Lab Activity 5

The Integumentary System
Martini Chapter 5
Skin

- Epidermis: Superficial layer
  - Made of stratified squamous keratinized epithelium
  - 4-5 Layers
- Dermis: Underlying connective tissue layer
  - 2 Layers
- Hypodermis: Not part of the skin, it is deep to the dermis
  - Primarily adipose tissue
Layers of the Epidermis

1. **Stratum corneum**: Outermost layer
   - 20-30 cell layers thick
   - Cells are dead and flattened
   - Full of keratin
   - Constantly being rubbed off

2. **Stratum lucidum**: Thin translucent layer of dead keratinocytes
   - Found only in thick skin
3. **Stratum granulosum**: Cells contain granules
   - The upper part of this layer has cells that are beginning to die
   - Lamellated granules contain a waterproofing glycolipid that is secreted into the extracellular space
   - Keratohyaline granules combine with intermediate filaments to form keratin fibrils
Layers of the Epidermis

4. **Stratum spinosum**: several cell layers
   - Cells also dividing
   - Cells contain bundles of intermediate filaments made of pre-keratin

5. **Stratum basale**: single row of cells
   - Adjacent to the dermis
   - Constantly dividing and pushing up layers
Dermis

- The dermis is the connective tissue layer under the epidermis

1. **Papillary Layer**: Superficial dermal region
   - Areolar connective tissue
   - Contains capillaries, lymphatics and sensory neurons
   - **Dermal Papillae**: the fingerlike projections from the superior surface
   - **Epidermal ridge**: The epidermal layer that dips down into the dermal papillae
     - Create fingerprints
Finger Prints

Epidermal Ridge

Pores of sweat gland ducts

Epidermal ridge
2. **Reticular Layer**: Deepest skin layer
   - Dense irregular connective tissue
   - Contains the arteries, veins, sweat and sebaceous glands
   - **Cleavage lines**: the deep creases (like in the palm) where collagen and elastic fibers are arranged in parallel bundles.
Cleavage Lines
Hypodermis

- Subcutaneous layer that is not part of the skin
  - Beneath the dermis layer
  - Composed of adipose and areolar connective tissue
- Highly vascular
Cells of the Epidermis

- **Keratinocytes**: The main cells of the epidermis
  - Produce keratin, a fibrous protein that gives skin its durability and protective capabilities
- **Melanocytes**: Spidery black cells
  - In stratum basale
  - Produce melanin, the pigment that protects skin from UV damage
Cells of the Epidermis

• **Langerhans’ Cells**: Also called epidermal dendritic cells
  • In stratum spinosum
  • Macrophages that migrated from the bone marrow that phagocytize pathogens
  • Immunologic surveillance cells
Cells of the Epidermis
Hair

- **Root:** Everything that is not sticking out of the skin
- **Shaft:** The part sticking out of the skin
- **Bulb:** Active growing site
Hair Histology

- epidermis
- dermis
- arrector pili muscle
- hypodermis
- hair follicles
- inner and outer root sheath
- dermal papilla
- dermal sheath
- hair
- bulb
Arrector Pili Muscle

- Arrector pili muscle: Smooth muscle that pull hair upright during fright or cold (goose bumps)
Apocrine Sweat Glands

- **Apocrine glands**: secrete a protein and fat rich substance that bacteria can use for nutrients (creates body odor)
- Found in the armpits, around nipples and in the pubic region
- Secrete products into hair follicles or directly onto the surface.
- Begin functioning at puberty
Apocrine Sweat Glands

- Red arrow - Apocrine Sweat Glands
- Green arrow - Hair follicle
Eccrine (Merocrine) Sweat Glands

- Eccrine sweat glands are not associated with hair follicles.
- Ducts open directly on the surface of the epidermis.
Sebaceous Glands

- Sebaceous glands
  - Produce oily substance called sebum
  - Helps waterproof the skin
  - Acne: infection of the sebaceous gland
Sebaceous Follicle

- Sebaceous glands not associated with hair follicles
- Secrete their product directly on the skin surface
- Located on face, back, chest, nipples and external genitalia
Pancinian (Lamellated) Corpuscle

- Lie deep in the dermis
- Respond only when deep pressure is first applied
- Monitor high frequency vibrations
Meissner’s (Tactile) Corpuscle

- Located in the dermal papillae
- Receptor for light touch
Merkel Cells

- **Merkel Cells**: At the junction of the sensory nerve endings
  - In stratum basale
Fingernails

- Scale like modification of the epidermis
- **Free edge:** part that grows away from the finger
- **Body:** visible attached portion
- **Root:** Embedded in skin and sticks to the nail bed
- **Nail Bed:** Extension of the stratum basale beneath the nail
- **Nail Matrix:** Proximal part of the nail bed responsible for nail growth
- **Lunula:** white crescent area; Most active growth region of nail matrix
Fingernail Structures

