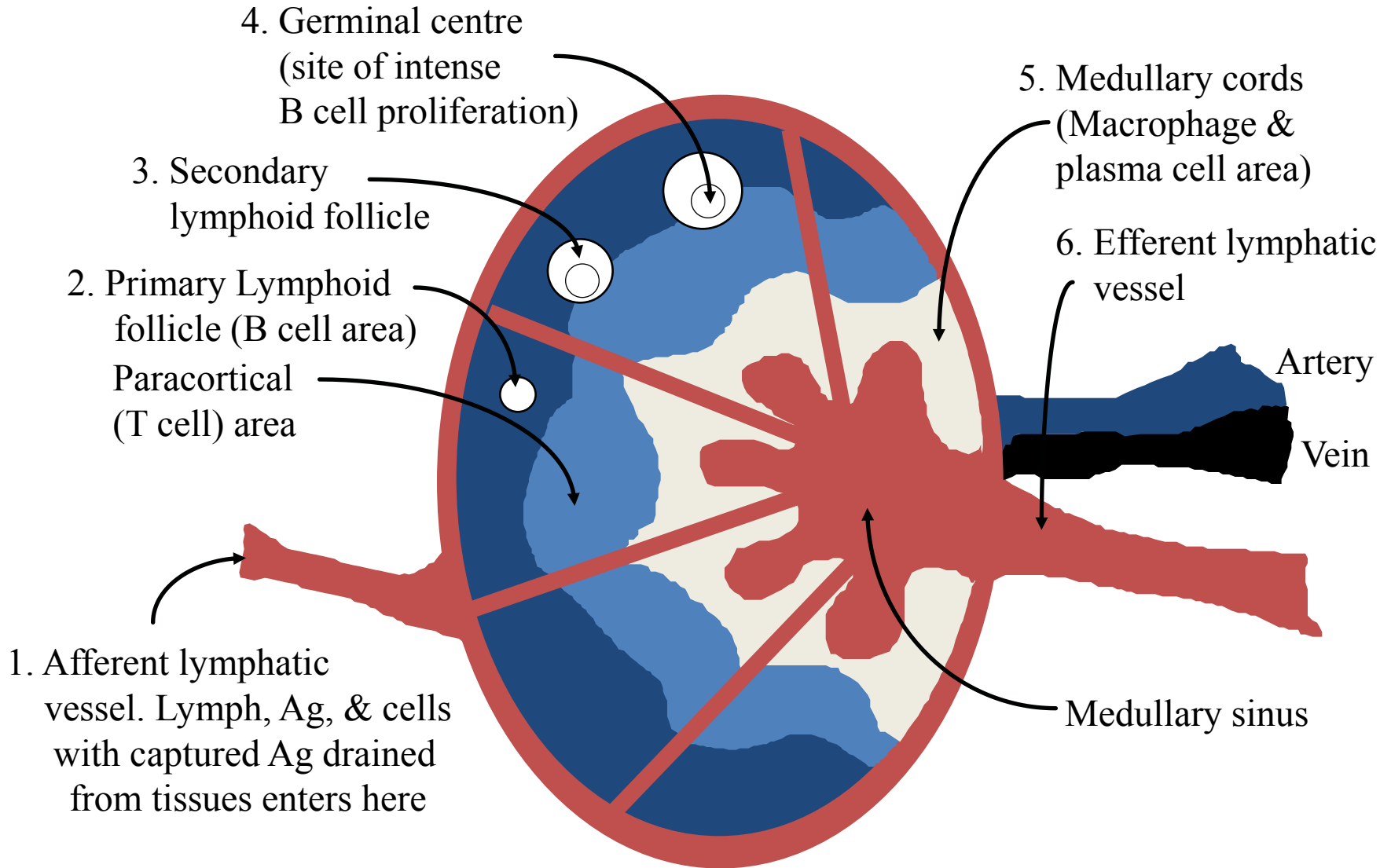
هناك yellow marrow و red marrow بيطي 4% من وزن الانسان وفي منه نوعين
وال bone marrow مسؤول عن تصنيع ال blood cell (haematopoiesis) ومسؤول عن تصنيع ال B cell وحكينا
انه ال B cell بصير الها differentiation ل plasma cell

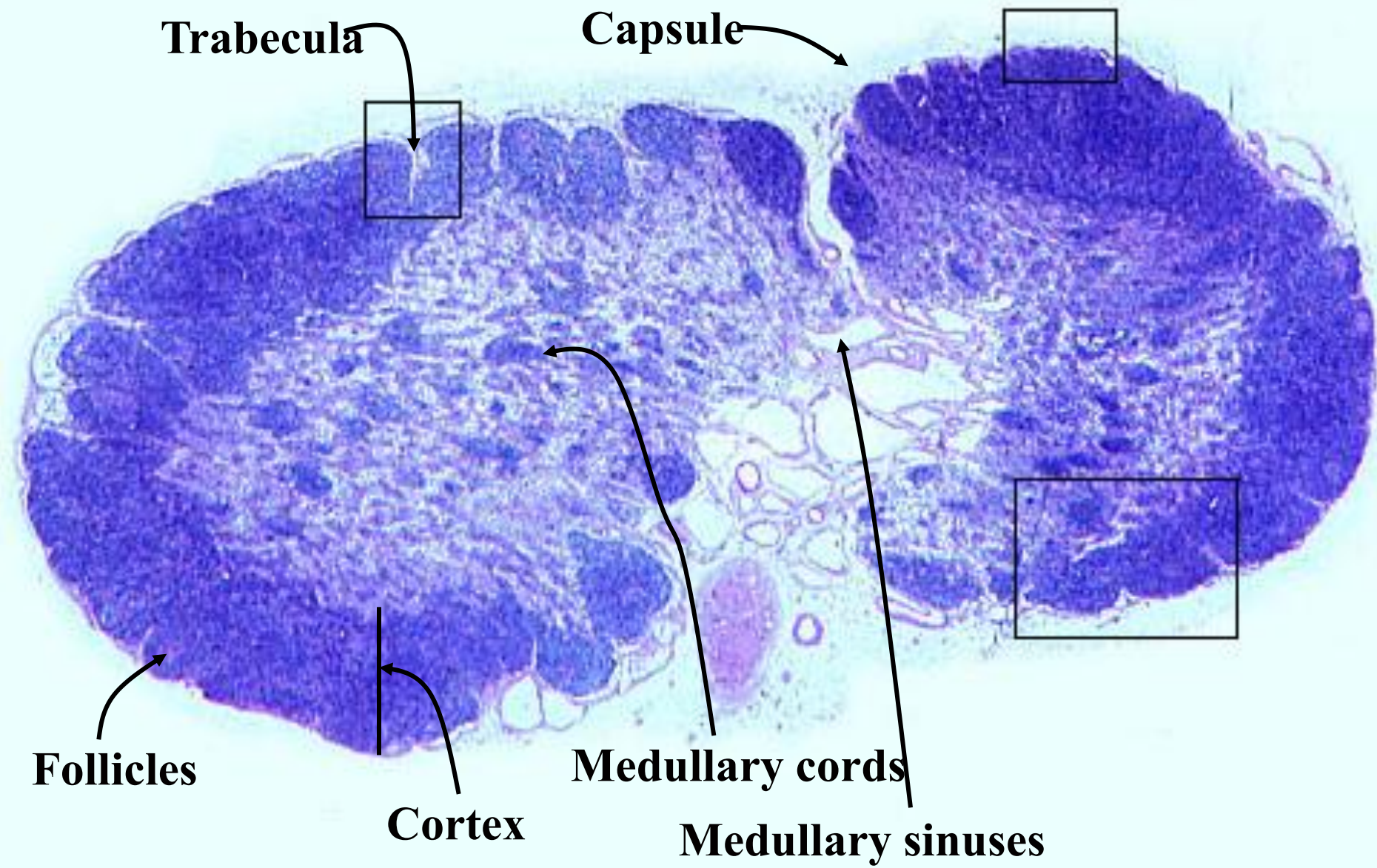
3. Lymph Nodes

- Lymph nodes are a nodular aggregates of lymphoid tissue located a long lymphatic channels through out the body
- As the lymph pass through the lymph nodes immune cells sample the antigens of microbes that might enter the body
- Antigens that might enter the body became concentrated and captured in the lymph nodes

