

Immunology

THE DEFENCE SYSTEM



TABLE 1-4 Immunity in multicellular organisms

Taxonomic group	Innate immunity (nonspecific)	Adaptive immunity (specific)	Invasion-induced protective enzymes and enzyme cascades	Phagocytosis	Antimicrobial peptides	Pattern-recognition receptors	Graft rejection	T and B cells	Antibodies
<i>Higher plants</i>	+	—	+	—	+	+	—	—	—
<i>Invertebrate animals</i>									
Porifera (sponges)	+	—	?	+	?	?	+	—	—
Annelids (earthworms)	+	—	?	+	?	?	+	—	—
Arthropods (insects, crustaceans)	+	—	+	+	+	+	?	—	—
<i>Vertebrate animals</i>									
Elasmobranchs (cartilaginous fish; e.g., sharks, rays)	+	+	+	+	equivalent agents	+	+	+	+
Teleost fish and bony fish (e.g., salmon, tuna)	+	+	+	+	probable	+	+	+	+
Amphibians	+	+	+	+	+	+	+	+	+
Reptiles	+	+	+	+	?	+	+	+	+
Birds	+	+	+	+	?	+	+	+	+
Mammals	+	+	+	+	+	+	+	+	+

KEY: + = definitive demonstration; — = failure to demonstrate thus far; ? = presence or absence remains to be established.

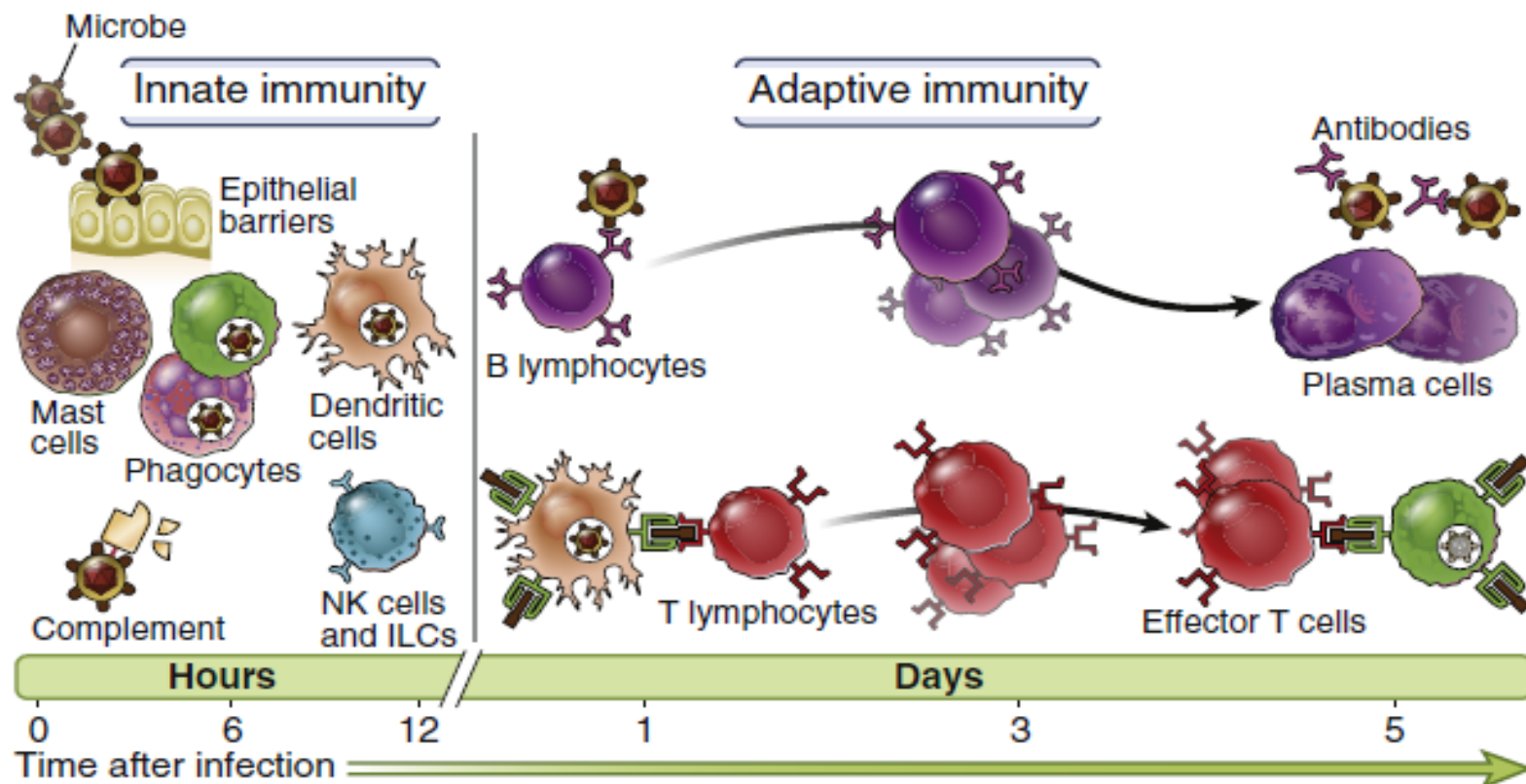


TABLE 1-3

Comparison of adaptive and innate immunity

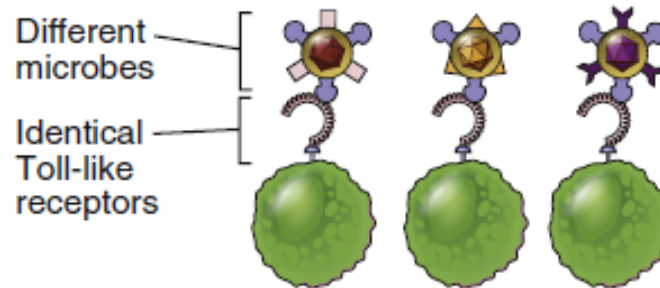
	Innate	Adaptive
Response time	Hours	Days
Specificity	Limited and fixed	Highly diverse, improves during the course of immune response
Response to repeat infection	Identical to primary response	Much more rapid than primary response

Innate immunity

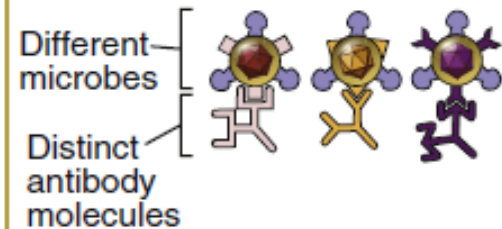
Adaptive immunity

Specificity

For structures shared by classes of microbes (pathogen-associated molecular patterns) or damaged cells (damage-associated molecular patterns)

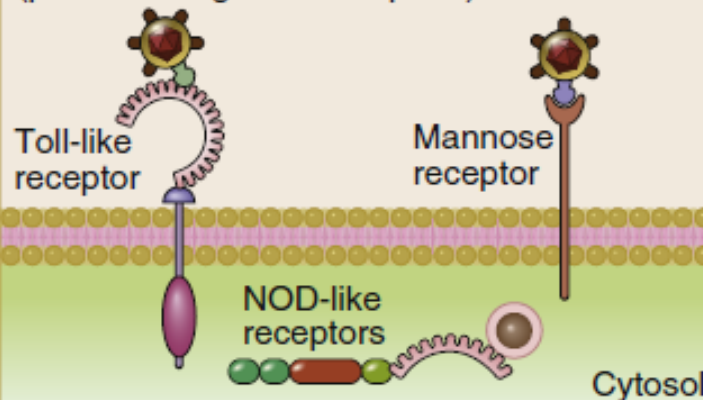


For structural detail of microbial molecules (antigens); may recognize nonmicrobial antigens

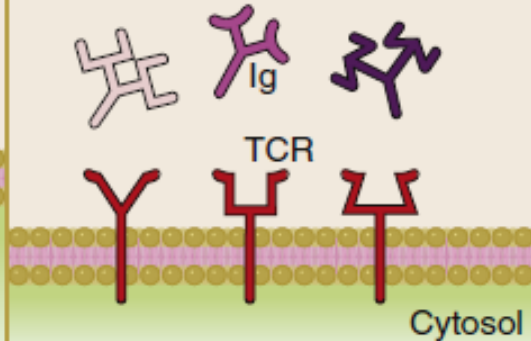


Receptors

Encoded in germline; limited diversity (pattern recognition receptors)



Encoded by genes produced by somatic recombination of gene segments; greater diversity



Distribution of receptors

Nonclonal: identical receptors on all cells of the same lineage

Clonal: clones of lymphocytes with distinct specificities express different receptors

