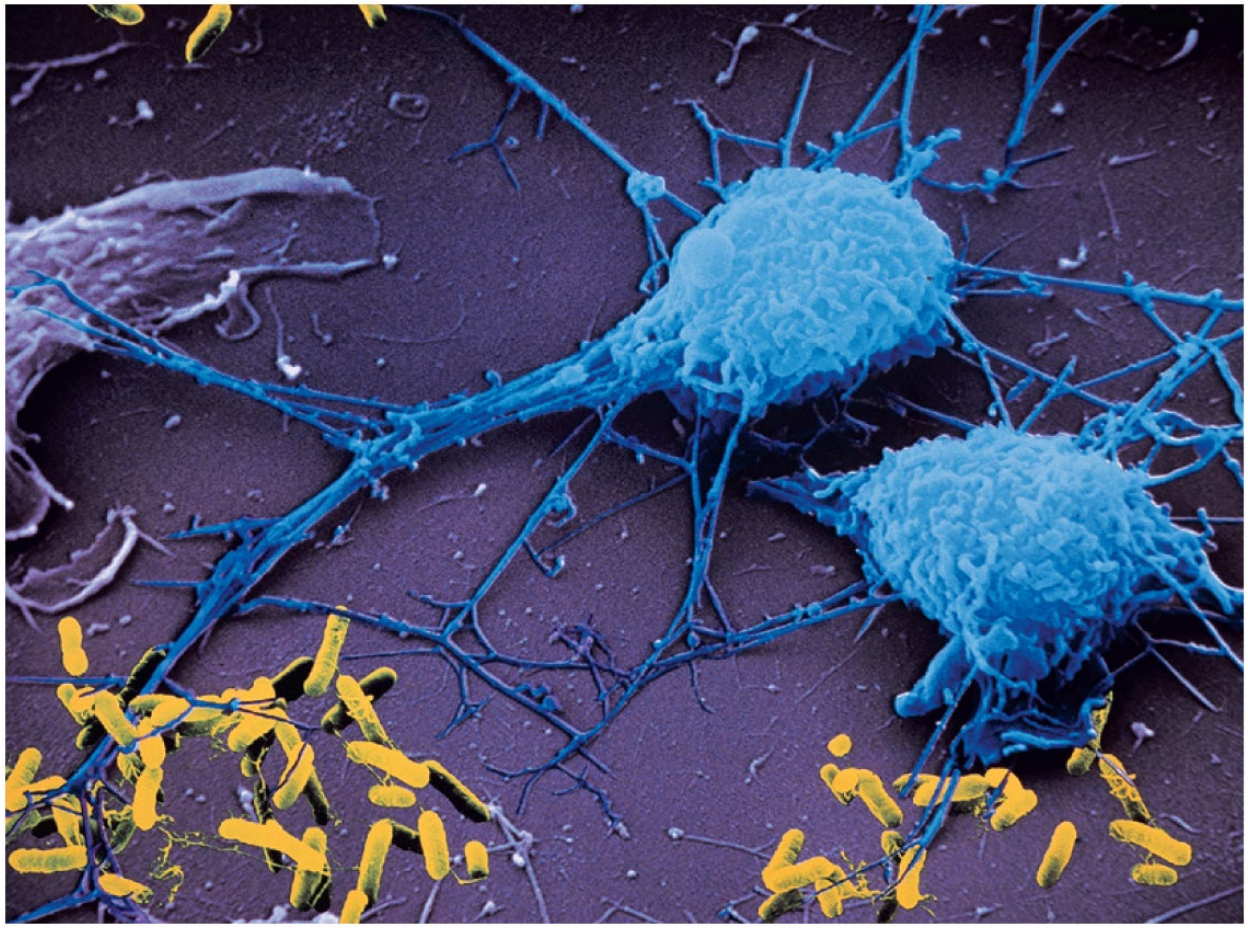
Chapter 21.3

Lymphatic Cells VS Lymphatic Tissue VS Lymphatic Organs?

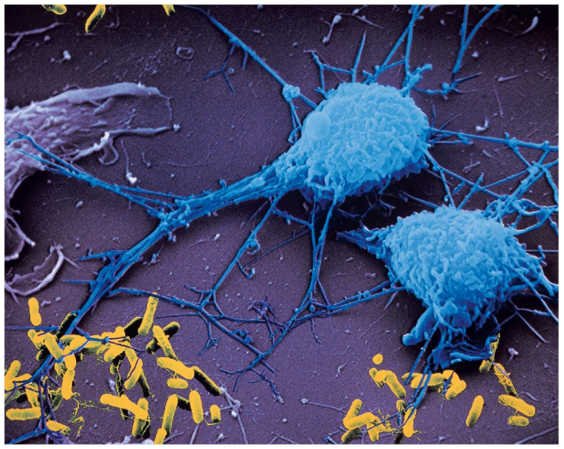


What is the Difference Between Lymphatic Cells, Lymphatic Tissue, and Lymphatic Organs?

Lymphatic cells are white blood cells. These are the cells responsible for cleaning up cell damage and ridding the body of pathogens.

Lymphatic cells are "nomadic". They do not adhere to each other and are free to move through your body. One moment they are in the blood, then in the interstitial space, then move into our organs by using the seams of connective tissue to penetrate the organs. Crazy!

These cells are constantly on the hunt looking for pathogens.

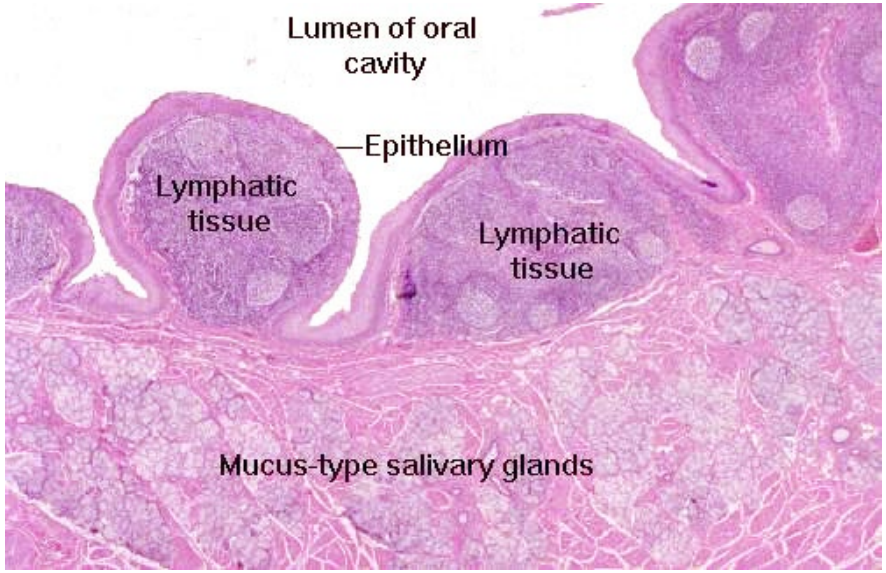


What is the Difference Between Lymphatic Cells, Lymphatic Tissue, and Lymphatic Organs?

Lymphatic cells form lymphatic tissue when different classes of WBC converge in an area to destroy a pathogen. Lymphatic tissue is a cluster of lymphatic cells.

Different WBC bring their unique function to the site of infection as they cluster together.

Working as a team, lymphatic cells will overcome the threat. (If we are lucky!) After their victory, the cells disband and return to their nomadic function looking to find new pathogen to defeat.

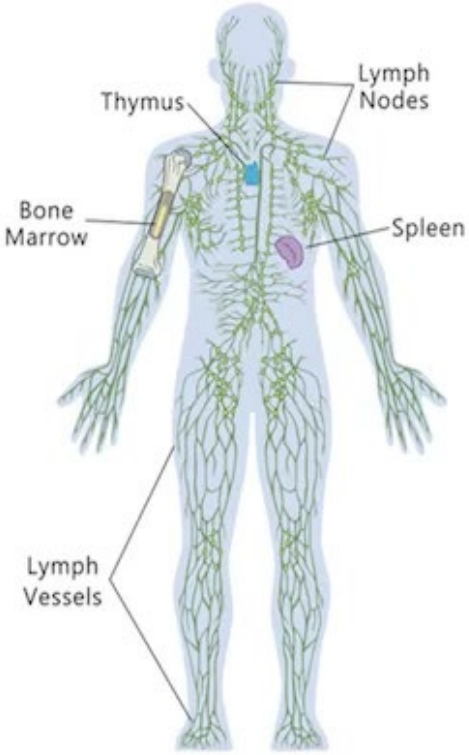


Lymphatic cells form lymphatic tissue when they migrate to site of infection. Lymphatic tissue is not surrounded by connective tissue.

