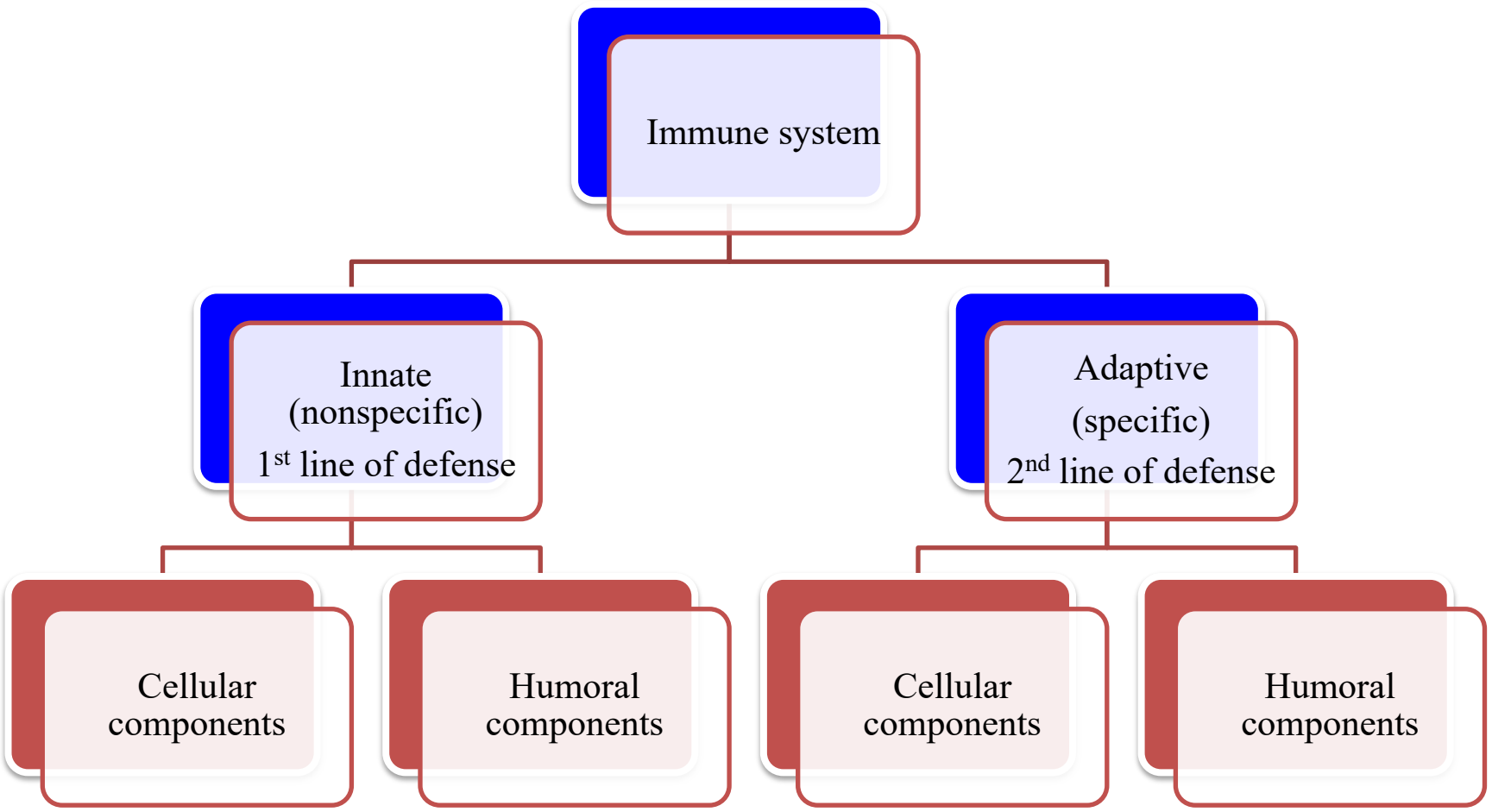
Lecture 4
BT304
7 Aug 2023

Overview of the immune system



The immune system

Immune system

Innate (non-specific) immunity

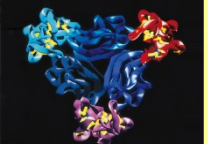
- Anatomic barriers (Skin, mucous membranes)
- Physiological barriers (temperature, pH)
- Phagocytic barriers (cells that eat invaders)
- Inflammatory barriers (redness, swelling, heat and pain)

Adaptive (specific) immunity

- Antigen specificity
- Diversity
- Immunological memory
- Self/non-self recognition

TABLE 1-3 Comparison of adaptive and innate immunity

	Innate	Adaptive
Response time	Hours	Days
Specificity	Limited and fixed	Highly diverse, improves during the course of immune response
Response to repeat infection	Identical to primary response	Much more rapid than primary response
Found in:	all multicellullar organisms	Vertebrates only
Substances that trigger:	A limited number of pathogen-associated molecular patterns (PAMPs)	Virtually any component of pathogens
Receptors:	A limited number of Pattern Recognition Receptors (PRRs) expressed on many cells types	Highly variable receptors of 2 types: antibody made by B cells and TCR made by T cells

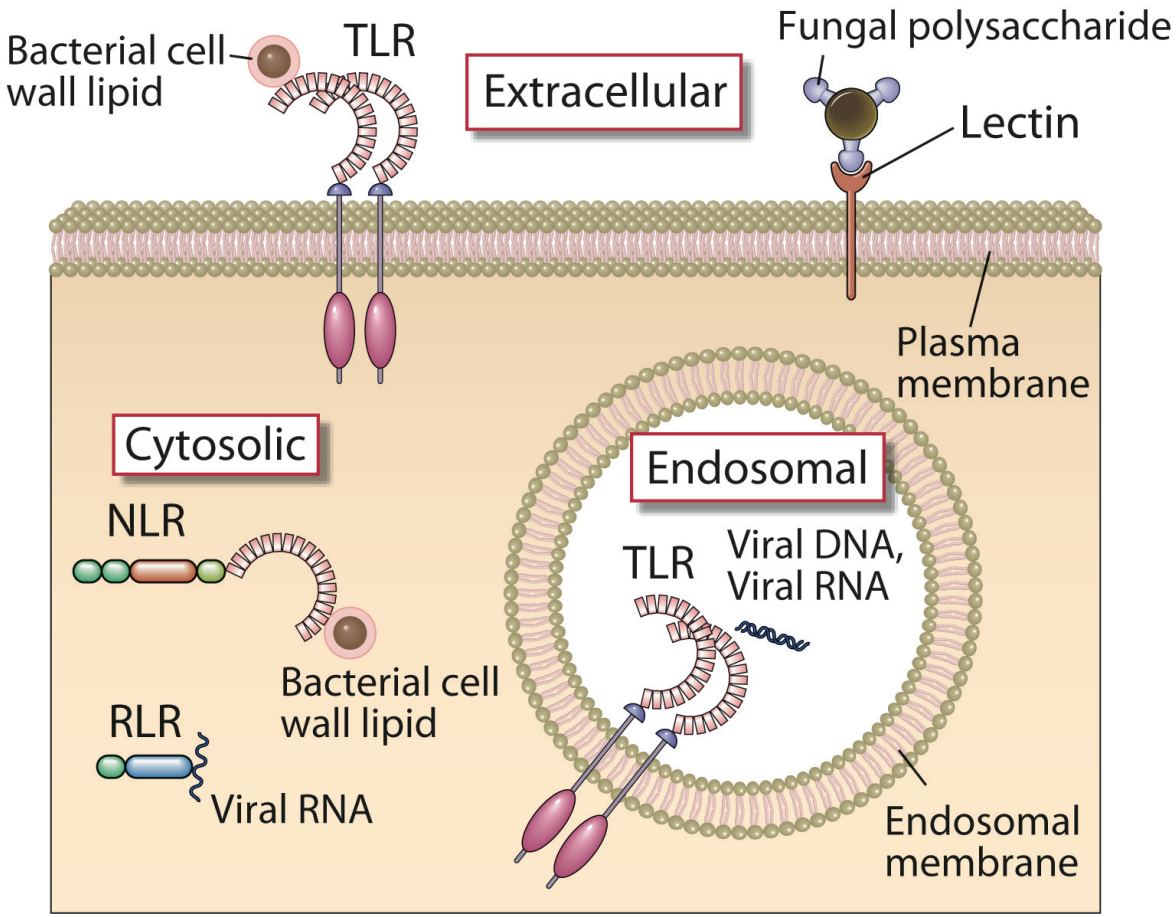


Specificity of Innate and Adaptive Immunity

	Innate immunity	Adaptive immunity
Specificity	**For pathogen-associated molecular patterns (PAMPS)** Different microbes Identical mannose receptors	**For structural details of any molecules (antigens)** Different microbes Distinct antibody molecules
Receptors	**Encoded in germline (pattern recognition receptors)** Toll-like receptor N-formyl methionyl receptor Mannose receptor	**Encoded by lymphocyte genes produced by somatic recombination** Ig TCR
Distribution of receptors	**Non-clonal**	**Clonal**

Table 4-1

Cellular Location of Innate Immune Receptors



- **RIG-I-like receptors** (retinoic acid-inducible gene-I-like receptors, **RLRs**)
- Toll like receptors (TLR)
- **nucleotide-binding oligomerization domain-like receptors**, or **NOD-like receptors** (**NLRs**)

