Chapter 04
Organization & Regulation of Body Systems

Organ system → Organism

Organ system → Organ → Tissue → Cells

Atom → Molecule
Organization and Regulation of Body Systems
Points to ponder

- What is a tissue? Organ? Organ system?
- What are the 4 main types of tissue?
- What do these tissues look like, how do they function, and where are they found?
- What is the integumentary system?
- How can you prevent skin cancer?
- What is homeostasis and how is it maintained?
What are the organ systems of the human body?

**Integumentary systems**
- Protects body.
- Provides temperature homeostasis.
- Synthesizes vitamin D.
- Receives sensory input.
  Organ: Skin.

**Cardiovascular systems**
- Transport system for nutrients, waste.
- Provides temperature, pH, and fluid homeostasis.

**Lymphatic and Immune systems**
- Defends against infectious diseases.
- Provides fluid homeostasis.
- Assists in absorption and transport of fats.
  Organs: Lymphatic vessels, lymph nodes, spleen.

**Digestive system**
- Ingests, digests, and processes food.
- Absorbs nutrients and eliminates waste.
- Involved in fluid homeostasis.
  Organs: Oral cavity, esophagus, stomach, small intestine, large intestine, salivary glands, liver, gallbladder, pancreas.

**Respiratory system**
- Exchanges gases at both lungs and tissues.
- Assists in pH homeostasis.
  Organs: Lungs.

**Urinary system**
- Excretes metabolic wastes.
- Provides pH and fluids homeostasis.
  Organs: Kidneys, urinary bladder.

*Figure 4.13. Organ systems of the body.*
What are the organ systems of the human body?

**Figure 4.13.** Organ systems of the body.

- **Skeletal system**
  - provides support and protection
  - assists in movement
  - stores minerals
  - produces blood cells
  Organs: Bones

- **Muscular system**
  - assists in movement and posture
  - produces heat
  Organs: Muscles

- **Nervous system**
  - receives, processes, and stores sensory input
  - provides motor output
  - coordinates organ systems
  Organs: Brain, spinal cord

- **Endocrine system**
  - produces hormones
  - coordinates organ systems
  - regulates metabolism and stress response
  - involved in fluid and pH homeostasis
  Organs: Testes, ovaries, adrenal glands, pancreas, thymus, thyroid, pineal gland

- **Reproductive system**
  - produces and transports gametes
  - nurtures and gives birth to offspring in females
  Organs: Testes, penis, ovaries, uterus, vagina
Tissues

• Groups of cells with a common function

• Four primary tissues
  ➢ Epithelia
  ➢ Connective tissues
  ➢ Muscle
  ➢ Nervous
Epithelial Tissues: Classification

Function: Line body cavities and cover surfaces

1) Number of layers

➢ **Simple/single-layered**
  
  • Adapted for diffusion across cell barriers
  • Line glands, and respiratory, digestive, reproductive systems

![Diagram of simple/ single-layered epithelium with basement membrane]
Epithelial Tissues: Classification

Function: Line body cavities and cover surfaces

1) Number of layers

- **Simple/single–layered**
  - Adapted for diffusion across cell barriers
  - Line glands, and respiratory, digestive, reproductive systems

- **Stratified/multiple–layered**
  - Provide protection → skin surface
Epithelial Tissues: Classification

2) Shape

➢ Squamous
  • Flattened cells
  • Line vessels, part of lungs, body surface

➢ Cuboidal
  • Cube shaped
  • Form lining of tubules, glands

➢ Columnar
  • Column shaped
  • Line respiratory, digestive, reproductive tracts
The Basement Membrane Provides Structural Support

- Basement membrane
  - Provides structural support to overlying cells
  - Attaches epithelial layer to underlying tissues
- Junctions (A Review): hold epithelial cells together
  - **Tight junctions** → nothing passes
  - **Adhesion junctions/spot desmosomes**
    - Some movement between cells
  - **Gap junctions** → Protein channels
a) **Tight junctions** form leak-proof seals between cells.

b) **Anchoring/Adhesion junctions** anchor two cells together, yet allow flexibility of movement.

c) **Gap junctions** provide for the direct transfer of water and ions between adjacent cells.
What does epithelial tissue look like?

