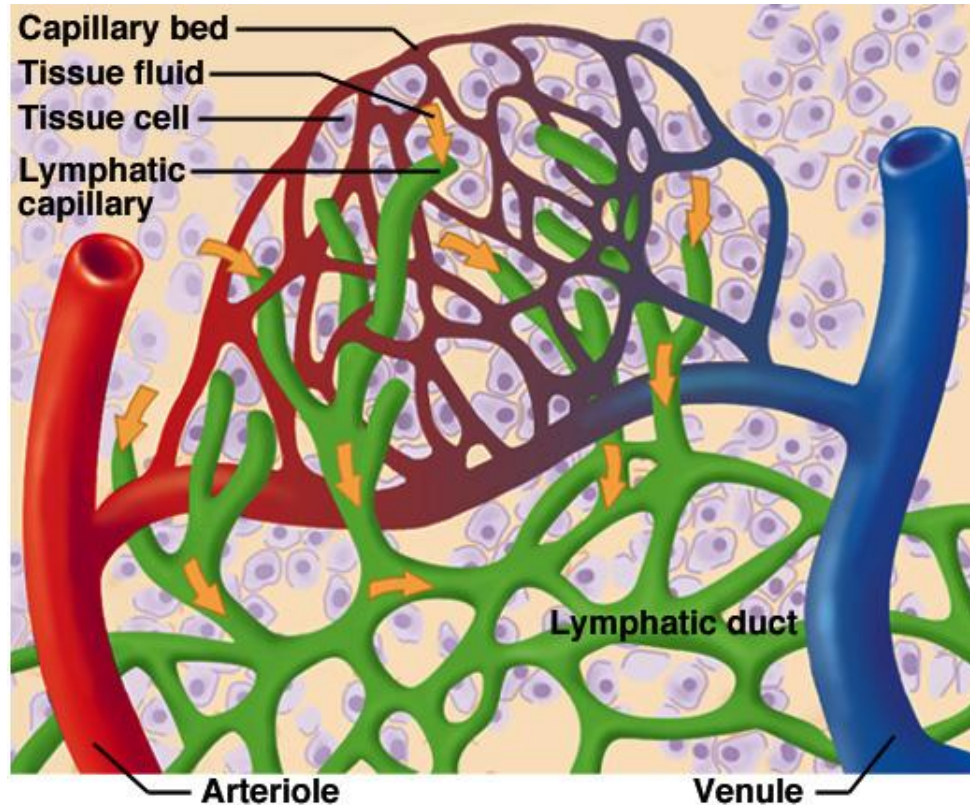


# Chapter 21

## Lymphatic and Immune Systems



- Maintain fluid balance
- Protect body from infection and disease



# Functions of Lymphatic System

- Immunity
  - fluids from all capillary beds are filtered
  - immune cells stand ready to respond to foreign cells or chemicals encountered
- Lipid absorption
  - Lacteals in small intestine absorb dietary lipids
- Fluid recovery
  - absorbs plasma proteins and fluid (2 to 4 L/day) from tissues and returns it to the bloodstream
    - interference with lymphatic drainage leads to severe edema



# Route of Lymph Flow

- Lymphatic capillaries
- Collecting vessels: course through many lymph nodes
- Lymphatic trunks: drain major portions of body
- Collecting ducts :
  - **right lymphatic duct** – receives lymph from R arm, R side of head and thorax; empties into R subclavian vein
  - **thoracic duct** - larger and longer, begins as a prominent sac in abdomen called the cisterna chyli, receives lymph from below diaphragm, left arm, left side of head, neck and thorax; empties into L subclavian vein



# Mechanisms of Lymph Flow

- Lymph flows at low pressure and speed
- Moved along by rhythmic contractions of lymphatic vessels-stretching of vessels stimulates contraction
- Flow aided by skeletal muscle pump
- Thoracic pump aids flow from abdominal to thoracic cavity
- Valves prevent backward flow
- Rapidly flowing bloodstream in subclavian veins, draws lymph into it
- Exercise significantly increases lymphatic return



