

# Immunology-introduction

# Immune system

- One of basic homeostatic mechanisms of the body.
- Its function is the recognition of foreign/dangerous substances.
- The dangerous substances trigger complex reactions which result in elimination of those substances.

# Immune system

- Recognizes foreign/dangerous substances from the environment (mainly microbes)
- Is involved in elimination of old and damaged cells of the body.
- Attacks tumor and virus-infected cells.

# Functions of the immune system

- Defence
- Autotolerance
- Immune surveillance

# Antigen

- Substance, that is recognised by the immune system as a foreign and triggers immune reaction (immunogenicity).
- Products of the immune reaction (antibodies, T-lymphocytes) react with the antigen.

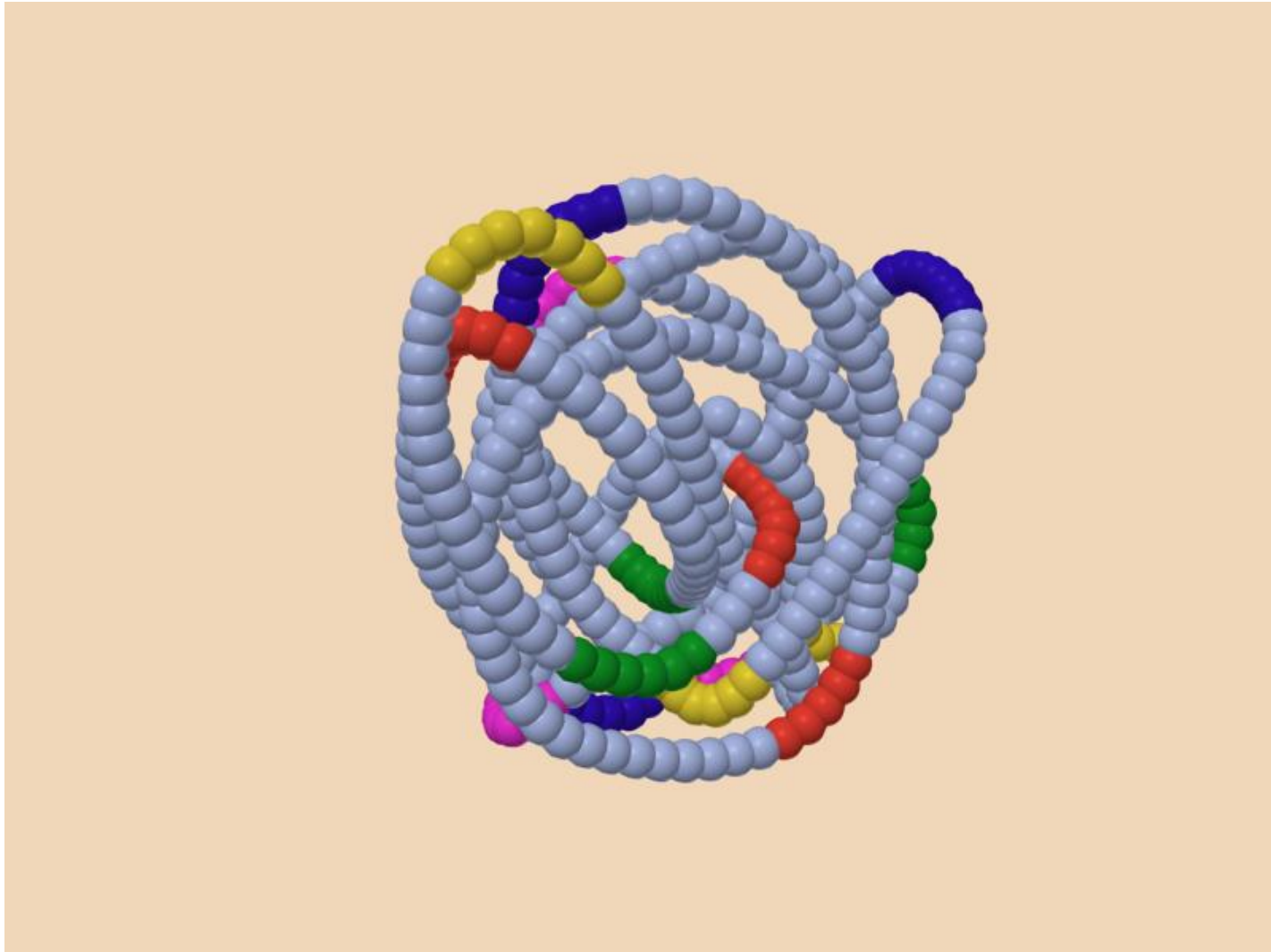
# Characteristics of immunogenicity

- Foreign (unknown) for the immune system
- High molecular weight ( $> 6$  kDa)
- Chemical complexity

# Antigen – functional components

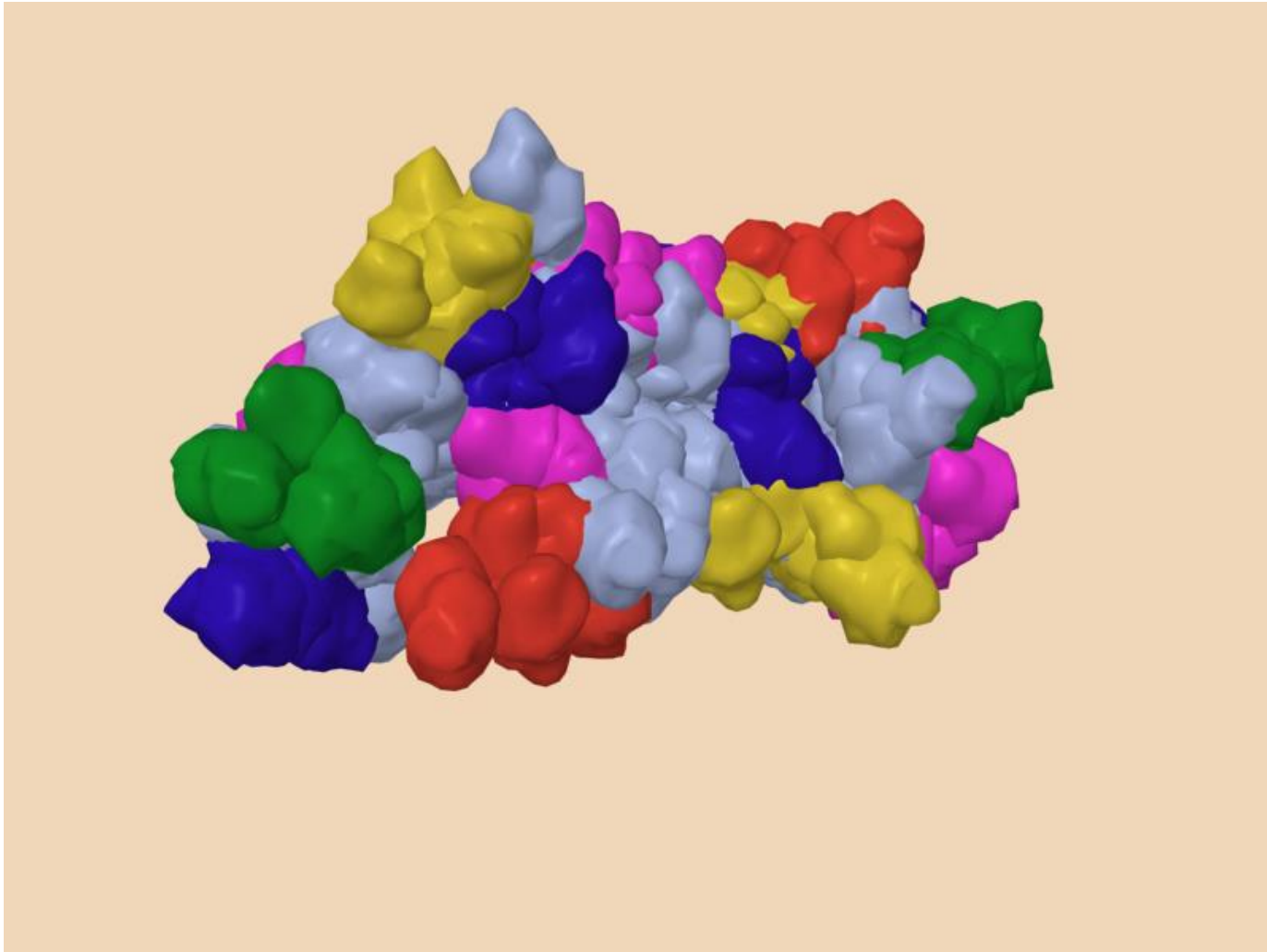
- Carrier part of the molecule
- Antigenic determinant- epitope (cca 5-7 aminoacids)

