The Animal Body: Introduction to Structure and Function

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Multicellularity

- **Multicellularity** and cell specialization enabled organisms to evolve and adapt to many environments.
- **Unicellular** organisms are limited by size and all functions must be performed by the one cell.
- Cells → Tissues → Organs → Organ systems

Kingdoms

<table>
<thead>
<tr>
<th>Name</th>
<th>Pro- / Eu- karyote?</th>
<th>Uni- / Multi-cellular?</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monera</td>
<td>prokaryote</td>
<td>unicellular</td>
<td>bacteria</td>
</tr>
<tr>
<td>Protista</td>
<td>eukaryote</td>
<td>unicellular</td>
<td>algae, seaweed, protists, water molds</td>
</tr>
<tr>
<td>Fungi</td>
<td>eukaryote</td>
<td>multicellular</td>
<td>yeasts, molds, mildews, mushrooms, rust</td>
</tr>
<tr>
<td>Plantae</td>
<td>eukaryote</td>
<td>multicellular</td>
<td>mosses, ferns, trees, shrubs, plants</td>
</tr>
<tr>
<td>Animalia</td>
<td>eukaryote</td>
<td>multicellular</td>
<td>worms, insects, sponges, birds, mammals</td>
</tr>
</tbody>
</table>

Organization of the Body

- Bodies of all vertebrates are basically a tube within a tube.
- all vertebrate bodies supported by internal skeleton
- Four levels of organization:
  - cells
  - tissues
  - organs
  - organ systems
**Organization of the Body**

- **Tissues**
  - Groups of cells similar in structure and function are organized into tissues.
  - Early in development, embryo cells differentiate into three germ layers.
    - endoderm
    - mesoderm
    - ectoderm

**Embryonic Tissues** – all adult tissues are derived from one of three embryonic tissues

- **Ectoderm** = “outside skin”
- **Mesoderm** = “middle skin”
- **Endoderm** = “inside skin”

**Stem Cells**

- Undifferentiated cells with potential to develop into many cell types
  - Embryonic stem cells, more versatile
  - Adult stem cells, less versatile
5 Major Body Cavities
- Cranial cavity
- Spinal cavity
- Thoracic cavity
- Abdominal cavity
- Pelvic cavity

Fate of Embryonic Tissues
- Ectoderm will become the outer covering of the body and the nervous system
- Mesoderm will become the muscles and internal skeletons
- Endoderm will become the lining of the gastrointestinal tract, lungs, vessels and ducts

Organization of the Body
- Tissues
  - Tissue consists of a group of closely associated, similar cells that carry out specific functions
  - Tissues associate to form organs, such as the heart
  - Groups of tissues and organs form organ systems

Organization of the Body
- Organs and organ systems
  - Organs are body structures composed of several different tissues that form a structural and functional unit.
  - An organ system is a group of organs that operate to perform the major activities of the body.
The Animal Body - Achadiah Rachmawati

Tissues

- Main types of animal tissue (adult vertebrates)
  - Epithelial
  - Connective
  - Muscle
  - Nervous
- Classification depends on structure and origin

Characteristics of Epithelial Tissue

- **Epithelium** tissue forms a continuous layer or sheet covering a body surface or lining a body cavity or every major surface of the vertebrate body
  - derived from all three germ layers
    - Protection
    - Absorption
    - Secretion
    - Sensation

Characteristics of Epithelial Tissue

- Types of epithelial tissues
  - **simple** - one layer thick
    - squamous - lining of lungs
    - cuboidal - lining of kidney tubules
    - columnar - lining of stomach
  - **stratified** - several cell layers thick and named according to features of their uppermost layers
  - **pseudostratified**

Simple squamous epithelium

- Nuclei of squamous epithelial cells
Characteristics of Epithelial Tissue

- **Simple squamous epithelium**
  - Lines blood vessels and air sacs in the lungs
  - Exchange of materials by diffusion

- **Simple cuboidal epithelium**

- **Simple columnar epithelium**
  - Lines passageways
  - Specialized for secretion and absorption
Characteristics of Epithelial Tissue