Discrimination of normal self and nonself

Yes; healthy host cells are not recognized, or they may express molecules that prevent innate immune reactions

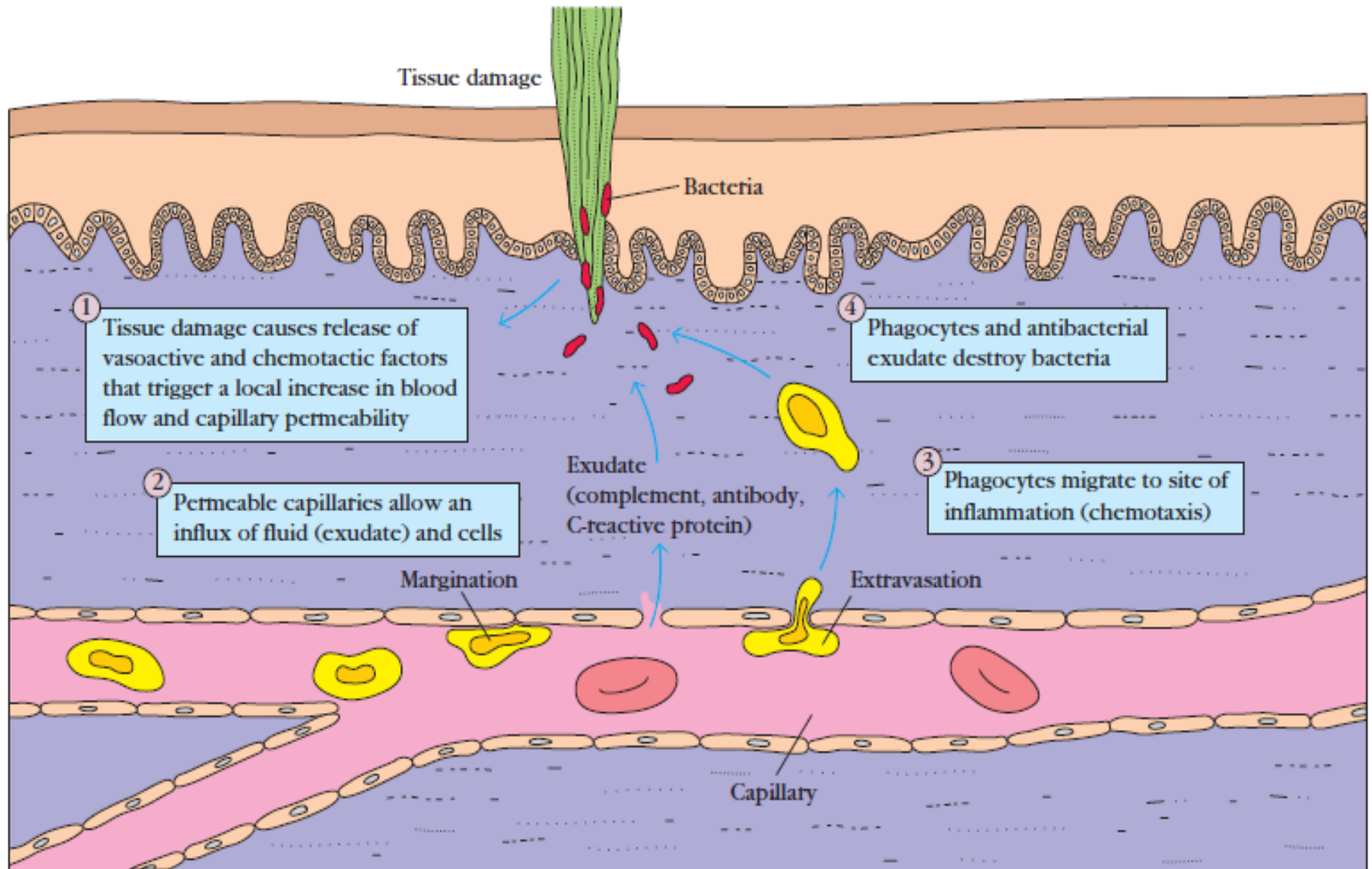
Yes; based on selection against self-reactive lymphocytes; may be imperfect (giving rise to autoimmunity)

Innate Response

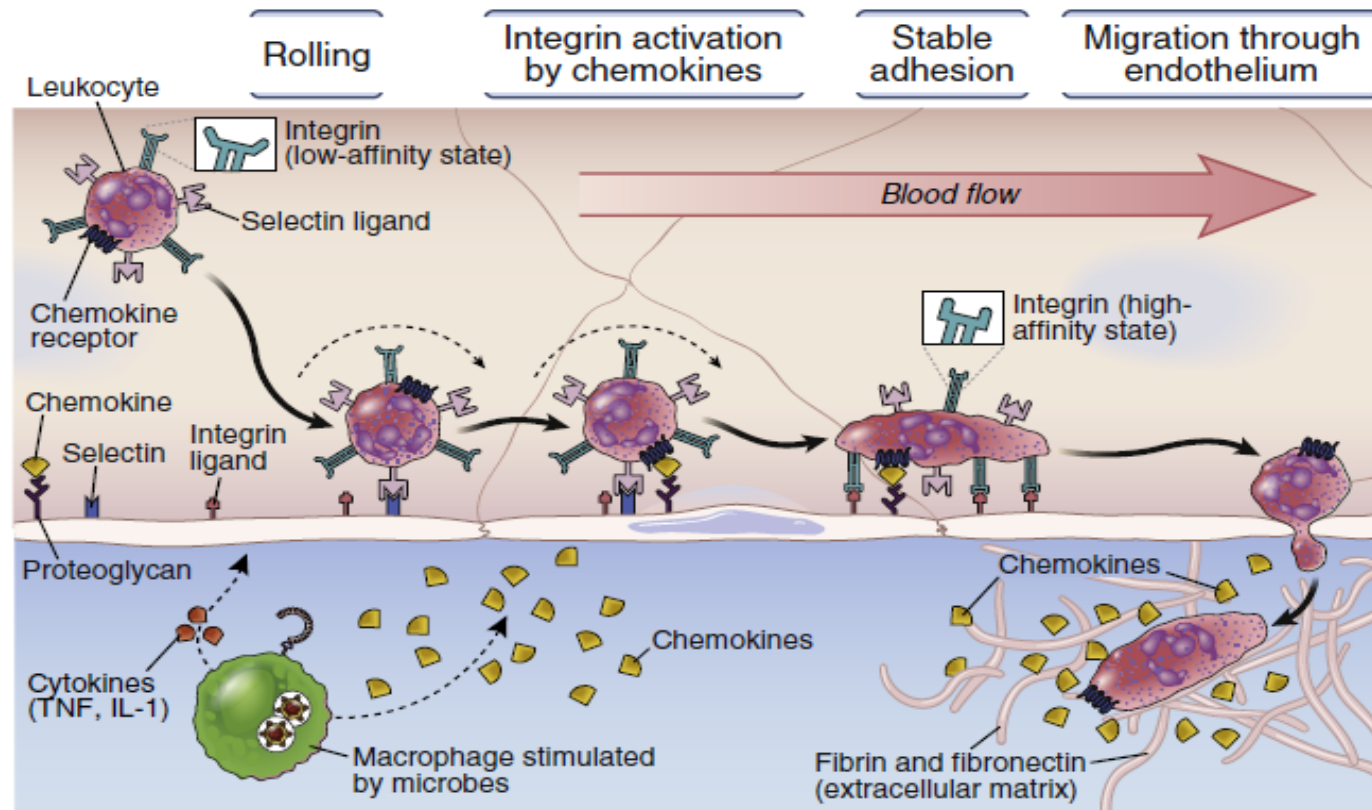
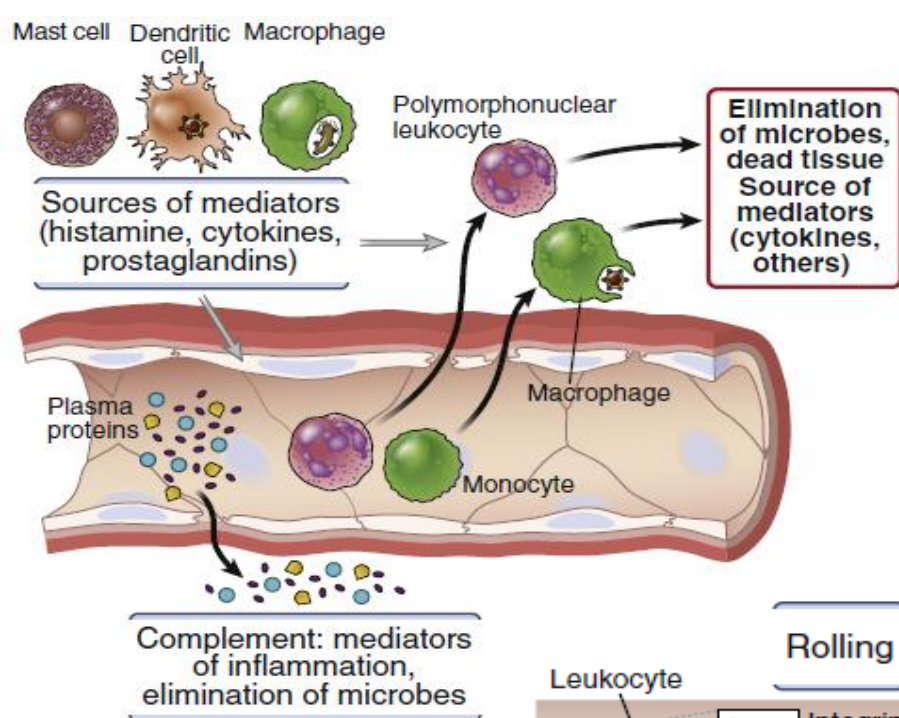
TABLE 1-2 Summary of nonspecific host defenses

