Basic Immunology 2020’

Lecture 1st

Introduction

Requirements of the Department.

Historical overview. Composition of the immune system. General characteristics of the immune machinery.

Requirements and information

- **Lectures are in online form**
- **Preparation of own lecture note**
- **Handbooks**

- **Examination: online exam in *Medtraining***

Score limits: satisfactory 66-71%, average 72- 77%, good 78-83%, excellent up to 84%

It is able to collect extra points during the lectures!

www.immbio.hu

While important is the immunology for pharmacists?

Basic terms

Basic terms

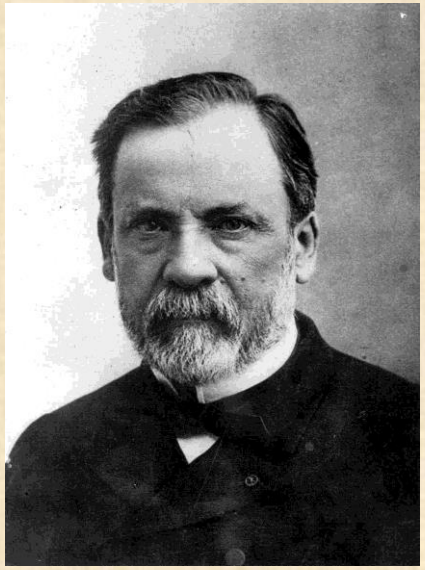
- **Immunis,- e** (*Julius Caesar*) = exempt, free of burden (E.g. tax, law, or diseases)
- **IMMUNE:** individuals who do not capitulate to a disease when infected;
- **IMMUNITY:** status of **specific** resistance to a disease;
- **IMMUNOLOGY:** branch of theoretical biology focuses on mechanisms responsible for **self and non-self recognition, elimination of the foreign invaders or altered self structures with protection of the basic structural elements.**

History

- Athen (B.C. 5th century Thukidites - plaque survivors), ancient Chinese papers about the pox immunity
- Infections, epidemies, vaccination

Edward Jenner

(1749 - 1823)



Louis Pasteur

(1822 - 1895)

Edward Jenner (1749 - 1823)

- He was a doctor in Berkeley, Gloucestershire. In 1796 he carried out his now famous experiment on eight-year-old James Phipps. Jenner inserted pus taken from a cowpox pustule on the hand of milkmaid Sarah Nelmes and inserted it into an incision on the boy's arm. He was testing his theory, drawn from the folklore of the countryside, that milkmaids who suffered the mild disease of cowpox never contracted smallpox.
- Jenner subsequently proved that having been inoculated with cowpox Phipps was now immune to smallpox. He submitted a paper to the Royal Society in 1797 describing his experiment but was told that his ideas were too revolutionary and that he needed more proof. Undaunted, Jenner experimented on several other children, including his own 11-month-old son. In 1798 the results were finally published and Jenner coined the word vaccine from the Latin vacca for cow, and called the process vaccination.

Smallpox vaccination (1796 – 1979)

THE NOBEL PRIZE LAUREATES IN IMMUNOLOGY

1901 **E.A. Von Behring** *(Germany)* for the work on serum therapy especially its application against diphtheria.

1905 **R. Koch** *(Germany)* for the investigations concerning tuberculosis.

1908 **E. Metchnikoff** *(Russia)* and **P. Ehrlich** *(Germany)* for their work on immunity (respectively, phagocytosis/cellular theory and humoral theory).

1913 **C.R. Richet** *(France)* for the work on anaphylaxis.

1919 **J. Bordet** *(Belgium)* for the discoveries relating to immunity (complement).

1930 **K. Landsteiner** *(Austria/USA)* for the discovery of human blood groups.

1951 **M. Theiler** *(South Africa)* for the discoveries and developments concerning yellow fever.

1957 **D. Bovet** *(Italy/Switzerland)* for the discoveries related to histamine and compounds, which inhibit action of histamine and other substances on the vascular system and the skeleton muscles.

1960 **Sir F.McFarlane Burnet** *(Australia)* and **Sir P.B. Medawar** *(Great Britain)* for the discovery of acquired immunological tolerance.

1972 **G.M. Edelman** *(USA)* and **R.R. Porter** *(Great Britain)* for their discovery concerning the chemical structure of antibodies.

1977 **R. Yalow** *(USA)* for the development of radioimmunoassays of peptide hormones.

1980 **B. Benacerraf** *(USA)*, **J. Dausset** *(France)* and **G.D. Snell** *(USA)* for their discoveries concerning genetically determined structures on the cell surface (major histocompatibility complex) that regulate immunological reactions.

1982 **S. K. Bergstrom** *(Sweden)*, **B. I. Samuelsson** *(Sweden)* and **J. R. Vane** *(UK)* for their discoveries concerning prostaglandins and related biologically active substances.

1984 **N.K. Jerne** *(Denmark/Switzerland)* for theories concerning the specificity in development (lymphocyte clonality) and control of the immune system; **G.J.F. Köhler** *(Germany/Switzerland)* and **C. Milstein** *(Argentina/Great Britain)* for the discovery of the principle for production of monoclonal antibodies.

1987 **S. Tonegawa** *(Japan/USA)* for the discovery of the genetic principle for generation of antibody diversity.

1990 **J.E. Murray** and **E.D. Thomas** *(USA)* for their discovery concerning organ and cell transplantation in the treatment of human diseases.

1996 **P.C. Doherty** *(Australia/USA)* and **R.M. Zinkernagel** *(Switzerland)* for their discoveries concerning the specificity of the cell mediated immune defense ("dual recognition").

1997 **S.B. Prusiner** *(USA)* for the discovery of prions as a new biological principle of infection.

1999 **G. Blobel** *(USA)* for discoveries concerning signal transduction.

Main fields of applied immunology

- **Infectious immunity**

  Basic empirical observations on survivors during the big epidemics (plague, pox, cholera, etc) in the Middle Age. New aspects occurred in the end of the 21st century: sever viral infections (HIV, influenza), fungal infections, antibiotic resistance in different bacteria.

- **Tumor immunology**

  Animal experiments with tumor transplantation clarified the genetic mechanisms of graft rejection, and the correlation between the blood groups and the transplantation immunity (*Gorer, 1927*). New immunological concept developed in biology and medicine in the first decades of 20th century: immune system is responsible for the self integrity of individuals. The defense against tumors is not known in details yet, however, the role and heredity of major histocompatibility complex (MHC) was discovered during the tumor-transplantation experiments establishing the immunogenetics.

- **Transplantation immunology**

  Immunonological aspects of organ transplantaions

- **Cellular and molecular immunology** (Basic and applied immunological research, related innovations and R&D) diagnostics ant drug designe.

- **Immunological biotechnology** (increased need for individual diagnostics ant therapy)

- **Biological therapies** (Therapeutic monoclonal antibodies, recombinant cytokines)

What is the main function of the immune system?

Saving the individual integrity against foreign invaders (pathogens) and the modification of self structures by mutations, tumorous transformations, physical or chemical effects, or virus infections.

Immune system

- Individuals and species
- Organs
- Cells
- Molecules
- Functions

Immune system is a general structural and functional **network** composed by molecular and cellular elements of the body.

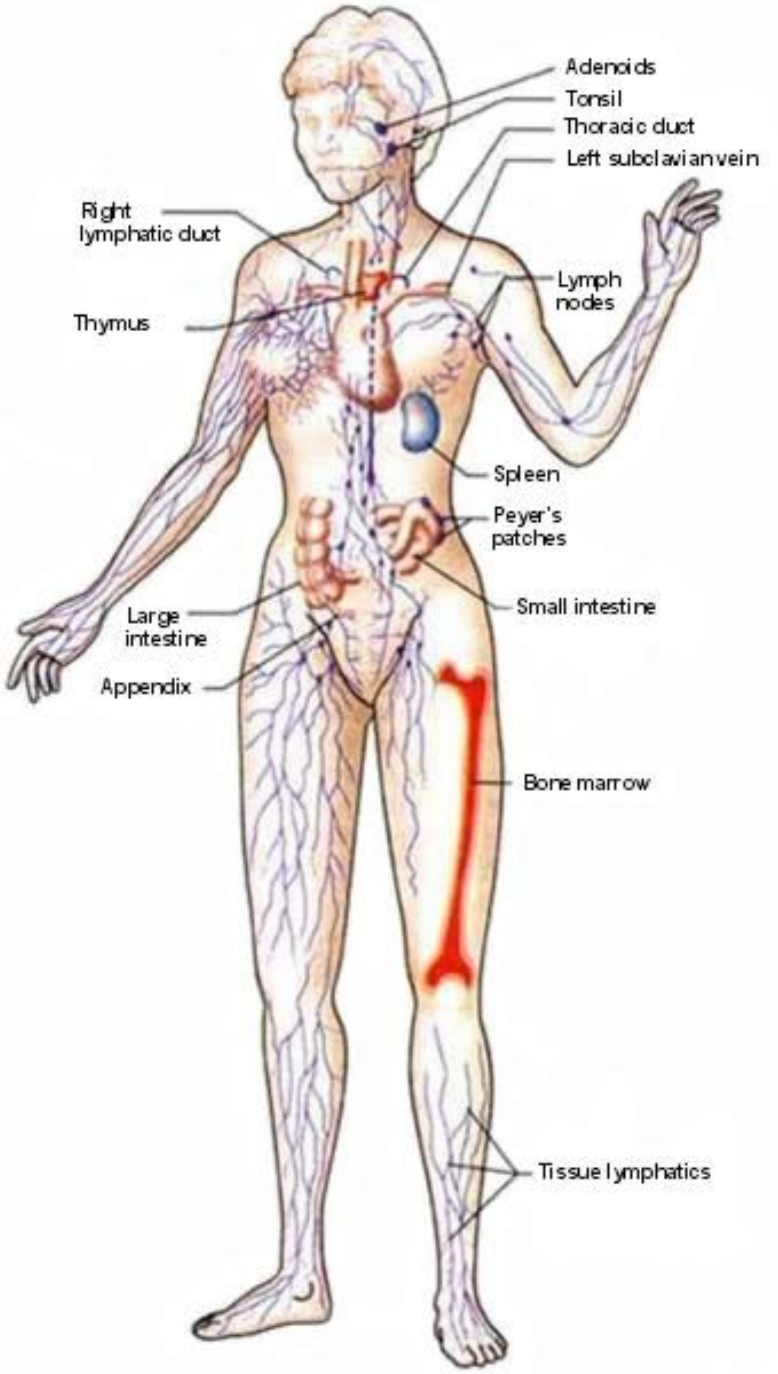
Organs of the immune system

Primary (central)

