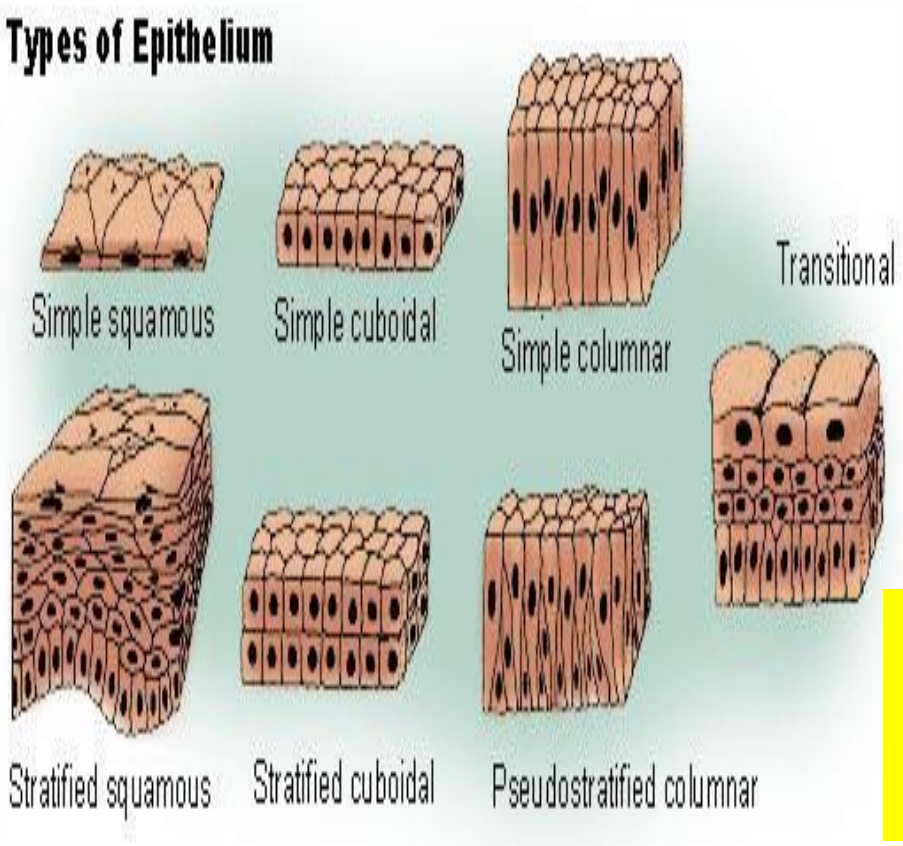
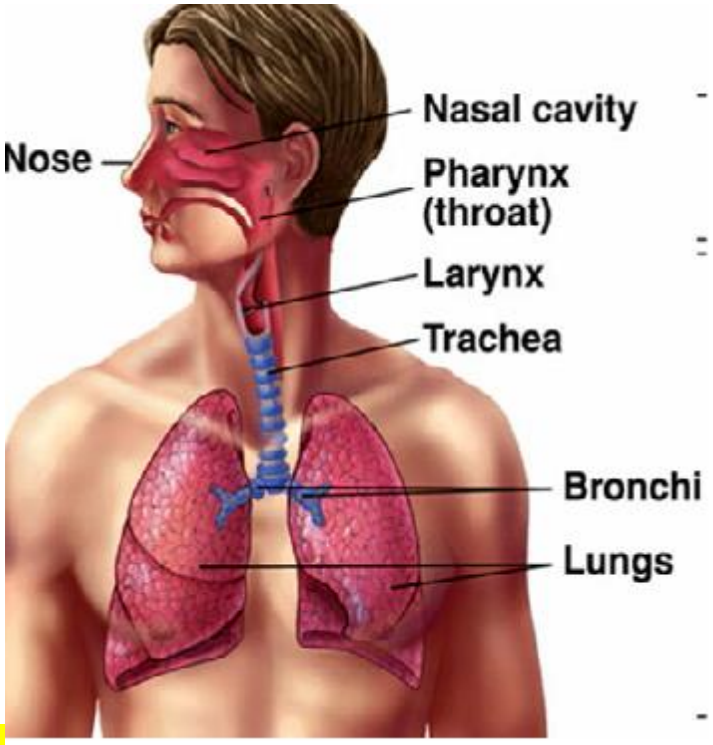
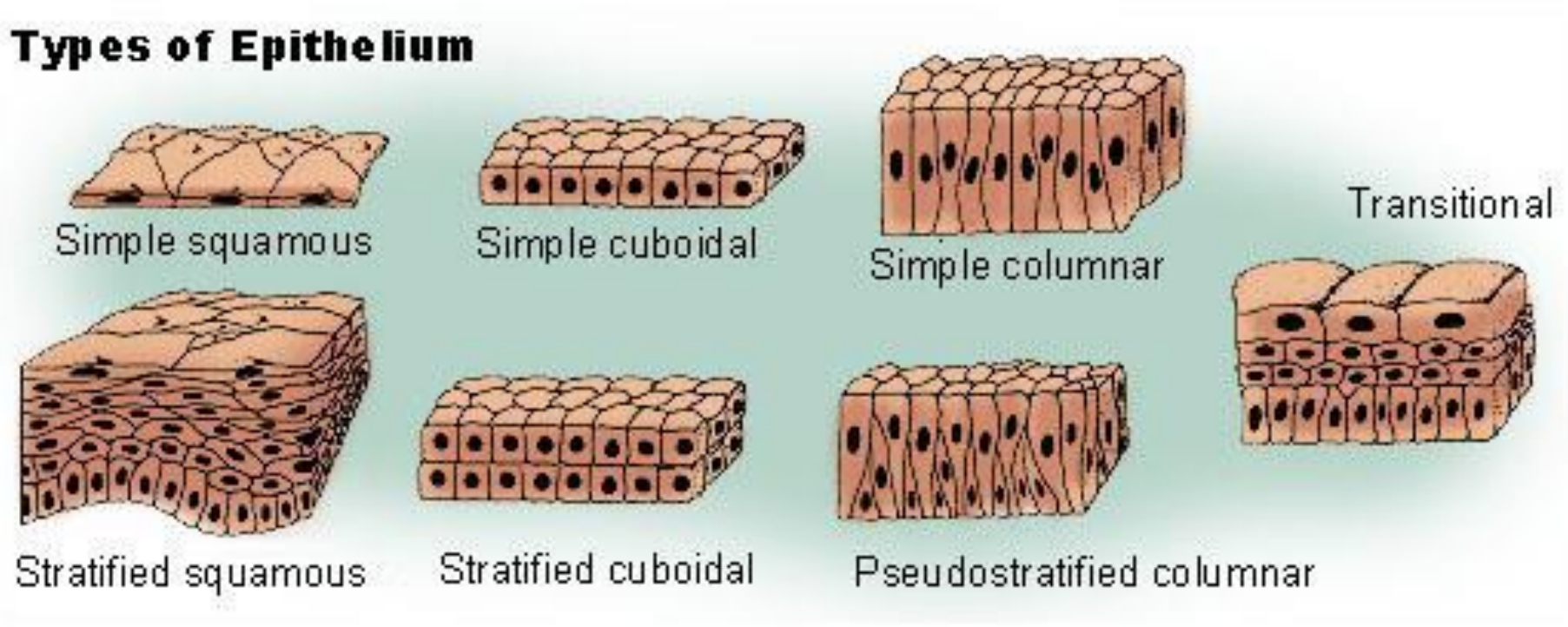
Epithelial Tissue





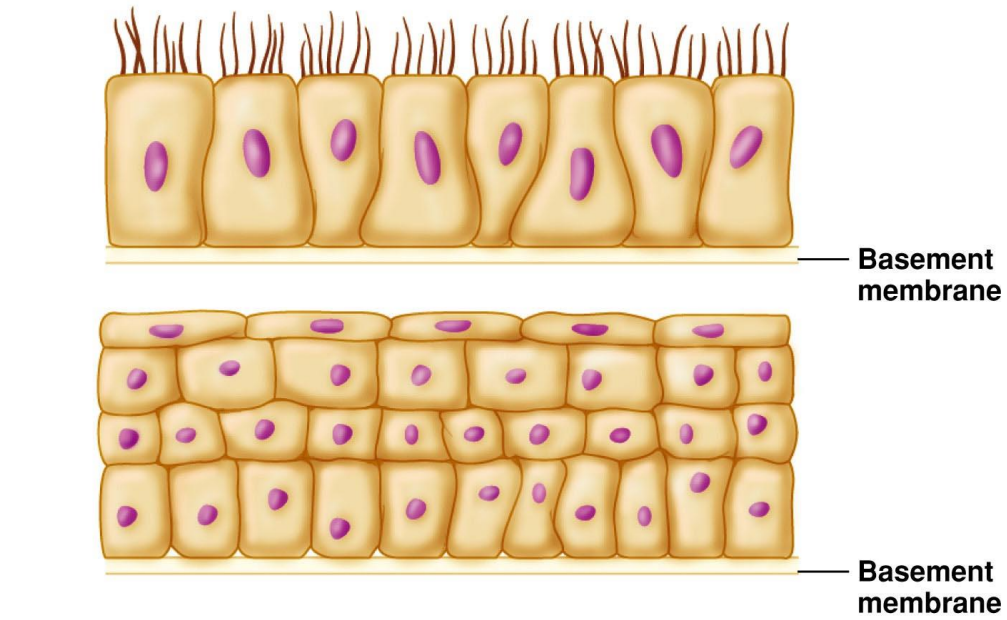
Presented by:
Shaymaa H. Al-Kubaisy
B.Sc. M. & Ph. D. Med. Microbiology

Epithelial Tissue

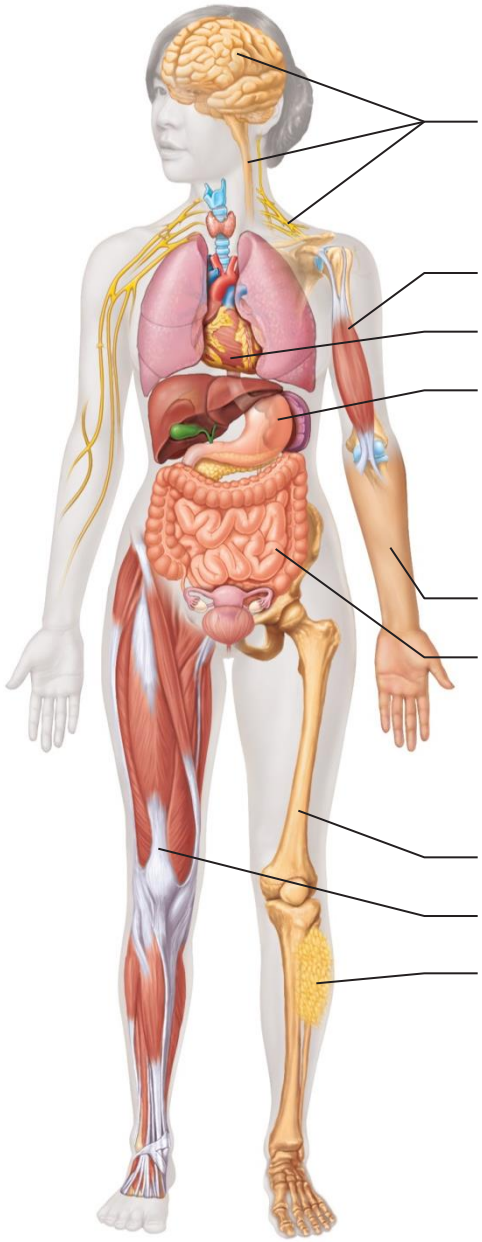


Cells and Tissues

- Cells are the building blocks of all living things
- Tissues are groups of cells that are similar in structure and function – protection, absorption, secretion, movement, electrical impulses, etc.



