Chapter 4: Tissue: The Living Fabric

Objectives:
1. List the steps involved in preparing animal tissue for microscopic viewing.
2. List several structural and functional characteristics of epithelial tissue.
3. Name, classify, and describe the various types of epithelia; also indicate their chief function(s) and location(s).
5. Describe how multicellular exocrine glands are classified structurally and functionally.
6. Indicate common characteristics of connective tissue, and list and describe its structural elements.
7. Describe the types of connective tissue found in the body, and indicate their characteristic functions.
8. Indicate the general characteristics of nervous tissue.
9. Compare and contrast the structures and body locations of the three types of muscle tissue.
10. Describe the structure and function of cutaneous, mucous, and serous membranes.
11. Outline the process of tissue repair involved in normal healing of a superficial wound.
12. Indicate the embryonic origin of each tissue class.
13. Briefly describe tissue changes that occur with age.

Tissue – groups of cells that are similar in structure and perform a common or related function

4 basic types of tissue form “fabric” of the body
1. Epithelial (covering)
2. Connective (support)
3. Muscle (movement)
4. Nervous (control)

4 above types of tissues are formed from 3 embryonic germ layers
1. Ectoderm (outside) gives rise to ET and NT
2. Mesoderm (middle) gives rise to ET, CT and MT
3. Endoderm (inside) gives rise to ET
Histology – study of tissues

I. Epithelial Tissue (Epithelium)
   A. sheet of cells covers a body surface or lines body cavity
   B. 2 ways found in body
      1. covering and lining epithelium
         a. forms outer layer of the skin
         b. dips into and lines open cavities
         c. covers walls and organs of closed ventral cavities
      2. glandular epithelium
         a. fashions glands of the body
   C. Forms boundaries of different environments
   D. Functions of Epithelial Tissue
      1. protection
      2. absorption
      3. filtration
      4. excretion
      5. secretion
      6. sensory reception
   E. Special Characteristics of Epithelium
      1. Polarity
         a. apical surface – upper free surface exposed to the exterior or cavity
         b. basal surface – attached to tissue below
         c. microvilli – fingerlike extensions of plasma membrane
            1) increase surface area
            2) cilia
            3) basal lamina
               a) noncellular, adhesive sheet
               b) selective filter
         d. specialized contacts
            1) epithelial cells fit close together
            2) tight junctions
            3) desmosomes
         e. supported by connective tissue
            1) reticular lamina – layer of extra cellular material
            2) basement membrane – reinforces the epithelial sheet helping to resist stretching and tearing
         f. avascular but innervated
            1) no blood vessels
2) supplied by nerve fibers
g. regeneration 
   1) high regeneration capacity

F. Classification of Epithelia
1. 2 names 
   a. first name = number of cell layers present 
   b. second = shape of cells

2. Simple epithelia 
   a. single layer 
   b. found where absorption and filtration occur

3. Stratified epithelia 
   a. 2 or more cell layers stacked 
   b. found in high-abrasion areas where protection is important

4. 3 shapes 
   a. squamous cells – flat and scale like 
   b. cubodial cells – boxlike 
   c. columnar cells – tall and column shaped

5. Nucleus Shape
   a. corresponds to the shape of the cell 
   b. squamous – flattened disc 
   c. cubodial – spherical 
   d. columnar – elongated from top to bottom and usually located close to base of cell

6. Identify epithelial cells 
   a. simple – named for layer of cells 
   b. stratified – named according to shape of cells in apical layer

G. Simple Epithelia 
1. concerned with absorption, secretion, and filtration 
2. single layer very thin, very little protection 

3. Simple Squamous Epithelium 
   a. found where filtration or exchange of substances by rapid diffusion is important 
   b. kidneys, lungs

4. Simple Cubodial Epithelium 
   a. function in secretion and absorption 
   b. forms walls of ducts of gland and kidney tubules

