

Cells and tissues of the immune system

Milan Číž

Lymphoreticular tissue

reticular connective tissue, loose cells

reticular connective tissue – reticulocytes

loose cells – different developmental stages of lymphocytes,
macrophages, microphages

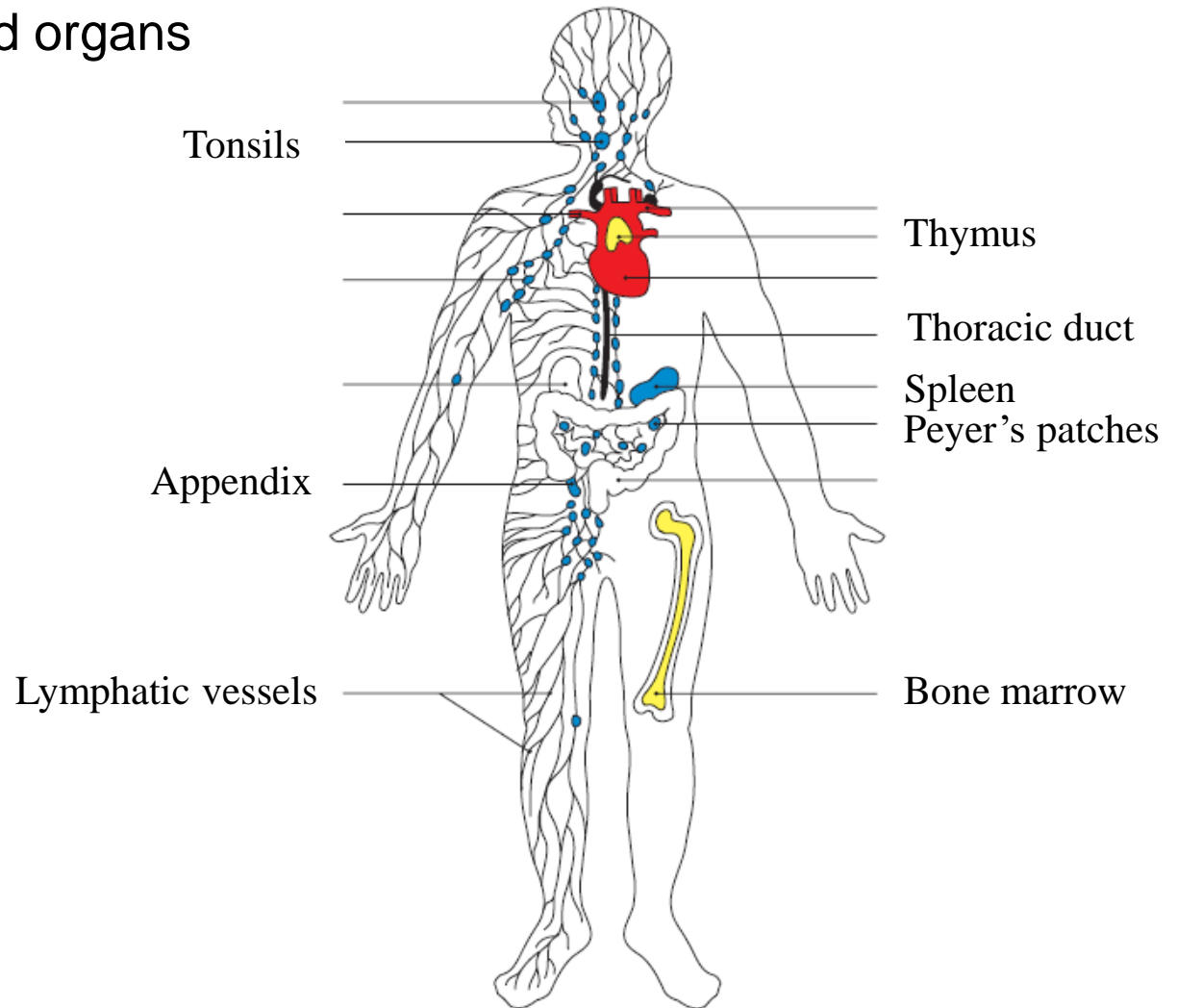
thin lymphoid tissue – mainly reticulocytes

dense lymphoid tissue – mainly lymphocytes

Lymphoreticular tissue

primary lymphoid organs
secondary lymphoid organs

lymphatic system



Lymphatic system

- defense mechanisms – lymph nodes
- regulation of homeostasis
- drainage of extracellular fluid from tissues
- drainage of lipids to superior vena cava
- drainage of metabolism products from the body (harmful, useless compounds)
- transport of nutrients to blood

lymphatic capillaries – lymphatic vessels – lymphatic nodes
– thoracic duct – venous system

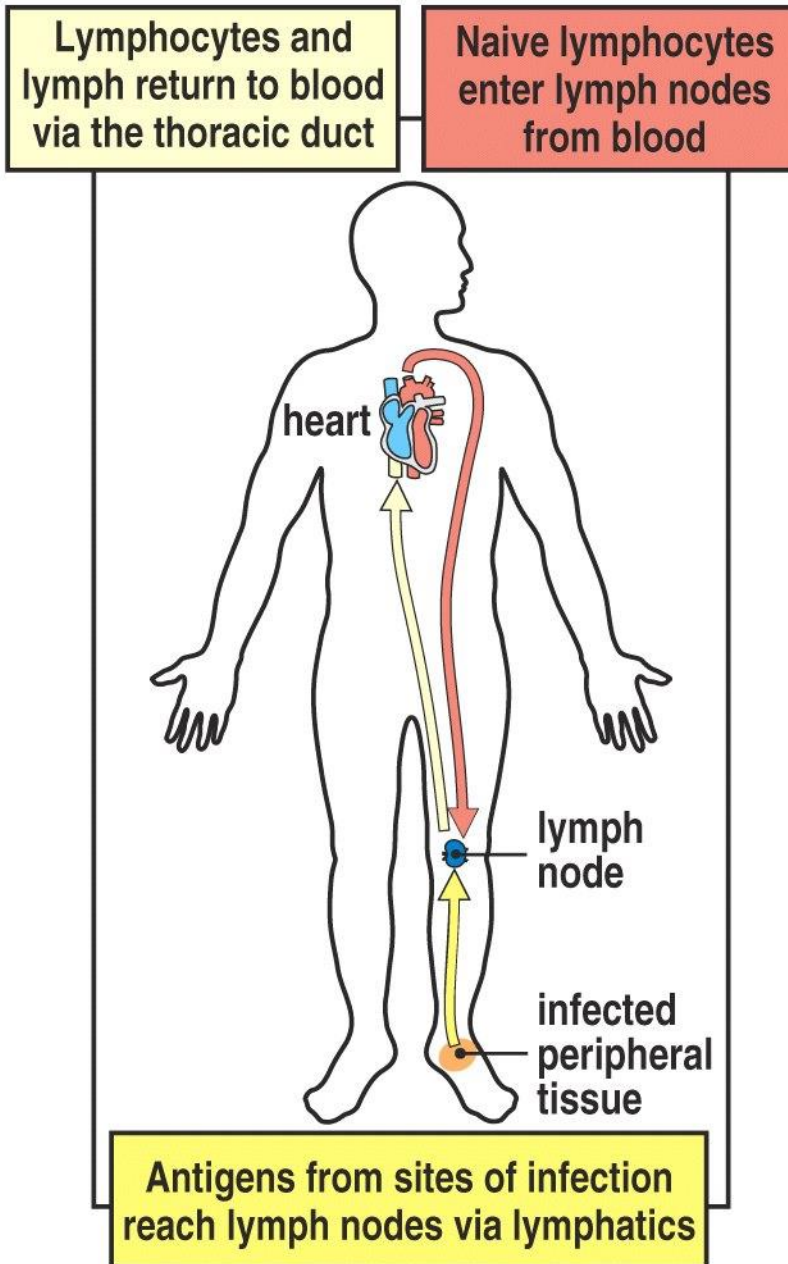


Figure 1-11 Immunobiology, 6/e. (© Garland Science 2005)