- Bone marrow
- Thymus
- (Embryonic liver)

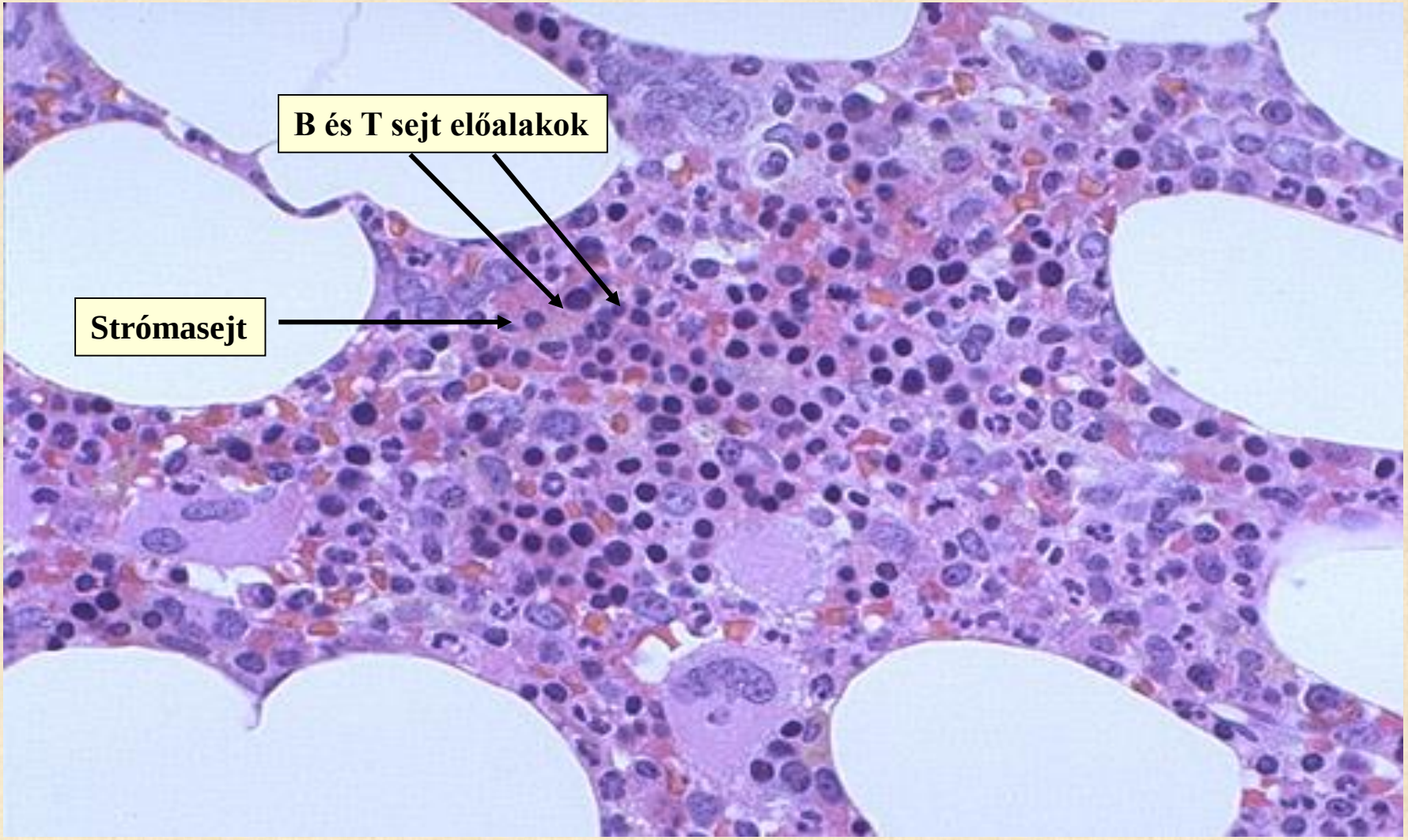
Secondary (peripheral)

- Lymph nodes
- Spleen
- MALT
- SALT



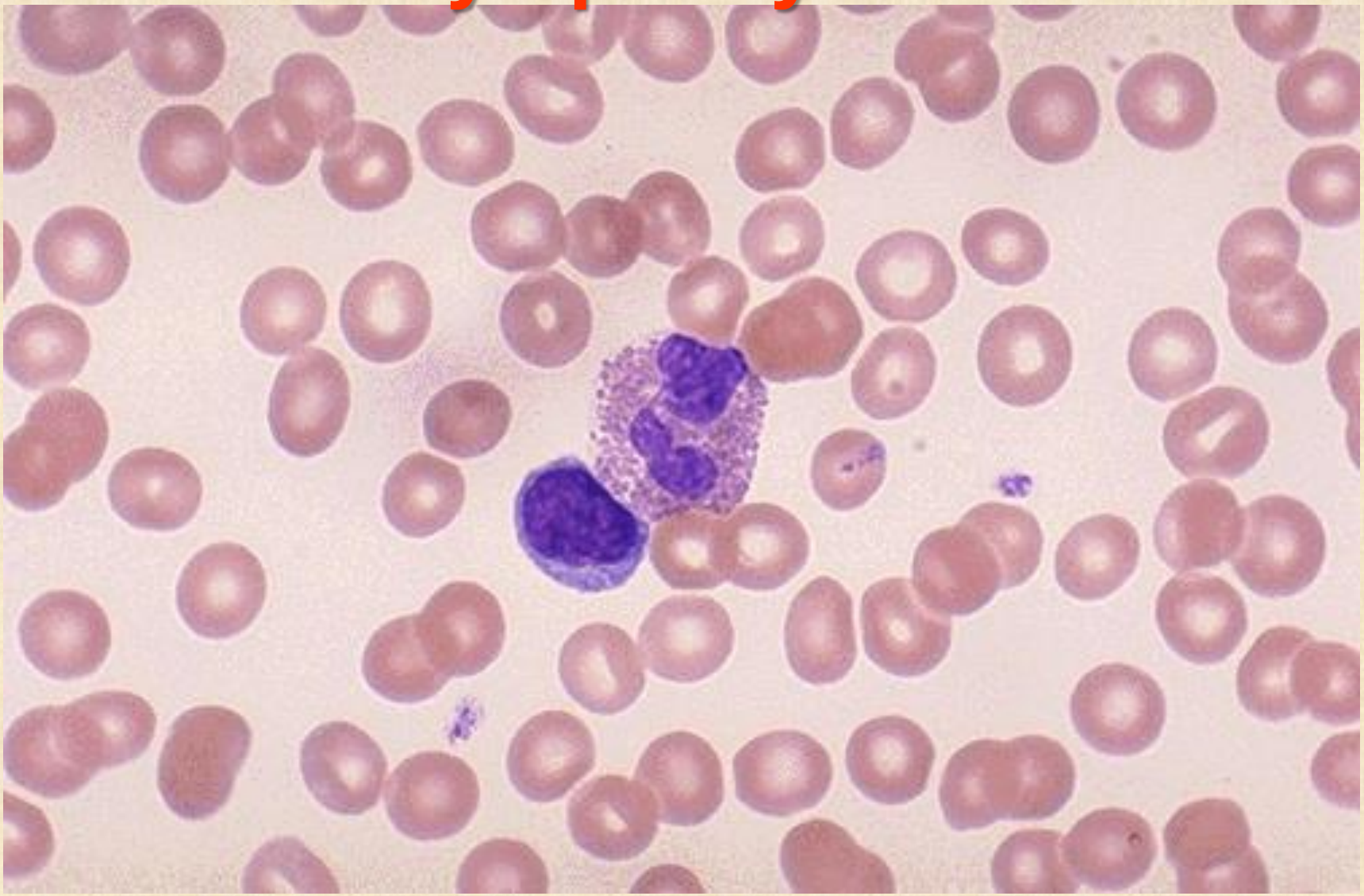
Red and yellow bone marrow

Normal bone marrow (HE)

