

# IMMUNOLOGY 1

# IMMUNOLOGY

- Study of how the body limits invasion by non-self and recognises and eliminates altered self
- damaged cells and cancer cells
- It is the study on immunity

# What is Immunity?

Immunity (derived from *immunitas*: exemption from civic duties and prosecution) means protection from disease and especially infectious disease

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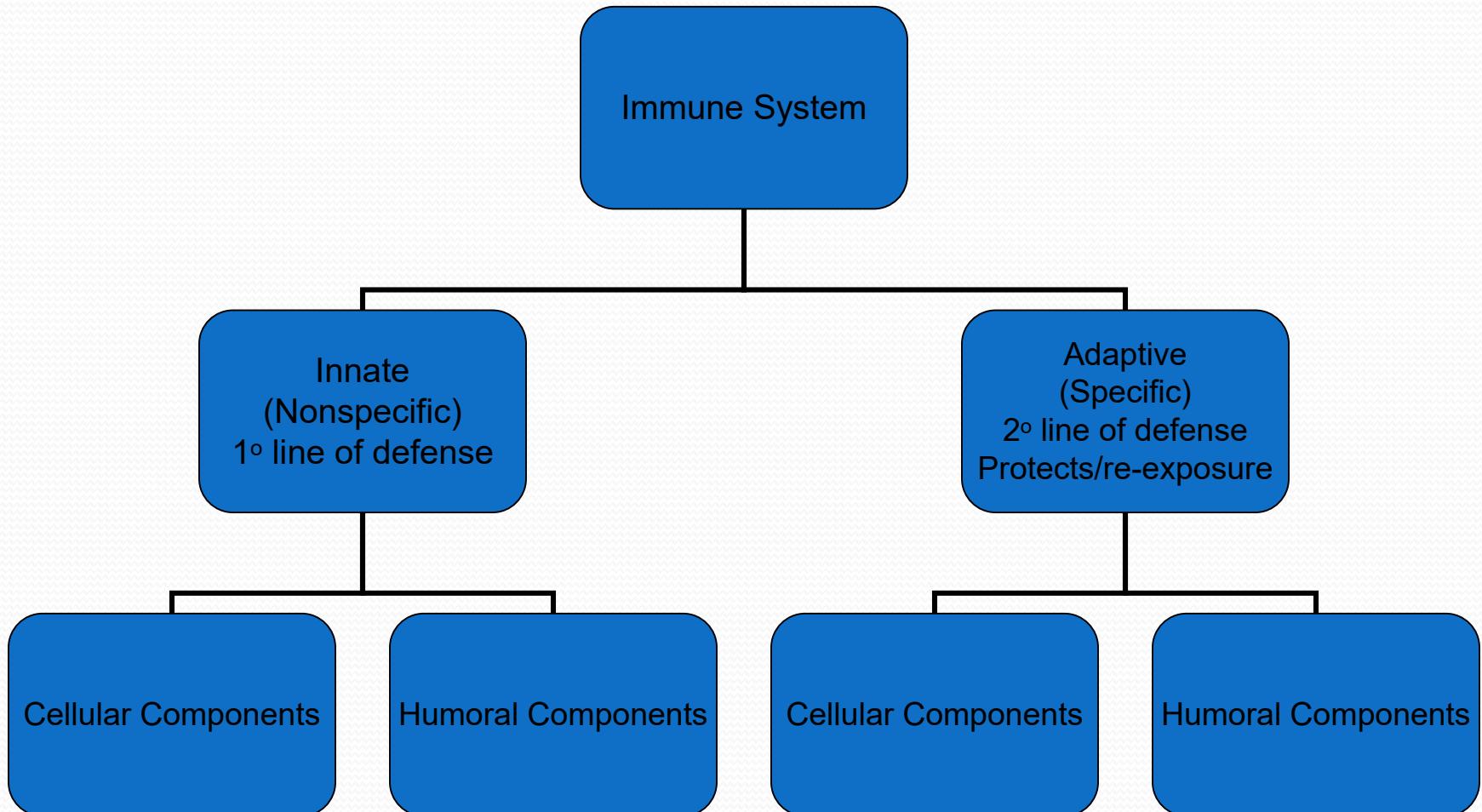
**Immune system** consist of cells and molecules involved in such protection and the response to introduction of a foreign agent is known as the **immune response**.

