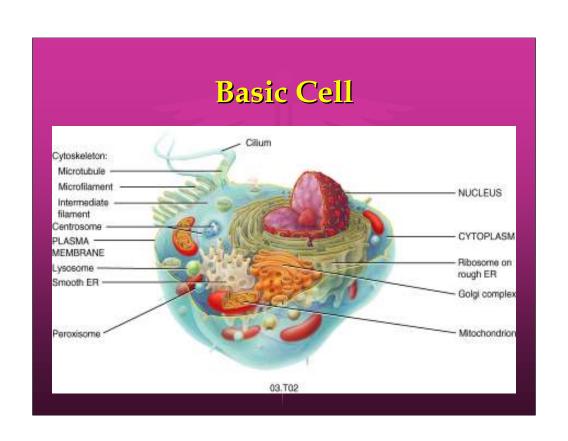
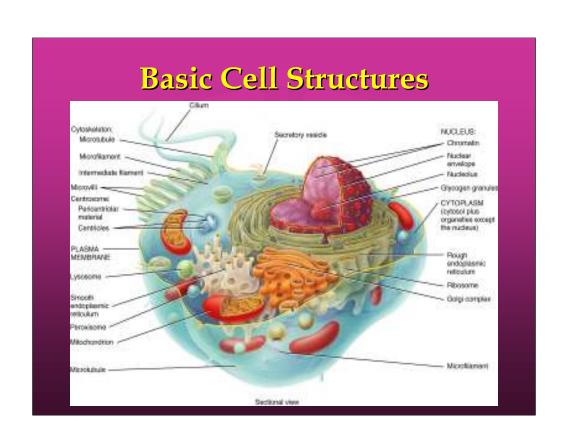
# CELLS The basic living, structural, and functional unit of all organisms.

#### **Basic Cell Structure**

- Cell (Plasma) Membrane
- Cytosol
- Organelles
- Nucleus





#### Cytosol

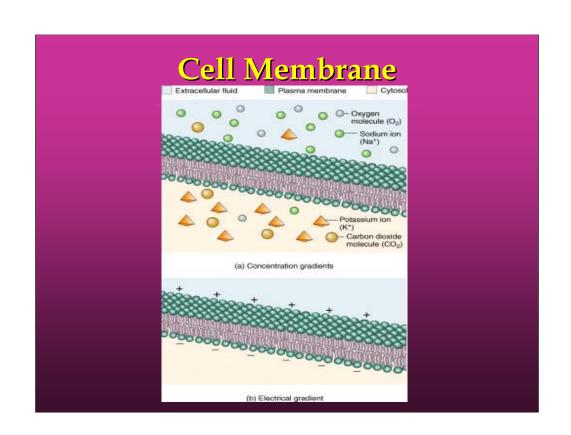
- The semi-fluid component of cytoplasm or intracellular fluid
- 75% 95% water
- May contain organelles, large carbohydrates, fat, and protein molecules

#### **Function of Cytosol**

- Location of chemical reactions (anaerobic energy metabolism)
- Synthesis of cellular substances
- Packaging of chemicals for transport
- Facilitates excretion of waste material

#### The Cell (Plasma) Membrane

• Thin structure that separates the internal cellular components from the external environment.

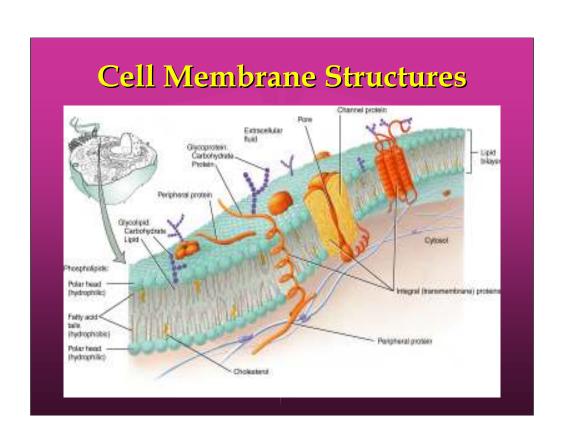


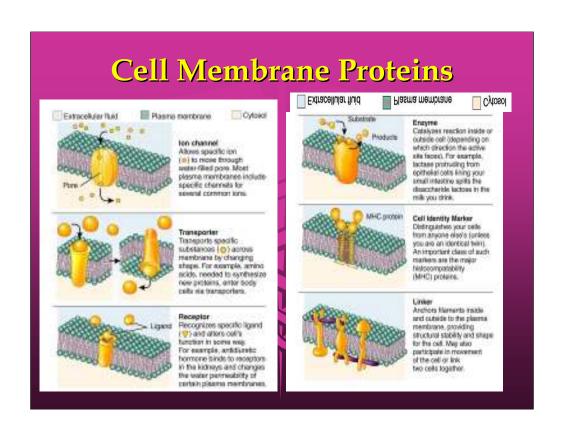
#### Structure of the Cell Membrane

- Phospholipid bilayer
- Hydrophilic phosphoric heads face outward
- Hydrophobic fatty acid tails face inward
- Carbohydrates assist in cell identification/communication
- Cholesterol increases strength of cell membrane

#### **Cell Membrane Proteins**

- Integral Proteins are proteins imbedded in the phospholipid bilayer
  - gates or channels are transport proteins
  - receptor sites for hormones
  - enzymes
  - cellular identity markers
- Peripheral Proteins are loosely bound to plasma membrane
  - function not completely understood



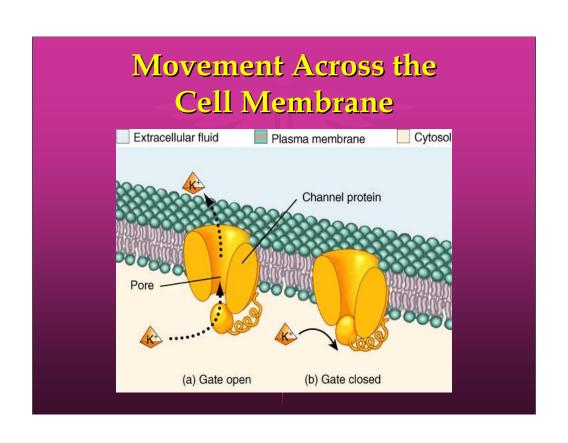


### Functions of the Cell Membrane

- Flexible boundary
- Facilitates contact with other cells and environment
- Receptor sites hormones, enzymes, neurotransmitters, nutrients, antibodies
- Selectively permeable mediates entrance and exit of material into and out of cell.

