TOPIC 1: Structural Organization of the Human Body

Levels of structural Organization that Make up the Human Body (pg 3-4)

—> Levels of Structural Organization

-Chemical levels: simplest structural organization

-atoms combine with molecules such as water and proteins. Molecules associate in specific ways to form organelles.

-Cellular Level: various have common functions, but individual vary widely in shape reflecting unique functions

-single cells

-tissue level

-group of similar cells that have common function.

-four types: epithelium, muscle, connective tissue, and nervous tissue

-organ: a structure composed of at least two tissue types, performs a specific function for the body

-Organ level

-complex functions become possible

-Organ system level

- organs working together to accomplish a common purpose

-organism

-highest level of organization , the living human being

-sum total of all structural level working together to keep us alive

—> Maintaining Life

- necessary life functions

- all body cells are interdependent but work together

The Structural Organization of the Human Body

—> Atom: smallest particle of an element (ex. C, Cl)

-properties of element

- electrons, protons and neutrons

—>Molecule: smallest amount of substance that can exist alone

- combination of atoms

- ex. water, carbon dioxide, ATP and glucose

—> Organelles: molecules associate in specific ways to form organelles

- =basic components of living cells

- ex. mitochondria, lysosme, vacuoles, ribosomes

—> Cell: Fundamental structural and functional unit of living thing

- cells vary widely in size & shape, reflecting unique functions in the body

-ex. muscle cells, neurones, liver cells have different characteristics due to different roles

—> Tissues: Groups of similar cells that have a common function:

1) Epithelium: protections, outer covering and inner lining

2) Muscle: movement, smooth muscle (organ walls). cardiac muscles, skeletal muscles

3) Connective Tissue: linkage and structural (filler component)
4) Nervous Tissue: Communication
- organ: various tissues
- organ system: ex cardiovascular system, endocrine, digestive and lymphatic system

Cell Strucutre	Funciton
Plasma Membrane	***Membrane, composed of phospholipids, cholesterol, and proteins, that encloses cell contents; outer limiting cell membrane***
Mitochondria	***cytoplasmic organelles responsible for ATP generation for cellular activities***
Ribosomes	***Cytoplasmic organelles at which proteins are synthesized***
Rough Endoplasmic Reticulum	***its ribosomes manufacture all proteins secreted from cells. In high abundance in secretary cells, antibody - producing plasma cells and liver cells, which produce more blood proteins. Cells membrane factory***
Smooth Endoplasmic Reticullum	***enzymes catalyze reactions involved with: metabolize lipids, synthesize cholesterol and synthesize the lipid components of proteins (liver cells). Synthesize steroid-based hormones such as sex hormones. Absorb, synthesize and transport fats (intestinal cells), detoxify drugs, retain pesticides and cancer causing chemicals. to break down stored glycogen to form free glucose (liver)***
Golgi Apparatus	***membranous system close to the nucleus that package protein secretions for export, packages to enzymes into lysosomes for cellular use, and modifies proteins destined to become part of cellular membranes***
Lysosomes	***organelles that originate from the golgi apparatus and contain strong digestive enzymes***
Peroxisomes	***Membranous sacs in cytoplasm containing powerful oxidase enzymes that use molecular oxygen to detoxify harmful or toxic substances, such as free radicals.***
Microtubulies	***one of three types of rods in the cytoskeleton of a cell; hollow tubes made of spherical protein that determine the cell shape as well as the distribution of cellular organelles***
Microfilaments	***Thin strands of the semiflexible strands of protein actin. work with microtubules to form the structure that allows a cell to hold its shape, move itself and organelles***