حطيت على
قوت

Lymph node





4. Spleen

هسا ال spleen نفسه يعتبر big lymph node
بس يختلف عن ال lymph node العادية انه ما
بفوت عليه lymph، رح يفوت عليه (supplied)
blood وال blood رح يدخل لل spleen عن
طريق sinusoid

- Abdominal organ that serve as a big lymph node
- Unlike the lymph nodes the spleen is not supplied by lymphatic vessels
- The spleen had two main compartment the red pulp and the white pulp separated by diffuse marginal zone
- Blood enter the spleen through a network of channels called sinusoids
- Blood-borne antigen are trapped and concentrated in the spleen
- Immune cells in the spleen identify, ingest and destroy microbes

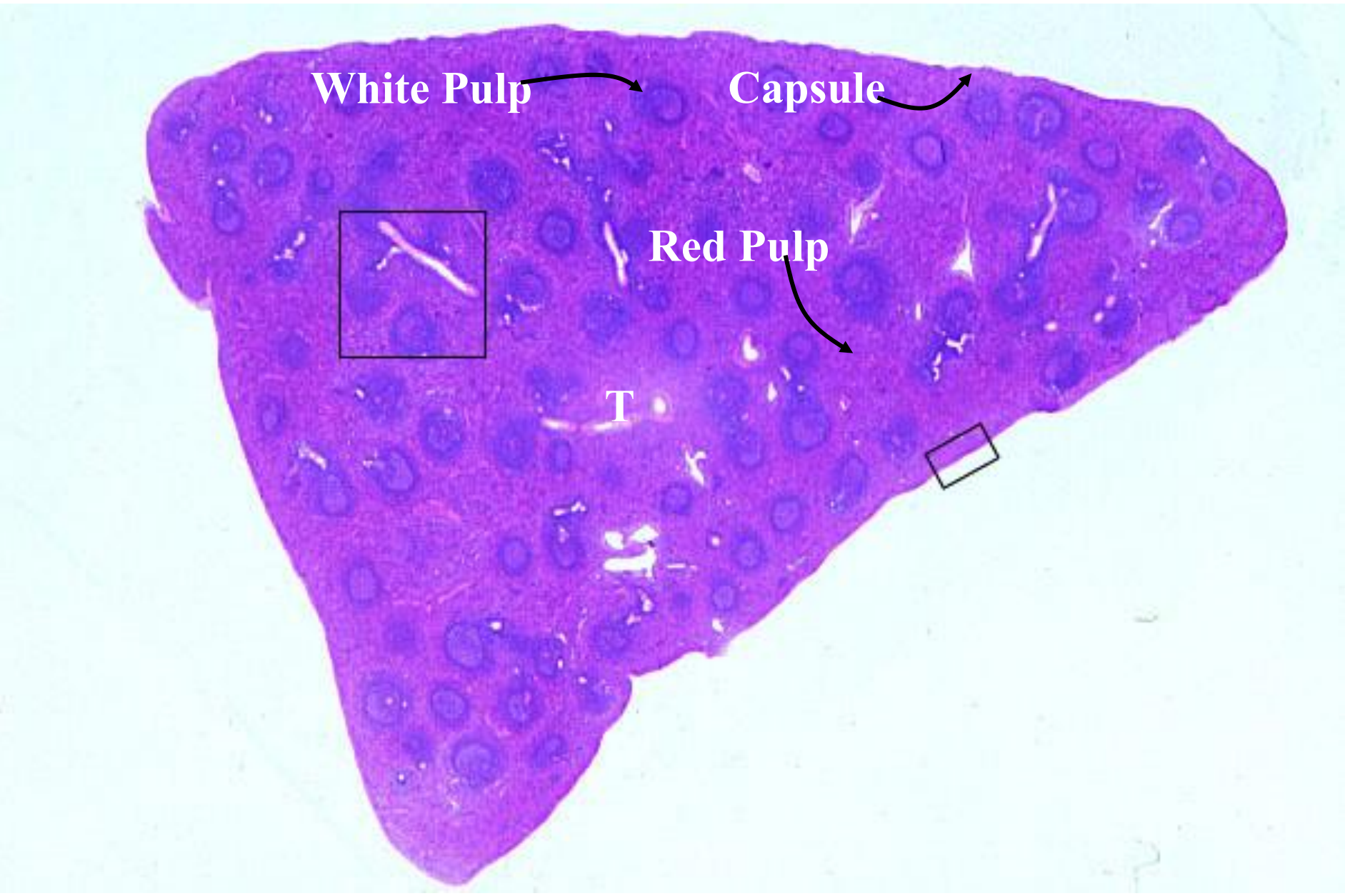
الطحال في immun cell بتعمل trapping لل antigen الي جاي من ال blood
وال immun cell هاي رح تقدر تعمل identify (تتعرف) ingest (تبتلع)
و ال microbs اذا كانت موجوده (الي اصلا تعرفت عليها بسبب
ال antigen)