- **Simple squamous**: Lining of lungs, blood vessels; protects
- **Simple cuboidal**: Lining kidney tubules, various glands; absorbs molecules
- **Simple columnar**: Lining of small intestine, oviducts; absorbs nutrients
- **Pseudostratified, ciliated columnar**: Lining of trachea; sweeps impurities towards that
- **Stratified squamous**: Lining of nose, mouth, esophagus, anal canal, vagina; protects

**Figure 4.8.** The basic types of epithelial cells.
Epithelial Tissues

Simple squamous
- Lines blood vessels and air sacs of lungs
- Permits exchange of nutrients, wastes, and gases

Stratified squamous
- Outer layer of skin, mouth, vagina
- Protects against abrasion, drying out, infection

Simple cuboidal
- Lines kidney tubules and glands
- Secretes water and small molecules

Stratified cuboidal
- Lines ducts of sweat glands
- Secretes water and ions

Simple columnar
- Lines most digestive organs
- Absorbs nutrients, produces mucus

Stratified columnar
- Lines epididymus, mammary glands, larynx
- Secretes mucus

Goblet cell
- Basement membrane

a) Most epithelial tissues line or cover surfaces or body cavities.
Epithelial Tissues

• Glandular epithelia
  • Exocrine glands
    – Secrete into ducts to exterior of body
  • Endocrine glands
    – Secrete into the blood to carry chemical messages throughout the body

b) Glandular epithelia secrete a product.
Connective Tissue

- General functions
  1) Supports softer organs
  2) Protection of vital organs
  3) Transport nutrients & waste
  4) Connects parts of body
  5) Stores energy/insulation
  6) Body defense

- Extracellular matrix (ECM) → ground substance + protein fibers
- Grd substance → fluid or gelatinous or solid
Connective Tissue Fiber Types

1) Collagen fibers
   • Very strong, flexible & inelastic fibers
   • Collagen protein (pinkish)

2) Elastic fibers
   • Strong but flexible fibers (thin/black)

3) Reticular fibers
   • Small branching collagen fibers
   • Forms a network or reticulum
3 main types of connective tissue

A. Fibrous CT
B. Supportive CT
C. Fluid/Vascular CT

CT cell suffixes
- blasts → produce
- clasts → breakdown
- cytes → mature

Figure 4.4 Types of connective tissue.
Connective Tissue Categories

A. Fibrous Connective Tissue
   A. surrounds many organs
   B. lines cavities around blood vessels

B. Dense Connective Tissue
   • forms tendons, ligaments, deeper layers of skin

C. Vascular (Fluid) Connective Tissue
   • Forms blood components
   • Defense
   • $O_2/CO_2$ transport
What does fibrous connective tissue look like?

- **Elastic fiber**: branched and stretchable
- **Collagen fiber**: unbranched, strong but flexible
- **Fibroblast**: divides to produce other types of cells
- **Reticular fiber**: branched, thin, and forms network
- **White blood cell**: engulfs pathogens or produces antibodies
- **Adipose cell**: stores fat
- **Ground substance**: fills spaces between cells and fibers
- **Blood vessel**

**Figures 4.1 and 4.2** Connective tissues (components and knee).
a) **Loose areolar connective tissue** (X 160). In loose connective tissue the collagen and elastin fibers are arrayed in a random pattern.
b) **Adipose tissue** from the subcutaneous layer under the skin (x 140). Adipose tissue consists almost entirely of fat cells. The fat deposit within a fat cell can become so large that the nucleus is pushed to the side.

Brown adipose tissue?
b) Dense connective tissue (X 160). In dense connective tissue the fibers are primarily collagen fibers. In tendons and ligaments the fibers are oriented all in the same direction, with fibroblasts occupying narrow spaces between adjacent fibers.
What do bone and cartilage look like?

Figure 4.2 Connective tissues in the knee.
b!1. Supportive CT: Hyaline Cartilage

a) Cartilage from the trachea (X 300). Mature cartilage cells, called chondrocytes, become trapped in chambers called lacunae within the hard, rubbery ground substance. Ground substance is composed of collagen fibers, polysaccharides, proteins, and water.

Hyaline cartilage

- Location: trachea, larynx, articular surface, end of nose, nasal septum
- Who likes rib cartilage?

Elastic cartilage

- Location: external ear, epiglottis, auditory tubes
B3. Supportive CT: Bone

• 2 types are distinguished by types of fibers.
  1. **Compact** – made of repeating circular units called osteons
      ▪ Hard matrix, living cells, and blood vessels
      Location: Shafts of long bones
  2. **Spongy** – open latticework with irregular spaces
      Location: Ends of long bones
Compact Bone

- Osteon
- Osteon canal
- Lamellae
- Lacunae
- Osteoblasts
- Canaliculi
- Volkmann’s Canal
C. Vascular or Fluid connective tissue: Blood

- Made of a fluid matrix called **plasma** and cellular components that are called formed elements