(c) Epithelial cells



Nervous tissue: Internal communication
- Brain, spinal cord, and nerves

Muscle tissue: Contracts to cause movement
- Muscles attached to bones (skeletal)
- Muscles of heart (cardiac)
- Muscles of walls of hollow organs (smooth)

Epithelial tissue: Forms boundaries between different environments, protects, secretes, absorbs, filters
- Skin surface (epidermis)
- Lining of GI tract organs and other hollow organs

Connective tissue: Supports, protects, binds other tissues together
- Bones
- Tendons
- Fat and other soft padding tissue

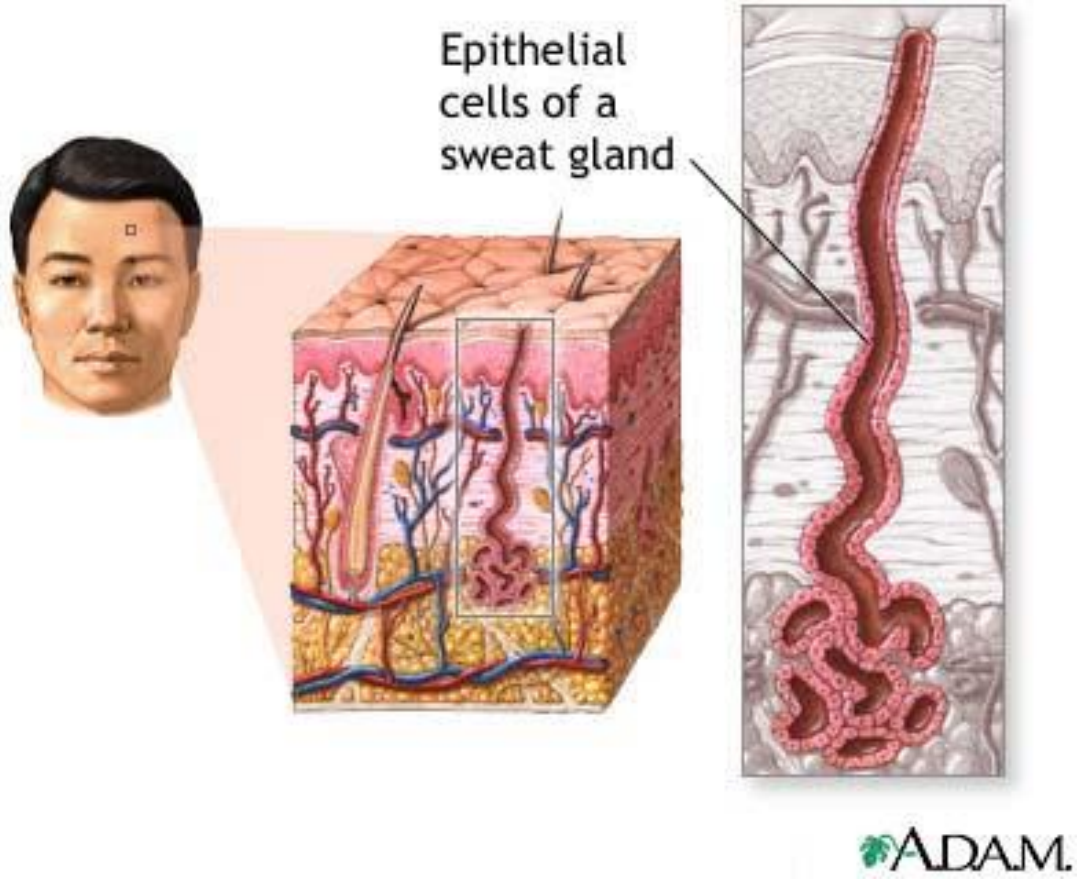
Figure 4.1

Tissues

- Four types of tissue
  - **Epithelial = covering**
  - **Connective = support**
  - Muscle = movement
  - Nervous = control
- Most organs contain all 4 types
- Connective tissue has non-living extra-cellular material (matrix) between its cells

Tissues

- Epithelial
  - Covers body surfaces
  - Lines body cavities
  - Lines hollow organs
  - Ducts
  - Forms glands

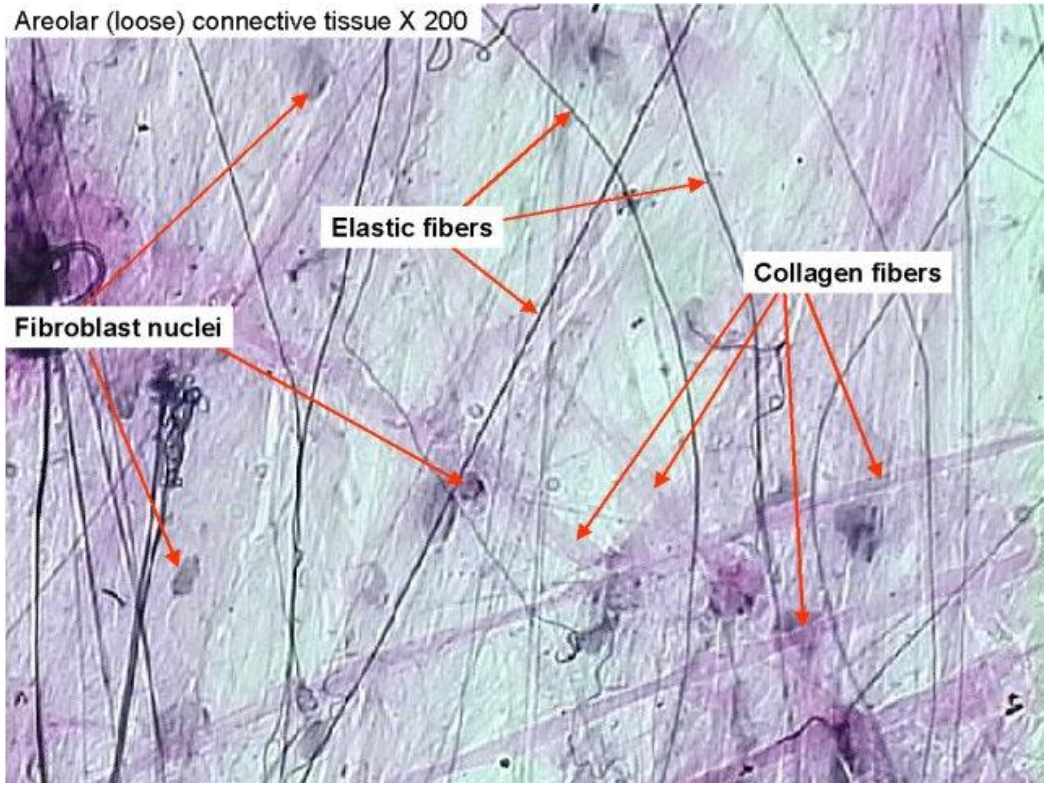


Epithelial Tissue (Epithelium)

- Two main types (by location):
  1. Covering and lining epithelia
     - On external and internal surfaces
  2. Glandular epithelia
     - Secretory tissue in glands

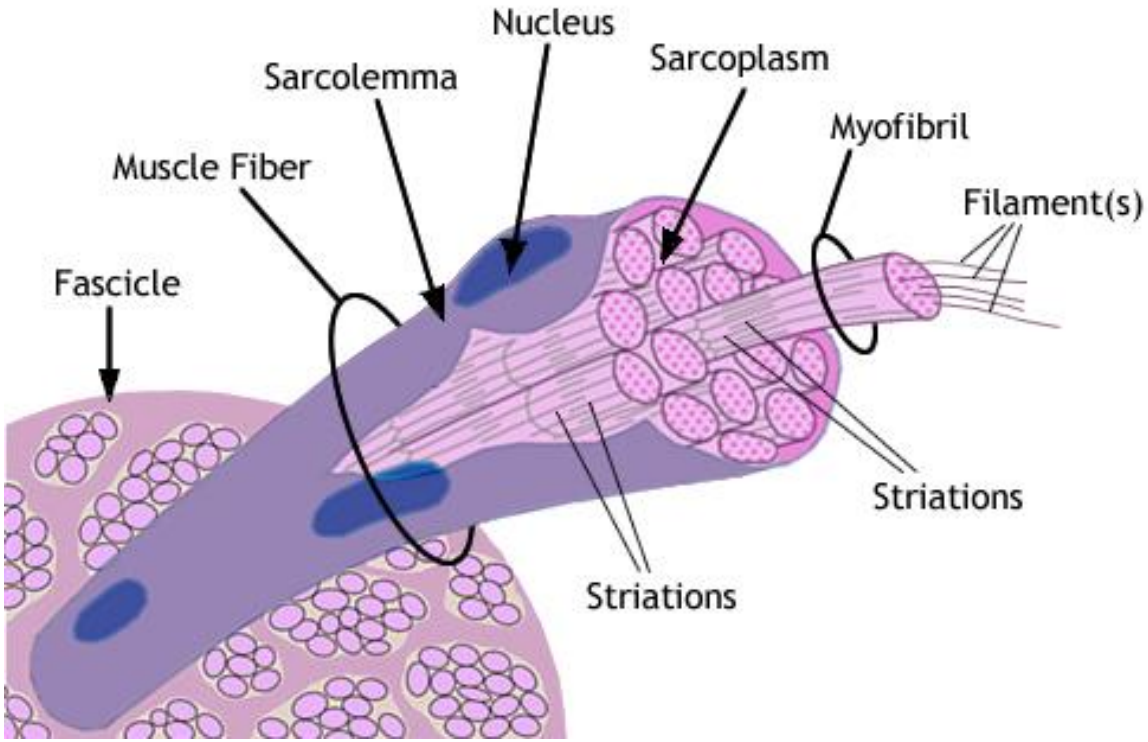
Tissues

- Connective
  - Protection and support
  - Binds organs together
  - Stores energy – bone marrow
  - Immunity