Not all immune responses protect from disease;

- some foreign agents, such as the **allergens** found in house dust mite, cat dander or rye grass pollen, cause disease as a consequence of inducing an immune response.
- Likewise some individuals mount immune responses to their own tissues as if they were foreign agents.

- Thus, the immune response can cause the **autoimmune** diseases common to man such as multiple sclerosis, diabetes.
- Most individuals do not suffer from autoimmune disease because they have developed **tolerance** towards their own (**self**) tissues.

# Overview of the Immune System



Interactions between the two systems

Most types of blood cell are components of the immune system

NONSPECIFIC DEFENSE MECHANISMS		SPECIFIC DEFENSE MECHANISMS (IMMUNE SYSTEM)
First line of defense	Second line of defense	Third line of defense
<ul style="list-style-type: none"> <li>• Skin</li> <li>• Mucous membranes</li> <li>• Secretions of skin and mucous membranes</li> </ul>	<ul style="list-style-type: none"> <li>• Phagocytic white blood cells</li> <li>• Antimicrobial proteins</li> <li>• The inflammatory response</li> </ul>	<ul style="list-style-type: none"> <li>• Lymphocytes</li> <li>• Antibodies</li> </ul>

# Innate immunity:

- Skin, mucous membranes, saliva
- Cough, sneeze, & vomiting reflexes
- Acidic pH of tissues
- Fever
- Interferon and other substances released by leukocytes; several plasma proteins
- Natural killer cells, macrophages; CNS microglia

# Components of the Innate Host Defenses

- Anatomical barriers
  - Mechanical factors
  - Chemical factors
  - Biological factors
- Humoral components
  - Complement
  - Coagulation system
  - Cytokines
- Cellular components
  - Neutrophils
  - Monocytes and macrophages
  - NK cells
  - Eosinophils

# Anatomical Barriers - Mechanical Factors

System or 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 Factors

System or Organ	Component	Mechanism
Skin	Sweat	Anti-microbial fatty acids
Mucous Membranes	HCl (parietal cells) Tears and saliva	Low pH Lysozyme
	Defensins (respiratory & GI tract)	Antimicrobial
	Surfactants (lung)	Opsonin

# Anatomical Barriers - Biological Factors

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

# Humoral Components

Component	Mechanism
Complement	Lysis of bacteria and some viruses Opsonin Increase in vascular permeability Recruitment and activation of phagocytic cells
Coagulation system	Increase vascular permeability Recruitment of phagocytic cells
Lysozyme	Breaks down bacterial cell walls
Cytokines	Various effects

# Cellular Components

Cell	Functions
Neutrophils	Phagocytosis and intracellular killing Inflammation and tissue damage
Macrophages	Phagocytosis and intracellular killing Extracellular killing of infected or altered self targets Antigen presentation for specific immune response
NK and LAK cells	Killing of virus-infected and altered self targets
Eosinophils	Killing of some parasites

# Acquired immunity

- Present only in vertebrates
- Generally one is born with capacity to respond, but defense is triggered only if organism had prior experience with the invader.
- Discovered by Edward Jenner (18th century):
  - Injected a boy with pus from dairy maid w/ cow pox.
  - Boy later exposed to small pox; he didn't catch it.
  - Vaccination.

# Types of Acquired Immunity

## I. Naturally Acquired Immunity: Obtained in the course of daily life.

### A. Naturally Acquired Active Immunity:

*Antigens* or pathogens enter body naturally.

Body generates an immune response to antigens.

Immunity may be lifelong (chickenpox or mumps) or temporary (influenza or intestinal infections).

### B. Naturally Acquired Passive Immunity:

*Antibodies* pass from mother to fetus via placenta or breast feeding (*colostrum*).

No immune response to antigens.

Immunity is usually **short-lived** (weeks to months).

Protection until child's immune system develops.

# Types of Acquired Immunity (Continued)

**II. Artificially Acquired Immunity:** Obtained by receiving a vaccine or immune serum.

## 1. Artificially Acquired Active Immunity:

**Antigens** are introduced in vaccines (**immunization**).

Body generates an immune response to antigens.

Immunity can be lifelong (oral polio vaccine) or temporary (tetanus toxoid).

## 2. Artificially Acquired Passive Immunity:

Preformed **antibodies (antiserum)** are introduced into body by injection.

Snake antivenom injection from horses or rabbits.

Immunity is short lived (half life three weeks).