- **3 formed elements:**
  1. **Red blood cells** (erythrocytes) – cells that carry $O_2/CO_2$ & buffers $H^+$.
  2. **White blood cells** (leukocytes) – cells that fight infections
  3. **Platelets** (thrombocytes) – pieces of cells that clot blood
C. Vascular or Fluid connective tissue: Blood

Figure 4.3 The formed elements of blood.
Vascular Connective Tissue

- Erythrocytes (RBC)
- Leukocytes (WBC)
  - Agranulocyte
    - Monocyte (3-8%)
      - Macrophage
    - Lymphocyte (20-25%)
      - B & T cells
  - Granulocytes
    - Neutrophil (65-75%)
    - Eosinophil (2-4%)
    - Basophil (< 1%)
Muscle Tissue

**Skeletal muscle**

Moves skeletal body parts

Voluntary, multinucleated

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a) **Skeletal muscle** (X 100). Skeletal muscle cells are very long and have many nuclei.
Muscle Tissue

**Cardiac muscle**
- Location: heart
- Involuntary, single nucleus

Intercalated Disc (gap junctions)


Muscle Tissue

**Smooth** muscle

Surrounds hollow structure

Involuntary, single nucleus

thin and tapered

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Smooth muscle
- has spindle-shaped cells, each with a single nucleus.
- cells have no striations.
- functions in movement of substances in lumens of body.
- is involuntary.
- is found in blood vessel walls and walls of the digestive tract.

b. © McGraw-Hill Education/Dennis Strete
Nervous Tissues Transmit Impulses

- **Neuron**: specialized nervous system cell
  - Function: generate and transmit electrical impulses
  - Structural components: cell body, dendrites, axon

- **Glial cells** support neurons
A. Nervous tissue - neurons

- Components:
  - Dendrites → info to cell body
  - Cell body
  - Axon → info away from cell body

Three Types of Neurons

Figure 4.6. A neuron and examples of supporting neuroglia cells.
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A. Nervous tissue - neuroglia

- They are a collection of cells that support and nourish neurons.
- They outnumber neurons 9:1.
- Examples are oligodendrocytes, astrocytes, and microglia.

Figure 4.6. A neuron and examples of supporting neuroglia cells.
Organs and Organ Systems Perform Complex Functions

• Organs
  – Contain two or more tissue types joined together; perform specific functions

• Organ systems
  – Groups of organs that perform a common function
  – Examples
    • Digestive system: mouth, throat, stomach, intestines, and liver
    • Lymphatic system: lymph nodes, tonsils, and spleen
Organ systems of the human body

**Integumentary systems**
- protects body.
- provides temperature
- Homeostasis
- synthesizes vitamin D.
- receives sensory input
  Organ: Skin.

**Cardiovascular systems**
- transport system for nutrients, waste
- provides temperature, pH, and fluid
- homeostasis
  Organ: Heart

**Lymphatic and Immune systems**
- defends against infectious diseases
- provides fluid
- homeostasis
- assists in absorption and transport of fats
  Organs: Lymphatic vessels, lymph nodes, spleen

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  Organs: Lungs

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*Figure 4.13. Organ systems of the body.*
Organ systems of the human body

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**Endocrine system**
- produces hormones
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- regulates metabolism and stress response
- involved fluid and pH homeostasis
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**Reproductive system**
- produces and transports gametes
- nurtures and gives birth to offspring in females
  Organs: Testes, penis, ovaries, uterus, vagina

Figure 4.13. Organ systems of the body.
What are the body cavities?

- **Thoracic cavity**: Contains heart, lungs, and esophagus.
- **Abdominal cavity**: Contains digestive and other organs.
- **Pelvic cavity**: Contains reproductive and other organs.
- **Cranial cavity**: Contains brain.
- **Plural cavity**: Contains esophagus, heart, and lungs.
- **Pericardial cavity**: Contains heart and lungs.
- **Vertebral cavity**: Contains spinal cord.
- **Anterior cavity**: Contains stomach, liver, spleen, pancreas, gallbladder, and intestines.

**Figure 4.14.** Body cavities of humans.
Figure 4.8

Pelvic cavity
Abdominal cavity
Diaphragm separates thoracic and abdominal cavities
Pericardial cavity
Pleural cavity
Thoracic cavity
Vertebral canal
Cranial cavity
Posterior cavity
Anterior cavity
Abdominal cavity
Pelvic cavity
Body membranes that line the cavities?