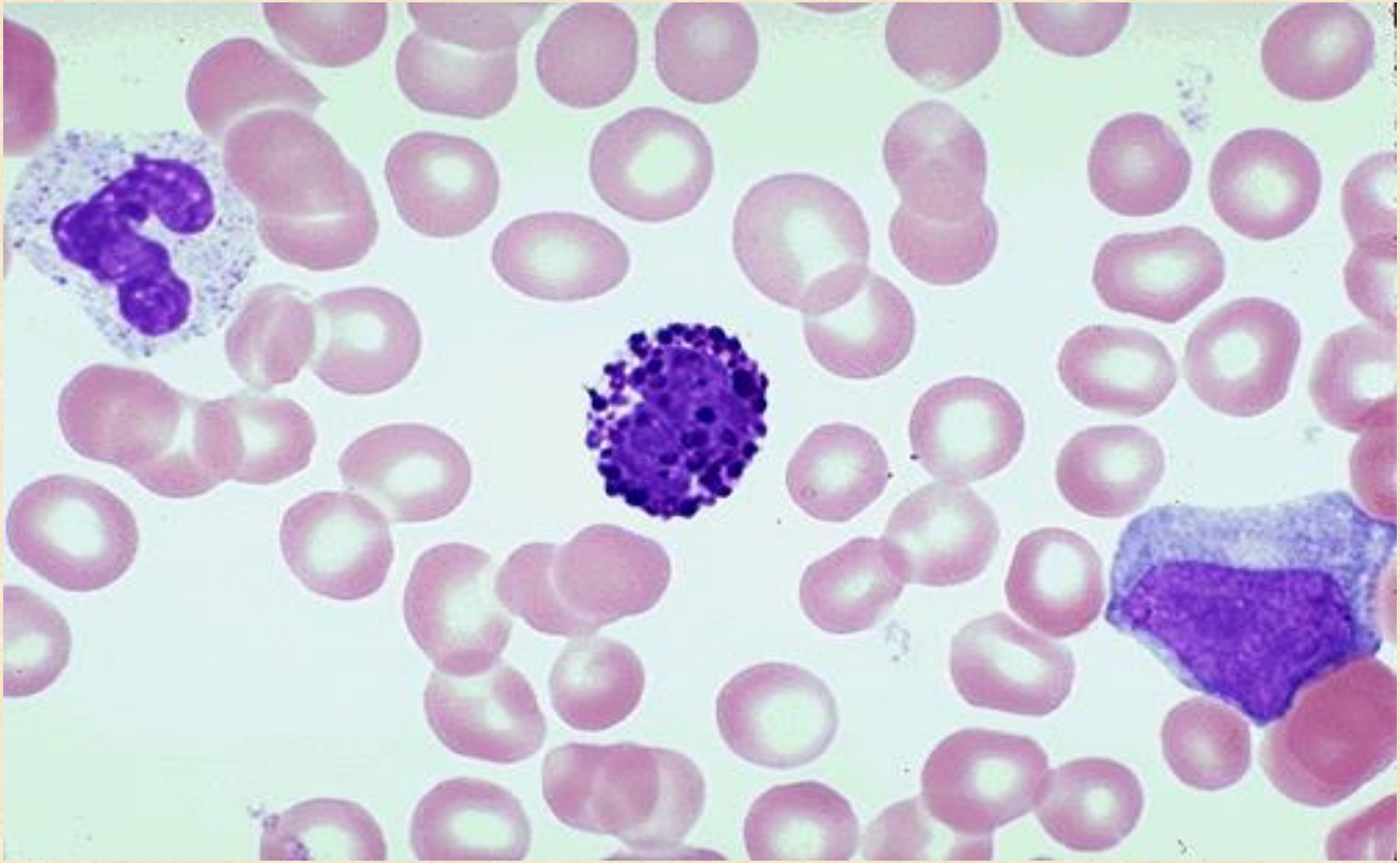


Neutrophil granulocytes

Eosinophil granulocyte and a small lymphocyte

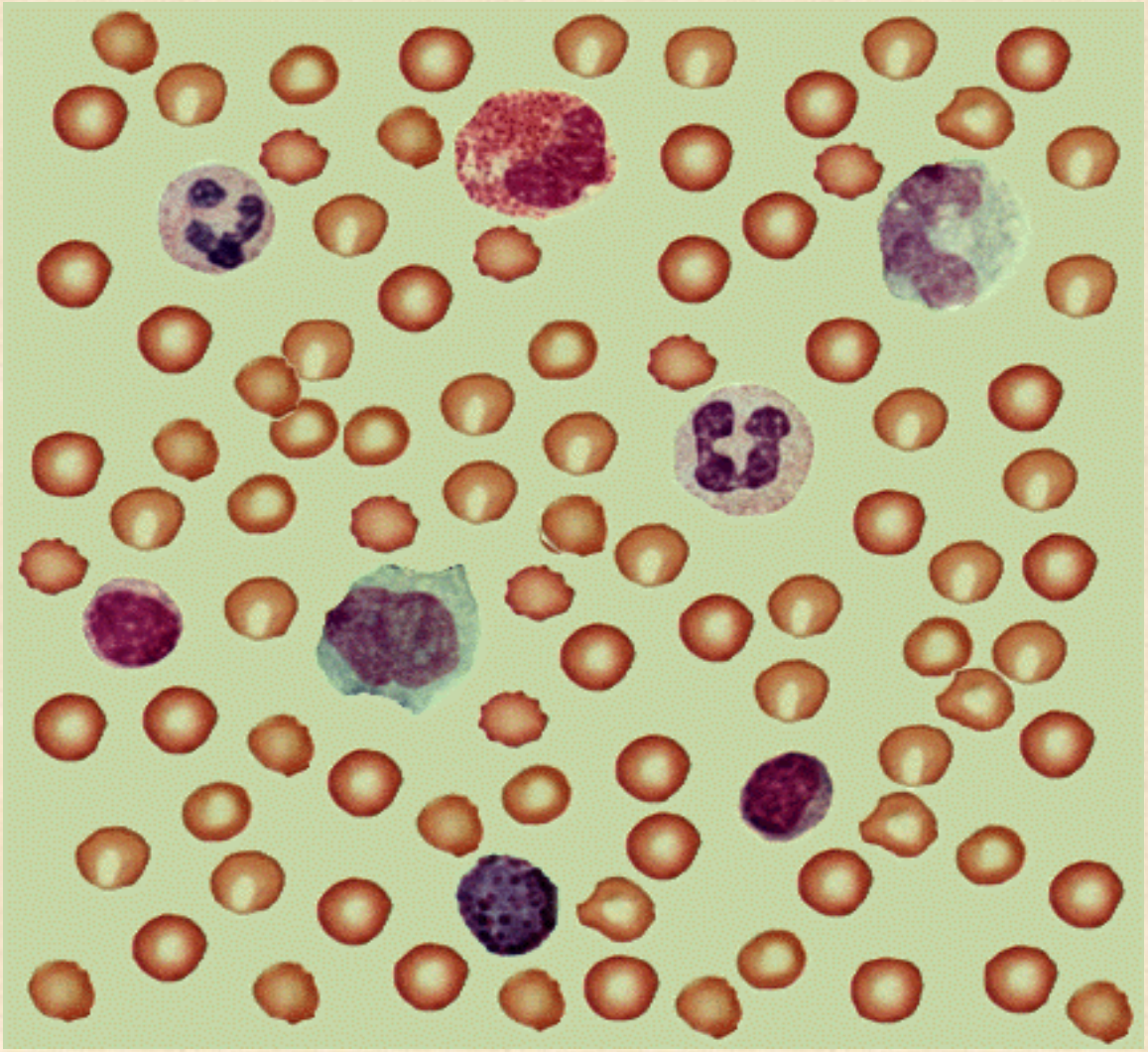


Bazophil granulocyte, neutrophil granulocite and a large lymphocyte