Tissues

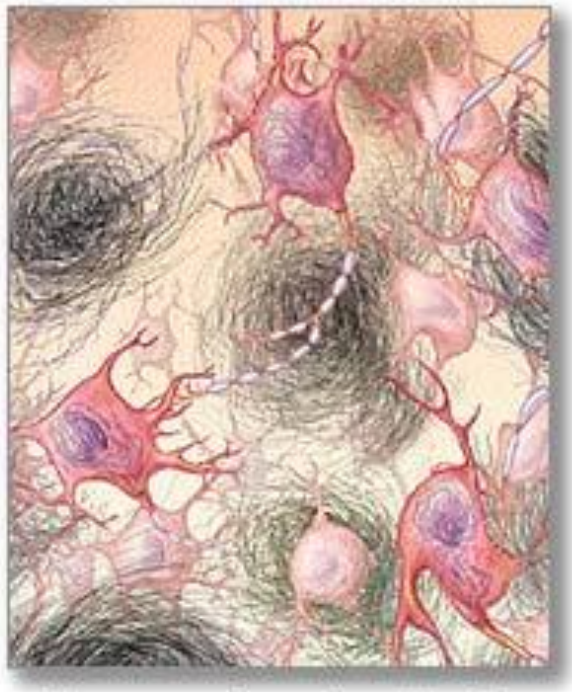
- Muscle
  - Movement



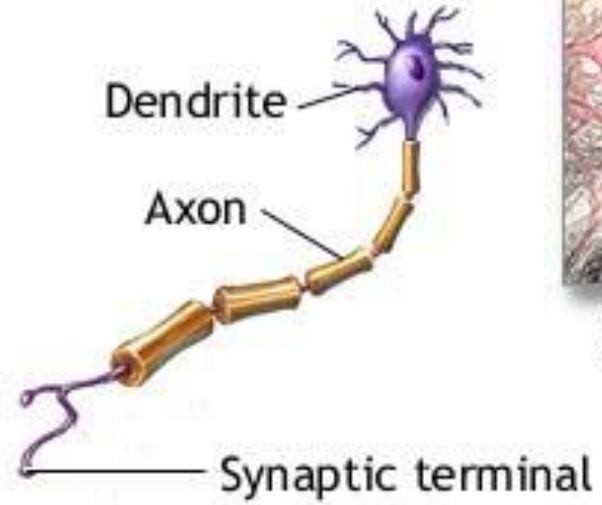
Tissues

- Nerve
  - Detects change
  - Nerve impulses
  - Homeostasis

Aging brain

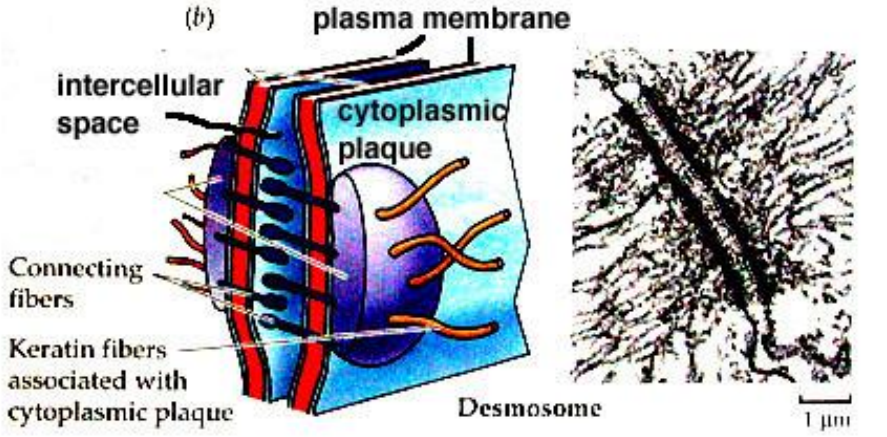


Neurons in aging brain

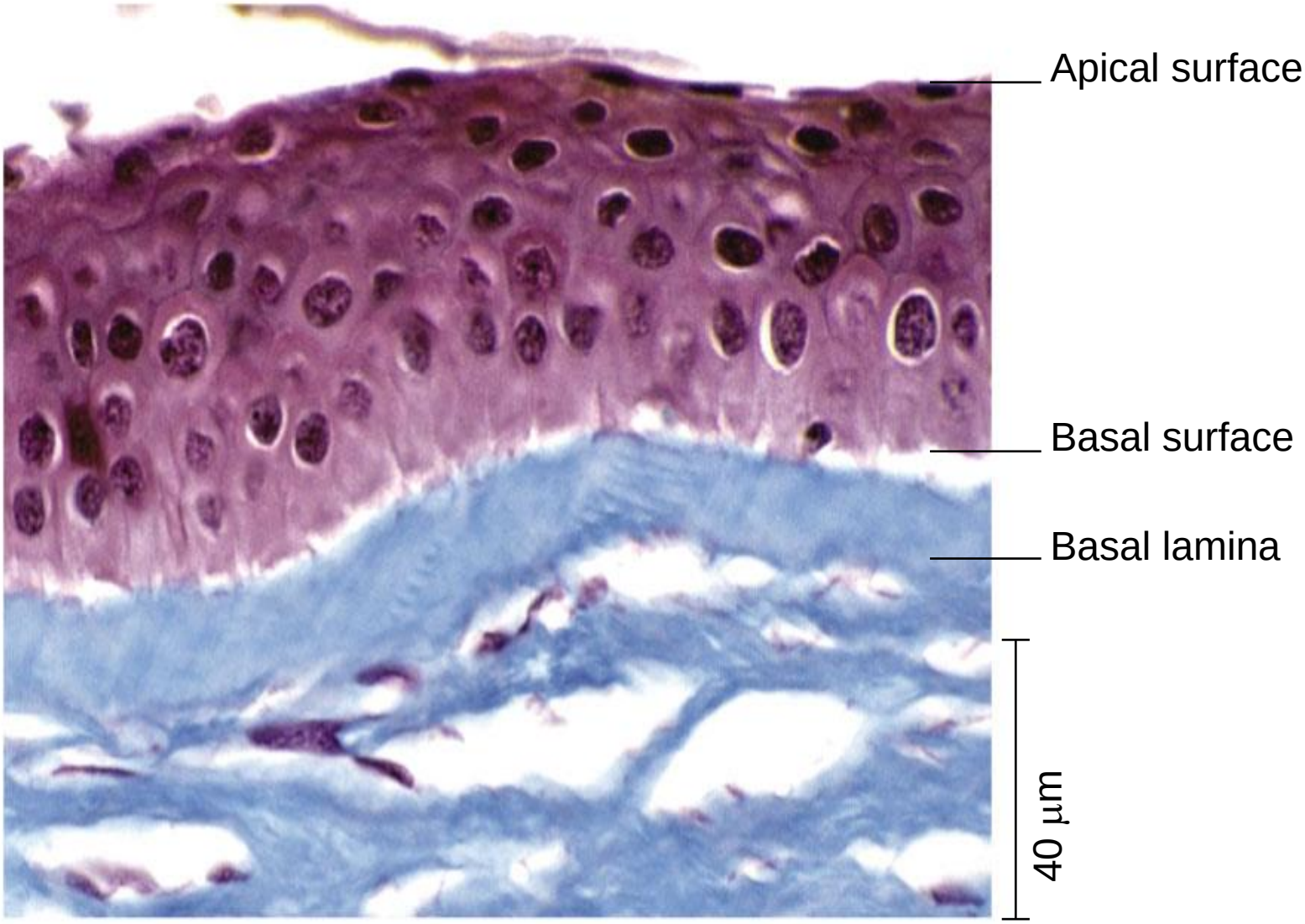


Epithelial Tissue

- Tightly packed cells
- Cell Junctions – form continuous sheets held together by **cell junctions**.
  - Tight junctions – Nothing passes through
- Surfaces – apical, lateral and basal



Desmosomes tightly link adjacent cells but permit materials to move around them in the intercellular space. Anchored in dense plaques, cell adhesion proteins cross the intercellular space, bnding adjacent cells together. Keratin fibers extend through the cytoplasm from one plaque to another.

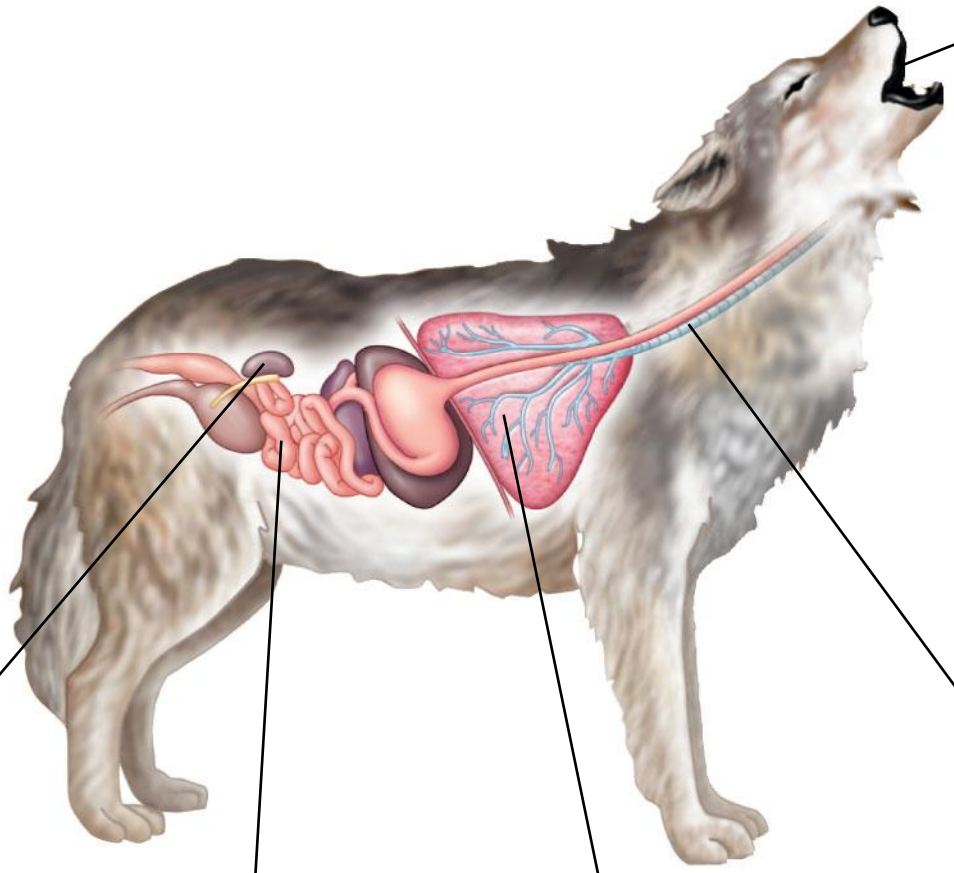


Polarity of epithelia

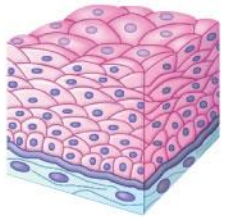
Epithelial Tissues

- Found in different areas
  - Body coverings
  - Body linings
  - Glandular tissue
- Functions
  - Protection – Skin, lining of internal organs
  - Absorption – intestines
  - Filtration – Kidney
  - Secretion – Hormones, mucus, sweat, etc.

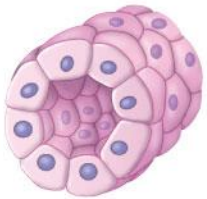
1. Epithelial Tissue



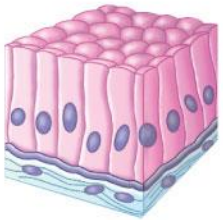
Stratified squamous epithelium



Cuboidal epithelium

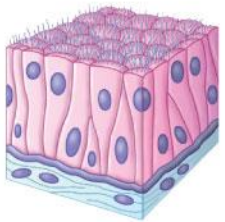


Simple columnar epithelium



Simple squamous epithelium

Pseudostratified columnar epithelium



Epithelial Tissues

- Two types:
  1. Covering and lining epithelium
     - Outer covering of skin, and internal organs
     - Body cavities
     - Blood vessels and ducts
     - Interior of respiratory, digestive, urinary and reproductive organs
     - Parts of sense organs
  2. Glandular epithelium
     - Secreting portion of glands

Epithelium Characteristics

- Cells fit closely together
- Tissue layer always has one exposed surface (Apical surface)
- The lower surface (basal surface) is bound by a **basement membrane** – Fibers
- The side surface (lateral surface) is bound to other epithelial cells.
- Avascular (have no blood supply)
- Nerve supply
- Regenerate easily if well nourished

Classification of Epithelium

- Number of cell layers
  - Simple – one layer: diffusion (lungs), osmosis, filtration (kidneys), secretion (glands), absorption (intestines)
  - Stratified – more than one layer: protection, secretion

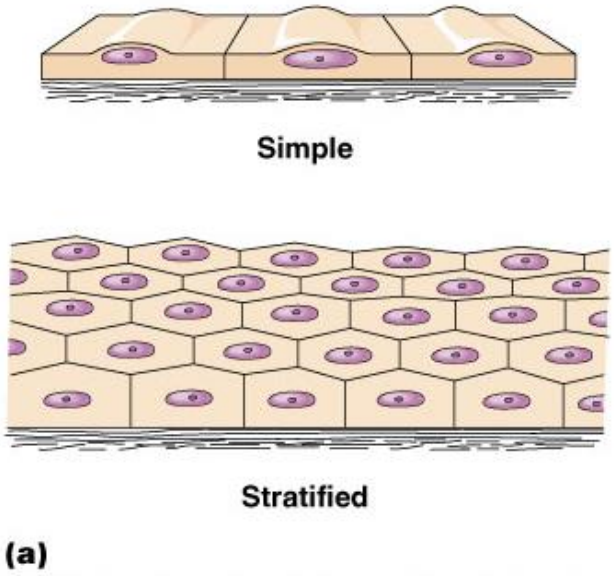


Figure 3.16a

Classification of Epithelium

- Shape of cells
  - Squamous – flattened
  - Cuboidal – cube-shaped
  - Columnar – column-like
- Cilia
  1. Nonciliated – absorptive cells (microvilli) and goblet cells (secrete mucus)
  2. Ciliated – to move substances (Ex. Ovaries)