- **Stratified squamous epithelium**
  - Outer layer of skin
  - Lines passageways into the body
  - Provides protection
- **Pseudostratified epithelium**
  - Lines passageways
  - Protects underlying tissue

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Pseudostratified epithelium

- **Epithelial membrane**
  - Sheet of epithelial tissue
  - A layer of underlying connective tissue
- **Mucous membrane**
  - Lines a cavity that opens to the outside of the body
- **Serous membrane**
  - Lines a cavity that does not open to the outside of the body
Characteristics of Epithelial Tissue

- Glands of vertebrates are derived from invaginated epithelium.
  - exocrine glands - connection between the gland and the epithelial membrane is maintained as a duct
  - endocrine glands - ductless glands - connections with the epithelium, from which they are derived, are lost during development
    - secrete hormones

Connective Tissue Proper

- Connective tissues are divided into:
  - connective tissue
    - divided into loose and dense connective tissues
  - special connective tissues
    - include cartilage, bone, and blood
  - extracellular material generically known as matrix

Connective Tissue Proper

- Connective tissue consists of fewer cells separated by intercellular substance, fibers in a matrix
  - Collagen fibers
  - Elastic fibers
  - Reticular fibers
Connective Tissue Proper

- Connective tissue contains specialized cells
  - Fibroblasts
  - Macrophages
- Functions of connective tissue
  - Joins other tissues
  - Supports the body and its organs
  - Protects underlying organs

Loose connective tissue
- cells scattered within amorphous mass of proteins that form a ground substance
- strengthened by collagen, elastin, and reticulin - secreted by fibroblasts
- adipose cells found in loose connective tissue
- in the subcutaneous tissue
- between many body parts
- fibers in a semifluid matrix

Dense connective tissue
- regular
  - collagen fibers lined up in parallel
  - tendons and ligaments
- irregular
  - collagen fibers have many orientations
  - organ coverings - capsules
  - muscle coverings - epimysium
  - nerve coverings - perineurium
  - bone covering - periosteum
Special Connective Tissues

- **Bone**
  - Many bones are first modeled in cartilage. The cartilage matrix calcifies at particular locations, thus chondrocytes are no longer able to obtain oxygen and nutrients through diffusion.

**The Structure of Bone**

- New bone is formed by osteoblasts that secrete collagen organic matrix in which calcium phosphate is later deposited.
  - Cells then encased in spaces called lacunae in the calcified matrix.
- Bone is constructed in thin, concentric layers or lamellae, laid down around Haversian canals that run parallel to the length of the bone.
  - Contain nerve fibers and blood vessels.

**Bone formation**

- **Flat bones** - Osteoblasts located in a web of dense connective tissue produce bone within that tissue.
- **Long bones** - Bone first “modeled” in cartilage.
  - Ends and interior composed of spongy bone.
Osteocytes

- Secrete and maintain the matrix of bone
- Compact bone consists of spindle-shaped units called **osteons**
  - Central blood vessel through a Haversian canal surrounded by lamellae

Special Connective Tissues

**Cartilage**

- Specialized connective tissue in which fibers are laid down along the lines of stress in long, parallel arrays
  - Firm and flexible
  - **chondrocytes** - cartilage cells that live within spaces (lacunae) within cartilage matrix

**Blood**

- Classified as connective tissue because it contains plasma and platelets
  - **erythrocytes** - contain hemoglobin
  - **leukocytes** - have nuclei and mitochondria, but lack hemoglobin
    - Neutrophils, eosinophils, and basophils
    - Lymphocytes and monocytes

Cartilage

- **Cartilage**
  - Specialized connective tissue
  - Fibers laid down along lines of stress
  - Chondrocytes - cells within spaces (lacunae)
Muscle Tissue

- Muscle cells are the motors of the vertebrate body.
  - **three types**: smooth - skeletal - cardiac
  - Skeletal and cardiac muscles are **striated** because their cells have transverse stripes when viewed in longitudinal section.
  - Contraction of skeletal muscle is under voluntary control, whereas contraction in cardiac and smooth muscle is generally involuntary.