Fig. 4-1

Structure, Location, and Specificities of TLRs

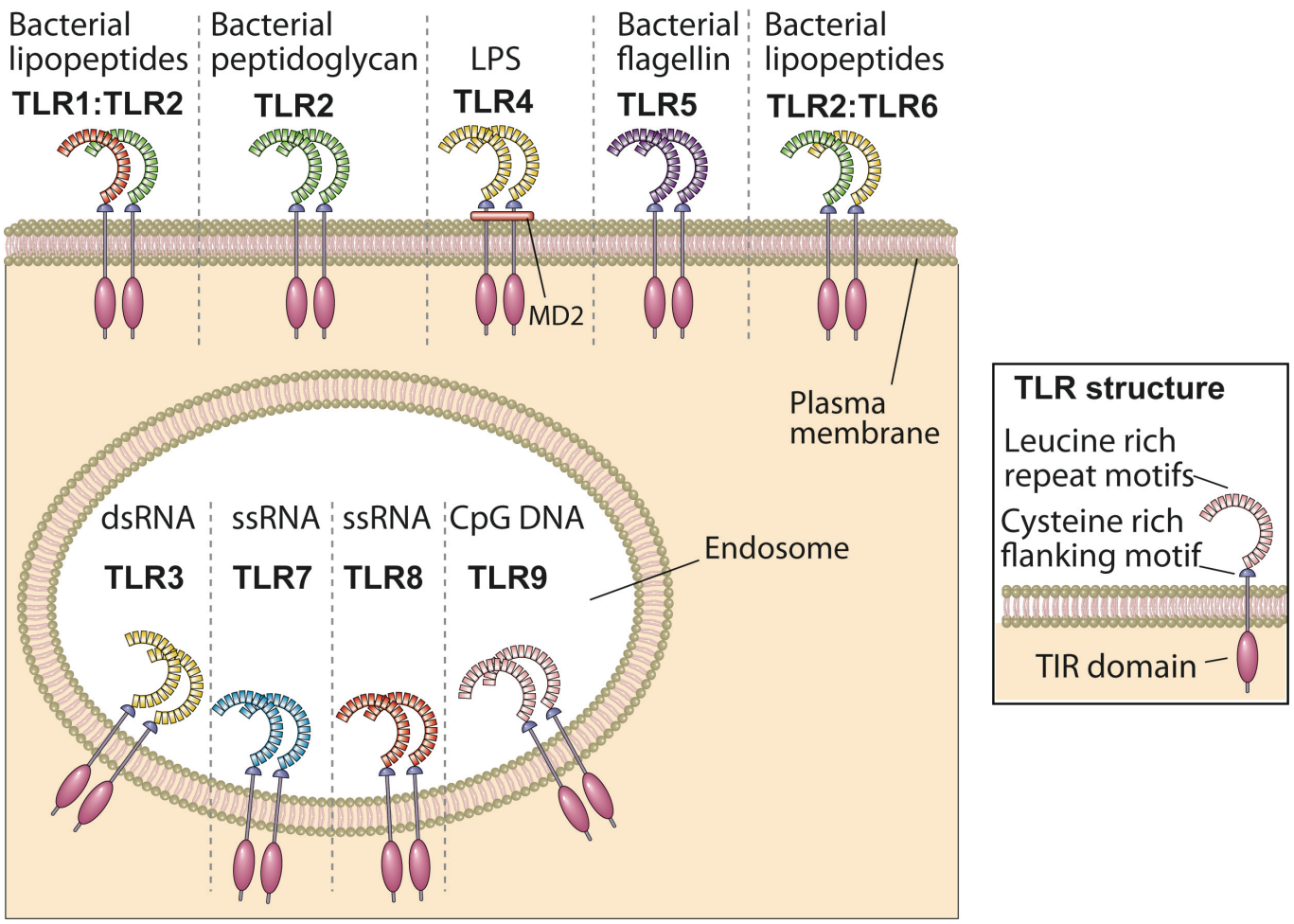
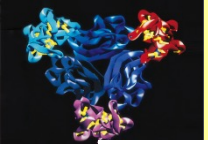
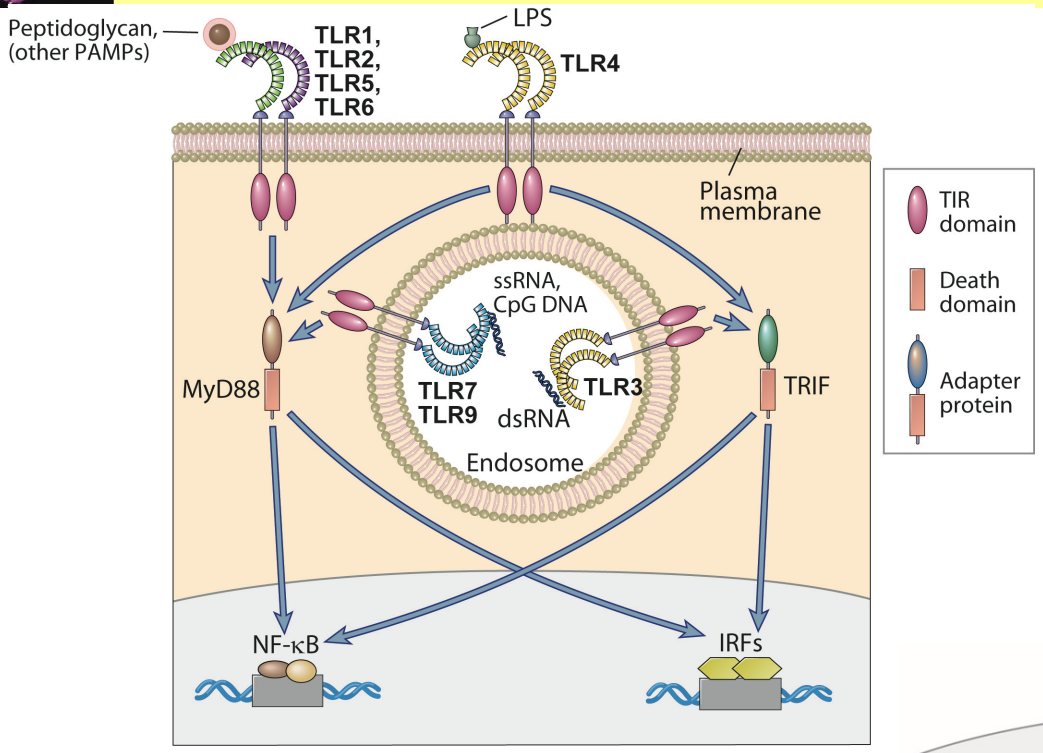