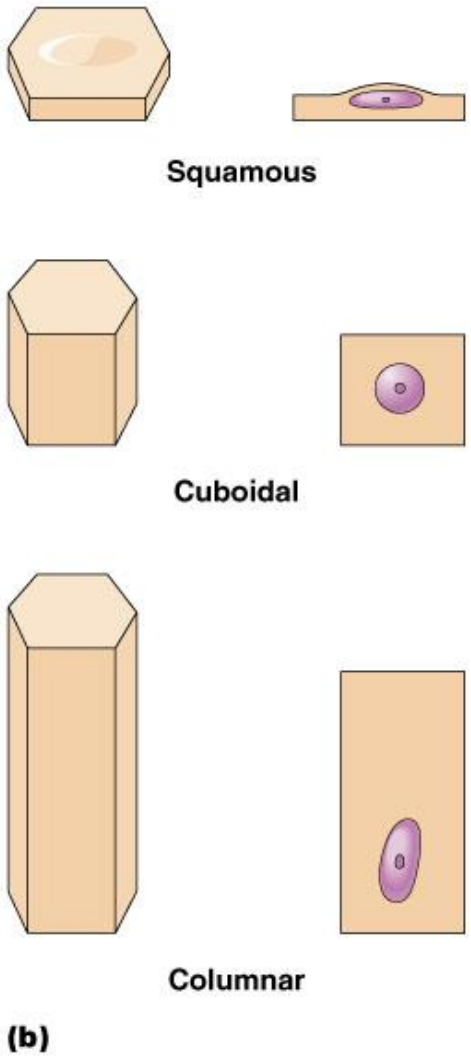
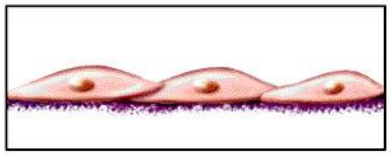


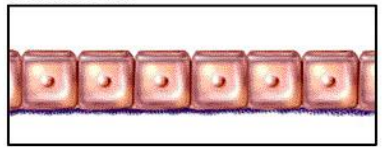
Figure 3.16b

Simple Epithelia

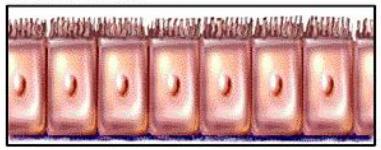
Squamous



Cuboidal



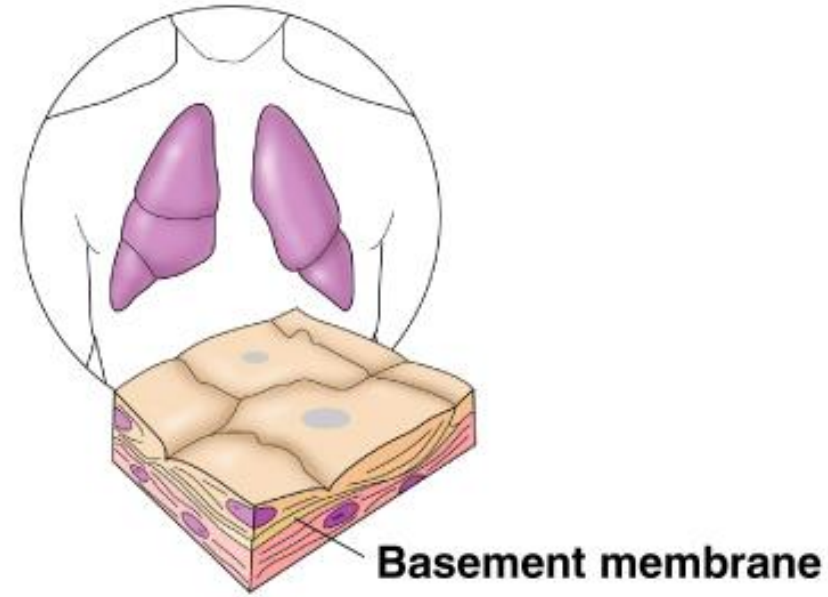
Columnar



Type	Cell shape	Example
Squamous	Squashed	Endothelium (lines blood vessels), mesothelium (serous lining of celom)
Cuboidal	Cubed	Walls of glands
Columnar	Columns	Lining of gut tube; sometimes with cilia like lining of uterine tube
Pseudo-stratified	Flat cells give rise to columns	With cilia in respiratory tubes to move mucous/particles out of lungs

Simple Epithelium

- Simple squamous
  - Single layer of flat cells
  - Usually forms membranes
    - Lines body cavities
    - Lines lungs and capillaries



(a) Simple squamous

Figure 3.17a

Simple Epithelium

- Simple cuboidal
  - Single layer of cube-like cells
  - Common in glands and their ducts
  - Forms walls of kidney tubules
  - Covers the ovaries

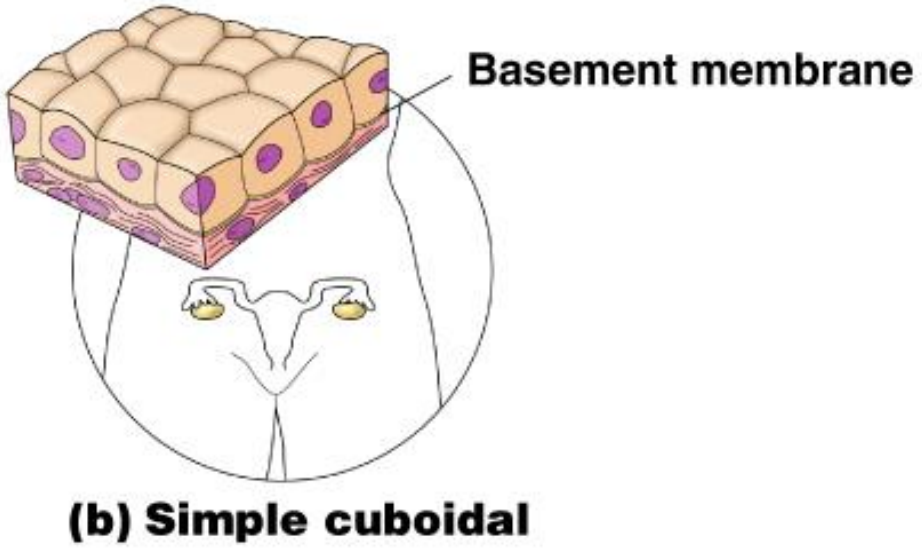
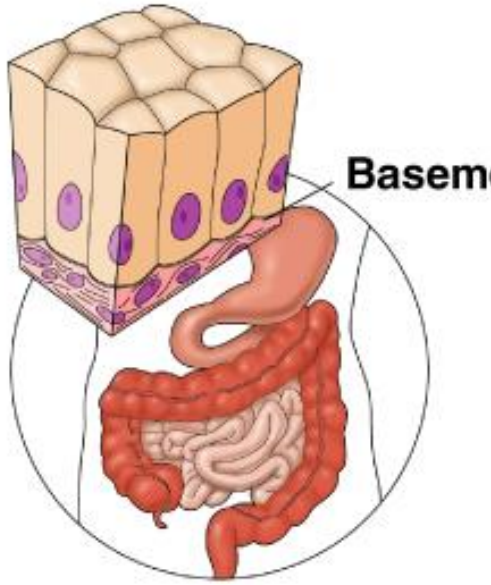


Figure 3.17b

Simple Epithelium

- Simple columnar
  - Single layer of tall cells
  - Often includes goblet cells -- produce mucus
  - Lines digestive tract – absorption of nutrients.



(c) Simple columnar

Figure 3.17c

Stratified Epithelium

- Stratified squamous
  - Cells at the free edge are flattened
  - Cells below can have other shapes
  - Found as a protective covering where friction is common
  - Locations
    - Skin
    - Mouth
    - Esophagus

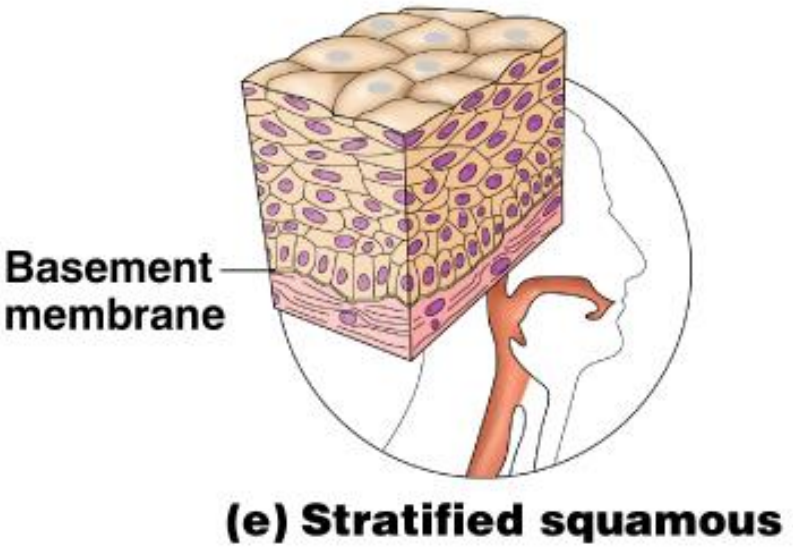


Figure 3.17e

Stratified Epithelium

- Stratified squamous
  1. Keratinized stratified squamous
     - Keratin deposit in apical layer and several layers below it.
  2. Non-keratinized stratified squamous
     - No keratin

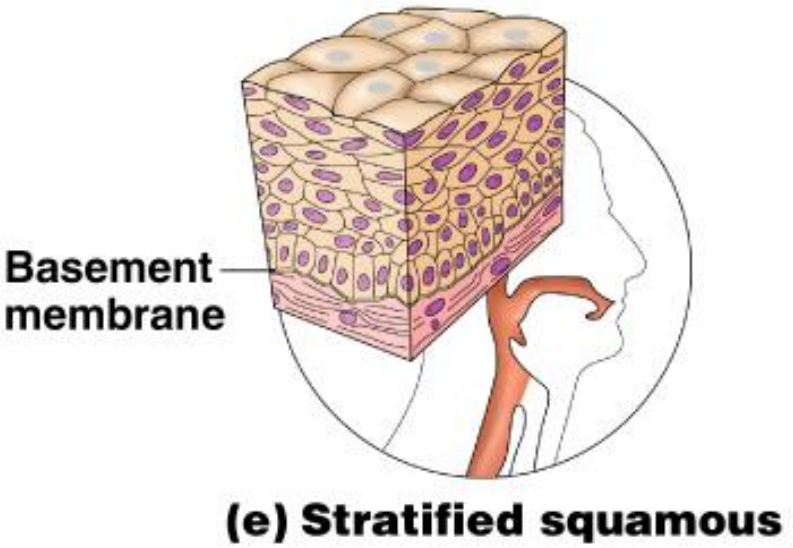


Figure 3.17e

Stratified Epithelium

- Stratified cuboidal – Rare
  - More than two layers of cuboidal cells
  - Protection, secretion, absorption
- Stratified columnar – Rare
  - Surface cells are columnar, cells underneath vary in size and shape
  - Protection and secretion

Stratified Epithelium

- Transitional epithelium
  - Elastic
  - Shape of cells depends upon the amount of stretching
  - As the cells stretch, they become flattened
  - Lines organs of the urinary system