Host immune system does not respond to antigens.

# Comparison of Innate and Adaptive Immunity

## Innate Immunity

- No time lag
- Not antigen specific
- No memory

## Adaptive Immunity

- A lag period
- Antigen specific
- Development of memory

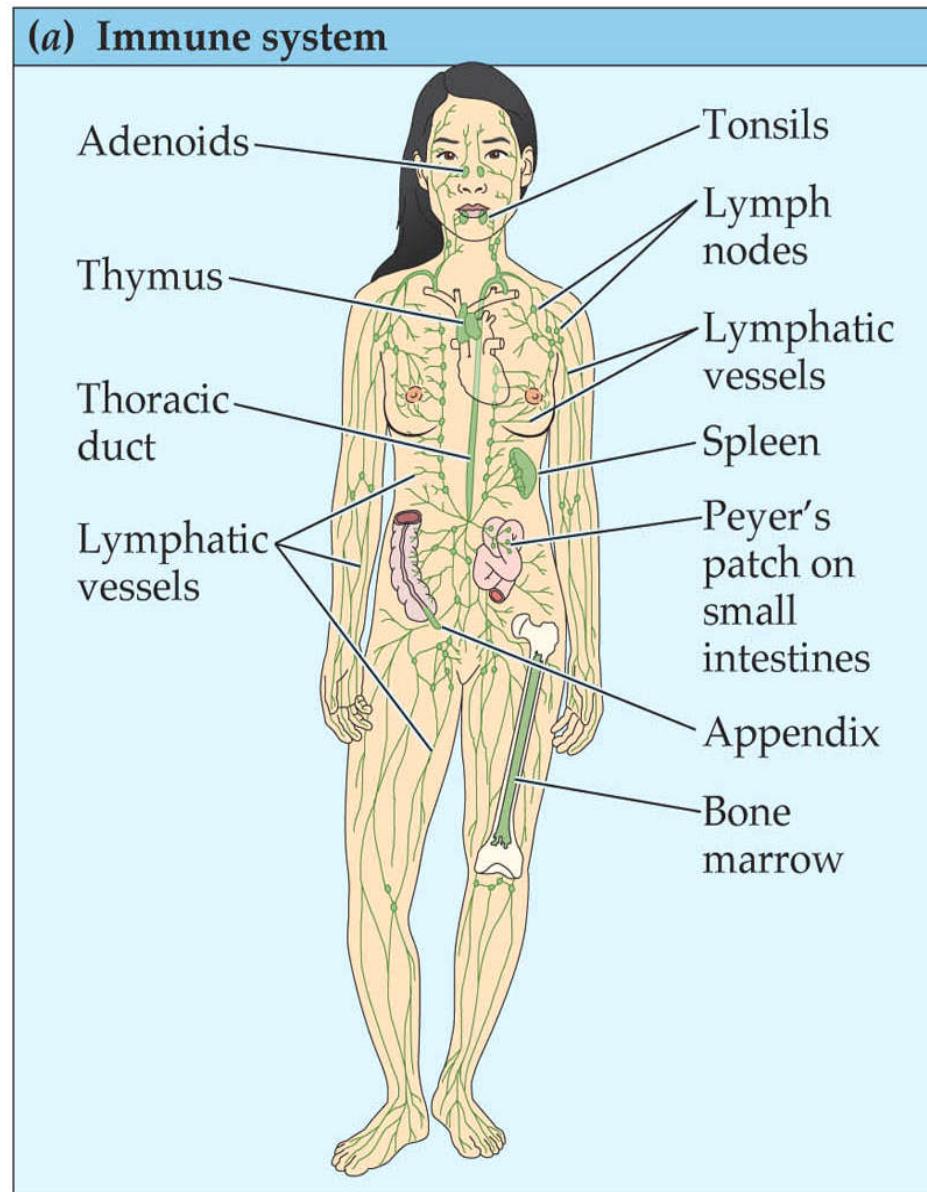