Fig. 4-2

Signaling functions of TLRs





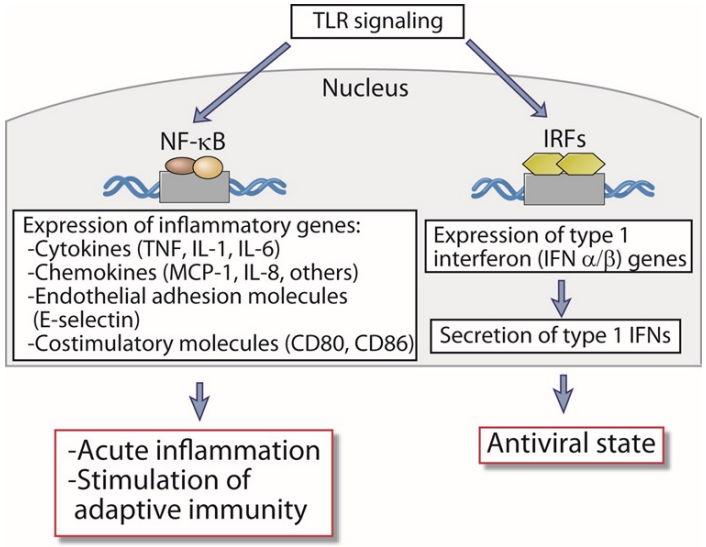


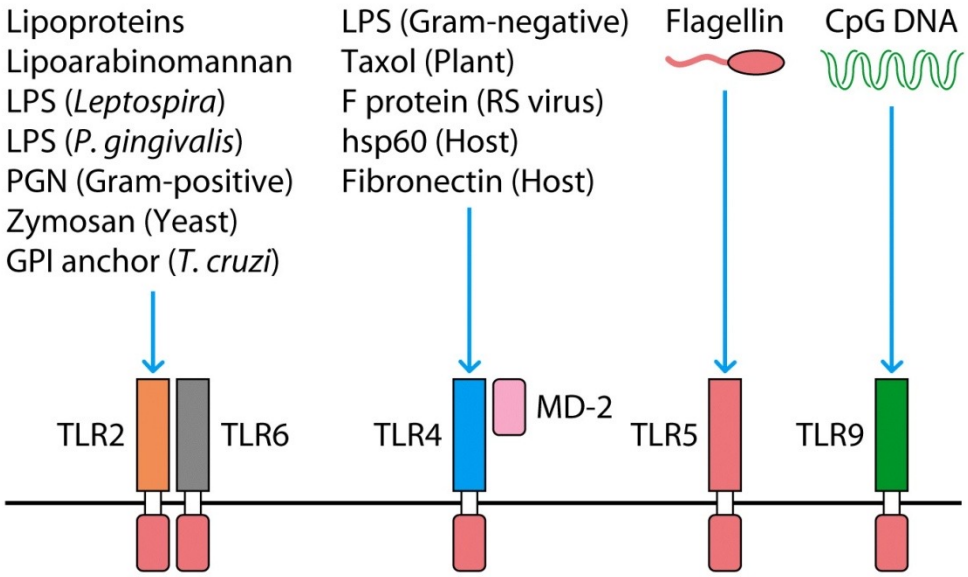
Fig. 4-3 A

Table 4-2. Examples of PAMPs and DAMPs

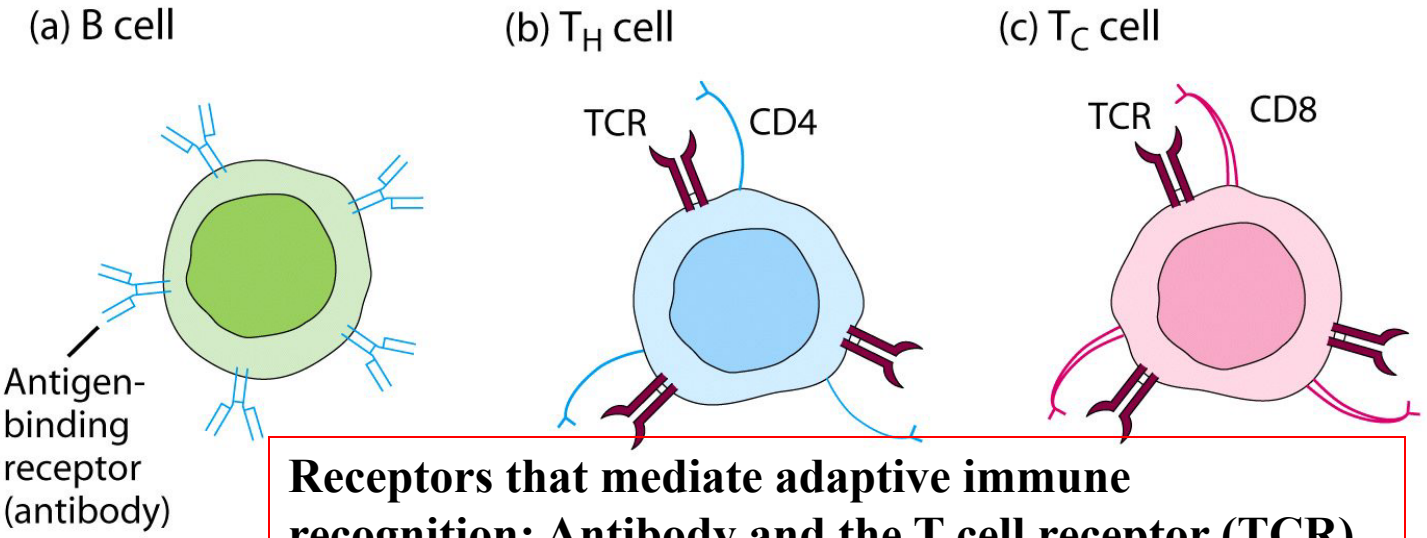
Pathogen-Associated	Molecular Patterns	Microbe Type
Nucleic acids	ssRNA	Virus
	dsRNA	Virus
	CpG	Virus, bacteria
Proteins	Pilin	Bacteria
	Flagellin	Bacteria
Cell wall lipids	LPS	Gram-negative bacteria
	Lipoteichoic acid	Gram-positive bacteria
Carbohydrates	Mannan	Fungi, bacteria
	Dectin glucans	Fungi
Damage-Associated	**Molecular Patterns**	
Stress-induced proteins	HSPs	
Crystals	Monosodium urate	
Nuclear proteins	HMGB1	

Damage associated molecular patterns (DAMPs)

Comparison of innate and adaptive immune recognition



Receptors that mediate innate immune recognition: Toll-like receptors (TLR)

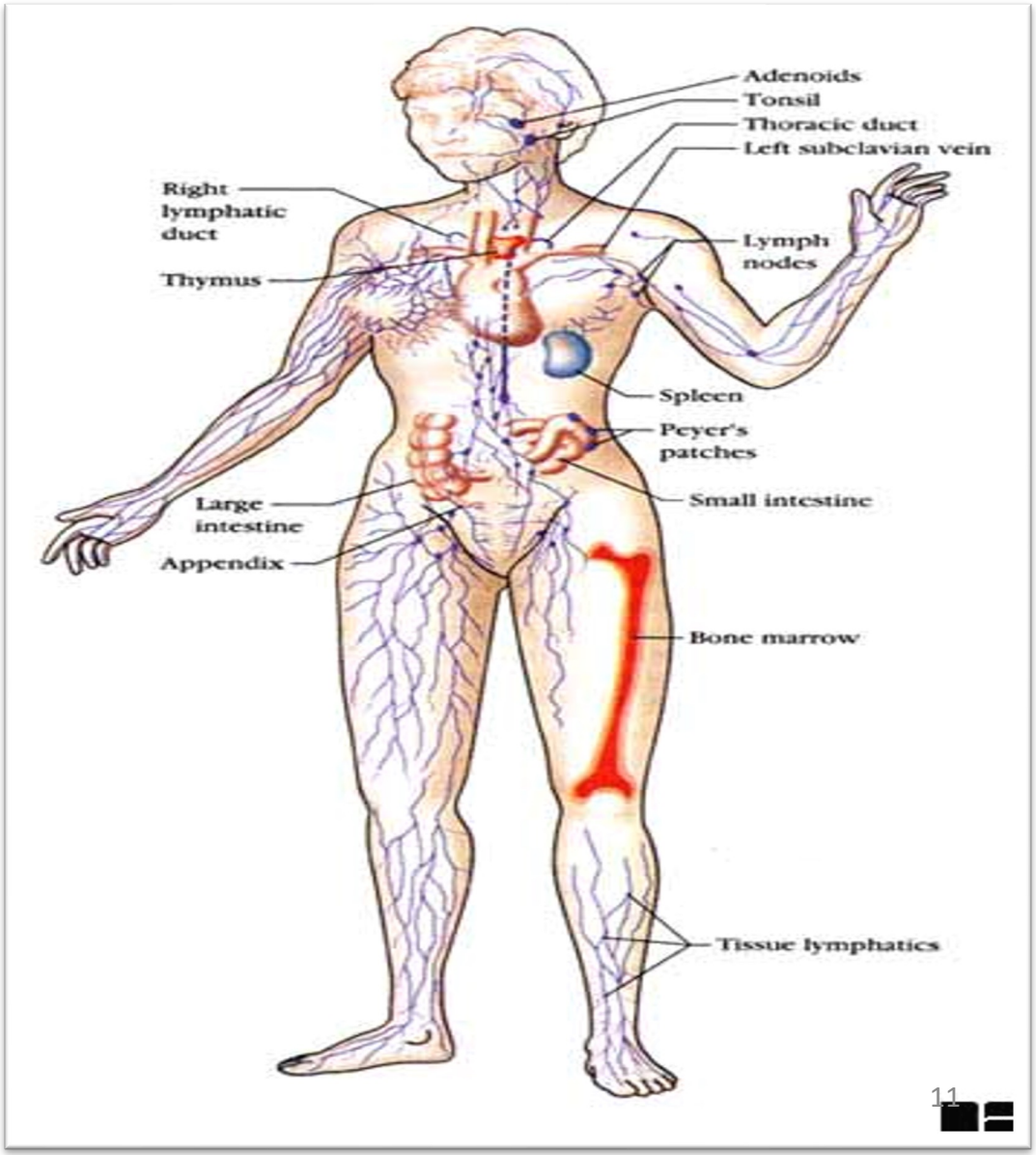


Receptors that mediate adaptive immune recognition: Antibody and the T cell receptor (TCR)

What is immunity?

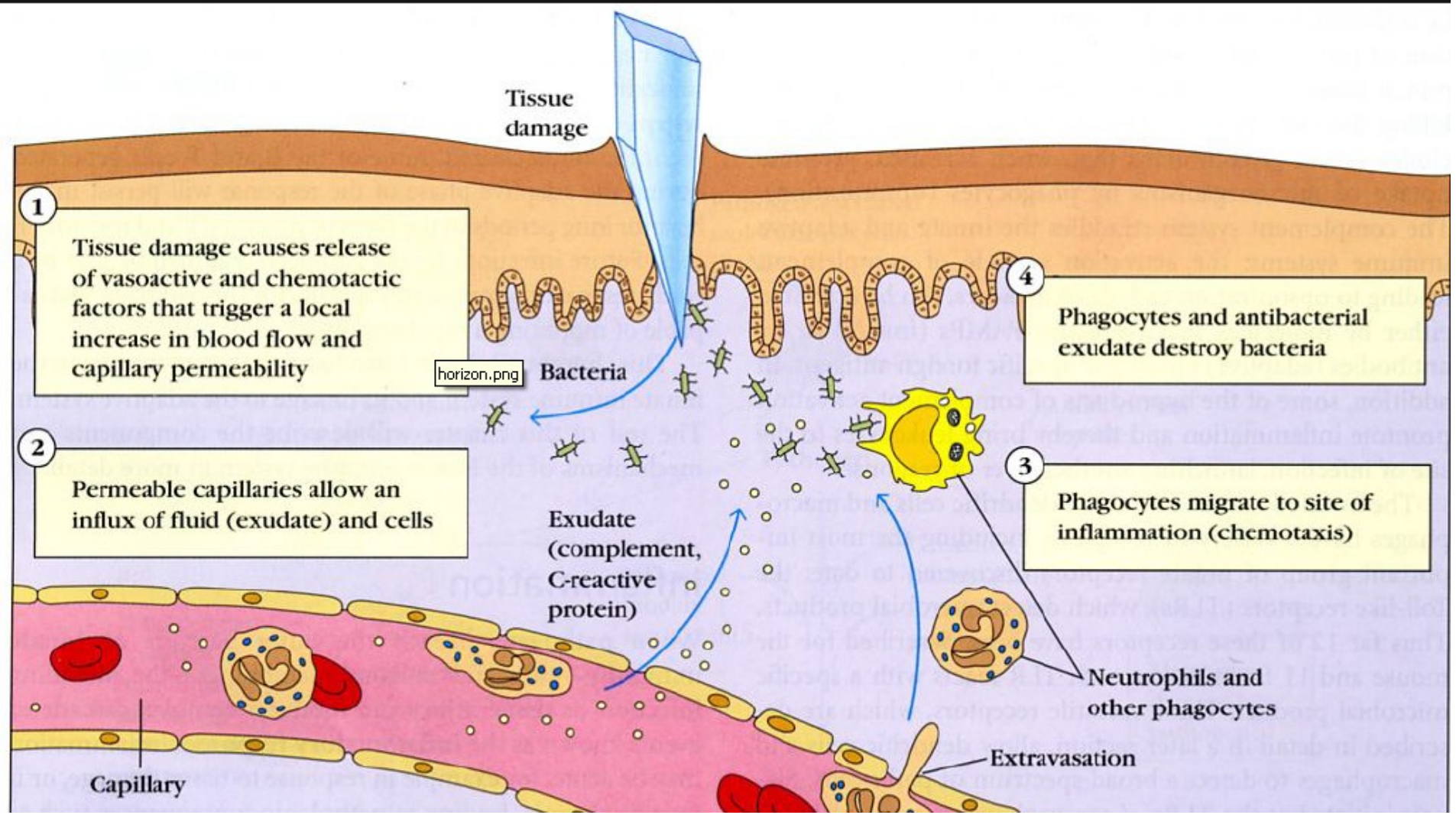
- Resistance to a disease causing organism

or harmful substance



Lecture 5
BT304
8 Aug 2023

What happens when the physical and chemical barriers are breached?



