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Anatomy bone vessels and nerves

5th Lecture

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Bone :

Living tissue: adapts to stress by changing structure.

Composition: cells, fibers, and mineralized matrix.

Properties: hard and elastic (due to minerals

and organic fibers).

Functions:

protection (skull, spine, ribs),

support (levers in limbs), to create movement and force.

Calcium storage: Holds around 99% of the body's calcium,

critical for bones and other functions.

Bone marrow protection: **Encases and protects** bone marrow, responsible for blood cell production.

Structure:

- **Periosteum**: Fibrous tissue covering bone surfaces, except for joints. Contains nerves and blood vessels, helps with bone repair and growth.
- **Compact bone**: Dense, solid form of bone found in the outer layer of bones.
- **Cancellous bone**: Spongy form of bone with a network of thin plates (trabeculae) and spaces filled with bone marrow.

- Bones are attached to muscles, tendons, and ligaments via Sharpey's fibers from the periosteum.
- The periosteum is sensitive to injury and plays a vital role in bone healing.

Bone Classification **Two main : Regional and Shape.**

- Regional:
  - Axial skeleton: Central axis (skull, spine, ribs).
  - Appendicular skeleton: Limbs (girdles and extremities).
- Shape:
  - Long (e.g., humerus, femur).
  - Short (e.g., wrist and ankle bones).
  - Flat (e.g., skull bones).
  - Irregular (e.g., vertebrae, hip bones).
  - Sesamoid (small bones within tendons, e.g., kneecap).

Cartilage

- Connective tissue: embedded in gel-like matrix, providing firmness and resilience.
- Types: **hyaline**, **fibrocartilage**, **elastic**.
- Hyaline: supports bone growth, covers joint surfaces, not self-repairing.
- Fibrocartilage: found in joint discs, limited self-repair.
- Elastic: found in ears and airways, limited self-repair.
- General: all types prone to calcification with age.

Bone Surface Markings :

Bones have raised or roughened areas where muscles, tendons, and other structures attach.

These markings develop after birth due to the pull of these structures on the **periosteum**.

Large markings have specific names (e.g., **epicondyles**, **trochanters**).

Function:

provide **attachment** points for muscles, tendons, and ligaments.

Bone Development:

- **Membranous**: Bone directly from connective tissue (e.g., skull vault).
- **Endochondral**: Cartilaginous model replaced by bone (e.g., long bones).
- **Stages**: Diaphysis (shaft), epiphysis (ends), epiphyseal plate (growth zone), metaphysis (transition area).

Completion: Around 18-20 years for most bones.

Bone Marrow:

- Red marrow: Produces blood cells (active in younger individuals).
- Yellow marrow: Primarily fat storage (increases with age).
- Location: Varies in different bones (mostly skull, spine, ribs, hips, and limb ends in adults).

Additional Points:

- Skull bones have gaps at birth allowing for molding during delivery.
- Endochondral development is a slower process compared to membranous.

Nervous System :

- Controls and integrates body activities, working alongside the endocrine system.
- **Two main parts:**
  - **Central** Nervous System (CNS):

    Brain and

    spinal cord.
  - **Peripheral** Nervous System (PNS):

    Cranial nerves and

    spinal nerves with ganglia.
- **Functional division:**
  - **Somatic** Nervous System: Controls skeletal muscles, mostly voluntary responses.
  - **Autonomic** Nervous System (ANS): Controls internal organs, mostly involuntary responses.

Central Nervous System (CNS) :

- Made of nerve **cells** (**neurons**) and

  supporting neuroglial cells.
- Neurons: individual nerve cells with three parts:
  - Cell **body**: main part containing the nucleus.
  - **Dendrites**: short processes receiving signals from other neurons.
  - **Axon**: long process sending signals to other neurons.
- Groups of neuron cell bodies in the CNS called **nuclei.**

CNS Interior and Protection :

- **Gray matter**: Nerve cell **bodies** and **neuroglia** (grayish color).
- **White** matter: Nerve fibers (**axons**) and **neuroglia** (whitish color)
- Gray matter organization: H-shaped in spinal cord.
- Central **canal**: Filled with cerebrospinal fluid, runs through the CNS.
- **Meninges**: Three protective membranes surrounding the CNS (dura mater, arachnoid mater, pia mater).

The **peripheral nervous system** is a network of nerves and ganglia outside the brain and spinal cord. It branches out through cranial nerves (head/neck) and spinal nerves (rest of body).

- **Cranial nerves:** 12 pairs, connected to the brain, serve the head and neck **except** for the vagus nerve which also reaches thorax and abdomen.
- **Spinal nerves:** 31 pairs, connected to the spinal cord, serve various regions of the body according to their location.

Each spinal nerve starts as **2** sets of bundles: front (motor) and back (sensory).

These bundles **join**, then **split** into a main nerve and smaller branches. The **main** nerve carries both motor and sensory signals,

while the smaller branches go to specific areas like muscles or skin.

