ANP 1105 – CHAPTER 4 September 9th , 12th , 2019

TISSUE: THE LIVING FABRIC (CHAPTER 4, PAGES 116-137)

INTRO:

- Tissues are groups of cells similar in structures that work to perform a series of common functions. There are 4 main tissue types and they are organized into organs
- **How do we study tissue structure?**
  - **Histology** is the study of tissues
  - Fixation/freezing
  - Thin sections
  - Dyed or heavy metals or antibodies that have been conjugated into dyes

UNI VS MULTI – WHICH IS BETTER?

- **Unicellular** organisms independently carry out all activities necessary for life (single person)
  - We begin life as single cells
  - How do we get bigger?
    - Cell division
  - What prevents single cells from getting really big?
    - Surface area to volume ratios
  - What are the processes needed to make us multicellular?
    - Differentiation
    - Cell-cell interactions
    - Movement
- **Multicellular** organisms, cells are specialized to perform specific tasks (division of labour – like family)
  - Why do multicellular organisms live longer?
  - Pros:
  - Cons:
    - Promote dependency…ife specialized cells die then the organism is hurt

EPITHELIAL TISSUE (EPITHELIUM):

Intro

- Sheets of cells (cover body surfaces/cavities, by lining the surfaces of skin, digestive organs and respiratory tract)

- Covering and lining epithelia:
    - On external and internal surfaces (skin)
- Glandular epithelia:
    - Secretory tissue in glands (salivary glands)
- **Selecive barriers:** intestinal epithelium allows passage of certain substances (nutrients) but not others (toxins, microorganisms)
    - **Bidirectional**, highly regulated in healthy tissue and disease
    - Gut microbiome (mostly bacteria)
- FUNCTIONS: protection, absorption, filtration, excretion, secretion and sensory reception.

Special characteristics of epithelial tissue

- POLARITY
    - Apical surface (top) is exposed to surface (lumen) / cavity
        - Most apical surfaces are smooth but have microvilli (increase surface area for absorption) or cilia
    - Basal surface (bottom) facing inwards toward body
        - Attaches to basal lamina (connective tissue), an adhesive sheet that holds basal surface of epithelial cells to underlying cells.
        - Cancer cells (need to be present for proper function
- SPECIALIZED INTERCELLULAR CONTACTS
    - Cells need to fit closely together to form a barrier
    - Specialized contact points bind adjacent epithelial cells together
    - Lateral (between) contacts include:
        - Tight junctions: prevent substances from leaking btwn cells (regulated – constant, less? More? Adjustments. Decisions?)
        - Adherens junction: mediate cell-cell adhesion via cadherins (protein) (stick together)
        - Desmosomes: prevent cells from pulling apart in tissues subject to mechanical stress (protein: desmoglein)
        - Gap junctions: mediated by connexins (intercellular communication)
- SUPPORTED BY CONNECTIVE TISSUE
    - All epithelia have a basement membrane (BM)
        - Reinforces, resists stretching, tearing, defines epithelial boundary
        - Consists of basal lamina (layer of extracellular matrix ECM proteins) and reticular lamina (deep to basal lamina, network of collagen 3 fibers)
        - Cancer
- AVASCULAR BUT INNERVATED
    - No blood vessels (nutrients and oxygen diffuse from connective tissue)
    - Nerves are present (sensory nerve endings in the skin)

- REGENERATION:
    - High regenerative capacities: stimulated by loss of apical-basal polarity and broken lateral contacts
    - Some cells exposed to friction or hostile substances result in damage:
        - Must be replaced
        - Nutrients and cell division
        - Wound healing
    - WHERE DO NEW EPITHELIAL CELLS COME FROM? Stem cells
        - Continuing repopulation of daughter stem cells
        - Asymmetric (2 diff: 1 epithelial and 1 still stem)

Classification of epithelia is based on:

- NUMBER OF CELL LAYERS
    - Simple epithelia are a single layer thick
    - Stratified epithelia are 2+ layers thick and are involved in protection (skin)
- CELL SHAPE
    - Squamous: numerous, flattened and scale-like
        1. Compose most of the cells in the outer layer of the skin (epidermis)
        2. Line passages of respiratory and digestive tracts
        3. Linings of hollow organs
    - Cuboidal: box-like
    - Columnar (tall, column-like)
        1. In stratified epithelia, shape can vary in each layer, so its classified according to the shape in the apical layer

Types of SIMPLE EPITHELIUM:

- Simple Squamous (many, flattened & scale-like)
    - Description: Single layer of flattened cells with disc-shaped central nuclei and sparse cytoplasm; the simplest of the epithelia.
      Function: Allows materials to pass by diffusion and filtration in sites where protection isn't important but rapid diffusion is. Secretes lubricating substances in serosae (linings of ventral body cavity.) Involved in absorption, secretion, or filtration
    - Location: kidney glomeruli, lung air sacs, lining of heart, blood vessels, lymphatic vessels, serosae
    - Endothelium:
        2. Lines inner surface of blood vessels, lymphatic vessels and heart
        3. Derived from ectoderm and endoderm in the early embryo
    - Mesothelium:
        1. Form serous membranes surrounding pericardium, peritoneum, pleura and internal reproductive organs (outer surfaces)

2. Derived from mesoderm
3. Two membrane system w fluid in btwn (helps w motion, car + oil)

- Simple cuboidal:
    - Description: Single layer of cubelike cells w large spherical central nuclei
    - Function: Secreation and absorption
    - Location: Kidney tubules, ducts and secretory portions of small glands, ovary surface

- Simple columnar:
    - Description: Single layer of tall closely packed cells w round to oval nuclei. Many bear microvilli and cilia. May contain mucus secreting unicellular glands (goblet cells)
    - Function: Absorption, secretion of mucus, enzymes, and other substances; ciliated type propels mucus (or reproductive cells) by ciliary action.
    - Location: Nonciliated type lines most of the digestive tract (stomach to rectum), gallbladder, and excretory ducts of some glands; ciliated variety lines small bronchi, uterine tubes, and some regions of the uterus.

- Simple pseudostratified columnar
    - Description: Single layer of cells of differing heights, some not reaching the free surface; nuclei seen at different levels; may contain mucus-secreting cells and bear cilia
    - Function: secrete substances, particularily mucus, propulsion of mucus by ciliary action
    - Location: ciliated variety lines the trachea and most of the upper respiratory tract; nonciliated type in males' sperm-carrying ducts and ducts of large glands.

Types of STRATIFIED EPITHELIUM:

- Intro
    - Have 2+ layers of cells
    - New cells generate from below (basal cells divide and migrate toward surface)
    - More durable than simple epithelia because protection is the major role
    - Outer layer of skin (epidermis), Passages of respitory and digestive tracts, Linings of hollow organs

- Stratified Squamous epithelium
    - Most widespread of stratified epithelia
    - Description: Thick epithelium composed of several cell layers. Basal cells are cuboidal/columnar and metabolically active while surface (apical) cells are

flattened (squamous.) In the keratinized type, the surface cells are dead. Basal cells are active in mitosis and produce the cells of the more superficial layers
    - Function: Protects underlying tissues in areas subjected to abrasion
    - Location: high areas of wear and tear: Non-keratinized type forms the moist linings of the esophagus, mouth and vagina while keratinized type forms the epidermis of the skin (dry epithelium)

- Stratified cuboidal epithelium
    1. Rare
    2. Found in sweat and mammary glands
    3. Typically only 2 layers thick

- Stratified columnar epithelium
    - Very limited distribution in body: small amnts found in pharynx, male urethera and lining some glandular ducts
    - Usually occurs at transition areas between two other types of epithelia
    - Only apical layer is columnar

- Transitional epithelium
    - Description: resembles both stratified squamous and stratified cuboidal; basal cells cuboidal or columnar; surface cells dome shaped or squamouslike, depending on degree of organ stretch.
    - Function: stretches readily, permits stored urine to distend urinary organ.
    - Location: Lines the ureters, bladder, and part of the urethra