Innate Immunity- First Line of Defense

Characteristics:

- rapid
- does not generate immunologic memory
- dependent upon germ line encoded receptors recognizing structures common to many pathogens

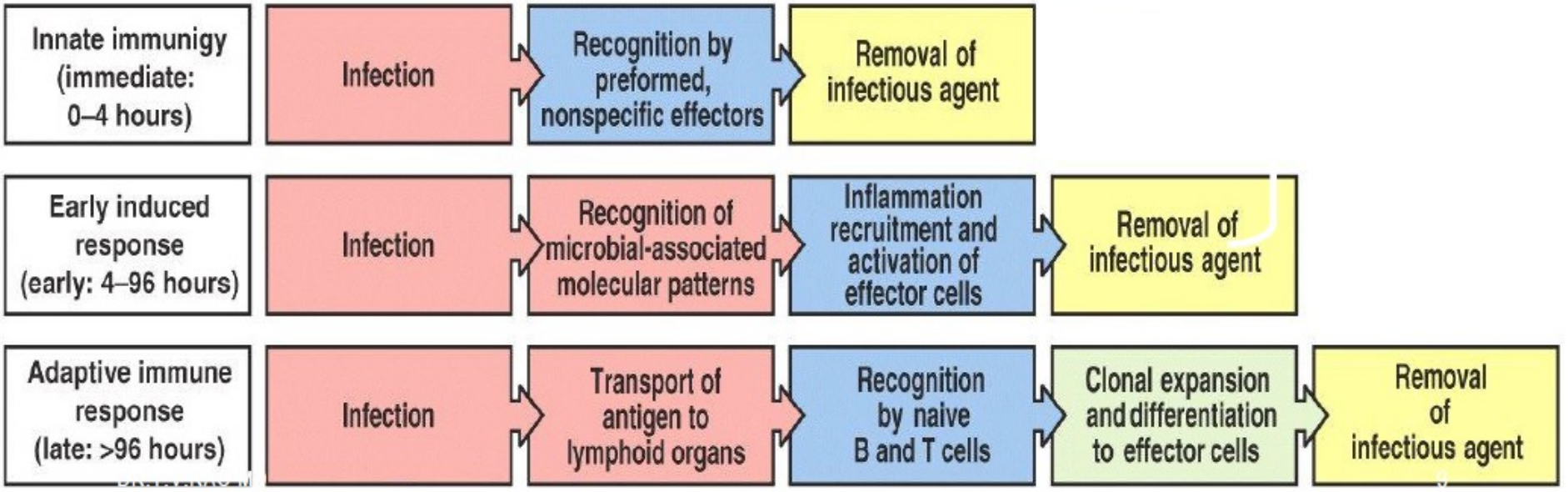
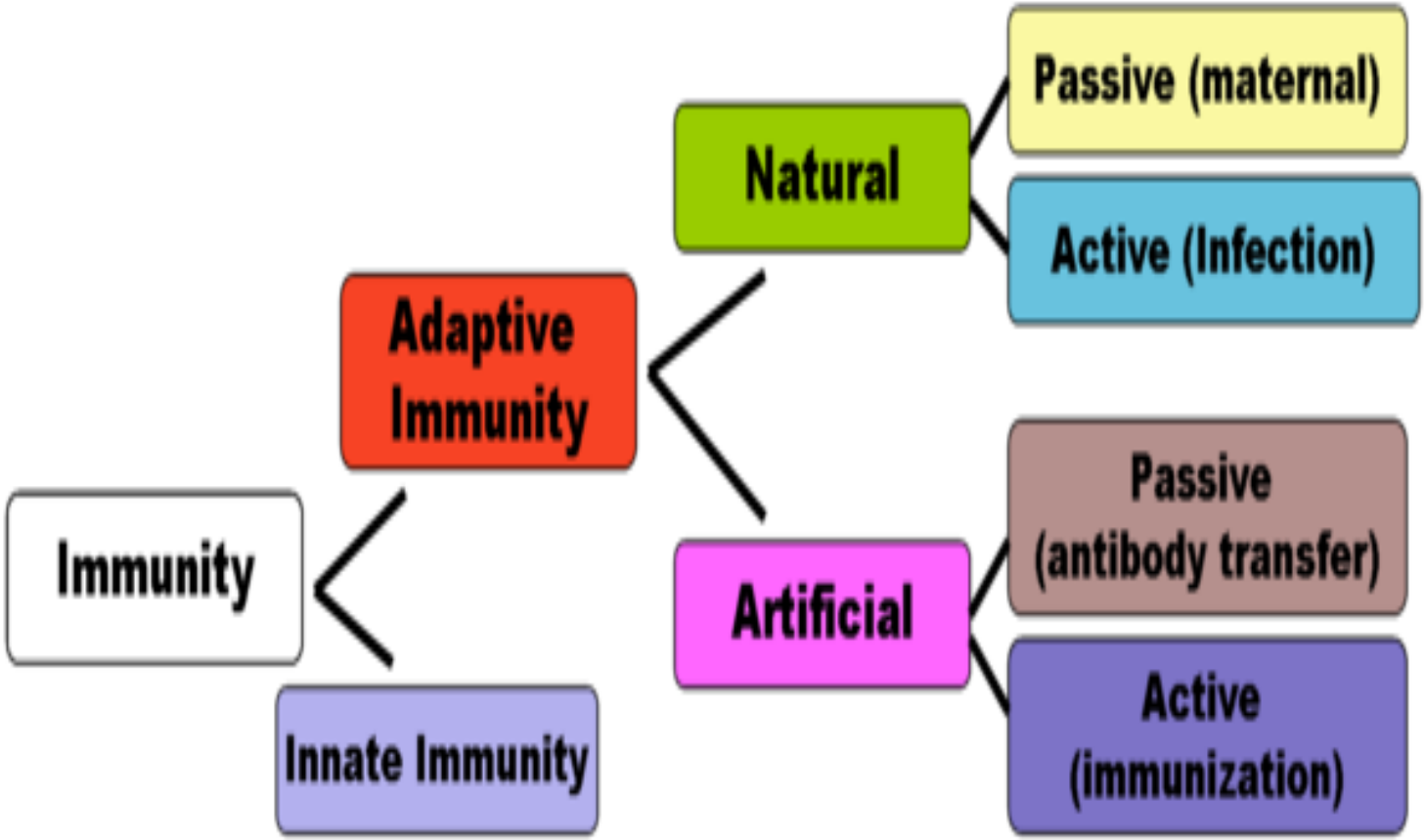


Figure 2-1 Immunobiology, 6/e. (© Garland Science 2005)