After the pathogen is eliminated, the lymphatic cells will migrate away from the site of the infection.

What is the Difference Between Lymphatic Cells, Lymphatic Tissue, and Lymphatic Organs?

Lymphatic organs are surrounded by a connective tissue capsule with many different types of "resident WBCs". Lymphatic organs provide a resting place for lymphatic cells, like a half-way house. We find the highest concentration of lymphocytes and macrophage inside lymphatic organs. The WBC are free to leave and wander about your body but like to have a "resting place".

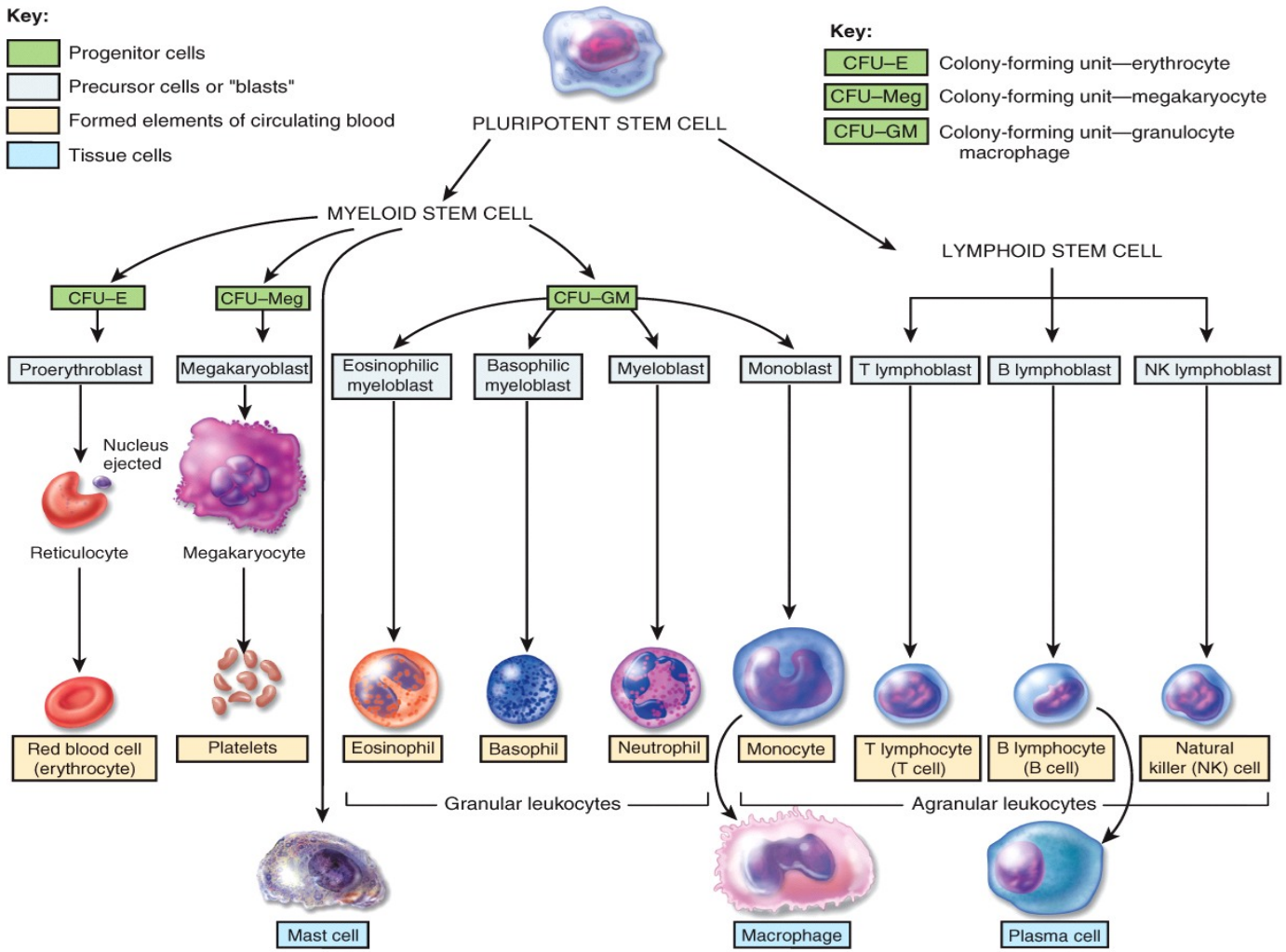


Lymph node

Spleen

Lymphatic Cells

We have already covered the formed elements of blood. You should already have flash cards made to review the function of these WBCs. Slides six through 26 are review slides and will not be covered again as a lecture topic.



Leukocytes (WBCs)

Least abundant of all the formed elements // 5,000 to 10,000 WBCs/μL (out numbered by RBC and platelets

Primary function = protect against infectious microorganisms and other pathogens

WBCs have conspicuous nucleus

Spend only a few hours in the blood stream before migrating out of blood and into connective tissue (i.e. reticuloendothelial system)

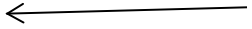
Retain their organelles for protein synthesis

All WBC have granules, but some cells don't stain!

Types of Leukocytes

Granulocytes // these cells stain // known as the "NEBs"

–neutrophils (60-70
–eosinophils (2-4%)
–basophils (<1%)



The "NEB"

Agranulocytes // these don't stain

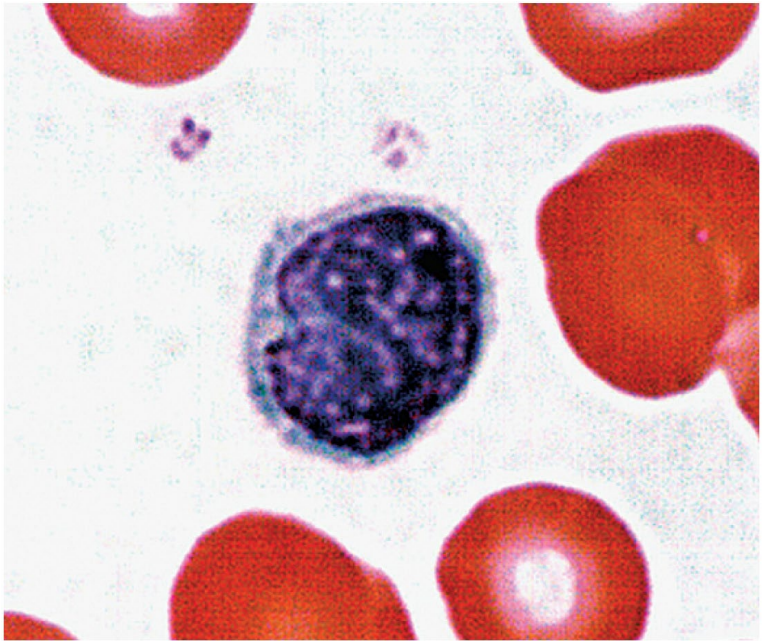
–lymphocytes (25-33%)
–monocytes (3-8%)

The "LM"