# Antigen - epitopes, carrier part

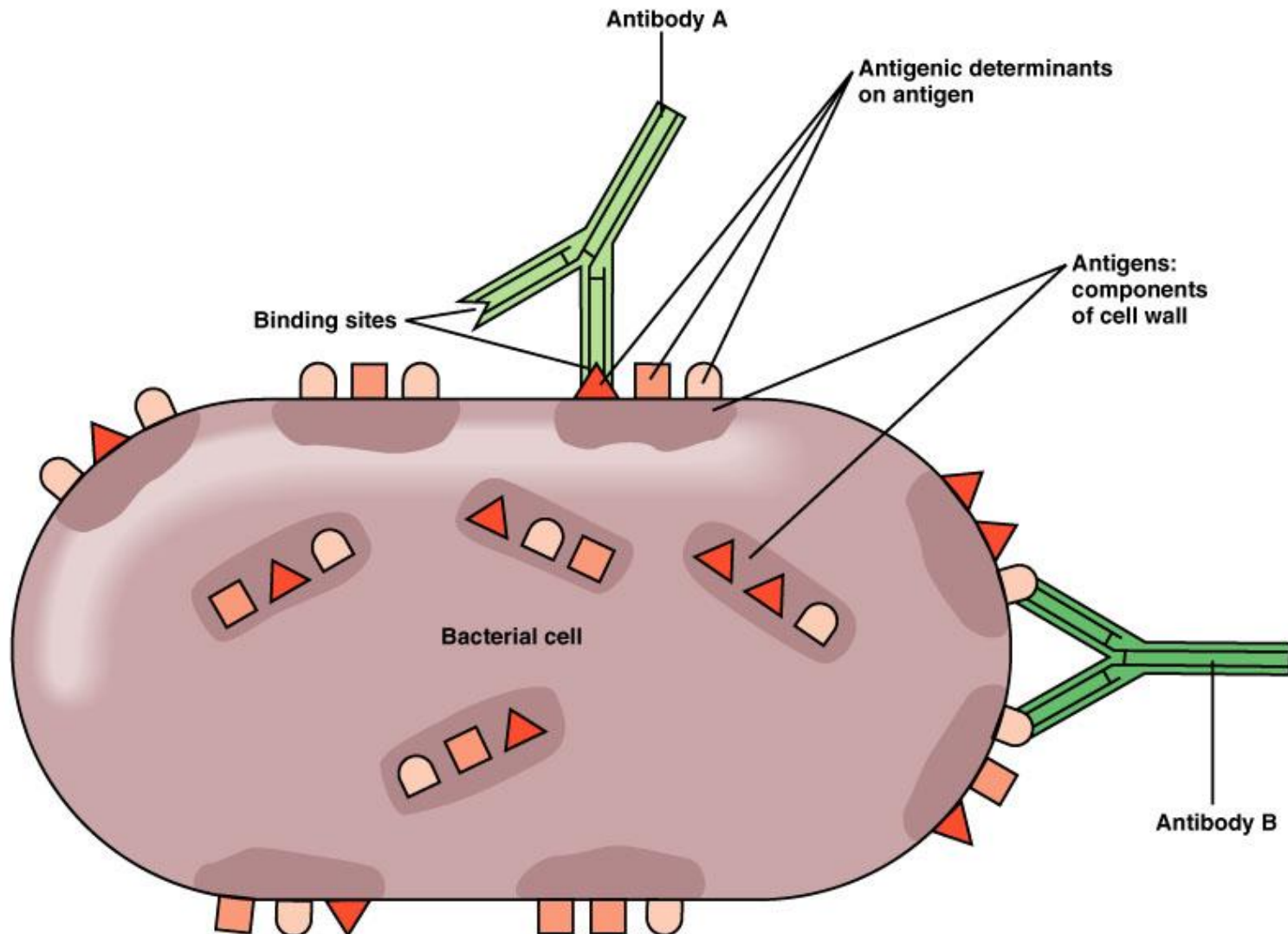




Antigen - epitopes, carrier part



# Antigen and epitope



# Chemical composition of antigens

- Proteins – usually very good antigens.
- Polysacharides- usually only as a part of glycoproteins.
- Nucleic acids- poor antigenicity, limited to complexes with proteins
- Lipids – only exceptionally, best known are sfingolipids.

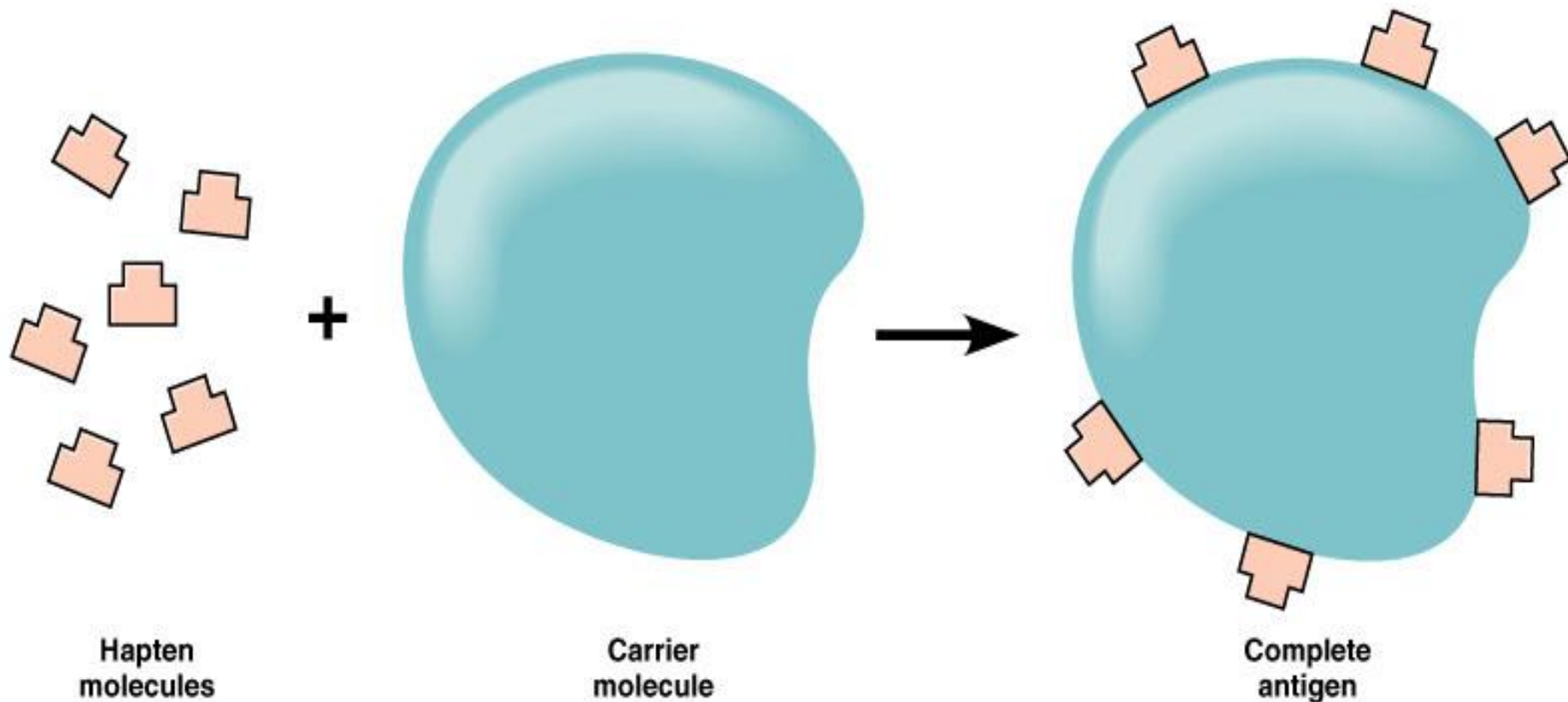
# Protective and nonprotective antigens

- Protective antigens – elicit protective immune response that leads to elimination of the microbe.
- Non-protective antigens – elicit non-protective immune response, but it does not lead to elimination of the microbe (e.g. antibodies against HIV).

# Hapten

- Low-molecular weight substances that trigger immune reaction after binding to various proteins of the body.
- They react with products of the immune reaction.
- Typical examples are metals (Cr, Ni) that trigger type IV immunopathological reactions. Drugs (antibiotics, local anesthetics) cause type I immunopathological reaction.