Type	Mechanism
<i>Anatomic barriers</i>	
Skin	Mechanical barrier retards entry of microbes. Acidic environment (pH 3–5) retards growth of microbes.
Mucous membranes	Normal flora compete with microbes for attachment sites and nutrients. Mucus entraps foreign microorganisms. Cilia propel microorganisms out of body.
<i>Physiologic barriers</i>	
Temperature	Normal body temperature inhibits growth of some pathogens. Fever response inhibits growth of some pathogens.
Low pH	Acidity of stomach contents kills most ingested microorganisms.
Chemical mediators	Lysozyme cleaves bacterial cell wall. Interferon induces antiviral state in uninfected cells. Complement lyses microorganisms or facilitates phagocytosis. Toll-like receptors recognize microbial molecules, signal cell to secrete immunostimulatory cytokines. Collectins disrupt cell wall of pathogen.
<i>Phagocytic/endocytic barriers</i>	Various cells internalize (endocytose) and break down foreign macromolecules. Specialized cells (blood monocytes, neutrophils, tissue macrophages) internalize (phagocytose), kill, and digest whole microorganisms.
<i>Inflammatory barriers</i>	Tissue damage and infection induce leakage of vascular fluid, containing serum proteins with antibacterial activity, and influx of phagocytic cells into the affected area.