Primary lymphoid organs

formation, development and differentiation of immune cells

thymus

bursa Fabricii ~ bone marrow

Primary lymphoid organs

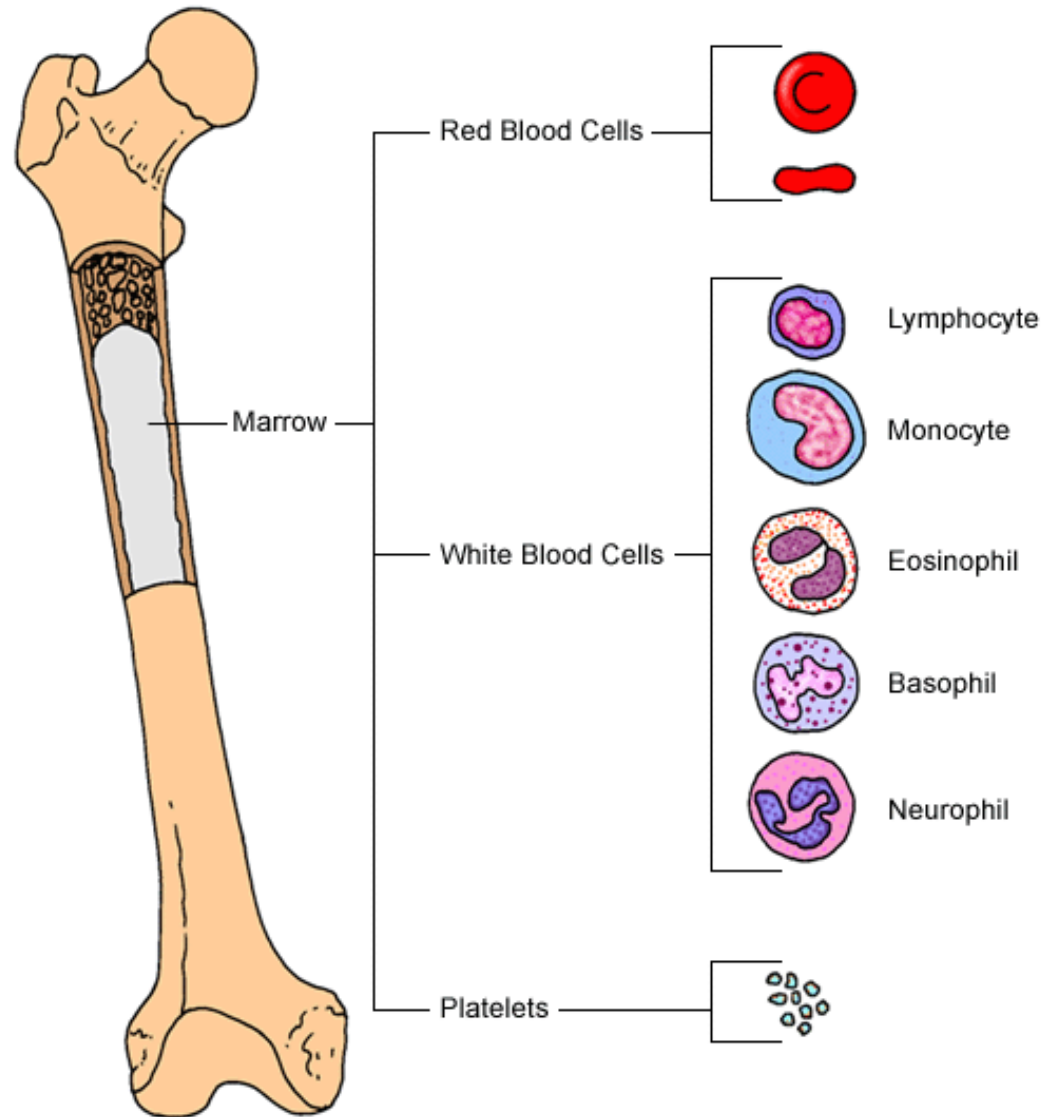
Bone marrow

hematopoietic stem cells

erythroid lineage

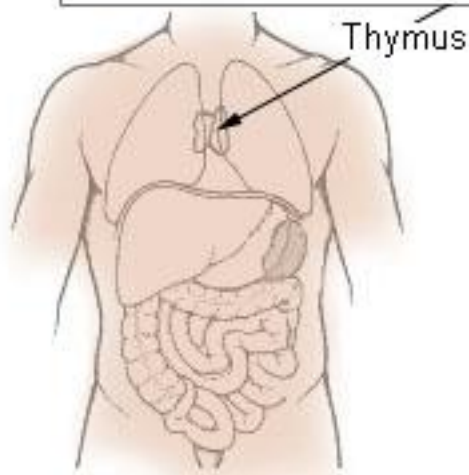
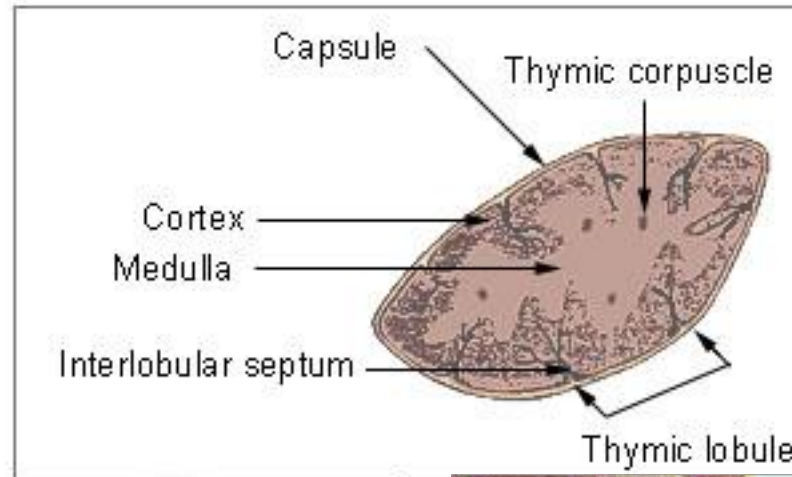
lymphoid lineage

myeloid lineage



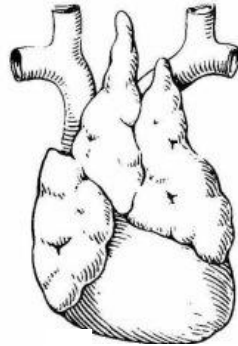
Primary lymphoid organs

Thymus

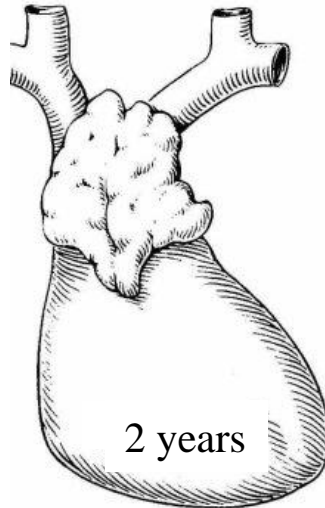


Primary lymphoid organs

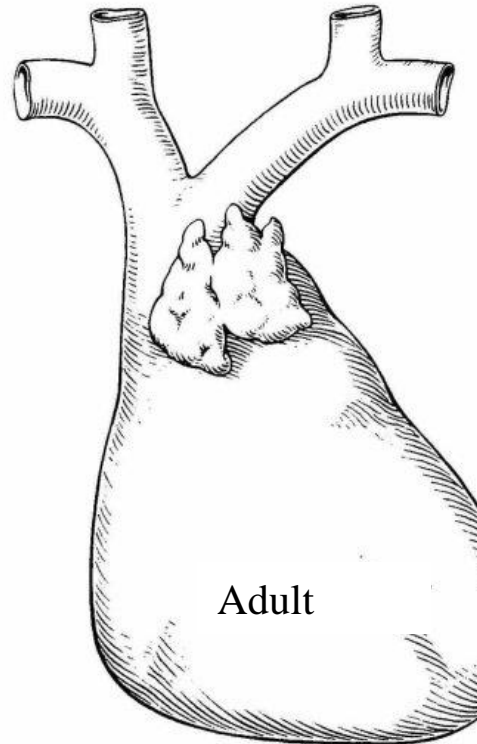
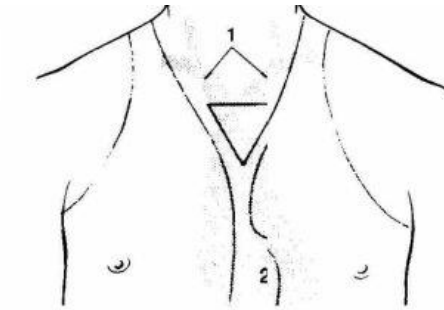
Thymus