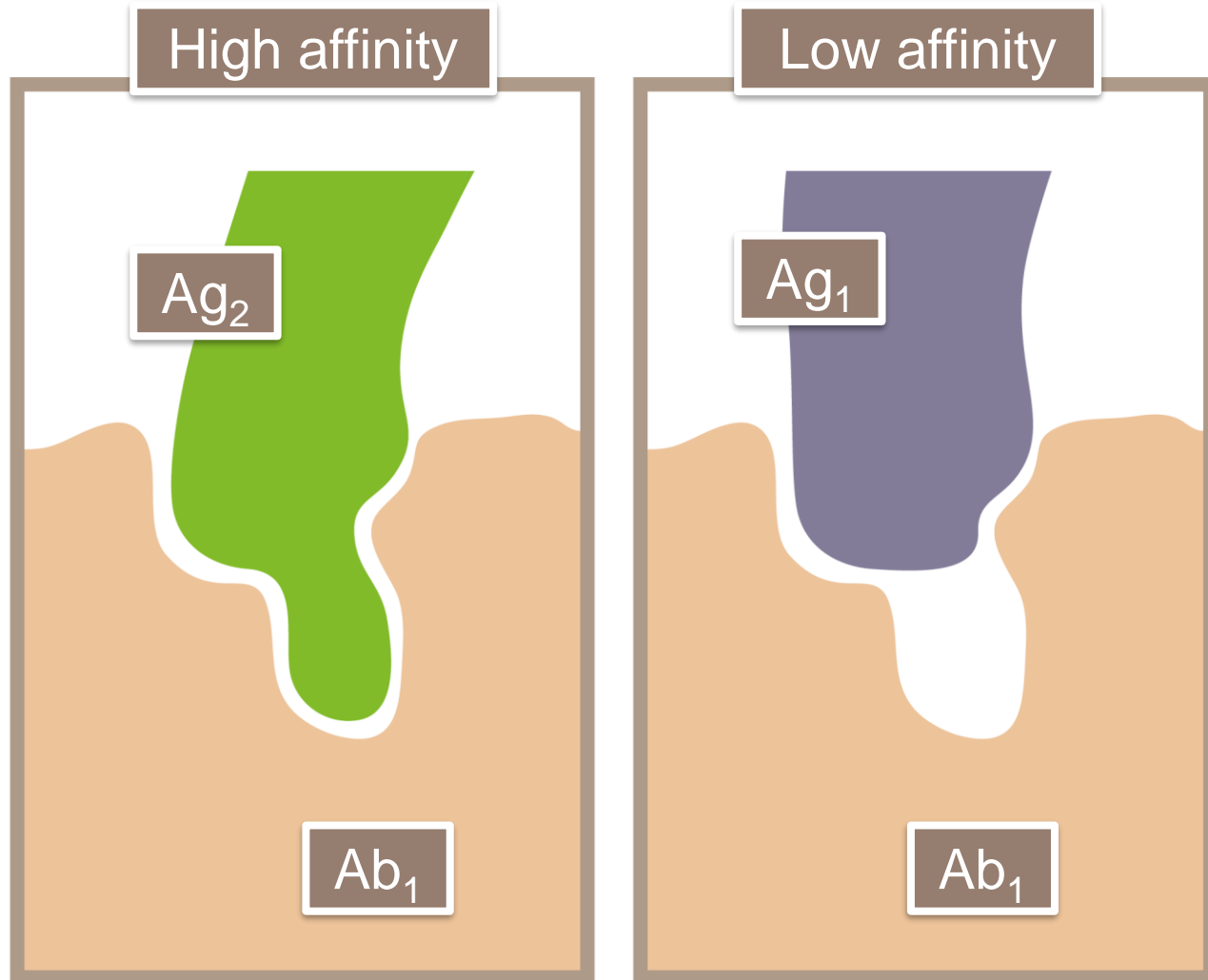
# Immunogenicity of hapten



# Cross reactivity of antigens

- Products of the immune reaction may, in some situations, react with substances that are very different from the initial immunogen.
- Immunological cross-reactivity not necessary mean similar chemical composition.
- The degree of cross reactivity may be different.
- Cross reactivity is important in pathogenesis of several autoimmune diseases.

# Cross reactivity of anntigens





# Adjuvants

- Substances, that, when mixed with antigen, non-specifically enhance immune reaction against the antigen.
- Freud's adjuvant: killed Mycobacterium tuberculosis + water-in-oil emulsion. Used in veterinary medicine.
- Alum precipitate -  $Al(OH)_3$  - used in human medicine.
- Mechanisms: improved presentation of the antigen, fixation of the antigen in the place of application.

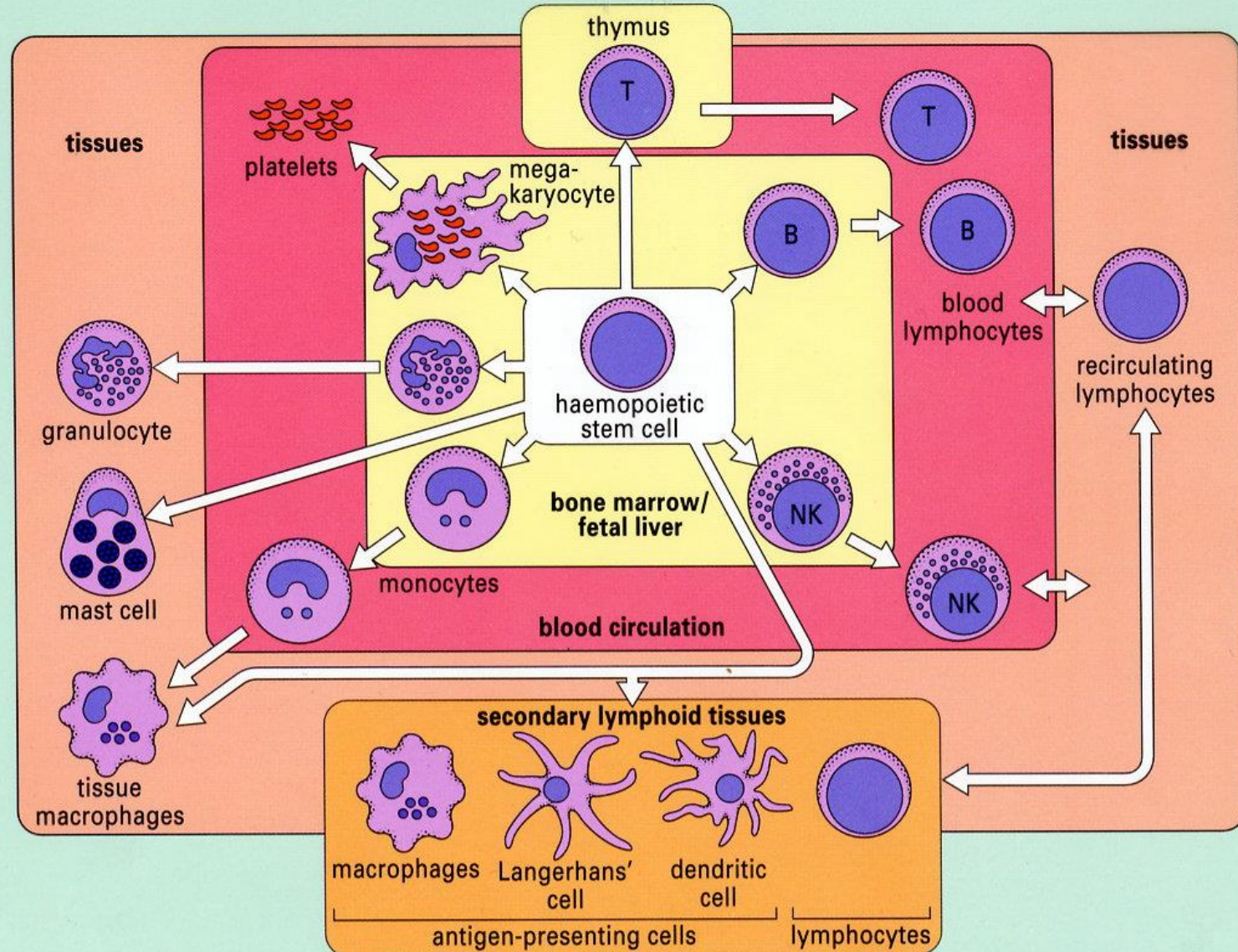
# Two branches of the immune response

- Innate, nonspecific – very quickly recognizes most foreign substances and eliminates them. There is no memory.
- Adaptive, specific – high degree of specificity in distinction between self and non-self. The reaction requires several days to be effectively triggered. Immune memory is induced.