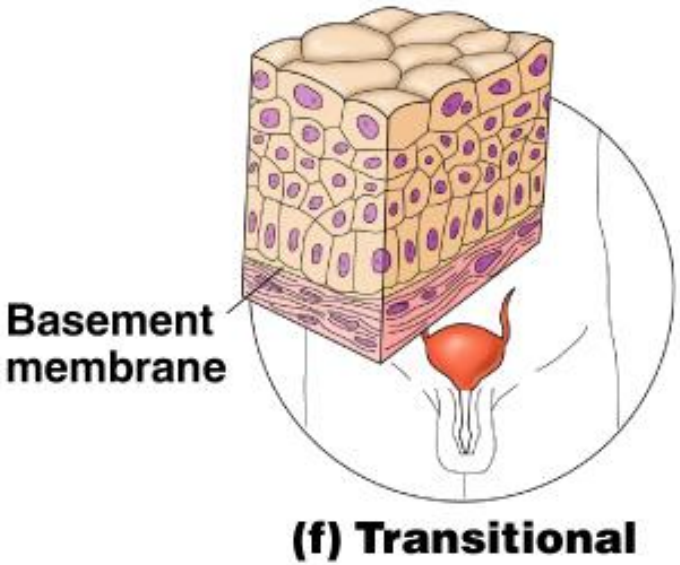
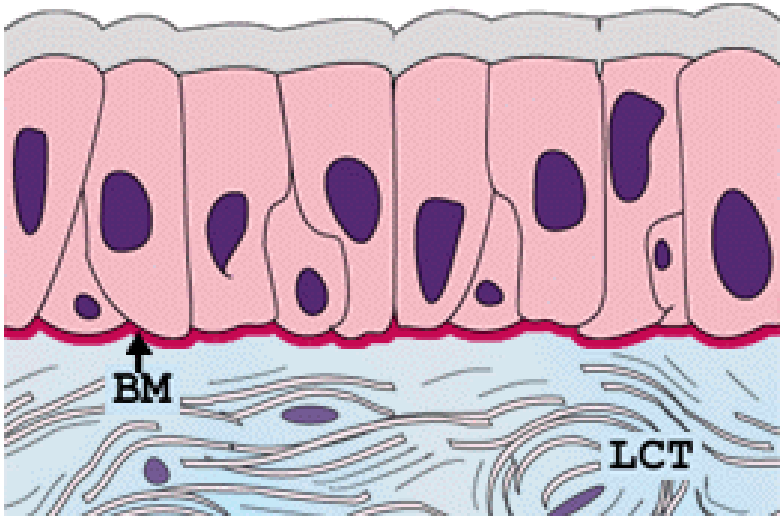
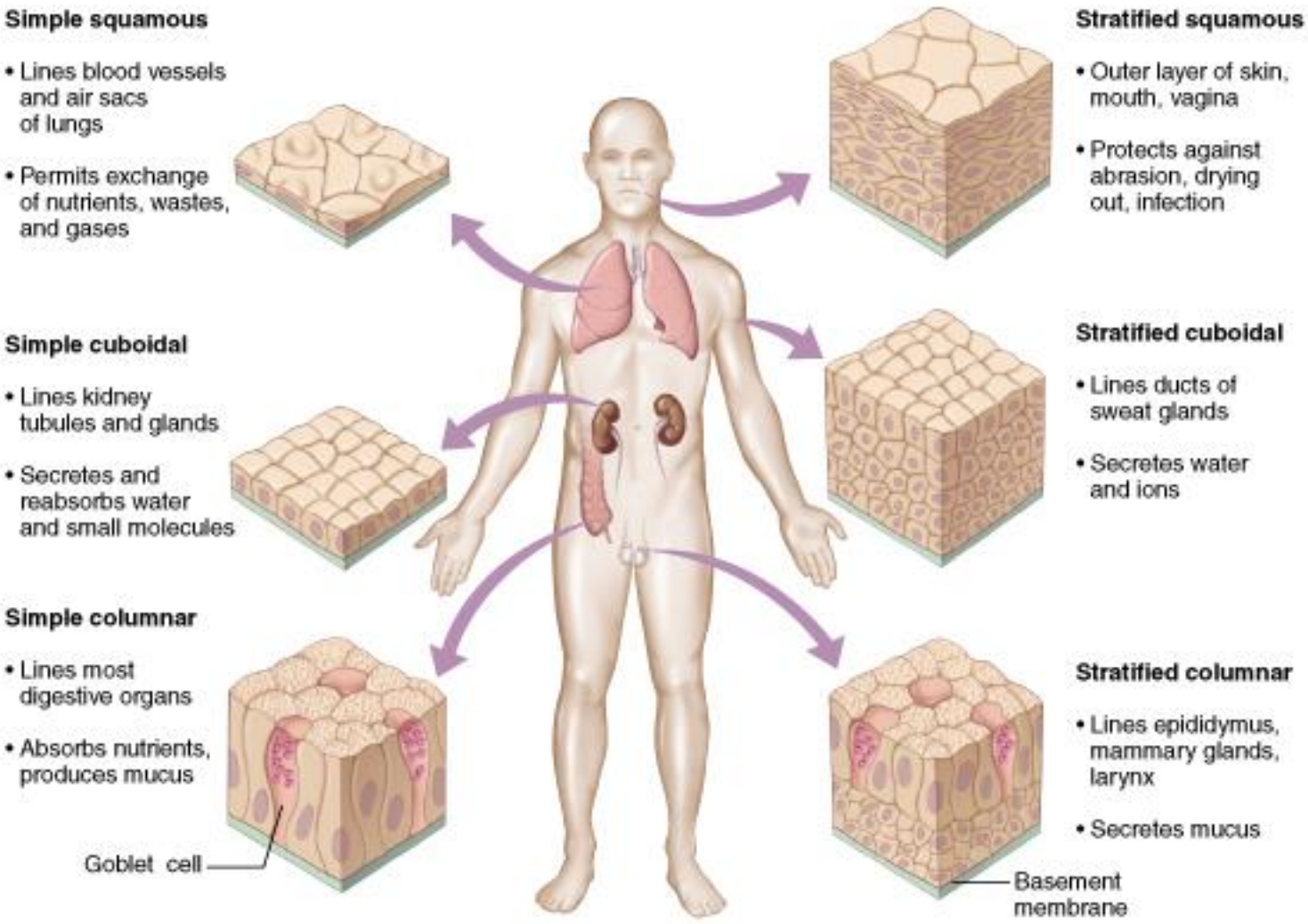


Figure 3.17f

Pseudostratified Columnar Epithelium

- Not a true stratified tissue.
- All cells are attached to the basement membrane but not all reach the apical surface.
- When viewed from the side, it appears that they have several layers



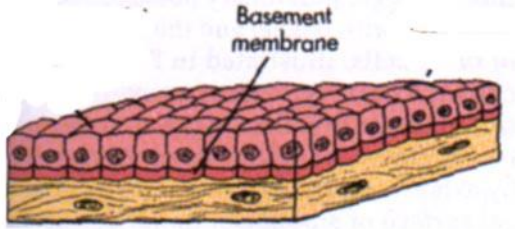


(a) Most epithelial tissues line or cover surfaces or body cavities

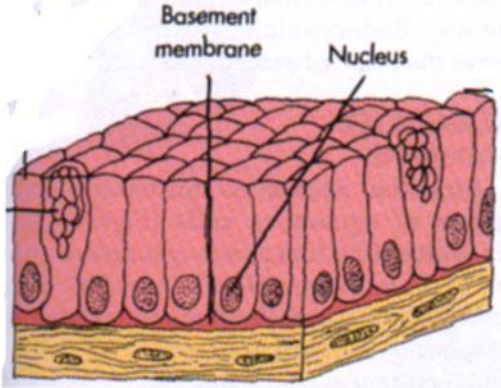
Quiz!!

Can You Identify the Classes of Epithelium?

E

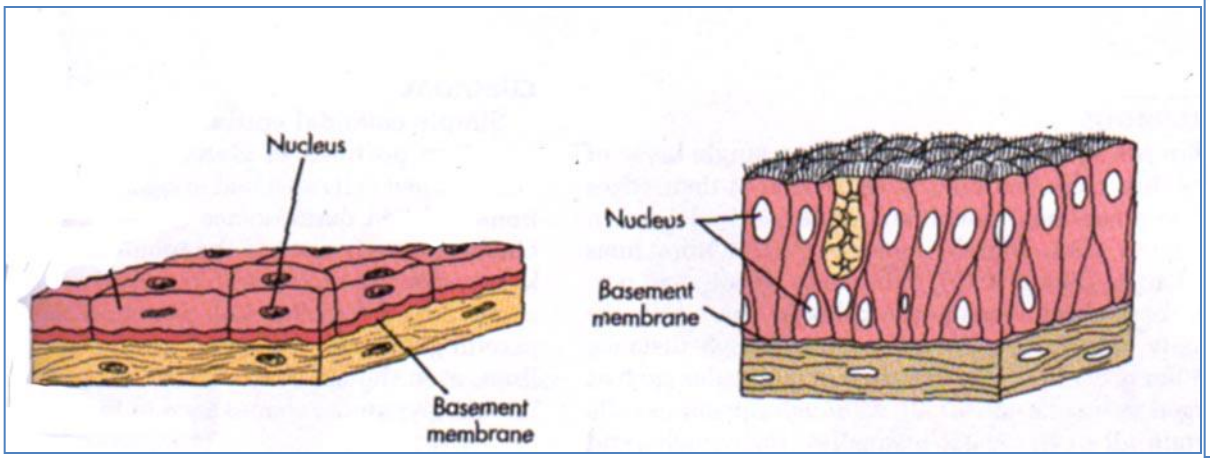


D

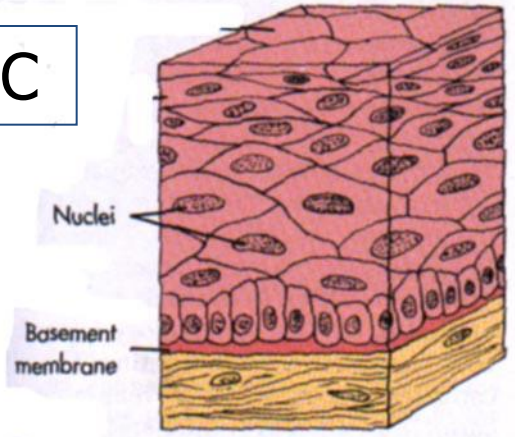


A

B

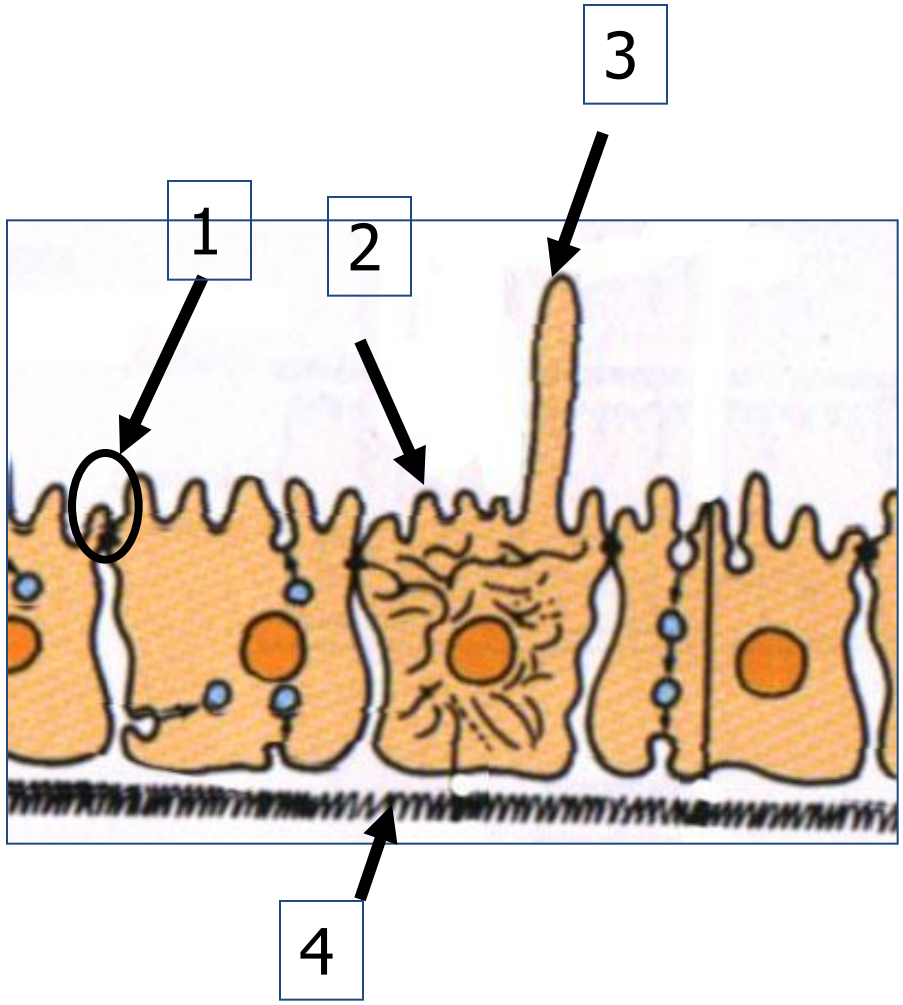


C



Name that Epithelial Feature!