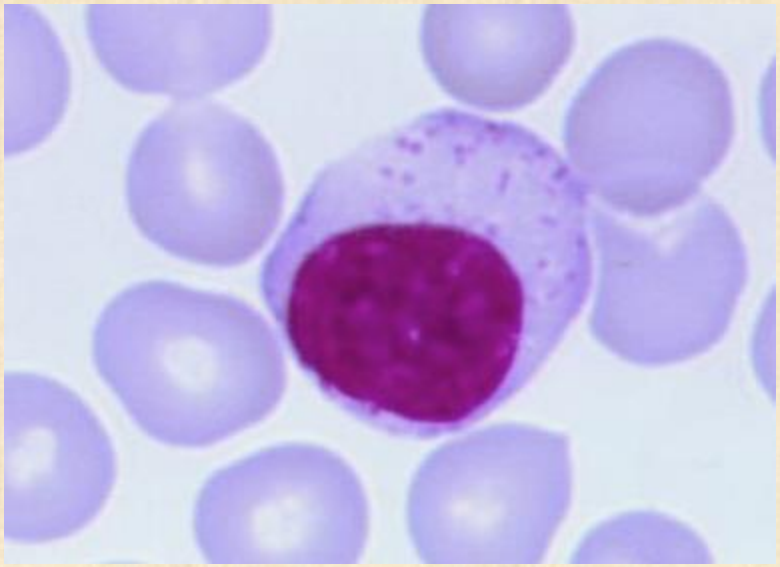


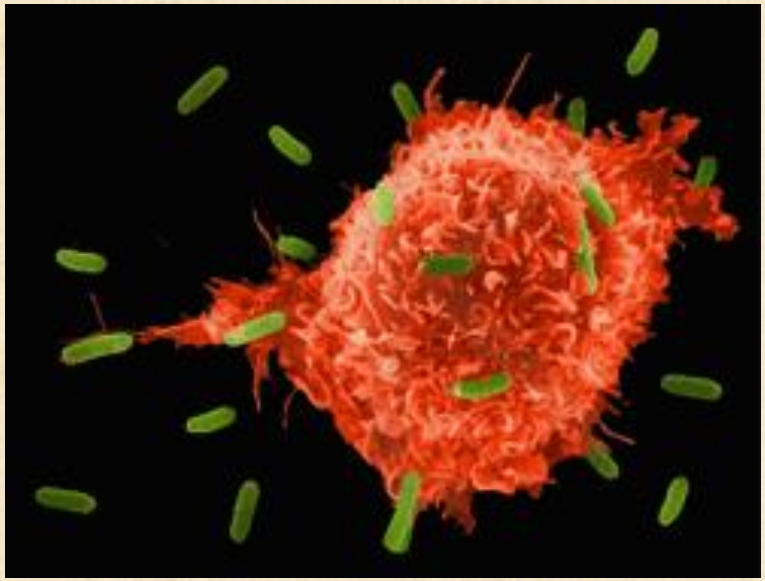
Monocyte

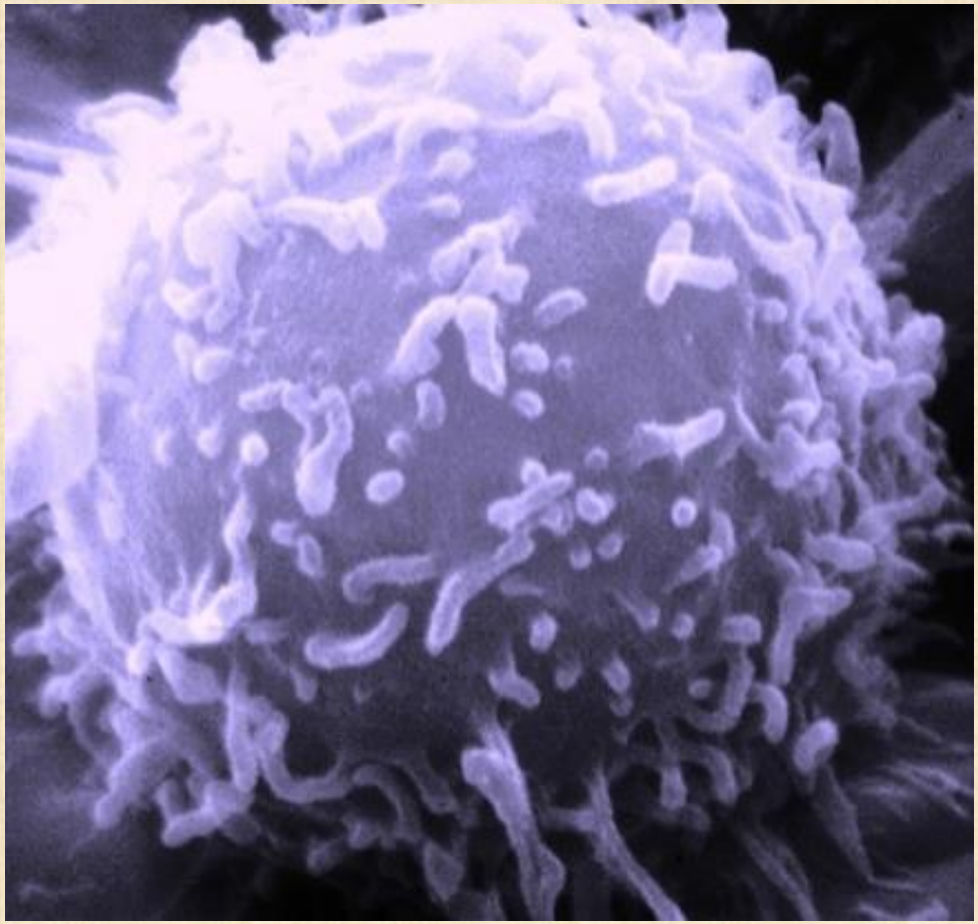
White blood cells in peripheral blood smears