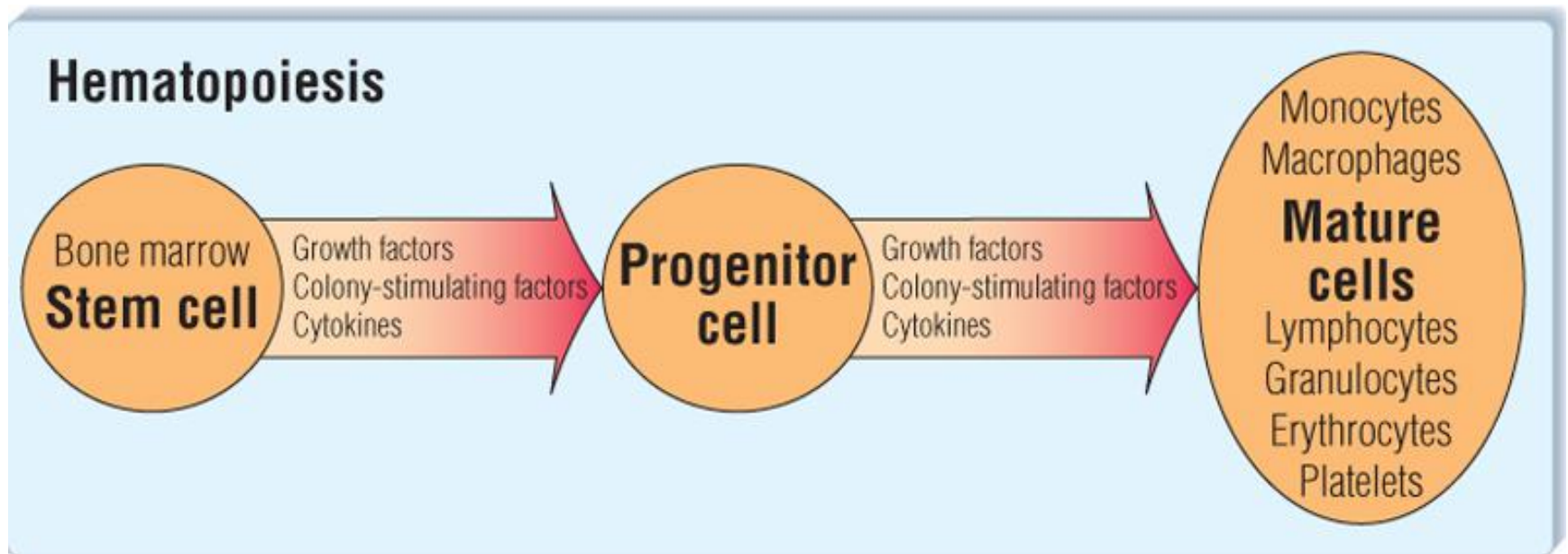
# Cells of the immune system

- Main cells of the immune system
  - Lymphocytes (T a B)
- Accessory cells of the immune system
  - Granulocytes
  - Monocytes
  - Tissue macrophages
  - Mast cells
  - Dendritic cells
  - NK cells
  - Endotelial cells
  - Thrombocytes, erythrocytes, fibroblasts, epithelial cells

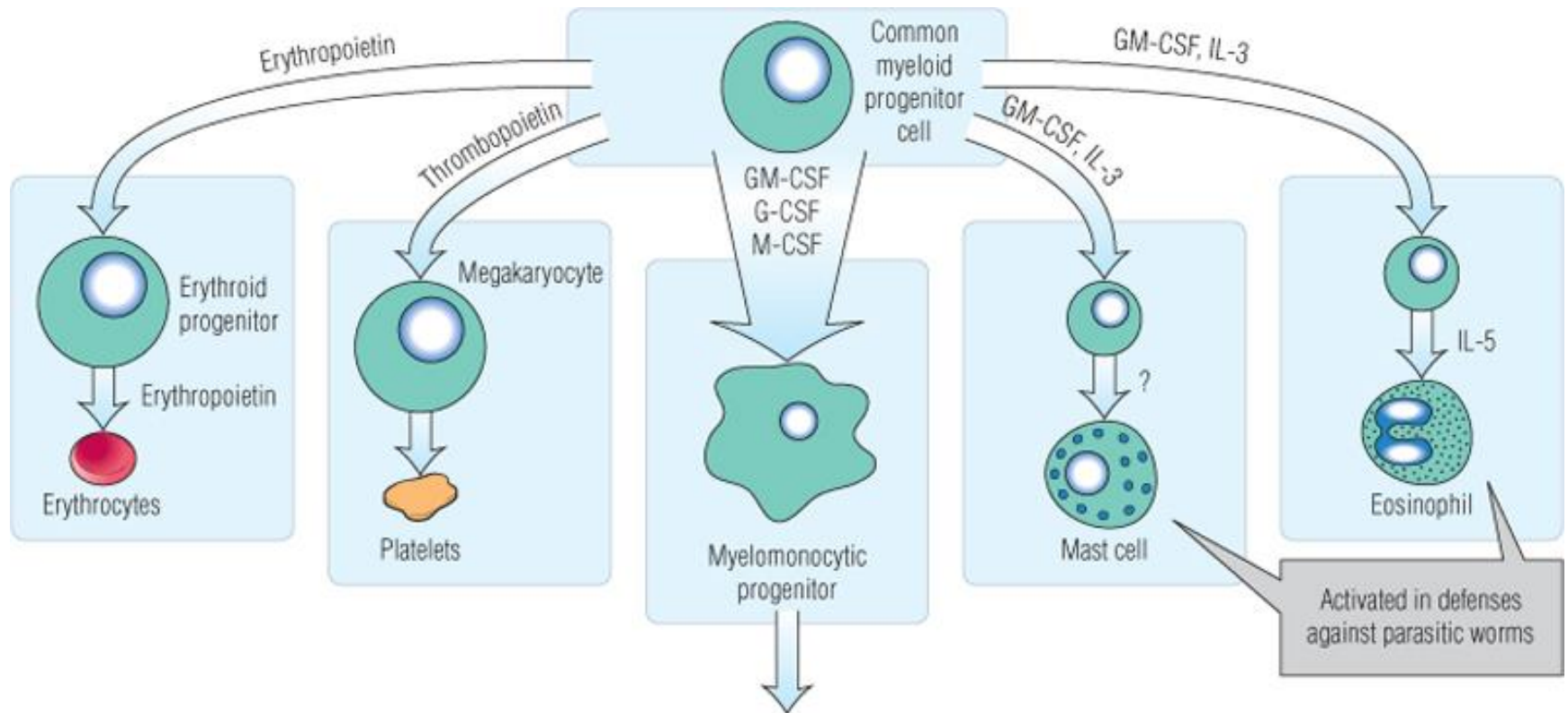
# Majority of immune system cells originate in bone marrow

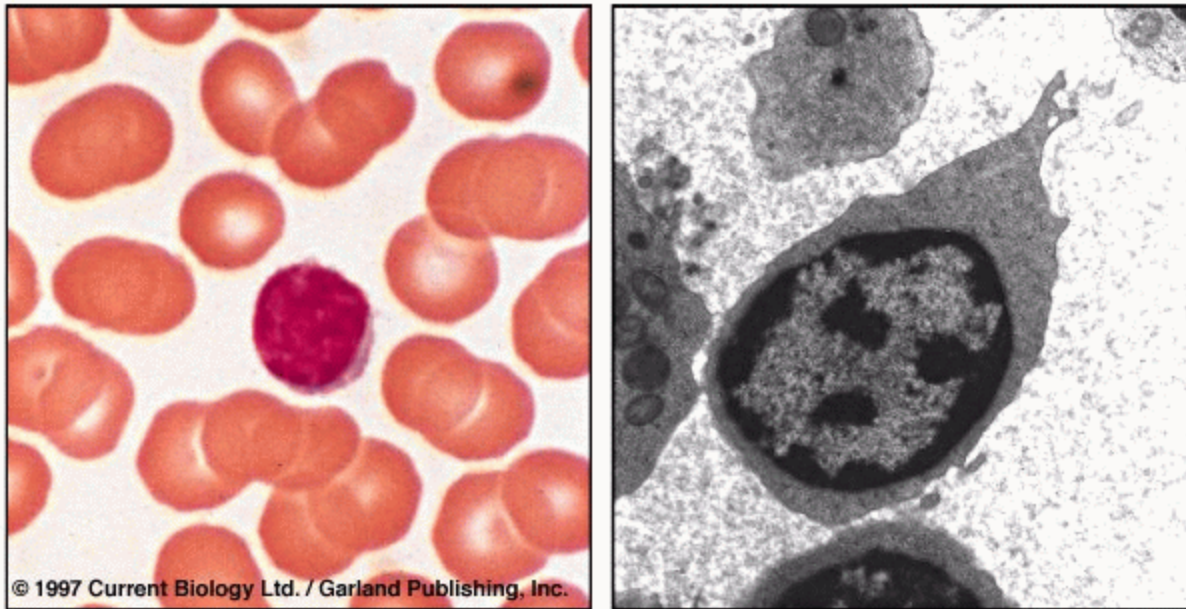


# Differentiation of cells during hematopoiesis



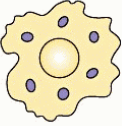


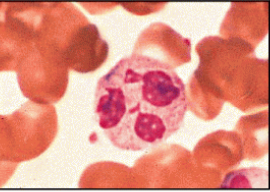

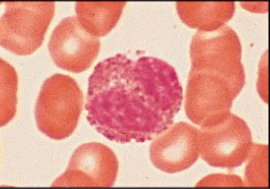

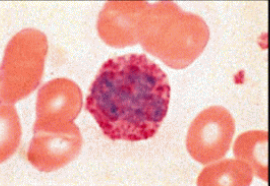
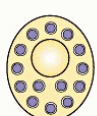
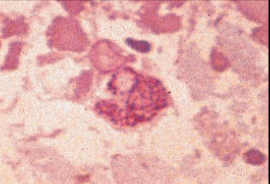
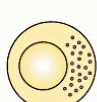
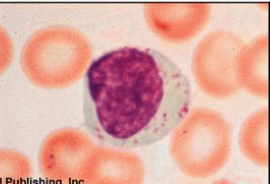
# Differentiation of haematopoietic stem cell is influenced by the local environment