# Factors Influencing Permeability of Plasma Membrane

- Size of molecules
- Solubility in lipids
- Charge on ions
- Presence of carrier molecules



#### Intracellular Fluid

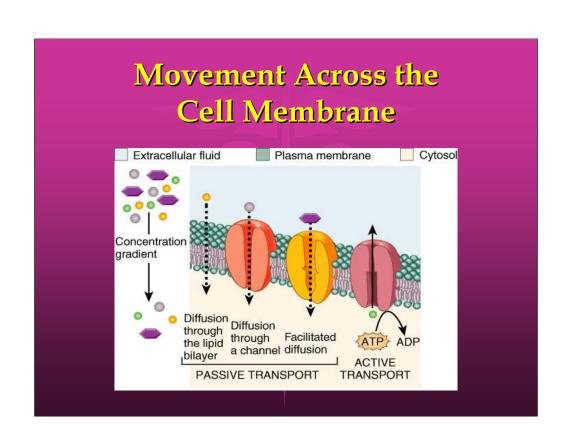
- Fluid found in living cells
- Comprises > 66% of body's total water
- Mostly water
  - may also contain potassium, phosphates, magnesium, chloride, and other ions

## The Extracellular Environment

- Interstitial Fluid (Intercellular Fluid)
  - Fluid found in the microscopic spaces between cells
- Plasma
  - Extracellular fluid within blood and lymph vessels

#### Movement Across the Plasma Membrane

- Passive Processes
  - No energy expenditure
  - Moves down a concentration gradient
  - High →low concentration
- Active Processes
  - Requires energy expenditure
  - Moves against a concentration gradient
  - Low → high concentration
  - May utilize 40% of cells ATP supply

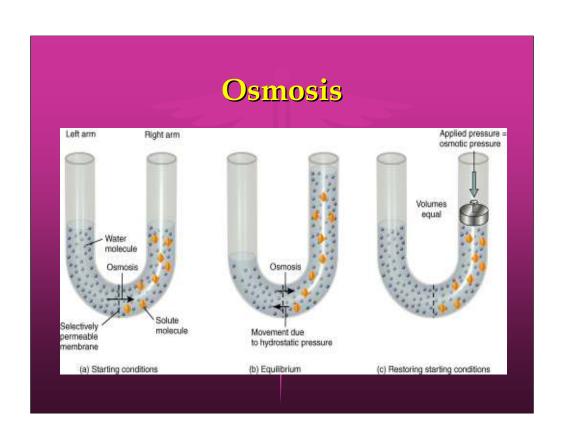


#### **Passive Transport**

- Diffusion
- Facilitated Diffusion
- Osmosis
- Dialysis
- Filtration

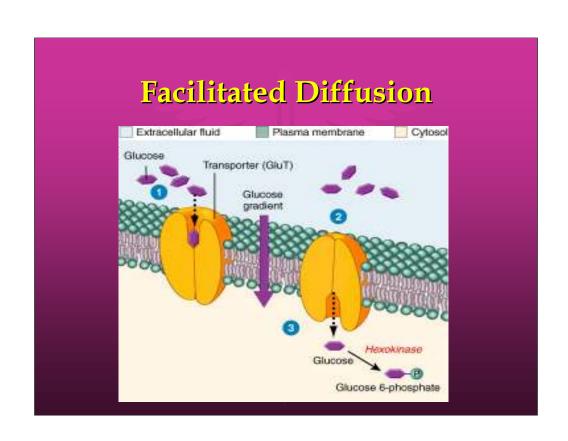
#### **Diffusion**

- The movement of molecules from a higher concentration to a lower concentration. Does not require energy.
- Ex: perfume, electrolytes



#### Facilitated Diffusion

- Facilitated diffusion is the process of diffusion through the protein channels of the cell membrane.
- Ex: glucose



#### Dialysis

- Dialysis is the diffusion of small solute particles through a selectively permeable membrane resulting in the separation of large and small solutes.
- Example: Kidney dialysis

#### **Filtration**

- Filtration is the process of removing particles from a solution by allowing the liquid to pass through a membrane.
   It is influenced by gravity and hydrostatic pressure.
- Example: Filtration in the glomerulus of the kidney nephron.

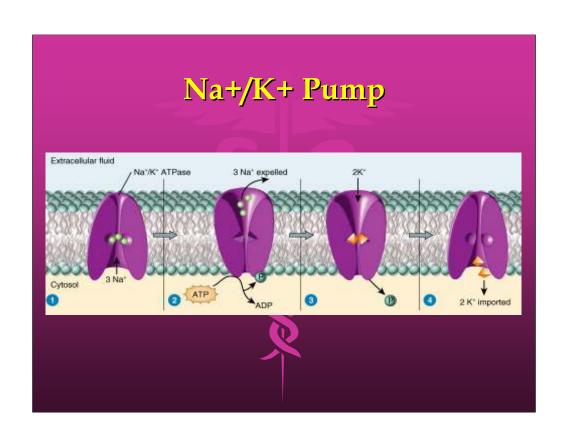
#### **Active Transport Processes**

- 1. Endocytosis occurs when the molecules are too big to enter the cell by diffusion or active transport, a vesicle is formed from the cell membrane.
- Example: Phagocytosis or cell eating.

- 2. Exocytosis
- Any remaining particles from phagocytosis may be expelled from the cell when the vesicle joins with the cell membrane and the contents are removed from the cell.

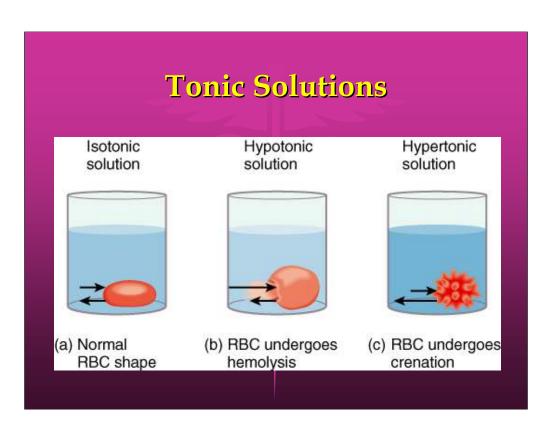
#### **Active Transport**

- Active Transport
  - Uses energy
  - Ions move against a concentration gradient
- Na+/K+ pump
  - Estimated 40% ATP use in the body
- Cytosis (Bulk Transport)
  - Endocytosis
    - Phagocytosis cell eating
    - Pinocytosis cell drinking
    - Receptor mediated endocytosis
  - Exocytosis



#### **Effects of Osmosis**

- Isotonic Solutions
- Hypotonic Solutions
- Hypertonic Solutions

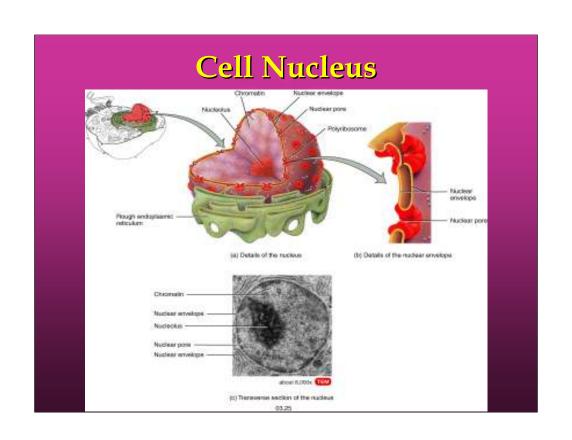


#### **Nucleus**

- The "control center" of the cell
- Usually the largest structure in the cell
- Contains genetic information
- Controls cellular function and structure

#### **Nuclear Structures**

- Nuclear Membrane
- Nucleoplasm
- Nucleolus
  - site of ribosome synthesis
- Genetic Material DNA
  - Chromatin contains DNA in thread-like form (cell is not dividing)
  - Chromosomes contains DNA in short, rod-like structures (cell is reproducing)



#### **Organelles**

- Specialized structures and portions of the cell with characteristic shapes that assume specific roles:
  - growth
  - repair
  - maintenance
  - control of cellular functions

