Chapter 4: Histology

Histology – study of normal structures of __________

Tissue:
   a. Discrete population of _______ related in structure & function
   b. Have surrounding material: ____________ (ECM)

Module 4.1: Introduction to Tissues

TYPES OF TISSUES

Four primary tissue types
   a. Epithelial tissues (epithelia)
      – tightly packed sheets of cells with no visible ECM
      - glands that manufacture secretions (__________) or chemical messengers (__________)
   b. Connective tissues (CT)
      - connect tissues to one another;
      - ECM is a prominent feature for most CT with cells scattered throughout
   c. Muscle tissues
      - __________
   d. Nervous tissues
      consist of cells:
      - neurons
      - neuroglia

THE EXTRACELLULAR MATRIX

Extracellular matrix
   a. Composed of substances in a liquid, gel, or solid that surround cells
   b. Functions:
      – Provides tissue with strength to resist tensile (stretching) and compressive forces
      – Directs cells to proper positions within tissue and holds those cells in place
      – Regulates development, mitotic activity, and survival of cells
c. 2 main components
   [ground substance & protein fibers]

1) Ground substance
   - makes up most of ECM extracellular fluid (ECF or interstitial fluid)
   - components:

   Macromolecules:
   a. Glycosaminoglycans (GAGs)
      – ex. chondroitin sulfate (cartilage) and hyaluronic acid
   b. Proteoglycans
      - GAGs bound to a protein core (bottle brush)
   c. Cell-adhesion molecules (CAMs)
      - made up of different types of glycoproteins
      - bind surface proteins

2) Protein fibers
   a. Collagen fibers (white, fibrous)
      - 20–25% of all proteins in body
      -
   b. Elastic fibers (yellow)
      - protein elastin surrounded by glycoproteins
      -
   c. Reticular fibers (weblike)
      - meshwork or scaffold that supports cells and ground substance of many tissues

Diseases of Collagen and Elastic Fibers

• Protein fibers vital to structural integrity of many tissues and organs

   Ehlers-Danlos syndrome

   Marfan syndrome
Module 4.2: Epithelial Tissues

Functions:

1. Protection –
2. Immune defenses – form physical barriers; contain cells of immune system
3. Secretion –
4. Transport into other tissues – form selectively permeable membranes
5. Sensation – detects changes in internal and external environments (ex. )

Components and Classification of Epithelia

- Consist of tightly packed cells that form continuous sheets
- Fairly impermeable and resistant to physical stresses and mechanical injury
- BM (basement membrane)

Classified based on:

- Simple epithelia consist of a ________ cell layer
- Stratified epithelia consist of ________ layers
- Pseudostratified looks layered but is not
- Squamous cells
- Cuboidal cells
- Columnar cells

Covering and Lining Epithelia

- Four types of simple epithelia:

1. Simple squamous epithelium
   - very thin single layer of cells with a “fried egg” appearance;
   - adapted for ____________________
found in air sacs of lung, parts of kidney, and lining blood vessel walls

(endothelium)

2. Simple cuboidal epithelium
   – single layer of ________________
   - found in renal tubules, respiratory passages, ducts of glands, and thyroid gland

3. Simple columnar epithelium
   – single layer of rectangular-shaped cells
   - often has ___________ (increases surface area for absorption of substances) or ________ (propel substances through hollow organs)

4. Pseudostratified columnar epithelium
   - appears to be layered because nuclei are found at various heights, but only one cell-layer thick
   - found in segments of respiratory tract and nasal cavity; ciliated

Stratified epithelium
– more than one layer of cells;
- protective barriers due to wear and tear

1. Stratified squamous epithelium
   a. Keratinized stratified squamous epithelium
      • outer cellular layers are dead
         • lack nuclei
         • filled with protein ____________
         • outer layers of skin (epidermis)
   
   b. Nonkeratinized stratified squamous epithelium
      • apical cellular layers retain nuclei; still alive
      • ________________________ (ex. mouth, throat, esophagus, anus, and vagina)

2. Stratified cuboidal epithelium
   • rare in humans
   • lines ________________

3. Stratified columnar epithelium
   • relatively rare in humans
   • found in male urethra, cornea of eye, ducts of salivary glands
4. Transitional epithelium

- only found in urinary system
- basal cell layers are cuboidal while apical cell layers are dome-shaped when tissue is relaxed
- ability of apical cells to flatten contributes to ability of urinary tissues to

**GLANDULAR EPITHELIA**

- **Gland** – specialized cells that *produce secretions*
  Products are released by two mechanisms:
  - **Endocrine**
  - **Exocrine**