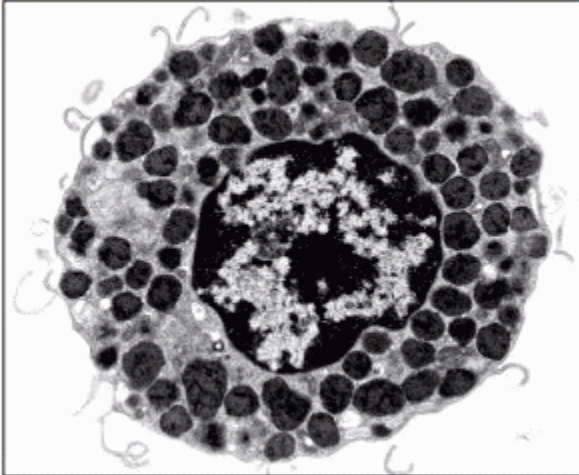
Lymphocyte – central cell of the immune system

# Auxiliary cells of the immune system

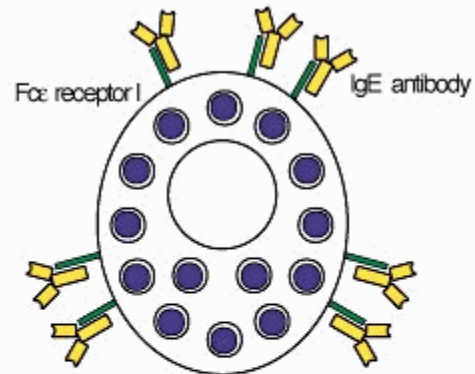
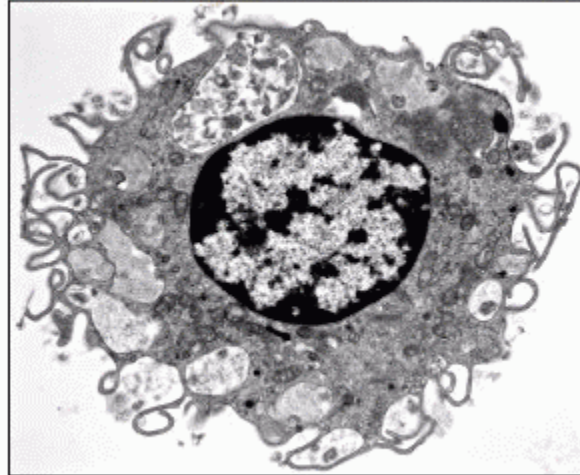
Cell		Activated function
<p data-bbox="664 258 745 272">Macrophage</p> 		<p data-bbox="1128 334 1205 348">Phagocytosis</p>
<p data-bbox="664 454 736 468">Neutrophil</p> 		<p data-bbox="1128 508 1205 572">Phagocytosis and activation of bactericidal mechanisms</p>
<p data-bbox="664 649 736 664">Eosinophil</p> 		<p data-bbox="1128 715 1205 765">Killing of antibody-coated parasites</p>
<p data-bbox="664 845 726 859">Basophil</p> 		<p data-bbox="1128 929 1186 943">Unknown</p>
<p data-bbox="664 1041 726 1055">Mast cell</p> 		<p data-bbox="1128 1079 1205 1179">Release of granules containing histamine and other active agents</p>
<p data-bbox="664 1236 803 1250">Natural killer (NK) cell</p> 		<p data-bbox="1128 1286 1205 1365">Release of lytic granules that kill some virus-infected cells</p>



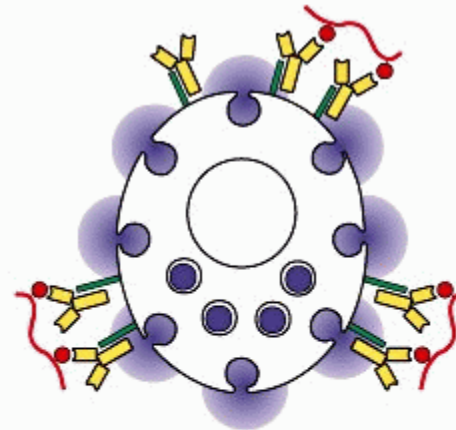
Resting mast cell



Activated mast cell

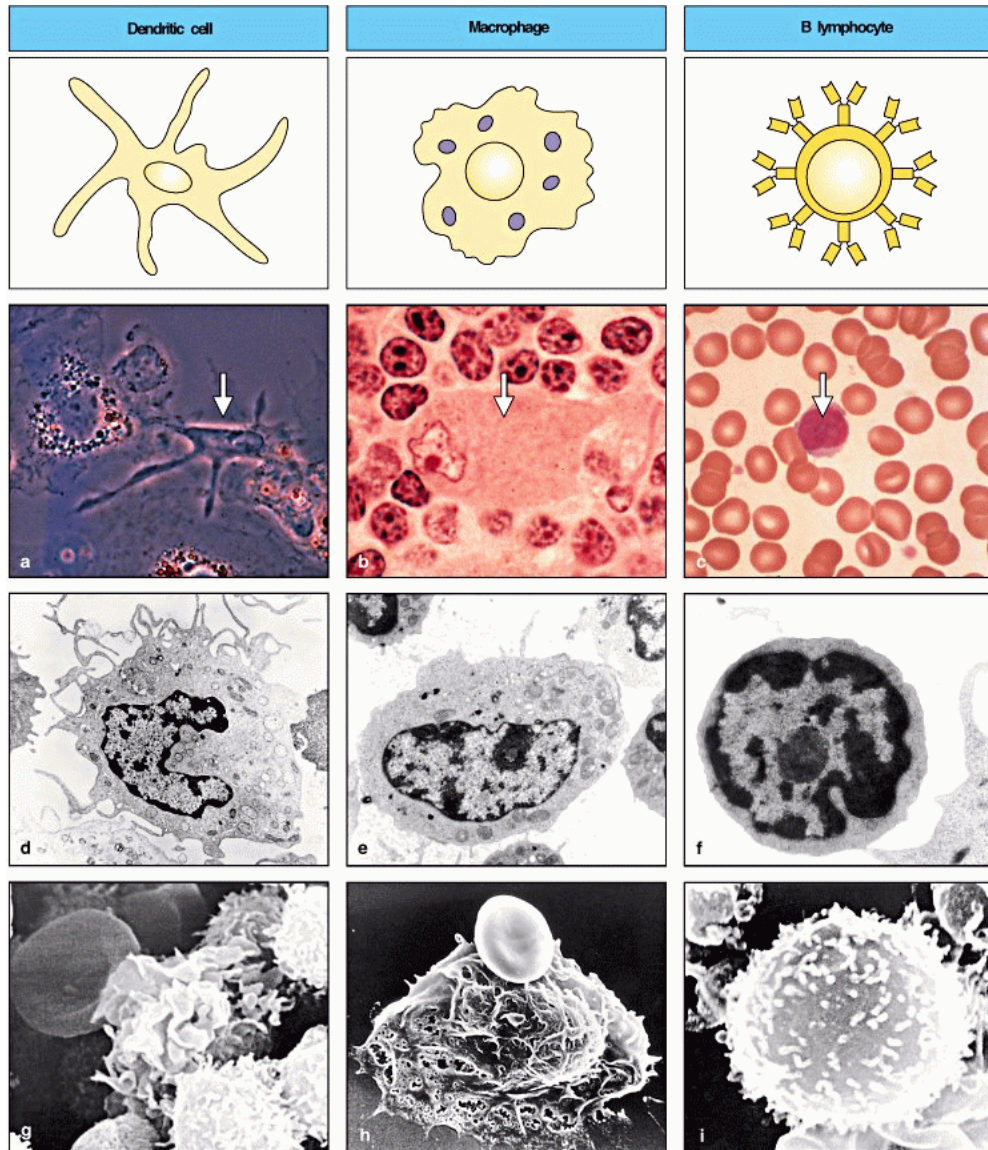


Resting mast cell contains granules containing histamine and other inflammatory mediators