## **Organelles and Structures**

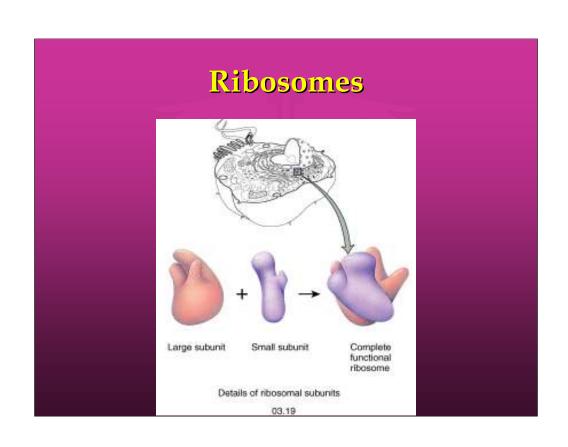
- Ribosomes
- Endoplasmic Reticulum
- Golgi Complex
- Mitochondria
- Lysosomes
- Vacuoles
- Peroxisomes
- Microfilaments
- Microtubules

## Organelles and Structures, cont

- Centrioles
- Centrosomes
- Flagella
- Cilia
- Microvilli

#### **Ribosomes**

- Appear as small, round, granular structures within the cell
- Sites of protein synthesis by assembling the amino acids in the correct order.
- Made up of special type of RNA called ribosomal RNA (rRNA)

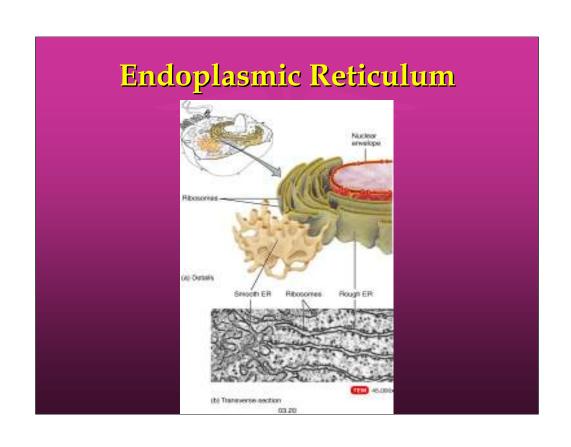


## **Endoplasmic Reticulum**

- Double membranous channels which are continuous with the nuclear membrane
- Granular (Rough) Endoplasmic Reticulum
  - studded with ribosomes
  - site of protein synthesis
- Agranular (Smooth) Endoplasmic Reticulum
  - free of ribosomes
  - site of lipid synthesis

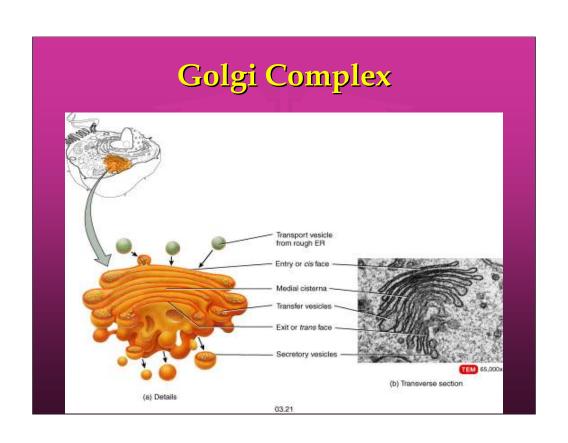
#### Functions of Endoplasmic Reticulum

- Mechanical support and distribution of cytoplasm
- Surface area for chemical reactions
- Intracellular transport system
- Storage of synthesized molecules
- Protein (RER) and lipid (SER) synthesis
- Detoxification of certain molecules
- Release of calcium ions in muscles



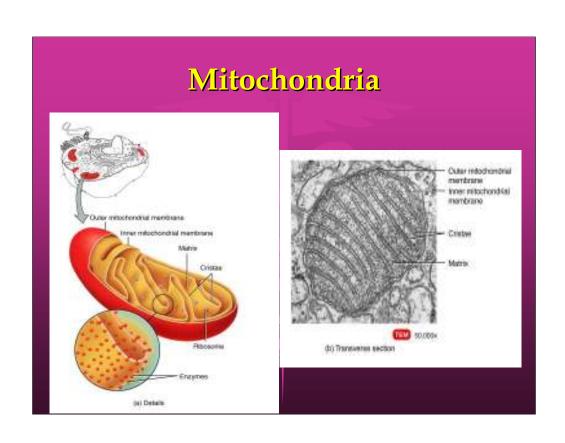
## Golgi Complex (Bodies)

- Flattened membranous sacs (4 8) stacked upon one another
- Processes, packages, sorts, and delivers proteins to various parts of the cell
- Secretion of lipid molecules from the cell



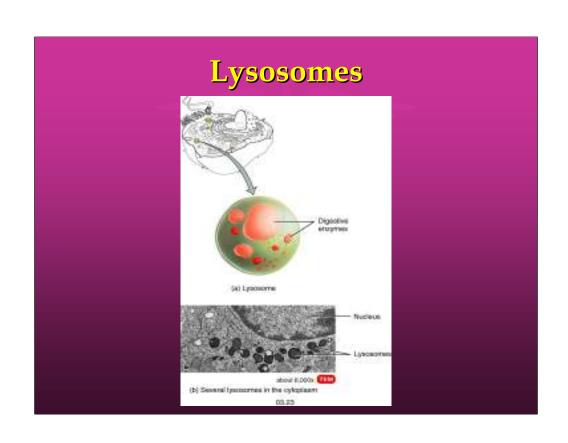
#### Mitochondria

- Powerhouse of the cell
- Small, spherical or rod-shaped structures
- Sites of cellular respiration
  - conversion of glucose and lipids to ATP
  - aerobic energy metabolism



#### Lysosomes

- Nicknamed "suicide packets"
- Small membrane enclosed spheres of digestive enzymes
- Intracellular digestion
  - Autophagy is the process by which old worn out organelles are digested
  - Autolysis is the process by which lysosomes digest themselves



## Vacuoles

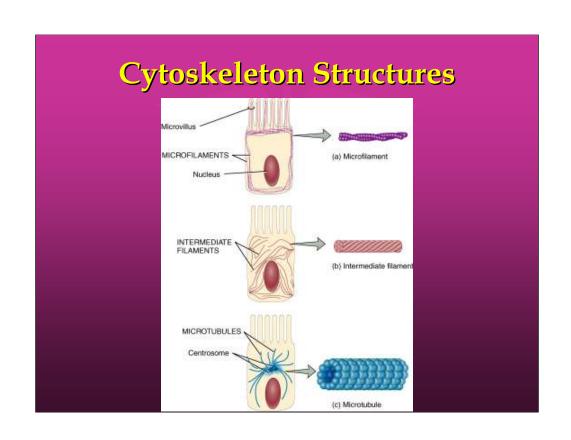
- Fluid filled organelles enclosed by a membrane
- Used to store digested cellular food or water

#### Peroxisomes

- Similar to lysosomes but much smaller
- Usually found in the liver and kidney
- Must have metabolic oxygen present to function properly
- Role in detoxifying molecules (alcohol)

## The Cytoskeleton

- Complex internal structure of cytoplasm that consists of small lattice-like or web-like structures
- Provides support and maintains shape of the cell
- Provides organization for chemical reactions
- Assists in transport of substances through the cytosol



# Structures of the Cytoskeleton

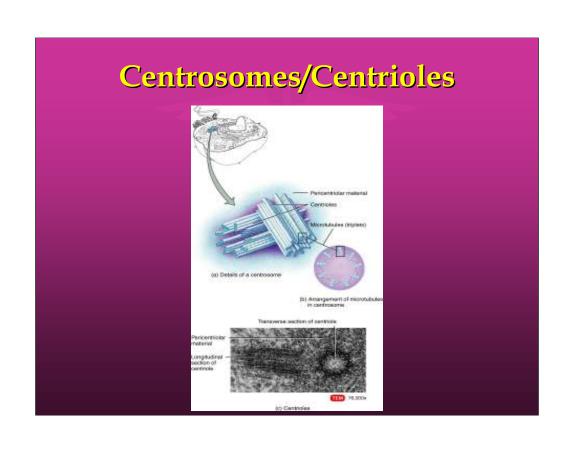
- Microfilaments are rod-like, variable length -Actin and Myosin in muscles
- Microtubules are straight cylindrical structures
- Intermediate Filaments provide structural support and framework
- Microfilaments, Microtubules, and Intermediate Filaments make up the Microtrabecular Lattice