Cell Strucutre	Funciton
Intermediate Filaments	***Tough, insoluble protein fibres constructed like woven ropes composed of tetramer. Work in cytoskeleton and have most stable and permanent of the cytoskeletal elements and have high tensile strength.***
Centriole	***help in cell division.move to opposite ends of cell and a spindle fibers appear***
Cilia	***help moves substances in one direction across cell surfaces.***
Flagella	***projection formed by centrioles, but much longer. propels the cell itself (only one in human body is a sperm)***
Microvilli	***fingerlike extensions of the plasma membrane that project from an exposed cell surface. Increase cell surface and help in absorption and various surfaces***
Nucleus	***control centre. genetic library it contains the instruction needed to build proteins. Dictates the kinds and amounts of proteins to be synthesized at any one time in response***
Nuclear Membrane	***nuclear envelope. double membrane. the outer nuclear membrane is continuous with the rough ER and studded with ribosomes on external. controls what comes in and out of nuclear membrane***
Nucleoli	***made up of proteins and RNA. its primary function is to transcribe and modify ribosomal RNA and integrate ribosomal proteins to form immature ribosomes***
Chromatin	***1) to package DNA into a smaller volume to fit in the cell 2) to strengthen the DNA to allow mitosis 3)prevent DNA damage 4) to control gene expression and DNA replication. Primary component include histones and compact DNA***

Describing the Different Tissues of the Human Body

-Individual body cells, specialized; division of labour

-At organ level, cooperation for organ to work as a whole

—> Tissue:

- group of structurally similar cells that perform common/ related functions
- 4 Primary tissue types:

1) epithelial:covering
   - inner lining to structures
2) connective:support
   - pathways for blood vessels and nerves

- cartilage and bone

3) muscle:movement
   - skeletal
   - cardiac muscle
   - smooth muscle (inside of organ)

4) nervous:control (regulation)
   - sub type of tissue
   - neuron, AP, synapsis etc.

- usually all 4 to make up organ like heart, kidney
- histology: study of tissues & their cellular organization
  - preserve tissue and look at sections

A. Epithelial Tissue: sheet of cells that covers a body surface or lines a body cavity creates boundaries (ex. skin, lines reparatory system)

1) covering and lining epithelium – e.g.
   - skin
   - lining of trachea and stomach (any hallow organ)
2) glandular epithelium
   - organized into small organs, secrete materials (ex sweat glands, hormone glands)

—> functions of various epithelia:

1)protection (mechanical, chemical, infectious) – skin
   - controls rate of fluid loss, physical protection, important factor
   - protection of walls of organs (ex air bacteria and trachea)
2) absorption - GI tract
   - transport
   - SI, absorb breakdown molecules of digestion
   - have to get across epithelia cells
3) filtration - kidney
   - filtering blood, keeping good (reabsorbing)
   - lining blood vessels
4) excretion - kidney
   - transport waste products
5) secretion - glands
   - organization

- multi cellular, ducts, can send secretion

6) sensory reception - taste buds, olfactory membranes . . .

- mostly neurones
- modified epithelia cells

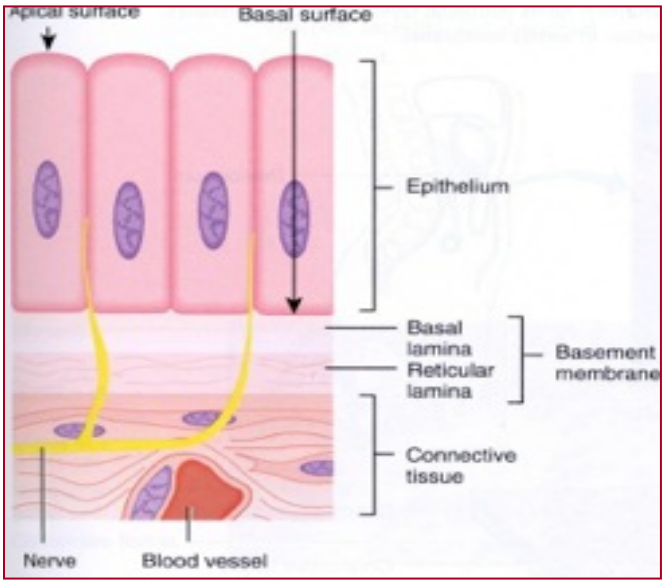


image: epithelia cell sitting on membrane, nerve attached not blood vessels (don't reach it)
important molecules diffuse through membrane to cells