White Pulp

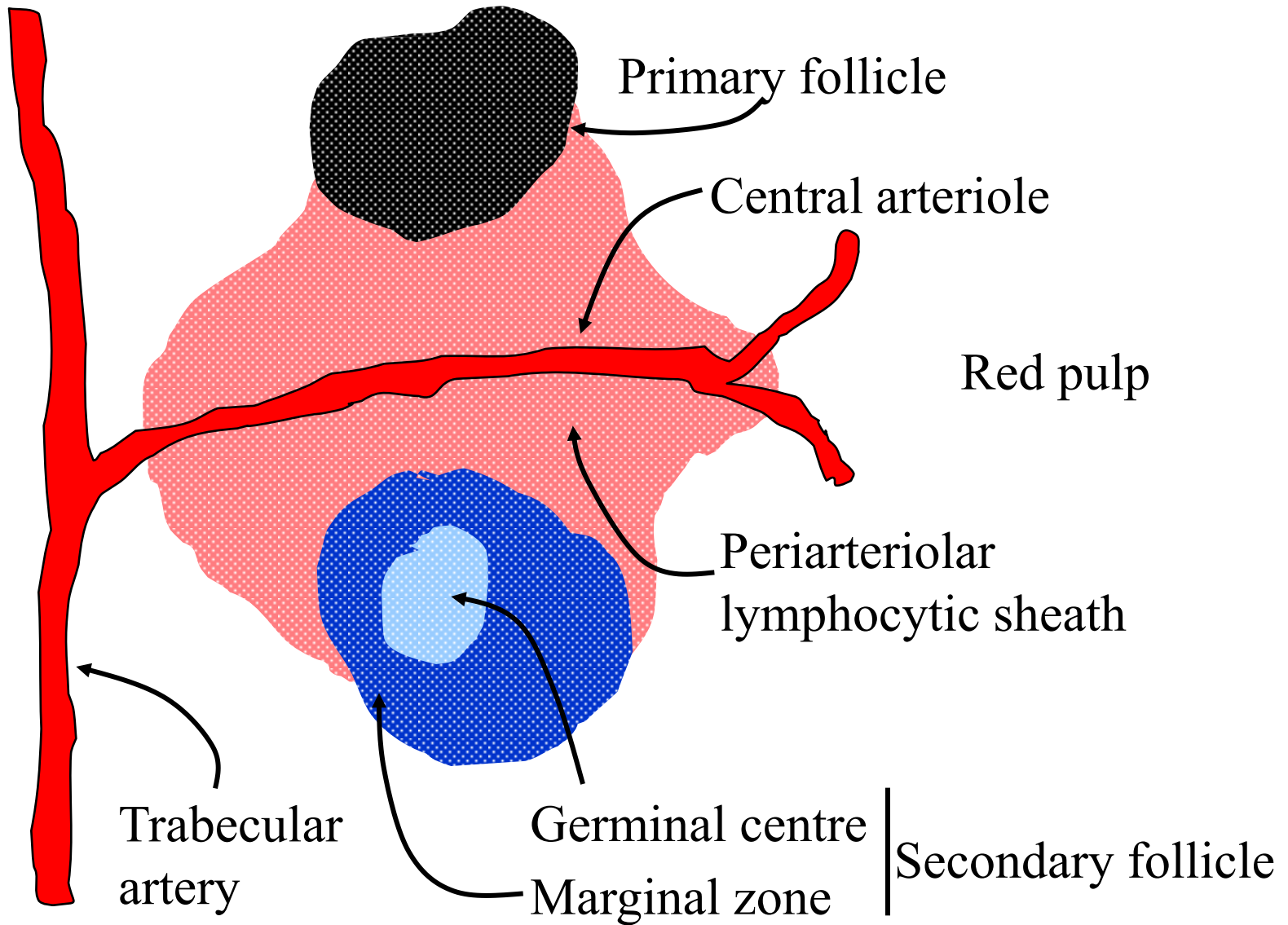
Capsule

Red Pulp

T



Spleen

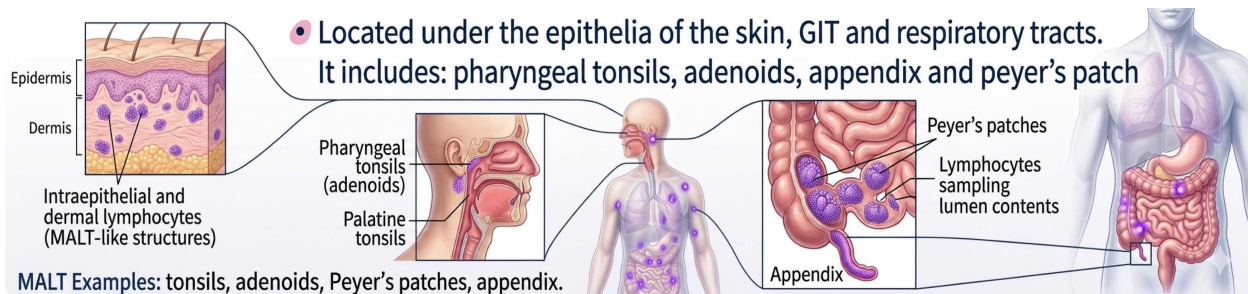


5. Cutaneous and Mucosal Lymphoid Organs

- Located under the epithelia of the skin, GIT and respiratory tracts. It includes: pharyngeal tonsils, adenoids, appendix and peyer's patch
- Sites of immune response to microorganisms that breach epithelia

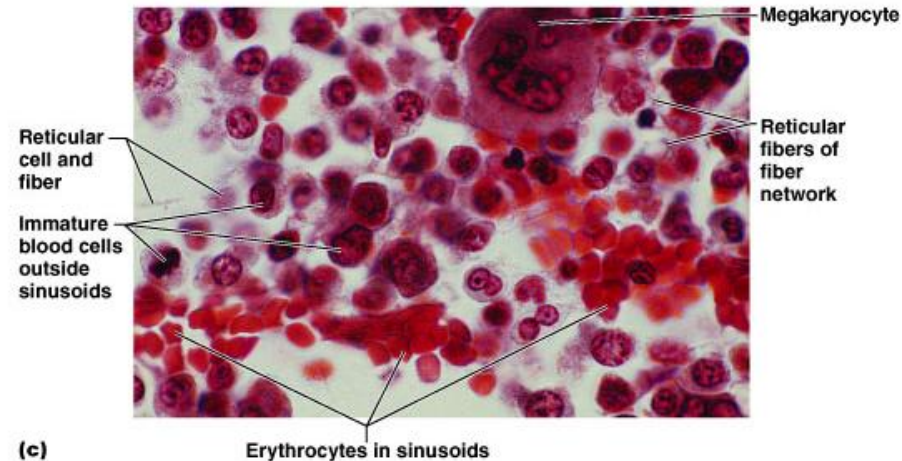
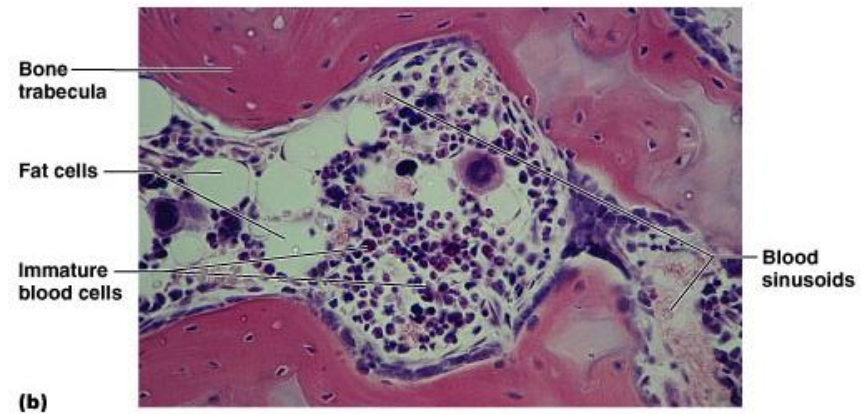
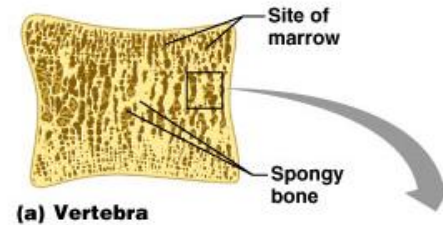
هذول ال cell يعملو لما ال microorganism تخترق ال epithelia