#### Centrioles

A pair of cylindrical structures located within the centrosome which serves as center of chromosome movement during cell division (mitosis)

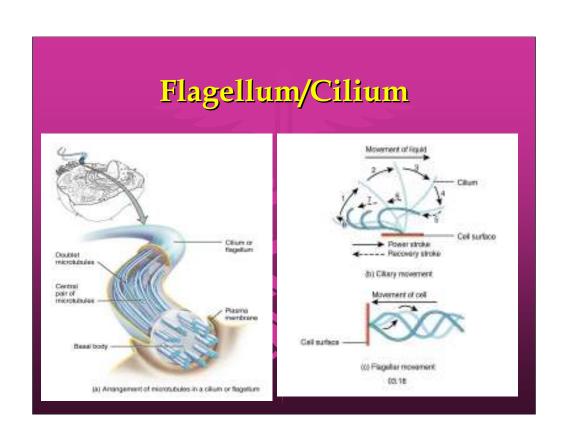
#### Centrosomes

Dense area of spherical cytoplasm generally located near the nucleus



# Modifications of the Plasma Membrane

- Microvilli
  - folds in the cell membrane
  - increase surface area for absorption of nutrients
- Cilia
  - slender projections of the cell membrane
  - move substances across surface of the cell
- Flagellum
  - single whip-like projection
  - used for cellular locomotion

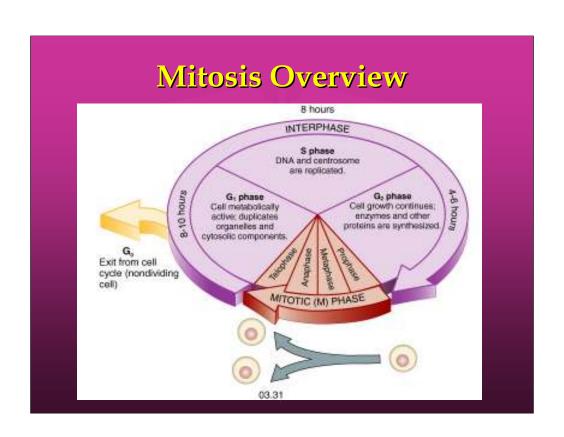


#### **Cell Division**

- Process by which cells reproduce themselves
- Results in increased number of cells or HYPERPLASIA
- Nuclear Division
  - Somatic cell nuclear division (MITOSIS)
  - Sex cell nuclear division (MEIOSIS)
- Cytoplasmic Division Cytokinesis

#### **Results of Mitosis**

Formation of two new daughter cells with identical genetic make up of parent cell

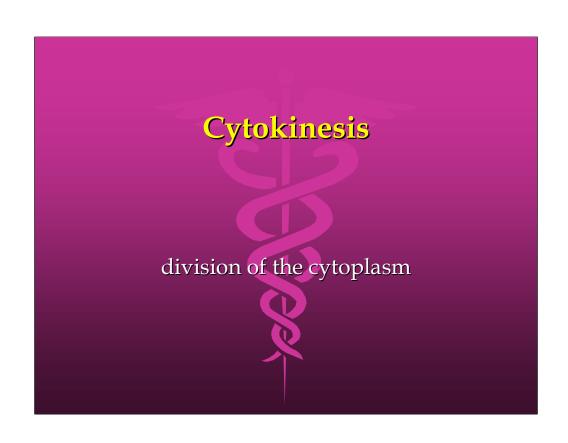


## **Interphase**

- metabolic phase between cell division
- replication of chromosomes
- replication of centrioles
- time highly variable from:
  - non existent
  - years
- normally about 18 to 24 hours

#### Meiosis

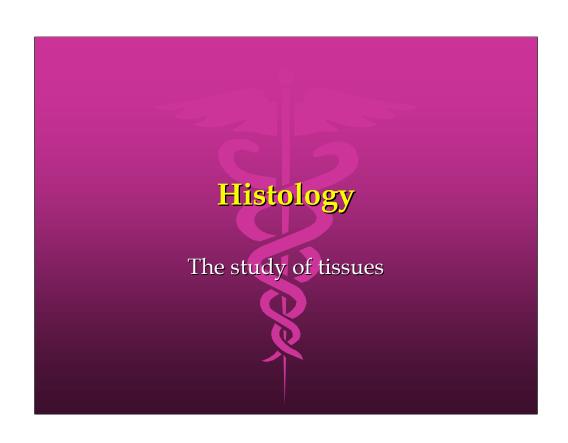
- mechanism by which sperm and egg cells are produced
- results in the production of sex cells GAMETES
  - Ovary ---> Oogenesis ---> Ovum
  - Testes ---> Spermatogenesis ---> Sperm
- union and fusion of gametes is called fertilization
- cell produced by fertilization Zygote





## **Tissues**

A group of cells with a common embryonic origin performing a similar function

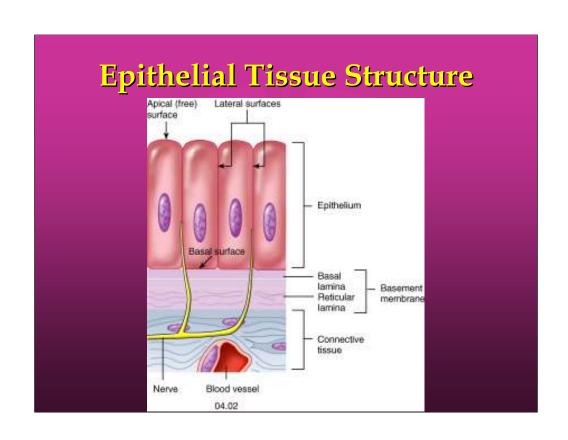


#### **Classification of Tissues**

- Epithelial Tissues covers body surfaces, lines body cavities and ducts, forms glands
- Connective Tissue protects and supports the body, binds organs together, stores energy
- Muscular Tissue contractile tissue
- Nervous Tissue conductive tissue

## Characteristics of Epithelial Tissue

- Tightly packed cells
- · Little or no intercellular space
- Avascular
- Contains a Basement Membrane which helps to hold the tissue to other tissues



# Covering and Lining Epithelium

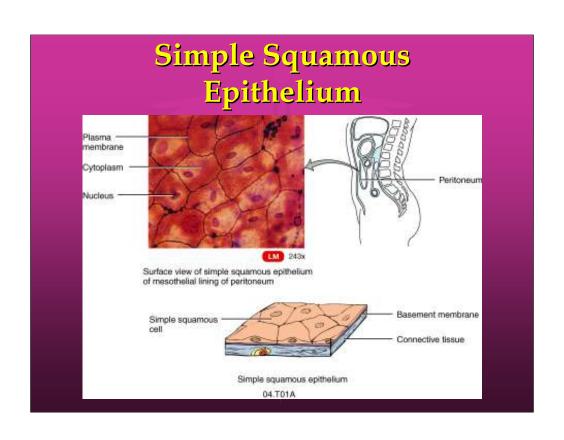
- Outer covering of external body surfaces and some organs
- Lines body cavities, interiors of respiratory and gastrointestinal tract, and forms ducts
- Makes up portions of sense organs
- Tissue from which gametes develop

