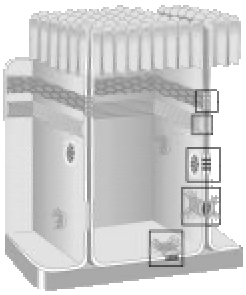
Chapter 4
The Tissue Level of Organization



- *Group of similar cells*
  - *common embryonic origin*
  - *common function*
- *Histology*
  - *study of tissues*
- *Pathologist*
  - *looks for tissue changes that indicate disease*

4-1

4 Basic Tissues (1)

- *Epithelial Tissue*
  - *covers surfaces because cells are in contact*
  - *lines hollow organs, cavities and ducts*
  - *forms glands when cells sink under the surface*
- *Connective Tissue*
  - *material found between cells*
  - *supports and binds structures together*
  - *stores energy as fat*
  - *provides immunity to disease*

4-2

4 Basic Tissues (2)

- *Muscle Tissue*
  - *cells shorten in length producing movement*
- *Nerve Tissue*
  - *cells that conduct electrical signals*
  - *detects changes inside and outside the body*
  - *responds with nerve impulses*

4-3

Origin of Tissues

- *Primary germ layers within the embryo*
  - *endoderm*
  - *mesoderm*
  - *ectoderm*
- *Tissue derivations*
  - *epithelium from all 3 germ layers*
  - *connective tissue & muscle from mesoderm*
  - *nerve tissue from ectoderm*

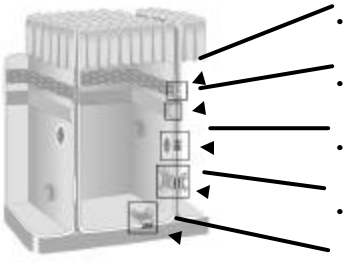
4-4

Biopsy

- *Removal of living tissue for microscopic examination*
  - *surgery*
  - *needle biopsy*
- *Useful for diagnosis, especially cancer*
- *Tissue preserved, sectioned and stained before microscopic viewing*

4-5

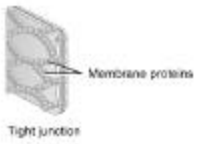
Cell Junctions



- *Tight junctions*
- *Adherens junctions*
- *Gap junctions*
- *Desmosomes*
- *Hemidesmosomes*

4-6

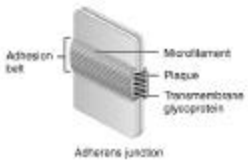
Tight Junctions



- *Watertight seal between cells*
- *Plasma membranes fused with a strip of proteins*
- *Common between cells that line GI and bladder*

4-7

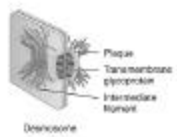
Adherens Junctions



- *Holds epithelial cells together*
- *Structural components*
  - *plaque = dense layer of proteins inside the cell membrane*
  - *microfilaments extend into cytoplasm*
  - *integral membrane proteins connect to membrane of other cell*

4-8

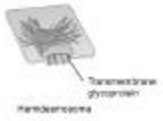
Desmosomes



- *Resists cellular separation and cell disruption*
- *Similar structure to adherens junction except intracellular intermediate filaments cross cytoplasm of cell*
- *Cellular support of cardiac muscle*

4-9

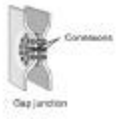
Hemidesmosomes



- *Half a desmosome*
- *Connect cells to extracellular material*
  - *basement membrane*

4-10

Gap Junctions



- *Tiny space between plasma membranes of 2 cells*
- *Crossed by protein channels called connexons forming fluid filled tunnels*
- *Cell communication with ions & small molecules*
- *Muscle and nerve impulses spread from cell to cell*
  - *heart and smooth muscle of gut*