5. Simple Columnar Epithelium 
   a. function in absorption, secretion, and protection 
   b. digestive tract lining 
   c. goblet cells – secrete a protective lubricating mucus
6. Psuedostratified Columnar Epithelium
   a. secretes and absorbs substances
   b. ciliated version lines most of respiratory tract and secretes mucous
   c. cells vary in height and nucleus is at different levels to give the false (pseudo) impression that several layers are present

H. Stratified Epithelia
   1. regenerate from below
   2. major role is protection
   3. Stratified Squamous Epithelium
      a. apical cell surface is squamous, deeper layers are cubodial or columnar
      b. functions in protection
      c. Non-keratinized
         1) lining of mouth
         2) lining of throat
      d. Keratinized (proteins used for strength, structure)
         1) epidermis of skin
   4. Stratified Cuboidal and Columnar Epithelium
      a. quite rare
      b. found in ducts of large glands
   5. Transitional Epithelium
      a. many layers of cells that change shape in response to tension
      b. functions in distensibility (stretching to allow urine to fill bladder)
      c. found in lining of hollow urinary organs

I. Glandular Epithelium
   1. usually simple cubodial or columnar
   2. functions in secretion
   3. 2 major types
      a. Endocrine glands
         1) ductless glands
         2) secrete hormones directly into extracellular space
      b. Exocrine glands
         1) secrete products onto body surface or into body cavities
         2) mucous, sweat, oil, salivary, liver, pancreas
   4. Types of secretion
      a. merocrine glands
         1) secrete fluids through cell membrane into duct
         2) pancreas, sweat glands, salivary glands
b. holocrine glands
   1) release entire cell as secretion
   2) sebaceous glands

II. Connective Tissue
   A. found everywhere in the body
   B. 4 classes
      1. connective tissue paper (ligaments)
      2. cartilage
      3. bone
      4. blood
   C. Functions
      1. binding and support
      2. protection
      3. insulation
      4. transportation
   D. Common Characteristics
      1. common origin
         a. all connective tissue arise from mesenchyme (embryonic tissue)
      2. degrees of vascularity
         a. cartilage is avascular
         b. dense connective tissue is poorly vascularized
         c. all other types have rich supply of blood vessels
      3. extracellular matrix
         a. non-living matter that separates living cells
   E. Structural Elements
      1. 3 main elements
         a. Ground substance
            1) unstructured material that fills the space between cells and contains the fibers
            2) holds large amounts of fluid; functions as a sieve
         b. Fibers
            1) provide support
            2) collagen fibers
               a) composed of protein collagen
               b) extremely tough; provide high tensile strength
               c) also called white fibers because of appearance
            3) elastic fibers
               a) composed of protein elastin
b) long, thin gibers form branching networks
c) also called yellow fibers

4) reticular fibers
   a) short, fine fibers
   b) abundant where connective tissue meets other tissue
c. Cells
   1) “blast” cells – undifferentiated cells; still forming
      a) connective tissue proper – fibroblast
      b) cartilage – chondroblast
      c) bone – osteoblast
      d) blood – hematopoietic stem cell
   2) once blast cells synthesize the matrix they assume their less active, mature mode, -cyte
   3) if damage occurs will go back to mitotically active -blast form

F. Types of Connective Tissue
   1. Arise from embryonic tissue called mesenchyme
   2. Connective tissue proper
      a. 2 sub classes
         1) Loose connective tissue
            a) areolar connective tissue
               1. supporting and binding other tissues
               2. holding body fluids
               3. defending against infection
               4. loose arrangement of fibers
               5. gel-like matrix with fibroblasts, macrophages, mast cells and collagen and elastic fibers
               6. Location = beneath epithelium, surrounds organs;
               7. Functions = wraps & cushions organs, inflammation, diffusion of nutrients and gases
            b) Adipose Tissue
               1. closely packed adipocytes (fat-cells) with nuclei pushed to one side within areolar matrix
               2. Location = under skin, around kidneys & eyeballs,
               3. Functions = energy store, insulation, protection;
            c) Reticular connective tissue
               1. network of reticular fibers within loose ground substance
2. Location = basement membranes, lymph nodes, thymus, spleen
3. Function = support