## **Strategies for Identifying Epithelial Tissues**

- Layers of Cells
  - simple
  - stratified
  - pseudostratified
- Shapes of Cells
  - squamous
  - cuboidal
  - columnar

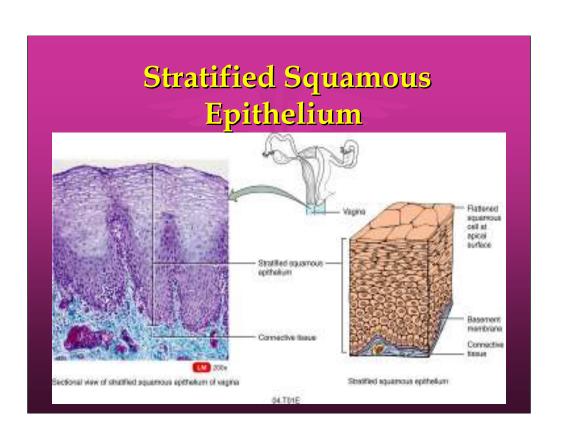
# Simple Epithelium

- Single layer of cells
- Absorption, diffusion, filtration
- Minimal wear and tear
- Found in capillaries and alveoli



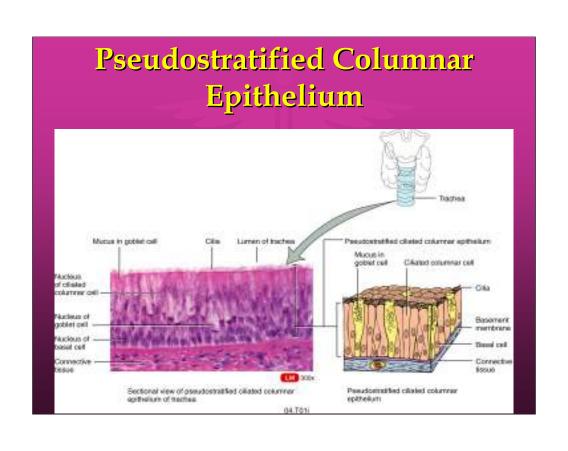
# Stratified Epithelium

- Cells stacked in several layers.
- High degree of wear and tear.
- Used for protection.
- Found in the epidermis of the skin.



## Pseudostratified Epithelium

- Only one layer of cells and looks like multiple layers.
- All cells attached to a basement membrane.
- Not all cells reach the free surface.
- Many have cilia on the free surface.
- Many have goblet cells to secrete mucous.



## **Epithelial Cell Shapes**

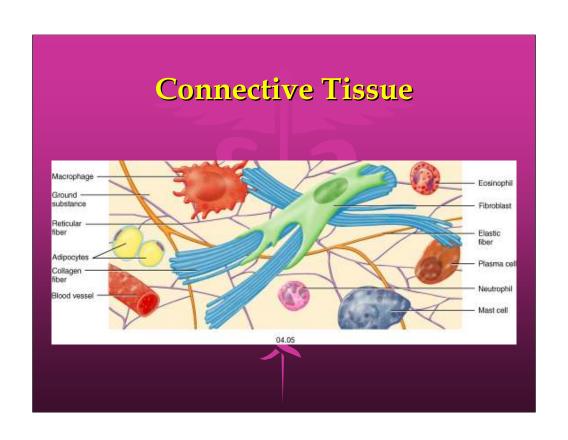
Squamous – flat, scale-like shaped cells

Cuboidal - box or cube-shaped cells

Columnar – column or rectangularshaped cells

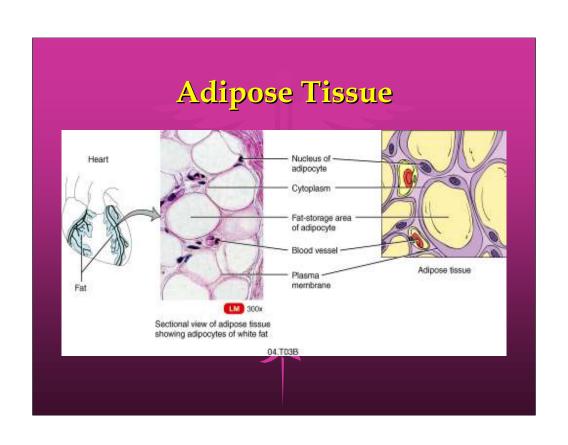
#### Connective Tissue

- Most abundant tissue in the body.
- Binding and supporting tissue.
- Primarily composed of collagen fibers.
- Contain the protein collagen.
- Extremely vascular
  - (Except cartilage which is avascular)



#### Adipose Tissue

- Loose connective tissue in which special cells, adipocytes, store fat
- Derived from fibroblasts
- Nucleus and cytoplasm pushed to the side of the cell by large fat droplet
- Fat droplet triglyceride molecules
- Major energy reserve
- Protects and insulates internal organs
- Reduces heat loss through the skin



## Cartilage

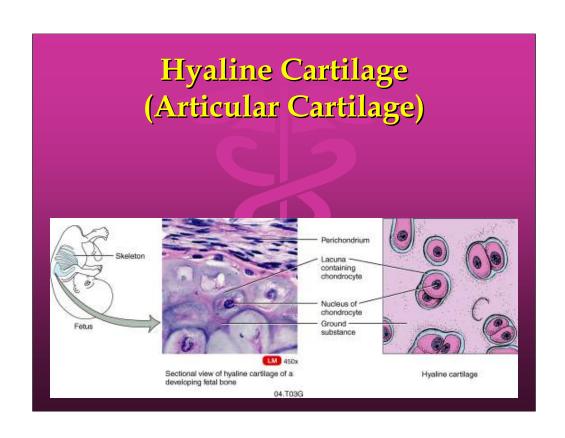
- Avascular no blood vessels or nerves so very slow healing
- can withstand tremendous forces
- Chondrocytes mature cartilage cells
- Lacunae spaces where chondrocytes are located
- Perichondrium dense connective tissue covering that surrounds the surface of cartilage

# Types of Cartilage

- Hyaline Cartilage (Articular Cartilage)
- Fibrocartilage
- Elastic Cartilage

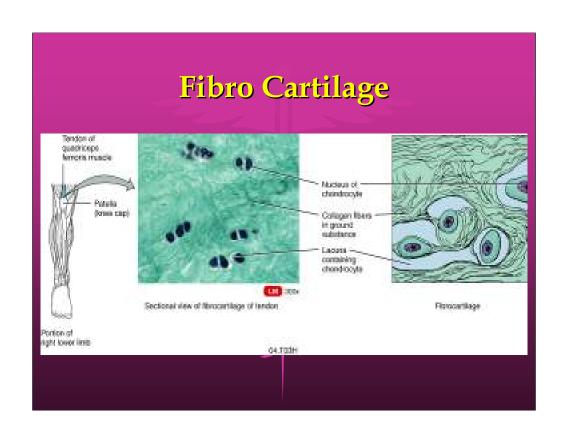
# **Hyaline Cartilage**

- Most abundant type of cartilage
- Bluish-white in appearance
- Covers ends of long bones
- Reduces friction at joints (can absorb some shock)
- Forms costal cartilage at ends of ribs
- Makes up most of the embryonic skeleton



# Fibrocartilage

- Main role is shock absorption
- More elastic than hyaline cartilage
- Location:
  - intervertebral disks
  - pubic symphysis
  - menisci of knee (
  - epiglottis