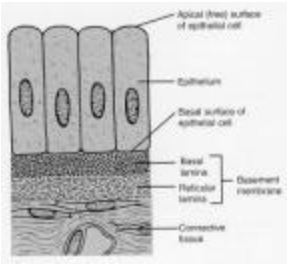
4-11

Epithelial Tissue -- General Features

- *Closely packed cells forming continuous sheets*
- *Cells sit on basement membrane*
- *Apical (upper) free surface*
- *Avascular---without blood vessels*
  - *nutrients diffuse in from underlying connective tissue*
- *Good nerve supply*
- *Rapid cell division*
- *Covering / lining versus glandular types*

4-12

Basement Membrane



- *Basal lamina*
  - *from epithelial cells*
  - *collagen fibers*
- *Reticular lamina*
  - *secreted by connective tissue cells*
  - *reticular fibers*
- *holds cells to connective tissue*
- *guide for cell migration during development*

4-13

Types of Epithelium

- *Covering and lining epithelium*
  - *epidermis of skin*
  - *lining of blood vessels and ducts*
  - *lining respiratory, reproductive, urinary & GI tract*
- *Glandular epithelium*
  - *secreting portion of glands*
  - *thyroid, adrenal, and sweat glands*

4-14

Classification of Epithelium

- *Classified by arrangement of cells into layers*
  - *simple = one cell layer thick*
  - *stratified = many cell layers thick*
  - *pseudostratified = single layer of cells where all cells don't reach apical surface*
    - *nuclei at found at different levels so it looks multilayered*
- *Classified by shape of surface cells*
  - *squamous =flat*
  - *cuboidal = cube-shaped*
  - *columnar = tall column*
  - *transitional = shape varies with tissue stretching*

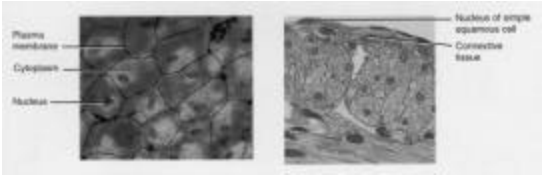
4-15

Simple Squamous Epithelium

- *Single layer of flat cells*
  - ***lines blood vessels (endothelium), body cavities (mesothelium)***
  - ***very thin --- controls diffusion, osmosis and filtration***
  - ***nuclei centrally located***
- *Cells in direct contact with each other*

4-16

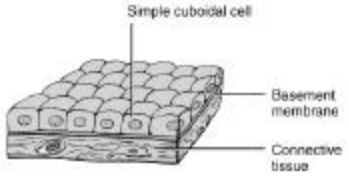
Examples of Simple Squamous



- *Surface view of lining of peritoneal cavity*
- *Section of intestinal showing serosa*

4-17

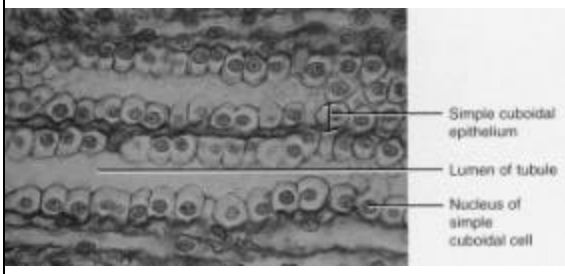
Simple Cuboidal Epithelium



- *Single layer of cube-shaped cells viewed from the side*
- *Nuclei round and centrally located*
- *Lines tubes of kidney*
- *Absorption or secretion*

4-18

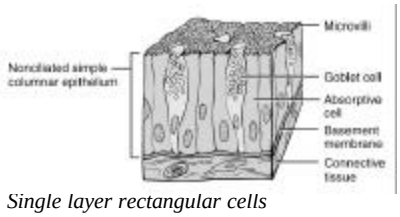
Example of Simple Cuboidal



- *Sectional view of kidney tubules*

4-19

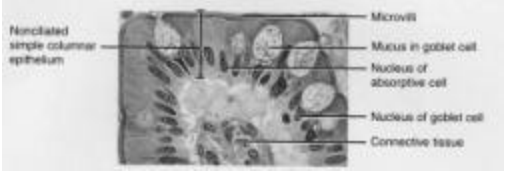
Nonciliated Simple Columnar



- *Single layer rectangular cells*
- *Unicellular glands =goblet cells secrete mucus*
  - *lubricate GI, respiratory, reproductive and urinary systems*
- *Microvilli = fingerlike cytoplasmic projections*
  - ***for absorption in GI tract (stomach to anus)***