Different types of Immunity



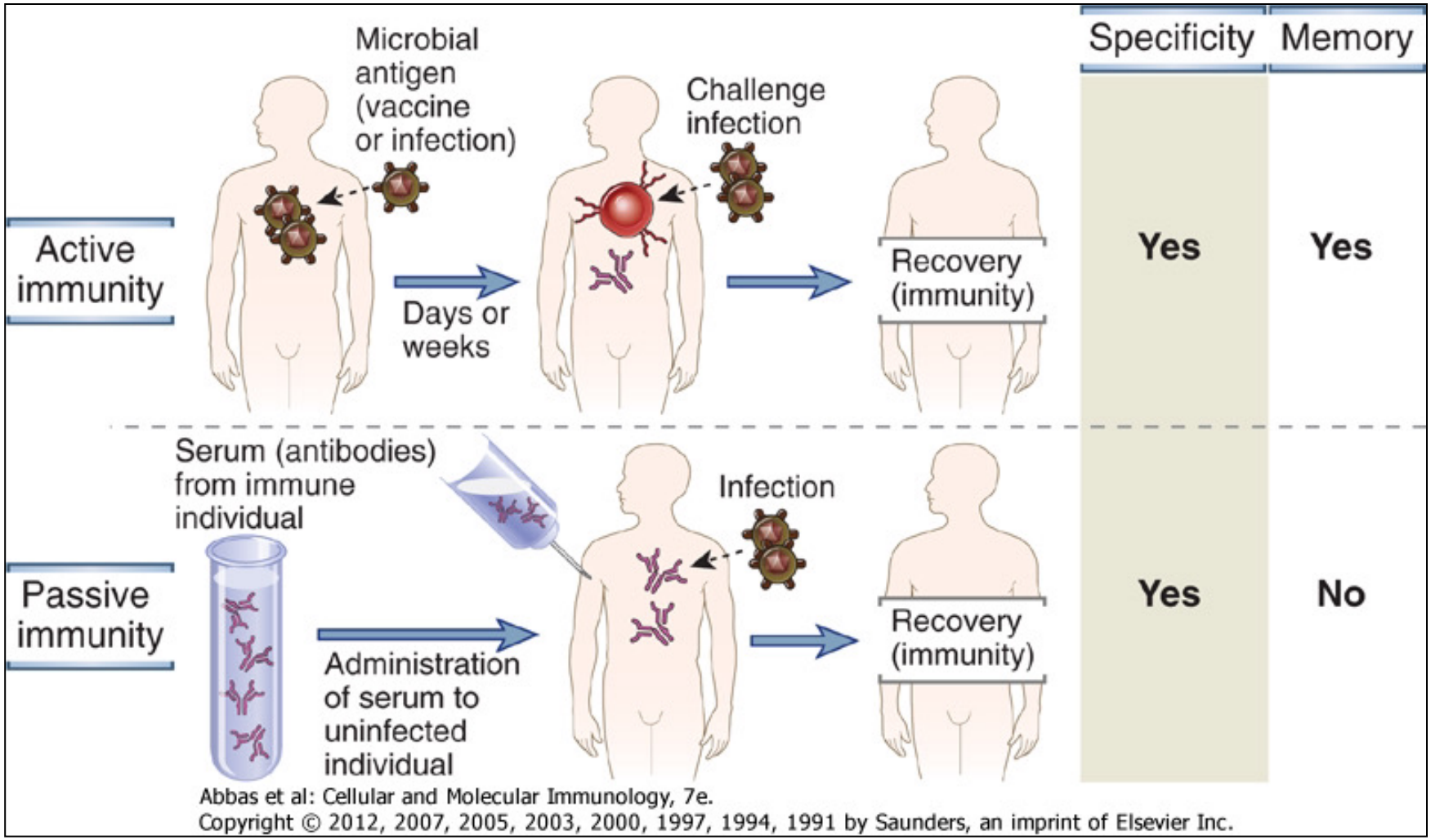


Figure 1-3 Active and passive immunity. Active immunity is conferred by a host response to a microbe or microbial antigen, whereas passive immunity is conferred by adoptive transfer of antibodies or T lymphocytes specific for the microbe. Both forms of immunity provide resistance to infection and are specific for microbial antigens, but only active immune responses generate immunologic memory. Cell transfers can be done only between genetically identical donor and recipient (e.g., inbred mice) to avoid rejection of the transferred cells.

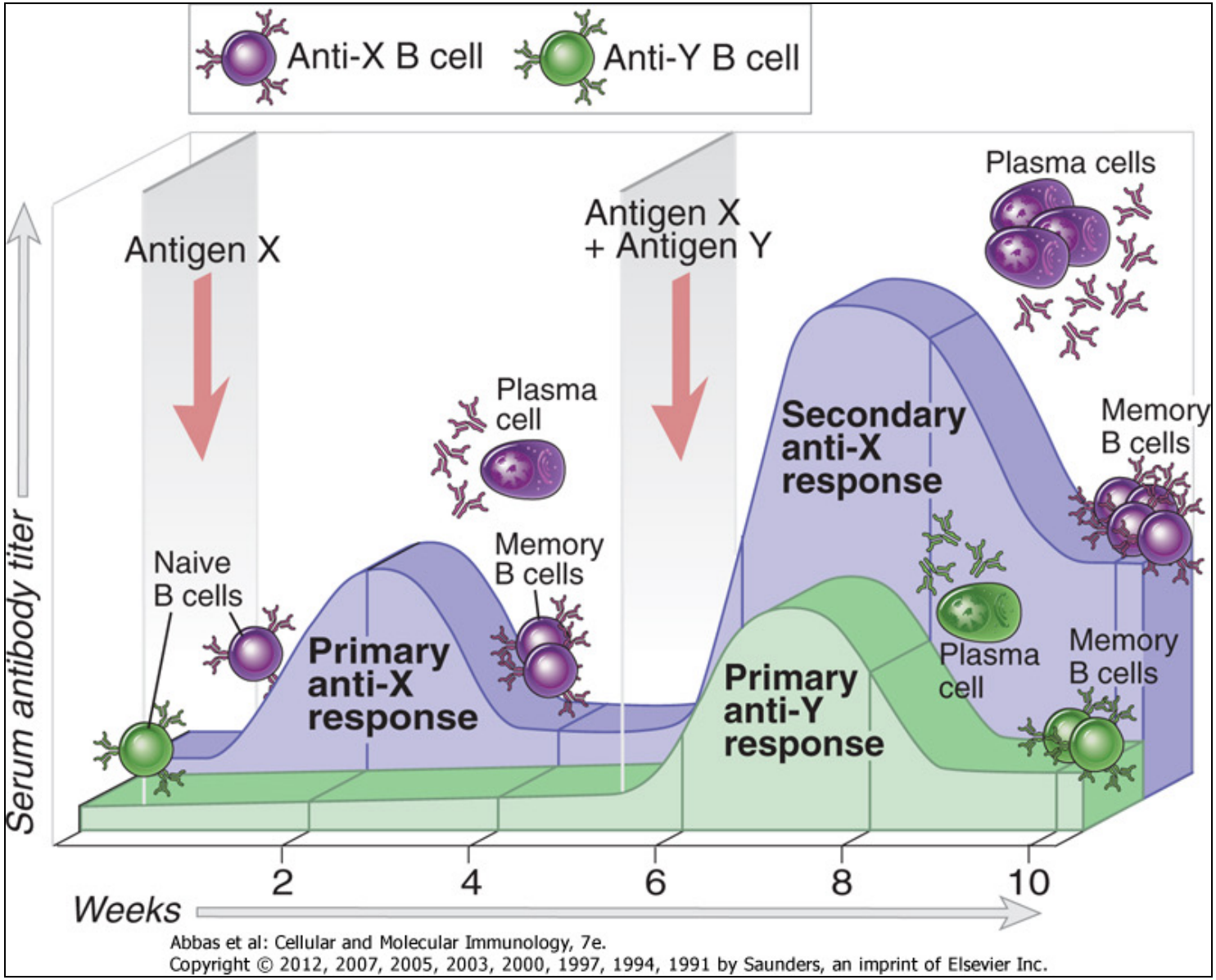
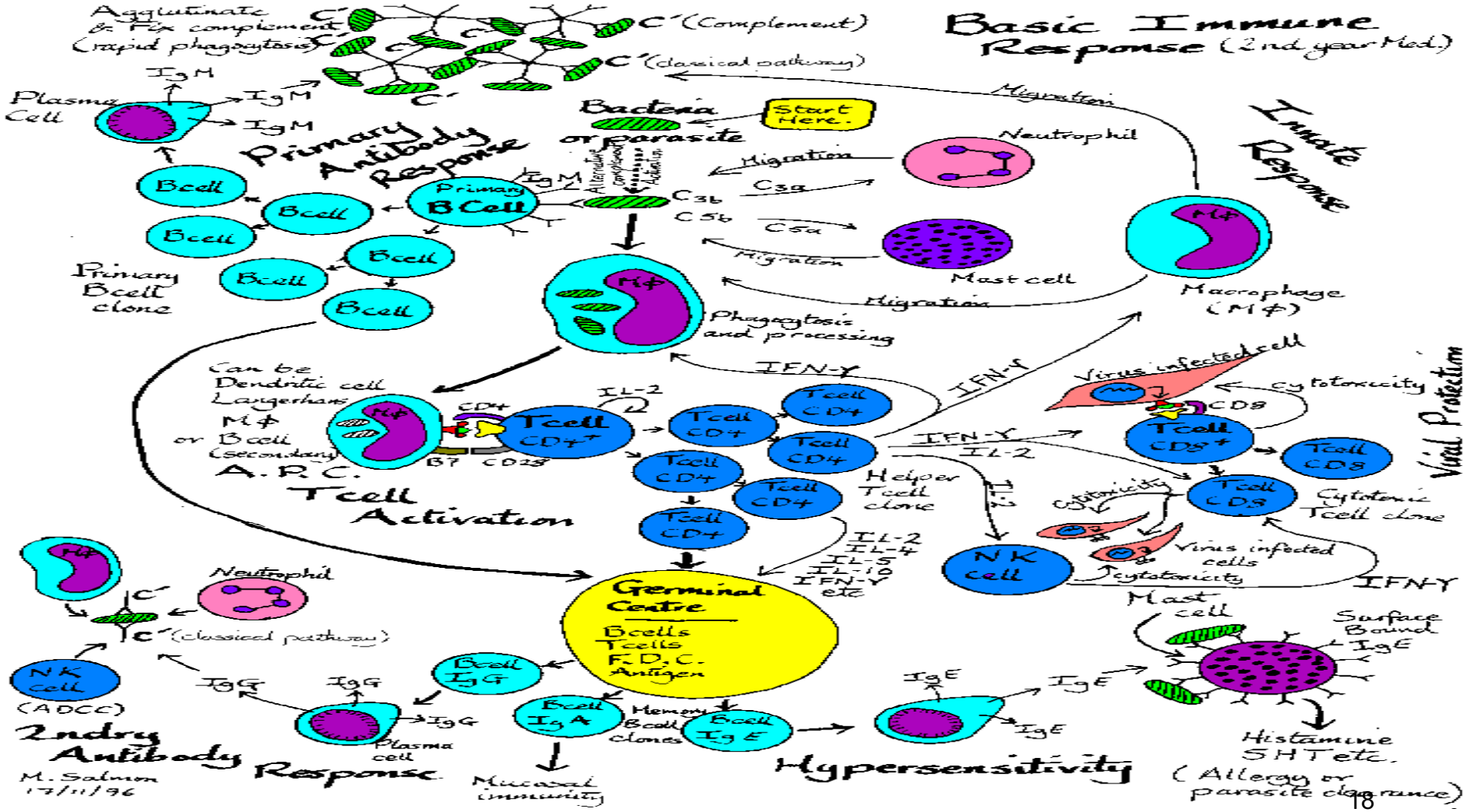


Figure 1-4 Specificity, memory, and contraction of adaptive immune responses. Antigens X and Y induce the production of different antibodies (specificity). The secondary response to antigen X is more rapid and larger than the primary response (memory). Antibody levels decline with time after each immunization (contraction, the process that maintains homeostasis). The same features are seen in cell-mediated immune responses.