Newborn



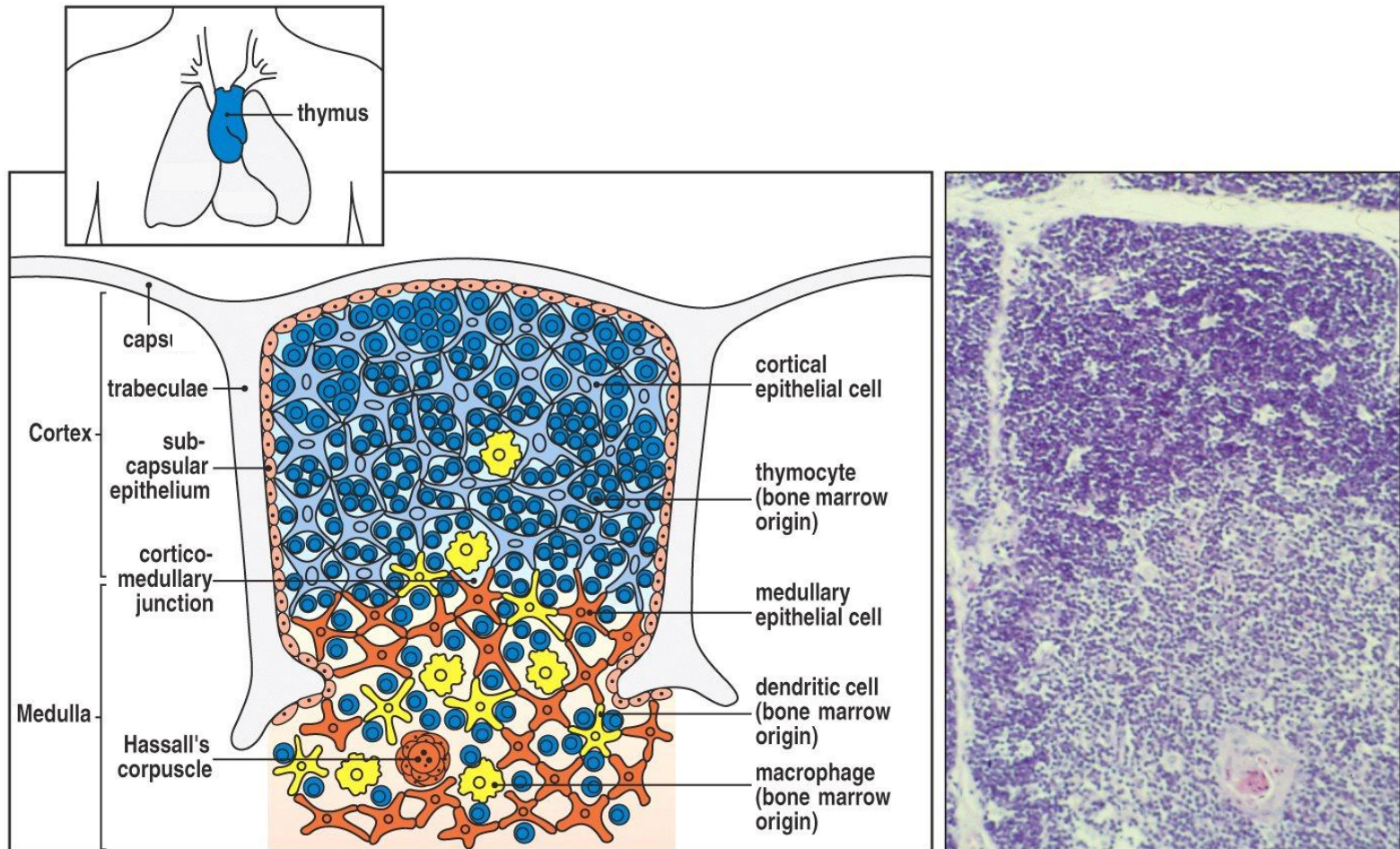
2 years



Adult

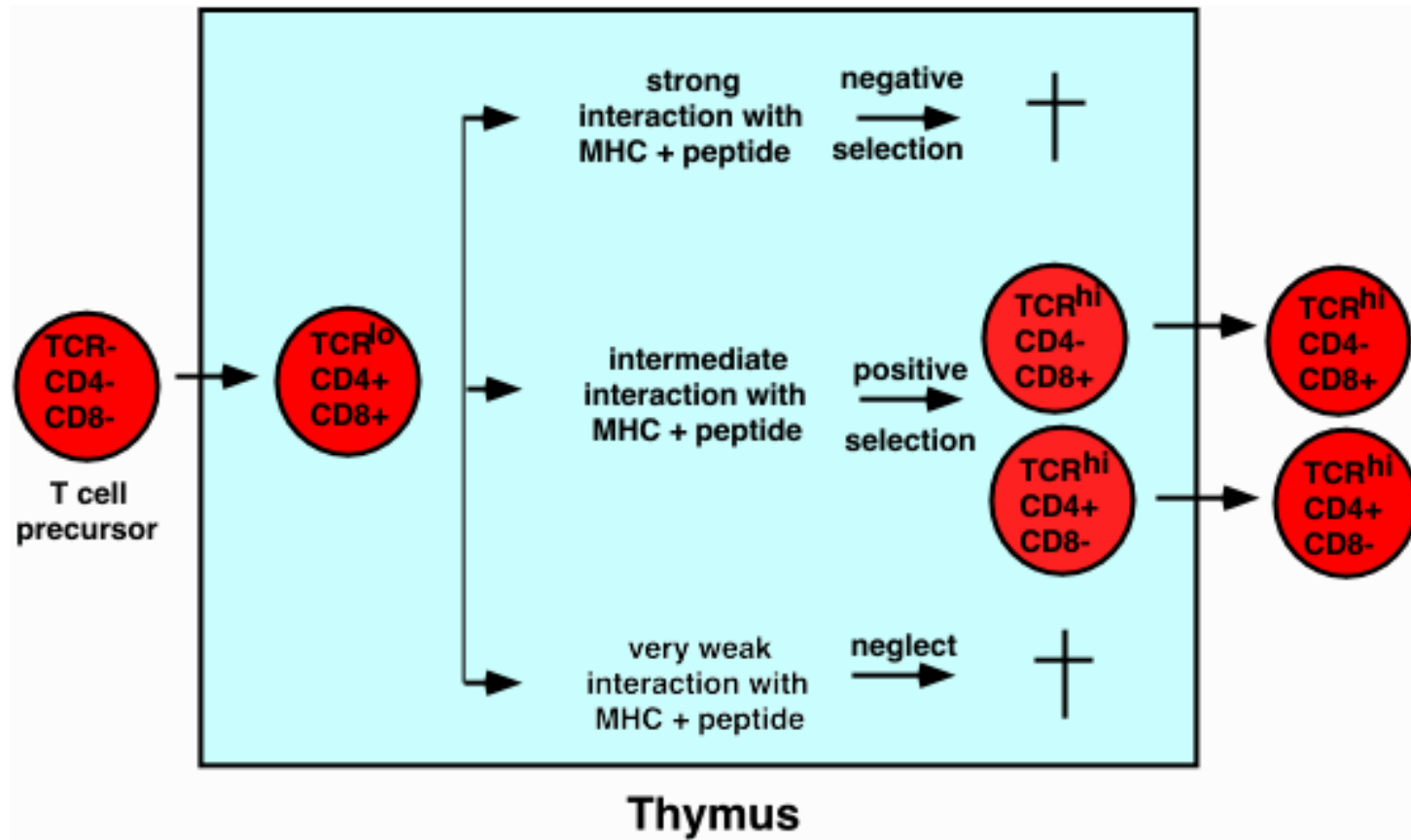
Primary lymphoid organs

Thymus



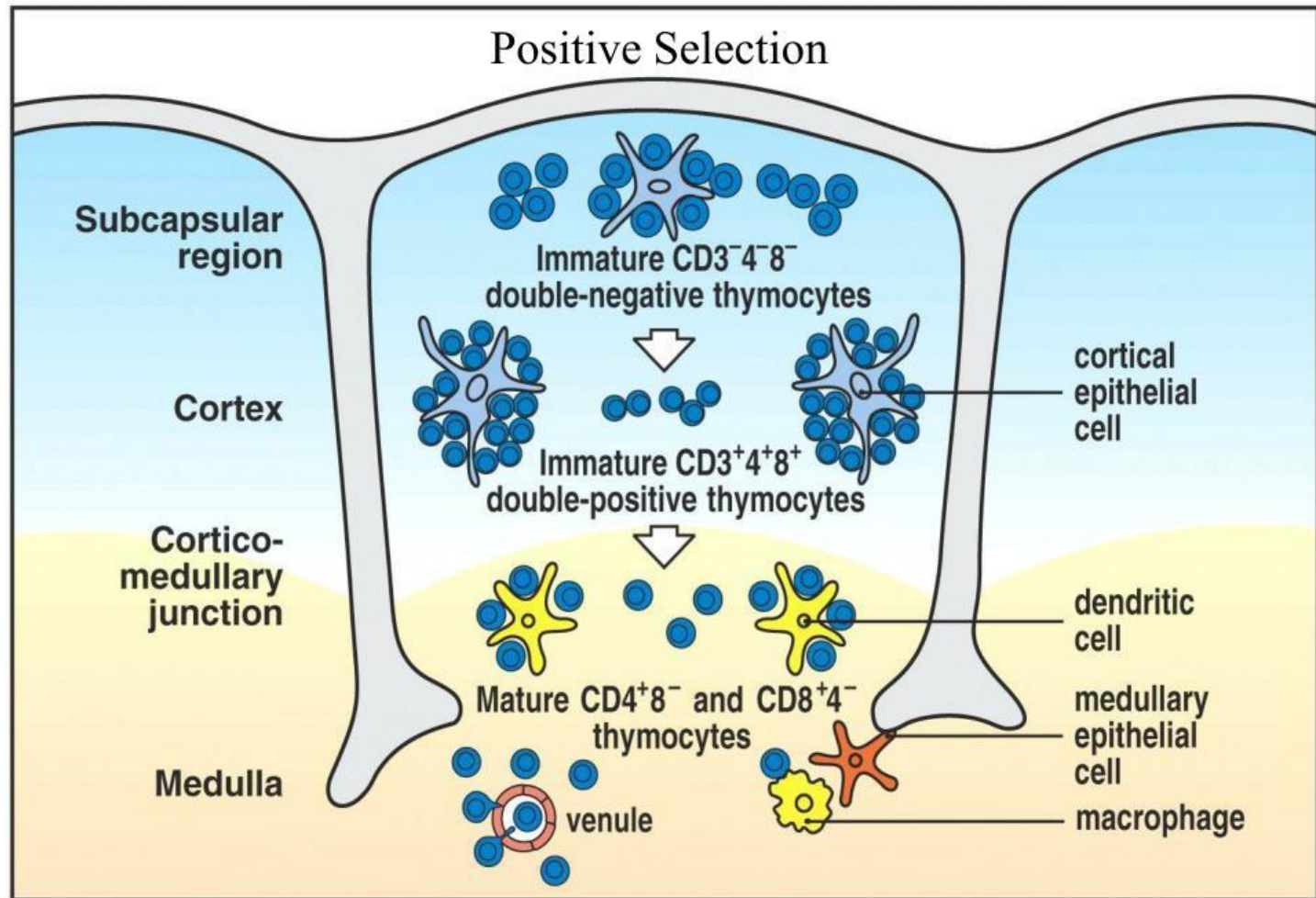
Primary lymphoid organs

Thymus



Primary lymphoid organs

Thymus



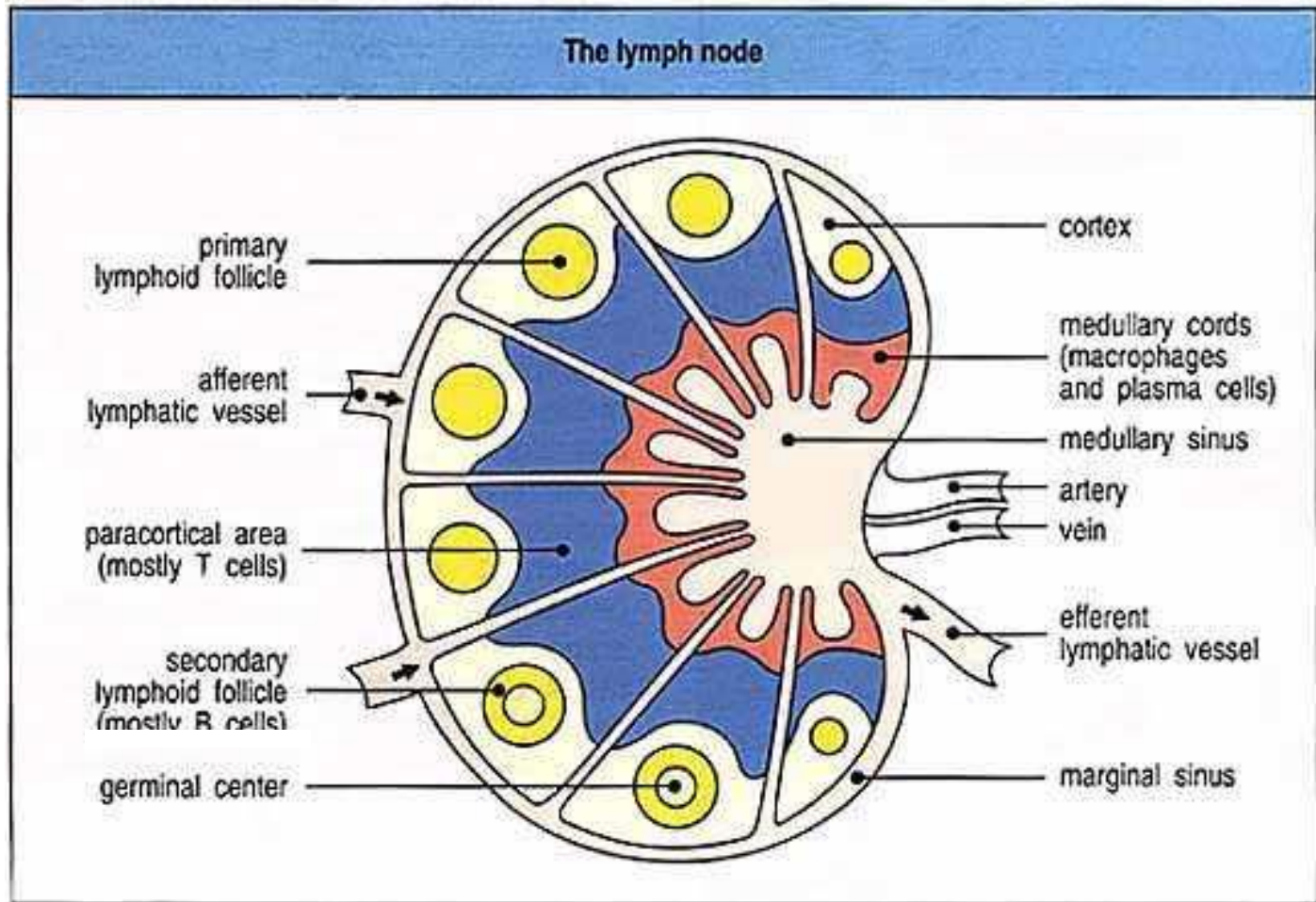
Secondary lymphoid organs

Lymphoid follicles

formations of dense lymphoid tissue
temporary

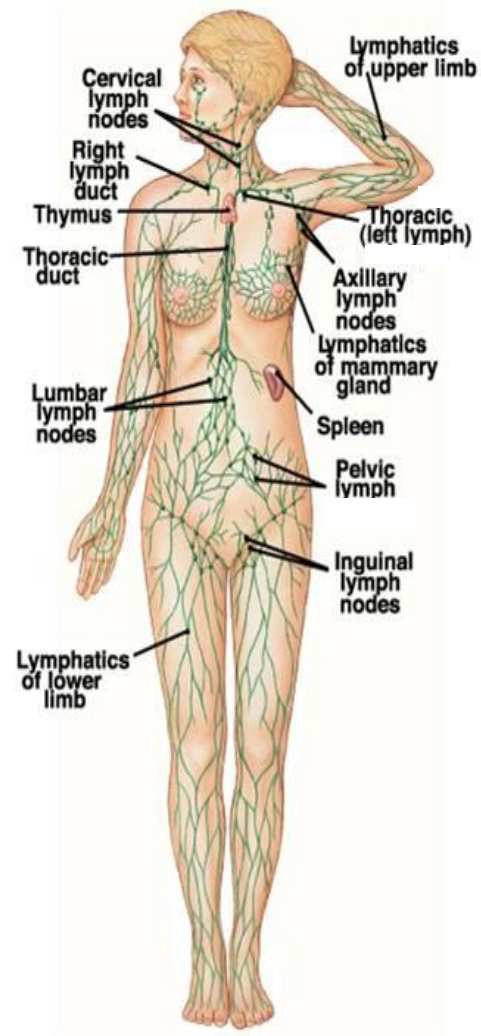
Secondary lymphoid organs

Lymph nodes



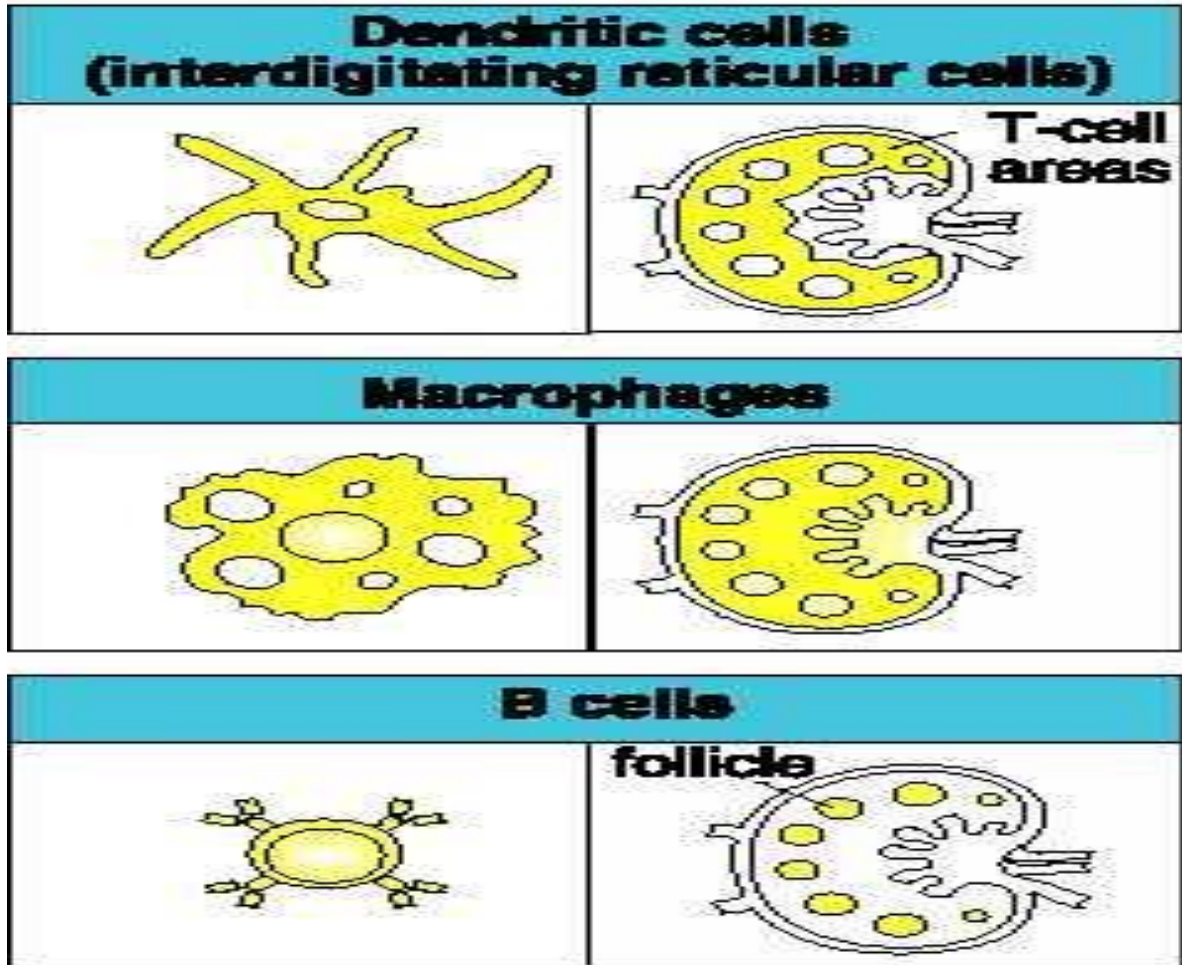
Secondary lymphoid organs

Lymph nodes



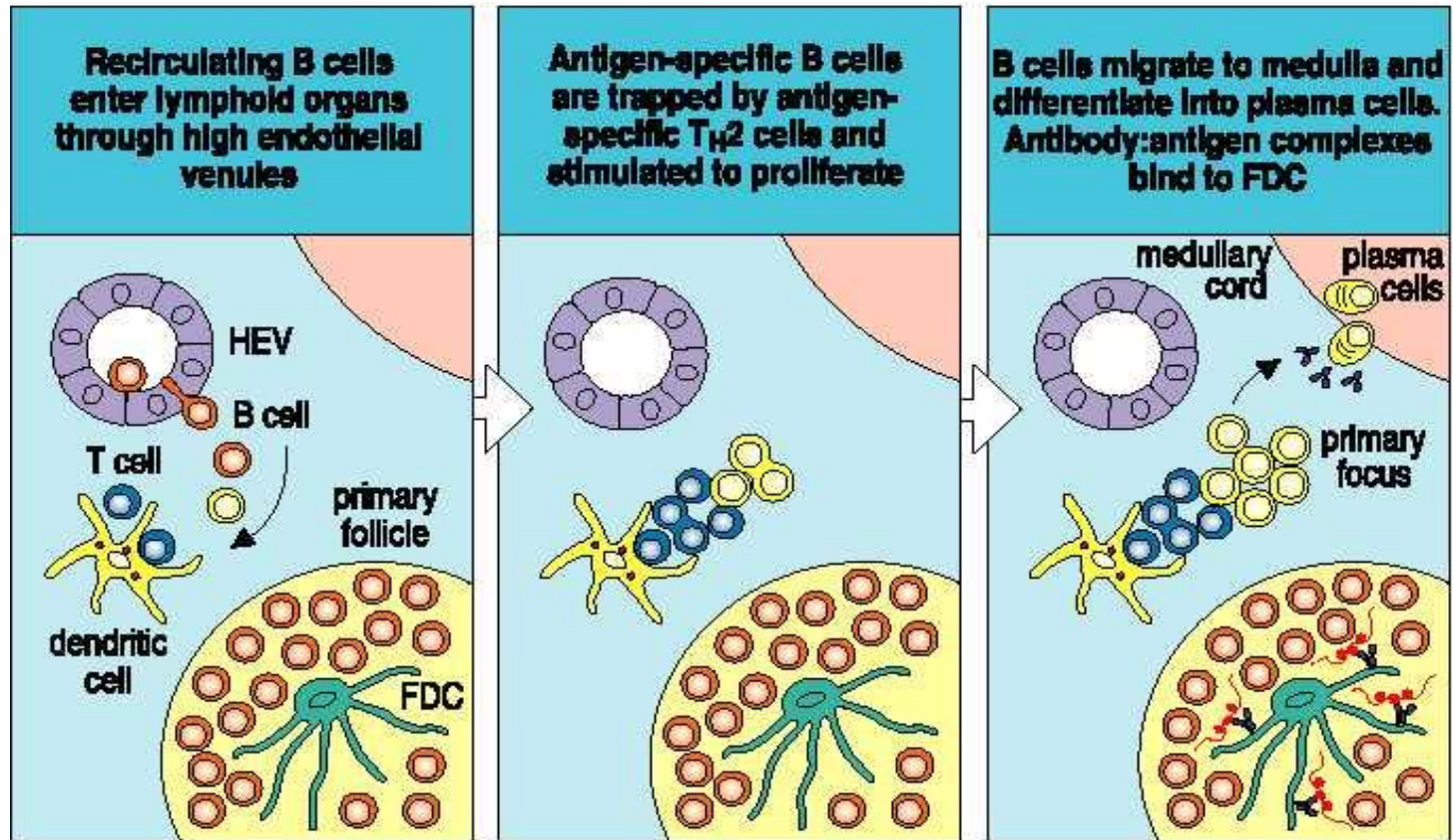
Secondary lymphoid organs

