Histology – study of normal structures of _______

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

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

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

The Extracellular Matrix

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
The Extracellular Matrix

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 (p.126)

- Protein fibers vital to *structural integrity* of many tissues and organs
  - **Ehlers-Danlos syndrome**
  - **Marfan syndrome**

Epithelial Tissues

**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)**

*Figure 4.3 Structure of epithelial tissue.*

**Classification of Epithelia**

Classified based on:
- **Simple epithelia** consist of a ________ cell layer
- **Stratified epithelia** consist of ________ layers
- **Pseudostratified** looks layered but is not

*Figure 4.4a Classification of epithelial cells.*

**Components and Classification of Epithelia**

- **Squamous cells**
- **Cuboidal cells**
- **Columnar cells**

*Figure 4.4b Classification of epithelial 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)

*Figure 4.5a Structure of simple epithelia.*

- **Simple cuboidal epithelium**
  - single layer of __________
  - found in renal tubules, respiratory passages, ducts of glands, and thyroid gland

*Figure 4.5b Structure of simple epithelia.*

- **Simple columnar epithelium**
  - single layer of rectangular-shaped cells
  - often has __________ (increases surface area for absorption of substances) or __________ (propel substances through hollow organs)

*Figure 4.5c Structure of simple epithelia.*

**Covering and Lining Epithelia**

- **Simple columnar epithelium**
  - single layer of rectangular-shaped cells
  - often has __________ (increases surface area for absorption of substances) or __________ (propel substances through hollow organs)
Covering and Lining Epithelia

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

Figure 4.5d Structure of simple epithelia.

Covering and Lining Epithelia

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

1. Stratified squamous epithelium
a. Keratinized stratified squamous epithelium
b. outer cellular layers are dead
  - lack nuclei
  - filled with protein
  - outer layers of skin (epidermis)

Figure 5.3 Structure of the epidermis.

Covering and Lining Epithelia

b. Nonkeratinized stratified squamous epithelium
  - apical cellular layers retain nuclei; still alive
  - (ex. mouth, throat, esophagus, anus, and vagina)

Figure 4.7a Structure of stratified epithelia.

Covering and Lining Epithelia

2. Stratified cuboidal epithelium
  - relatively rare in humans
  - lines

Figure 4.7b Structure of stratified epithelia.

Covering and Lining Epithelia

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

Figure 4.7c Structure of stratified epithelia.

Covering and Lining Epithelia

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

Figure 4.7d Structure of stratified epithelia.
Covering and Lining Epithelia

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 (p. 130)

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

Connective Tissue

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

Connective Tissue Cells

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

Connective Tissue Proper

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

Connective Tissue

Connective tissues
- Connective tissue proper
  - Loose
  - Dense (regular & irregular)
  - Reticular
  - Adipose
- Specialized connective tissue
  - Cartilage
  - Bone
  - Blood

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 Proper

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 (Figure 4.14b)
   - 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 (Figure 4.15)
     • Also found in __________
     • Forms part of B.M. that supports epithelia, internal structure of liver and bone marrow

Note: arrangement of fibers in dense regular and irregular connective tissues is another example of the Structure-Function Core Principle
## Connective Tissue Proper

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 (p. 142)

- 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** –
  - 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 – liquid ECM called ____________; consists of mostly water, dissolved solutes, and proteins

### Specialized Connective Tissues

- Bone tissue (osseous tissue) – _______________; muscle attachments; stores calcium, and bone marrow (produces blood cells and stores fat)
Specialized Connective Tissues

- **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

Osteoarthritis and Glucosamine Supplements (p. 144)

- **Osteoarthritis**
- **Glucosamine**

Connective Tissues

Figure 4.20 Summary of connective tissues.