(name and location on cell)



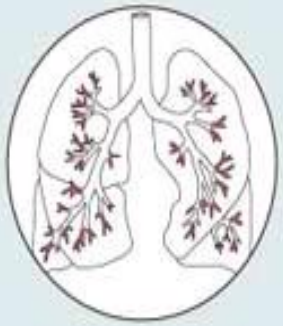
- Cilia →3
- Tight junction →1
- Microvilli →2
- Basement membrane →4

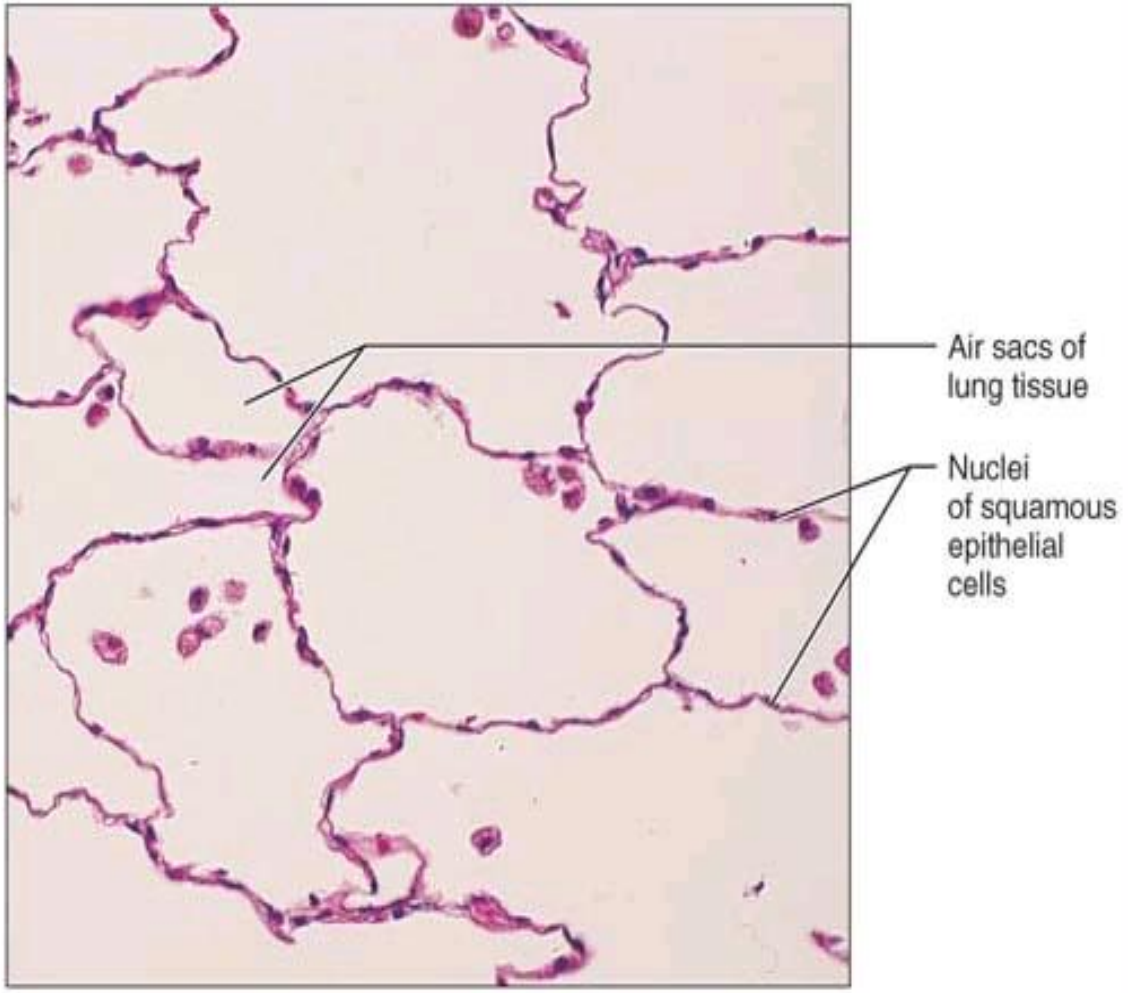
(a) Simple squamous epithelium

Description: Single layer of flattened cells with disc-shaped central nuclei and sparse cytoplasm; the simplest of the epithelia.

Function: Allows passage of materials by diffusion and filtration in sites where protection is not important; secretes lubricating substances in serosae.

Location: Kidney glomeruli; air sacs of lungs; lining of heart, blood vessels, and lymphatic vessels; lining of ventral body cavity (serosae).





Photomicrograph: Simple squamous epithelium forming part of the alveolar (air sac) walls (400×).

Epithelia: Simple Squamous

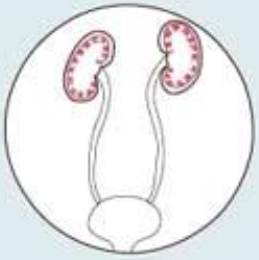
- Two other locations
  - Endothelium
    - The lining of lymphatic vessels, blood vessels, and heart
  - Mesothelium
    - The epithelium of serous membranes in the ventral body cavity

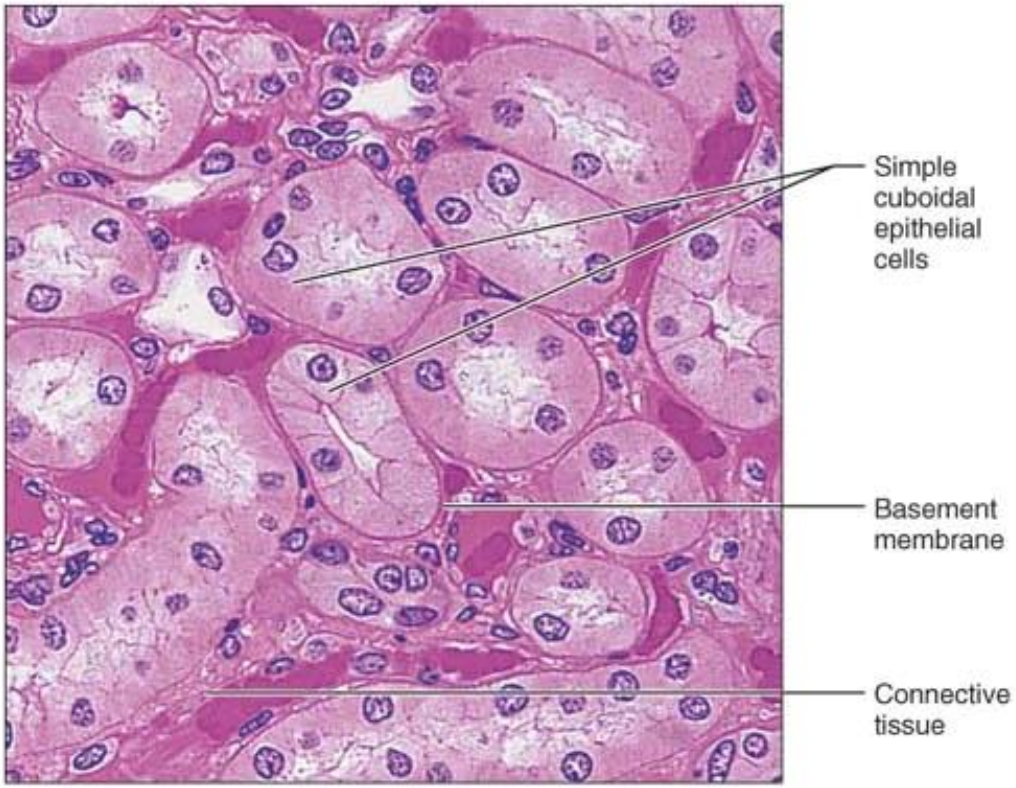
(b) Simple cuboidal epithelium

Description: Single layer of cubelike cells with large, spherical central nuclei.

Function: Secretion and absorption.

Location: Kidney tubules; ducts and secretory portions of small glands; ovary surface.

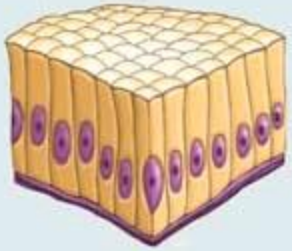




Photomicrograph: Simple cuboidal epithelium in kidney tubules (400×).

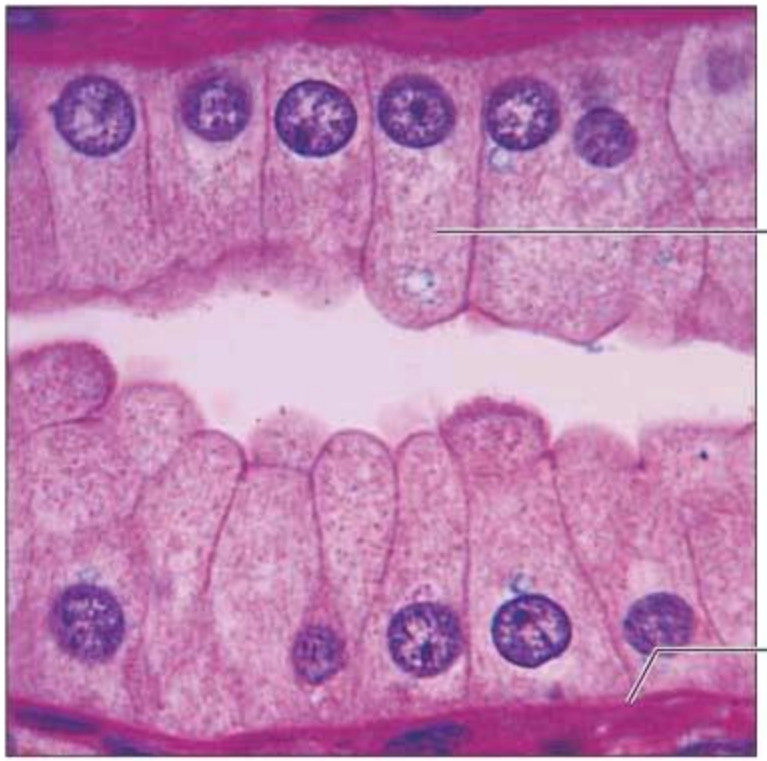
(c) Simple columnar epithelium

Description: Single layer of tall cells with *round* to *oval* nuclei; some cells bear cilia; layer 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 anal canal), gallbladder, and excretory ducts of some glands; ciliated variety lines small bronchi, uterine tubes, and some regions of the uterus.