**Endocrine glands** secrete, *directly into bloodstream* (no ducts)

- Allows products to have widespread systemic effects on *distant cells* in different areas of body
- Glands vary in complexity from single cells to large multicellular glands with branching

- **Ex.**

**Exocrine glands**

- Secretions have only *local effects* on cells in general vicinity
- Unicellular (mucus)
  - digestive & respiratory tracts
  - protects underlying epithelia
- Multicellular (sweat glands, salivary glands)

Types of Exocrine glands secretions:

- **Merocrine secretion**
  - fluid product in vesicles
  - salivary and sweat glands

- **Holocrine secretion**
  - entire cells released
  - sebaceous gland
Carcinogens and Epithelial Tissues

- Epithelia cover all body surfaces; therefore more subject to injury than most other tissues

- Carcinogens

- Carcinoma –

- Basal Cell Carcinoma –

Module 4.3: Connective Tissues

**CONNECTIVE TISSUES**

- Connective tissue proper
  - Loose
  - Dense (regular & irregular)
  - Reticular
  - Adipose

- Specialized connective tissue
  - Cartilage
  - Bone
  - Blood

Connective tissue functions:

- __________
  - anchor tissue layers in organs and link organs together

- **Support**
  - bone and cartilage support weight of the body

- __________
  - bone tissue protects certain internal organs
  - cartilage and fat provide shock absorption
  - components of immune system found throughout CT

- **Transport** – blood main transport medium in body

- Characteristics of CT:
  - **Cells** are surrounded by protein fibers and embedded in ground substance
  - **ECM** plays an extensive role in the function of CT
  - Usually vascular
**CONNECTIVE TISSUE CELLS**

- Fibroblasts
- Adipocytes
- Mast cells – produce histamine that causes inflammation
- Phagocytes - includes macrophages that ingest foreign invaders

**CONNECTIVE TISSUE PROPER**

- Four basic types of connective tissue proper:
  - Loose connective tissue
  - Dense connective tissue
  - Reticular tissue
  - Adipose tissue

1. **Loose connective tissue**
   - mostly ground substance, also fibers, fibroblasts, and occasionally adipocytes
   - located beneath epithelium of skin, in membranes lining body cavities, and within walls of hollow organs

2. **Dense connective tissue** (fibrous connective tissue)
   a. **Dense irregular connective tissue**
      - mostly disorganized collagen bundles
      - located in__________, surround organs and joints
   b. **Dense regular connective tissue**
      - Organized into parallel collagen bundles
      - Located in __________________________
   c. **Dense regular elastic CT(elastic tissue)**
      - Mostly parallel-oriented elastic fibers with some collagen fibers
      - Found in walls of organs that need to__________(large blood vessels and some ligaments)

3. **Reticular tissue**
   - composed mostly of reticular fibers produced by fibroblasts (reticular cells);
   - form fine networks that support vessels
     - Also found in __________________________
     - Forms part of B.M. that supports epithelia, internal structure of liver and bone marrow
4. **Adipose tissue** (fat tissue)
   - consists of fat-storing__________ (& surrounding fibroblasts and ECM)
     - Fat storage (major energy reserve)
     - Shock absorption and protection

**Adipose Tissue and Obesity**

- **Obesity** – condition of having *excess adipose tissue* in proportion to lean body mass:
  - **Hypertrophic**
  - **Hypercellular**

Both types increase risk for certain health problems; depends on *distribution of adipose tissue* and *genetic factors*

**SPECIALIZED CONNECTIVE TISSUES**

**Specialized connective tissues**

- **Cartilage** –
- **Bone tissue (osseous tissue)** – ________;
  - muscle attachments; stores calcium, and bone marrow (produces blood cells and stores fat)
- **Blood** – liquid ECM called______; consists of mostly water, dissolved solutes, and proteins

**Cartilage**

- Rigid matrix
- **Chondroblasts** – immature cells that *divide by mitosis* → ECM
- ____________ in lacunae
- Mostly avascular (blood supply limited to outer sheath - *perichondrium*)

3 types of cartilage:

- **Hyaline cartilage**
  - - ends of long bone, trachea, nose, most of fetal skeleton
- **Fibrocartilage**
  - great tensile strength
  - ________________, menisci of knee, symphysis pubis
- **Elastic**
  - ____________
  - *external* ear, auditory tube, epiglottis
• **Bone**
  - Hard matrix
  - Supports and protects
  - Hemopoiesis
  - Skeleton
  - Osteoblasts, osteocytes in lacunae, osteoclasts