4-20

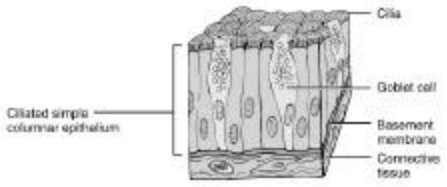
Ex. Nonciliated Simple Columnar



- *Section from small intestine*

4-21

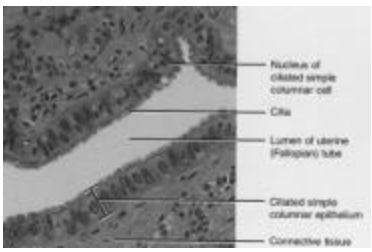
Ciliated Simple Columnar Epithelium



- *Single layer rectangular cells with cilia*
- *Mucus from goblet cells moved along by cilia*
  - ***found in respiratory system and uterine tubes***

4-22

Ex. Ciliated Simple Columnar

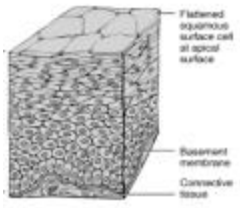


- *Section of uterine tube*

4-23

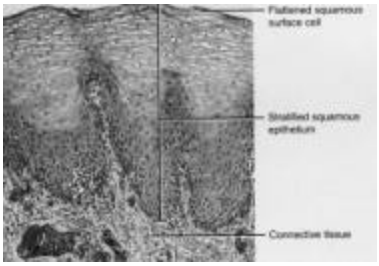
Stratified Squamous Epithelium

- *Several cell layers thick*
- *Surface cells flat*
- *Keratinized = surface cells dead and filled with keratin*
  - ***skin (epidermis)***
- *Nonkeratinized = no keratin in moist living cells at surface*
  - ***mouth, vagina***



4-24

Example of Stratified Squamous



- *Section of vagina*

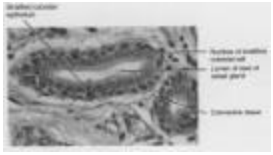
4-25

Papanicolaou Smear (Pap smear)

- *Collect sloughed off cells of uterus and vaginal walls*
- *Detect cellular changes (precancerous cells)*
- *Annually for women over 18 or if sexually active*

4-26

Stratified Cuboidal Epithelium

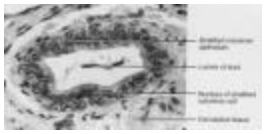


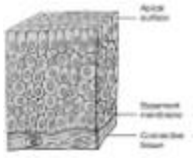
- *Multilayered*
- *Surface cells cuboidal*
  - *rare (only found in sweat gland ducts & male urethra)*

4-27

Stratified Columnar Epithelium

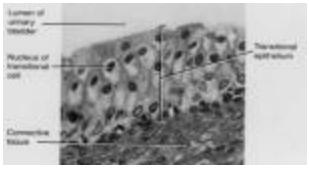
- *Multilayered*
- *Surface cells columnar*
- *Rare (very large ducts & part of male urethra)*



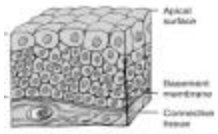


4-28

Transitional Epithelium

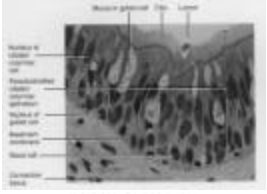


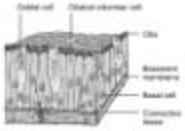
- *Multilayered*
- *Surface cells varying in shape from round to flat if stretched*
- *Lines hollow organs that expand from within (urinary bladder)*



4-29

Pseudostratified Columnar





- *Single cell layer*
- *All cells attach to basement membrane but not all reach free surface*
- *Nuclei at varying depths*
- *Respiratory system, male urethra & epididymis*