Lymph nodes



Secondary lymphoid organs

Lymph nodes



Sekundární lymfoidní orgány

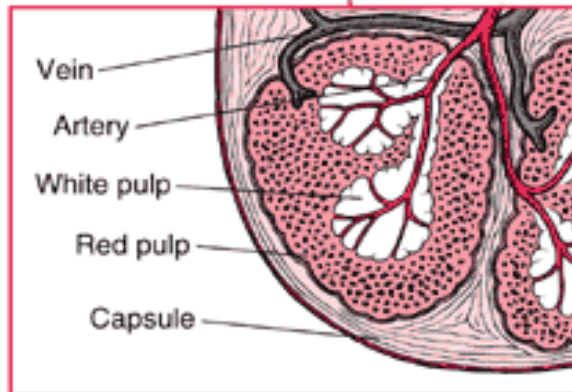
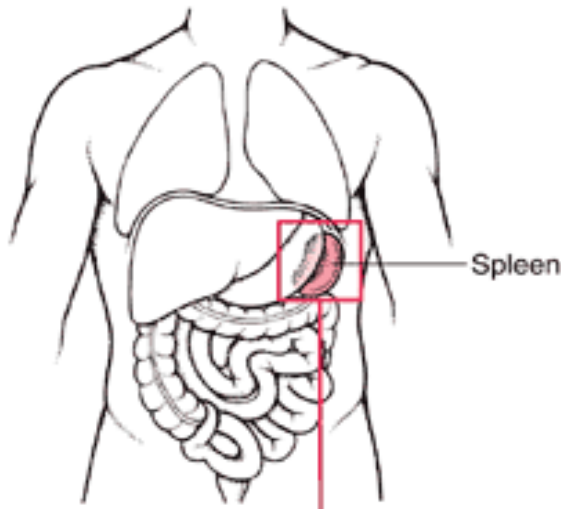
Tonsils

Waldeyer's tonsillar ring:

- adenoids (pharyngeal tonsils) - roof of pharynx
- palatine tonsils - sides of oropharynx between palatoglossal and palatopharyngeal arches
- lingual tonsils - behind terminal sulcus (tongue)
- tubal tonsils - roof of pharynx near to the outfall of Eustachian tube

Secondary lymphoid organs

Spleen

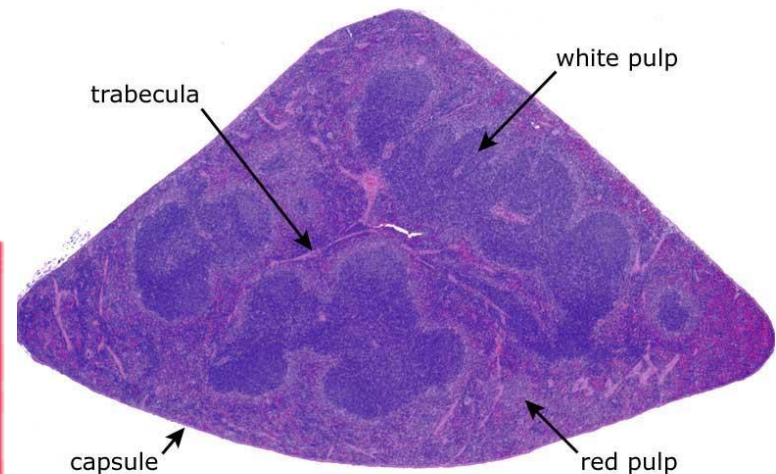


Red pulp

- reservoir of red blood cells (cca 1% of total blood volume)