Inflammation

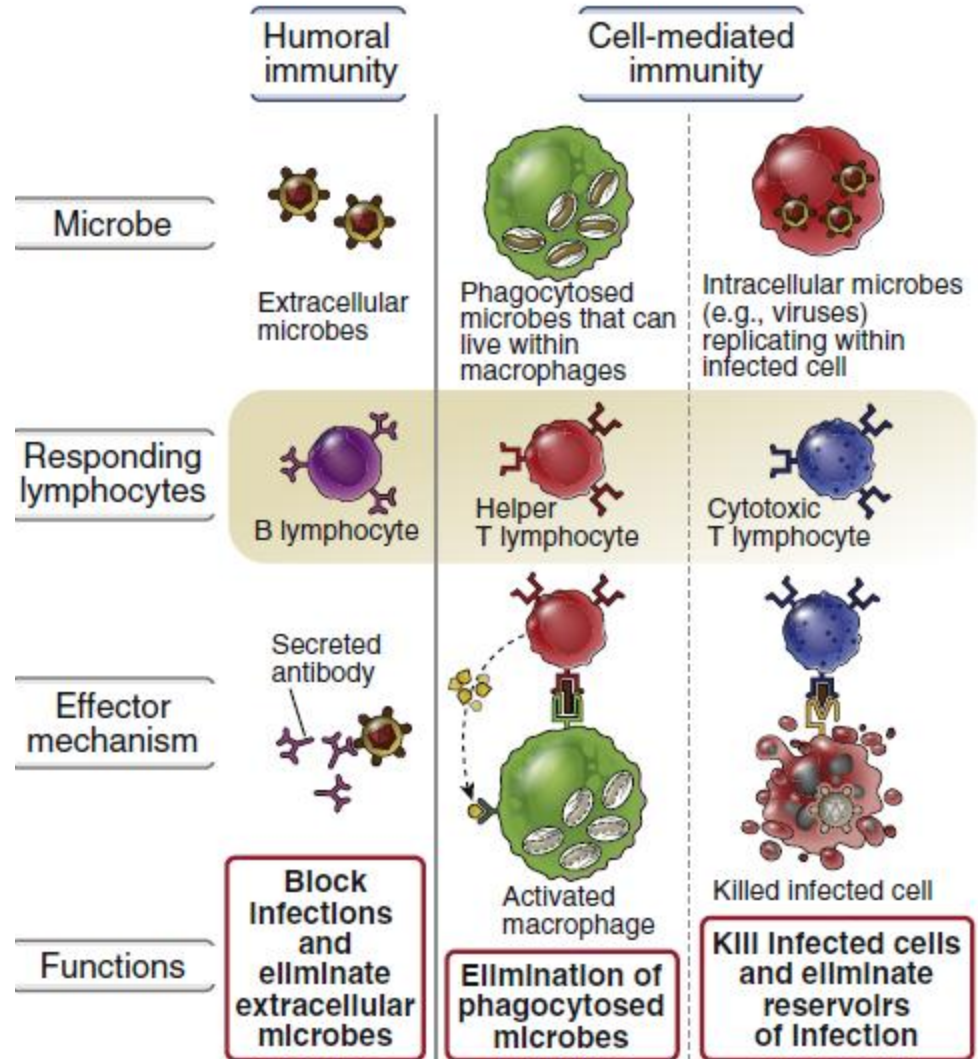


Inflammation

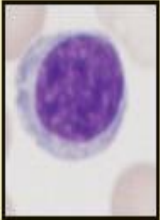

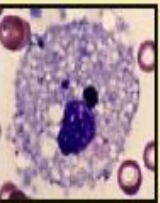


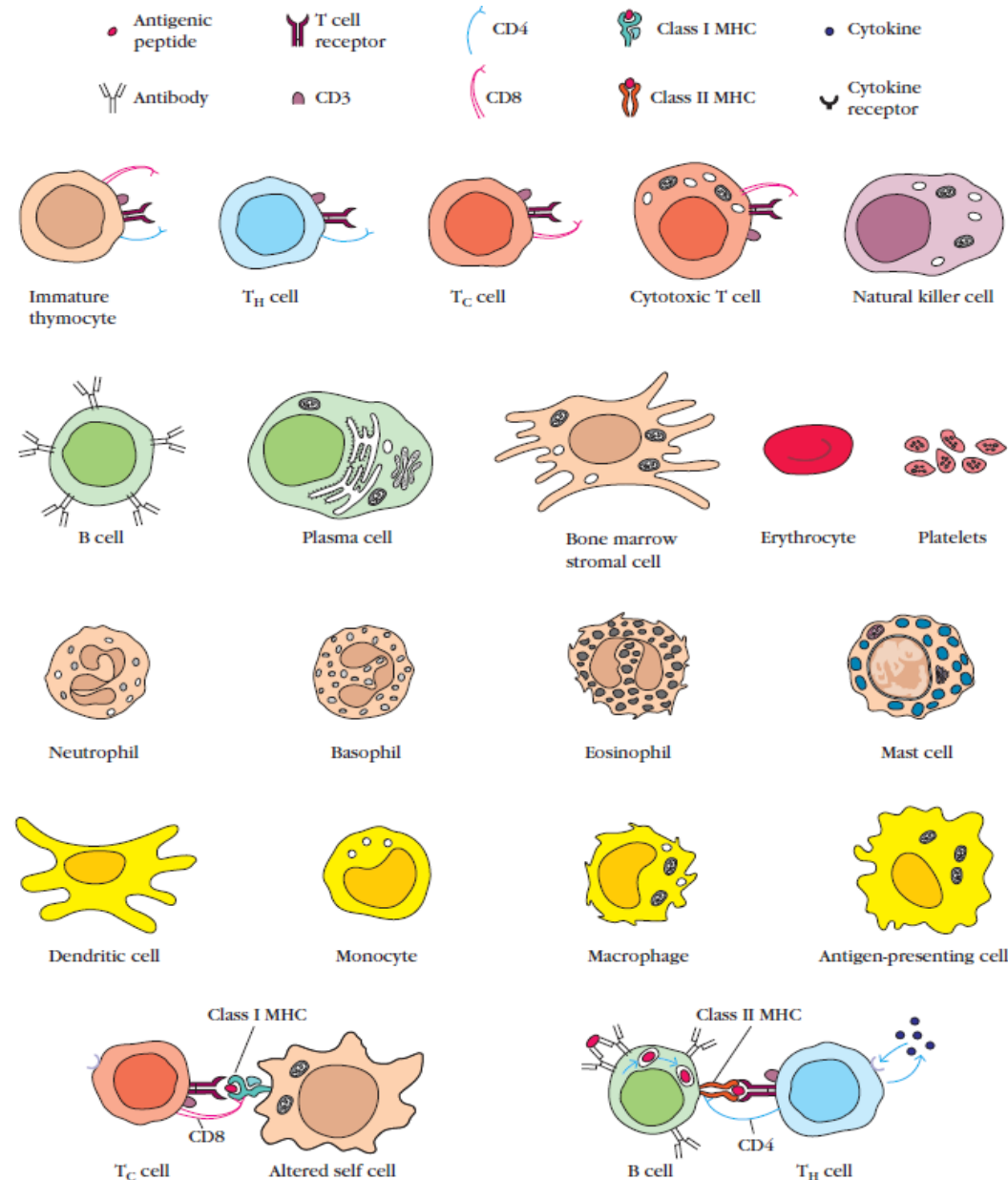
Acquired Response

Feature	Functional significance
Specificity	Ensures that distinct antigens elicit specific responses
Diversity	Enables immune system to respond to a large variety of antigens
Memory	Leads to enhanced responses to repeated exposures to the same antigens
Clonal expansion	Increases number of antigen-specific lymphocytes from a small number of naive lymphocytes
Specialization	Generates responses that are optimal for defense against different types of microbes
Contraction and homeostasis	Allows immune system to respond to newly encountered antigens
Nonreactivity to self	Prevents injury to the host during responses to foreign antigens

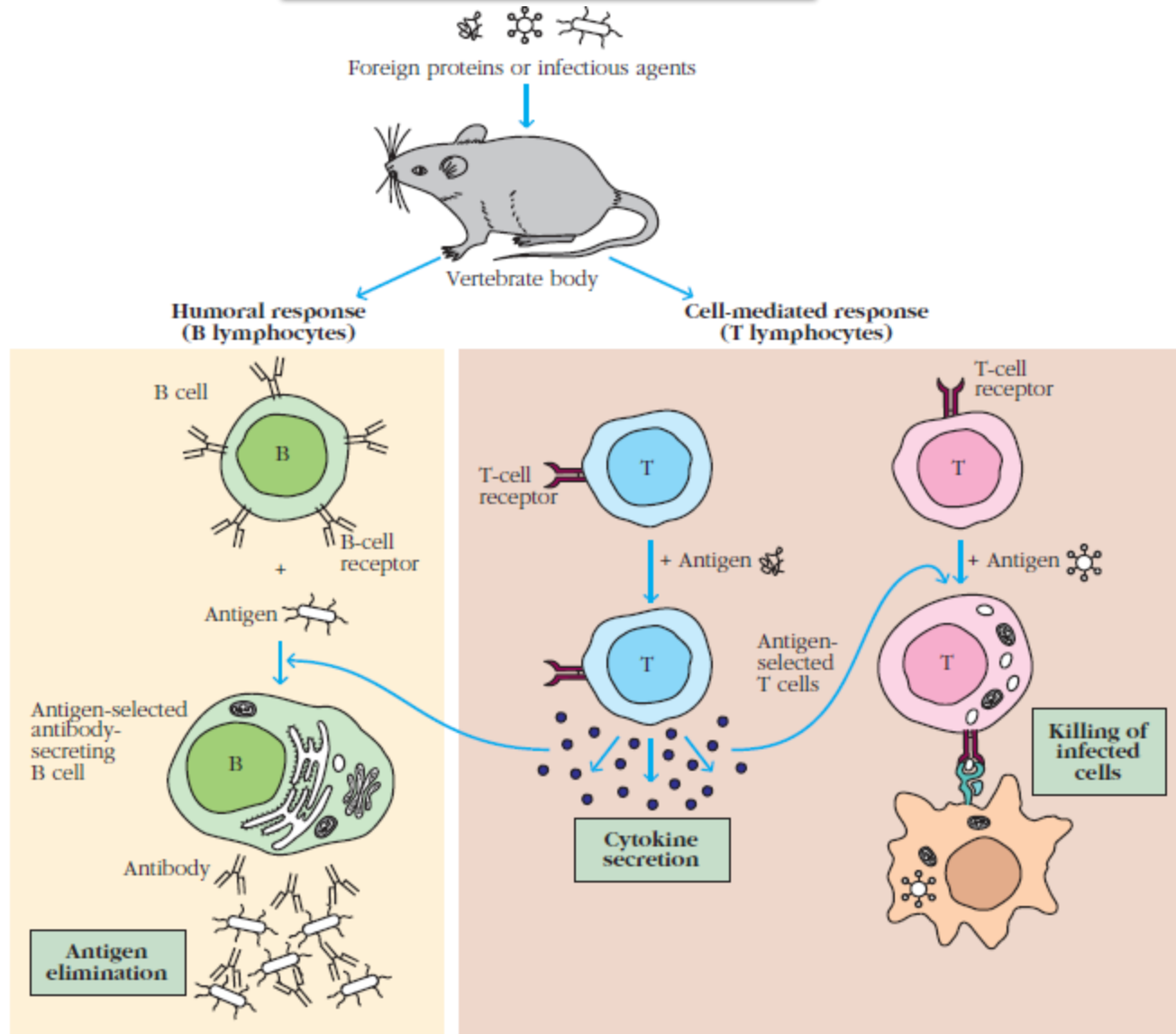


Major Cells of Immune system

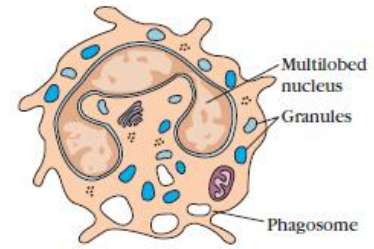
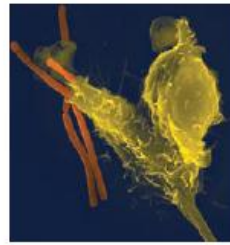
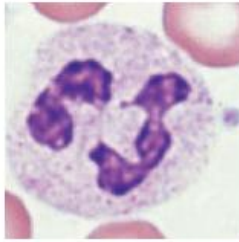
Cell type	Principal function(s)
Lymphocytes: B lymphocytes; T lymphocytes  <i>Blood lymphocyte</i>	Specific recognition of antigens <ul style="list-style-type: none"> • B lymphocytes: mediators of humoral immunity • T lymphocytes: mediators of cell-mediated immunity
Antigen-presenting cells: dendritic cells; macrophages; B cells; follicular dendritic cells  <i>Dendritic cell</i>	Capture of antigens for display to lymphocytes: <ul style="list-style-type: none"> • Dendritic cells: initiation of T cell responses • Macrophages: effector phase of cell-mediated immunity • Follicular dendritic cells: display of antigens to B lymphocytes in humoral immune responses
Effector cells: T lymphocytes; macrophages; granulocytes  <i>Macrophage</i>	Elimination of antigens: <ul style="list-style-type: none"> • T lymphocytes: activation of phagocytes, killing infected cells • Macrophages: phagocytosis and killing of microbes • Granulocytes: killing microbes



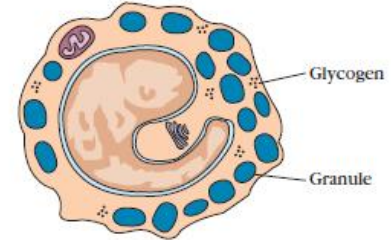
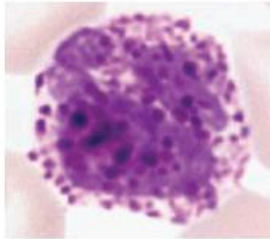
Acquired Response: T-B Cross talk



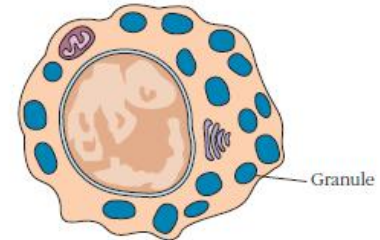
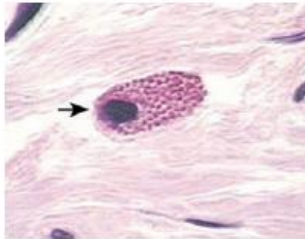
(a) Neutrophil