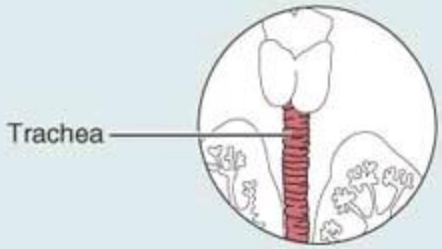
Photomicrograph: Simple columnar epithelium of the stomach mucosa (1300×).

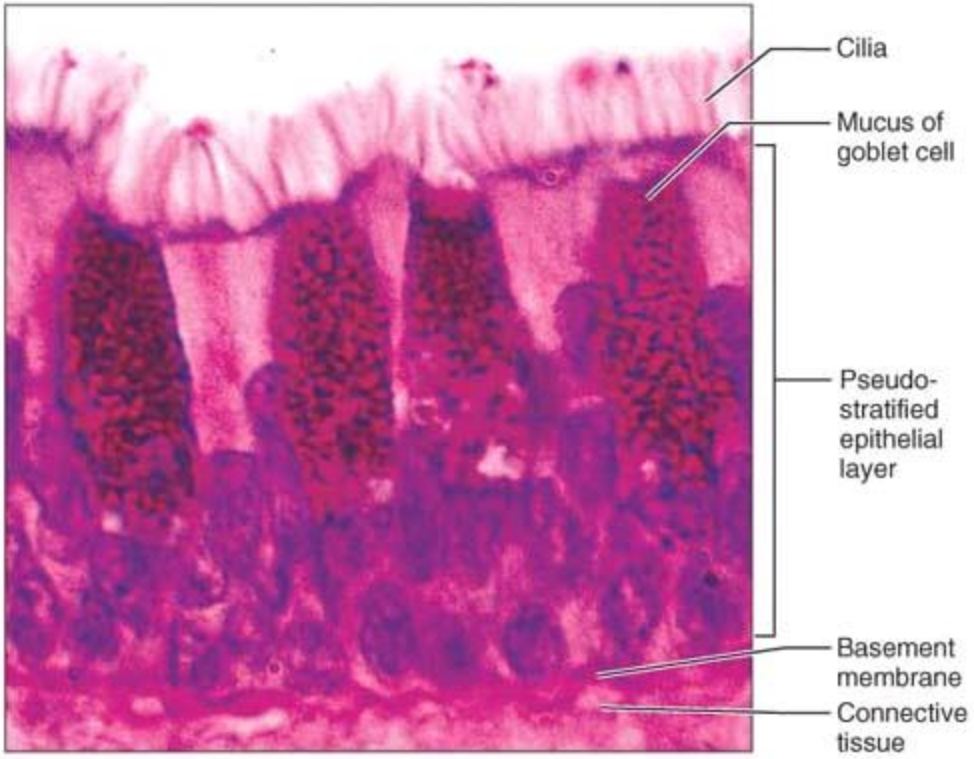
(d) Pseudostratified columnar epithelium

Description: Single layer of cells of differing heights, some not reaching the free surface; nuclei seen at different levels; may contain goblet cells and bear cilia.

Function: Secretion, particularly of mucus; propulsion of mucus by ciliary action.

Location: Nonciliated type in male's sperm-carrying ducts and ducts of large glands; ciliated variety lines the trachea, most of the upper respiratory tract.

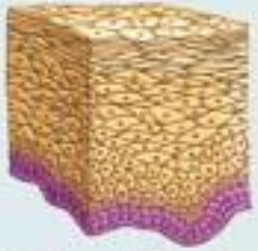




Photomicrograph: Pseudostratified ciliated columnar epithelium lining the human trachea (400×).

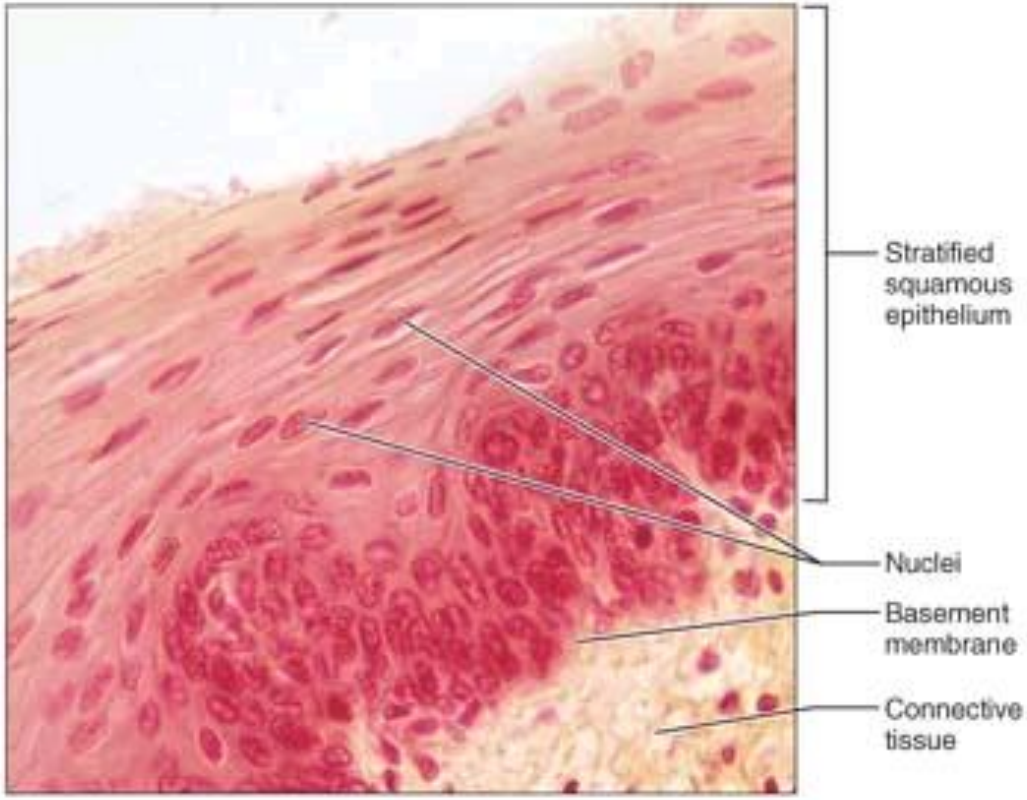
(e) Stratified squamous epithelium

Description: Thick membrane composed of several cell layers; basal cells are cuboidal or columnar and metabolically active; surface cells are flattened (squamous); in the keratinized type, the surface cells are full of keratin and 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.

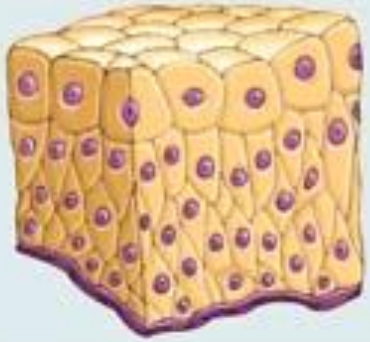
Location: Nonkeratinized type forms the moist linings of the esophagus, mouth, and vagina; keratinized variety forms the epidermis of the skin, a dry membrane.



Photomicrograph: Stratified squamous epithelium lining the esophagus (425×).

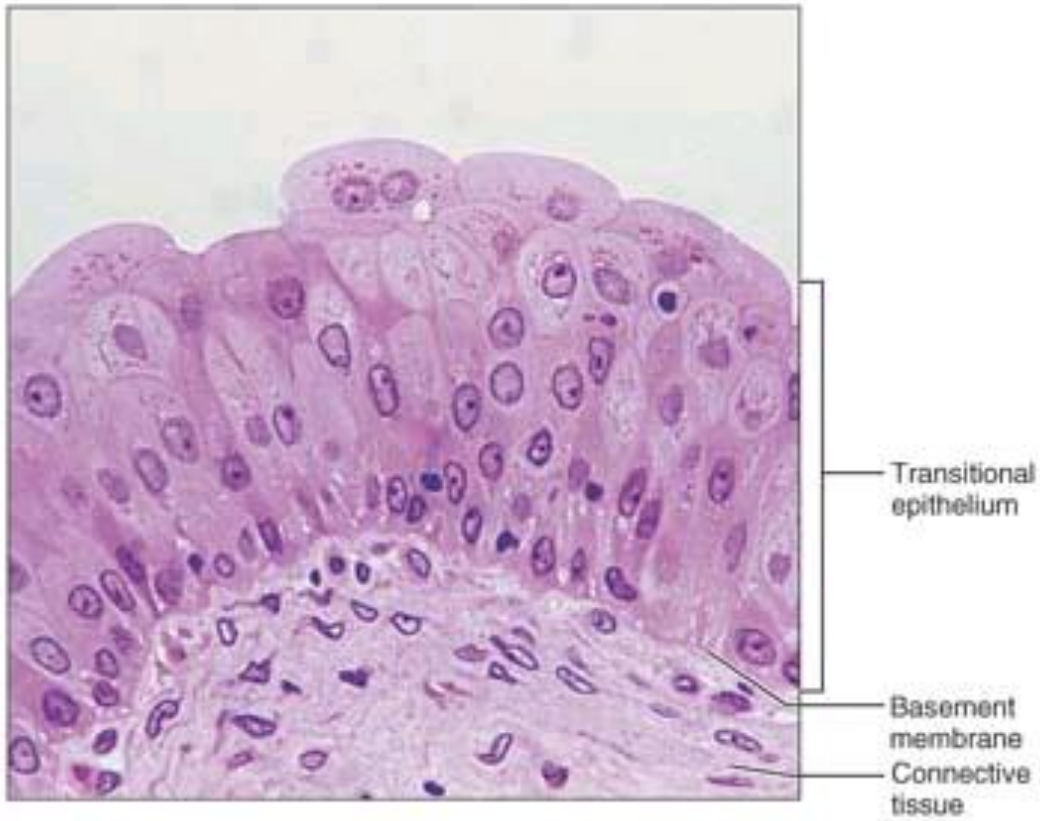
(f) Transitional epithelium

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 and permits distension of urinary organ by contained urine.

Location: Lines the ureters, bladder, and part of the urethra.



Photomicrograph: Transitional epithelium lining the bladder, relaxed state (500×); note the bulbous, or rounded, appearance of the cells at the surface; these cells flatten and become elongated when the bladder is filled with urine.