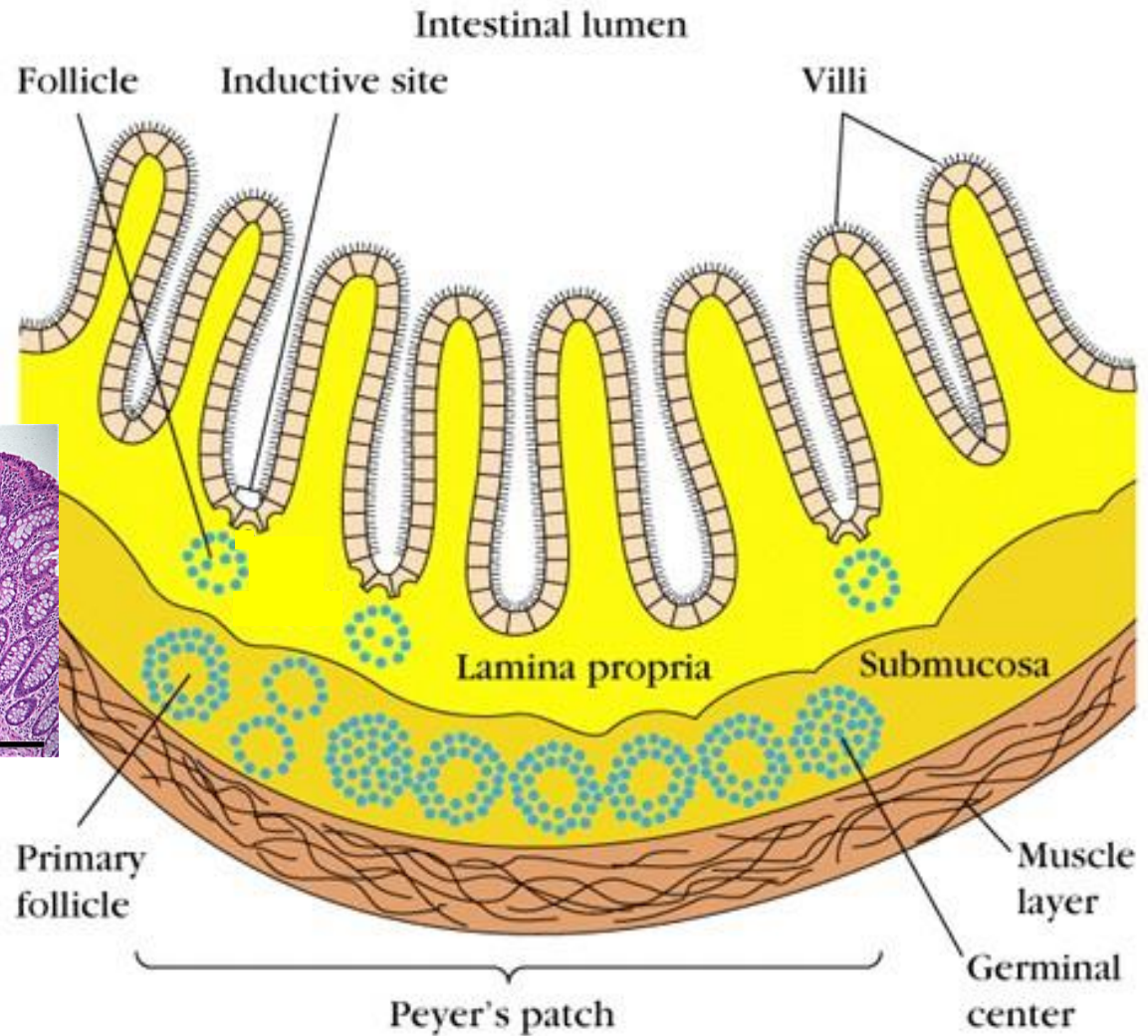
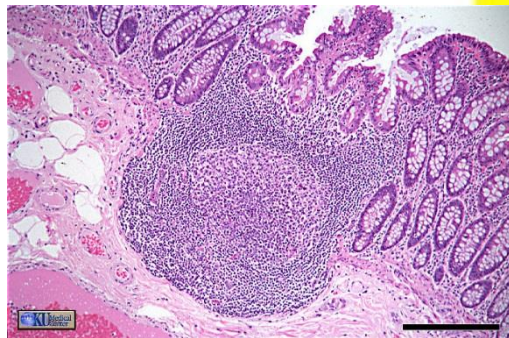
White pulp

- lymphocytes, monocytes, macrophages (degrade 90% of erythrocytes in red pulp)
- synthesis of antibodies
- elimination of immunocomplexes



Secondary lymphoid organs

Peyer's patches



Secondary lymphoid organs

Mucosa-associated lymphoid tissue (MALT)

common defense mechanisms (movement of cilia, air and liquid flow, glandular secretions)

organised lymphatic system (lymphoid follicles, induction of immune response)

diffused lymphatic system (loose leukocytes and their effector mechanisms)

GALT = gut-associated I.t. (Peyer's patches, appendix)

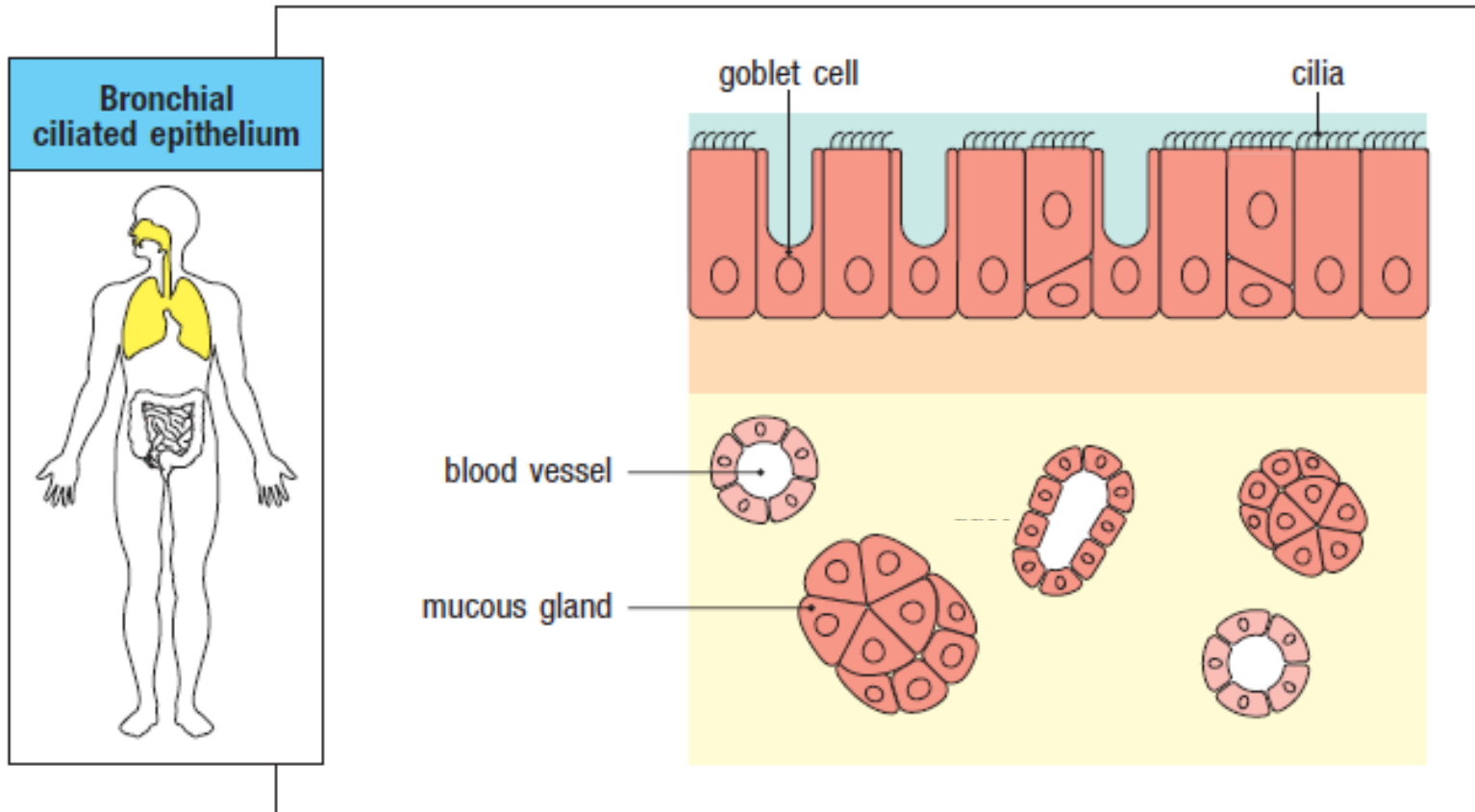
BALT = bronchial/tracheal-associated I.t. (tonsils)

NALT = nose-associated I.t.

VALT = vulvovaginal-associated I.t.