How to remember WBC ranking = Never let monkeys eat bananas

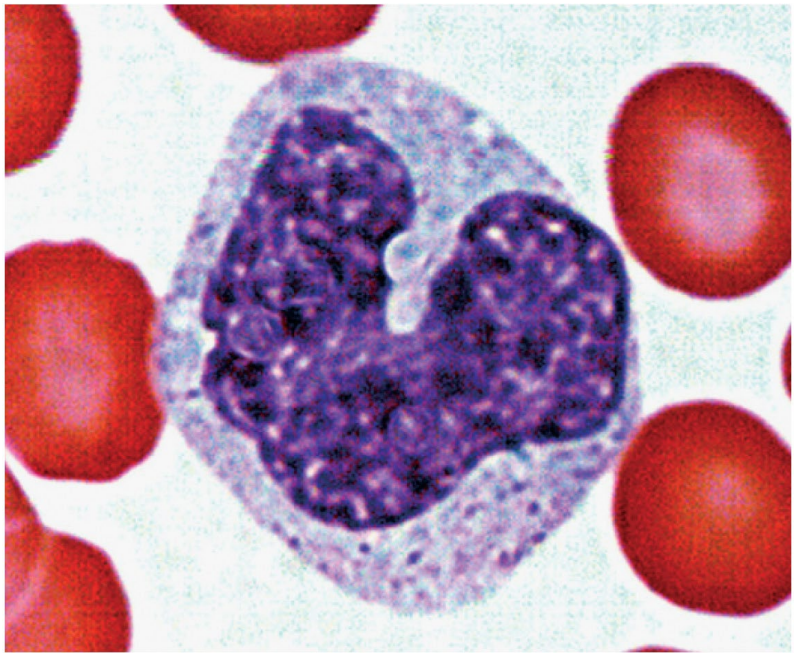
Immunity and Agranulocytes

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



Lymphocyte

10 µm



Monocyte

10 µm

Agranulocytes
The Lymphocytes and Monocytes

Three Types of Lymphocytes

Natural killer cells (NK)

–large lymphocytes

–responsible for immune surveillance

–attack and destroy bacteria

–Attach and destroy transplanted tissue

–Attack and destroy host cells infected with viruses or cells that become cancerous

T lymphocytes (T cells)

–mature in thymus

–Helper T Cells, Cytotoxic T Cells, Memory T Cells, Regulatory T Cells

B lymphocytes (B cells)

–activation causes proliferation and differentiation into **plasma cells**

–**Plasma cells** produce **antibodies**

–Memory B Cells

–Antigen presenting cell

Monocytes
(Monocytes Change to Macrophage)

3-8% // largest WBC; ovoid, kidney or horseshoe shaped nucleus

Increased numbers in viral infections and inflammation

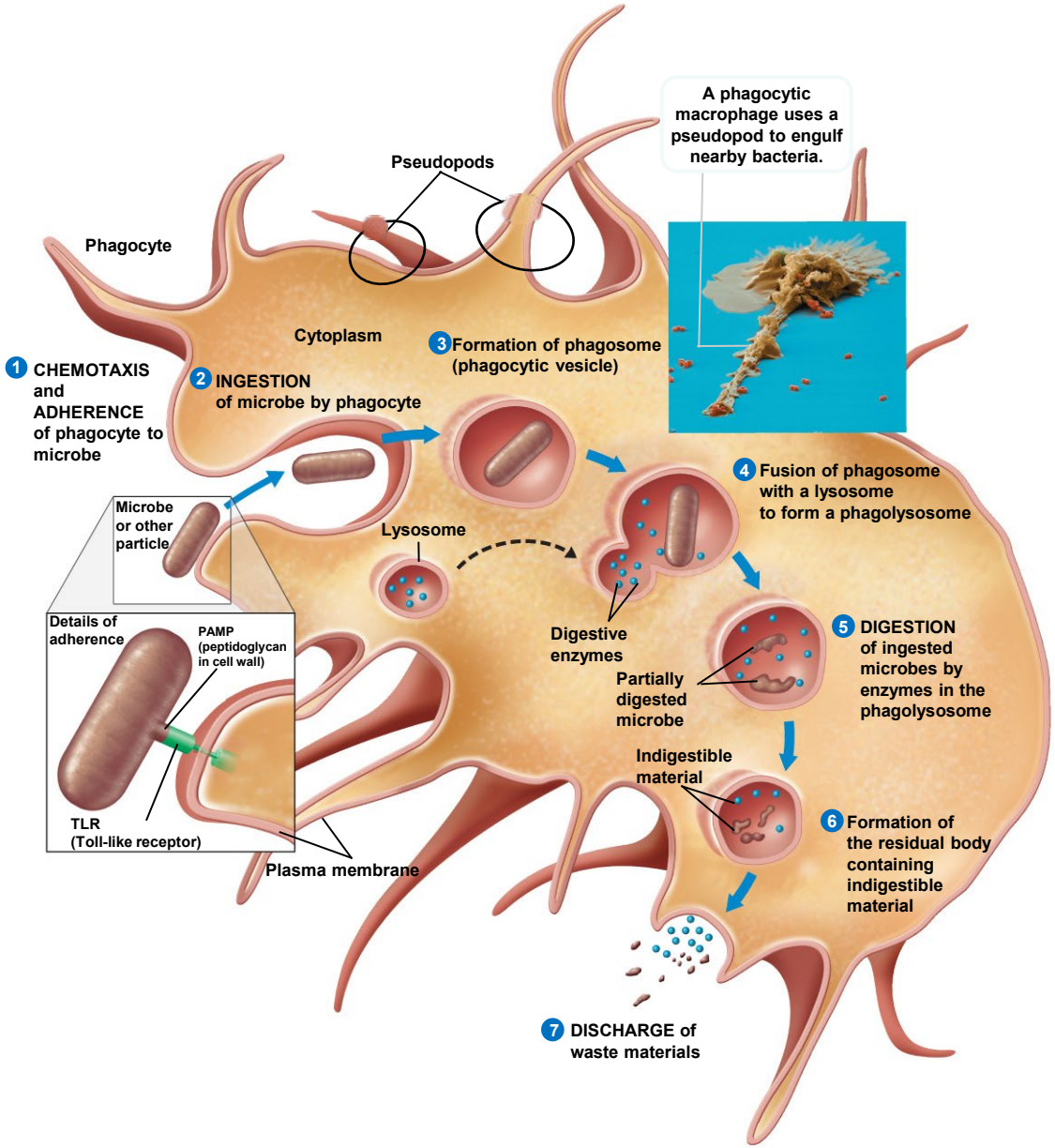
Produce and secrete **cytokines** = group of molecules which regulate an immune response

Same cell will leave bloodstream and transform into **macrophages** (i.e. big eater) – preforms two important functions

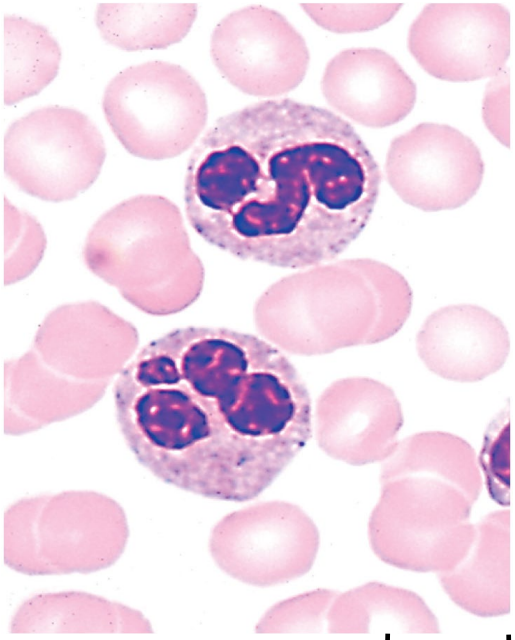
#1 - phagocytize pathogens and debris // the “garbage collector”

#2 - “present” antigens to activate other immune cells // **antigen presenting cells** (APCs) /// shares this function with B cells and dendritic cells

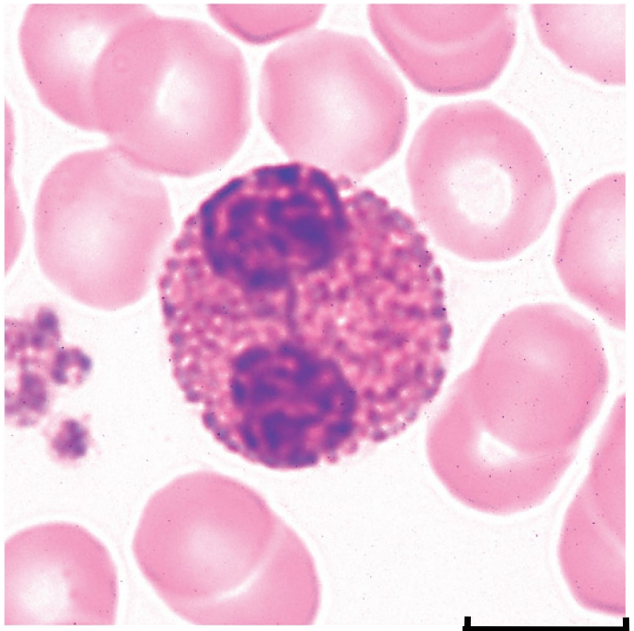
The Phases of Phagocytosis and Antigen Presentation