Serous membranes – line the lungs, heart, and abdominal cavity and cover the internal organs;
• Pleura: lungs
• Peritoneum: abdominal cavity and organs
• Pericardium: heart
➢ Reduces friction

Figure 4.14. Body cavities of humans.
**Body membranes that line the cavities?**

**Thoracic cavity:** contains heart, lungs, and esophagus

**Abdominal cavity:**
- Contains digestive and other organs

**Pelvic cavity:**
- Contains reproductive and other organs

**Mucous membranes** – line the digestive, respiratory, urinary, and reproductive systems:
- Lubricates surface, captures debris

**Figure 4.14.** Body cavities of humans.
Body membranes that line the cavities?

**Thoracic cavity:** Contains heart, lungs, and esophagus

**Abdominal cavity:** Contains digestive and other organs

**Pelvic cavity:** Contains reproductive and other organs

**Cranial cavity:** Contains brain

**Vertebral cavity:** Contains spinal cord

**Pluræ**

**Pericardium**

**Peritoneum**

**Thoracic cavity:** Contains esophagus, heart, and lungs

**Abdominal cavity:** Contains digestive and other organs

**Pelvic cavity:** Contains reproductive and other organs

**Meninges** — cover the brain and spinal cord

*Figure 4.14. Body cavities of humans.*
Body membranes that line the cavities?

**Synovial membranes** – line the cavities of freely movable joints.
The Skin as an Organ System

• Integumentary system
  ▪ skin, hair, nails, glands

• Functions
  ▪ Prevents dehydration
  ▪ Protects from injury
  ▪ defense against microbes
  ▪ Regulates body temperature
  ▪ Makes vitamin D
  ▪ Provides sensation
2 regions of the skin

- Epidermis (Langerhan cells, melanocytes)
- Dermis
- Subcutaneous

Figure 4.9. Anatomy of human skin.
Skin Consists of **Epidermis** and **Dermis**

Epidermis (Outer layer)
- Stratified squamous epithelial
- No blood vessels
- Two major cell types
  - Specialized keratinocytes
  - Melanocytes

Epidermis
- Dead cells of epidermis
- Living cells of epidermis
- Dermis with blood vessel

Dermis
- Blood vessel
- Basement membrane
- Dividing keratinocyte (basal cell)
- Keratinocyte containing melanin
- Melanocyte containing melanin granules
Skin Consists of Epidermis and Dermis

• Dermis
  ▪ Lies underneath the epidermis
  ▪ Supports tissues
  ▪ Fibers
    ▪ Collagen
    ▪ Elastic
  ▪ Cells
    ▪ Fibroblasts
    ▪ Mast cells
    ▪ White blood cells
    ▪ Fat cells
  ▪ Tattoos

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Skin Consists of Epidermis and **Dermis**

- Dermis (Lies underneath the epidermis)
  - Supports tissues
  - Blood vessels
  - Nerve endings/receptors
  - Sweat & sebaceous glands
  - Hair follicles
  - Cells
    - Fibroblasts & Mast cells
    - White blood cells & Fat cells
  - Tattoos
Accessory Structures of Dermis

- **Hair**
  - Shaft
  - Follicle

- **Smooth muscle**
  - Attached to hair follicle, raises hair to upright position

- **Oil glands/sebaceous glands**
  - Secretion moistens and softens skin
### ABCDE’s of Melanoma

<table>
<thead>
<tr>
<th>Benign</th>
<th></th>
<th>Malignant</th>
</tr>
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<tbody>
<tr>
<td>Symmetrical</td>
<td>A</td>
<td>Assymetrical (the two sides do no match)</td>
</tr>
<tr>
<td>Borders are even</td>
<td>B</td>
<td>Borders are uneven</td>
</tr>
<tr>
<td>One color</td>
<td>C</td>
<td>Two or more colors</td>
</tr>
<tr>
<td>Smaller than 6 mm (1/4 inch)</td>
<td>D</td>
<td>Larger than 6 mm (1/4 inch)</td>
</tr>
<tr>
<td>Ordinary mole</td>
<td>E</td>
<td>Changing in size, shape, color, or another trait</td>
</tr>
</tbody>
</table>
Types of skin cancers

- Basal cell carcinoma
- Squamous cell carcinoma
- Melanoma

- Dead cells of epidermis
- Living cells of epidermis
- Dermis with blood vessel
- Keratinocyte containing melanin
- Melanocyte containing melanin granules
- Dividing keratinocyte (basal cell)

Most Common Types of Skin Cancer

- Melanoma
- Basal Cell Carcinoma
- Squamous Cell Carcinoma
Accessory Structures of Dermis

• Sweat glands
  – Secrete sweat, help in temperature regulation

• Blood vessels
  – Supply nutrients, remove waste, assist in temperature regulation

• Sensory nerve endings
  – Detect heat, cold, touch, deep pressure, vibration