هناك الامكانات
التي يتواجد فيها
الخلايا الليمفاوية
في الجلد



Hematopoiesis

- Formation of blood cells
- Occurs mostly in red bone marrow
- All cells arise from same **blood stem cell** (pluripotent hematopoietic stem cells)

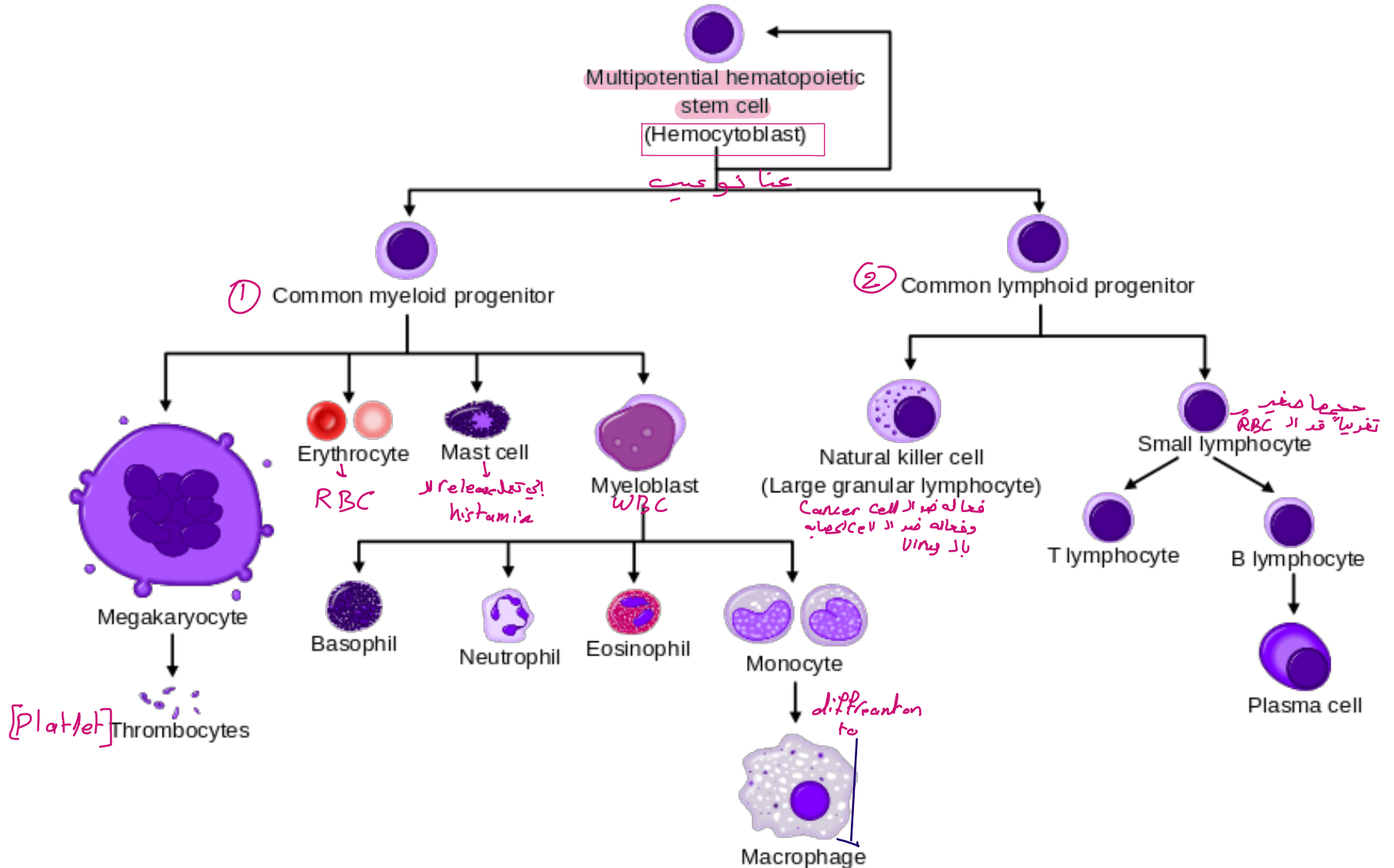


منها انه تنوع
خلايا متعددة

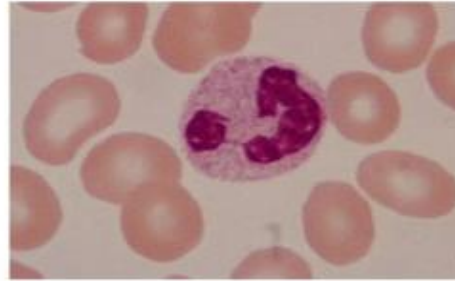
هي عملية تصنيع ال blood cell وتحدث بbone marrow (بال red bone marrow تحديدًا) كل الخلايا تنتج من خلية اسمها blood stem cell وهي تعتبر قطعه غيار لاي خليه بالجسم بكل الانواع



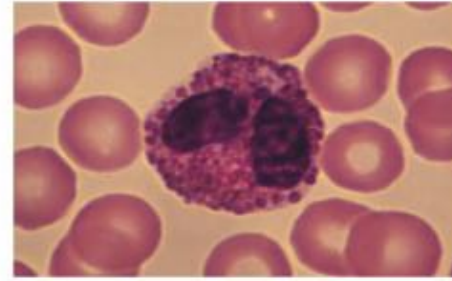
Formation of Blood Cells



Leukocytes



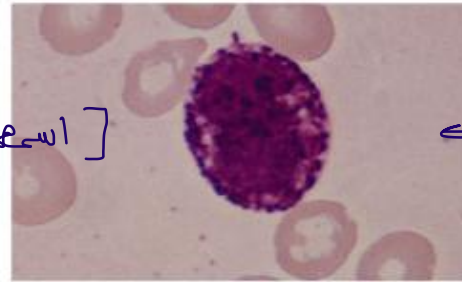
(a) neutrophil [3-5] lobes



eosinophil [2] Lobes

حکینا ایسا لہی
لغیبہ

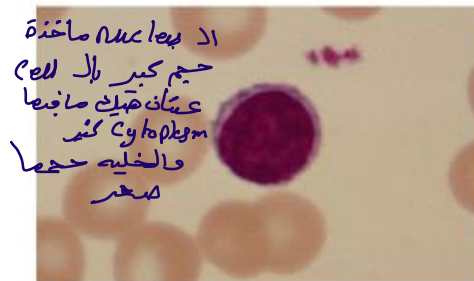
arabic → granule نيم [Granulocyte اسم]
واد nucleus نوكلا Lobes