4-30

Glandular Epithelium

- *Derived from epithelial cells that sank below the surface during development*
- *Exocrine glands*
  - *cells that secrete---sweat, ear wax, saliva, digestive enzymes onto free surface of epithelial layer*
  - *connected to the surface by tubes (ducts)*
  - *unicellular glands or multicellular glands*
- *Endocrine glands*
  - *secrete hormones into the bloodstream*
  - *hormones help maintain homeostasis*

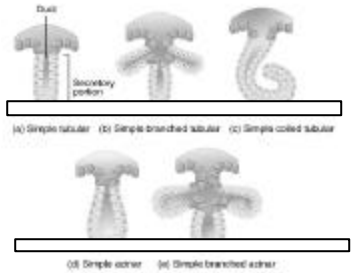
4-31

Structural Classification of Exocrine Glands

- *Unicellular are single-celled glands*
  - *goblet cells*
- *Multicellular glands*
  - *branched (compound) or unbranched (simple)*
  - *tubular or acinar (flask-like) shape*

4-32

Examples of Simple Glands



- *Unbranched ducts = simple glands*
- *Duct areas are blue*

4-33

Examples of Compound Glands

- *Which is acinar? Which is tubular?*

4-34

Duct of Multicellular Glands

- *Sweat gland duct*
- *Stratified cuboidal epithelium*

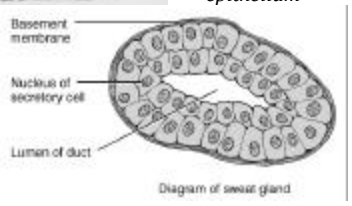
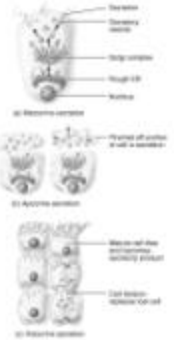


Diagram of sweat gland

4-35

Methods of Glandular Secretion



- *Merocrine -- most glands*
  - *cells release their products by exocytosis---saliva, digestive enzymes & sweat*
- *Apocrine*
  - *smelly sweat & milk*
  - *upper part of cell possibly pinches off & dies (perhaps--see EM data)*
- *Holocrine -- oil gland*
  - *whole cells die & rupture to release their products*

4-36

Connective Tissues

- *Cells rarely touch due to extracellular matrix*
- *Matrix(fibers & ground substance secreted by cells*
- *Consistency varies from liquid, gel to solid*
- *Does not occur on free surface*
- *Good nerve & blood supply except cartilage & tendons*

4-37

Cell Types

- *Blast type cells = retain ability to divide & produce matrix (fibroblasts, chondroblasts, & osteoblasts)*
- *Cyte type cells = mature cell that can not divide or produce matrix (chondrocytes & osteocytes)*
- *Macrophages develop from monocytes*
  - *engulf bacteria & debris by phagocytosis*
- *Plasma cells develop from B lymphocytes*
  - *produce antibodies that fight against foreign substances*
- *Mast cells produce histamine that dilate small BV*
- *Adipocytes (fat cells) store fat*

4-38

Connective Tissue Ground Substance

- *Supports the cells and fibers*
- *Helps determine the consistency of the matrix*
  - *fluid, gel or solid*
- *Contains many large molecules*
  - *hyaluronic acid is thick, viscous and slippery*
  - *condroitin sulfate is jellylike substance providing support*
  - *adhesion proteins (fibronectin) binds collagen fibers to ground substance*

4-39

Types of Connective Tissue Fibers

- *Collagen (25% of protein in your body)*
  - *tough, resistant to pull, yet pliable*
  - *formed from the protein collagen*
- *Elastin (lungs, blood vessels, ear cartilage)*
  - *smaller diameter fibers formed from protein elastin surrounded by glycoprotein (fibrillin)*
  - *can stretch up to 150% of relaxed length and return to original shape*
- *Reticular (spleen and lymph nodes)*
  - *thin, branched fibers that form framework of organs*
  - *formed from protein collagen*