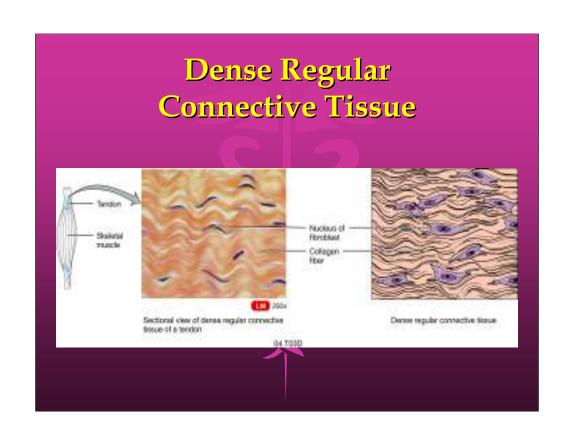


# **Elastic Cartilage**

- Structural cartilage
- Provides strength, rigidity, and maintains shape of some organs
  - larynx
  - ear (pinna or auricle)
  - trachea
  - Auditory (Eustachian) tubes
  - nose

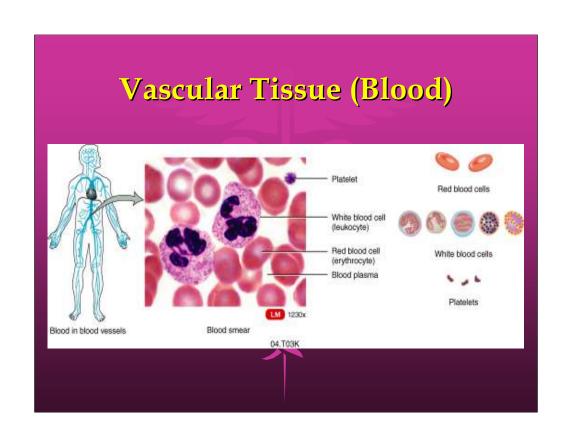
# Dense Collagenous Tissue Regular Arrangement

- Adapted for tension in one direction
- Fibers arranged in orderly parallel fashion
- Principle component of:
  - tendons
  - aponeuroses
  - ligaments



# Vascular Tissue (Blood)

- Plasma intercellular liquid
  - straw colored, mostly water
- Formed Elements Blood Cells
  - Erythrocytes Red Blood Cells
  - Leukocytes White Blood Cells
  - Thrombocytes Platelets

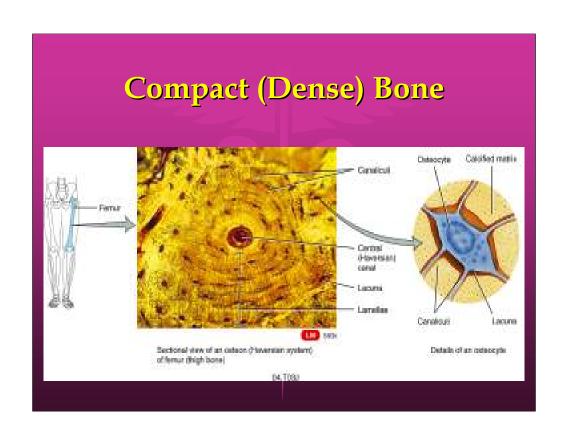


# Osseous Tissue (Bone)

- Maintained by specialized cells
  - osteoblasts -osteocytes -osteoclasts
- Intercellular substances consists of mineral salts
  - calcium carbonate
  - calcium phosphate
  - collagen fibers
- Two types of bone tissue:
  - Compact Bone-Spongy Bone

## Compact (Dense) Bone

- Structure called osteons (Haversian System)
- Concentric rings of bone called lamellae
- Vertical canals within lamellae house blood vessels and nerves (Central Haversian Canals)
- Perforating (Volkman's Canals)
- Lacunae lake of fluid containing osteocytes
- Canaliculi canals to nourish and support osteocytes



# Spongy (Trabecular) Bone

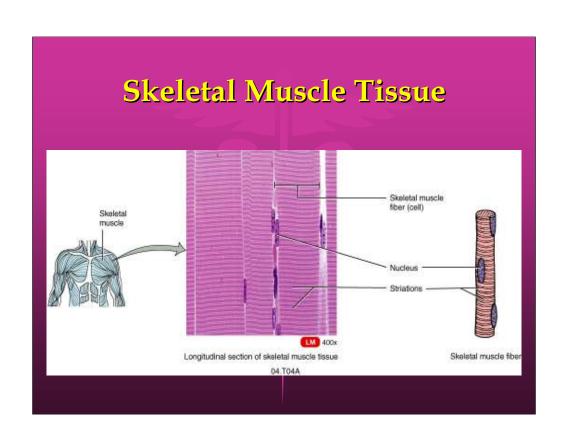
- Calcium salts and collagen fibers not as densely packed
- Matrix is made up of thin plates of mineral salts and collagen fibers called spicules or trabeculae
- Spaces between the matrix contain red bone marrow
- Hematopoietic Tissue

## Muscle Tissue

- Composed of muscle cells (muscle fibers)
- Highly specialized (produces tension)
- Can convert chemical energy to mechanical energy
- Plays a major role in thermoregulation
- Three Types of Muscle Tissue:
  - Skeletal Cardiac Smooth

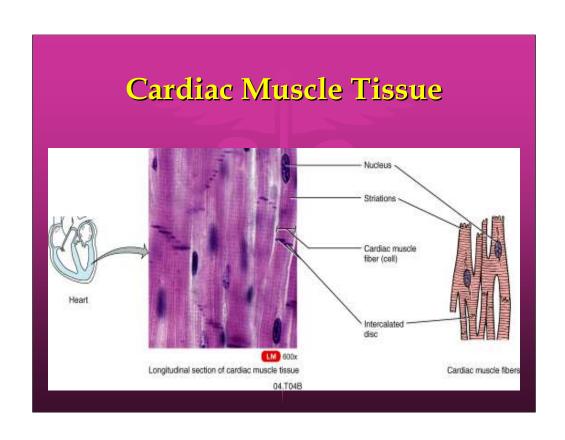
#### Skeletal Muscle

- Attached to bones
- Striated appearance under a microscope
- Voluntary muscle (conscious control)
- Multinucleated
- Contractile elements Myofilaments
- Sarcolemma muscle cells membrane
- Sarcoplasm muscle cells cytoplasm



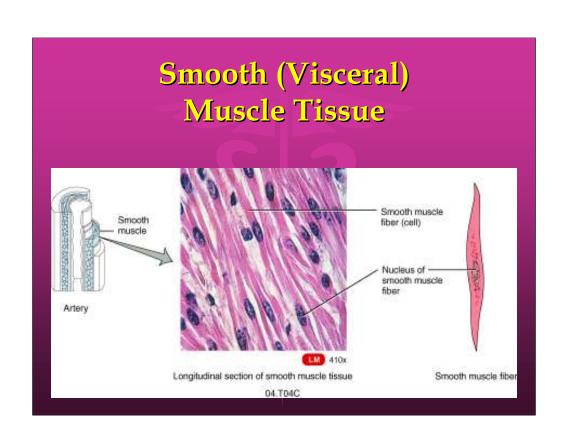
#### Cardiac Muscle

- Forms bulk of heart wall (myocardium)
- Striated muscle
- Involuntary muscle (generally)
- Typically has a centrally located nucleus
- Sarcolemma has specialized structures called intercalated discs
  - transmits action potential from cell to cell
  - strengthens the myocardium