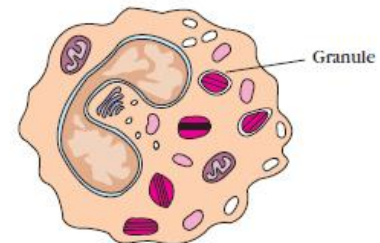
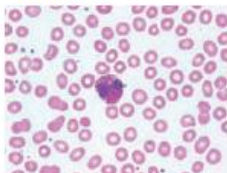
(b) Basophil



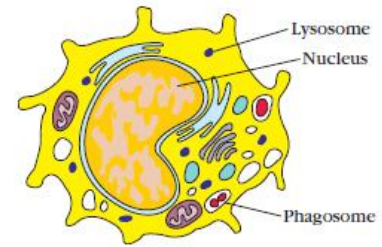
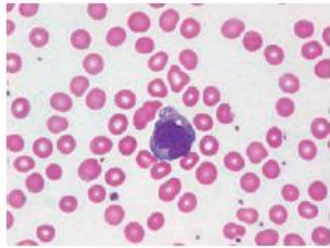
(c) Mast cell



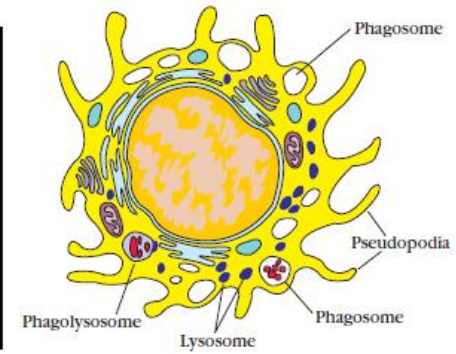
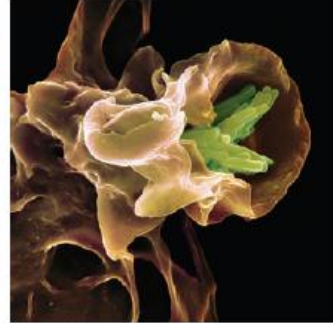
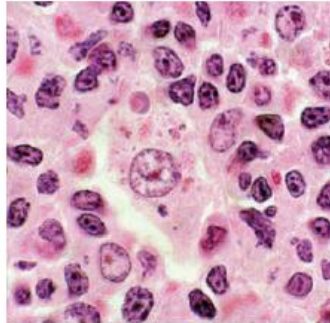
(d) Eosinophil



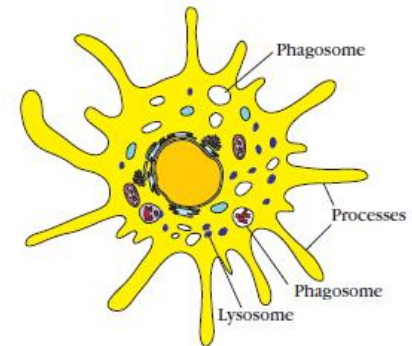
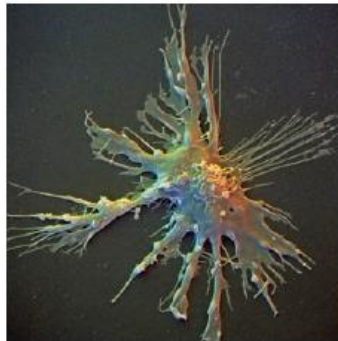
(a) Monocyte



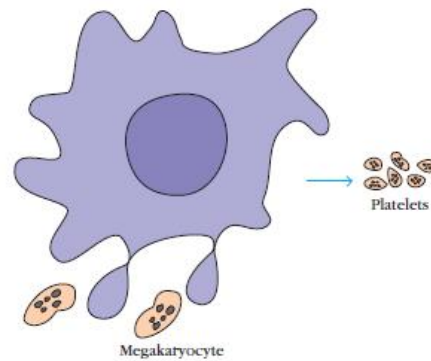
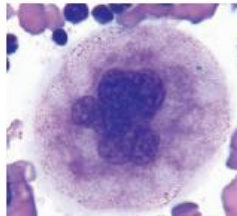
(b) Macrophage



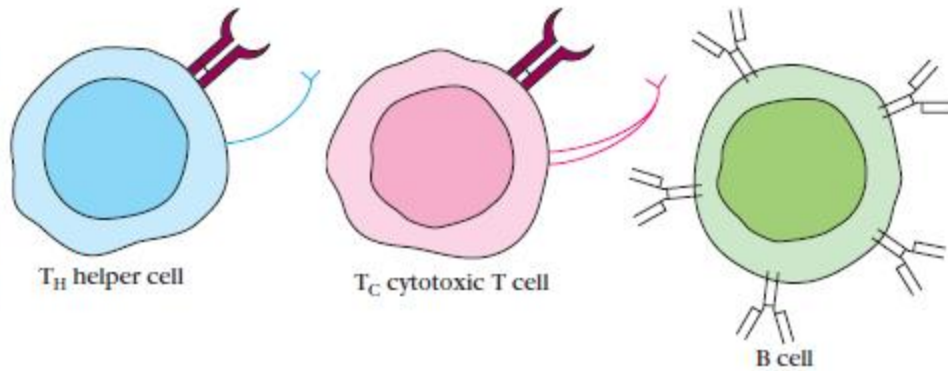
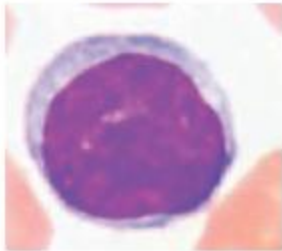
(c) Dendritic cell



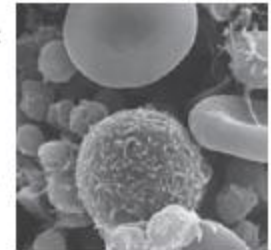
(d) Megakaryocyte



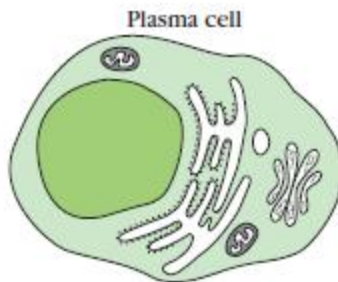
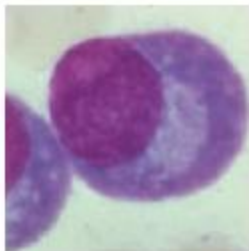
(a) Lymphocyte



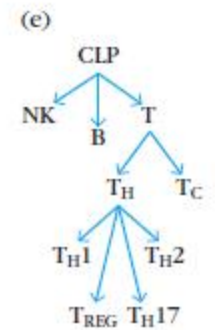
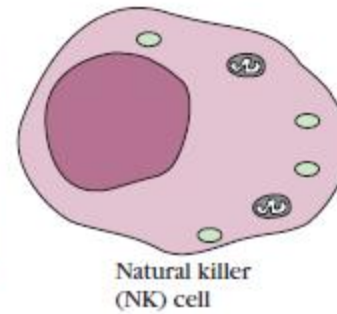
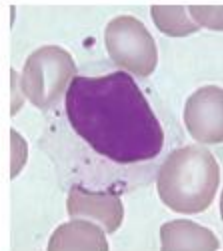
(b) Lymphocyte with red blood cells