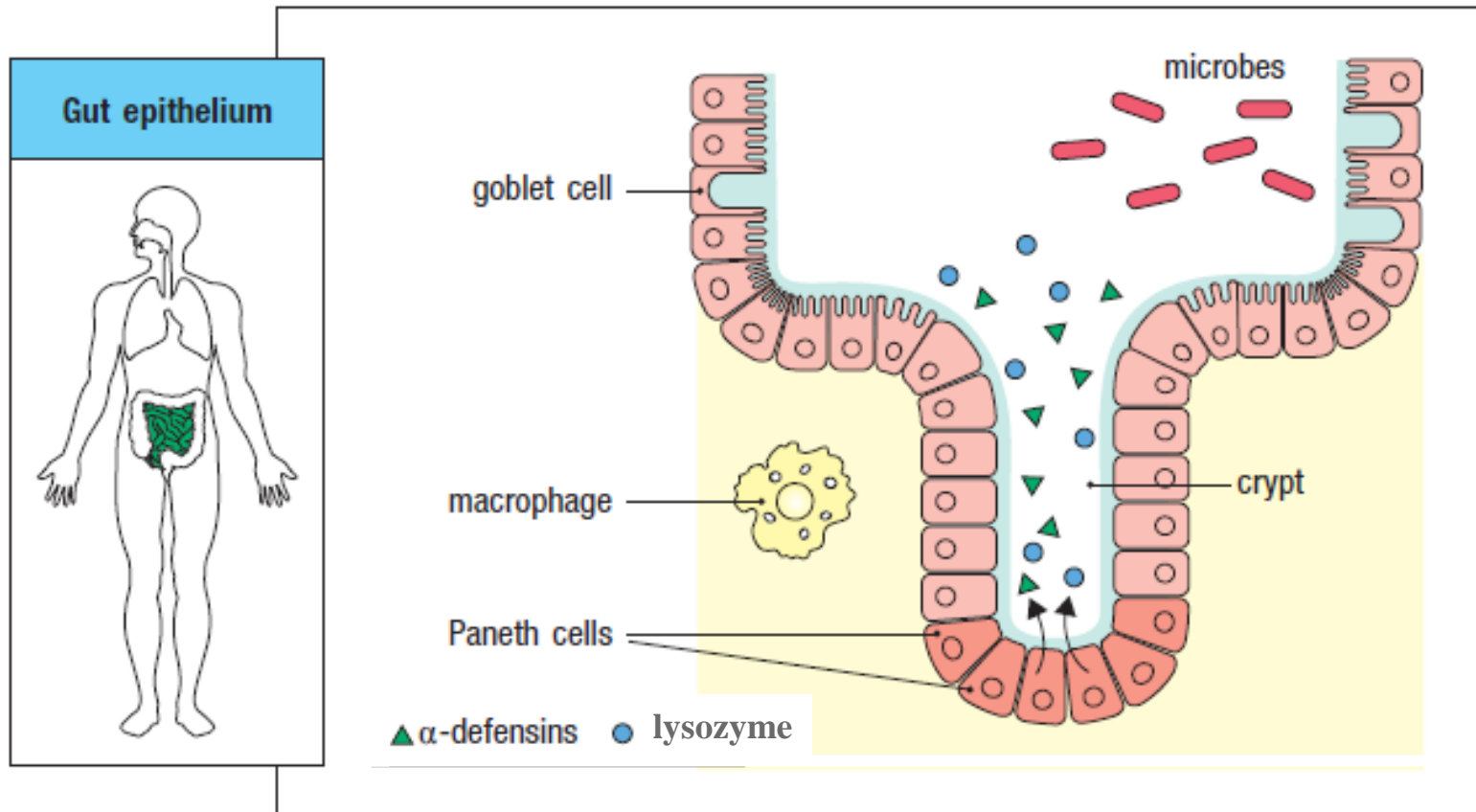
Secondary lymphoid organs

Mucosa associated lymphoid tissue

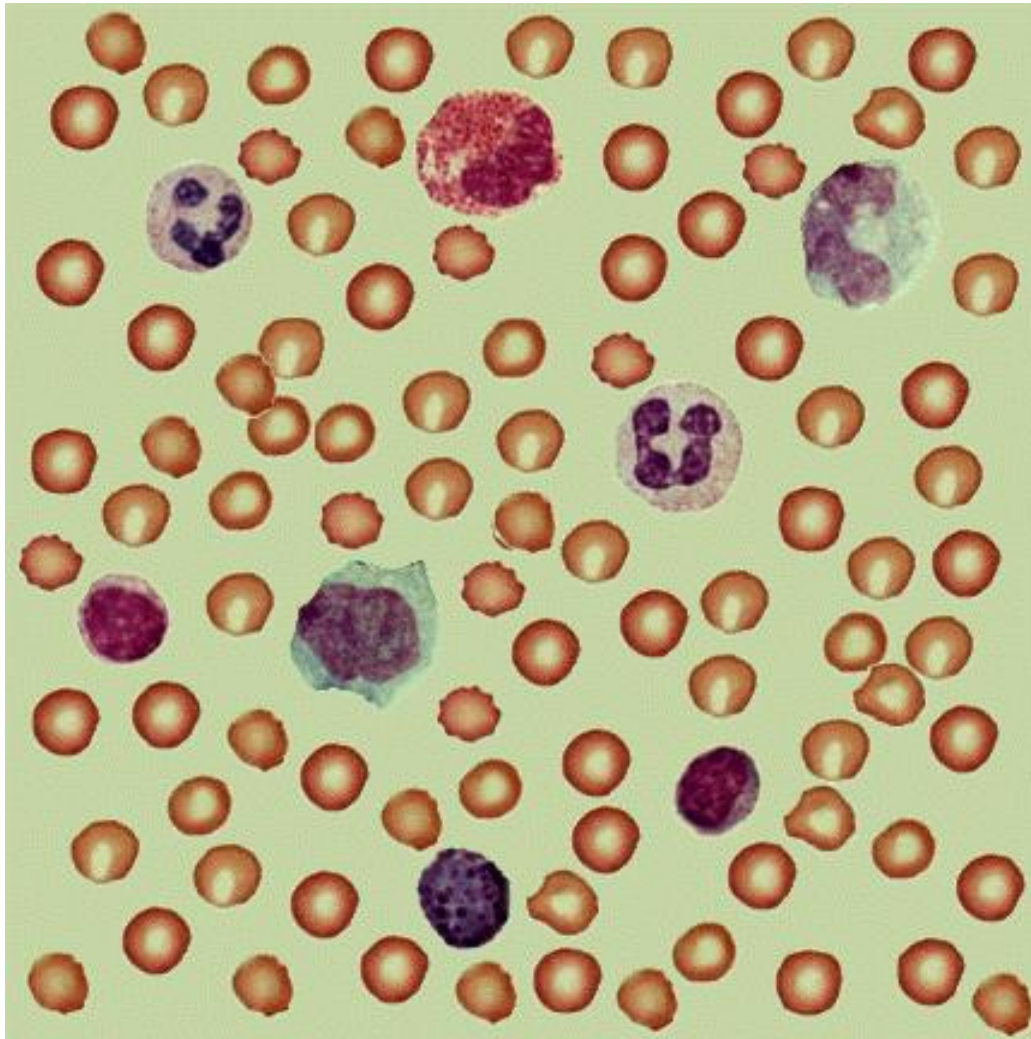


Secondary lymphoid organs

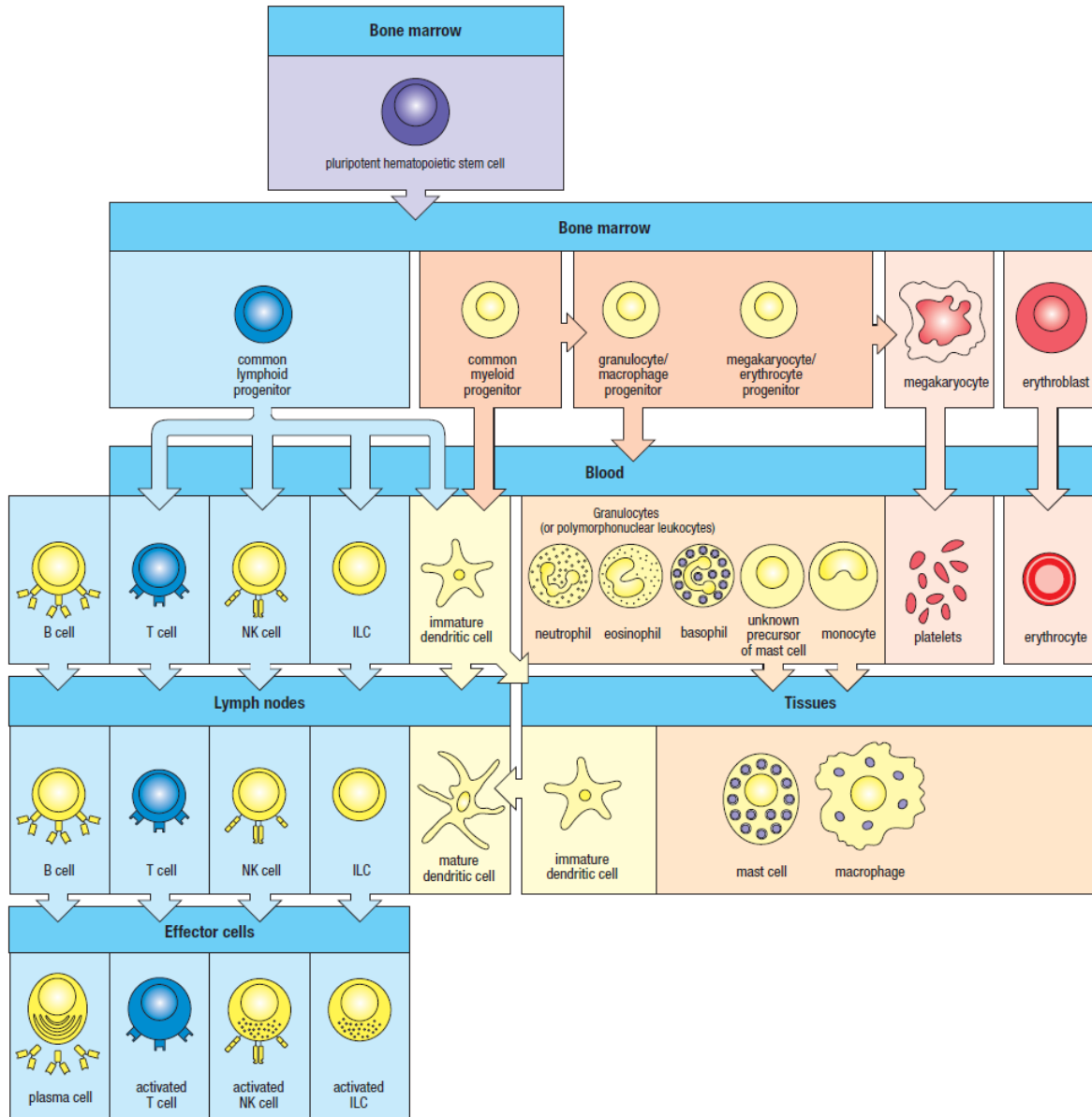
Mucosa associated lymphoid tissue



Cells of the immune system



Cells of the immune system



Cells of the immune system

Mononuclear phagocytic system

5 – 10 % of all leukocytes

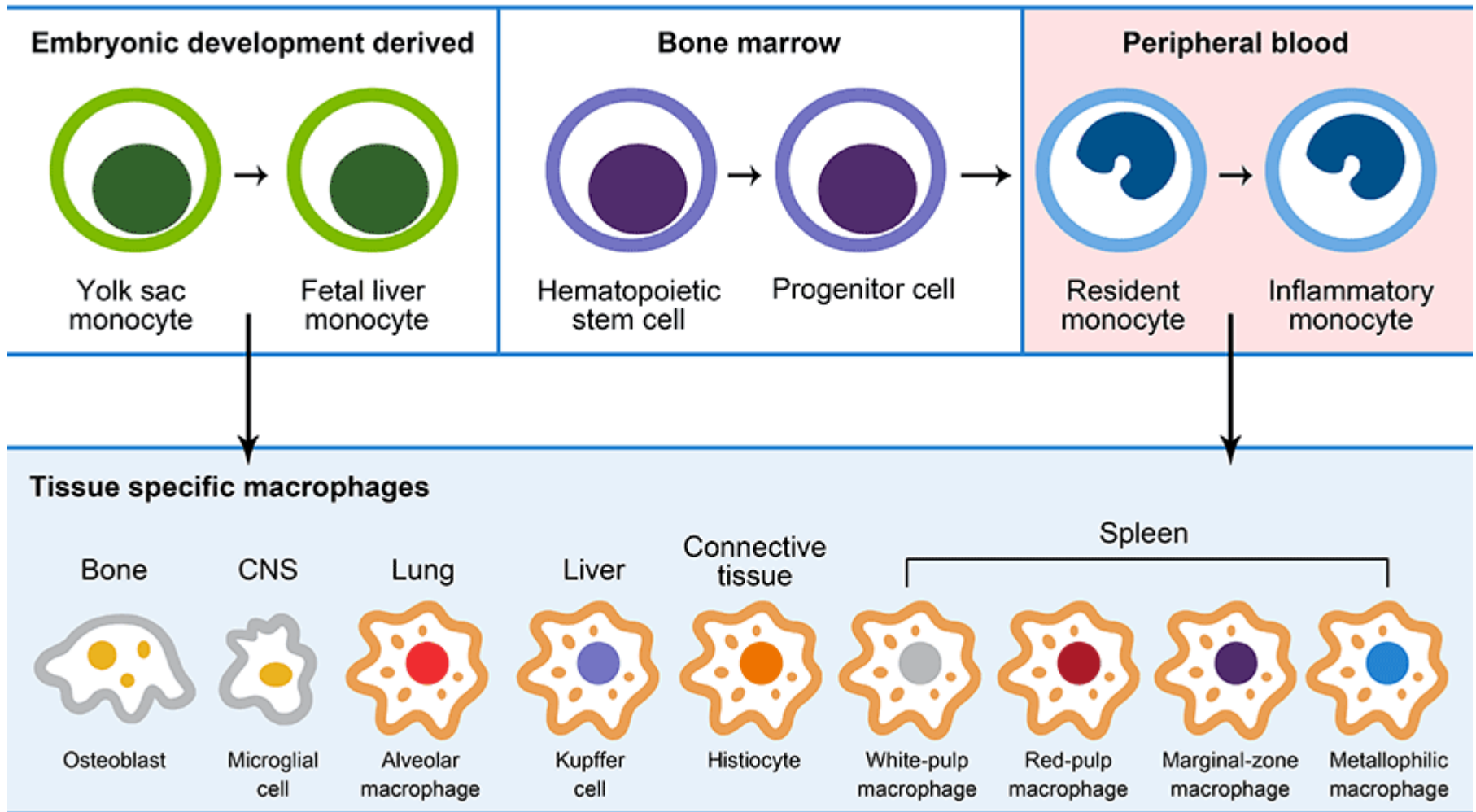
80 days

preserved capability of mitosis

large amoeboid cells with kidney-shaped nucleus

Cells of the immune system

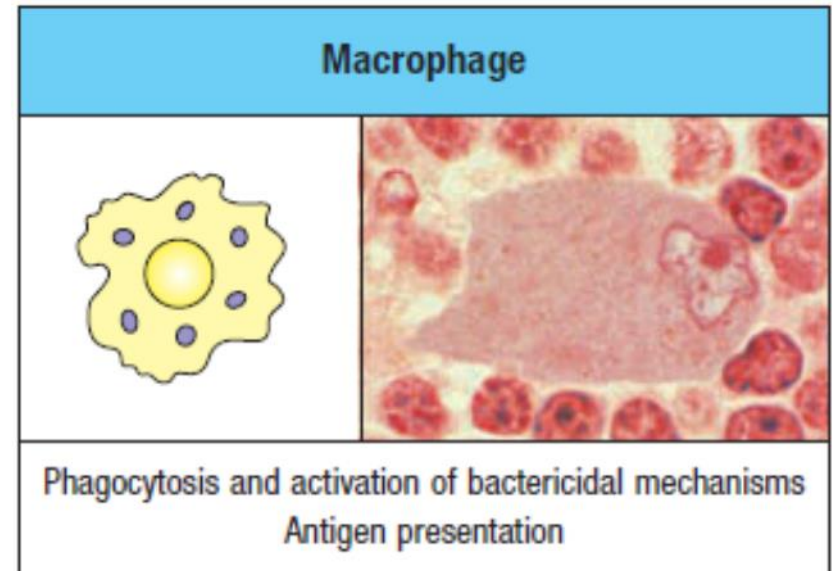
Mononuclear phagocytic system



Cells of the immune system

Mononuclear phagocytic system

- phagocytosis, killing, tissue regeneration, antigen presentation
- characteristic nucleus
- CD14 membrane marker
- activated by cytokines
- produce cytokines
- eliminate malignant and altered self structures



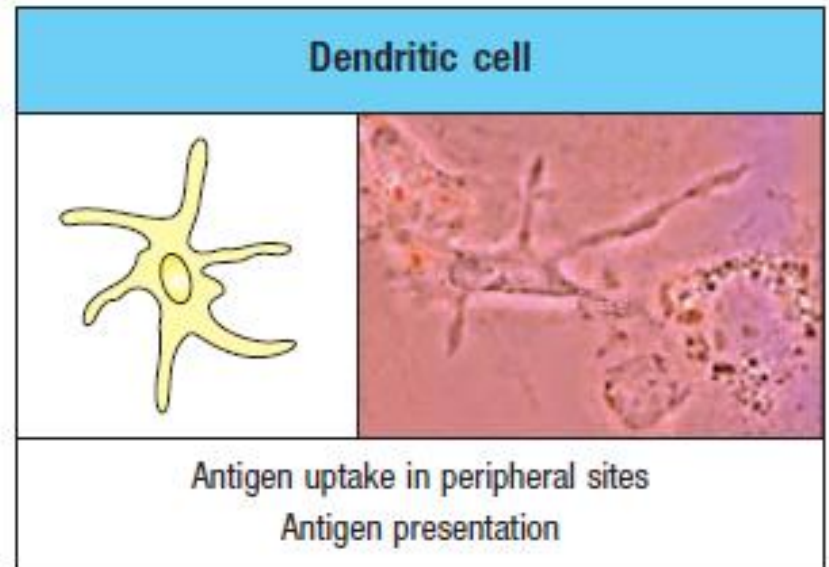
Cells of the immune system

Dendritic cells

heterogenous cell population
(various phenotype and
functional markers)

catch antigens in peripheral
tissue

professional APC



Cells of the immune system

Polymorphonuclear phagocytic system