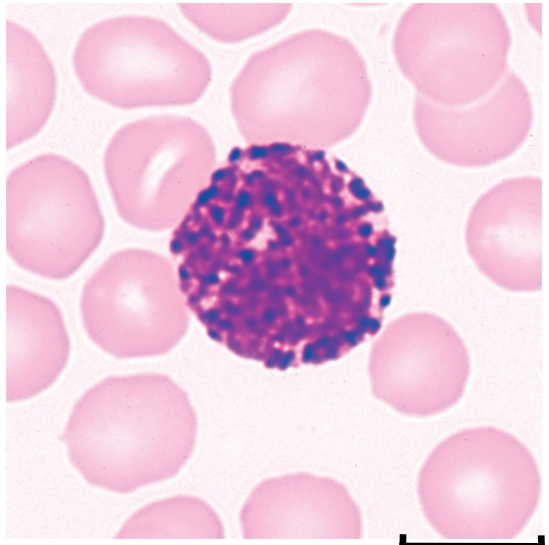
Immunity and Granulocytes



Neutrophils



Eosinophil



Basophil

Granulocytes
Neutrophils, Eosinophils, and Basophils

Neutrophils

60-70% of WBC / Most numerous WBC circulating in blood

Also known as polymorphonuclear leukocytes

Barely visible granules in cytoplasm // 3 to 5 lobed nucleus

Phagocytosis of bacteria while in blood / phagosomes kill bacteria

Emigrate into tissue spaces / chemotaxis

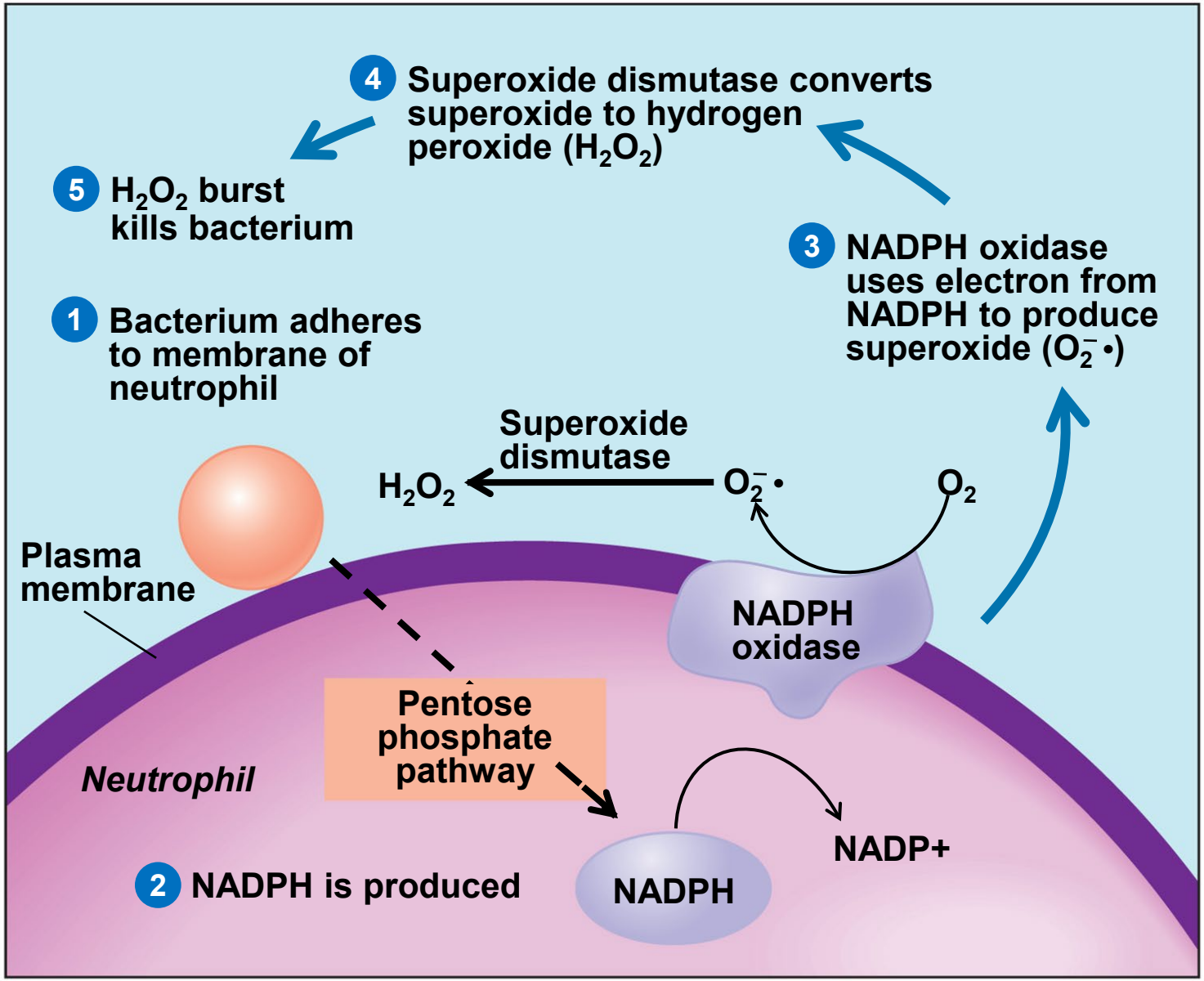
First WBC to arrive in the first phase of inflammation

Increasing numbers in response to **bacterial infections** / neutrophilia – increase 5x

Release antimicrobial chemicals // called the **"respiratory burst"** – like a nuclear bomb! // hypoclorite – hydrogen peroxide – free radicals

What is an “Oxidative Burst”?

Neutrophils and eosinophils produce oxidative bursts (also known as a respiratory burst). (Neutrophils also produce hypoclorite to kill bateria)



Eosinophils

Found especially in the mucous membranes

2 - 4% // large rosy-orange granules, bi-lobe nucleus

Stand guard against **parasites**, **allergens**, and other pathogens

Kill tapeworms and roundworms by producing superoxide, hydrogen peroxide, and toxic proteins

