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

} Widely distributed
Connects tissues & organs
Internal structure of some organs

• 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*

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 O_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
  – _____
  – _____

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) —UV light→ Vit. D_3 (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: 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 = r**oot 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** aà 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