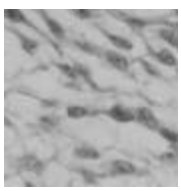
4-40

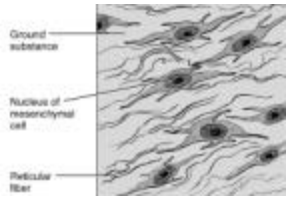
Marfan Syndrome

- *Inherited disorder of fibrillin gene*
- *Abnormal development of elastic fibers*
- *Tendency to be tall with very long legs, arms, fingers and toes*
- *Life-threatening weakening of aorta may lead to rupture*

4-41

Embryonic Connective Tissue: Mesenchyme

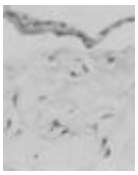


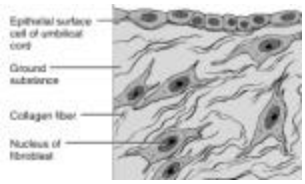


- *Irregularly shaped cells*
- *In semifluid ground substance with reticular fibers*
- *Gives rise to all other types of connective tissue*

4-42

Embryonic Connective Tissue: Mucous Connective Tissue





- *Star-shaped cells in jelly-like ground substance*
- *Found only in umbilical cord*

4-43

Mature Connective Tissue

- *Loose connective tissue*
- *Dense connective tissue*
- *Cartilage*
- *Bone*
- *Blood*
- *Lymph*

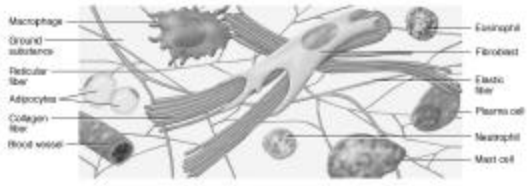
4-44

Loose Connective Tissues

- *Loosely woven fibers throughout tissues*
- *Types of loose connective tissue*
  - *areolar connective tissue*
  - *adipose tissue*
  - *reticular tissue*

4-45

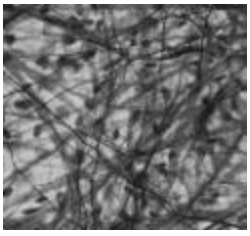
Areolar Connective Tissue

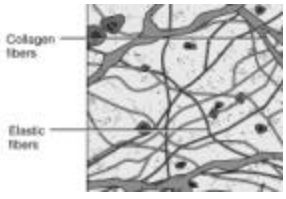


- *Cell types = fibroblasts, plasma cells, macrophages, mast cells and a few white blood cells*
- *All 3 types of fibers present*
- *Gelatinous ground substance*

4-46

Areolar Connective Tissue

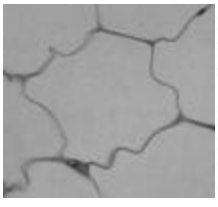


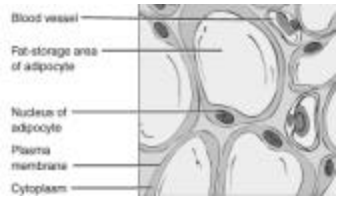


- *Black = elastic fibers,*
- *Pink = collagen fibers*
- *Nuclei are mostly fibroblasts*

4-47

Adipose Tissue





- *Peripheral nuclei due to large fat storage droplet*
- *Deeper layer of skin, organ padding, yellow marrow*
- *Reduces heat loss, energy storage, protection*
- *Brown fat found in infants has more blood vessels and mitochondria and responsible for heat generation*

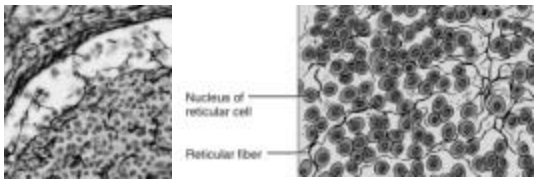
4-48

Liposuction or Suction Lipectomy

- *Suctioning removal of subcutaneous fat for body contouring*
- *Dangers include fat emboli, infection, injury to internal organs and excessive pain*