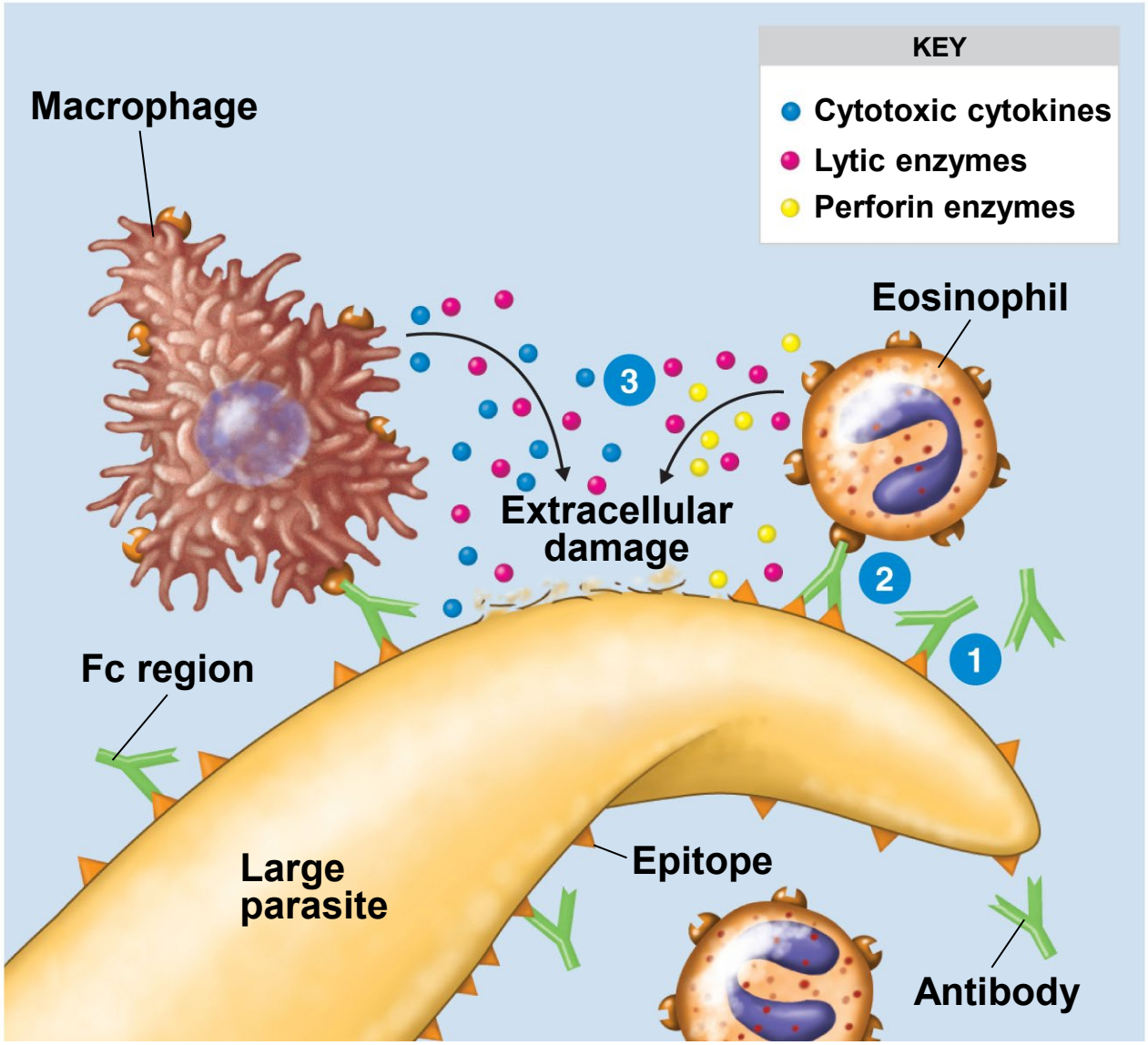
Promote action of **basophils** and **mast cells**

Phagocytize **antigen-antibody complexes**

Limit action of **histamine** and other inflammatory chemicals

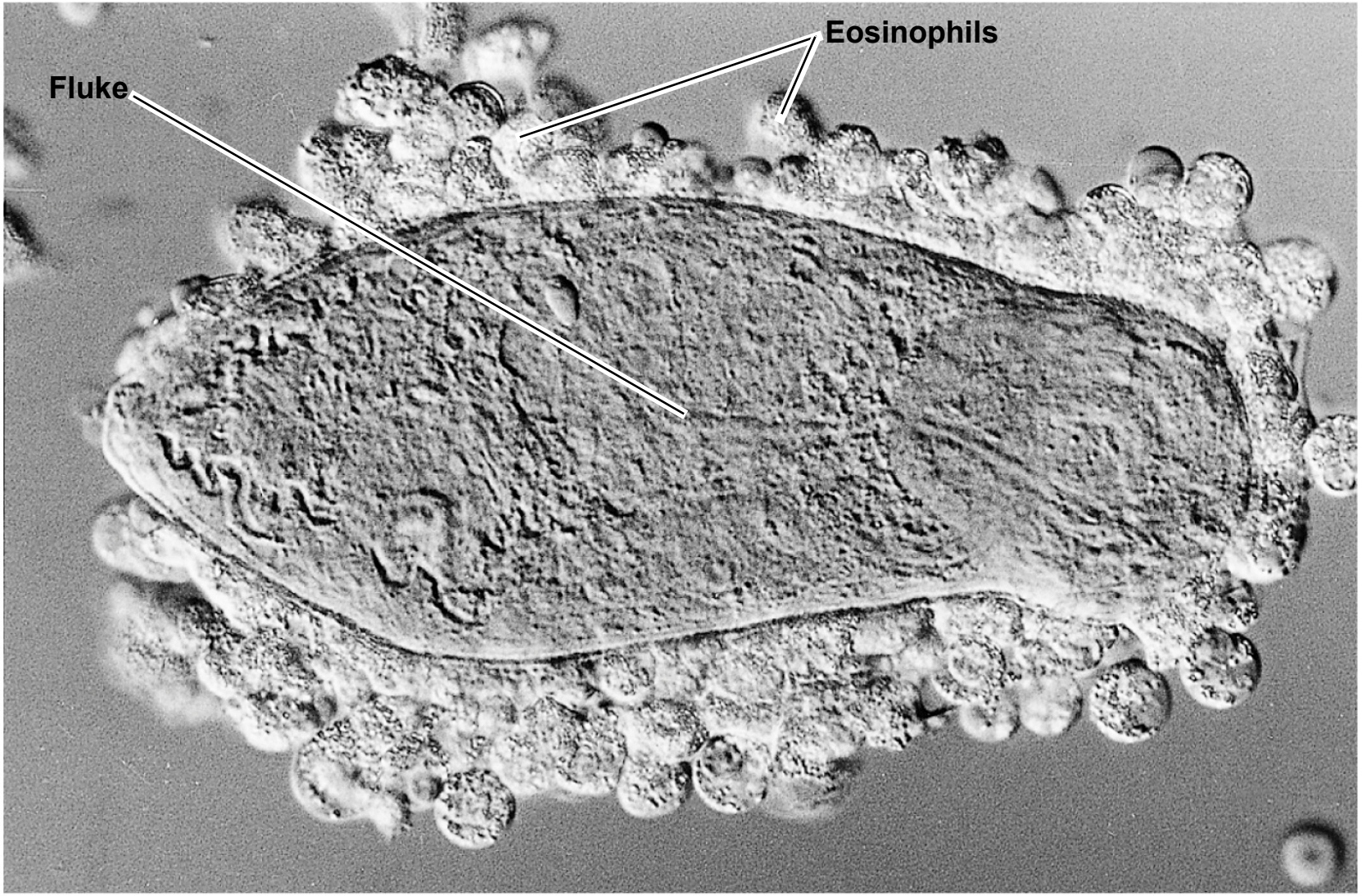
Increase numbers in collagen diseases, allergies, diseases of spleen and CNS

Antibody-dependent cell-mediated cytotoxicity (ADCC).



Organisms, such as many parasites, that are too large for ingestion by phagocytic cells must be attacked externally.

Antibody-dependent cell-mediated cytotoxicity (ADCC).



(b) **Eosinophils adhering to the larval stage of a parasitic fluke.**

SEM

20 μm

Basophils
(Basophils Change into Mast Cells)

Less than one percent // solid staining cytoplasm

Basophils in blood // called mast cells in tissue

Emigrate from blood to tissue // Change into a **mast cells**

Fix themselves to extracellular collagen fibers of the matrix

Acquire over time surface receptors = E class antibodies

As new IgE produced by plasma cells during “first exposure” to pathogen

Antibodies used to render invading pathogen harmless and tag it for destruction

Some of these same antibodies insert themselves into plasma membrane of mast cells

These mast cells will now be able to interact with similar pathogens in the future.