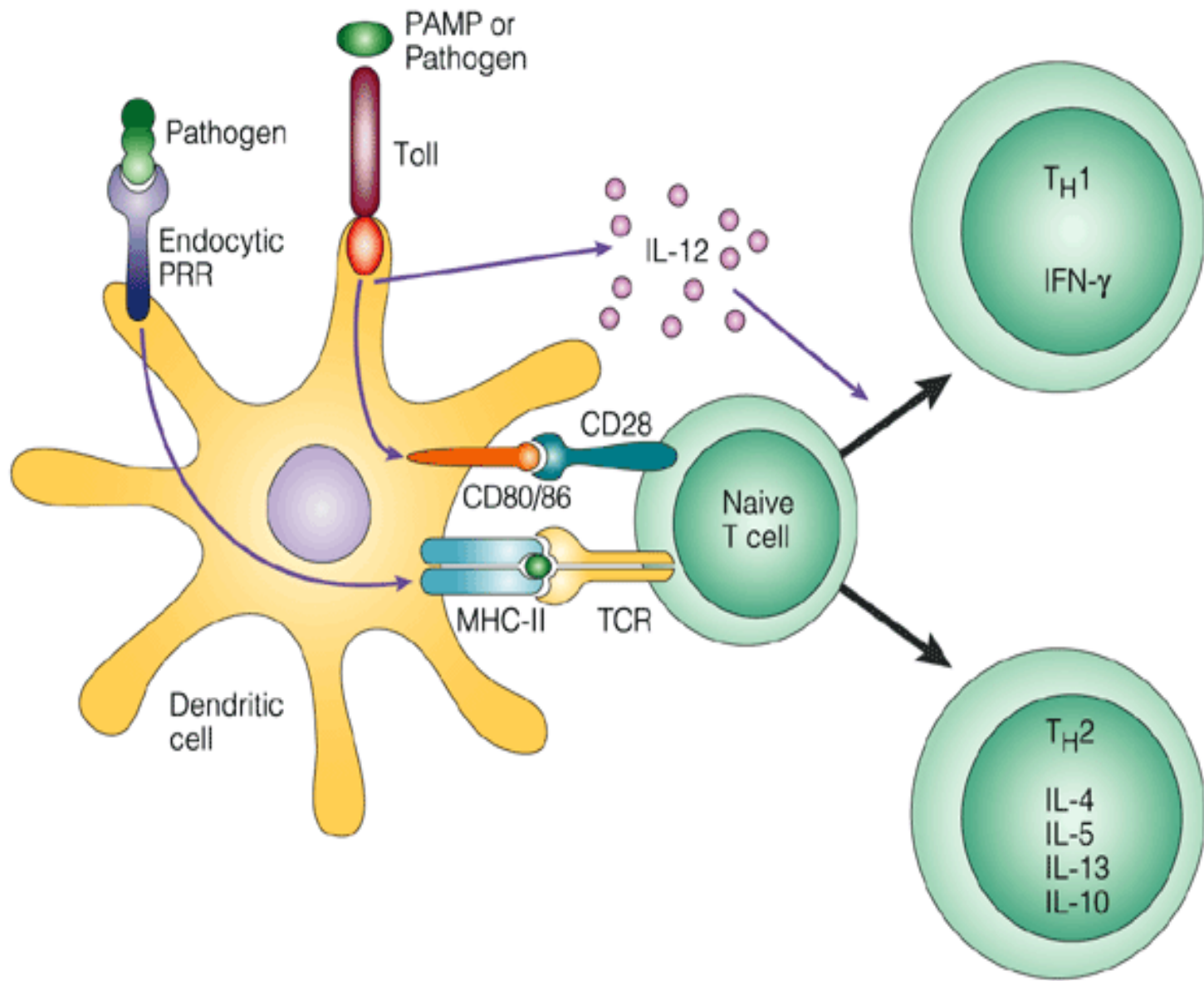
Multivalent antigen crosslinks bound IgE antibody, causing release of granule contents

# Antigen- presenting cells



# Dendritic cells

- An important component of the innate immunity involved in the activation of acquired immune system cells.
- The main function is antigen processing and its presentation to T-lymphocytes.
- They are also an important source of costimulatory signals.
- Langerhans dendritic cells are involved in the transfer of antigens from the epidermis of the skin.
- Non-activated dendritic cells also have a significant phagocytic capacity.



# Immature dendritic cells

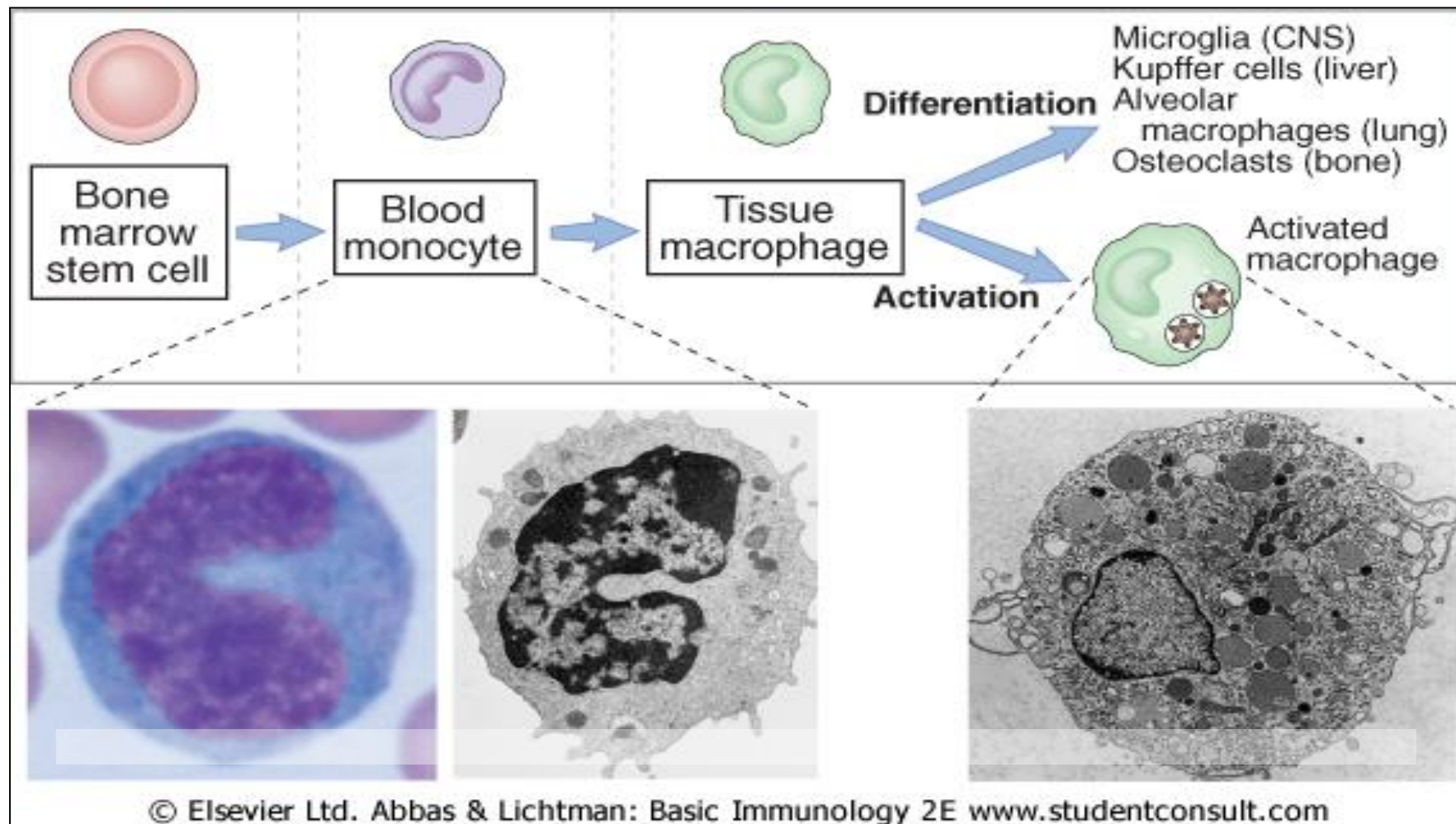
- They phagocytose dead cells, various other molecules, as well as foreign particles and pathogenic organisms.
- TLRs are mainly involved in the uptake of viruses or bacteria.
- Immature dendritic predominantly suppress immune response leading to formation of regulatory T lymphocytes.

# Mature dendritic cells

They are formed by the maturation of dendritic cells that have been activated by PRR.

The mature dendritic cell migrates to the lymph nodes and exposes fragments of bacterial / viral antigens to both HLA-II and HLA-I, thereby activating naïve CD4 + or CD8 + lymphocytes.