2) Dense Connective Tissue
   a) Dense Regular CT (White Fibrous CT)
      1. primarily collagen fibers (pink) with few fibroblasts
      2. Location = tendons, ligaments
      3. Functions = attachment, tensile strength
      4. Poor blood supply = slow to no healing
   b) Dense Irregular CT
      1. primarily collagen fibers randomly arranged
      2. Location = dermis of skin, heart valves
      3. Function = provides tensile strength
   c) Elastic CT
      1. primarily elastin fibers (purple)
      2. Location = lung tissue, wall of aorta
      3. Function = durability with stretch

3) Cartilage
   a) Hyaline cartilage
      1. amorphous matrix that surrounds cells = chondrocytes
      2. Locations = embryonic skeleton, costal cartilages, cartilage of the nose, trachea, and larynx
      3. Function = support
      4. Avascular = no healing
   b) Elastic cartilage
      1. same as above plus elastic fibers (purple)
      2. Locations = external ear, epiglottis
      3. Functions = maintenance of shape plus flexibility
   c) Fibrocartilage
      1. less firm than above
      2. Locations = intervertebral discs, pubic symphysis
      3. Functions = tensile strength plus shock absorber

4) Bone:
   a) hard, calcified matrix ([Ca₃(PO₄)₂(OH)₂] = rigidity), with collagen fibers (tensile strength) and cells = osteocytes (within lacunae)
   b) Location = bones
   c) Functions = protection, support, movement, calcium store and hematopoiesis
d) Highly vascular = fast healing

5) Blood
   a) red cells, white cells, and platelets in a fluid matrix called plasma
   b) Location = within blood vessels
   c) Function = transport of gases, nutrients, wastes

III. Nervous Tissue
   A. Regulates & controls body functions
   B. Neurons – highly specialized nerve cells that generate and conduct nerve impulses

IV. Muscle Tissue
   A. Highly cellular, well-vascularized tissue
   B. Responsible for body movements
   C. Skeletal Muscle
      1. attached to bones of skeleton
      2. contain muscle fibers – long cylindrical cells that contain many nuclei
      3. appear banded or striated
      4. voluntary muscle – under conscious control
   D. Cardiac Muscle
      1. found only in wall of heart
      2. are striated
      3. are uninucleate
      4. branching cells fit together tightly at junctions called intercalated discs
      5. involuntary control
   E. Smooth Muscle
      1. no visible striations
      2. one centrally located nucleus
      3. found in walls of hollow organs other than heart
      4. involuntary control

V. Covering and Lining Membranes
   A. Cutaneous Membrane
      1. skin
      2. organ system of keratinized stratified squamous epithelium attached to dense irregular connective tissue
      3. dry membrane
B. Mucous Membranes
   1. mucosae
   2. line body cavities that open to exterior
   3. wet membrane

C. Serous Membrane
   1. serosae
   2. line closed body cavities
   3. wet membrane

VI. Tissue Repair
A. 2 ways can occur
   1. regeneration – replacement of destroyed tissue with the same kind of tissue
   2. fibrosis – involves production of scar tissue (connective tissue)

B. Regenerative Capacity of Different Tissues
   1. Good regeneration
      a. epithelial
      b. bone
      c. areolar connective
      d. dense irregular connective
      e. blood
   2. Moderate regeneration
      a. smooth muscle
      b. dense regular connective
   3. Weak regeneration
      a. skeletal muscle
      b. cartilage
   4. No functional regeneration
      a. cardiac muscle
      b. nervous tissue

VII. Developmental Aspects of Tissues
A. Primary Germ Layers
   1. Ectoderm (outside) gives rise to ET and NT
   2. Mesoderm (middle) gives rise to ET, CT, and MT
   3. Endoderm (inside) gives rise to ET