- neutrophils (60 – 70% of all leukocytes)
- basophils (0 – 1% of all leukocytes)
- eosinophils (1 – 3% of all leukocytes)

segmented nucleus

CD66 membrane marker


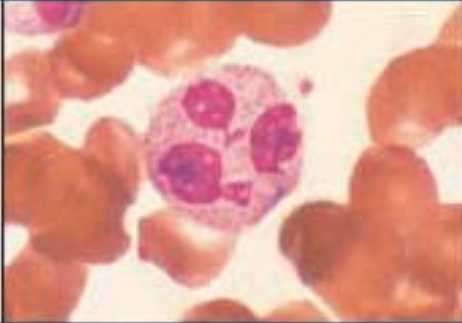
large quantity of diversely stained cytoplasmic granules


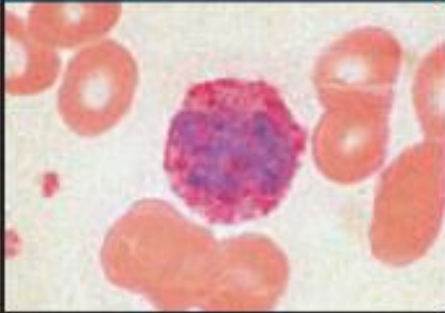
live for several hours - days


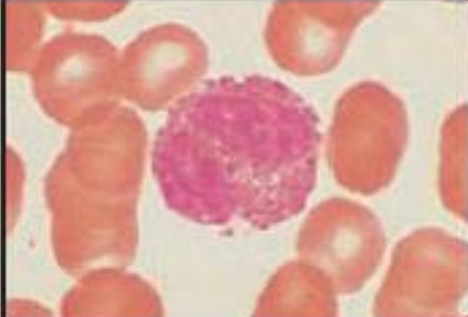
- first defense line against pathogenic microorganisms
- chemotaxis
- phagocytosis
- reactive oxygen and nitrogen species generation
- degranulation

Cells of the immune system

Polymorphonuclear phagocytic system

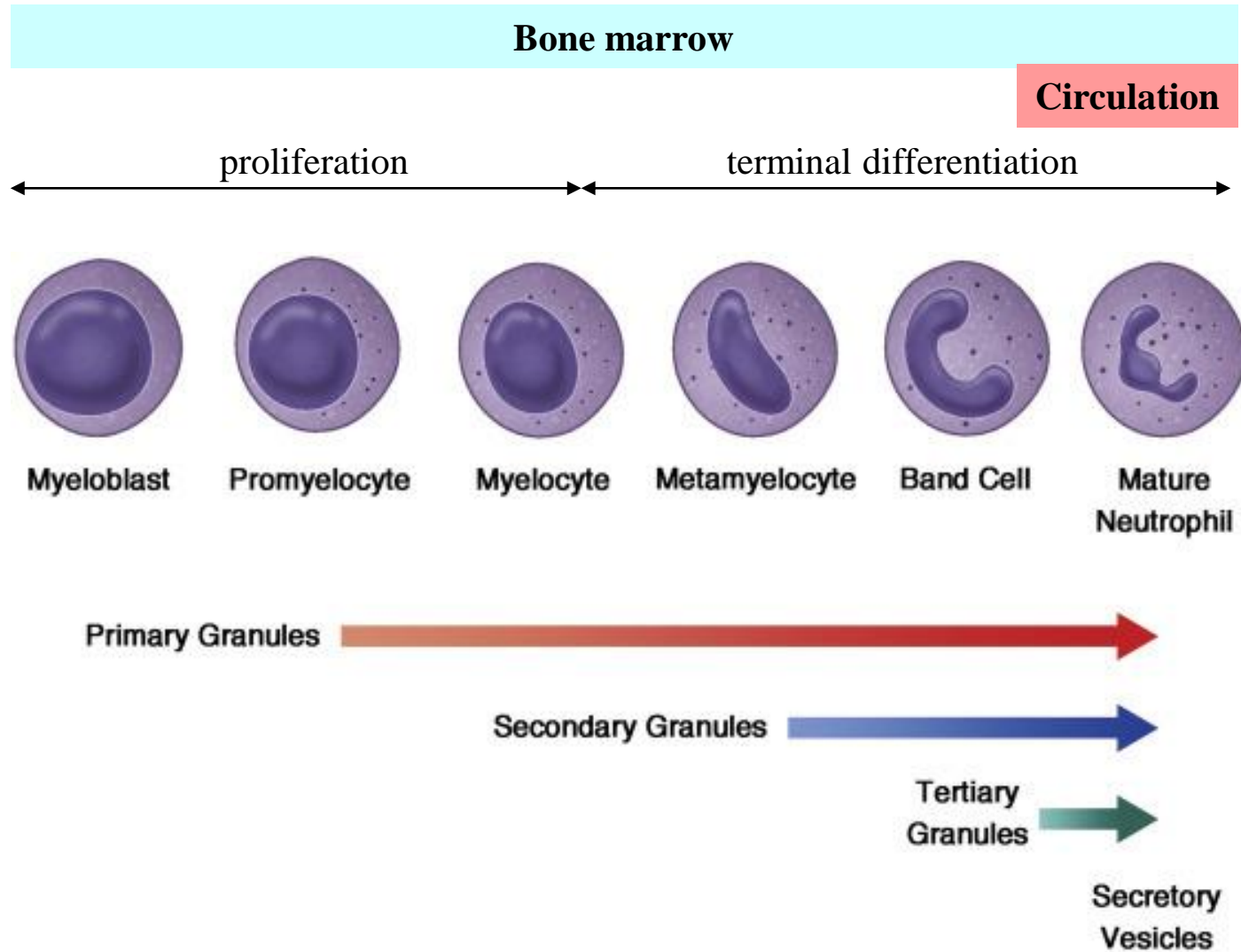
Neutrophil	
	
Phagocytosis and activation of bactericidal mechanisms	

Basophil	
	
Promotion of allergic responses and augmentation of anti-parasitic immunity	

Eosinophil	
	
Killing of antibody-coated parasites	

Cells of the immune system

Polymorphonuclear phagocytic system



Cells of the immune system

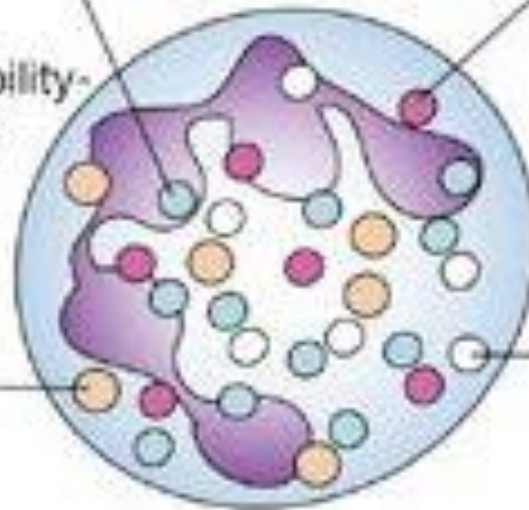
Polymorphonuclear phagocytic system

Azurophil granules

Myeloperoxidase
Neutral serine proteases
cathepsin G
elastase
proteinase 3
Bacterial/permeability-
increasing protein
Defensins
Lysozyme