Immunology is a Complex Subject



Innate Immunity

- Innate Immunity is resistance that is preexisting and is not acquired through contact with a nonself.
- Individual has innate immunity by genetic or constitutional make up.
- Non related to prior contact with microorganisms or immunization

Innate host defenses against infection

- Anatomical barriers
  - Mechanical, chemical, biological
- Humoral components
  - Complement, coagulation system, cytokines
- Cellular components
  - Neutrophils, monocytes & macrophages, NK cells, eosinophils

Anatomical barriers- mechanical

System/Organ	Cell type	Mechanism
Skin	Squamous epithelium	Physical barrier Desquamation
Mucous membranes	Non-ciliated epithelium (e.g. GI tract)	Peristalsis
	Ciliated epithelium (e.g. respiratory tract)	Mucociliary elevator
	Epithelium (e.g. nasopharynx)	Flushing action of tears, saliva, mucus, urine

Anatomical barriers- chemical

System/Organ	Component	Mechanism
Skin	Sweat	Antimicrobial fatty acids
Mucous membranes	HCl (parietal cells), tears & saliva	Low pH Lysozyme & phospholipase A
	Defensins (respiratory & GI tract)	Antimicrobial
	Surfactants (lung)	Opsonin

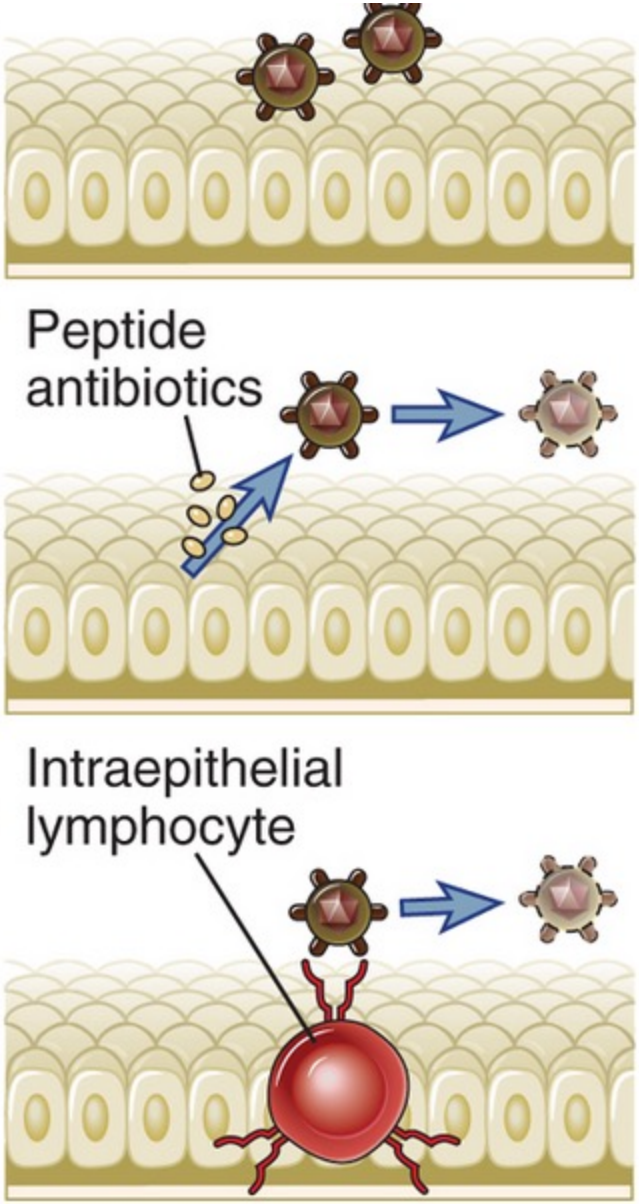
Anatomical barriers- biological

System/Organ	Component	Mechanism
Skin and mucous membranes	Normal flora	Antimicrobial substances Competition for nutrients and colonization

Physical barrier to infection

Killing of microbes by locally produced antibiotics, defensins, calthelicidins

Killing of microbes and infected cells by intraepithelial lymphocytes



Humoral components of innate immunity

Component	Mechanism
Complement	Lysis of bateria and some viruses Opsonin Increase in vascular permeability Recruitment and activation of phagocytic cells
Coagulation system	Increase vascular permeability Recruitment of phagocytic cells B-lysin from platelets – a cationic detergent
Lactoferrin and transferrin	Compete with bacteria for iron
Lysozyme	Breaks down bacterial cells walls
Cytokines	Various effects