(c) basophil

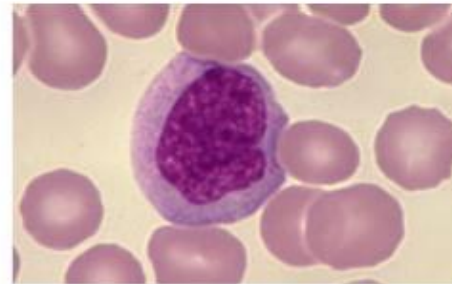
← darker granules

dic → Agranulocyte



(d) small lymphocyte

اد نوكلا ماخذة
حجم كبير بال cell
عشان هتبيك ماخذة
Cytoplasm كثر
والخليه حضا
كثير

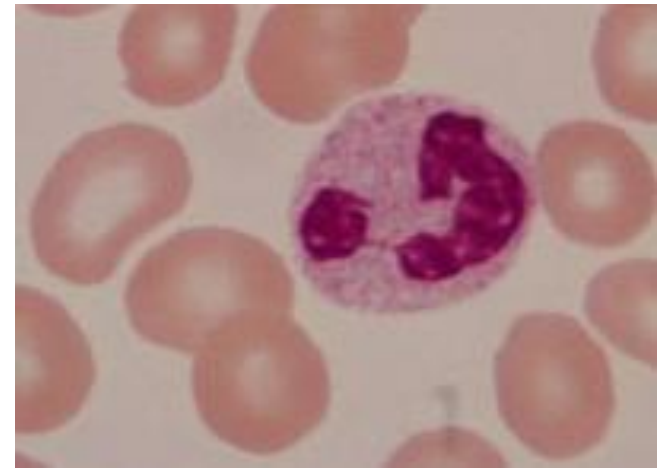


(e) monocyte

Leukocyte Types

- Artificial division into granulocytes and agranulocytes
- Granulocytes: neutrophils, eosinophils, basophils (according to how stain)
 - Granules
 - Lobed nuclei
 - All are phagocytic
- Agranulocytes: lymphocytes, monocytes

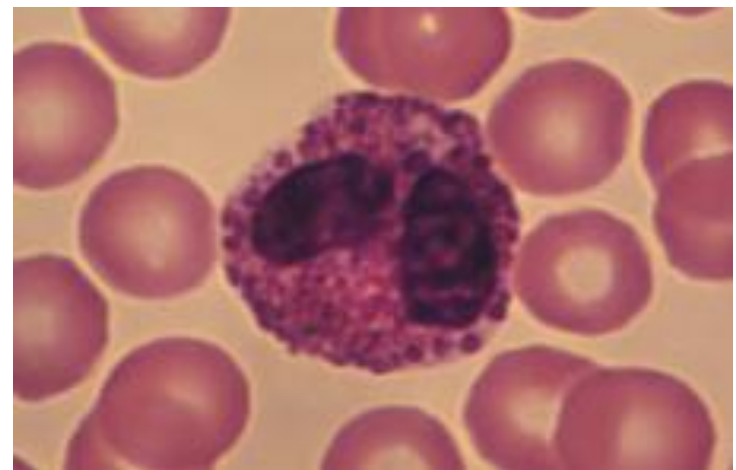
1. Neutrophils



- 60% of all WBCs
- Other names: Polymorphonuclear cells (PMNs, polys, segs)
- Appearance: pink granules in cytoplasm, nucleus has 3-5 lobes
- Function: Phagocytosis of **bacteria**
 - Granules have enzymes→
 - Can damage tissue if severe or prolonged
 - Form pus

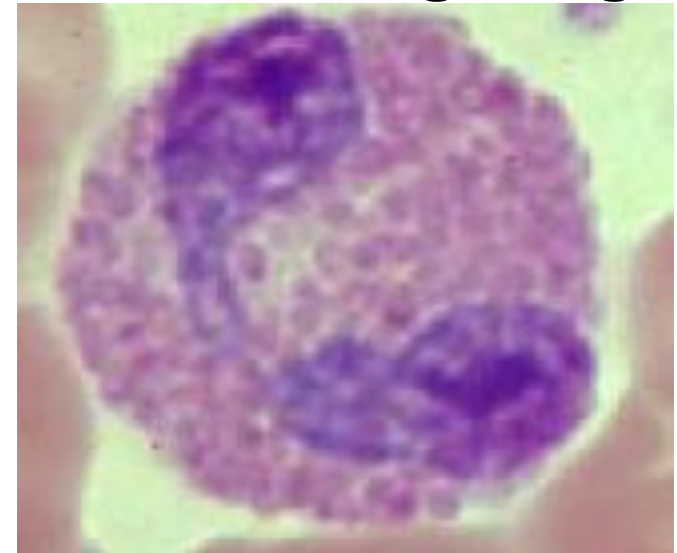
الenzyme يساعدو بعملية الphagocytosis
للbacteria وعشان هيك لما يكون في infection
الجسم رح يطلع pus دلالة على انه يقاوم

2. Eosinophils



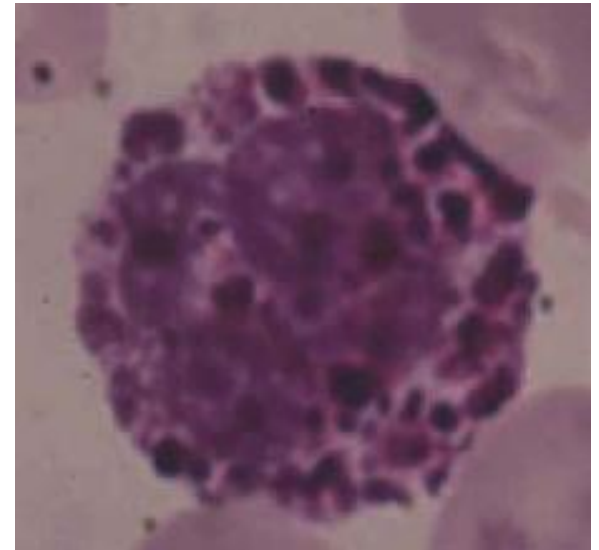
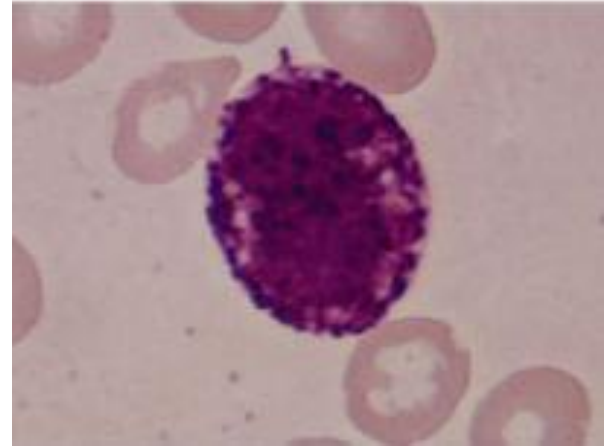
- 1-4 % of leukocytes
- Bilobed and contain eosinophilic granules which have digestive enzymes
- Role in ending allergic reactions and in fighting parasitic infections

إذا شفت نسبتها مرتفعة فيعني عند المريض aalergy او
إذا كان في parasitic infection (من الديدان او غيره)