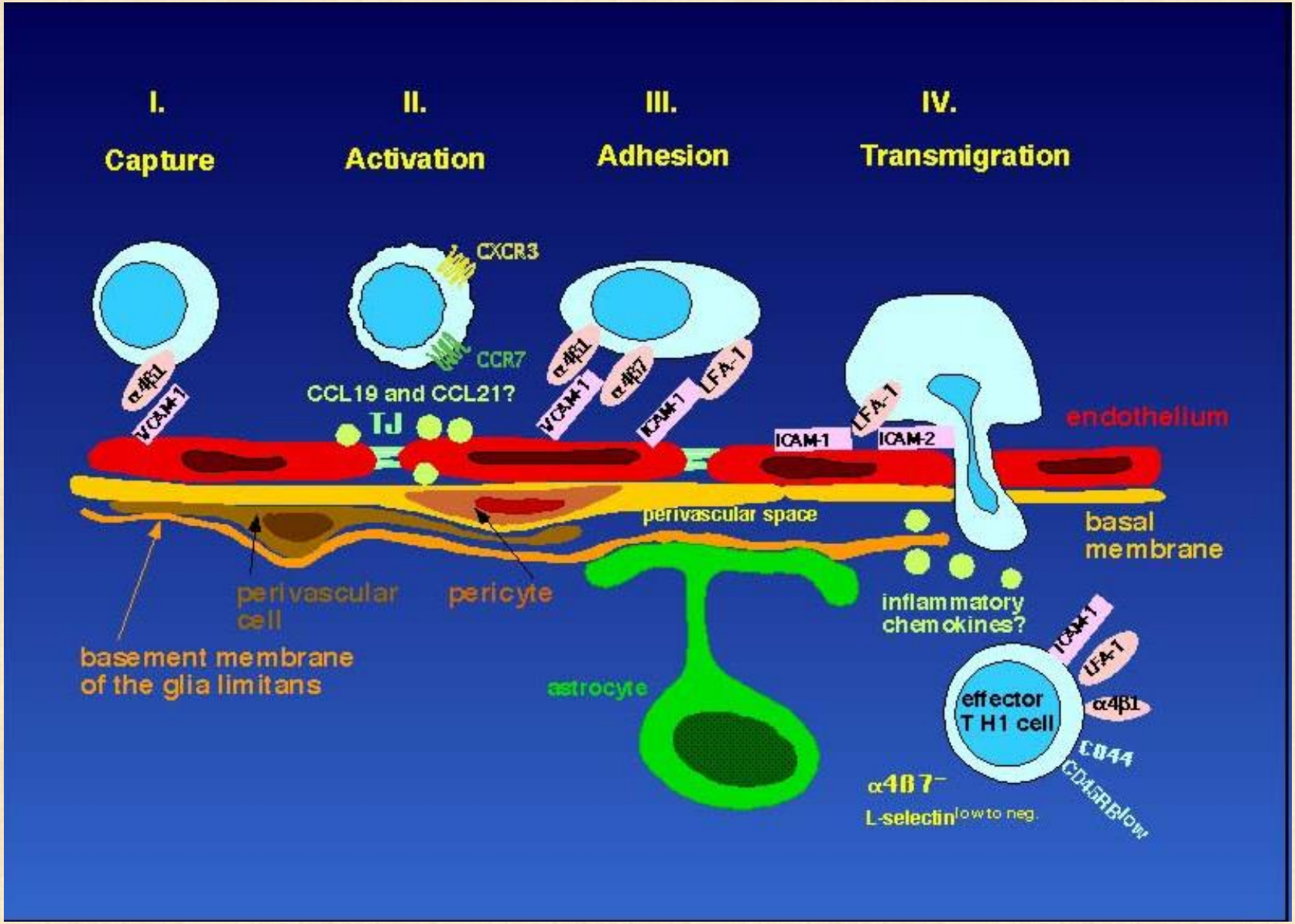
T cell



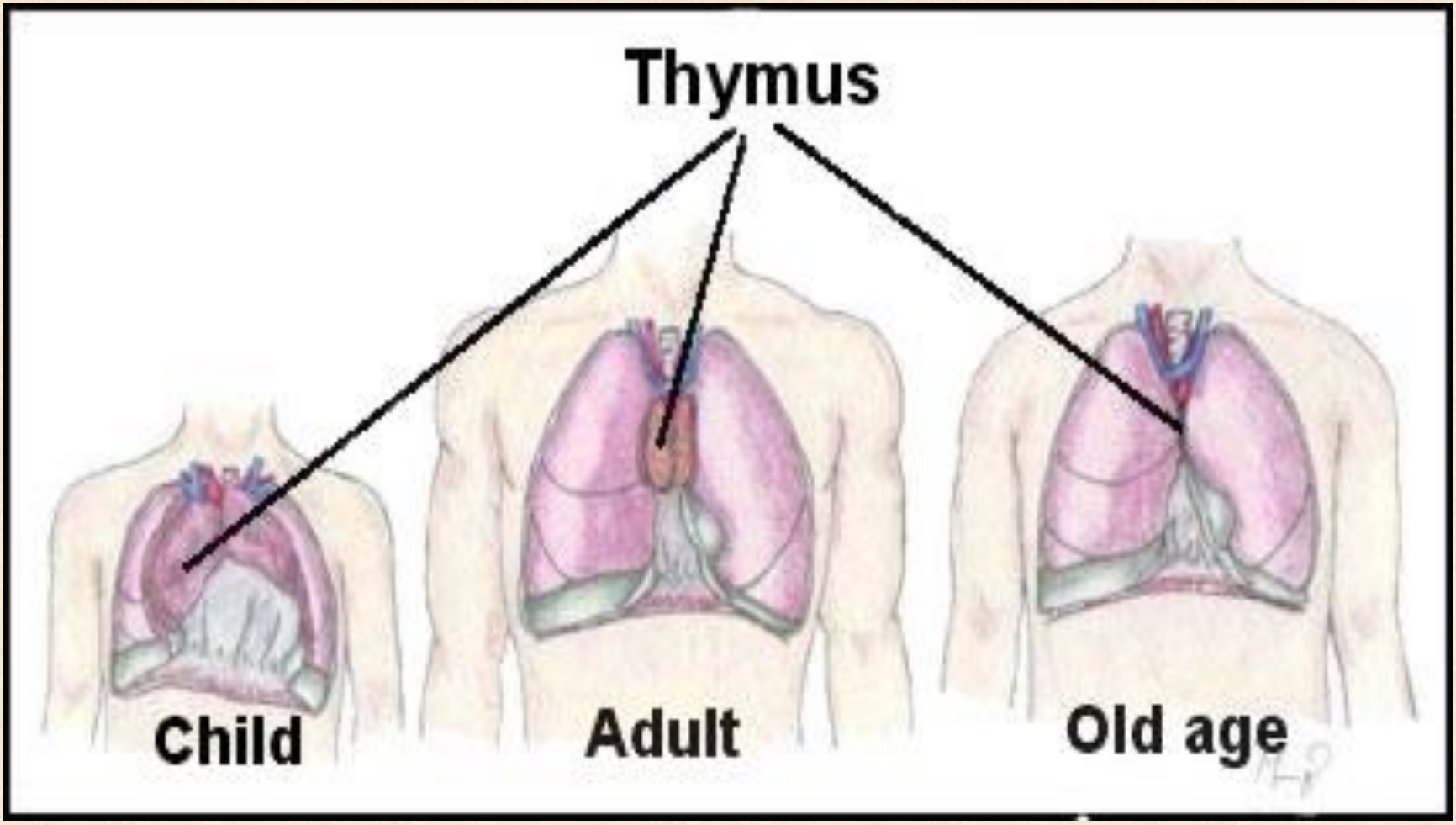




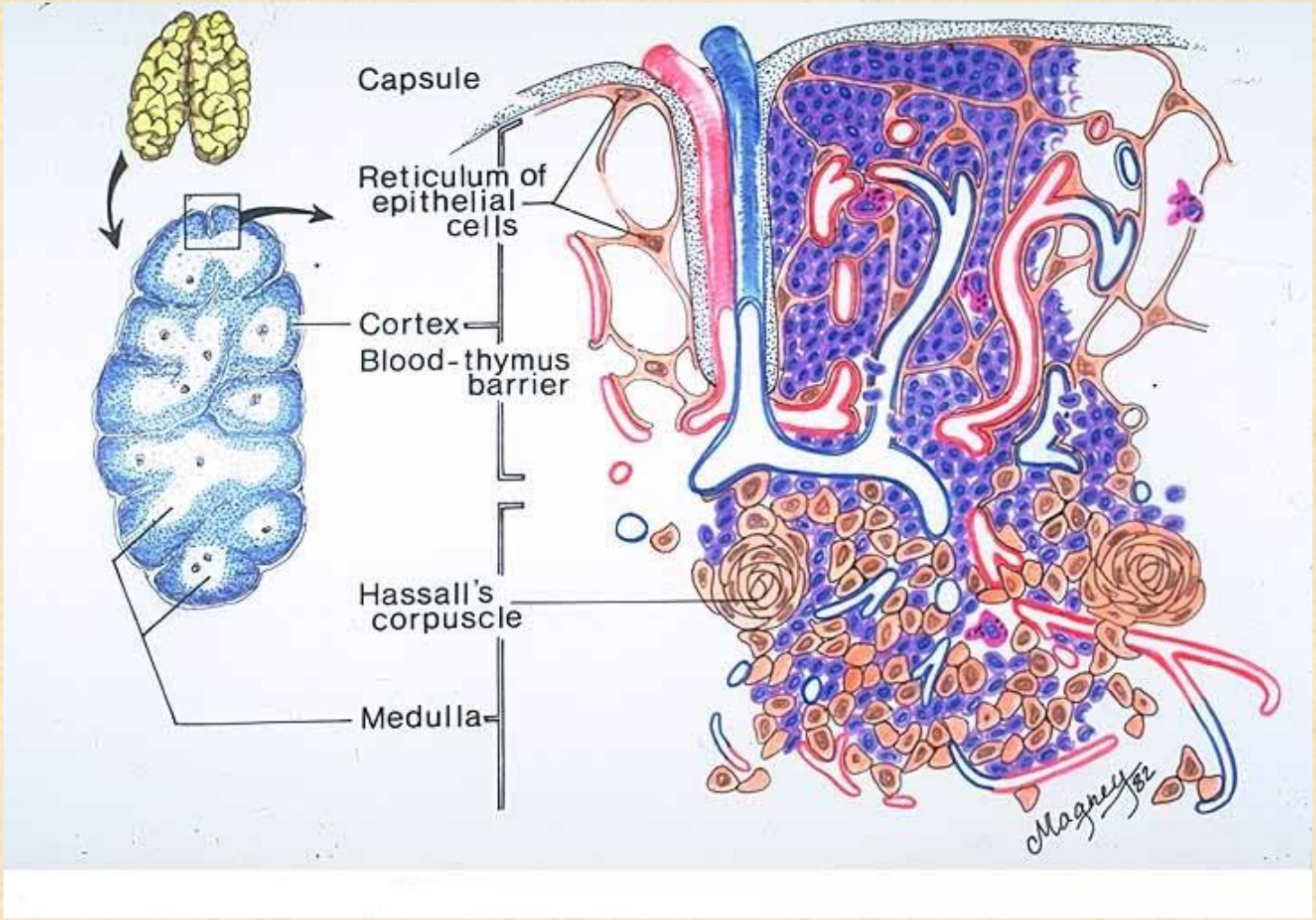
T cell migration



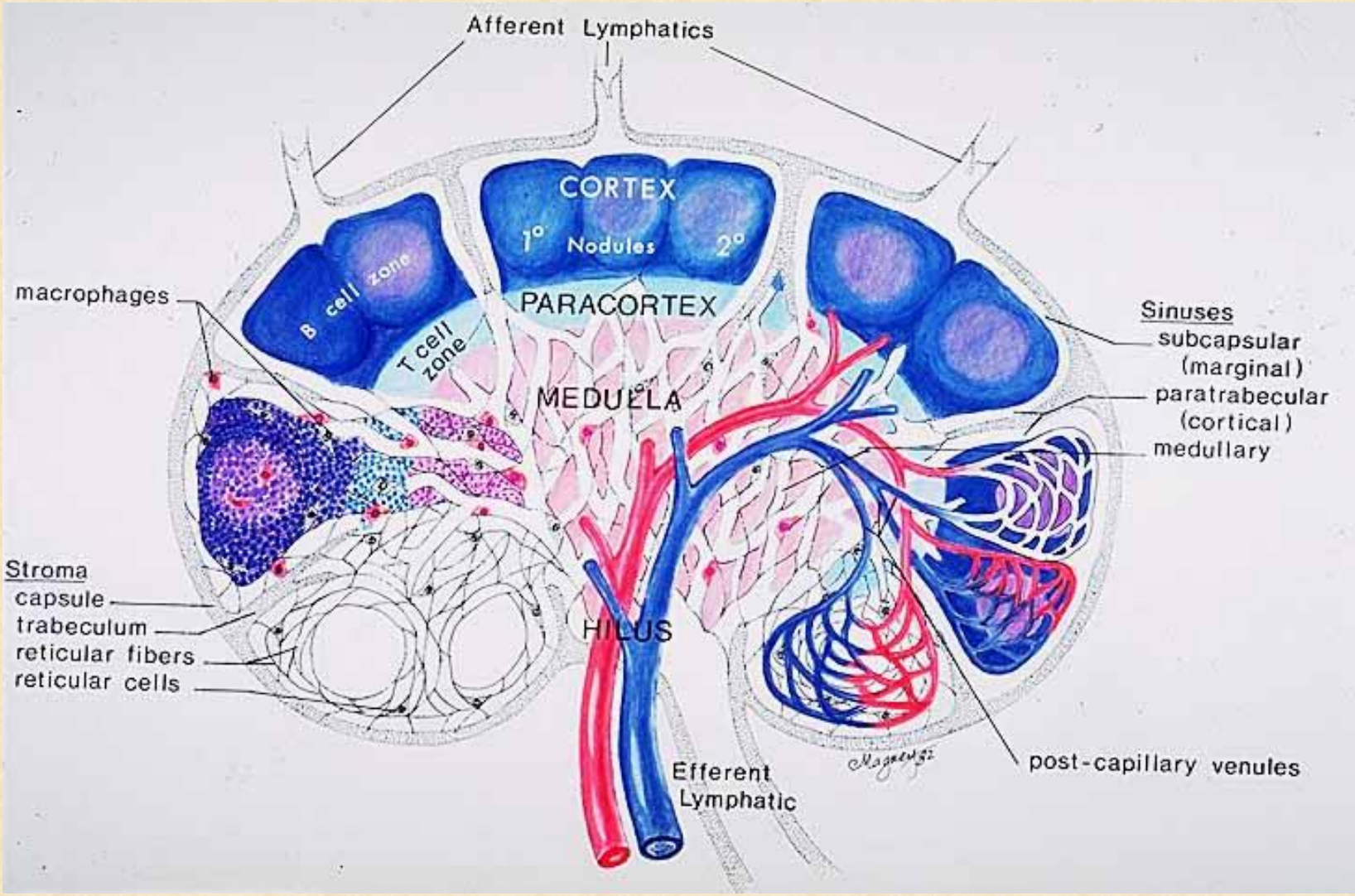
Thymus involution during aging



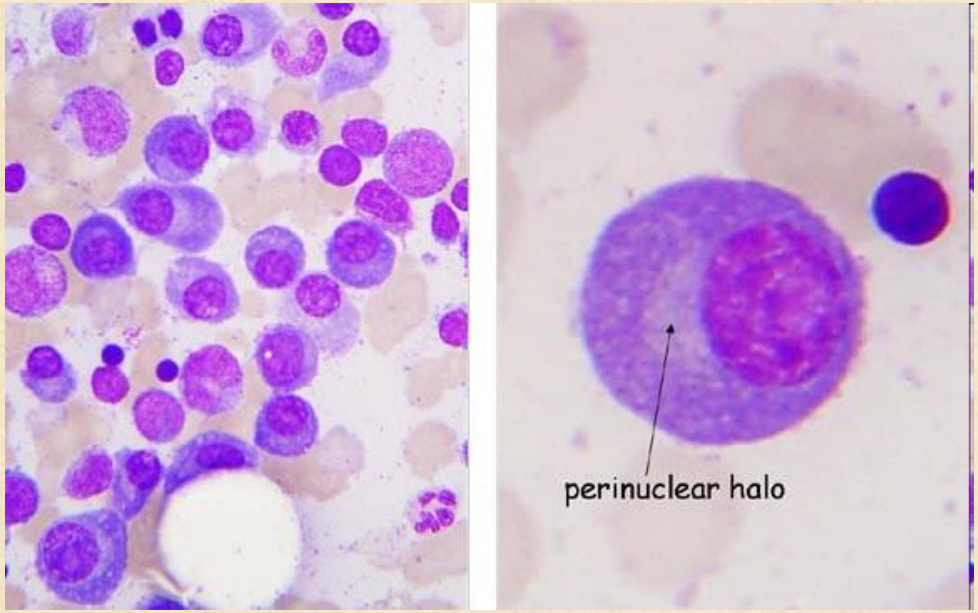
Thymus

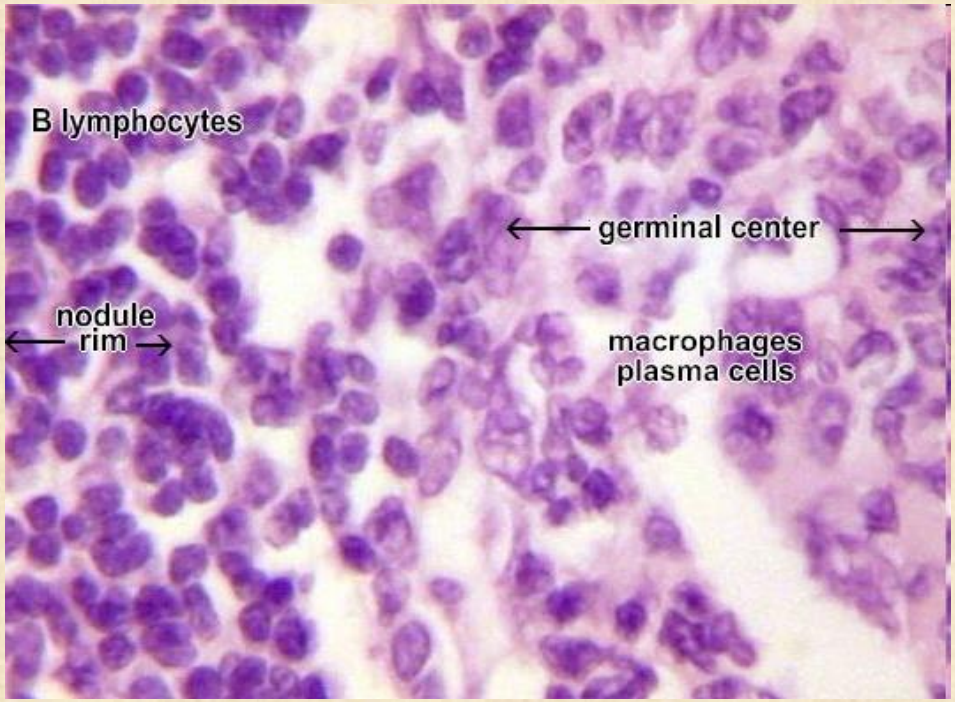

Capsule
Reticulum of epithelial cells
Cortex