Lecture 6
10 Aug 2023

Complement Pathways

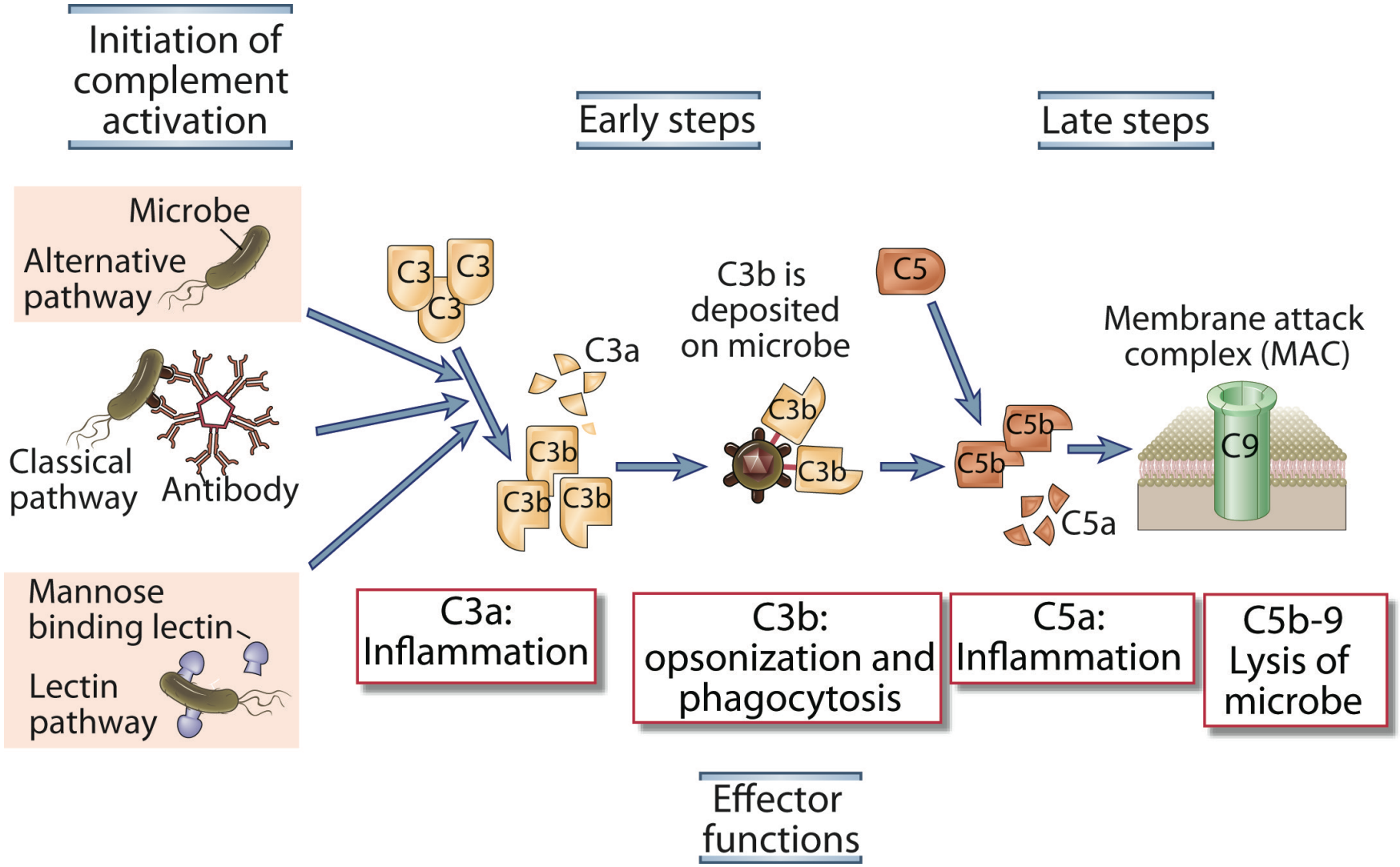
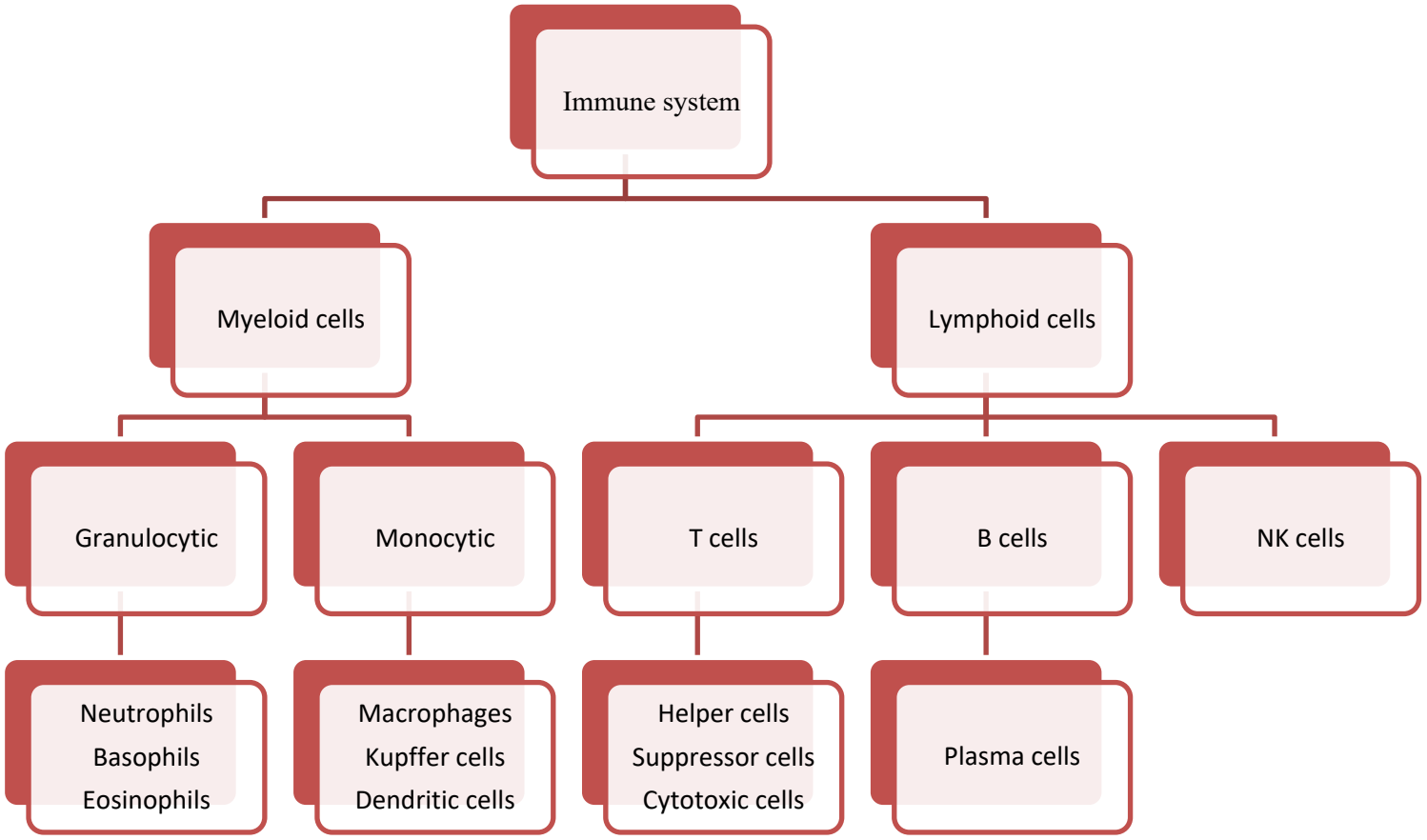
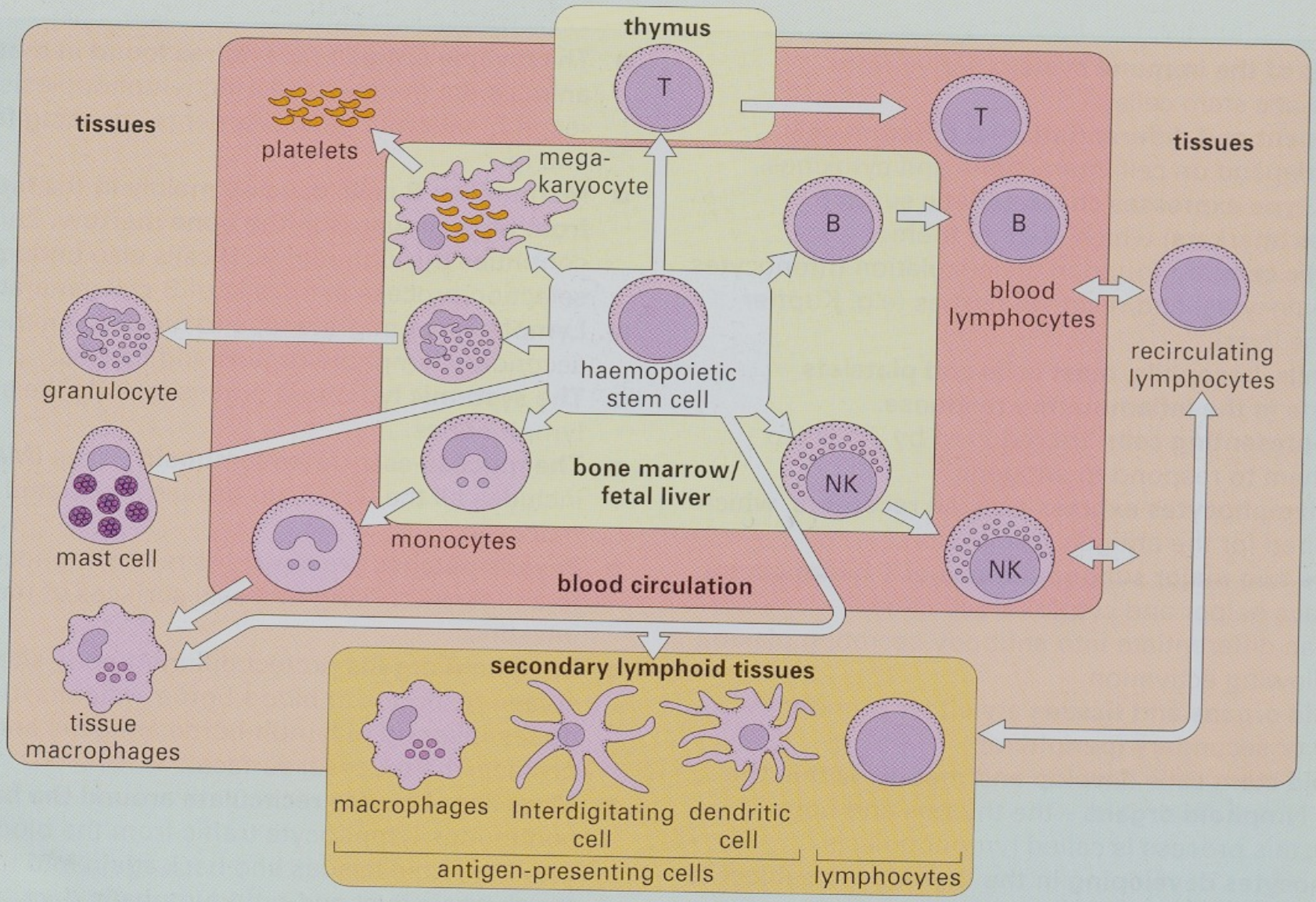