Mast Cells
(Basophils Change into Mast Cells)

Upon second exposure foreign antigen cause mast cells to release histamine and heparin

See increased numbers in chicken pox, sinusitis, diabetes // suggest increasing incident of inflammation

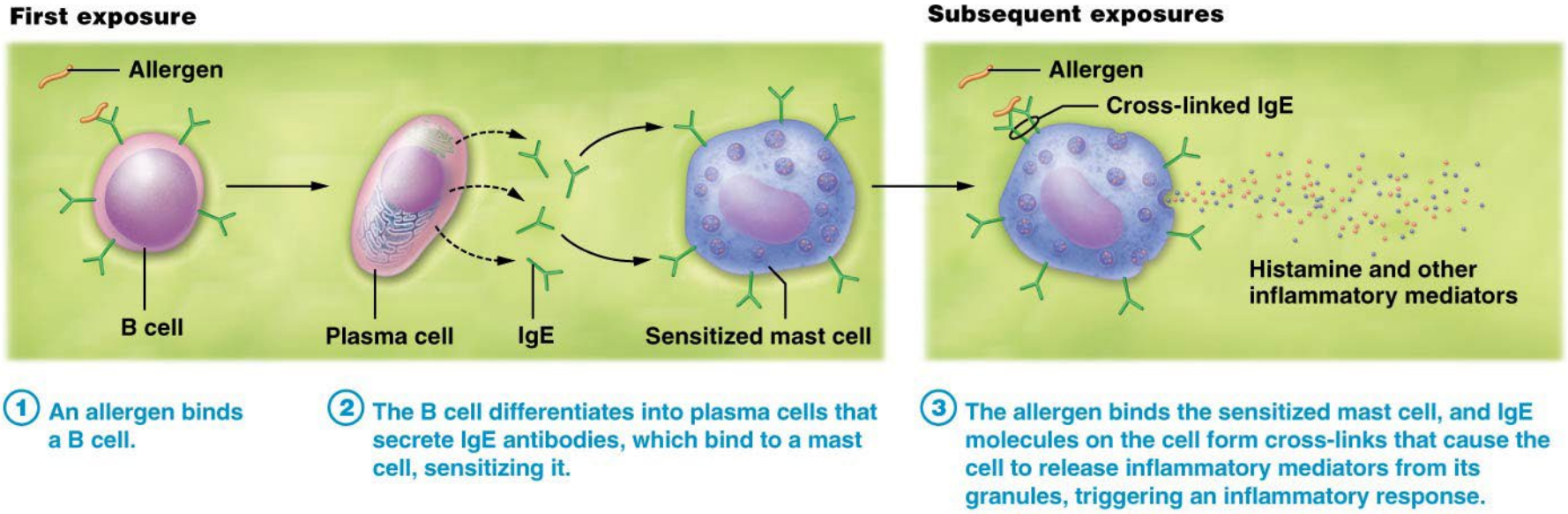
On second exposure to similar pathogen's antigen mast cells will release….

Histamine (vasodilator) // speeds flow of blood to an injured area

Heparin (anticoagulant) // promotes the mobility of other WBCs in the area

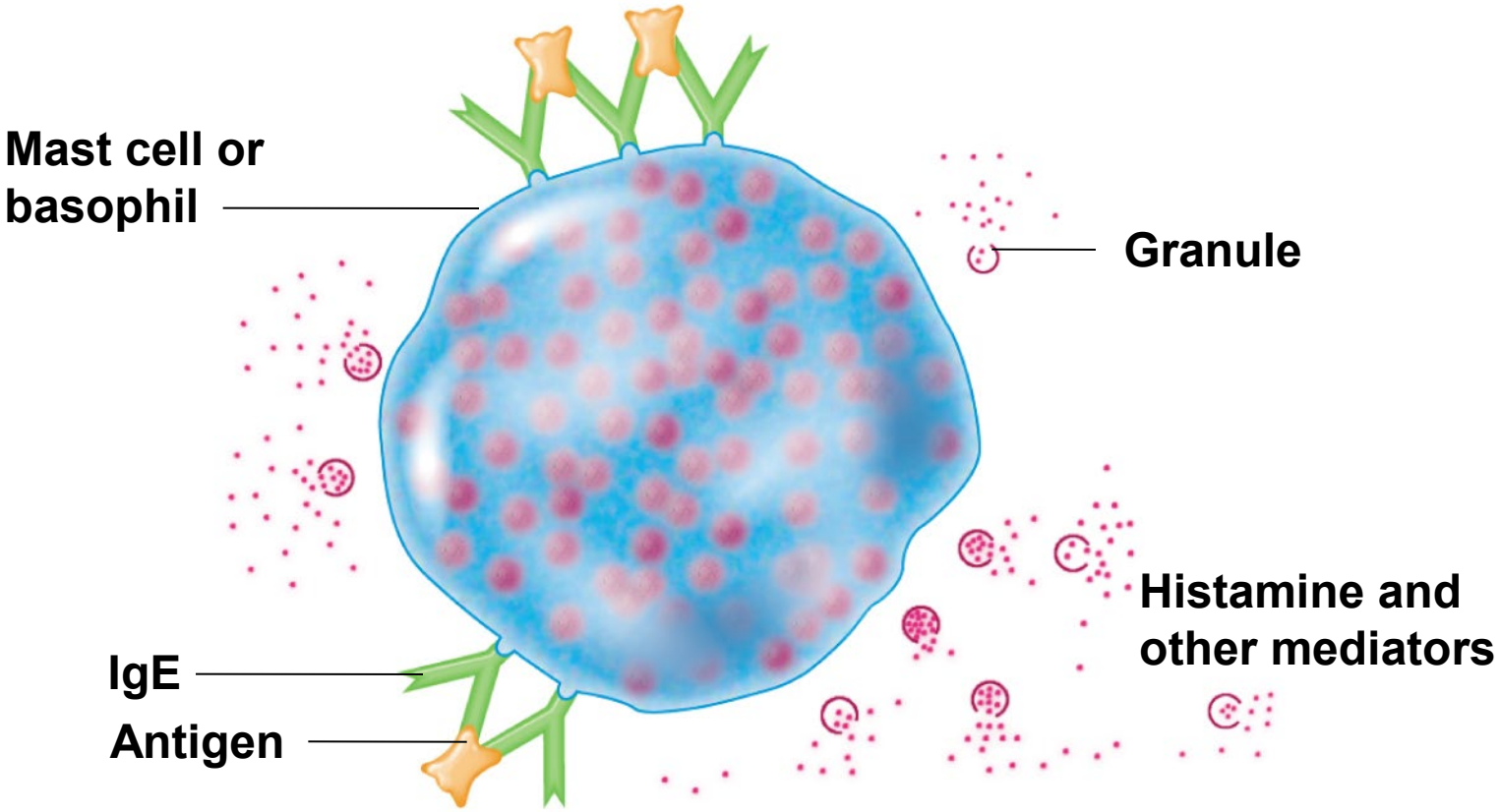
Basophils Become Mast Cells After They Acquire IgE "Receptors"

(Type I hypersensitivity response.)



Note: Basophils are in the blood / Mast cells are attached to collagen fibers within connective tissue.

The mechanism of anaphylaxis mediated by mast cell.



IgE antibodies, produced in response to an antigen, coat mast cells and basophils. When an antigen bridges the gap between two adjacent antibody molecules of the same specificity, the cell undergoes degranulation and releases histamine and other mediators.