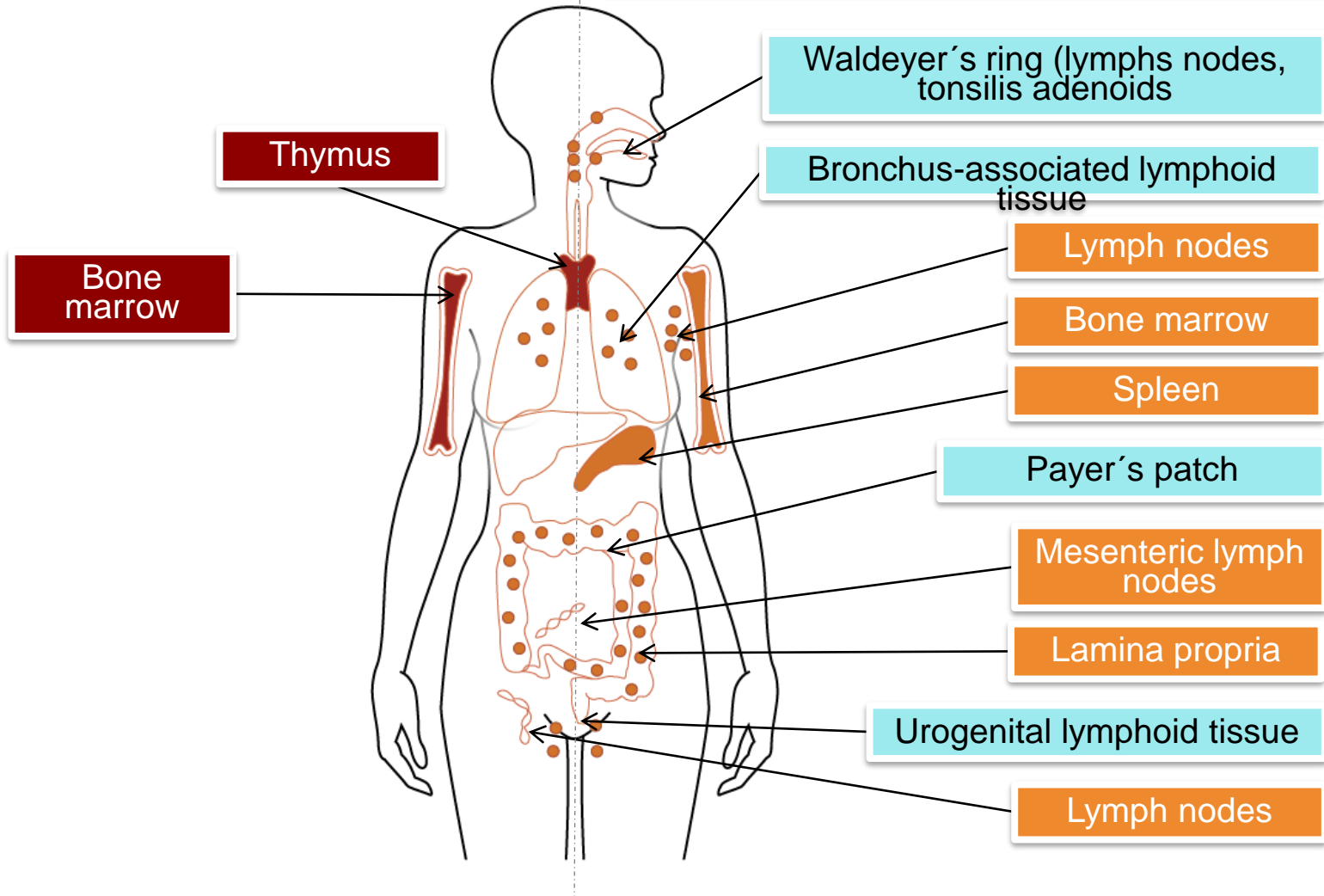
# Development of macrophages



# Organs of the immune system

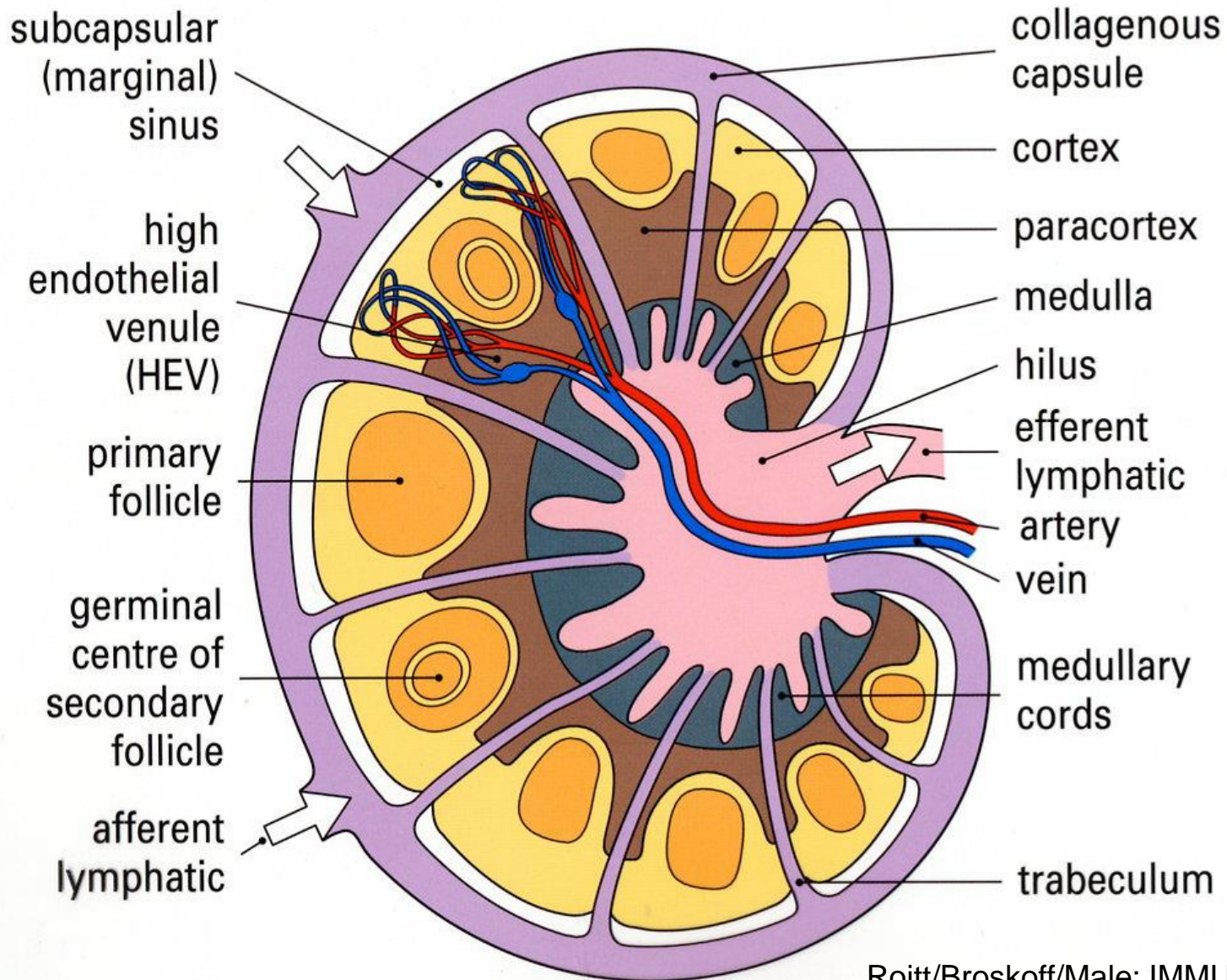
## Primary lymphoid organs

## Secondary lymphoid organs

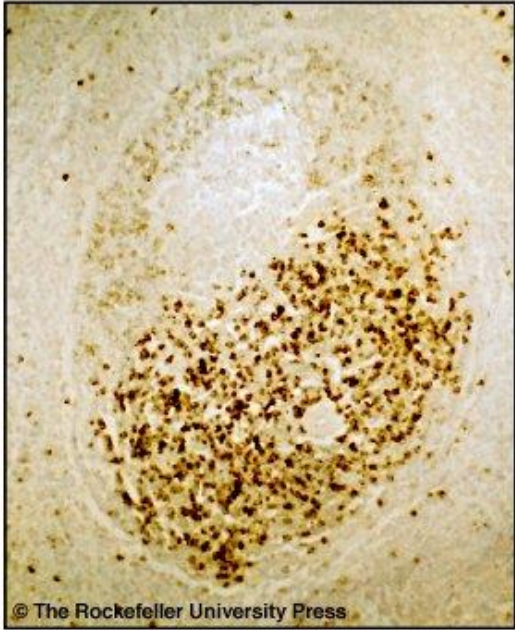
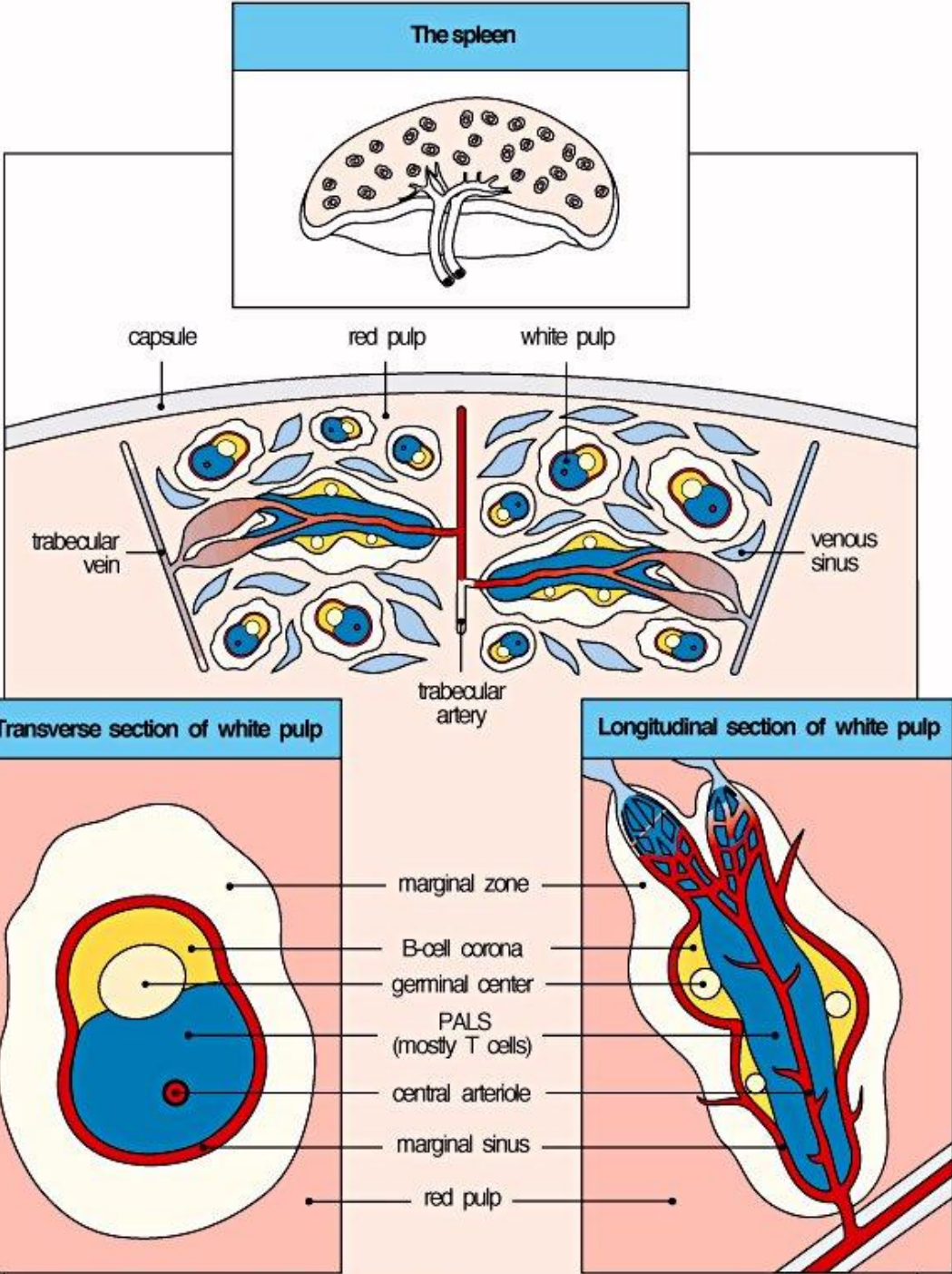