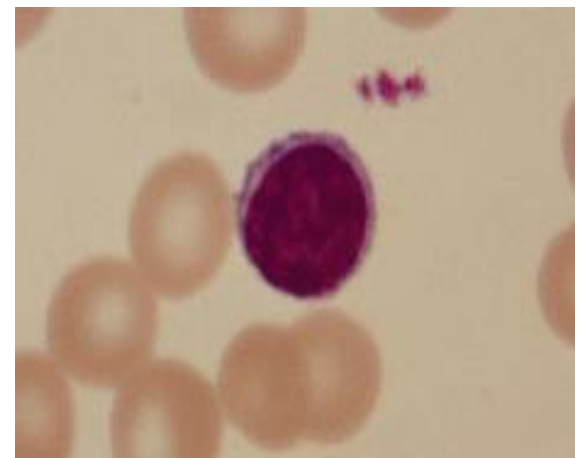
3. Basophils

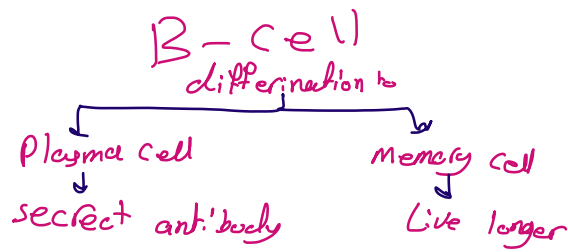
- Rarest WBC, <1% WBC
- Bilobed nucleus
- Dark purple granules (basophilic granules)
- Granules contain: histamine and heparin
- IgE receptors - Involved in allergy



4. Lymphocytes

- Most important WBC 20-45%
- Small (same size as RBCs)
- Mostly present in lymphoid connective tissue, e.g. lymph nodes, tonsils, spleen لتقاوم الأضرار
- Nucleus occupies most of the cell volume (little visible cytoplasm) and no specific granules
- Two main types attack antigens in different ways
 1. T cells
 2. B cellsplus “natural killer cells”

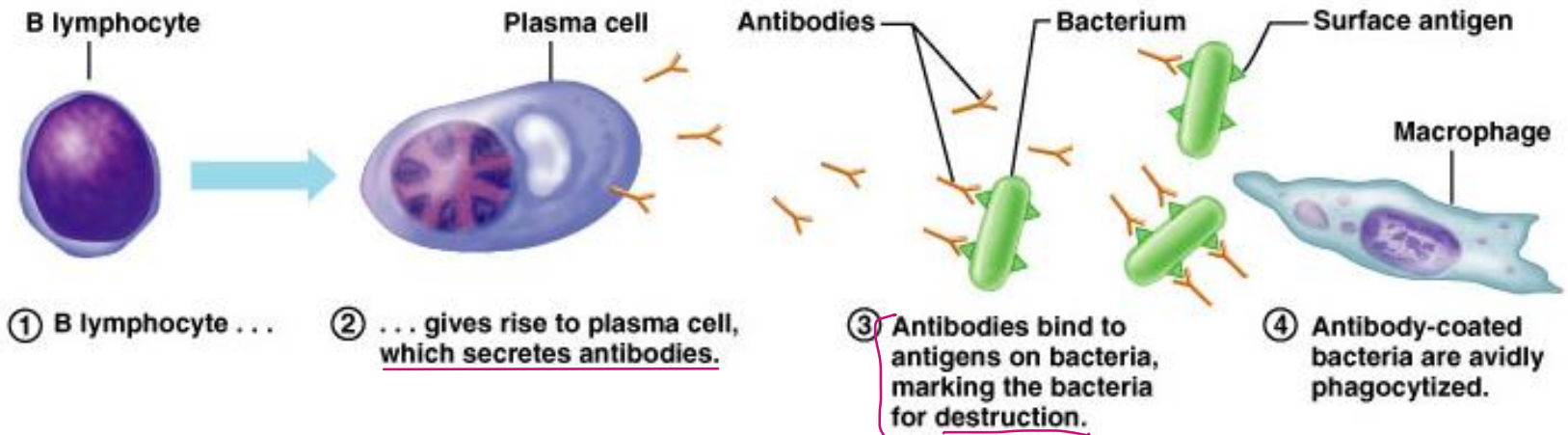




B cells

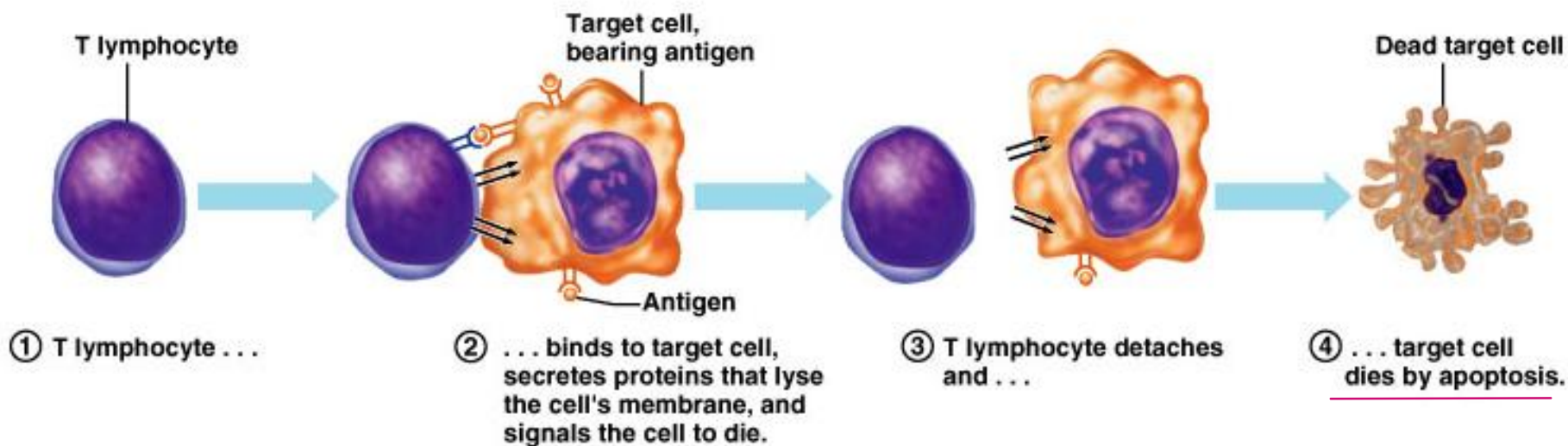
- Formed and mature in the bursa of Fabricius in birds and in bone marrow in mammals [Red bone Marrow]
- Differentiate into plasma cells that secrete antibodies or become a memory cells that live longer
- B cells also display antibodies on their *Membran*

لما تطلع الantibody على سطحها هي ،هاي الطريقة لتجذب الphagocyte و هيك رح تهاجم الmicrob

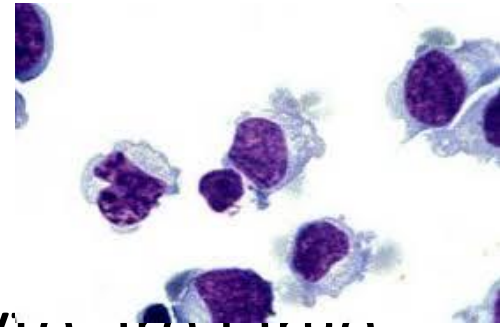


T cells

- T lymphocyte mature in thymus
- T cells antigen binding molecule called T cell receptor
في خلايا الها receptor لل Tcell وبنسميها T cell receptor
- T cells are subdivided into 3 main groups: Helper T cells, Cytotoxic T cells, and regulatory