There are 2 ways nerves are distributed:

1. Simply follow the **body segments** (like ribs).
2. Form complex networks called **plexuses,** where nerves from different segments mix and create new nerves. This happens in the neck, arm, and leg.

the autonomic nervous system:

- The autonomic nervous system (ANS) is the part of the nervous system that controls involuntary functions, such as heart rate, digestion, and breathing.
- It is divided into two parts: the sympathetic division and the parasympathetic division.
- The sympathetic division is responsible for the fight-or-flight response. It increases heart rate, blood pressure, and respiration.
- The parasympathetic division is responsible for the rest-and-digest response. It decreases heart rate, blood pressure, and respiration.
- The ANS is important for maintaining homeostasis, or balance, in the body.

Autonomic Nervous System (ANS):

- Two divisions: Sympathetic and parasympathetic, often acting in opposition.
- Sympathetic: Prepares body for emergencies (fight-or-flight), increases heart rate, blood pressure, etc.
- Parasympathetic: Promotes rest and recovery, decreases heart rate, etc.
- Sympathetic distribution: Complex but organized.
- Preganglionic neurons: Located in spinal cord (T1-L2), send fibers to sympathetic trunk.

the Parasympathetic Nervous System:

Scope and organization:
Smaller and simpler than the Sympathetic Nervous System.
Focused on head, body cavities, and genitals (not limbs or body wall).
"Craniosacral outflow": originates in brain (CNs) and sacral spinal cord.

Sympathetic trunk: Two chains alongside the spine, containing ganglia for connections.
Postganglionic fibers: Exit trunk and reach target organs via spinal nerves.
Four target regions: Body wall, limbs, head & neck, viscera (internal organs).

Preganglionic neurons:

- Brain: CNs III, VII, IX, X control head organs.
- Sacral cord (S2-S4): control pelvic organs.

Postganglionic neurons:

- Short, non-myelinated fibers near target organs.
- Ganglia are close to viscera they innervate.

Recent update:

- Sacral outflow now considered part of the Sympathetic Nervous System.
- Cranial outflow remains Parasympathetic.

Function:

- Promotes "rest and digest" activities.

The autonomic nervous system consists of two parts: the **sympathetic division** and the **parasympathetic division.** The sympathetic division prepares the body for emergency, whereas the parasympathetic division aids in recovery.

Blood Vessels

The three types of blood vessels are arteries, veins, and capillaries

Arteries

Arteries transport blood away from the heart

. The smallest arteries (<0.1 mm in diameter) are referred to as arterioles

some blood may enter a functional end

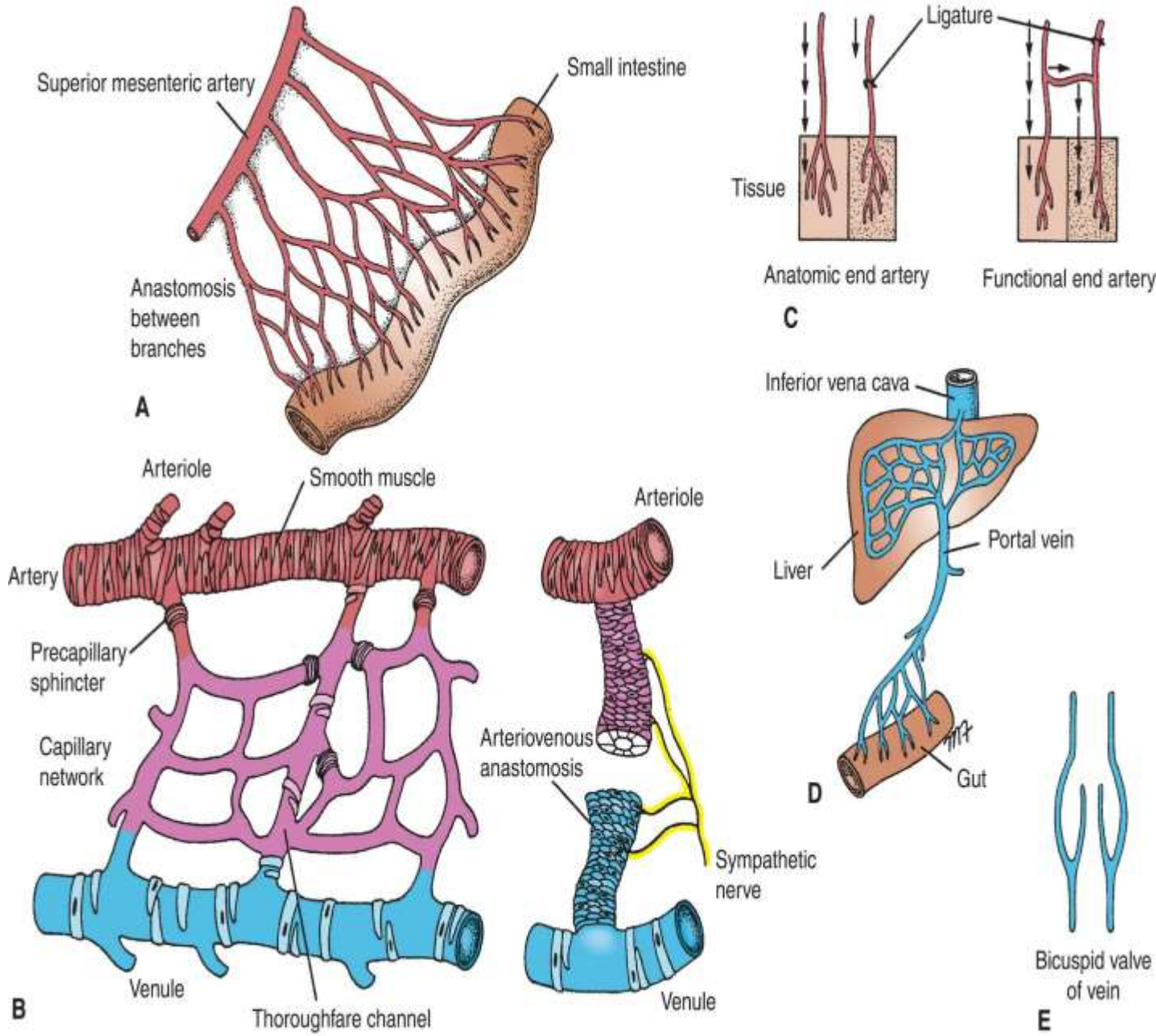
List of Key Points about Blood Vessels:

Types:

- Arteries: carry blood away from the heart, branching into arterioles (smallest arteries)
- Veins: carry blood towards the heart, branching into venules (smallest veins)
    - Many veins have valves to prevent backward flow
    - Two veins often accompany arteries as venae comitantes
    - Veins from the gastrointestinal tract form the portal system, entering the liver before reaching the heart
    - Many veins possess valves, which function to prevent reflux of blood
    - smallest veins are called venules
- Capillaries: microscopic vessels connecting arterioles to venules
    - Sinusoids resemble capillaries with irregular shape and wider diameter (found in bone marrow, spleen, liver, etc.)
    - Arteriovenous anastomoses: direct connections between arteries and veins in certain areas (e.g., fingertips)

Clinical Notes:

- Blood vessel diseases are common.
- Know the collateral circulation of major arteries and the distinction between anatomic and functional end arteries.
- Large arteries crossing joints may be kinked during movement, but collateral circulation prevents blood flow interruption.
- Coronary arteries are functional end arteries, so blockage can lead to tissue death and potentially death of the patient.



Summary of Blood Vessels:

1. **Arteries:**
   - Transport blood away from the heart.
   - Arterioles are small branches.
   - Anastomoses connect arteries.
   - Anatomic and functional end arteries differ in anastomotic patterns.
2. **Veins:**
   - Transport blood toward the heart.
   - Venules are small veins.
   - Venae comitantes accompany deep arteries.
   - Portal system in veins from the gastrointestinal tract.
3. **Capillaries:**
   - Microscopic vessels connecting arterioles to venules.
   - Sinusoids, wider than capillaries, found in specific organs.
   - Arteriovenous anastomoses in certain areas
4. **Blood Vessel Diseases:**
   - Common diseases impact blood vessels.
   - Understanding collateral circulation is crucial.
   - Considerations for tying off damaged arteries.
5. **Coronary Arteries:**
   - Coronary arteries are functional end arteries.
   - Coronary arterial occlusion can lead to myocardial infarction.

Collateral circulation is vital for managing coronary artery diseases

Lymphatic System

Components:

- **Lymphatic organs:** Lymph nodes, tonsils, thymus, spleen, lymph nodules
- **Lymphatic vessels:** Capillaries, collecting vessels, lymphatic trunks/ducts

Structures:

- Lymph **capillaries**: Fine vessels draining lymph from tissues
- **Lacteals**: Specialized capillaries in the small intestine absorbing fat
- **Collecting** vessels: Drain capillaries, often paired with veins and have valves
- Lymphatic **trunks**/ducts: Major vessels draining lymph into the bloodstream
- Lymph **nodes**: Filter lymph and contain immune cells

Functions:

- Collect tissue fluid and return it to the bloodstream
- Filter and cleanse lymph
- Produce lymphocytes (immune cells)

Flow:

Driven by extravascular forces (muscle contraction, respiration)
Lymphedema: Abnormally large accumulation of fluid due to obstruction
Drainage:
Upper right quadrant: Drains directly into veins on the right side
Rest of body: Drains into thoracic duct and then into the left side
Arrangement of ducts can vary

Lymph is clear tissue fluid that drains mainly into the venous system. Lymphatic organs (lymph nodes, tonsils, thymus, spleen) and lymphatic vessels (ducts and trunks) are the two major components of the lymphatic system.
The structure and function of the body may vary according to sex, age, and race.

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Relationship to Blood Vessels:

- Lymphatic channels generally follow blood vessel pathways (except in thorax)
- Understanding blood vessel anatomy helps understand lymphatic drainage


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