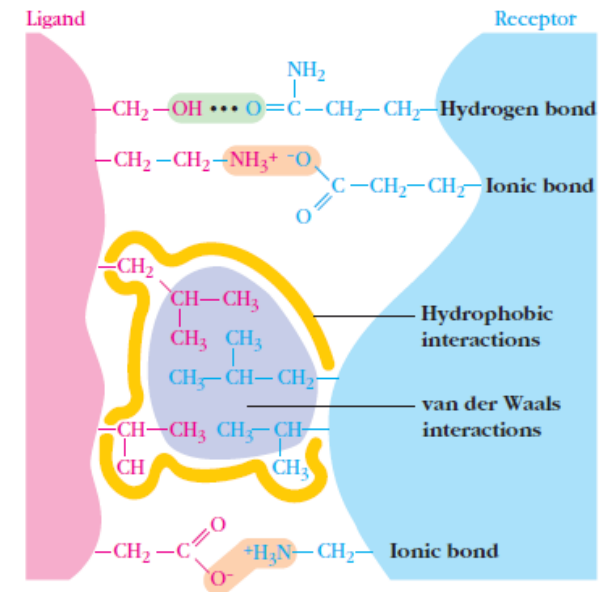
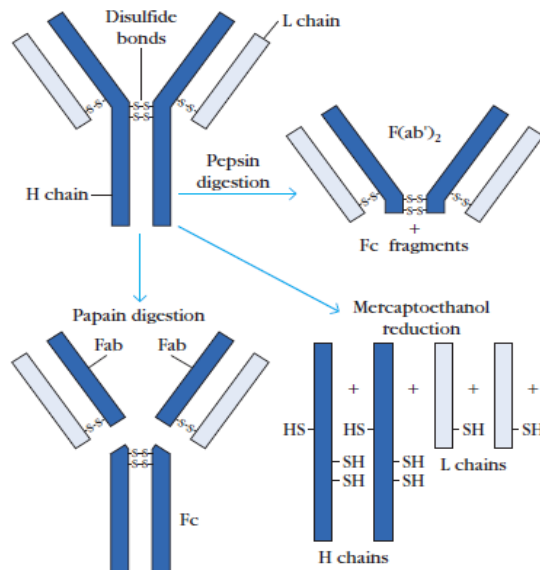
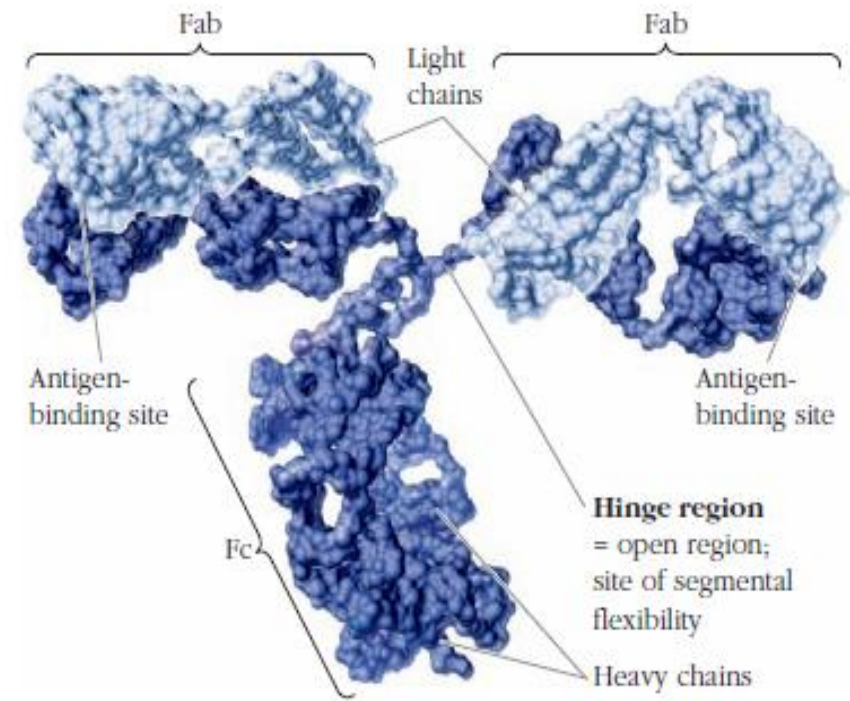
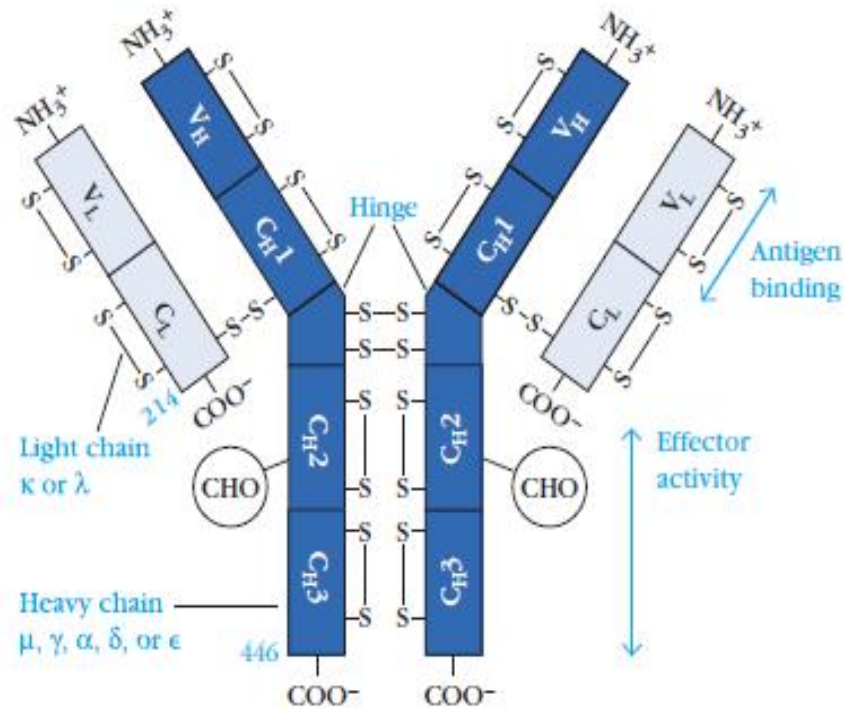
(c) Plasma cell



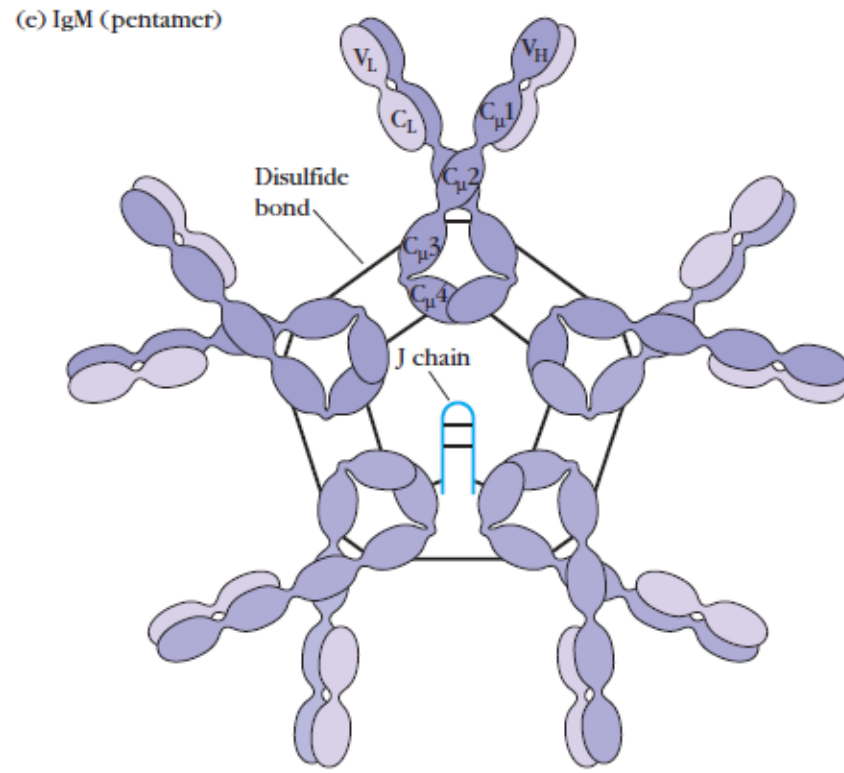
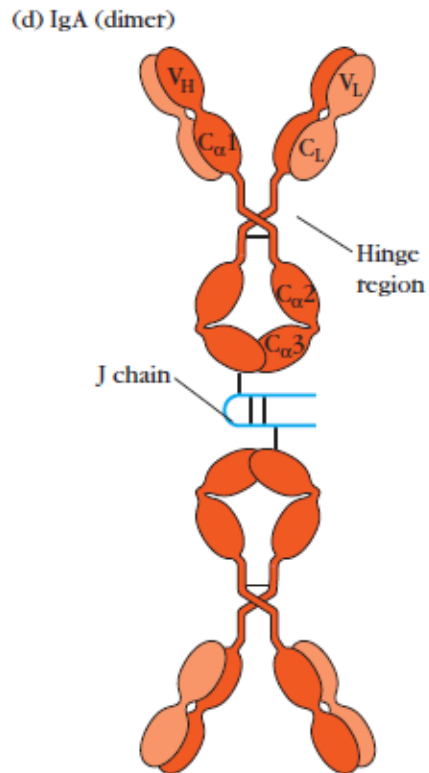
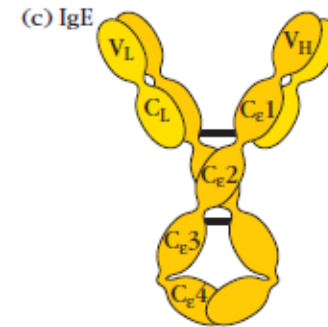
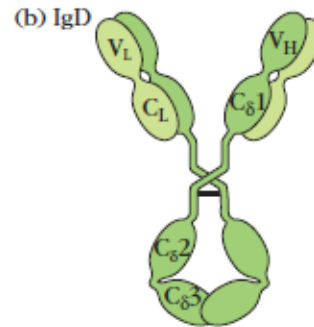
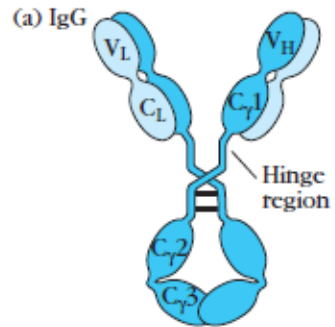
(d) NK cell