Blood-thymus barrier
Hassall's corpuscle
Medulla

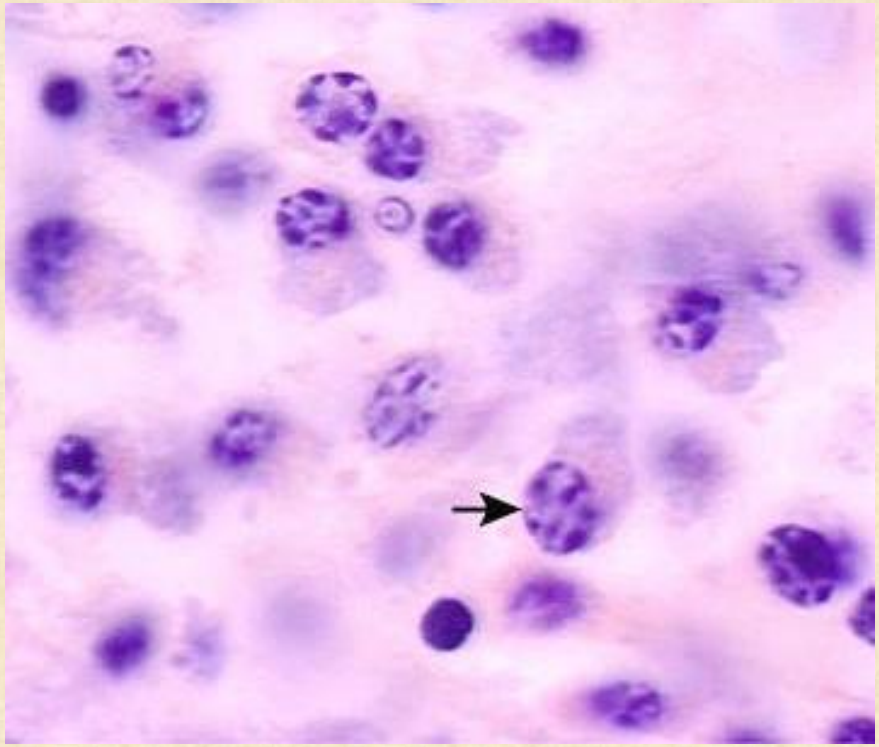
Lymph node


Afferent Lymphatics
CORTEX
1° Nodules 2°
B cell zone
T cell zone
PARACORTEX
MEDULLA
HILUS
macrophages
Stroma
capsule
trabeculum
reticular fibers
reticular cells
Sinuses
subcapsular (marginal)
paratrabecular (cortical)
medullary
post-capillary venules
Efferent Lymphatic