GLANDULAR epithelia

- Gland: 1+ cells that make and secrete aqueous fluid (secretion)
    - Classified by:
        1. **Site of product release**
            - Endocrine (internally secreting – hormones)
            - Exocrine (externally secreting – sweat)
        2. **Relative # of cells forming the cland**
            - Unicellular (goblet cells) or multicellular (salivary)
- Formation of multicellular exocrine and endocrine glands:
    - Multicellular epithelia glands form by inward growth of an epithelial sheet
    - Exocrine glands retain the connecting cells, which form a duct that transports secretions to the epithelial surface
    - Endocrine glands lose their ducts during development. They secrete hormones into the interstitial fluid. These hormones then enter the blood

- Endocrine glands
    - Ductless: secretions are not released into a duct but rather into surrounding interstitial fluid, which is picked up by circulatory system (blood)
    - Hormones: chemicals that travel through lymph or blood to target organs that respond in a characteristic way
    - EX: pineal, pituitary, pancreas, Ov, Test, thyroid and PTH, hypothalamus, adrenal

- Exocrine glands:
    - Secretions are released onto body surfaces (skin or body cavities) (ducts)
    - More numerous than exocrine glands
    - EX: mucous, sweat, oil, and salivary glands
    - Unicellular:
        - Mucous cells & goblet cells
        - Found in epithelial linings of intestinal and respiratory tracts
        - All produce mucin: sugar protein that can dissolve in water to form mucus (slimy protective lubricating coating)
    - Multicellular:
        - Composed of a duct and a secretory unit
        - Usually surrounded by supported connective tissue that supplies blood and innervation
            - Connective tissue can form capsule aroundgland and can also extend into gland, dividing it into lobes
        - Classified by structure and mode of secretion

CONNECTIVE TISSUE:

- **Intro:**
    - **Connective tissue** is the most abundantly and widely distributed of primary tissues
    - Functions**:** binding and support, protecting, insulating, storing reserve fuel, transporting substances (blood)

- **Common Characteristics of Connective Tissue:** (differentiate them from other primary tissues)**:**
    - All have common embryonic origin: mesenchyme
    - Possess varying degrees of vascularization (cartilage is avascular, bone is highly vascularized)
    - Cells are suspended/embedded in ECM (supports cells so that they can bear weight, withstand tensions and endure abuse)

- **Structural Elements of Connective Tissue**

- 2/3 of the elements make up the ECM (ground substance and fibers)
- Composition and arrangement of these 3 elements vary considerably in different types of connective tissues
- **GROUND SUSBTANCE:**
    - Unstructured gel-like material that fills space between cells (medium through which solutes diffuse btwn blood capillaries and cells
    - Components: interstitial fluid, cell adhesion proteins (glue for attachment), proteoglycans (sugar proteins) made up of protein core + large polysaccharides (chondroitin sulfate and hyaluronic acid)
    - Water also is trapped in varying amounts affecting viscosity of ground substance
- **CONNECTIVE TISSUE FIBERS:** (support)
    - **Collagen fibers -** Strongest & most abundant (provide tensile strength)
    - **Elastic fibers –** coiled and easy to stretch (flexibility)
    - **Reticular fibers** – made from shorter branches of collagen (diff chemistry)
- **CELLS:** (make the matrix)
    - Secrete the ground substance and the ECM fibers
    - Different types of blasts will be in different types of connective tissues

DRAWING

- **Connective Tissue Proper: LOOSE**
    - **AREOLAR:** (open space – not dense)
        - Description: Gel-like matrix with all three fiber types: cells, fibroblasts, macrophages, mast cells & wbcs
        - Function: Wraps and cushions organs, its macrophages phagocytize bacteria, plays important roles in inflammation, holds and conveys tissue fluid
        - Location: Widely distributed under epithelia of body (ex: forms lamina propria of mucous membranes, packages organs, surrounds capillaries)
    - **ADIPOSE**:
        - Description: matrix as in areolar, but very sparse. Closesly packed adipocytes (fat cells) have nucleus pushed to the side by a large fat droplet. Hardly any fibers (90% of tissue)
        - Functions: provide food and fuel reserve, insulation and support. Brown fat generates heat and white fat stores nutrients
        - Location: Under skin in subcutaneous tissue around kidneys and eyeballs, within abdomen, breasts
    - **RETICULAR:**
        - Description: Loose network of reticular fibers in a gel-like ground substance. Reticular cells lie on the fibers (spongier than collagen fibers)