5. Natural Killer Cells (NK)

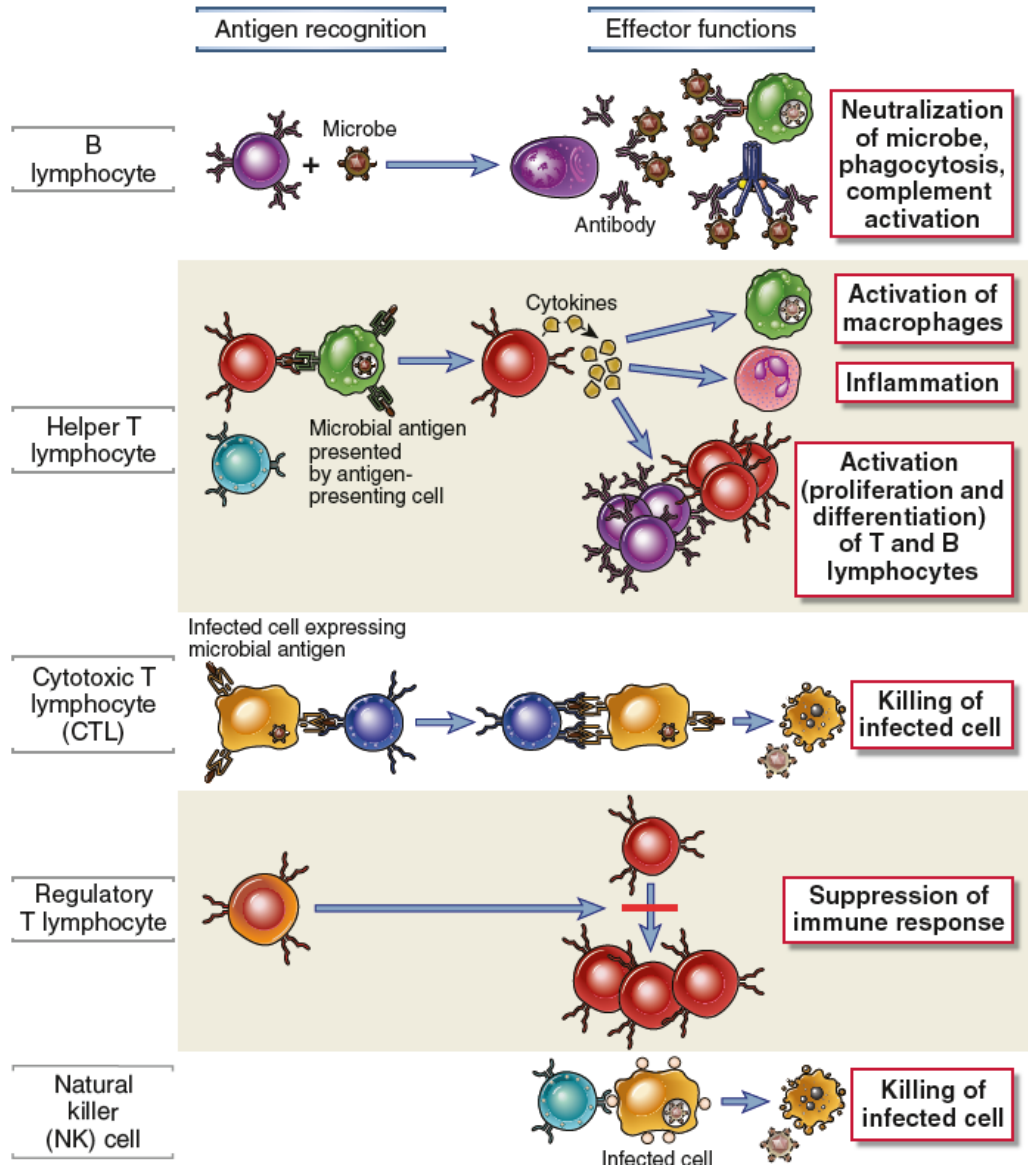


- Constitute 5-10% of human lymphocyte and granular cells
- Display cytotoxic activity against tumor cells and cells infected with viruses
- These cells don not have specific receptors for antigens on their surface and considered part of innate immunity
هاي الخلايا ما عندها antigen لل specific receptor عشان هيك اعتبروها من ال innate immunity بس الها ال receptor لل antibody وهيك بتقدر تهاجم ال target cell وتدمرها
- NK cells have receptors for antibodies and can destroy targeted cells through a process known as **antibody-dependent cells mediated toxicity**
بتقتل ال Cancer cell. وال cell الي فيها virusis بهاي ال process



Classes of Lymphocytes

لس تخلصوا دراسة
أرجو له لتراجوهم



6. Monocytes/ Macrophages



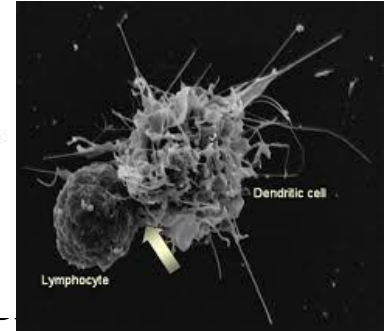
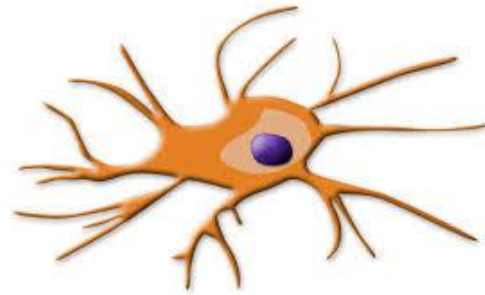
Monocyte

- 3-8% WBC
- Monocytes circulate in blood for about 8 hours then it enlarge and migrate into tissues and differentiate into specific tissue macrophage
- Recruited to sites of inflammation

Macrophages

- Macrophage play role in phagocytosis, bacterial killing, and antigen presentation
هسا بعد ما يصير ال phagocytosis ال طرح يطلع antigen على سطح الخلايا الميتة عشان تجذب خلايا T lymphocyte ولترتبط وتكمل شغل ال immun system
- Some macrophages move through the body and remain as free macrophage and some reside in particular tissue and become fixed macrophage like:
 - Peritoneal cavity: peritoneal macrophages
 - Lung: alveolar macrophages
هسا في macrophage تتحرك freely بالجسم بس ممكن تلاقي مكان تتركز فيه وحسب المكان الي تركزت فيه بصير اسمها على اسمها يعني راحت لل lung بصير اسمها alveolar macrophage
 - Liver: Kupffer cells
 - Intestinal macrophage
 - Microglial cells in brain موجوده بال BBB
 - Histocytes in connective tissue

7. Dendritic Cells



- Acquired its name because of its membrane extensions that resemble the dendrites of nerve cells
- Dendritic cells have 4 main classes:
 - Langerhans DCs
 - Interstitial DCs
 - Monocyte-derived DCs
 - Plasmacytoid-derived DCs
- DCs main functions are monitoring of body for pathogen invasion and presentations of antigens for T cells

Stages of Lymphocyte Activation

هاي ال lymphocyte ما تعرضت للantigen ابدا فوظيفتها انها تعمل
antigen recognition بتلاقيه اكثر بالlymp node حيث بتكون هون
موجوده لتعمل لل recognition الي جايه من ال tissue