# Smooth (Visceral) Muscle

- Located in the walls of hollow structures and organs
  - blood vessels stomach
  - intestines bladder
  - bronchi uterus
- Involuntary muscle (generally)
- Non-striated muscle

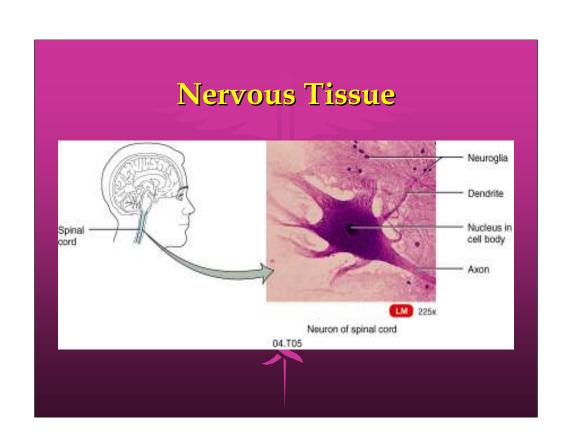


#### Nervous Tissue

- Highly specialized tissue sensitive to various stimuli. Basic unit is the neuron.
- Capable of converting stimulus to nervous impulses (electrical event)
- Transmits impulses to:
  - other neurons
  - glands
  - muscle fibers

## Nerve Cells (Neurons)

- Cell Body
  - contains nucleus and other cell organelles
- Axons
  - single, long processes that transmit nerve impulses away from the cell body
- Dendrites
  - highly branched processes that transmit nerve impulses toward the cell body

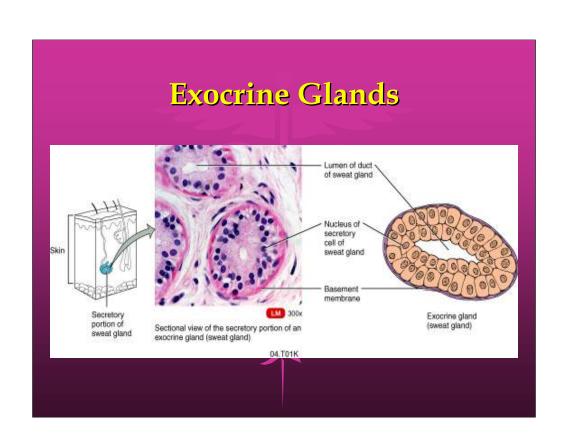


## Gland(s)

A cell or group of highly specialized epithelial cells that secrete substances into ducts, onto a surface, or into the blood.

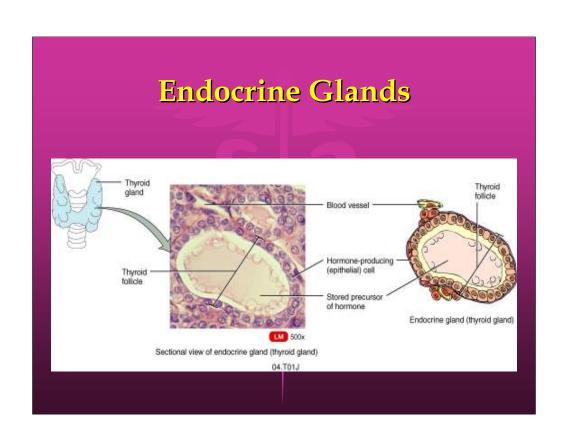
#### **Exocrine Glands**

- Secrete their products into ducts (tubes)
- May enter at the surface or lining of the covering epithelium.
  - goblet cell secret mucus
  - sweat glands secrete perspiration
  - cells lining the outer ear secreted oil and wax
  - salivary glands secret saliva and digestive enzymes



#### **Endocrine Glands**

- Ductless glands
- Secrete products into extracellular spaces where it diffuses into the blood.
- Secreted products are hormones, chemicals that regulate body functions.
- Examples of endocrine glands include the pituitary gland, thyroid gland, pancreas, ovaries, and adrenal glands.



#### Membranes

- Mucous Membranes
  - lines structures that have opening to the external environment
- · Serous Membranes
  - surrounds organs and lines body cavities without access to the external environment
- Cutaneous Membrane Skin
- Synovial Membrane
  - lines cavities of freely movable joints

#### Mucous Membranes

- Lines structures with opening to the external environment
- Epithelial layer secretes mucus
- Prevents cavities from drying out
- Traps foreign particles
- Lubricates particles as it moves through
- Lines respiratory, gastrointestinal, urinary, reproductive tracts

#### Serous Membranes

- Lines body cavities that do not open to the external environment
- Consists of two layers:
  - Visceral Layer covers organs or structures
  - Parietal Layer attached to cavity wall
- Secretes a fluid between the layers (Serous Fluid) that provides lubrication
- Pleura Pericardium Peritoneum

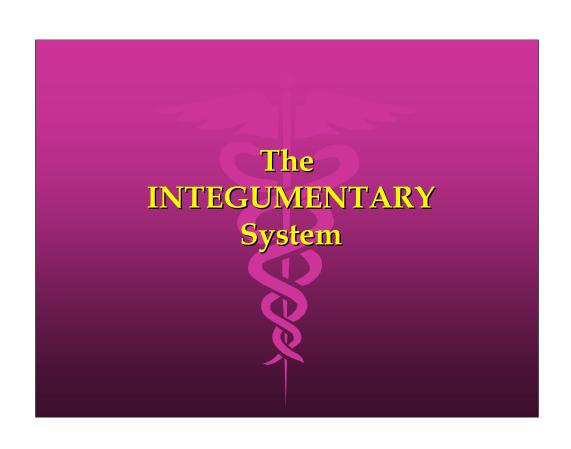
### Cutaneous Membrane

- Skin
- to be discussed in great detail next chapter

## Synovial Membrane

- Not really an epithelial membrane
- Contains no epithelial tissue
- Lines cavities of freely movable joints
- Secretes synovial fluid which lubricates hyaline (articular) cartilage
- Also nourishes the hyaline (articular) cartilage





### **Functions of the Skin**

- Protection
- Regulation of Body Temperature
- Reception of Stimuli
- Excretion
- Synthesis of Vitamin D
- Immunological Function

## Temperature Regulation

- One of the main functions of the Integumentary System is maintenance of body temperature
- Heat
  - Vasodilatation of blood vessels
  - Perspiration
- Cold
  - Vasoconstriction of blood vessels
  - Shivering
  - Increasing metabolism

### Glands of the Skin

- Sebaceous Glands (Oil Glands)
- Sudoriferous Glands (Sweat Glands)
  - Apocrine Sweat Glands
  - Eccrine Sweat Glands
- Ceruminous Glands

#### Sebaceous Glands

- Oil glands usually associated with hair follicles
- Secrete an oily substance called sebum a mixture of fats, cholesterol, protein and inorganic salts
- Keeps hair from drying out and becoming brittle
- Keeps skin soft and pliable
- Inhibits growth of certain bacteria

## Sudoriferous Glands (Sweat Glands)

- Glands secrete sweat a mixture of:
  - water salts amino acids
  - ammonia urea uric acid
  - sugar -lactic acid -ascorbic acid
- Primary function regulates body temperature by evaporation of water
- Eliminates some waste products
- Two types of sweat glands:
  - Apocrine Glands
- Eccrine Glands

### **Apocrine Sweat Glands**

- Located in skin of axilla, pubic region, pigmented areas of the body
- Secrete a thickened sweat that promotes the growth of bacteria
- Active during periods of emotional stress

#### **Eccrine Sweat Glands**

- Distributed throughout the body
- Secrete a watery sweat in response to elevated body temperature
- Density can be as high as 3000 per square inch in palms of the hands