        - Function: fibers form a soft internal skeleton (stroma) that supports other cell types including white blood cells, mast cells and macrophages. (Provides area for cells to reside)
        - Location: Lymphoid organs (+ bone marrow and spleen)

- **Connective Tissue Proper: DENSE**
    - **REGULAR:**
        - Description: Primarily parallel collagen fibers; few elastic fibers; major cell type is the fibroblast. Parallel bundles, can withstand some stretching and pulling, poorly vascularized (lack of blood vessels), aponeuroses: flat tendon
        - Function: Attaches muscles to bones or to muscles, attaches bones to bones, withstands great tensile strength when pulling force is applied in one direction
        - Location: Tendons, most ligaments, aponeuroses
    - **IRREGULAR:**
        - Description: Primarily irregularly arranged collagen fibers, some elastic fibers (less strong but more flexible), fibroblast is the major cell type,
        - Function: Withstand tension exerted in many directions + provides structural strength
        - Location: Fibrous capsules of organs and joints, dermis of skin (makes it so strong), submucosa of digestive tract
    - **ELASTIC**:
        - Description: Dense regular connective tissue containing a high proportion of elastic fibers
        - Function: allows tissue to recoil after stretching, maintains pulsatile flow of blood through arteries, aids passive recoil of lungs following inspiration
        - Location: Walls of large arteries, within certain ligaments associated with the vertebral column, within the walls of the bronchial tubes
- **Cartilage**
    - Matrix secreted from chondroblasts (youth/growth) and chondrocytes (adults)
        - Chondrocytes found in cavities called lacunae
        - 80% water, with packed collagen fibers and sugar proteins (proteoglycans) (ex: chondroitin and hyaluronic acid)
    - Tough and flexible material lacking nerve fibers
    - Avascular: receives nutrients and structural support from layer of dens irregular CY that surrounds it (perichondrium – provides nutrients to chondroblasts and chondrocytes)
    - **HYALINE:**
        - Description: Amorphous but firm matrix, collagen fibers form an imperceptible network, chondroblasts produce the matrix and when mature (as chondrocytes) lie in lacunae, "glass-like"

        - Function: Supports and reinforces, serves as resilient cushion, resists compressive stress
        - Location: Forms most of the embryonic skeleton, covers the ends of long bones in joint cavities, forms costal cartilages of the nose/trachea/larynx
    - **ELASTIC:**
        - Description: similar to hyaline cartilage but more elastic fibers in matrix
        - Function: maintains the shape of a structure while allowing greater flexibility
        - Location: Supports external ear (pinna) and epiglottis
    - **FIBROCARTILAGE:**
        - Description: Matrix similar to but less firm than that in hyaline cartilage, thick collagen fibers are predominate, lack of ability to be squished
        - Function: Tensile strength allows it to absorb compressive shock
        - Location: Intervertebral discs, pubic symphysis, discs of knee joint
    - Aging chondrocytes lose ability to divide so injuries heal slowly (e.g. sports injuries)
    - Later in life, cartilage can calcify or ossify (become bony), causing chondrocytes to be poorly nourished and die.
- **Bone:**
    - Description: Hard, calcified matrix containing many collagen fibers, osteocytes lie in lacunae, very well vascularized, outside = hard, middle = spongy, similar to cartilage except there's calcium for additional strength and rigidity, osteons form tubes that run through the center of the bones
    - Function: Supports and protects (enclosing,) provides levers for the muscles to act on, stores calcium (in order to supply us extra calcium when we need it) and other minerals and fat, marrow inside bones is the site for blood cell formation (hematopolesis)
    - Location: bones

- **Blood**
    - Description: Red and white blood cells in a fluid matrix (plasma + platelets,) derived from mesoderm
    - Function: Transports respiratory gases, nutrients, wastes and other substances
    - Fibers: soluble proteins that precipitate during clotting
    - Location: contained within blood vessels