—> Generalized features of epithelial cells

1) cellularity:
   - very cell dense, no extra space for other materials(for secreted material)
   - due to their purpose of being a barrier
2) specialized contacts: tight junctions & desmosomes - Why??
   - tight junctions: membranes of cell very close hold cells tightly together, don't allow things to diffuse things between cells
   ex. stomach lining. don't want acid running through protective lining
   -desmosomes: modified membranes and
3) polarity: apical and basal surfaces; apical surface often specialized such as having ? or ?
   - different organization, touch various surfaces in different orientations (directionality)

- important in tall cells, as they transport
-various services:
-apical: ex. cilia, microvilli
-basal: ex.
-lateral: ex.

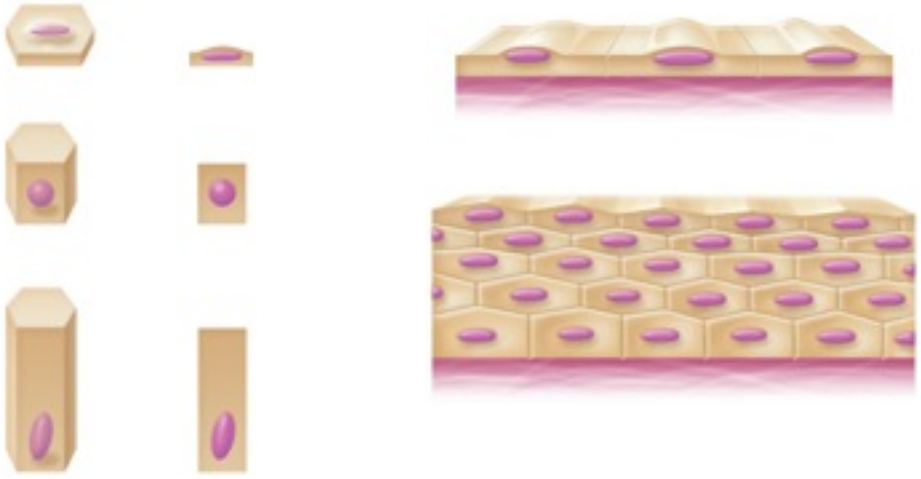
4) basal lamina: noncellular, underlying supportive sheet of primarily glycoproteins - What are two functions of a basal lamina??
- basal lamina: closest to eli cells. attachment place to cell, support cell migration, filtration (network of fibroids)
- reticular layer:

5) supported by connective tissue: basement membrane = basal lamina + underlying reticular CT (what **is reticular CT??**)
-*an important feature of cancerous epithelial cells is failure to respect the boundary imposed by the basement membrane
- break through and get to blood vessels and cancer spreads

6) innervated but avascular: how nourished?
- avascular, fluids, glucose molecules by diffusion
- move across concentration gradient

7) regeneration: high regenerative capacity - Why??
- regularly damaged, need to be able to replace
- want to keep a constant barrier

—> Cell shapes



CELL SHAPE	LAYERS
squamous	simple epithelia
cuboidal	stratified epithelia
columnar	

—> Examples of Simple Epithelia: (absorption, secretion, filtration)

1) simple squamous epithelium: thin & permeable - filtration, diffusion - eg: Endothelium & in Kidney, Lungs
   - want a thin barrier
   - much permeability
2) simple cuboidal epithelium: secretion & absorption - eg: kidney tubules, small glands
   - thicker than ssepi because of more activity (needs to be sturdy)
   -not to thick still need to transport
3) simple columnar epithelium: also digestion & secretion – eg. digestive tract
   - most likely will have microvilli
   - want to get into blood stream

- pseudostratified columnar epithelium: a single layer - eg: respiratory tract where cilia and mucus secretion are local specializations
  - pseudostratified: looks like several layers, but not really
  - ciliated: lining that's moving things along
  - columnar: tall, fatter
  - simple, single layer cells