Specific granules

Lactoferrin
Lysozyme
Cytochrome b558
Collagenase
Gelatinase
CD11b/CD18
fMLP-R



Gelatinase granules

CD11b/CD18
Cytochrome b558
Gelatinase
Lysozyme
Acetyltransferase

Secretory vesicles

CD11b/CD18
Cytochrome b558
CR1
Alkaline phosphatase
fMLP-R

Cells of the immune system

	Monocytes/macrophages	Neutrophils
Morphology	large mononuclear cells	small cells with segmented nucleus
Localization	blood/tissues	blood – recruited to the site of infection
After killing bacteria	migrate to local lymph nodes	die by apoptosis, eliminated by macrophages
Antigen presentation	yes (express MHC class II)	no (do not express MHC class II)

Cells of the immune system

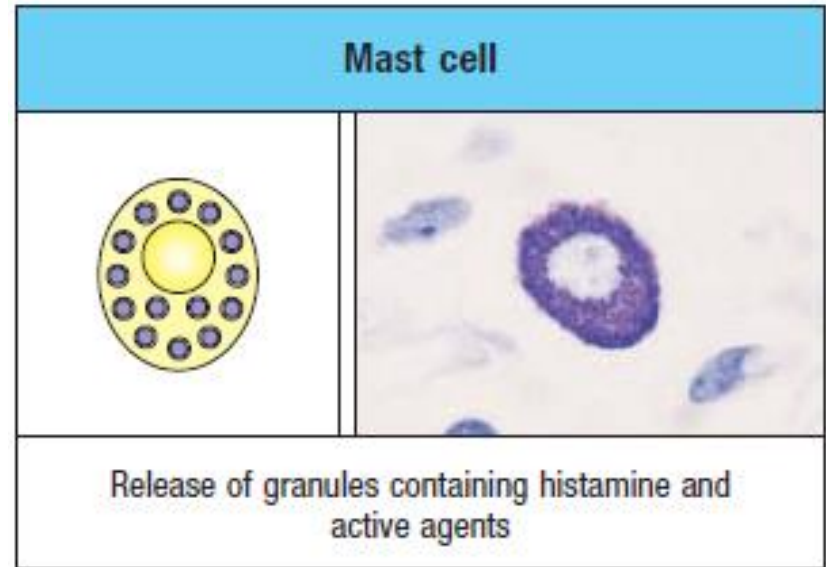
Mast cells

Skin, gastrointestinal tract

Function similar to that of basophils in blood

Release of histamine, heparin

$FC\epsilon R$



Cells of the immune system

Lymphocytes

B lymphocytes

T lymphocytes

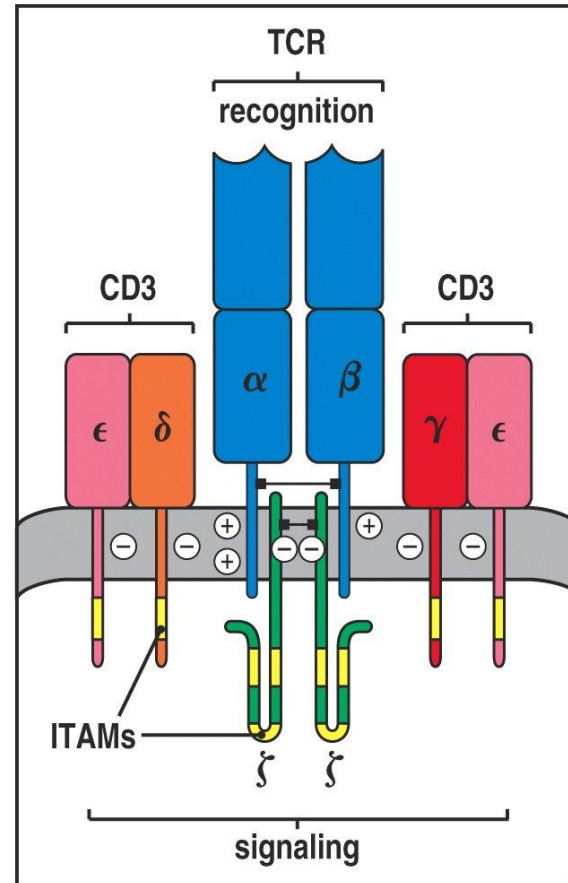
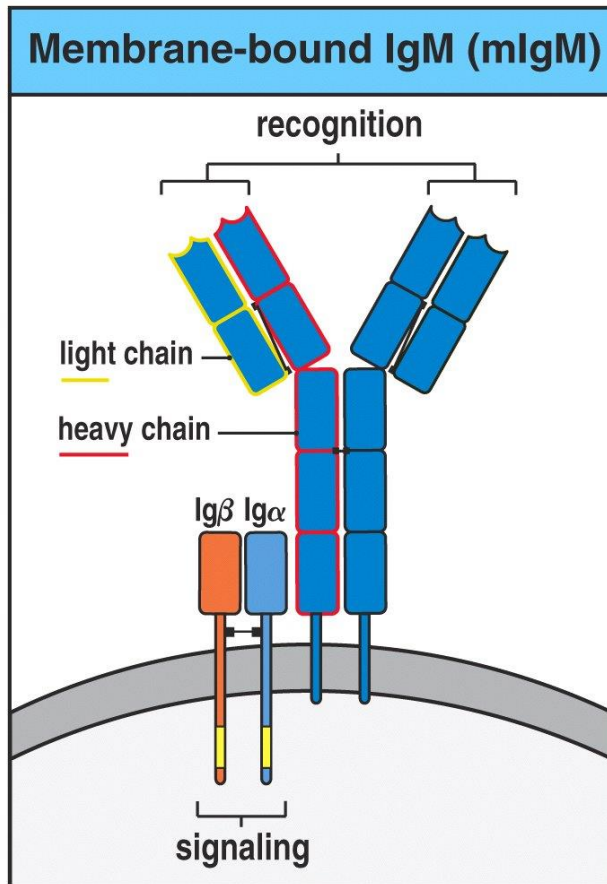
- T_H lymphocytes
- T_{reg} lymphocytes ~ T_S lymphocytes
- T_C lymphocytes

NKT lymphocytes

NK cells

Cells of the immune system

Lymphocytes



Cells of the immune system

Lymphocytes

T lymphocytes

T_{H1} lymphocytes: cooperate with macrophages, stimulate them to activated macrophages (inflammatory T lymphocytes; delayed type hypersensitivity), defense against intracellular pathogens

T_{H2} lymphocytes: cooperate with B lymphocytes, induce multiplication of specific B lymphocyte clone and their differentiation into plasmatic cells

T_{H17} lymphocytes: cooperate with neutrophils, defense against extracellular pathogens

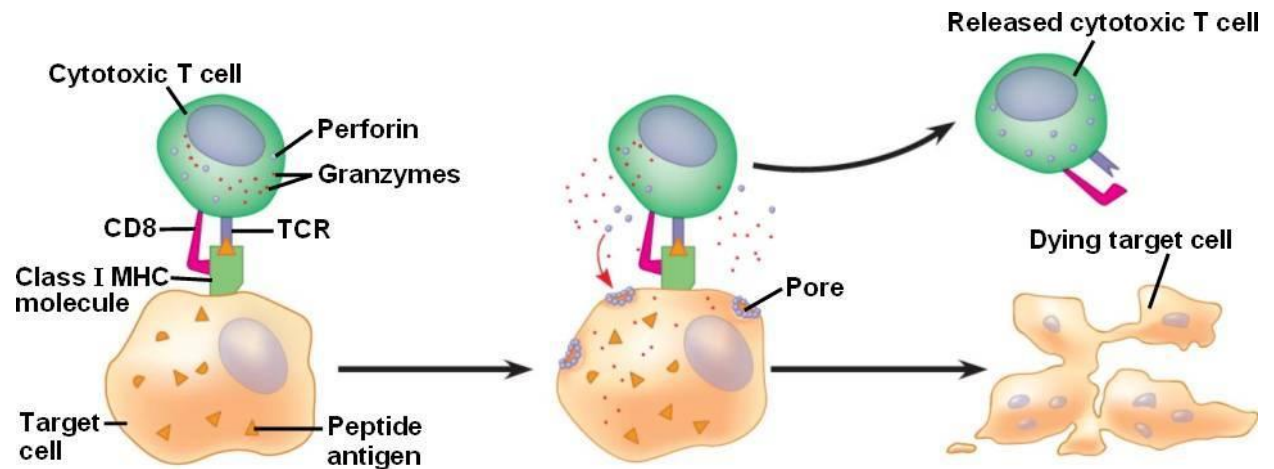
T_{H0} lymphocytes

T_{H3} lymphocytes

Cells of the immune system

Lymphocytes

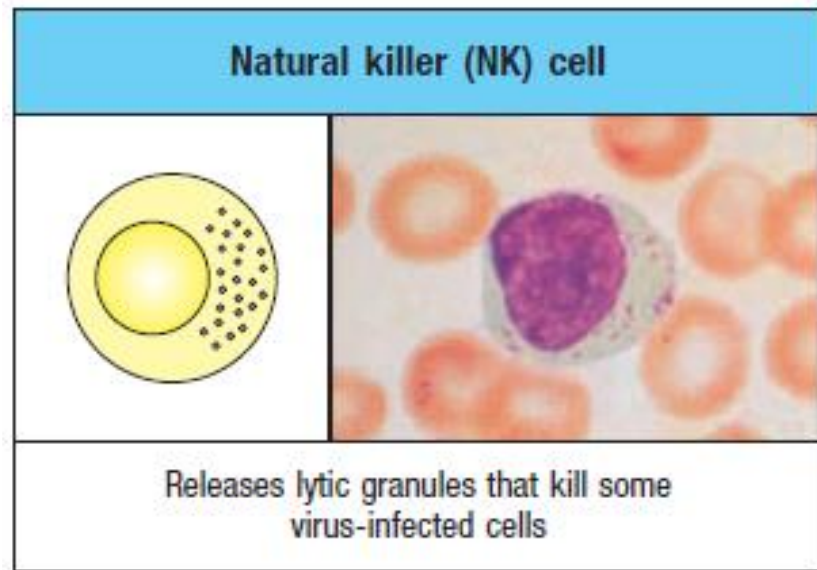
T_C lymphocytes:
cytotoxic granules (perforin, granzymes)
Fas-ligand
TNF- β (lymphotoxin)



Cells of the immune system

Lymphocytes

NK cells



large granular lymphocytes

recognize cells, which express little MHC-I on their surface (cancer cells, cells infected by viruses)

stimulatory (recognize surface, adhesion molecules) and inhibitory receptors (recognize MHC-I)

Cells of the immune system

Lymphocytes

NK cells