• **Blood**
  - ECM is *fluid* = plasma
  - *Plasma proteins* – not like fibers in other CT; smaller and involved in *transport* & *blood clotting*
  - *Erythrocytes* (__________) *transport* oxygen
  - *Leukocytes* (__________) function in *immunity*
  - *Thrombocytes* (__________) – cell fragments; major role in *blood clotting*

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**Osteoarthritis and Glucosamine Supplements**

• **Osteoarthritis**

• **Glucosamine**

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**Module 4.4: Muscle Tissues**

**MUSCLES TISSUES**

• **Muscle tissues** are specialized for ____________
  (use ATP as energy source)

• Movement of skeleton, heart beating, and propulsion of substances through hollow

• **Muscle cell** or **myocyte:** ____________(ability to respond to electrical or chemical stimulation)

• 3 types of **muscle tissue**:
  - Skeletal muscle
  - Cardiac muscle
  - Smooth muscle
• **Skeletal muscle**
  - Attached to bone
  - Striated

• **Cardiac**
  - Heart
  - Striated
  - __________
  - Intercalated discs

• **Smooth**
  - Walls of hollow organs, blood vessels
  - Non-striated
  - __________

**Module 4.5: Nervous Tissue**

**NERVOUS TISSUES**

• **Nervous tissue**
  - brain, spinal cord, nerves
  - two main cell types:
    - **Neurons** –
    - **Neuroglial cells** –

**Module 4.6: Big Picture of Tissues in Organs**

Two or more tissues that combine structurally and functionally form an **organ**:

• Simple organ example – **skeletal muscle**:
  Composed of two main tissues
  —skeletal muscle and dense irregular collagenous CT
  – Each has distinct functional role; skeletal muscle tissue allows it to contract;
    surrounding connective tissue binds muscle cells together and supports
    them so that their activity produces a contraction of **whole organ**

• More complex organ; consists of many different tissue types – **trachea**
  – Hollow organ; provides passageway through which air passes on its way into/out of
    lungs
  – illustration of tissues of trachea from **superficial to deep** with list of their main
    functions
  – Each tissue layer serves an important role in overall function of trachea:
    **conducting air**
Module 4.7: Membranes

Membranes – thin sheets of tissues that

• Serous membranes
  – line pericardial, peritoneal, and pleural cavities

• Synovial membranes
  - composed of CT
  - 

• Mucous
  – line tubes/organs that connect to outside of body
  – 
  – secrete mucus

• Cutaneous
  - 
Chapter 5: Integumentary System

Skin (_____________)= largest organ (10-15% of TBW)

2 main regions:

**Epidermis** – keratinized stratified squamous epithelium

**Dermis** – ________________

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**Module 5.1: Overview of Integumentary System**

SKIN STRUCTURE

- **Accessory structures:**
  - sweat glands, sebaceous glands, hair, nails

- **Sensory receptors**
  - detect _______, _______, _______, _______

- **Arrector pili muscles**
  - small bands of SMC associated with hair

  - **Epidermis** is ________________
    - Transport of O\textsubscript{2} and nutrients via diffusion

  - **Dermis** is vascular

- **Hypodermis** – aka superficial fascia or subcutaneous fat, is ________________
  - not part of skin, anchors skin to deeper structures
  - ________________
  - ________________

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**Cellulite**

- Dimpled or "orange peel" appearance

- **Thighs, hips, and gluteal area**
  - due to:

  - **Normal condition**

  - 

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FUNCTIONS OF THE INTEGUMENTARY SYSTEM

1. **Protection**- mechanical trauma, pathogens, and ____________

2. **Sensation** – perceive changes in the body's ________________ environment
3. Thermoregulation
   – relies on loops to maintain stable internal temperature (due to muscle activity and metabolism)

4. Excretion – process where waste products and toxins are eliminated (sweat)

5. Synthesis – Vitamin D, calcitriol

[Body Temperature above normal]

• **Stimulus**: body is too HOT (due to weather extremes or fever)
• **Receptors**: thermoreceptors detect an increase in ____________
• **Control center**: thermoregulatory center in brain (__________) acts as a thermostat
• **Effector/Response**: Control center stimulates sweating and vasodilation (VD) of vessels in dermis
• **Homeostasis and negative feedback**:
  - body temp. returns to normal
  - thermoregulatory center decreases output to glands and vessels

[Body Temperature below normal]