4-49

Reticular Connective Tissue



- *Network of fibers & cells that produce framework of organ*
- *Holds organ together (liver, spleen, lymph nodes, bone marrow)*

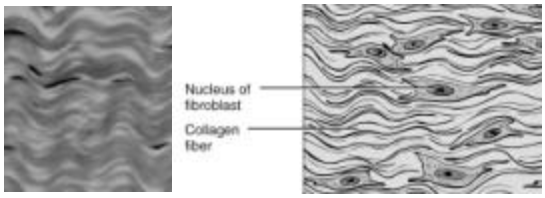
4-50

Dense Connective Tissue

- *More fibers present but fewer cells*
- *Types of dense connective tissue*
  - *dense regular connective tissue*
  - *dense irregular connective tissue*
  - *elastic connective tissue*

4-51

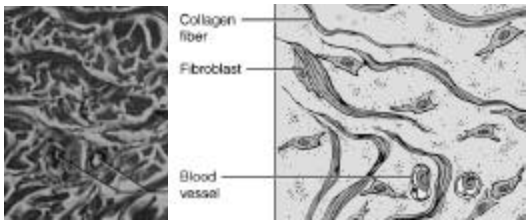
Dense Regular Connective Tissue



- *Collagen fibers in parallel bundles with fibroblasts between bundles of collagen fibers*
- *White, tough and pliable when unstained (forms tendons)*
- *Also known as white fibrous connective tissue*

4-52

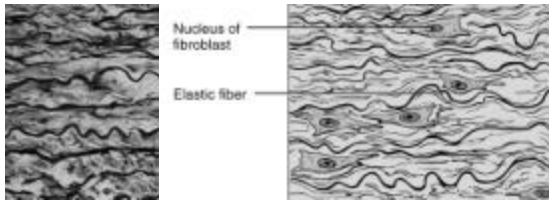
Dense Irregular Connective Tissue



- *Collagen fibers are irregularly arranged (interwoven)*
- *Tissue can resist tension from any direction*
- *Very tough tissue -- white of eyeball, dermis of skin*

4-53

Elastic Connective Tissue



- *Branching elastic fibers and fibroblasts*
- *Can stretch & still return to original shape*
- *Lung tissue, vocal cords, ligament between vertebrae*

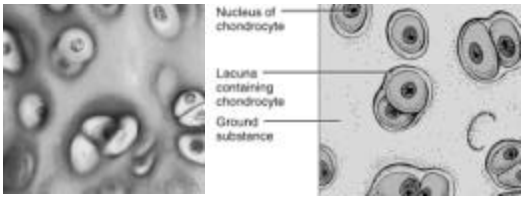
4-54

Cartilage

- *Network of fibers in rubbery ground substance*
- *Resilient and can endure more stress than loose or dense connective tissue*
- *Types of cartilage*
  - *hyaline cartilage*
  - *fibrocartilage*
  - *elastic cartilage*

4-55

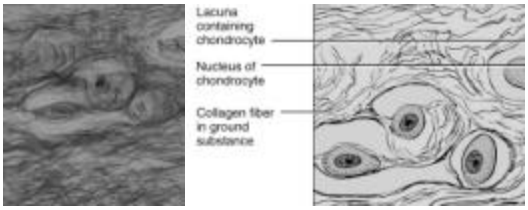
Hyaline Cartilage



- *Bluish-shiny white rubbery substance*
- *Chondrocytes sit in spaces called lacunae*
- *No blood vessels or nerves so repair is very slow*
- *Reduces friction at joints as articular cartilage*

4-56

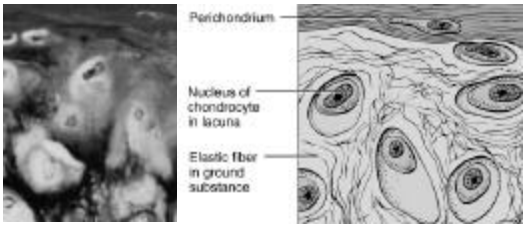
Fibrocartilage



- *Many more collagen fibers causes rigidity & stiffness*
- *Strongest type of cartilage (intervertebral discs)*