Diapedis: How Leukocytes Emigrate into Tissue Spaces

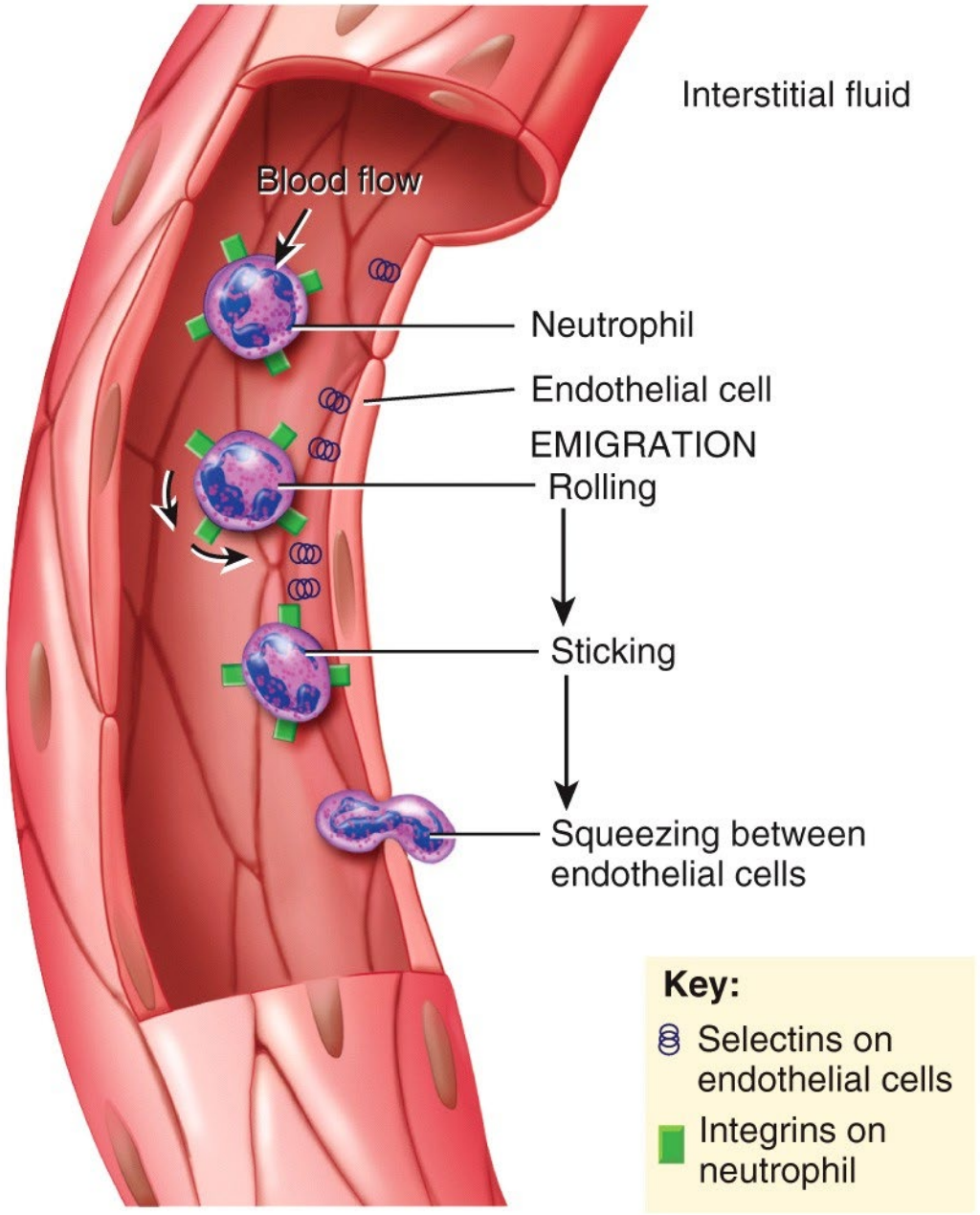
Circulating WBCs do not stay in bloodstream

Area of inflammation causes endothelial cells outer face to become “sticky” – results in margination

Granulocytes (NEB) leave in 8 hours and live 5 days longer

Monocytes leave in 20 hours, transform into macrophages and live for several years

Lymphocytes provide long-term immunity // live for decades // continuously recycled from blood to tissue fluid to lymphatic system and back into the blood


Interstitial fluid
Blood flow
Neutrophil
Endothelial cell
EMIGRATION
Rolling
Sticking
Squeezing between endothelial cells
Key:
Selectins on endothelial cells
Integrins on neutrophil

Leukocyte Disorders

Leuko*penia* - low WBC count below 5000/μL

– causes: radiation, poisons, infectious disease

– effects: elevated risk of infection

Leukocytosis - high WBC count above 10,000/μL

– causes: infection, allergy and disease

– differential WBC count – identifies what percentage of the total WBC count consist of each type of leukocyte

Leukocyte Disorders

Leukemia - cancer of hemopoietic tissue that usually produces an extraordinarily high number of circulating leukocytes and their precursors

Myeloid leukemia – uncontrolled granulocyte production

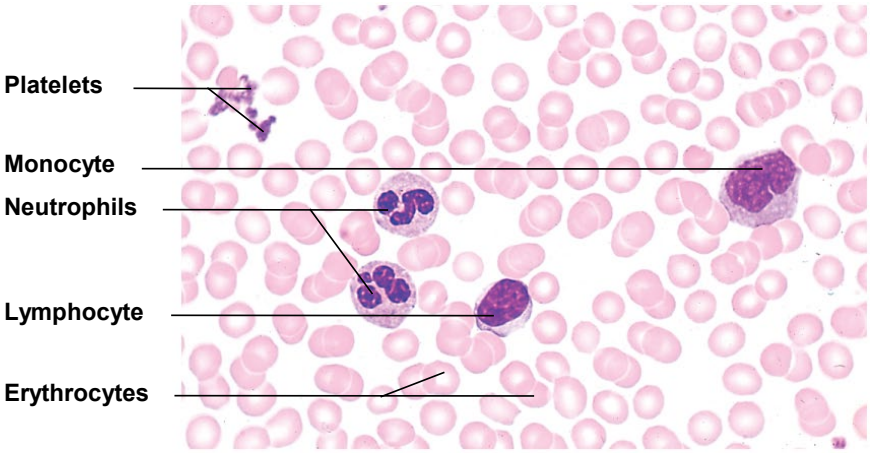
Lymphoid leukemia - uncontrolled lymphocyte or monocyte production

Acute leukemia – appears suddenly, progresses rapidly, death within months

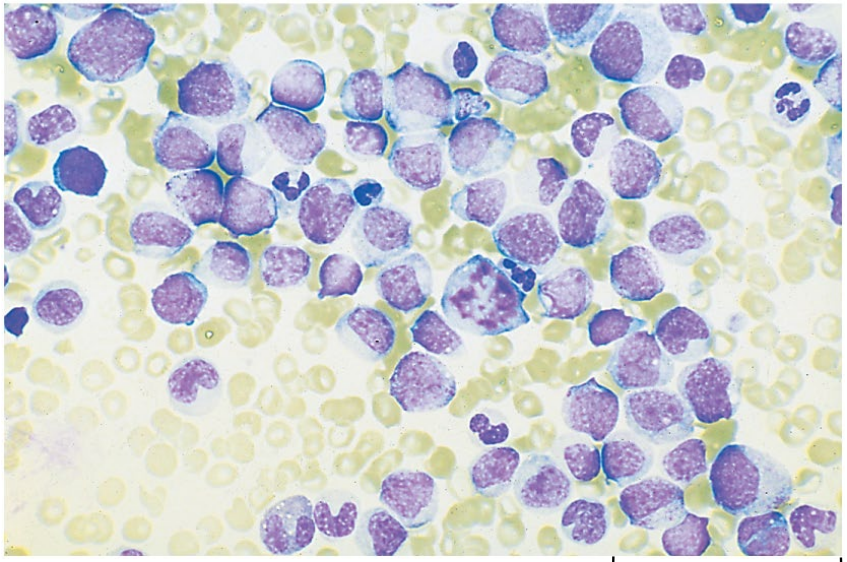
Chronic leukemia –undetected for months, survival time three years

Effects - normal cell percentages disrupted; impaired clotting; opportunistic infections

Normal and Leukemic Blood



(a)



(b)

What Is Lymphatic Tissue?

(Note - Lymphatic Tissue is Not an Organ!)

Lymphatic tissue are “groups or clusters” of transient “mobile lymphocytes” located within the connective tissues of mucous membranes and in the seams of connective tissue within various organs of the body

Lymphatic tissue in not surrounded by connective tissue

Simplest form is called diffused lymphatic tissue

If diffused then lymphocytes are more scattered, rather than densely clustered

Prevalent in body passages open to the exterior /// respiratory, digestive, urinary, and reproductive tracts

E.g. mucosa-associated lymphatic tissue (MALT)