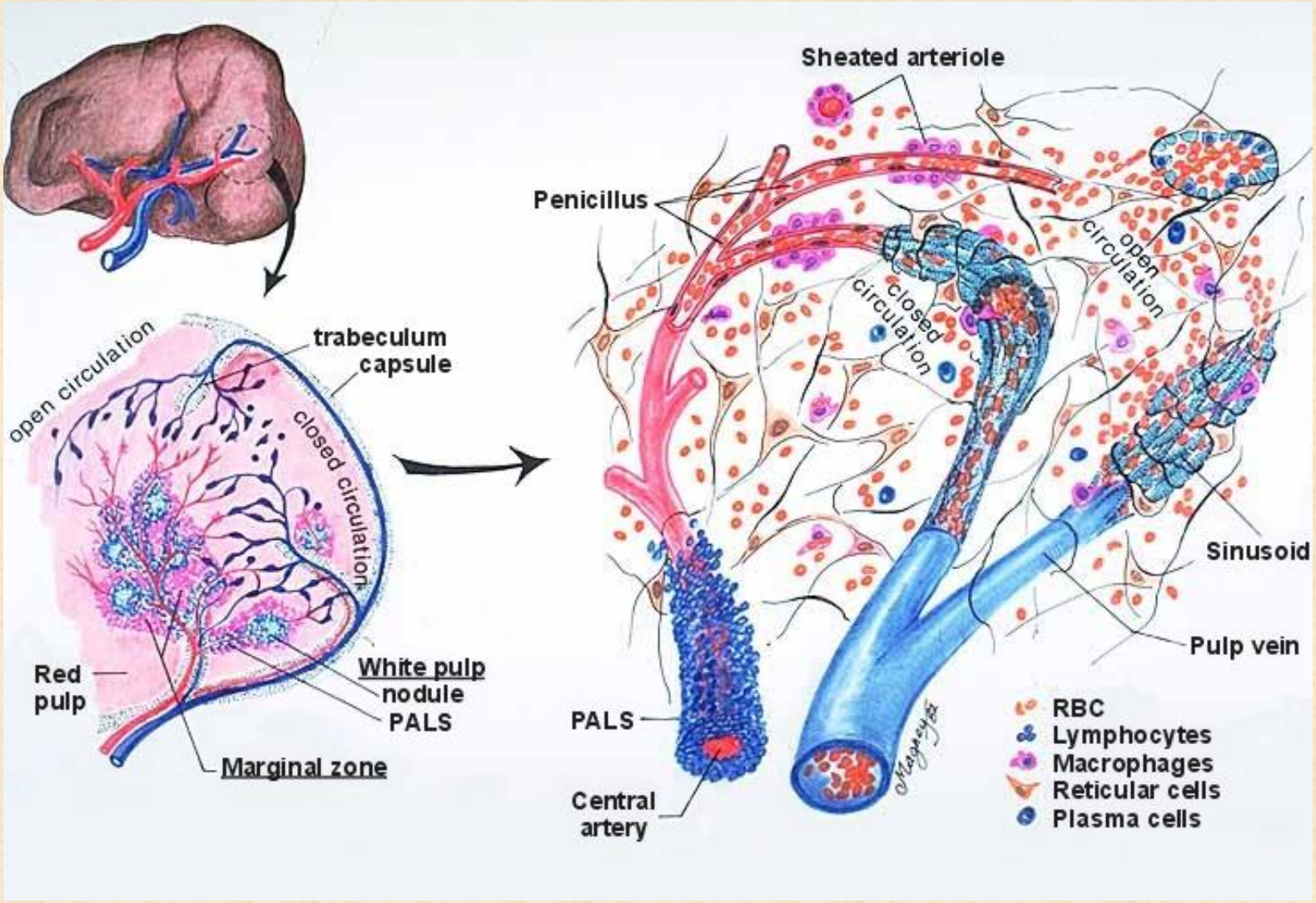
B cells


perinuclear halo

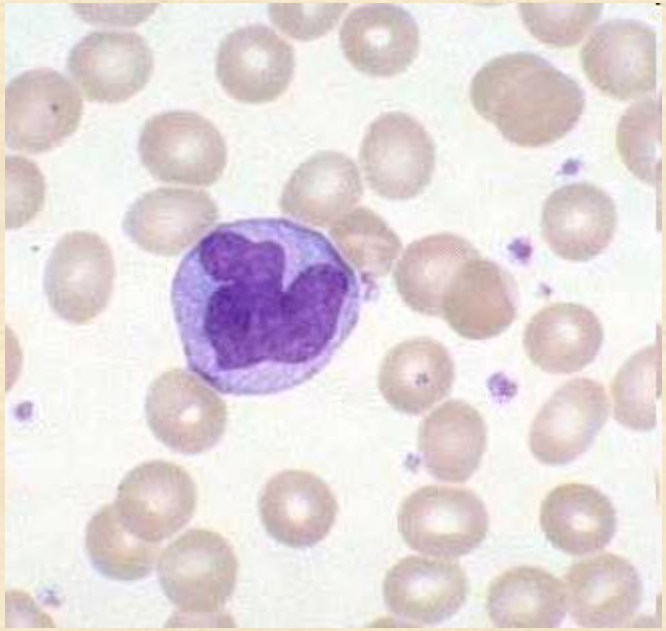

B lymphocytes
germinal center
nodule
rim
macrophages
plasma cells

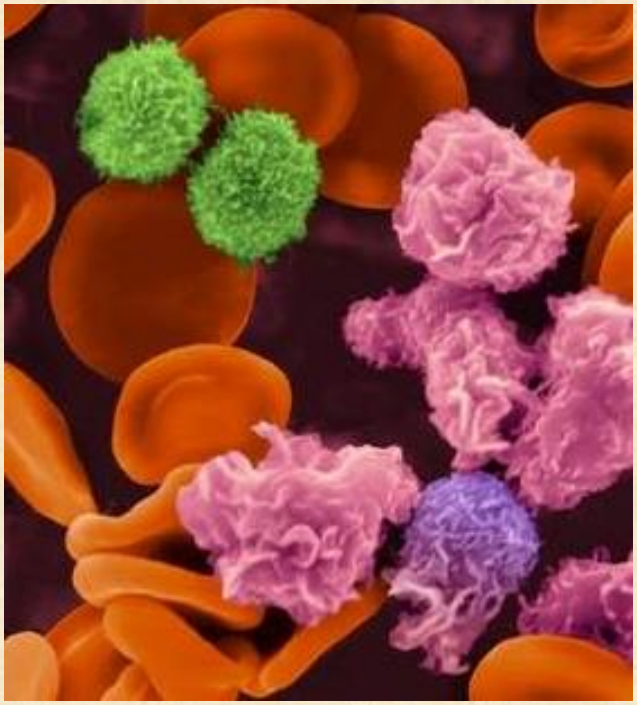


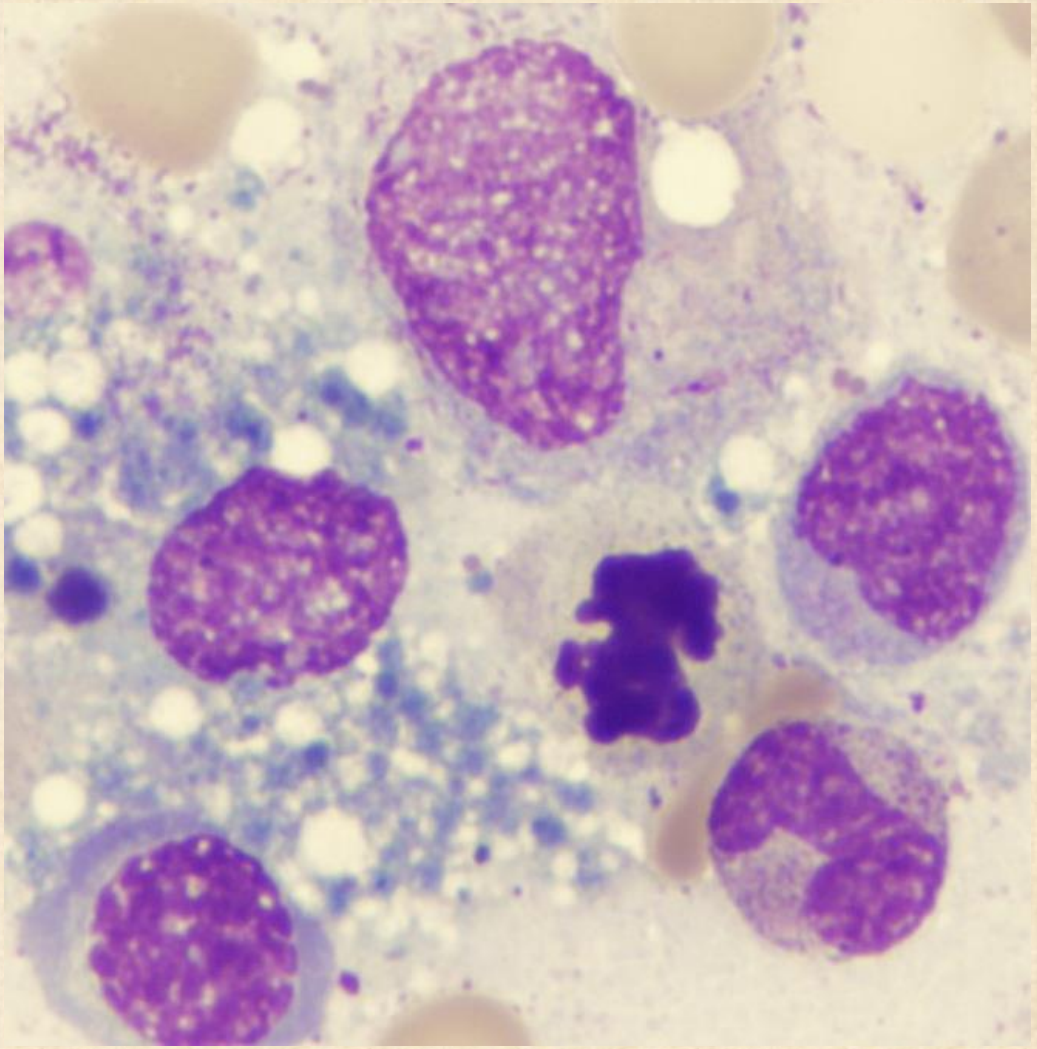
Spleen


Sheated arteriole
Penicillus
open circulation
closed circulation
open circulation
trabeculum
capsule
closed circulation
Red pulp
White pulp nodule
PALS
Marginal zone
Sinusoid
Pulp vein
PALS
Central artery
RBC
Lymphocytes
Macrophages
Reticular cells
Plasma cells

