

BIOL 1030 – TOPIC 13 LECTURE NOTES

Topic 13: Animal Form and Function (Ch. 40) – focus on vertebrates

- I. Organization of the vertebrate body
 - A. general mammalian body architecture (mammals used as representative vertebrates)
 1. tube within a tube
 - innermost tube is digestive tract, from mouth to anus
 - coelom separates outer tube from digestive tract
 2. mammals divide their coelom into two cavities
 - **thoracic cavity** (heart and lungs)
 - **abdominal cavity** (stomach, intestines, liver, etc.)
 - **diaphragm** (muscle sheet) forms the separation, is used for breathing
 3. internal skeletal system
 - jointed bones (in most cases) that grow with the body
 - includes **cartilage** and **ligaments**
 - connected to **muscles** with **tendons**
 - used for movement and support
 - B. four levels of organization
 1. **cell** – basic unit; many types; dozens to hundreds of types in most adult vertebrates
 2. **tissue** – a group of cells similar in structure and function
 - most differentiate early in development from three embryonic germ layers
 - endoderm (innermost)
 - mesoderm
 - ectoderm
 - four **primary tissues** in adult vertebrates
 - **epithelial**
 - **connective**
 - **muscle**
 - **nerve**
 3. **organ** – a structural and functional unit made of more than one tissue type
 4. **organ system**
 - a group of organs functioning together to perform a major body activity
 - generally 11 major organ systems are recognized; in the order that we will cover them:
 - skeletal
 - muscular
 - digestive
 - circulatory
 - respiratory
 - urinary or excretory
 - endocrine
 - reproductive
 - nervous
 - integumentary (not covered in this course)
 - lymphatic/immune (not covered in this course)
 - see Table 40.1
- II. **epithelial tissues**
 - A. derived from all three germ layers
 - B. both internal and external
 - C. form membranes that cover and protect all body surfaces
 1. barrier to water loss (see integumentary system)
 2. barrier to pathogens
 3. specializations for needed exchanges with the environment
 - D. form glands
 1. specialized for secretion (hormones, oils, enzymes, etc.)
 2. **exocrine glands** – have ducts (channels gland secretions)
 3. **endocrine glands** – ductless; secreted hormones enter blood capillaries
 - E. unifying characteristics
 1. tightly bound, with little space between cells

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2. thin (no blood vessels, creates diffusion limit)
3. tissue regeneration is common through cell divisions
 - skin epidermis renewed every two weeks
 - stomach epithelium renewed every 2-3 days
- F. two general classes
 1. simple – one cell layer thick
 2. stratified – several cell layers thick
- G. three cell shapes
 1. squamous – irregular, flattened shape with tapered edges
 2. cuboidal – about the same height, width, and depth
 3. columnar – taller than they are wide

III. connective tissues

- A. derived from mesoderm
- B. unifying structural characteristic:
 1. cells spaced widely apart
 2. imbedded in an abundant **extracellular matrix**
- C. perform a variety of functions, including support, connections, and transport
- D. two major classes – connective tissue proper and special connective tissue
- E. **connective tissue proper** – two types, loose and dense
 1. **loose connective tissue**
 - cells scattered in amorphous ground substance (matrix) composed mostly of proteins
 - mainly under skin and between organs
 - provides support, food storage, and sometimes insulation
 - **matrix** is gelatinous, with three major proteins:
 - **collagen** – strengthens
 - **elastin** – gives elasticity
 - **reticulin** – forms a supporting meshwork
 - cell types include, among others:
 - **fibroblasts** – secrete matrix proteins
 - **mast cells** – make **histamine** (blood vessel dilator) and **heparin** (anticoagulant)
 - **macrophages** – defend against invading organisms
 - **adipose cells** – triglyceride (fat) storage for energy
 2. **dense connective tissue**
 - strong (tightly packed collagen)
 - provides flexible, strong connections or coverings
 - mainly made of fibroblasts
 - two types, regular and irregular
 - **dense regular connective tissue**
 - collagen fibers parallel
 - **ligaments** – bone/bone connections
 - **tendons** – muscle/bone connections
 - **dense irregular connective tissue**
 - collagen fibers with various orientations
 - covers organs, muscles, nerves, and bones
- F. **specialized connective tissue** – cartilage, bone, and blood
 1. each have unique, specialized matrix for specialized functions
 2. **cartilage**
 - special glycoprotein in matrix
 - collagen in long, parallel rays along stress lines
 - firm, strong, flexible tissue that does not stretch
 - tougher than any connective tissue proper
 - entire skeleton for some vertebrates
 - for adult humans, found in: spinal discs, joints, outer ear, nose, trachea, larynx
 - provides flexible, shock-absorbing support and reduces friction at joints
 - "model" for many bones during development
 - cell type: **chondrocytes**
 - live in spaces called **lacunae**

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- living cells; exchange supplies and wastes by diffusion

3. **bone**

- most form within and replace cartilage models after deposition of hydroxyapatite crystals of calcium phosphate – provides great strength
- some (like cranial bones) formed within dense irregular connective tissue instead of replacing cartilage models
- collagen remains and provides flexibility; matrix is mainly calcium phosphate and collagen
- cell type: **osteocytes**
 - live within lacunae
 - have cytoplasmic processes that form a network between osteocytes; processes extend through tiny canals in the bone, or **canaliculi**
 - osteocytes remain alive because of blood vessels in bone and canaliculi to those blood vessels
- functions mostly as protection for organs and as a support for muscle attachment and movement

4. **blood**

- extracellular matrix is the fluid blood plasma
- blood travels to nearly every part of the body in vertebrates
- functions to circulate materials through the body (sugars, lipids, amino acids, oxygen, wastes, hormones, defense cells and materials)
- plasma proteins include:
 - **fibrinogen** – from liver; used in blood clotting
 - **albumin** – from liver; used for fluid balance
 - **antibodies** – from lymphocytes (specialized white blood cells); used in immune responses
- cell types include:
 - **erythrocytes** – red blood cells
 - most common blood cells
 - in mammals, lose their nucleus, mitochondria, and ER
 - mammalian red blood cells are disc-shaped
 - each one has about 300 million copies of the hemoglobin protein used to carry oxygen
 - hemoglobin with oxygen is red
 - **leukocytes** – white blood cells
 - several types
 - together only 1/1000 of red blood cell number
 - named in some cases based on staining properties, other cases based on function
 - primary role in immune system
 - **thrombocytes** – platelets; function in clotting

IV. **muscle tissues**

- A. develop from mesoderm
- B. function as the movement motors for animal bodies
- C. characterized by use of organized actin and myosin filaments specialized for contraction
- D. three kinds in vertebrates: smooth, skeletal, and cardiac

1. **smooth muscle**

- first to evolve
- in vertebrates, found in many blood vessel walls, wall of gut, and iris of eye
- not typically under voluntary control; rhythmic contractions typically regulated by the central nervous system
- sheets of long, spindle-like cells with one nucleus

2. **skeletal muscle**

- usually attached by tendons to bones
- typically under voluntary control
- means of most large-scale body movement in vertebrates
- very long, multinucleate cells called muscle fibers (from fusion of many cells during development)
- fibers run parallel to each other; each controlled by a nerve fiber
- within each fiber are many **myofibrils**;
 - arrays of actin and myosin filaments used for muscle contraction
 - ordered structure of these gives skeletal muscle a striated appearance

3. **cardiac muscle**

- striated, but cells are small, with one nucleus
- typically not under voluntary control