Muscle Tissues

- **Muscle tissues** are specialized for ____________ (use ATP as energy source)
- Movement of skeleton, heart beating, and propulsion of substances through hollow structures
- **Muscle cell or myocyte**: ________ (ability to respond to electrical or chemical stimulation)
- **3 types of muscle tissue**:
  - Skeletal muscle
  - Cardiac muscle
  - Smooth muscle

Types of Muscle Tissue

- **Skeletal muscle**
  - Attached to bone
  - Striated
- **Cardiac**
  - Heart
  - Striated
  - Intercalated discs
- **Smooth**
  - Walls of hollow organs, blood vessels
  - Non-striated
Nervous Tissues

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

The 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 connective
  - 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

The Big Picture of Tissues in Organs

• 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
  - Figure 4.23 (next slide) – 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

Membranes

Membranes – thin sheets of tissues that

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

• Synovial membranes
  - composed of CT

Membranes

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

• Cutaneous
  -
Skin (__________________) = largest organ (10-15% of TBW)

2 main regions:
Epidermis – keratinized stratified squamous epithelium
Dermis – _______________________

Tiny sweat pores open and leave thin film called a fingerprint on most surfaces.

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 $O_2$ and nutrients via diffusion
- **Dermis is vascular**

Skin Structure

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

Cellulite (p. 162)

- **Dimpled or “orange peel” appearance**
- **Thighs, hips, and gluteal area**
  - due to:
    - **Normal condition**

Functions of Integumentary System

1. **Protection** - mechanical trauma, pathogens, and ______
2. **Sensation** – perceive changes in the body’s __________ environment
3. **Thermoregulation** (Figure 5.2):
  - 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
Thermoregulation [Body Temperature above normal]

Functions of the Integumentary System

- **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

Thermoregulation [Body Temperature below normal]

Functions of the Integumentary System

- **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)

Functions of the Integumentary System

- Lose heat: ________________
- Conserve heat: ________________
- Produce heat: ________________

Functions of the Integumentary System

- **Vitamin D synthesis**:
  
  precursor to Vit.D $\xrightarrow{UV\ \text{light}}$ Vit. D$_3$ (cholecalciferol) 
  (dehydrocholesterol) (active form) 
  (in skin) 
  
  $\xrightarrow{}$ intermediate product $\xrightarrow{}$ calcitriol (hormone) 
  (in liver) (in kidneys)
  
  - Calcitriol - nec. for absorption of $Ca^{++}$ by S.I.
  - $Ca^{++}$ nec. for ___________, ___________, _______
The Epidermis

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

The Epidermis

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

The Epidermis

- 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

The Epidermis

• 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

The Dermis

- **Dermis** — Highly vascular layer deep to ______________

  - Functions:
    - Provides
    - Contains
    - Anchors epidermis in place

  - Composed of two distinct layers:
    - Papillary
    - Reticular

The Reticular Layer

- **Reticular layer**
  - Deepest thicker layer of dermis
  - Mostly ______________ (collagen and elastic fibers)
  - Rich in proteoglycans (keeps skin firm and hydrated)
  - ______________

  - Blood vessels, sweat glands, hairs, sebaceous glands, and adipose tissue are found in reticular layer

The Papillary Layer

- **Papillary layer**
  - Composed of ______________

  - Dermal papillae
    - Tiny projections
    - Capillary loops
    - Tactile (Meissner) corpuscles (______________)

Figure 5.4 Thick and thin skin.
**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, p. 170**

- Due to age-related decrease in collagen and
  elastic fibers, proteoglycans, and adipose
  tissue in the _______
- Reduces

**Skin Wrinkles**

- Appearance can be minimized by:
  - Botox
  - Fillers
  - Topical creams
- Delay wrinkles:

**Melanin**

- 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

**Melanin**

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

*Figure 5.8* Melanocytes and melanin function.
Melanin

- 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” (p. 172)

- 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

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

(Figure 5.9)

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)

(Figure 5.9)
Hair Structure

- **Matrix** – small number of actively dividing keratinocytes found at base of root
- Root is embedded in hair follicle

Hair Structure

- 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

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
Glands

Figure 5.11b Sweat glands and sebaceous glands.

Acne (p. 177)

- **Acne vulgaris**
- **Cause**
  - accumulation of ______________________
  - may be 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

Skin Cancer

- 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)

Skin Cancer

- **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

Figure 5.14c The three main forms of skin cancer.