4-57

Elastic Cartilage



- *Elastic fibers help maintain shape after deformations*
- *Ear, nose, vocal cartilages*

4-58

Growth & Repair of Cartilage

- *Grows and repairs slowly because is avascular*
- *Interstitial growth*
  - *chondrocytes divide and form new matrix*
  - *occurs in childhood and adolescence*
- *Appositional growth*
  - *chondroblasts secrete matrix onto surface*
  - *produces increase in width*

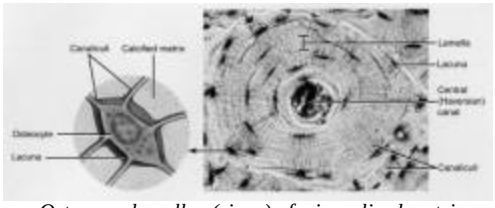
4-59

Bone (Osseous) Tissue

- *Spongy bone*
  - *sponge-like with spaces and trabeculae*
  - *trabeculae = struts of bone surrounded by red bone marrow*
  - *no osteons (cellular organization)*
- *Compact bone*
  - *solid, dense bone*
  - *basic unit of structure is osteon (haversian system)*
- *Protects, provides for movement, stores minerals, site of blood cell formation*

4-60

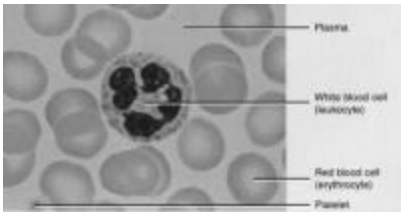
Compact Bone



- *Osteon = lamellae (rings) of mineralized matrix*
  - *calcium & phosphate---give it its hardness*
  - *interwoven collagen fibers provide strength*
- *Osteocytes in spaces (lacunae) in between lamellae*
- *Canaliculi (tiny canals) connect cell to cell*

4-61

Blood



- *Connective tissue with a liquid matrix = the plasma*
- *Cell types = red blood cells (erythrocytes), white blood cells (leukocytes) and cell fragments called platelets*
- *Provide clotting, immune functions, carry O2 and CO2*

4-62

Lymph

- *Interstitial fluid being transported in lymphatic vessels*
- *Contains less protein than plasma*
- *Move cells and substances (lipids) from one part of the body to another*

4-63

Membranes

- *Epithelial layer sitting on a thin layer of connective tissue (lamina propria)*
- *Types of membranes*
  - *mucous membrane*
  - *serous membrane*
  - *synovial membrane*
  - *cutaneous membrane (skin)*

4-64

Mucous Membranes

- *Lines a body cavity that opens to the outside*
  - *mouth, vagina, anus etc*
- *Epithelial cells form a barrier to microbes*
- *Tight junctions between cells*
- *Mucous is secreted from underlying glands to keep surface moist*

4-65

Serous Membranes

- *Simple squamous cells overlying loose CT layer*
- *Squamous cells secrete slippery fluid*
- *Lines a body cavity that does not open to the outside such as chest or abdominal cavity*
- *Examples*
  - *pleura, peritoneum and pericardium*
  - *membrane on walls of cavity = parietal layer*
  - *membrane over organs in cavity = visceral layer*

4-66

Synovial Membranes

- *Line joint cavities of all freely movable joints*
- *No epithelial cells---just special cells that secrete slippery fluid*

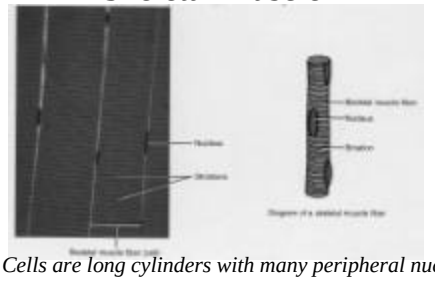
4-67

Muscle

- *Cells that shorten*
- *Provide us with motion, posture and heat*
- *Types of muscle*
  - *skeletal muscle*
  - *cardiac muscle*
  - *smooth muscle*