- Eponychium (cuticle)
- Proximal nail fold
- Lunula
- Lateral nail fold
- Body
- Free edge
- Nail matrix
- Nail bed
- Root
- Bone
- Nail plate
- Cuticle
- Lunula
- Nail folds
Lab Activity 6

Body Membranes
Martini Chapter 4, Pages 129-131
Body Membranes

- The majority of the body’s structures are lined by epithelial membranes.
- An epithelial membrane is a continuous multicellular sheet composed of epithelium bound to an underlying layer of connective tissue.
Epithelial Membranes

- **Cutaneous**: skin
- **Mucous**: lines body cavities open to the exterior (e.g., digestive and respiratory tracts)
- **Serous**: moist membranes found in closed ventral body cavity (mesothelium) for reducing friction
Epithelial Membranes: Serous

(c) Serous membranes

- Parietal peritoneum
- Visceral peritoneum
- Parietal pleura
- Visceral pleura
- Parietal pericardium
- Visceral pericardium
Mucous Membrane

- Line all body cavities open to the exterior
- Epithelial cells resting on a lamina propria (loose connective tissue)
- Goblet cells: columnar epithelial cells with large mucus containing vacuoles
  - Usually secrete mucous, but not always
  - Respiratory tract
  - GI tract
  - Urinary tracts
  - Genital tracts
Mucous Membrane
Serous Membranes

- Line all body cavities closed to the exterior and the internal surface of the organs
- Simple squamous epithelium with small amount of areolar connective tissue
- Is double layered
  - Parietal layer covers the cavity
  - Visceral layer covers the organs
  - There is serous fluid between the layers to reduce friction when they slide against each other
Parietal Layer

- Special name depending on the organ it is associated with
- **Parietal peritoneum**: covers abdominal wall
- **Parietal pleura**: covers chest cavity
- **Parietal pericardium**: outside layer of sac surrounding the heart
Pericardial Membranes

- Heart
- Parietal pericardium
- Pericardial space with serous fluid
- Visceral pericardium
Pleural Membranes
Peritoneal Membranes

- Parietal peritoneum is the blue line
- Visceral peritoneum is the pink lines
- Peritoneal cavity is the gray
Synovial Membranes

- Composed entirely of connective tissue
- Line cavities of joints
- Secrete synovial fluid for lubrication
Lab Activity 7

Bone Histology
Martini Chapter 6
Bone Tissues: Spongy Bone

- Honeycomb of small needle-like pieces called trabeculae.
  - Organized in an open framework
- Provides considerable strength with reduced weight
- The open spaces between the trabeculae are filled with bone marrow
Bone Tissue: Compact Bone

- Bones are composed of both compact and spongy bone tissue
  - **Compact bone** is found where great strength is needed.
  - It makes up the external surfaces of all bones and the shafts of long bones.
Note the gross differences between the spongy bone and the compact bone in the above photo.

Do you see the trabeculae?
Compare compact and spongy bone as viewed with the light microscope.
Microscopic Structure of Compact Bone

- Bone tissue is composed of repeating, circular units called Haversian systems or osteons.
- Osteons are the structural unit of compact bone.
  - The substance of compact bone is formed from many osteons cemented together.
  - Oriented parallel to the long axis of the bone, and parallel to the forces upon that bone.
Microscopic Structure of Compact Bone
Haversian System (Osteon) Components

- **Concentric Lamella:** Weight-bearing, column-like matrix tubes composed mainly of collagen that surround the central canal like rings on a tree.

- **Haversian, or central canal:** Central channel containing blood vessels and nerves.

- **Volkmann’s canals:** Channels lying at right angles to the central canal, connecting blood and nerve supply of the periosteum to that of the Haversian canal.
Interstitial Lamellae

- Interstitial Lamellae that are **not** part of an osteon
- They are incomplete lamellae
- They fill the gaps between forming osteons or are remnants of osteons that have been cut through by bone remodeling
Circumferential Lamellae

- **Circumferential** lamellae are deep to the periosteum
- Extend around the entire circumference of the shaft
Concentric lamellae

Osteon (Haversian system)
Circumferential lamellae

Lamella
Osteocyte

Lacuna
Canaliculus
Central (Haversian) canal

Blood vessel continues into medullary cavity containing marrow
Spongy bone

Perforating (Sharpey's) fibers
Compact bone
Periosteal blood vessel
Periosteum

Central (Haversian) canal
Perforating (Volkmann's) canal
Blood vessel
Microscopic Structure of Compact Bone

- Spider-shaped osteocytes occupy small cavities known as lacunae at the junctions of the lamellae.
- Hair like canals called canaliculi connect the lacunae to each other and to the central canal.
- Canaliculi allow the osteocytes to exchange nutrients, wastes, and chemical signals to each other via gap junctions.
Microscopic Structure of Spongy Bone

- No osteons are present
- Lamellae are irregularly arranged into plates called **trabeculae**.
  - Small needle-like pieces of bone
  - Have a lot of open space between them
  - Filled with bone marrow.
- Trabeculae are interconnected by canaliculi
- Trabeculae align precisely along lines of stress
Spongy Bone

- Osteocytes are nourished by diffusion from nearby Haversian canals
- The osteocytes are connected by canaliculi
Bone Cells

- Bone tissue is a type of connective tissue, so it consists of cells plus a significant amount of extracellular matrix.