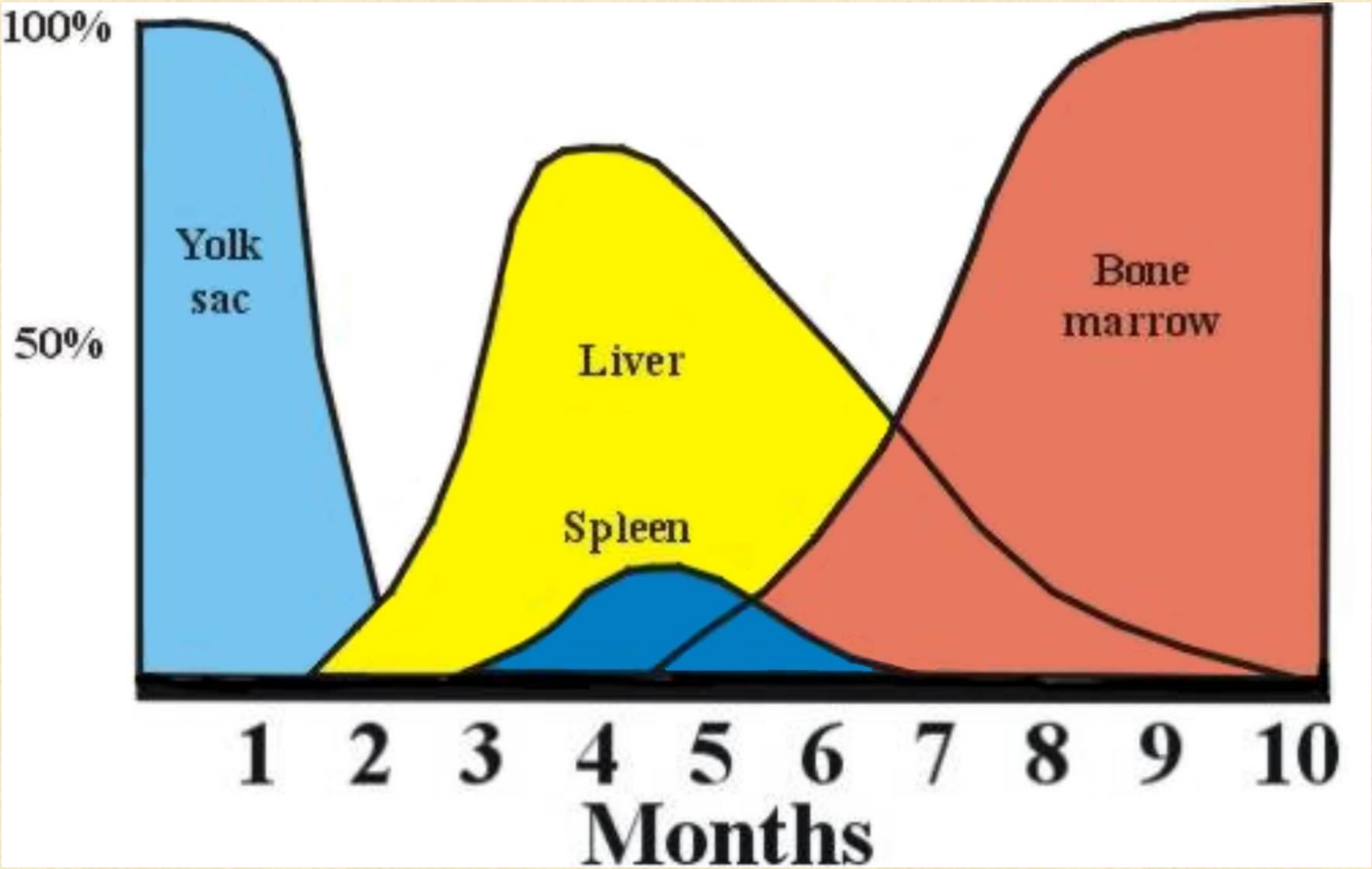
Macrophage



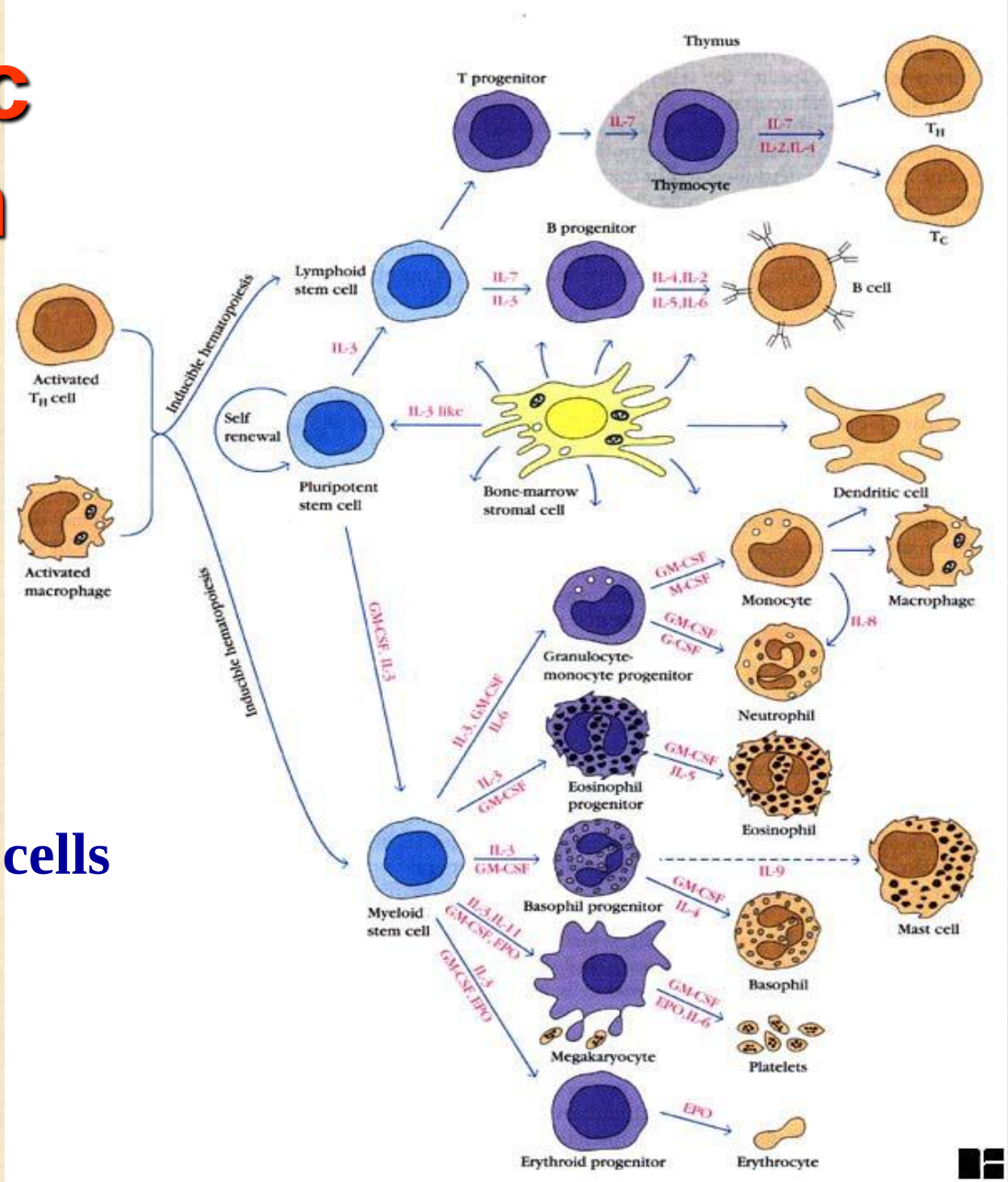




Haemopoiesis in embryonic life



Hematopoietic differentiation



Blue: stem cells

Dark blue: immature cells

Brown: matured cells

Cells of the immune system

Antigen-presenting cells: "professional" or "accidental"

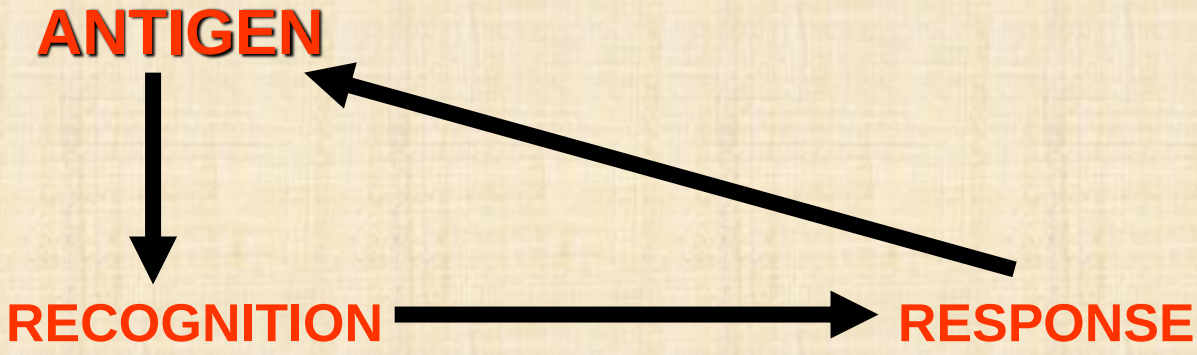
Antigen-binding cells: T- and B lymphocytes

Effektor cells: T, NK, granulocytes, mast cells, monocytes/macrophages

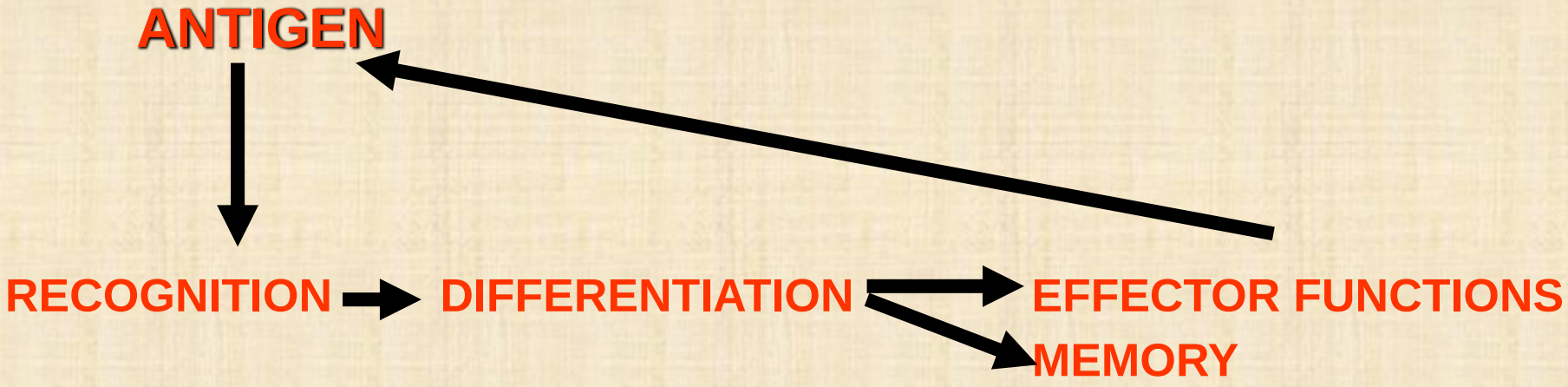
Organ distribution of T and B lymphocytes

Organ	% lymphocyte	
	T	B
Tymus	>99	<0.5
Lymph node	75	25
Spleen	50	50
Peripheral blood	55-75	15-30
Bone marrow	7	>75

Theoretical scheme of the innate immunity



Theoretical scheme of the adaptive immunity



Composition of the immune system

Innate

- None antigen specific
- No immunological memory
- Rapid reactivity
- Linear amplification of the reaction

Adaptive

- Antigen specific
- Immunological memory
- Activated after a latency
- Exponential amplification of the reaction

Natural

Innate-like immunity with adaptive features