# Lymphatic Cells

- T lymphocytes
  - Mature in thymus
- B lymphocytes
  - Activation causes proliferation and differentiation into plasma cells that produce antibodies
- Antigen Presenting Cells
  - Macrophages (from monocytes)
  - dendritic cells (in epidermis, mucous membranes and lymphatic organs)
  - reticular cells (also contribute to stroma of lymph organs)



# Lymphatic Tissue

- Diffuse lymphatic tissue: lymphocytes in mucous membranes and CT of many organs
  - Mucosa-Associated Lymphatic Tissue: particularly prevalent in passages open to the exterior
- Lymphatic nodules: dense oval masses of lymphocytes, congregate in response to pathogens
  - Peyer patches: more permanent congregation, clusters found at junction of small to large intestine



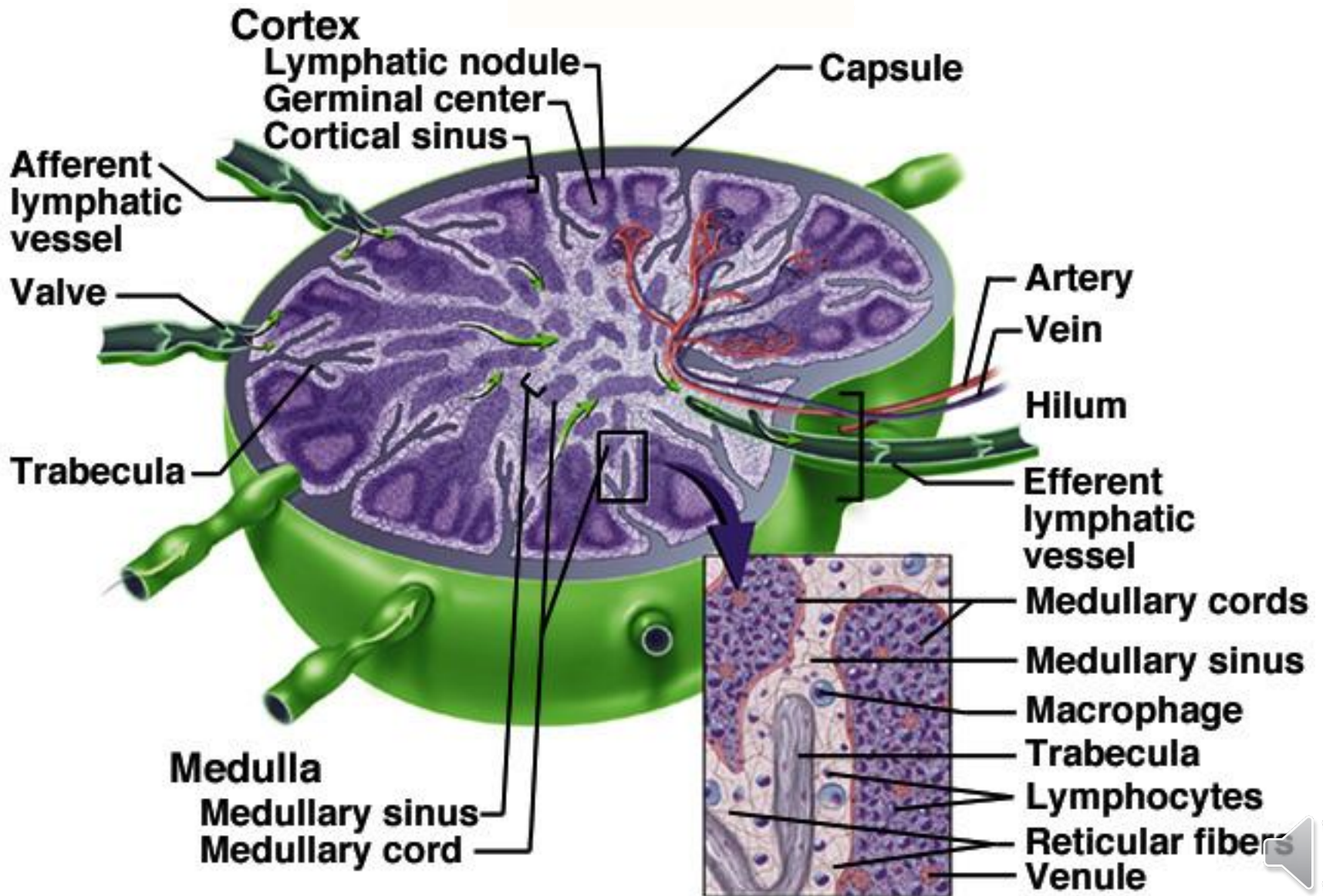
# Lymphatic Organs

- At well defined anatomical sites, have CT capsules
- Lymph nodes
  - cervical, axillary and inguinal regions close to surface
  - thoracic, abdominal and pelvic groups deep in cavities
- Tonsils
  - guard entrance to pharynx
- Thymus
  - between sternum and aortic arch
- Spleen
  - inferior to diaphragm, dorsolateral to stomach





# Lymph Node





# Defenses Against Pathogens

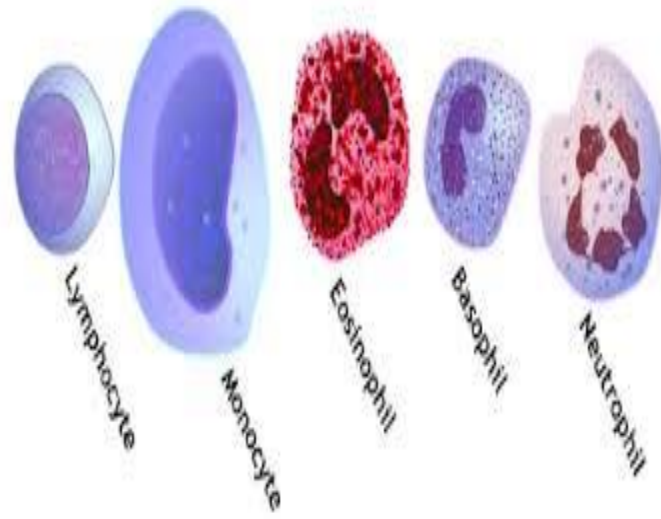
- Nonspecific defenses - broadly effective, no prior exposure
  - external barriers
  - phagocytic cells, antimicrobial proteins, inflammation and fever
- Specific defense - results from prior exposure, protects against only a particular pathogen
  - immune system



# External Barriers

- Skin
  - toughness of keratin
  - dry and nutrient-poor
  - defensins: peptides, from neutrophils attack microbes
  - lactic acid (acid mantle) is a component of perspiration
- Mucous membranes
  - stickiness of mucus
  - lysozyme: enzyme destroys bacterial cell walls