# Organs of immune system

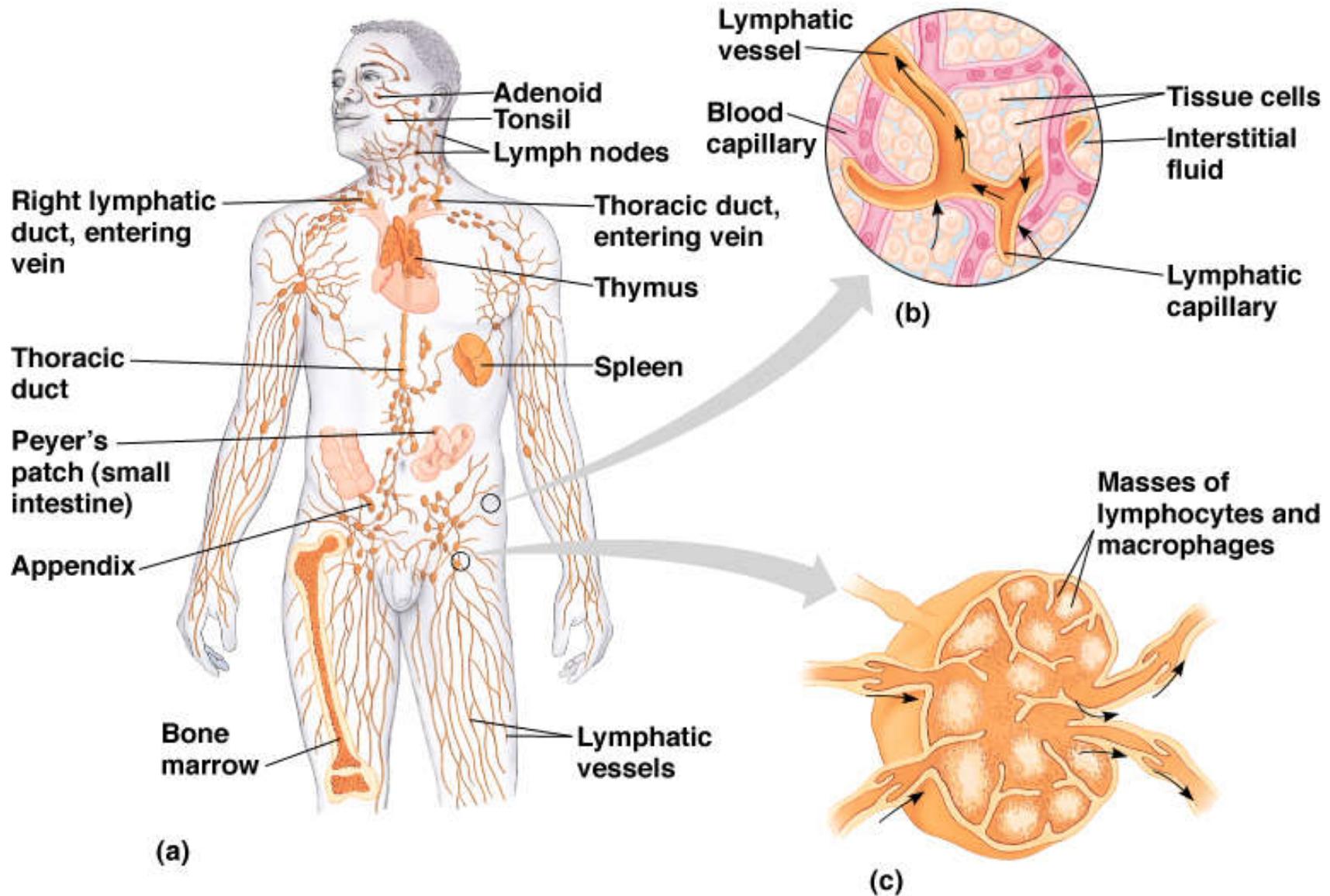
- Thymus: behind sternum (breast bone)
  - Immature T cells mature here. 90% die because they recognize “self” proteins
- Bone marrow: stem cells divide to produce immune system cells

