

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

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

Widely distributed
Connects tissues & organs
Internal structure of some organs

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*



Osteoarthritis and Glucosamine Supplements

- **Osteoarthritis**

- **Glucosamine**

→ **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

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 – _____

→ **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 O₂ and nutrients via diffusion*
- **Dermis is vascular**
- **Hypodermis** – aka **superficial fascia** or **subcutaneous fat**, is _____
 - *not part of skin*, anchors skin to deeper structures
 - _____
 - _____



Cellulite

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

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:

precursor to Vit. D (dehydrocholesterol) (in skin) $\xrightarrow{\text{UV light}}$ Vit. D₃ (cholecalciferol) (active form)

→ intermediate product (in liver) → calcitriol (hormone) (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?!*

CONCEPT BOOST: UNDERSTANDING EPIDERMAL GROWTH

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: Accessory 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*

- o **Nail plate** – sits on top of _____
- o **Lunula** - half-moon shaped region of proximal nail plate
- o **Eponychium** - _____
- o **Hyponychium** – St. corneum under free edge of nail

GLANDS

- **Sweat (sudoriferous) glands** à 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 _____
- 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

• 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