- Subepithelial areolar tissue
  - tissue gel: viscous barrier of hyaluronic acid
    - hyaluronidase: enzyme used by pathogens to spread





# Leukocytes and Cutaneous Defenses

- Neutrophils
  - phagocytize bacteria
  - create a killing zone
    - degranulation: lysosomes discharge into tissue fluid, triggers
    - respiratory burst: toxic chemicals are created ( $\text{O}_2^-$ ,  $\text{H}_2\text{O}_2$ ,  $\text{HClO}$ )
- Eosinophils
  - phagocytize antigen-antibody complexes, allergens, inflammatory chemicals
  - antiparasitic effects: aggregate and release enzymes



# Other Leukocytes

- Basophils
  - aid mobility and action of WBC's by the release of
    - histamine (vasodilator) ↑ blood flow to infected tissue
    - heparin (anticoagulant) prevents immobilization of phagocytes
- Monocytes
  - circulating precursors to macrophages
- Lymphocytes
  - natural killer (NK) cells, nonspecific defense, large cells lyse host cells infected with viruses or cancerous by release of perforin proteins



# Antimicrobial Proteins

- Interferons: polypeptides secreted by cells invaded by viruses
  - antiviral effect
    - generalized protection
    - interferons diffuse to neighboring cells and stimulate them to produce antiviral proteins
    - activate natural killer cells and macrophages
      - destroy infected host cells
  - anticancer effect
    - stimulate destruction of cancer cells



# Complement System

- Group of proteins in blood that must be activated by pathogens to exert their effect
- Pathways of complement activation (*see next slide*)
  - classical pathway
  - alternate pathway
- Mechanisms of action (*see next slide*)
  - enhanced inflammation
  - opsonization (promotes phagocytosis)
  - cytolysis (membrane attack complex)