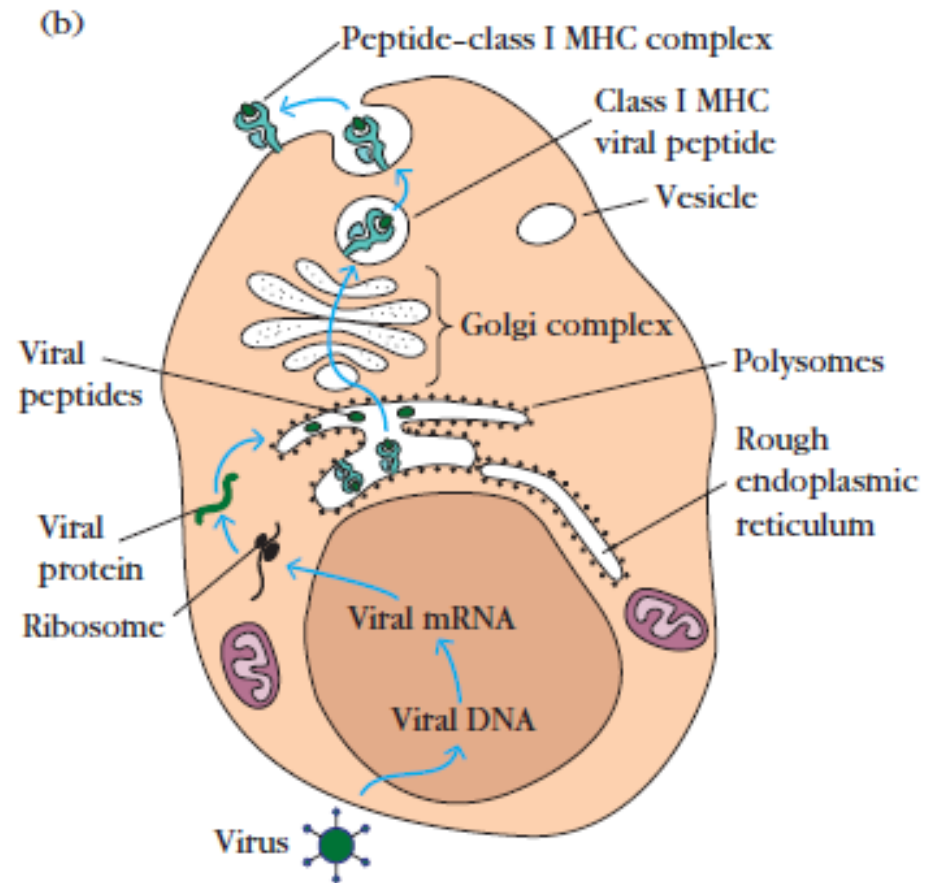
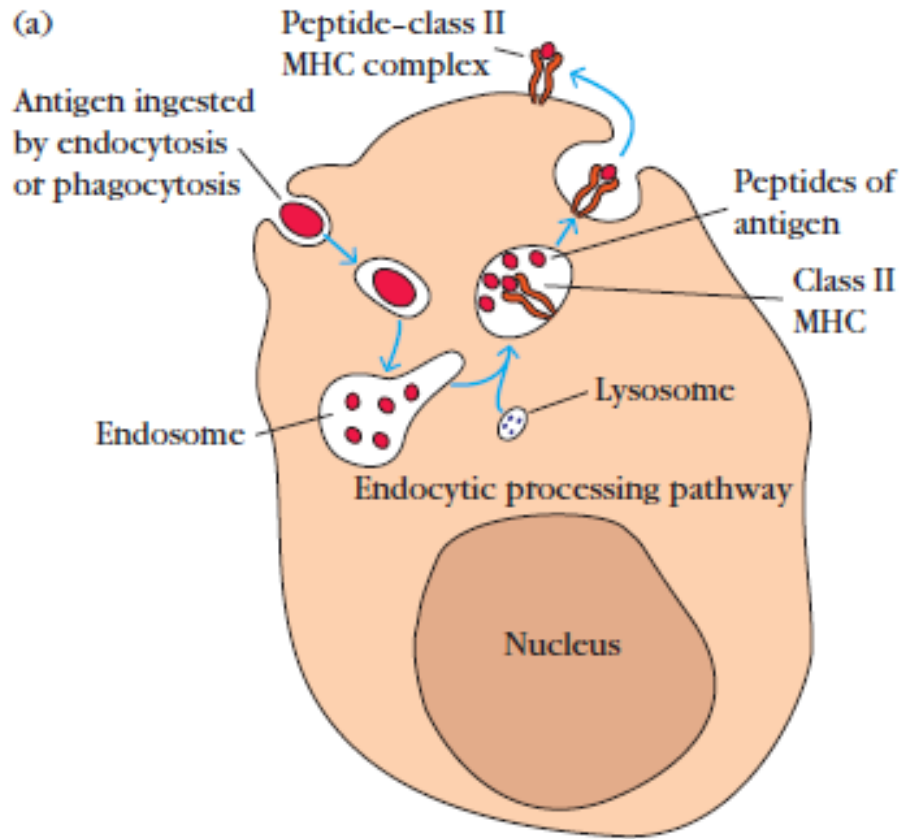
Typical structure of Immunoglobulin (Antibody)