-Transitional epithelium (not simple!):

- lines the bladder, an organ that has to fill – the basal layers are columnar to cuboidal and the apical layers become increasingly flattened & squamous-like as filling occurs
- several layers
- naming because of various shapes (based on how much pee is in bladder)

- Structure of stratified squamous epithelium and give a sample body location

-protective role; **basal** cells **cuboidal** & undergo mitosis to keep regenerating the layer from below

- to far away from blood vessels
- image of layer of skins, top is dead, bottom is alive

-What is the most widespread example of stratified squamous epithelium?

- skin

- What happens to the apical layers of cells?

- die because far away from blood source

- they get slapped off and replaced

—> Glands:

- Glandular Epithelia:

- gland: 1 or more cells that make & secrete a particular product

- endocrine: travel through to Extra cellular space, bloodstream (hormone)

-exocrine: travels through ducts to destinations (unless unicellular)

- Endocrine Glands:

-just know that they are ductless - products are called hormones

- Exocrine Glands:

- mucous, sweat, oil/salivary glands, liver, pancreas, etc.

a) Unicellular exocrine glands:

- no ducts because only one cell!

- really just the goblet cells (digestive & respiratory tracts)

b) Multicellular exocrine glands:

-epithelium-derived duct & secretory cells; surrounded by supportive CT which brings blood vessels & nerves

—> Secretory Method:

- merocrine(eccrine): exocytosis, most common type

-ex. pancreas, salivary glands, most sweat glands

-produce, packaged and exported

- holocrine: cell rupture; only sebaceous glands

- bursts to release contents

- apocrine: cell apex pinches off with secretory product

- top of cell membrane comes off and product come out

- Is mammary gland apocrine or merocrine? both (mixes both techniques) (won't be asked about this)

—> *Where to find epithelial cells (matching)*

Lines stomach, most intestines: Simple Columnar

Lines the inside of the mouth: Stratified Squamous

Lines much of the respiratory tract: Pseudostratified ciliated columnar

Endothelium: Simple Squamous

Composes lung alveoli: Simple Squamous

Simple cuboidal and stratified columnar not found in body

—> Connective Tissue

- 5 major types: mesenchyme, CT proper, cartilage, bone and blood

—> main functions:

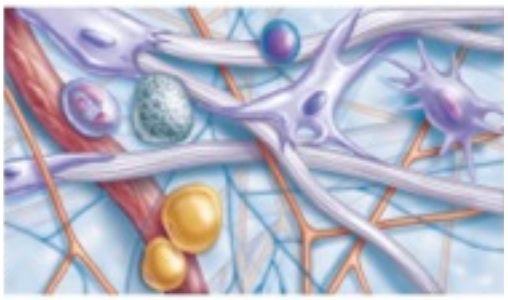
1) binding or support ex. bone holding up, cartilage supports
2) Protection ex skull protects brain, vertebrae column protects spinal cord, adipose tissue (fat)
3) Insulation ex Adipose tissue
4) Transportation ex. blood

—> Structural Elements of Connective Tissue:

a) <u>ground substance</u>: interstitial fluid (in-between cells) + cell adhesion proteins & proteoglycans (molecule with protein and sugar): molecular sieve —- slows things down

- fibronectin, laminin - help cells attach to CT elements
- proteoglycans - What are these? What do they do?
  - large molecules, with protein part chain of sugar
  - holds water (jello like), gives strength and structural support

b) <u>fibres</u>: possible to find in connective tissues, depending on which ones



- collagen fibres: high tensile strength
  - thick white ones, attach to each other and cells to each other
- elastic fibres: elastin has coiled structure to allow stretch + recoil
  -
  - orange thin ones, elastic fibbers
- reticular fibres: thin collagen protein; fine network to support blood vessels, soft tissues