# Organs of immune system

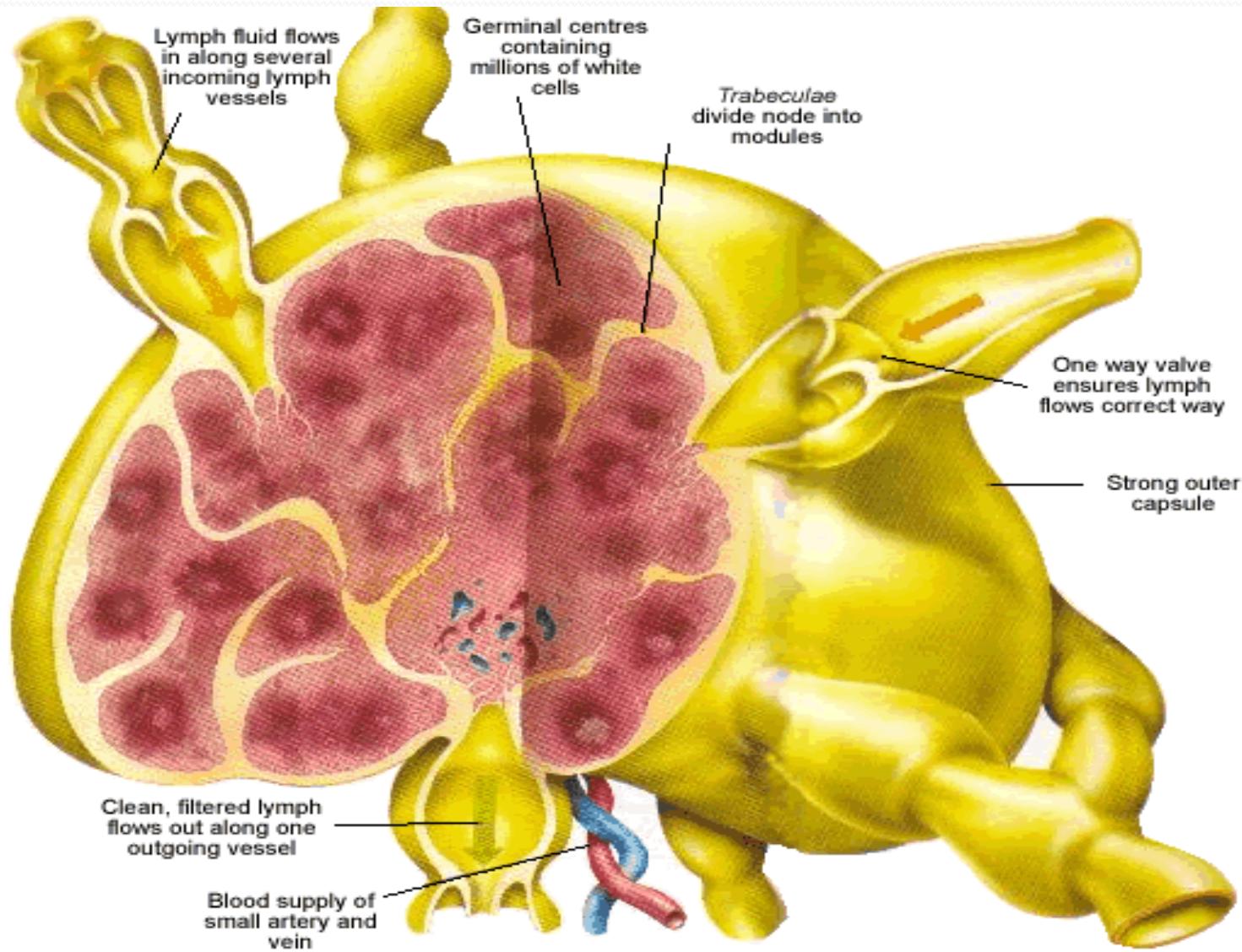
- Lymphatic system
  - Transport lymph: interstitial spaces to blood
  - Lymph nodes: enlarged spaces where foreign substances are trapped & phagocytized
- Spleen: upper left abdomen
  - Blood filter, storage for lymphocytes
  - Large phagocytic cells devour old red blood cells, bacteria, cell particles, toxins
  - Antibodies made and released here