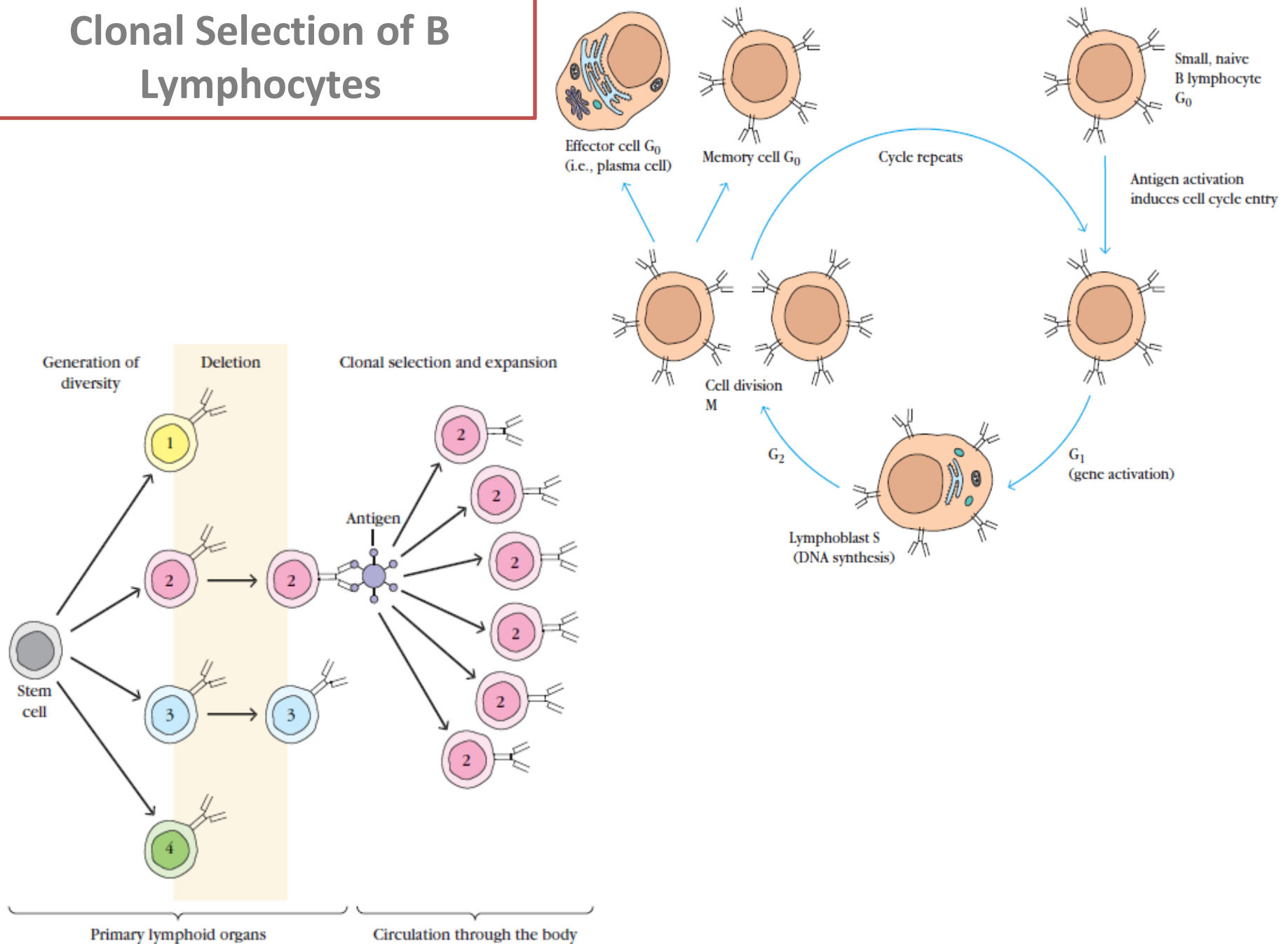
Antibody Subtypes

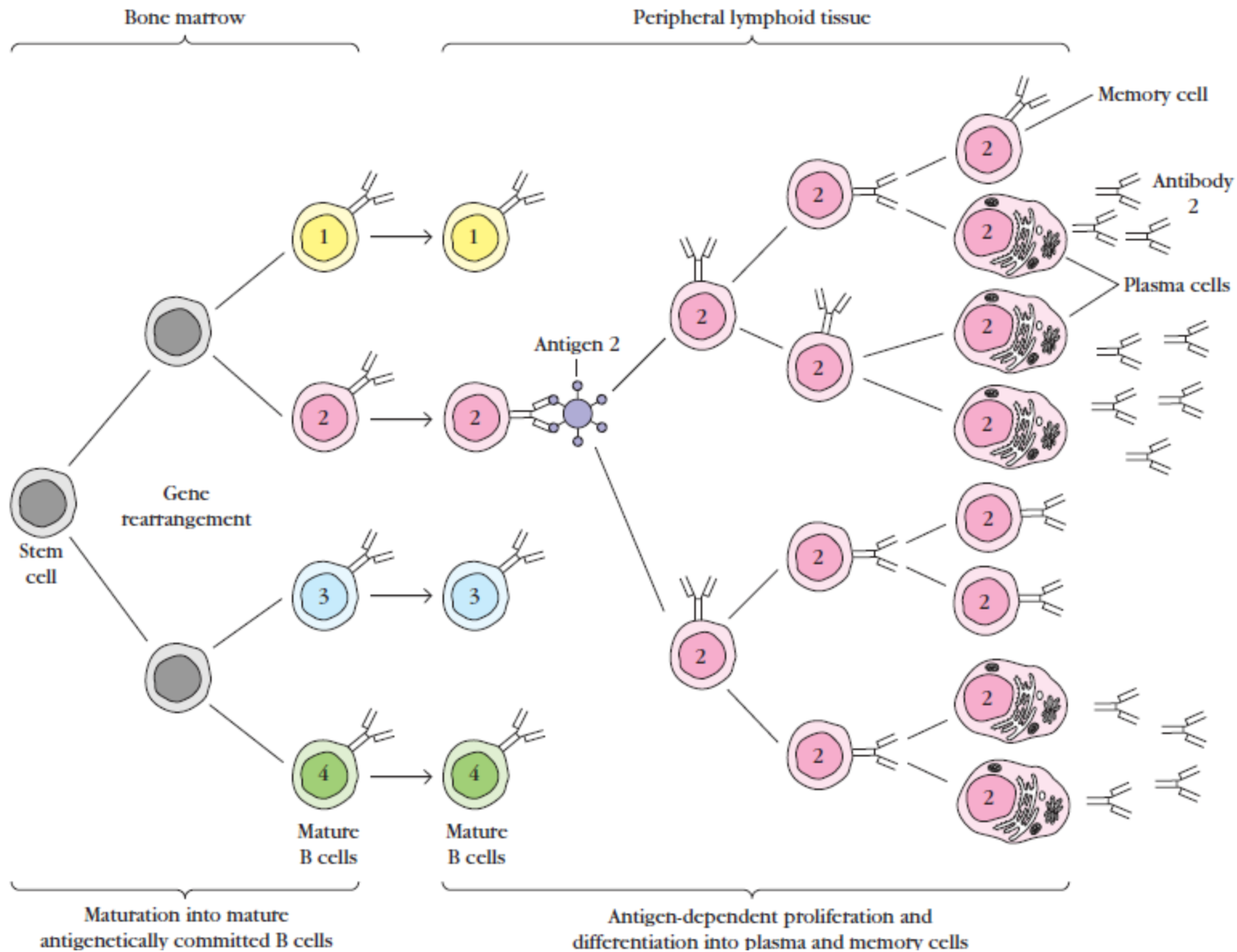


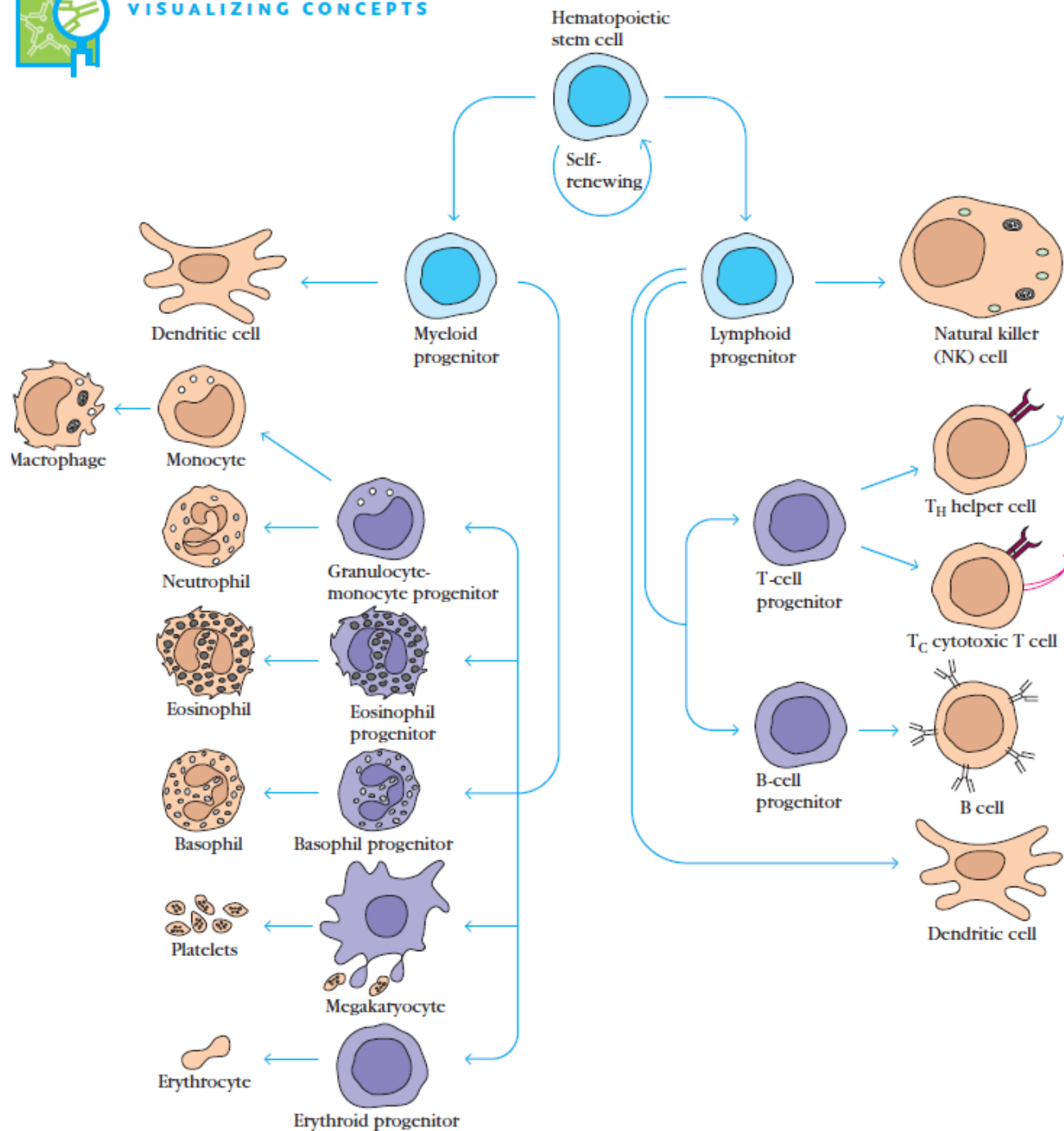
Antigen Presentation



Clonal Selection of B Lymphocytes







Lymphatic System and lymphoid organs