- Osteoprogenitor Cells
  - Undergo mitosis and become osteoblasts
  - Derived from mesenchyme
Osteoblasts

- **Bone-building cells.**
- Synthesize and secrete collagen fibers and other organic components of bone matrix.
  - Releases calcium and phosphate ions for production of hydroxyapatite
- Initiate the process of calcification.
- Found in both the periosteum and the endosteum
- Cannot undergo mitosis
Osteoblasts

- The blue arrows indicate the osteoblasts.
- The yellow arrows indicate the bone matrix they’ve just secreted.
Osteocytes

- Mature bone cells derived from Osteoblasts that have become trapped by the secretion of matrix
  - Maintain daily cellular activities
  - No longer secrete matrix
  - Cannot undergo mitosis
  - Will transform back to an osteoblast when bone remodeling is needed.
Osteocytes

- **Yellow arrows** indicate osteocytes: notice how they are surrounded by the pinkish bone matrix.
- **Blue** arrow shows an osteoblast in the process of becoming an osteocyte.
- **Green** arrow: Osteoclast
Bone Cells
Osteoclasts

- Huge cells derived from the fusion of as many as 50 monocytes or macrophages (a type of white blood cell).
- Function in bone resorption (i.e. destruction of bone matrix that is part of normal bone growth, development, maintenance and repair)
  - Breakdown of bone matrix via enzymes
- Concentrated in the endosteum
Osteoclasts

- resorption bay
- osteoclast
- bone
Bone Membranes

- **Periosteum**: Double-layered protective membrane
  - Outer fibrous layer is dense irregular connective tissue
  - Inner osteogenic layer is composed of osteoblasts and osteoclasts
  - Richly supplied with nerve fibers, blood, and lymphatic vessels, which enter the bone via nutrient foramina
  - Secured to underlying bone by Sharpey’s fibers (strands of collagen)
Bone Membranes

- **Endosteum**: Delicate membrane covering internal surfaces of bone
  - Covers the trabeculae of spongy bone in the marrow cavities and lines the canals that pass through compact bone.
  - Lines the medullary cavity
  - Contains both osteoblasts and osteoclasts.
Bone Marrow

• Marrow
  • Netlike mass of connective tissue that fills the spaces of bone
    • Medullary cavities of long bones
    • Irregular spaces of spongy bone
Bone Tissues

Red Marrow

- Formation of red blood cells, white blood cells, and blood platelets
- In infants
  - Found in the medullary cavity and all areas of spongy bone
- In adults
  - Found in the diploë of flat bones, and the head of the femur and humerus
Bone Tissues

Yellow Marrow

• As we age, the bone marrow is replaced by fat stores
  • Red becomes yellow marrow
  • Inactive in blood cell production
  • Functions in shock absorption
Structure of Short, Irregular, and Flat Bones

- Thin plates of periosteum-covered compact bone on the outside with endosteum-covered spongy bone on the inside
- Have no diaphysis or epiphyses
- Contain bone marrow between the trabeculae
Classification of Bones by Shape

- **Short bones**
  - Cube-shaped bones of the wrist and ankle

- **Sesamoid bones**
  - Bones that form within tendons (e.g., patella)
Classification of Bones by Shape

- **Flat bones**: Thin, flattened, and a bit curved (e.g., sternum, and most skull bones)
Classification of Bones by Shape

- **Irregular bones:** bones with complicated shapes (e.g., vertebrae and hip bones)

![Sphenoid Bone](Sphenoid_Bone)
Classification of Bones by Shape

- **Wormian** or sutural bones: Tiny bones between cranial bones.
- Vary in number and location in different people.
Classification of Bones by Shape

- **Long bones**: longer than they are wide (e.g., humerus, metacarpals)
- Consists of a shaft (diaphysis) plus 2 expanded ends (epiphysis).

(a) Long bone (humerus)
Features of Long Bones

• **Diaphysis**: shaft forms the long axis of the bone
  - Wall of compact bone surrounding a medullary (marrow) cavity

• **Epiphyses**: expanded bone ends
  - Articulates with another bone
  - Exterior made of a thin layer of compact bone
  - Interior made of spongy bone
Features of Long bones

- Hyaline cartilage
  - Covers joint surface of epiphysis
  - Cushions opposing bone ends
  - Absorb stress
The End