4-68

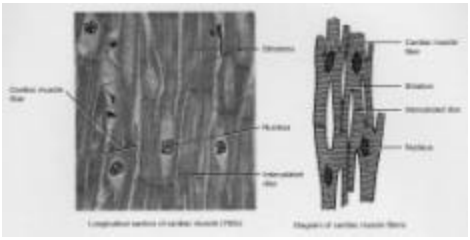
Skeletal Muscle



- *Cells are long cylinders with many peripheral nuclei*
- *Visible light and dark banding (looks striated)*
- *Voluntary or conscious control*

4-69

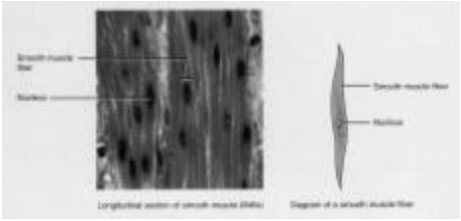
Cardiac Muscle



- *Cells are branched cylinders with one central nuclei*
- *Involuntary and striated*
- *Attached to and communicate with each other by intercalated discs and desmosomes*

4-70

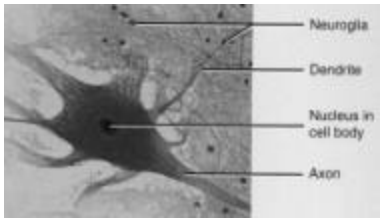
Smooth Muscle



- *Spindle shaped cells with a single central nuclei*
- *Walls of hollow organs (blood vessels, GI tract, bladder)*
- *Involuntary and nonstriated*

4-71

Nerve Tissue



- *Cell types -- nerve cells and neuroglial (supporting) cells*
- *Nerve cell structure*
  - *nucleus & long cell processes conduct nerve signals*
    - *dendrite --- signal travels towards the cell body*
    - *axon ---- signal travels away from cell body*

4-72

Tissue Engineering

- *New tissues grown in the laboratory (skin & cartilage)*
- *Scaffolding of cartilage fibers is substrate for cell growth in culture*
- *Research in progress*
  - *insulin-producing cells (pancreas)*
  - *dopamine-producing cells (brain)*
  - *bone, tendon, heart valves, intestines & bone marrow*

4-73

Tissue Repair: Restoring Homeostasis

- *Worn-out, damaged tissue must be replaced*
- *Fibrosis = replacement with stromal connective tissue cells (scar formation)*
- *Regeneration = replacement with original cell types (parenchymal cells)*
  - *some cell types can divide (liver & endothelium)*
  - *some tissues contain stem cells that can divide*
    - *bone marrow, epithelium of gut & skin*
  - *some cell types can not divide & are not replaced*
    - *muscle and nervous tissue*

4-74

Important Clinical Terminology

- *Regeneration versus fibrosis*
- *Granulation tissue*
  - *very actively growing connective tissue*
- *Adhesions*
  - *abnormal joining of tissue*
  - *occurs after surgery or inflammation*

4-75

Conditions Affecting Tissue Repair

- *Nutrition*
  - *adequate protein for structural components*
  - *vitamin C production of collagen and new blood vessels*
- *Proper blood circulation*
  - *delivers O2 & nutrients & removes fluids & bacteria*
- *With aging*
  - *collagen fibers change in quality*
  - *elastin fibers fragment and abnormally bond to calcium*
  - *cell division and protein synthesis are slowed*

4-76

Sjogren's Syndrome

- *Autoimmune disorder producing exocrine gland inflammation*
- *Dryness of mouth and eyes*
- *20 % of older adults show some signs*

4-77

Systemic Lupus Erythematosus (SLE)

- *Autoimmune disorder -- causes unknown*
- *Chronic inflammation of connective tissue*
- *Nonwhite women during childbearing years*
- *Females 9:1 (1 in 2000 individuals)*
- *Painful joints, ulcers, loss of hair, fever*
- *Life-threatening if inflammation occurs in major organs --- liver, kidney, heart, brain, etc.*

4-78