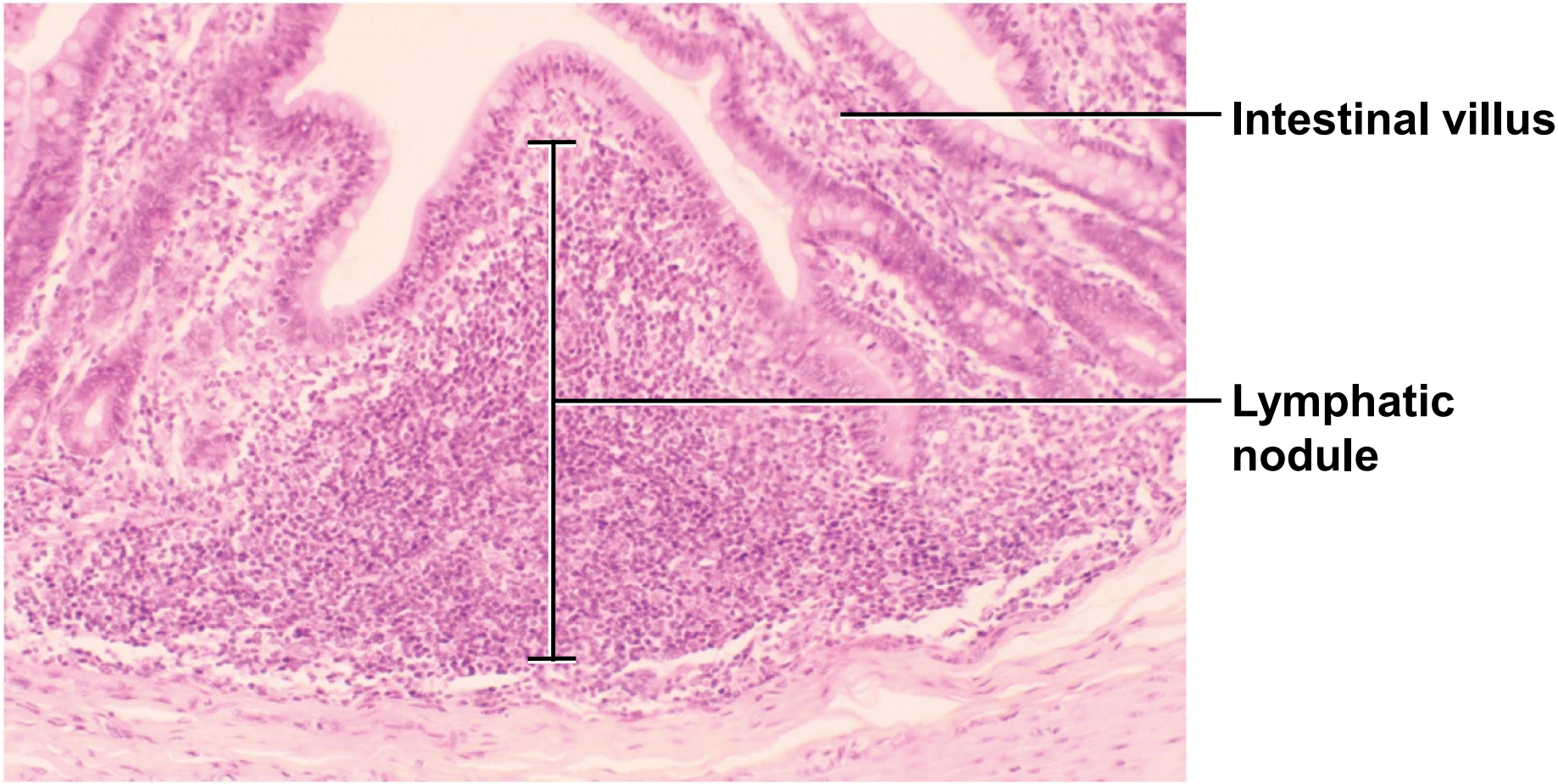
Lymphatic tissue is found in three areas.

#1 – Form lymphatic follicles

- concentrated masses of leukocytes
- lymphocytes and macrophages will congregate in
- response to pathogens // then disperses after
- pathogen defeated
- present in the tonsils
- present under mucous membranes

#2 - Peyer patches – dense clusters in the ileum, the distal portion of the small intestine

Lymphatic Nodule



Where Is Lymphatic Tissue Found In Body?

#3 - Also Found Inside All Lymphatic Organs

- Lymphatic organs have well-defined anatomical sites
- *Lymphatic organs have connective tissue capsules /// Spleen, thymus, tonsils, and lymph nodes*
- Capsules separate the lymphatic tissue from neighboring tissues
- Dense area of WBCs form “germination centers” // identifiable as “white pulp”

Lymphatic Organs

Primary lymphatic organs

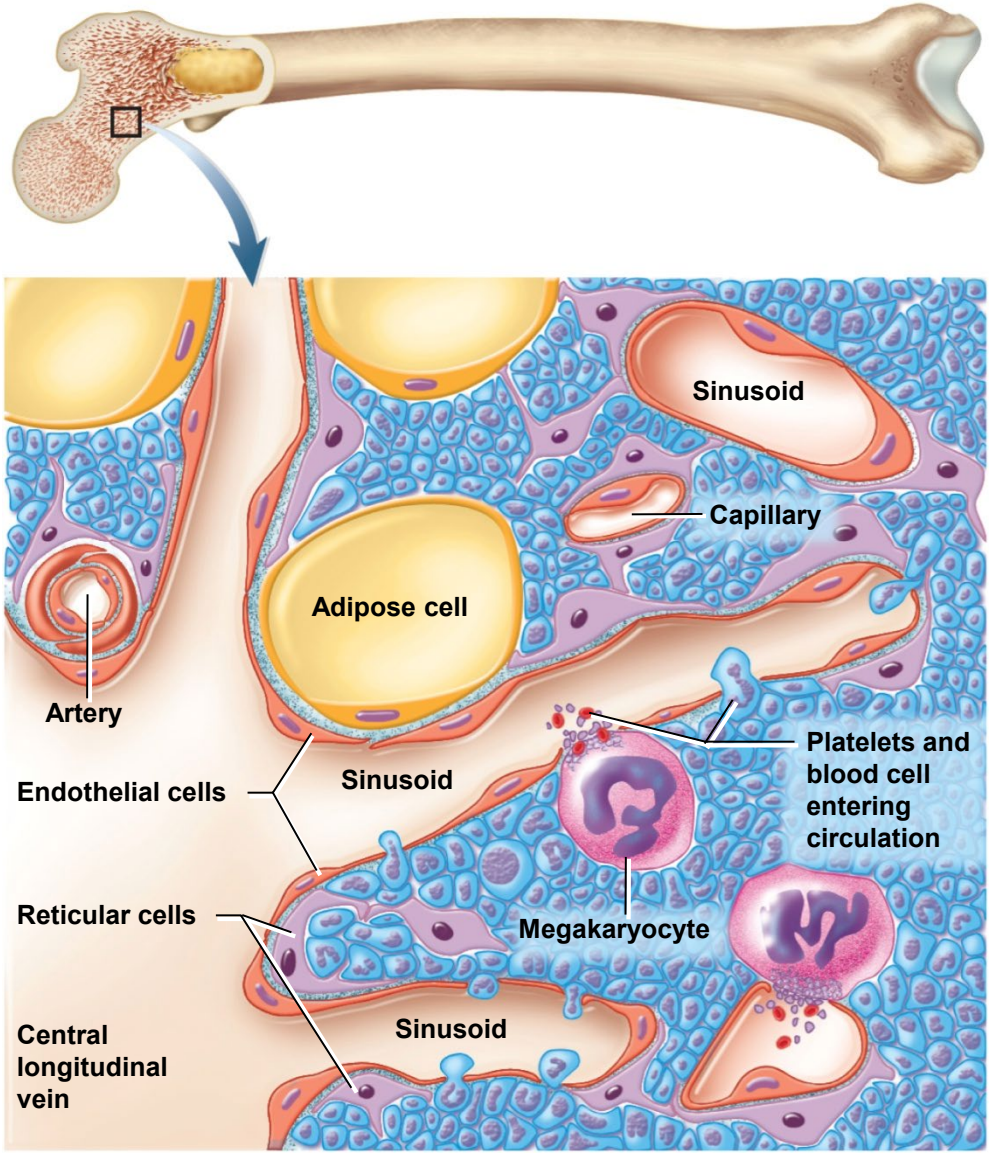
Red bone marrow and thymus

- where T and B cells become immunocompetent
- able to recognize and respond to antigens
- T and B cells develop plasma membrane receptors matched to pathogen's antigen

Secondary lymphatic organs

– lymph nodes, tonsils, and spleen
– T and B cells "deployed" to secondary lymphatic organs
– T and B cells are now "immuno-competent cells"
– these cells stay "niave" (not active) until T and B cells recognize foreigh antigen

Histology of Red Bone Marrow



What type of capillaries are i

Why?