Muscle Tissue

- Muscle tissue consists of cells specialized to contract
  - Each cell is an elongated muscle fiber containing contractile units called **myofibrils**

Muscle Tissue

- **Smooth muscle** - found in organs of internal environment (viscera)
  - Contracts involuntarily
  - Elongated, spindle-shaped fibers lack striation
  - Each fiber has a central nucleus
  - Responsible for movement of food through the digestive tract
Skeletal muscle - usually attached to tendons or bones, so when muscles contract causes bones to move at joints
  - made up of long muscle fibers that contract by myofibrils
  - made up of highly ordered arrays of actin and myosin filaments

Cardiac muscles
  - composed of smaller, interconnected cells, each with a single nucleus
  - interconnections appear as dark lines called intercalated disks
  - enable cardiac muscles to form single functioning unit - myocardium

Types of Skeletons
  - Hydrostatic skeletons - fluid-filled cavity encircled by muscle fibers
    - As the muscles contract, fluid in the cavity moves and changes cavity shape.
  - Exoskeletons - surround the body as a rigid, hard case
    - must be periodically shed
    - limits body size as exoskeleton has to grow increasingly thicker and heavier
Types of Skeletons

- **Endoskeletons** - rigid internal skeleton to which muscles are attached
  - composed of cartilage or bone
  - vertebrate skeleton
    - ax**ial skeleton** - forms axis of body and supports organs of the head, neck, and chest
    - app**endicular skeleton** - includes bones of the limbs, pectoral and pelvic girdles

Actions of Skeletal Muscles

- Skeletal muscles produce movement of the skeleton when they contract.
  - attachment to bones made by [tendons](#)
    - origin remains stationary during contraction
    - insertion attached to bone that moves during contraction

Actions of Skeletal Muscles

- **Synergists** - muscles that cause same action at a joint
- **Antagonists** - muscles that produce opposing actions
- **Isotonic contraction** - muscle and all fibers shorten in length thus force of contraction remains relatively constant
- **Isometric contraction** - tension is absorbed by tendons and other elastic tissue, and muscle does not change in length

Nerve Tissue

- Cells include [neurons and neuroglia (supporting cells)](#)
  - Neurons are specialized to produce and conduct electrochemical impulses.
Neuroglia do not conduct electrical impulses but instead support and insulate neurons and eliminate foreign materials in and around neurons.

- myelin sheath - insulating covering of neuroglia cells wrapped around axons
- nodes of Ranvier separate adjacent neuroglia cells

Nervous system is divided in the central nervous system (CNS) which includes the brain and spinal cord, and the peripheral nervous system (PNS) which includes nerves and ganglia.

- Nerves consist of axons in the PNS bundled together.
- Ganglia are collections of neuron cell bodies.

Elongated neurons receive and transmit information

- Dendrites receive signals and transmit them to the cell body
- Axon transmits signal to other neurons, a muscle, or a gland
- Synapse is a junction between neurons
Skin: An Organ System Integumentary

- **Epidermis**: Stratified epithelium
- **Dermis**: Dense connective tissues
- **Hypodermis**: Loose connective tissue and adipose tissue

Functions of Human Skin

- Protects body from injury, dehydration, UV radiation, and some pathogens
- Helps control temperature
- Receives external stimuli
- Involved in vitamin D production

Sun Damages Skin

- UV light stimulates melanin production
  - Tans skin
- Tan protects inner layers against UV damage
- UV exposure causes
  - Elastin fibers to clump
  - Skin to age prematurely
  - Skin cancer

Important stuff, this
**Animal Organ Systems - continued**

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<tr>
<th>System</th>
<th>Major Component</th>
<th>Function</th>
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<td>Lungs or Gills</td>
<td>Gas Exchange</td>
</tr>
<tr>
<td>Digestive</td>
<td>Gastrointestinal Tract</td>
<td>Nutrient Acquisition</td>
</tr>
<tr>
<td>Urinary</td>
<td>Kidneys</td>
<td>Waste Elimination</td>
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<td>Ovaries and Testes</td>
<td>Production of New Individuals</td>
</tr>
<tr>
<td>Immune</td>
<td>White Blood Cells and Lymph Glands</td>
<td>Internal Protection</td>
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