Fig. 4-9

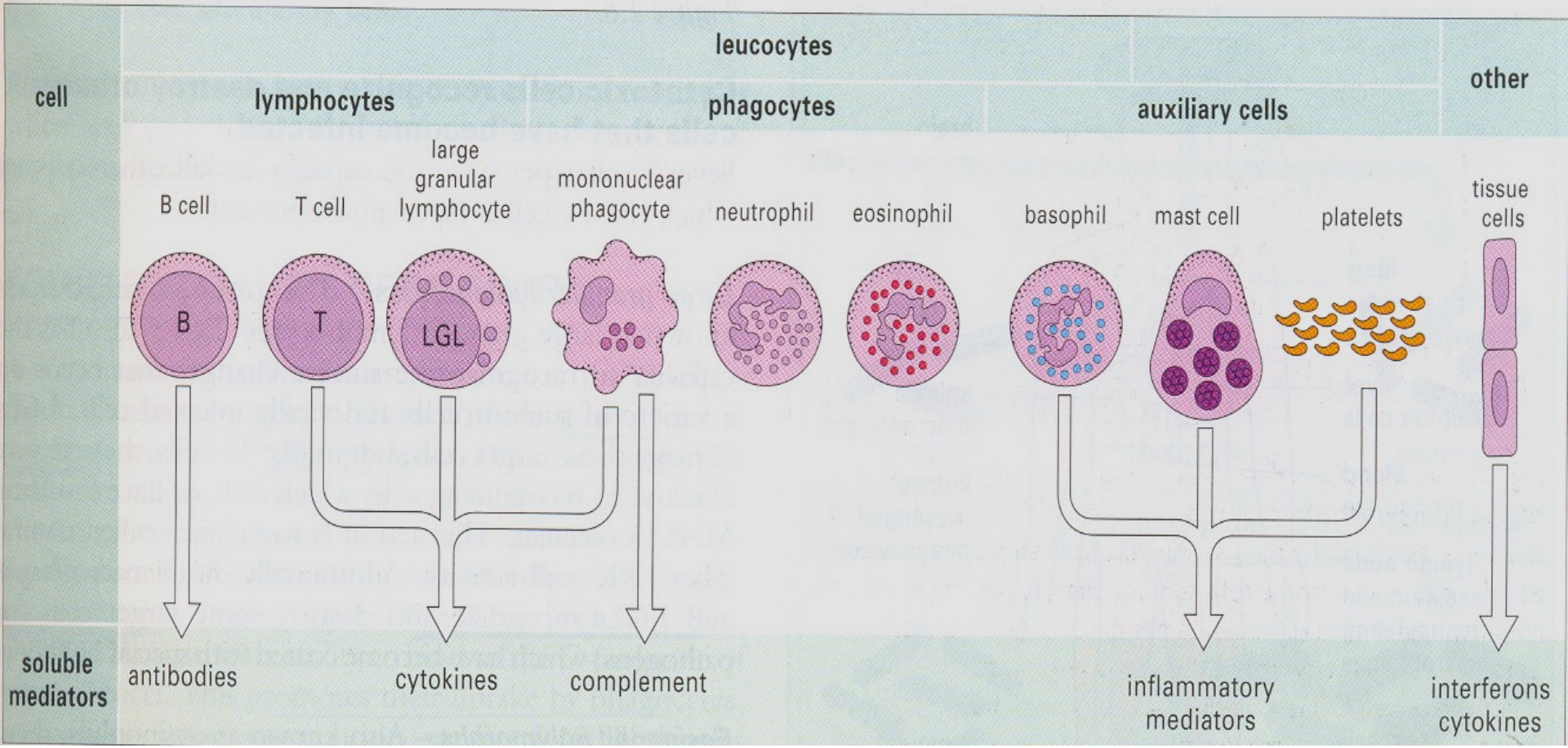
Cells of the immune system



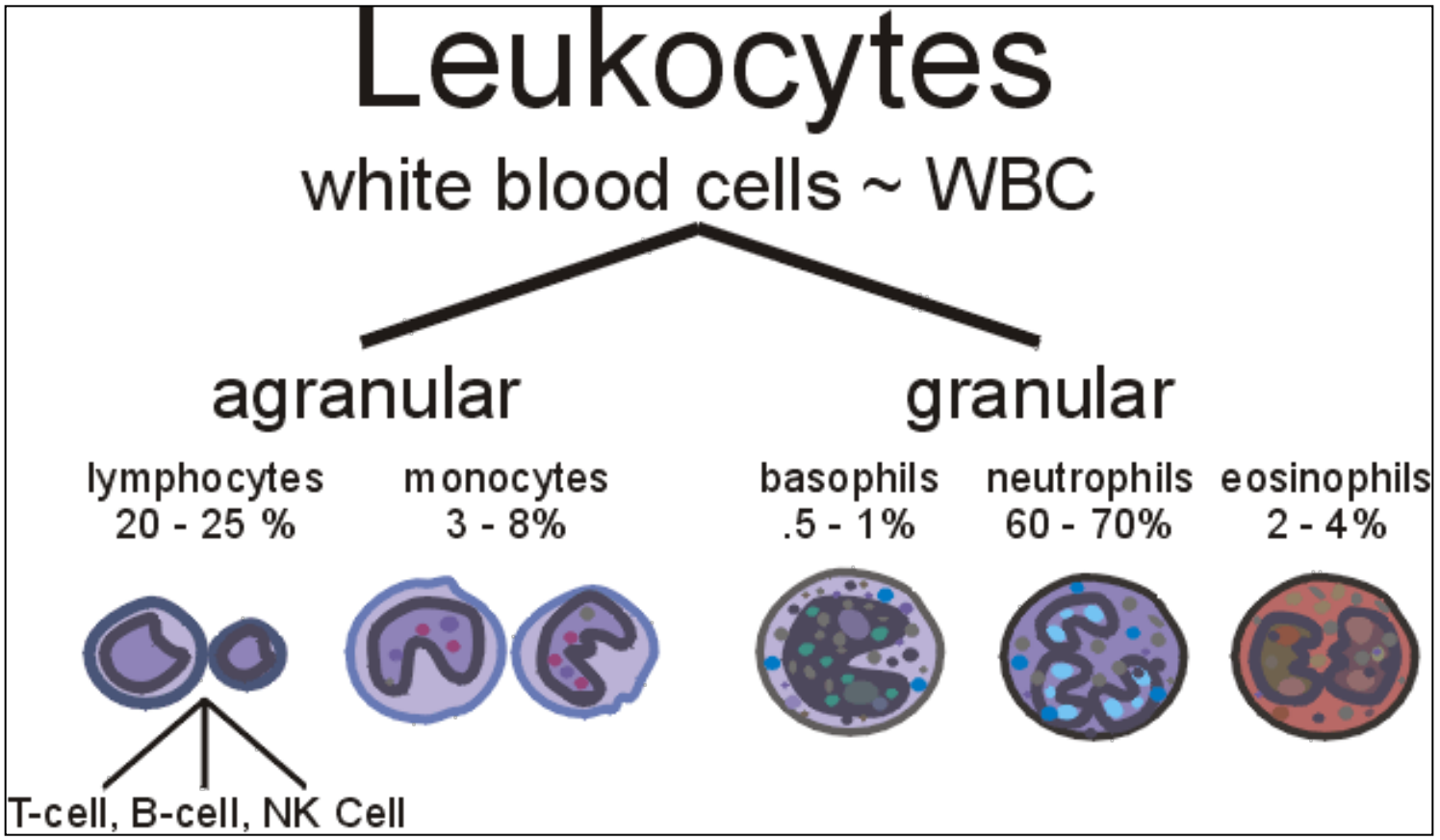
Origin of cells of the immune system

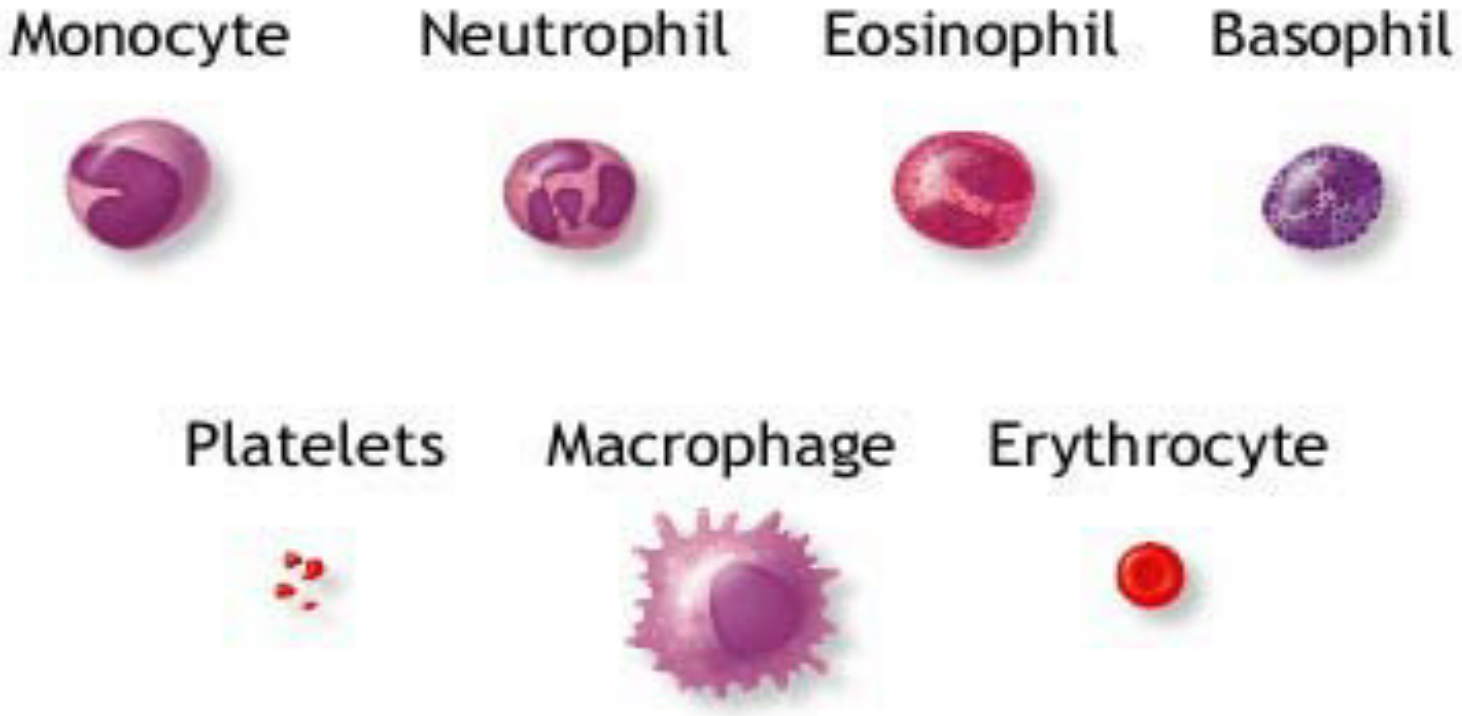


Components of the immune system



Blood Cells: RBC + WBC + Platelets or thrombocytes




Monocyte
Neutrophil
Eosinophil
Basophil
Platelets
Macrophage
Erythrocyte

Cells of the immune system: **Innate**

- Phagocytes
  - ➢ PMNs/neutrophils
    - ✓ Phagocytosis and intracellular killing
    - ✓ Inflammation and tissue damage
  - ➢ Monocytes/macrophages
    - ✓ Phagocytosis and intracellular killing
    - ✓ Extracellular killing of infected or altered self targets
    - ✓ Tissue repair
    - ✓ Antigen presentation for specific immune response

- NK cells: Killing of virus-infected and altered self targets
- Basophils and mast cells: allergic reactions
- Eosinophils: Killing of certain parasites

- Platelets: Blood coagulations

Role of phagocytes

- Phagocytes are several types of white blood cells (including macrophages and neutrophils) that seek and destroy invaders. Some also destroy damaged body cells.
- Phagocytes are attracted by an inflammatory response of damaged cells.

Note: Demonstrate through animation video