• **Stimulus**: body temperature drops below normal range; too COLD
• **Thermoreceptors**: detect drop in temperature and relay information to hypothalamus
• **Control center** reacts
• **Effector/response**: blood vessels in dermis vasoconstrict (VC); decreased sweating;
  ____________
• **Homeostasis and negative feedback**:
  - body temp. returns to normal
  - thermoregulatory center decreases output to vessels and muscles (reduce shivering)
  – Lose heat: ____________
  – Conserve heat: ____________
  – Produce heat: ____________
• Vitamin D synthesis:
  \[ \text{UV light} \rightarrow \text{precursor to Vit. D}\rightarrow \text{Vit. D}_3 (\text{cholecalciferol}) \rightarrow \text{Vit. D}_2 (\text{active form}) \rightarrow \text{dehydrocholesterol} \rightarrow \text{intermediate product} \rightarrow \text{calcitriol (hormone)} \]
  (in skin) (active form) (in liver) (in kidneys)

• Calcitriol - nec. for absorption of Ca++ by S.I.
• Ca++ nec. for ________________, ______________. ______

**Module 5.2: The Epidermis**

**THE EPIDERMIS**

• **Epidermis**
  – most superficial region
  - composed of mostly keratinocytes
  - produce __________ (protein)

Organized into 5 layers (strata):

• **Stratum basale** (stratum germinativum)
  -
  - most metabolically and mitotically active

• **Stratum spinosum**
  – still close to blood supply
  - metabolically and mitotically active

• **Stratum granulosum**
  - three to five layers of cells
  - keratin filled cells (provides water resistance)

• **Stratum lucidum**
  – narrow layer of clear, dead keratinocytes
  - found ______________

• **Stratum corneum** (outermost)
  – outermost layer of epidermis
  - several layers of dead flattened
  - sloughed off or exfoliated mechanically
• Keratinocyte life cycle:
  - Dead keratinocytes are replaced by __________ of cells in stratum basale and
    spinosum close to blood supply
  - As keratinocytes in deeper strata divide they push cells above them into more
    superficial layers (40-50 days)
  - Mitosis takes place at night?!

OTHER CELLS OF THE EPIDERMIS

• Dendritic (Langerhans) cells
  – located in __________
  - __________ of immune system
  - protect skin and deeper tissues from pathogens

• Merkel cells
  - located in __________
  - sensory receptors detect __________
  - fingertips, lips, and at base of hairs

• Melanocytes
  – located in __________
  - produce __________ (protein skin pigment)

THICK AND THIN SKIN

• Thick skin
  - all five epidermal layers
  - thick stratum corneum
  - __________, many sweat glands

• Thin skin
  - has only four layers (no __________)
  - Many hairs, sweat glands, and sebaceous glands
    __________ – additional layers of st. corneum; form in either thick or thin skin
    due to repetitive pressure
Module 5.3: The Dermis

THE DERMIS

Dermis – highly vascular layer deep to __________

• Functions:
  – Provides
  – Contains
  – Anchors epidermis in place

• Composed of two distinct layers:
  – Papillary
  – Reticular

THE PAPILLARY LAYER

Papillary layer
– composed of _______________

Dermal papillae
- tiny projections
- capillary loops
- Tactile (Meissner) corpuscles (______________)

THE RETICULAR LAYER

Reticular layer
– deepest thicker layer of dermis
- mostly ________________ (collagen and elastic fibers)
- rich in proteoglycans (keeps skin firm and hydrated)
- Lamellated (Pacinian) corpuscles (____________________)
- Blood vessels, sweat glands, hairs, sebaceous glands, and adipose tissue are found in reticular layer

SKIN MARKINGS

Epidermal ridges
- enhance ________________
  – characteristic patterns; loops, arches, and whorls;
  – Sweat pores open along these ridges and leave a thin film or ________________ on most surfaces

Skin Wrinkles
• Due to age-related decrease in collagen and elastic fibers, proteoglycans, and adipose tissue in the ________________
• Reduces Appearance can be minimized by:
  – Botox
  – Fillers
  – Topical creams

Delay wrinkles:

Module 5.4: Skin Pigmentation

**MELANIN**

Skin color
• Melanin (melanocytes)
  - protect keratinocyte DNA from mutations induced by UV rays
  - number of melanocytes is ________________
  - spectrum of skin tones due to ________________

• Carotene (ingest yellow orange vegetables)
  – Imparts yellowish color to ________________