### Hair (Pili)

- Growths from the epidermis
- Primary function is protection
  - guards the scalp from injury and sunlight
  - eyebrows eyelashes protect the eye
  - ears and nostrils keep out foreign objects
- Helps regulate body temperature
- Touch receptors associated with hair follicles

### **Components of Hair**

- Shaft portion of hair above the surface of the skin
- Root portion of hair below the skin
  - Hair Follicle cells that surround the root
- Bulb onion shaped structure at the base of each hair follicle
  - Papilla indentation of bulb where blood vessels, nerves, etc. enter and exit
  - Matrix area of cell division and hair growth

### **Hair Color**

- Due to amount of melanin in the cells of the hair shaft
- Can accumulate air bubbles in the hair shaft which causes hair to turn gray or white



#### **Nails**

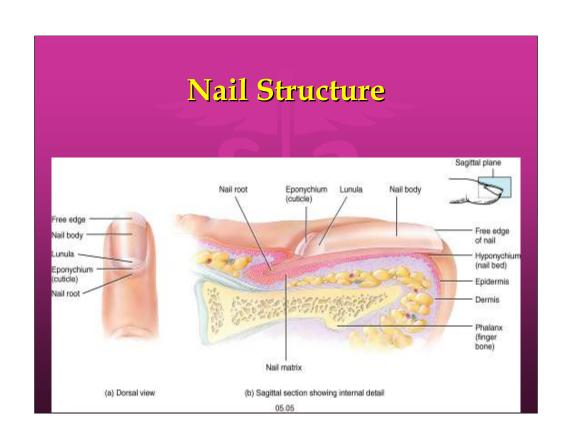
- Plates of tightly packed, hard, keratinized cells of the epidermis
- Forms a clear solid covering over the dorsal surface of the ends of the digits
- Provides protection to ends of digits
- Helps to grasp and manipulate small objects

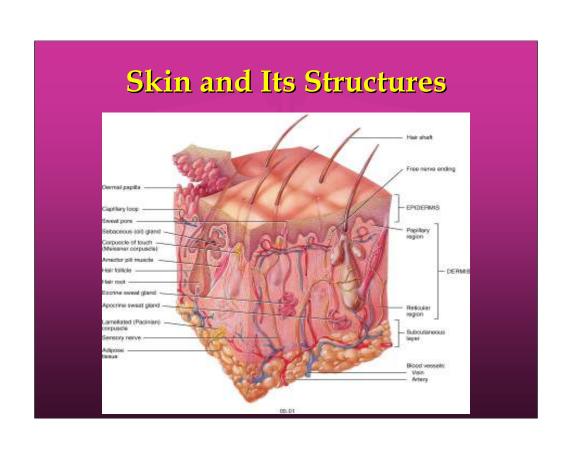
### Portions of Nails

- Nail Body portion of nail visible
  - Free Edge extends beyond the digits
  - Root hidden in proximal nail groove
  - Lunula whitish semilunar area at proximal end of the nail body
- Eponychium Cuticle
- Nail Matrix epithelium at proximal end of the nail
  - mitosis and nail growth from this area
  - grows at a rate of about 1 mm per week

## Layers of the Skin

- Epidermis
  - Stratum Basal
  - Stratum Spinosum
  - Stratum Granulosum
  - Stratum Lucidum
  - Stratum Corneum
- Dermis
  - Papillary Region
  - Reticular Region
  - Subcutaneous Layer (Hypodermis or Superficial Fascia)





## **Epidermis**

- Outer layer of skin
- · Avascular no blood vessels
- Composed of stratified squamous epithelium
- Growth stimulated by the hormone EGF (Epidermal Growth Factor)

# Cells of the Epidermis

- Keratinocytes
  - produces keratin
  - waterproofs the skin
  - protective barrier
- Melanocytes
  - produces melanin
  - protection from sunlight

#### **Dermis**

- Layer of skin under the epidermis
- Made up of collagen and elastic connective tissue fibers
- Contains the blood vessels, hair follicles, and nerve endings of the skin

### **Arrector Pili Muscle**

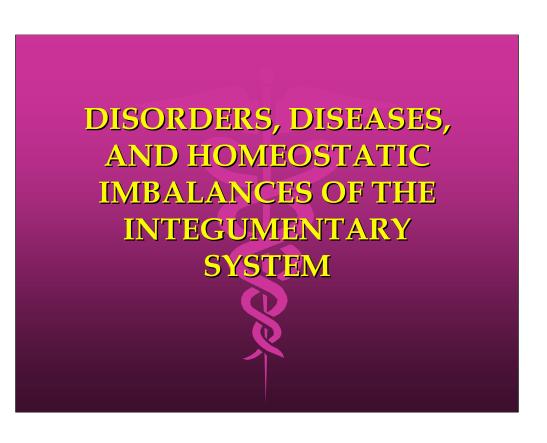
- Bundle of smooth muscles associated with each hair that makes the hair stand up when contracted
  - cold
  - frightened
  - aggressive posturing
  - emotions

### Receptors of the Skin

- Consists of distal ends of neurons
- Similar to antennae in that they receive information about the environment
  - Pacinian Corpuscles deep pressure
  - Meissner's Corpuscles light touch
  - temperature detecting receptors
  - pain receptors

### Subcutaneous Layer

- · Not part of the true skin
- Connective tissue that connects the skin to the muscle and organs underneath
- Also called the hypodermis or superficial fascia
- Contains nerve endings responsible for deep pressure (Pacinian Corpuscles)
- May contain enlarged fat cells in obese individuals



## Acne Vulgaris

- an inflammation of the sebaceous glands and hair follicles
- much more active at puberty
  - affects boys more severely than girls
- caused by bacteria that colonize in the sebaceous follicles
- usually treated by a synthetic form of vitamin A called Accutane
  - known to cause birth defects

#### **Skin Cancers**

- cancerous growths of skin tissue
- often caused by prolonged exposure to the sun
- three main types of skin cancers
  - Basal Cell Carcinomas
  - Squamous Cell Carcinomas
  - Malignant Melanomas

#### **Basal Cell Carcinomas**

- Tumors that arise from the basal cells of the epidermis
- Slow growing rarely metastasize
- Account for over 75% of all skin cancers
- Caused by chronic over-exposure to the sun
- More common in fair skinned individuals over 40 years of age
- Treated by excision of the tumor

### Squamous Cell Carcinomas

- Tumors that arise from the squamous cells of the epidermis
- Vary in the ability to metastasize
- Arise from pre-existing lesions on sun exposed skin
- More common in older, fair skinned males
- Treated by excision or X-Ray irradiation

## ABCD Method to Assess Skin Cancer

- A Asymmetry
- B Border
- · C Color
- D Diameter

### **Malignant Melanomas**

- Cancerous growths that arise from melanocytes of the stratum basale
- Leading cause of skin cancer deaths
- Spreads through the lymph and blood
- Least common type of skin cancer (3%)
- Caused by chronic over-exposure to UV light
- Treated by surgical removal of large amounts of tissue and X-Ray irradiation

#### **Skin Cancer Risk Factors**

- Skin Type
  - light skin greater risk
- Geographic Location
  - higher altitude greater risk
- Age
  - older greater risk
- Immunological Status
  - immuno-suppresed greater risk
- Personal Habits
  - occupations, leisure activities, recreation

### **Decubitus Ulcers**

- bed sores pressure sores
- lesion caused by prolonged pressure resulting in blood deficiency to a tissue overlying a bony projection
- seen most frequently in individuals bedridden for prolonged periods of time