- dark blue ones, more in WBC, finer mesh work

TISSUE TYPE	"BLAST"	"CYTE"
CT proper	fibroblast	fibrocyte
Cartilage	chondroblast	chondrocyte
Bone	osteoblast	osteocyte
Blood	hemocytoblast	RBCs, WBCs, platelets

c) <u>cells:</u> immature ("blast") forms vs mature ("cyte") forms

-"blasts" are actively dividing/synthesizing cells during growth & repair

- "cytes" primarily provide a level of maintenance

- immature cell - blast, growing and developing

- mature cell - cyte, maintaing properties

- chond - cartilage

—> Types of CT:

1) Mesenchyme:

-first tissue formed from mesoderm germ layer -

-mesenchymal cells + fluid ground substance & fine fibrils

- source of all other CTs (embryonic tissue)

2) CT Proper: 2 subclasses

A. Loose CT (areolar, adipose, reticular)

-less fiberles, more fluid fill space

—> Areolar CT: gel-like matrix with all 3 fiber types; cells = fibroblasts, macrophages, mast cells, & some WBCs

-Description: loose arrangement of fibers; reservoir of water & salts but is also a prime site of edema during i inflammatory reaction (sodium chloride in water)

-Location: widely distributed under epithelia of body - eg:under skin, hangs on to water, can hold water (swelling)

-Function: protective and cushioning of organs, immunity (macrophages) & inflammation; fluid reservoir

—> Adipose Tissue: areolar CT (connective tissue) modified to store nutrients; adipocytes (fat storing cells, grow with age)

- Description: **fat**-filled adipocytes with displaced nuclei; do not reproduce; scanty matrix
- Location: under skin, around kidneys & eyeballs, in bones & within abdomen, in breasts; 18% of average wt (15% ♂ & 22% ♀)
-Function: fuel reservoir, insulation, supports & protects organs

—> Reticular CT: like areolar CT, but only reticular fibers
- Loc: lymphoid organs (lymph nodes, bone marrow, spleen) (WBC and RBC production or stored here)
- Fcn: fibers form soft internal skeleton that supports free blood cells

B. Dense CT (dense regular, dense irregular, elastic)
-fibres are the predominant element, little secreted material

—> Dense Regular CT: bundles of collagen fibers running parallel to direction of pull à white, flexible tissue with great resistance to tension
-Location: tendons (muscles to bones), ligaments (bones to bones at joints), also aponeuroses (<— flattened sheet of ligaments)
- Function: attachment with strength

—> Dense Irregular CT: same as regular, but collagen bundles thicker & arranged irregularly
- Location: dermis, submucosa of digestive tract, fibrous capsules of organs & joints
- Function: withstand tension exerted in many directions; strength because of collagen

—> Elastic CT: like dense regular CT, but a very high content of elastic fibers; found in some very elastic ligaments, not found in body as much

—> Cartilage

- Feature between dense CT and bone, a touch but flexible

(i) avascular, devoid of nerve fibers

(ii) ground substance contains lots of the GAGs (glycol amino glycan) chondroitin sulfate & hyaluronic acid - also chondronectin, (adhesive protein) (holds a lot of water which makes it sturdy)
(iii) collagen fibers (can have some elastic fibers)
(iv) up to 80% H2O (held in place by GAGs)

—> Bone

-<u>calcium salts</u> give hardness & strength for support/protection of softer tissues; cavities for fat storage & synthesis of blood cells

- osteoblasts: immature cells, actively laying down collagen fibres
- osteocytes: mature cells
- osteoclasts: blood-calcium level maintained, takes calcium from bone to blood

—> Blood

-classified as a CT because it consists of *cells* (RBCs, WBCs) surrounded by a nonliving fluid *matrix*, blood plasma

-"fibre" components are soluble protein molecules - only visible during clotting

Practice Questions

1) What of the following fibrous elements give a CT high tensile Strength: Collagen Fibres

2) The cell that forms bone is: Osteoblast

3) Which kind of CT acts a sponge, soaking up fluid when edema occurs: Areolar CT