## 15.20 Main Components of the Human Immune System (Part 1)

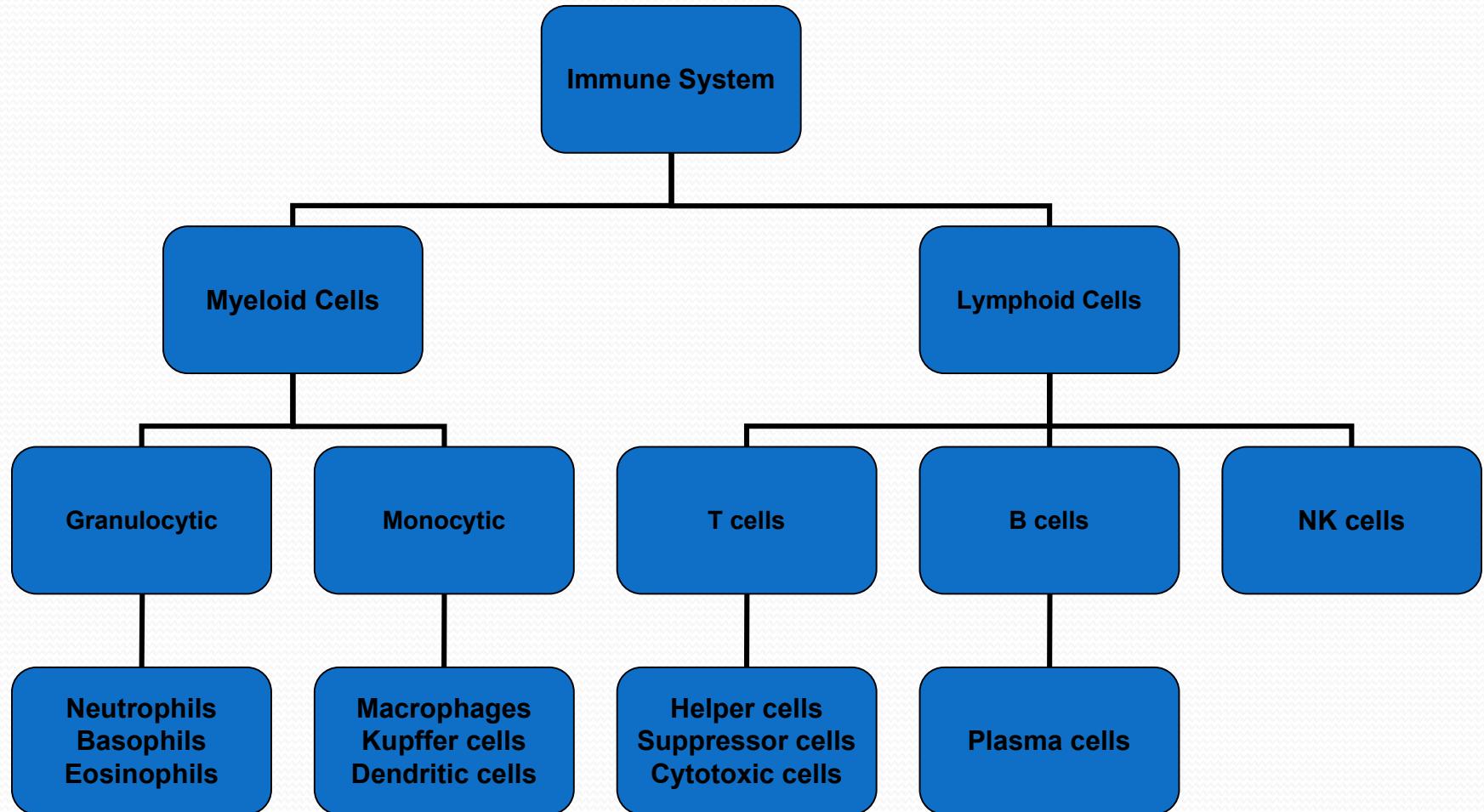




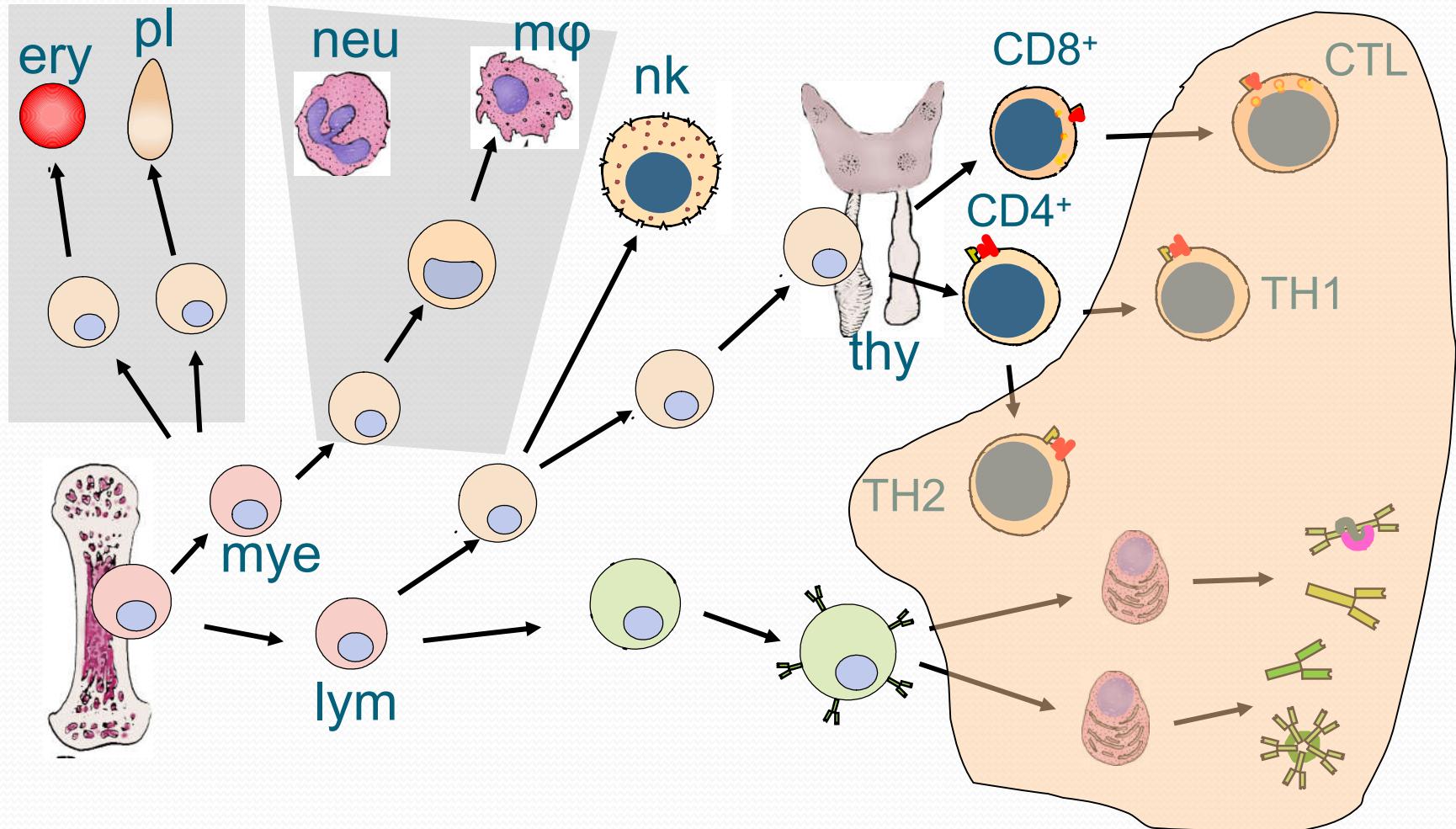
# Lymph node



# Cells of the Immune System



# Development of the Immune System



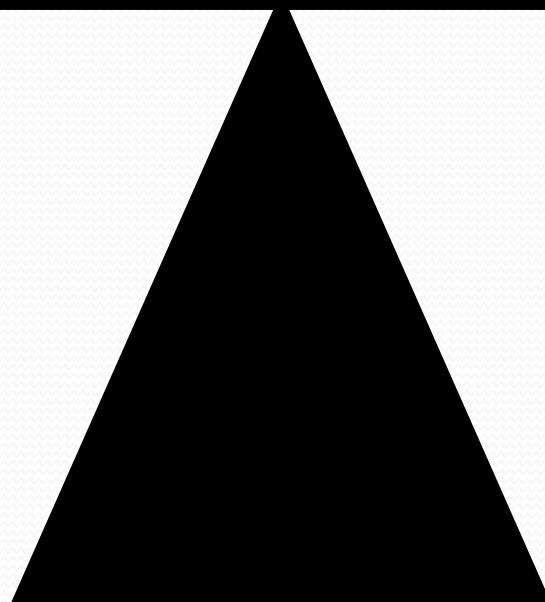
# Function of the Immune System (Self/Non-self Discrimination)

- To protect from pathogens
  - Intracellular (*e.g.* viruses and some bacteria and parasites)
  - Extracellular (*e.g.* most bacteria, fungi and parasites)
- To eliminate modified or altered self

# Infection and Immunity Balance

infection

immunity



# Effects of the Immune System

- **Beneficial:**
  - Protection from Invaders
  - Elimination of Altered Self
- **Detrimental:**
  - Discomfort and collateral damage (inflammation)
  - Damage to self (hypersensitivity or autoimmunity)