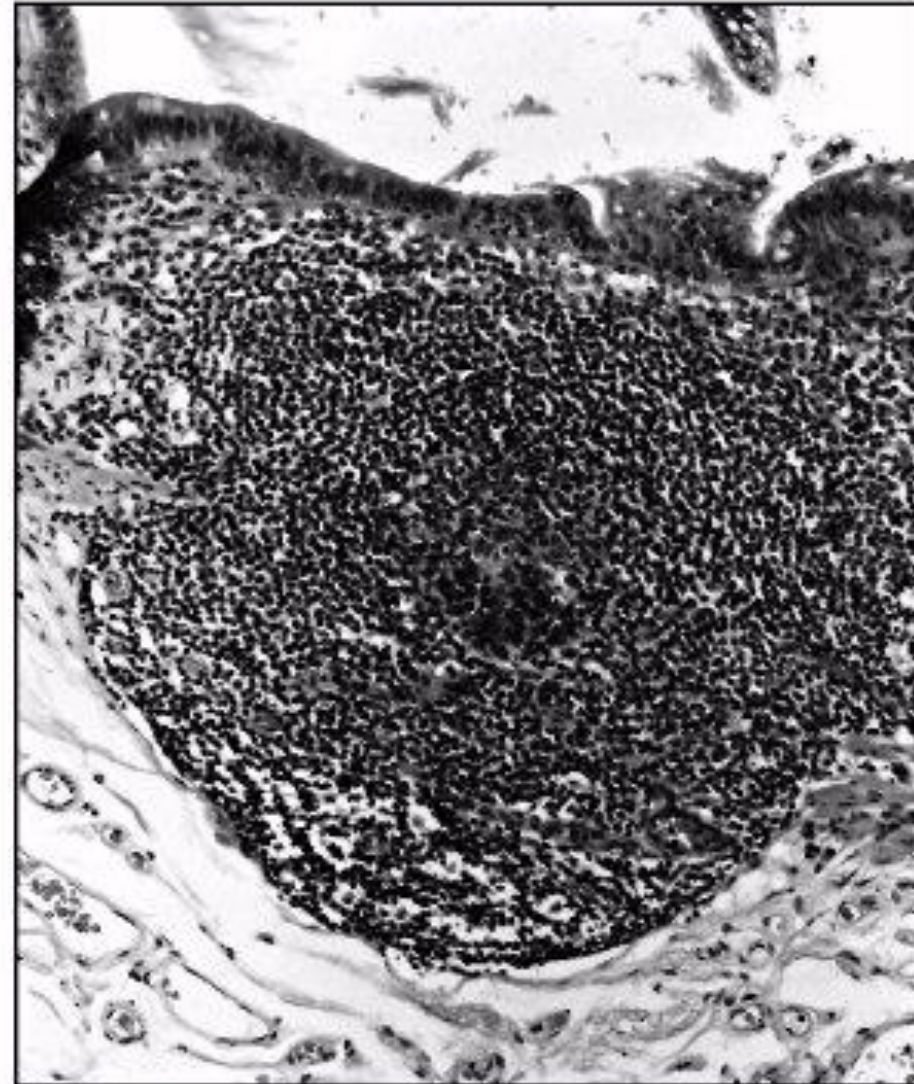
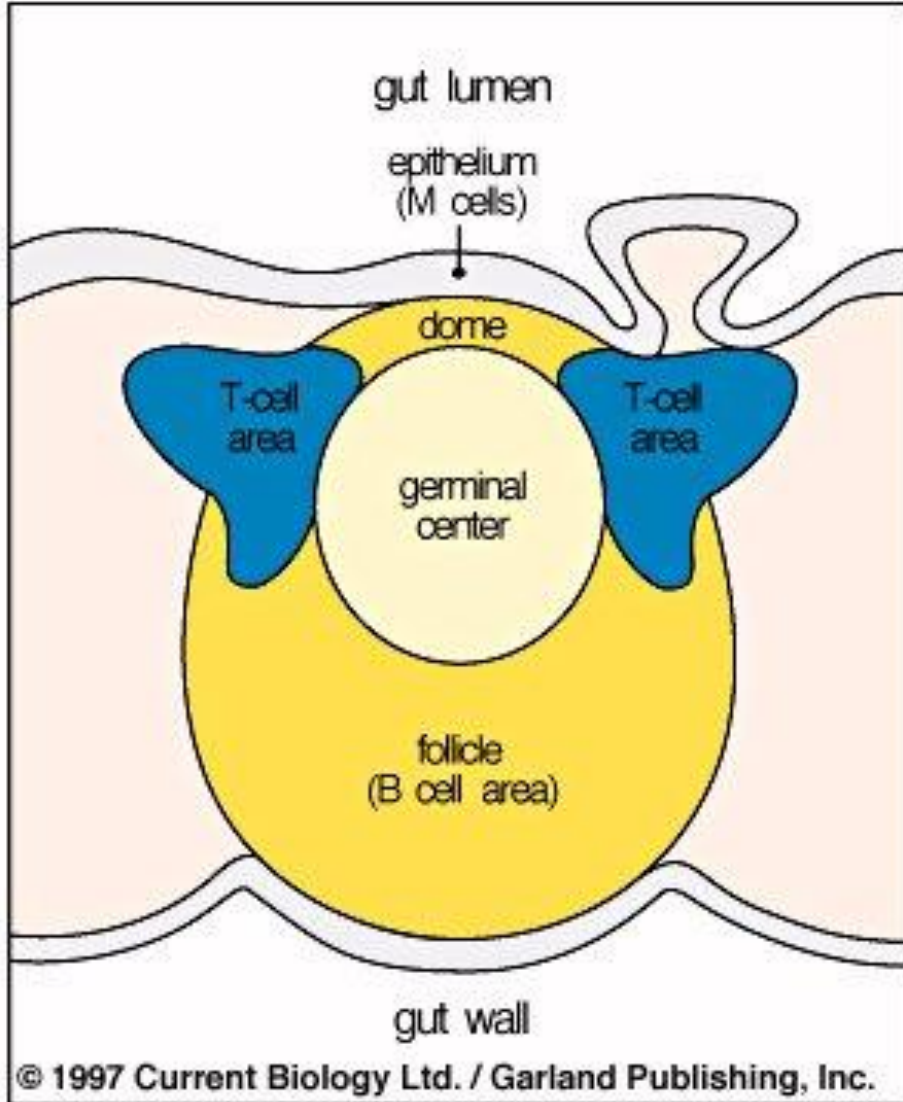
# Lymph node



# The Spleen



# Payer 's Patches



# High endothelial venules

- Specialized venules. The site where lymphocytes leave the blood stream and migrate into lymph nodes, spleen, organs of MALT.
- Adhesion molecules enable selective attachment of various types of lymphocytes.

# Circulation of Lymphocytes in the body

## The role of High Endotelial Venules