• Hemoglobin (RBCs)
  – coloration depends on blood flow to dermis

• Increased melanin synthesis with exposure to natural or artificial UV radiation (tan)
  • Erythema – ____________blood flow
  • Pallor – ____________blood flow
  • Cyanosis - low ____________blood

Common variations of pigmentation:
  – Freckle – small area of ____________pigmentation (melanin production)
  – Mole or nevus – area of increased pigmentation due to ________________
    (not increase in melanin production)
  – Albinism – melanocytes fail to manufacture tyrosinase ____________results in lack of pigmentation
Tanning and a “Healthy Tan”

- Tanning – salons promote notion of “healthy tan”
- THERE IS NO SUCH THING AS A HEALTHY TAN!
- UVA and UVB rays are associated
- ANY amount of tanning damages

Module 5.5: Accessary Structures of Integument: Hair, Nails, and Glands

Hair

Accessory structures (appendages):
- __________________________
  - derived from epithelium only

• Hair (pili)
  – protrude from surface of skin over entire body except thick skin, lips, and parts of external genitalia

Cuticle -
Cortex -
Medulla –

Hair

  – Protect by preventing __________________________
  – Protect underlying skin of scalp from __________________________
  - Sensory neuron detect changes in environment
**HAIR STRUCTURE**

- **Hair** - *stratified squamous keratinized epithelial*
  - **Shaft**
    - dead keratinized cells
  - **Root**
    - surrounded by sensory neuron
    - **hair papilla** - projection of blood vessels in indented base
    - **hair bulb** = root and hair papilla
    - many epithelial cells are still alive (have not completed keratinization process)
  - **Matrix** – small number of actively dividing keratinocytes found at base of root
  - Root is embedded in **hair follicle**

- Strand of hair has **three visible regions**:
  - **Inner medulla** – soft keratin
  - **Middle cortex** – hard keratin provides strength
  - **Outermost cuticle** – single layer of overlapping keratinocytes containing hard keratin; provides mechanical strength

- **arrector pili muscles** = _______________

- “**goosebumps**” = hair stands up (piloerection)

- **hair growth** varies, averages ~ 1-1.5 cm per month

**HAIR PIGMENT AND TEXTURE**

- Hair color is determined by _______________
  - **Blond** hair has__________melanin
  - **Black** hair which contains_________of melanin
  - **Red** hair has a special reddish pigment containing iron
  - **Gray or white** hair melanocytes produce

**NAILS**

- **Nails** – composed of **stratified squamous epithelium** filled with hard keratin
  - **Nail plate** – sits on top of ____________
  - **Lunula** - half-moon shaped region of proximal nail plate
  - **Eponychium** - ______________
  - **Hyponychium** – St. corneum under free edge of nail
GLANDS

- **Sweat (sudoriferous) glands** → sweat
  - **Eccrine**: widespread, mostly water, wastes, electrolytes
  - **Apocrine**: axillary, & anal regions, odoriferous, associated with hair follicle

Modified sweat glands:
- **Ceruminous**: (ear canal)
- **Mammary**: 

- **Sebaceous glands** → 
  - Thin skin only
  - Hydrophobic barrier

Module 5.6: Pathology of Skin

Acne

- **Acne vulgaris**

  - **Cause**
    - accumulation of 
    - maybe infected by bacteria → 
    - (testosterone)

SKIN CANCER

- **Cancer** → one of most common diseases in world; caused by mutations in DNA that induce a cell to lose control of cell cycle (Figure 5.14):
  - Unchecked cell division eventually leads to formation of a large population of undifferentiated cells known as a
  - Cancerous tumors are able to metastasize; tumor cells spread through
  - Damage caused by metastatic tumor cells alters function of invaded organs

- Three cancers affect skin
  - linked to UV radiation exposure
  - carcinogens (Cancer-inducing chemicals, toxins)

1. **Basal cell carcinoma**
   - Most common of all cancer types, including skin cancer
   - Arises from keratinocytes in stratum basale

2. **Squamous cell carcinoma**
   - Second most common skin cancer
   - Cancer of keratinocytes of stratum spinosum
3. Malignant melanoma

- cancer of ____________
- "Arms" of cancerous melanocytes extend down into dermis and access dermal blood vessels (metastasis)

Malignant melanoma can be distinguished from other skin cancers and normal moles using ABCDE rule:

- (A): ____________(two sides do not match)
- (B): ____________irregularity
- (C): ____________, usually blue-black or a variety of colors
- (D): ___________generally larger than 6 mm (pencil eraser size)
- (E): ____________(changing) shape and size