- Naïve lymphocytes
 - Mature lymphocytes that have not previously encountered antigen; function -- antigen recognition
 - Preferential migration to peripheral lymphoid organs (lymph nodes), the sites where antigens are concentrated and immune responses start
- Effector lymphocytes *هاي معناها activated lymphocyte*
 - Activated lymphocytes capable of performing the functions required to eliminate microbes (effector functions)
 - Effector T lymphocytes: cytokine secretion (helper cells), killing of infected cells (CTLs)
 - B lymphocytes: antibody-secreting cells (e.g. plasma cells)
- Memory lymphocytes
 - Long-lived, functionally silent cells; mount rapid responses to antigen challenge (secondary responses)

Function of Immune Cells

- Lymphocytes of the adaptive immune system
 1. T helper cells: regulate other immune cells
 2. T cytotoxic (killer) cells: kill infected cells
 3. B cells: produce antibodies (immunoglobulin)
- Dendritic cells and macrophage: directly kill microbes by phagocytosis and other mechanisms. They also help to activate T cells (connection between innate and adaptive immunity)
- Dendritic cells and other Antigen presenting cells (APCs) also play role in capturing microbes and then process and display antigens
- NK cells are lymphocytes: Recognizes and kill abnormal cells like tumour cells, and virus infected cells

Lymphocyte Circulation

- Lymphocytes constantly circulates between tissues in such a way that
 1. naïve lymphocytes traverse the peripheral lymphoid organs where immune response are initiated
 2. the effectors lymphocytes migrates to sites of infections to eliminates microbes
- Lymph: Fluids from all epithelia, connective tissues and paranchymal organs is drained by lymphatic's

Component	Status/Type	Path/Migration	Primary Purpose
Lymphocytes	Naïve	Traverse peripheral lymphoid organs.	To initiate the immune response upon meeting an
	Effector	Migrate to sites of infection.	To eliminate microbes and
Lymph	Fluid	Drained from epithelia, connective tissues, and	To transport antigens and fluid back to the lymphatic system.

Lymphocyte Circulation:

1. Lymphocytes & lymph return to blood via thoracic duct
2. Naïve lymphocytes enter lymph nodes from blood

Naïve lymphocytes: Have not seen Ag
 blood → Lymph nodes → lymphatics → thoracic duct → blood

Small T & B lymphocytes: Recirculating population of lymphocytes

Effector cells: Recognize (“seen”) Ag; Differentiate in lymph nodes

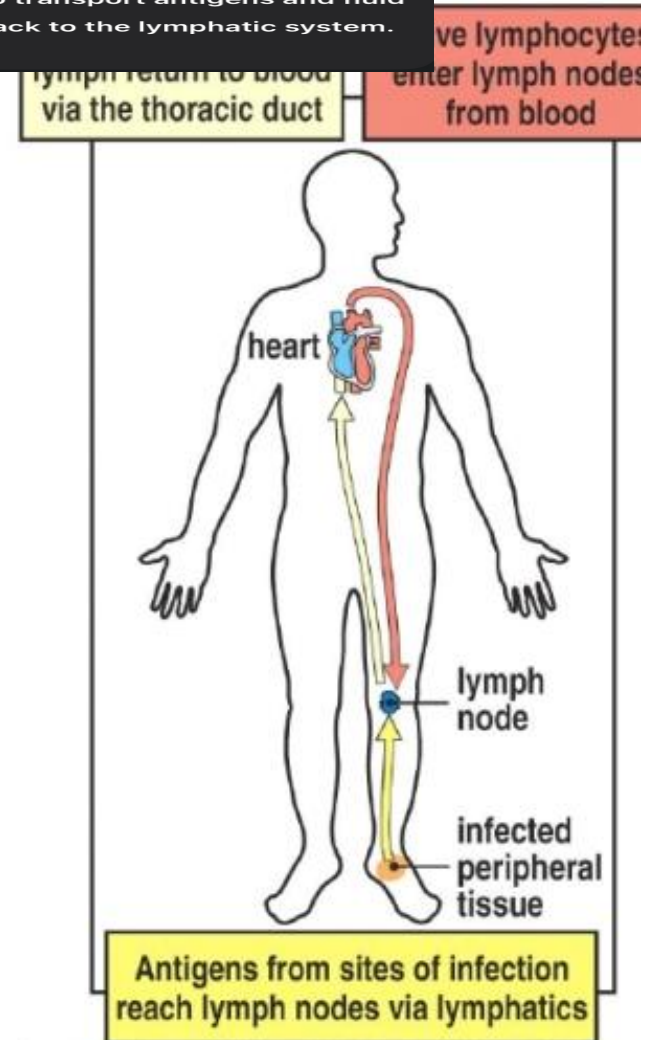


Figure 1-11 Immunobiology, 6/e. (© Garland Science 2005)

The CD Nomenclature

- Structurally defined leukocyte surface molecule that is expressed on cells of a particular lineage and recognized by a group (“cluster”) of specific antibodies is called a member of a cluster of differentiation (CD)
- Used to classify leukocytes into functionally distinct subpopulations, e.g. helper T cells are CD4+, Cytotoxic T cells are CD8+, and Regulatory T cells are CD4+ and CD25+
- Often involved in leukocyte functions
- Antibodies against various CD molecules are used to:
 1. Identify and isolate leukocyte subpopulations
 2. Study functions of leukocytes
 3. Eliminate particular cell populations

تتحدث هذه الصورة عن **عناقيد التمايز (Cluster of Differentiation)** والمعروفة اختصاراً بـ **CD**، وهي نظام يُستخدم لتمييز وتصنيف خلايا الدم البيضاء (Leukocytes) بناءً على الجزيئات الموجودة على سطحها.

إليك شرح مفصل للنقاط المذكورة في الصورة:

ما هي جزيئات الـ CD؟

هي جزيئات (بروتينات غالباً) توجد على سطح الخلية. يتم التعرف عليها بواسطة مجموعة أو "عنقود" من الأجسام المضادة المحددة. تسمح لنا هذه الجزيئات بمعرفة "هوية" الخلية ووظيفتها، لأن كل نوع من الخلايا المناعية يعبر عن جزيئات CD معينة تميزه عن غيره.

أهمية واستخدامات جزيئات الـ CD:

1. **التصنيف:** تمييز أنواع الخلايا (مثل الفرق بين الخلايا التائية المساعدة والقاتلة).
2. **الوظيفة:** هذه الجزيئات ليست مجرد علامات، بل غالباً ما تؤدي دوراً حيوياً في عمل الخلية (مثل استقبال الإشارات).
3. **التطبيقات الطبية:** تُستخدم الأجسام المضادة ضد هذه الجزيئات في:
 - عزل الخلايا: فصل نوع معين من الخلايا للدراسة.
 - التشخيص: التعرف على أنواع السرطانات (مثل سرطان الدم).
 - العلاج: استهداف خلايا معينة وتدميرها (مثل العلاج المناعي).

الوظيفة الأساسية (باختصار)	علامة الـ CD المميزة	نوع الخلية التائية (T Cell Type)
تنسيق الاستجابة المناعية وتحفيز الخلايا	CD4+	خلايا تائية مساعدة (Helper T cells)
الهجوم المباشر على الخلايا المصابة	CD8+	خلايا تائية سامة (Cytotoxic T cells)
تنظيم وتثبيط الجهاز المناعي لمنع أمراض	CD4+ و CD25+	خلايا تائية منظمة (Regulatory T cells)