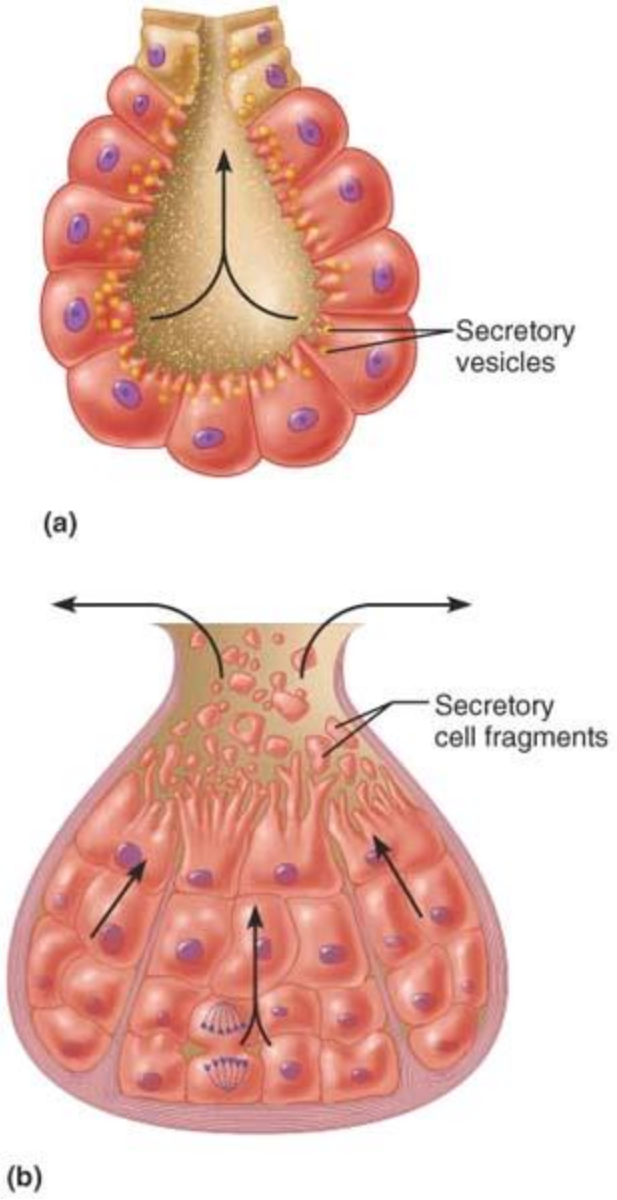
Glandular Epithelia

- A gland is one or more cells that makes and secretes an aqueous fluid
- Classified by:
  - Site of product release—endocrine or exocrine
  - Relative number of cells forming the gland—unicellular (e.g., goblet cells) or multicellular

Glands: epithelial cells that secrete

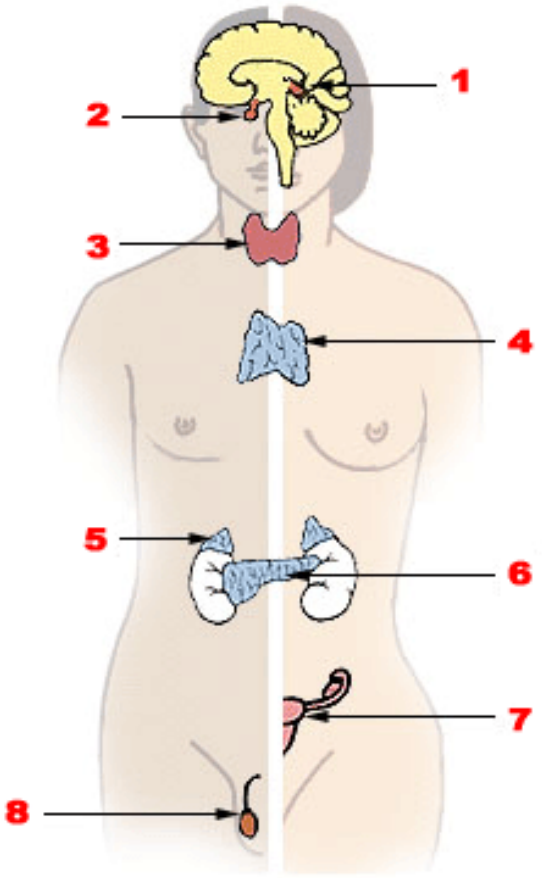
- Exocrine Glands
  - Secrete substance onto body surface or into body cavity
  - Have ducts
  - E.G., salivary, mammary, pancreas, liver

- Endocrine Glands
  - Secrete product into blood stream
  - Either stored in secretory cells or in follicle surrounded by secretory cells
  - Hormones travel to target organ to increase response
  - No ducts



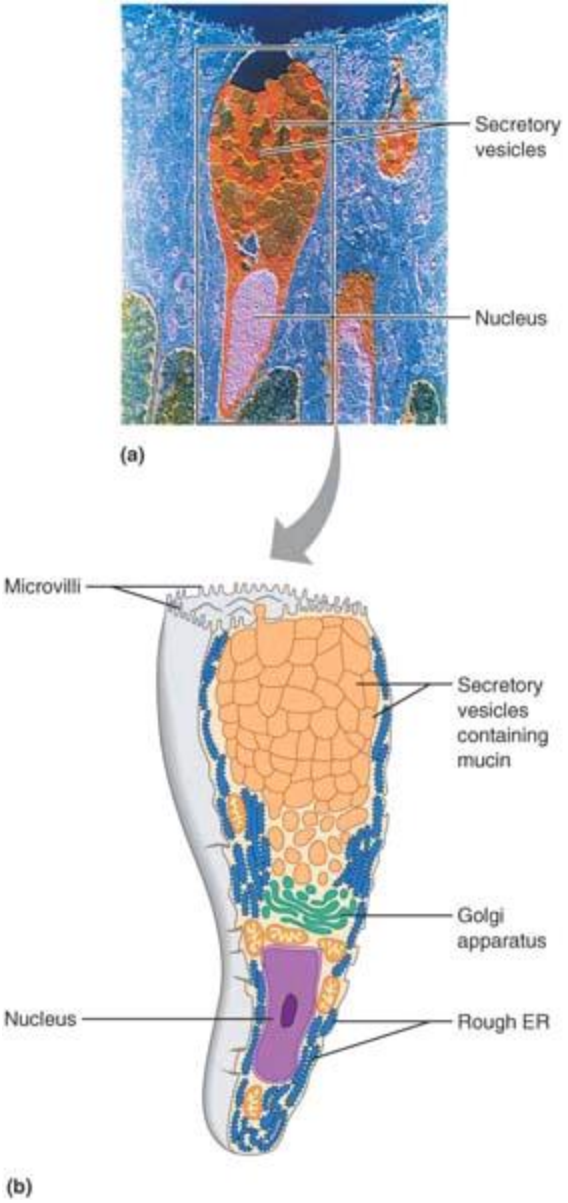
Endocrine Glands

- Secretion enter the interstitial (between cells) fluid and diffuse into blood stream – Hormones
  - Pituitary
  - Thyroid
  - Adrenal
- Secretions include amino acids, proteins, glycoproteins, and steroids



Exocrine Glands

- Secretion into ducts that empty at the surface of covering and lining epithelium or onto a free surface
  - Skin
  - Interior surface of a hollow organ (lumen)
- Examples
  - Sweat
  - Saliva
- Some glands of the body have both endocrine and exocrine parts
  - Pancreas
  - Ovaries and testes



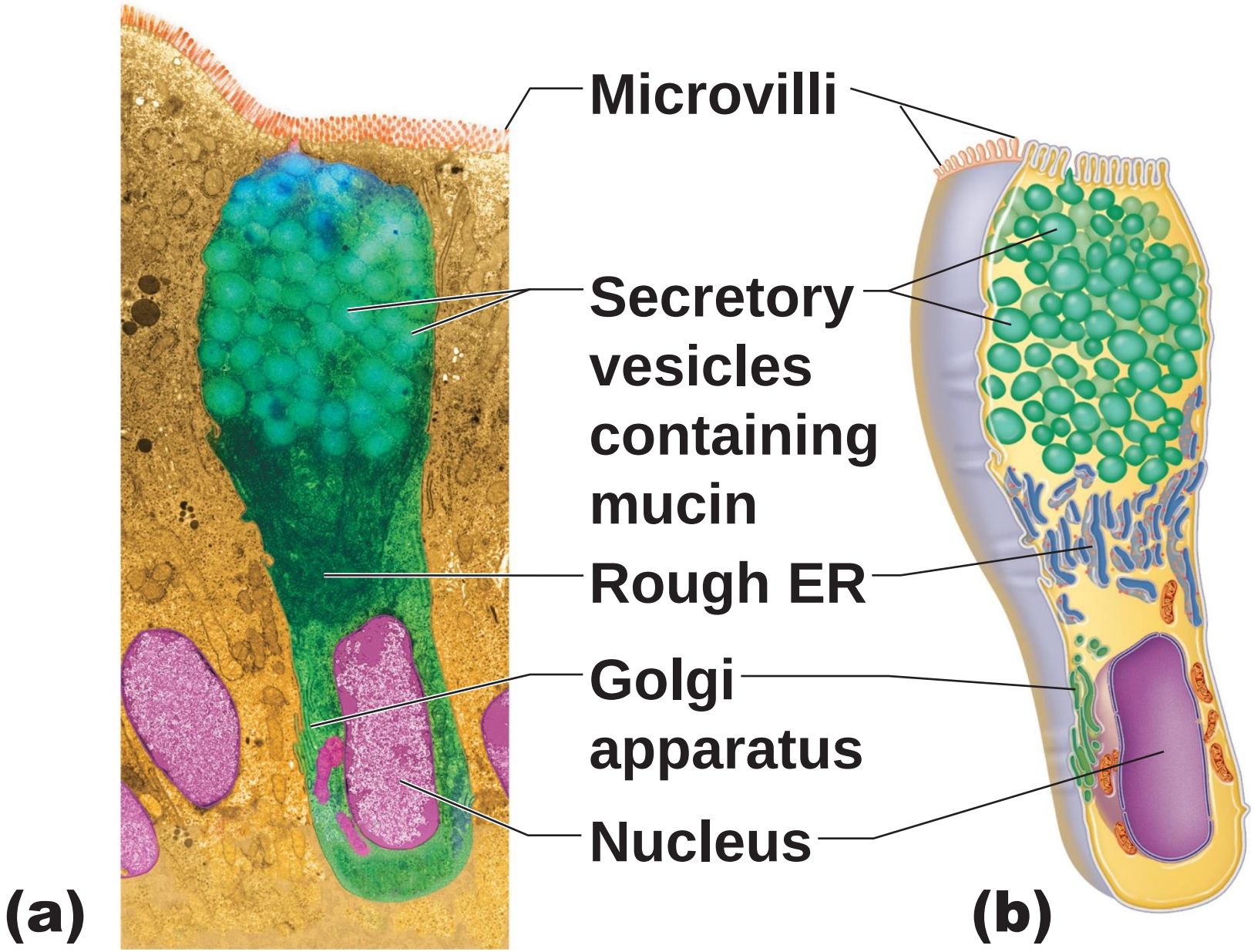


Figure 4.4

Exocrine Glands

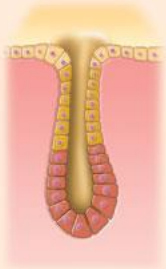
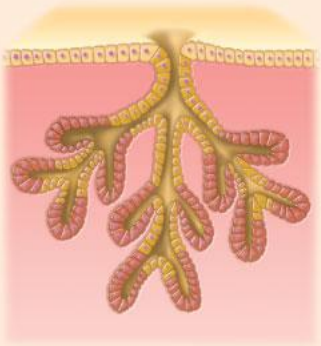
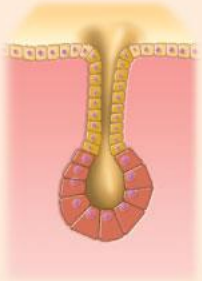
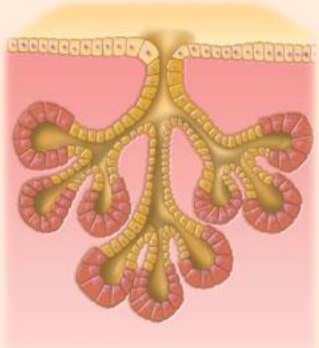
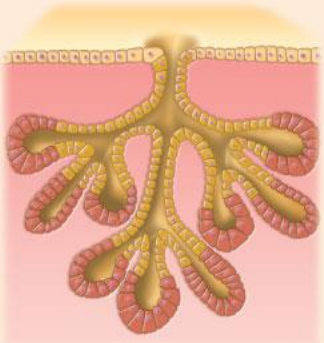
- More numerous than endocrine glands
- Secrete products into ducts
- Secretions released onto body surfaces (skin) or into body cavities
- Examples include mucous, sweat, oil, and salivary glands

Unicellular Exocrine Glands

- The only important unicellular gland is the goblet cell

Multicellular Exocrine Glands

- Multicellular exocrine glands are composed of a duct and a secretory unit
- Classified according to:
  - Duct type (simple or compound)
  - Structure of their secretory units (tubular, alveolar, or tubuloalveolar)

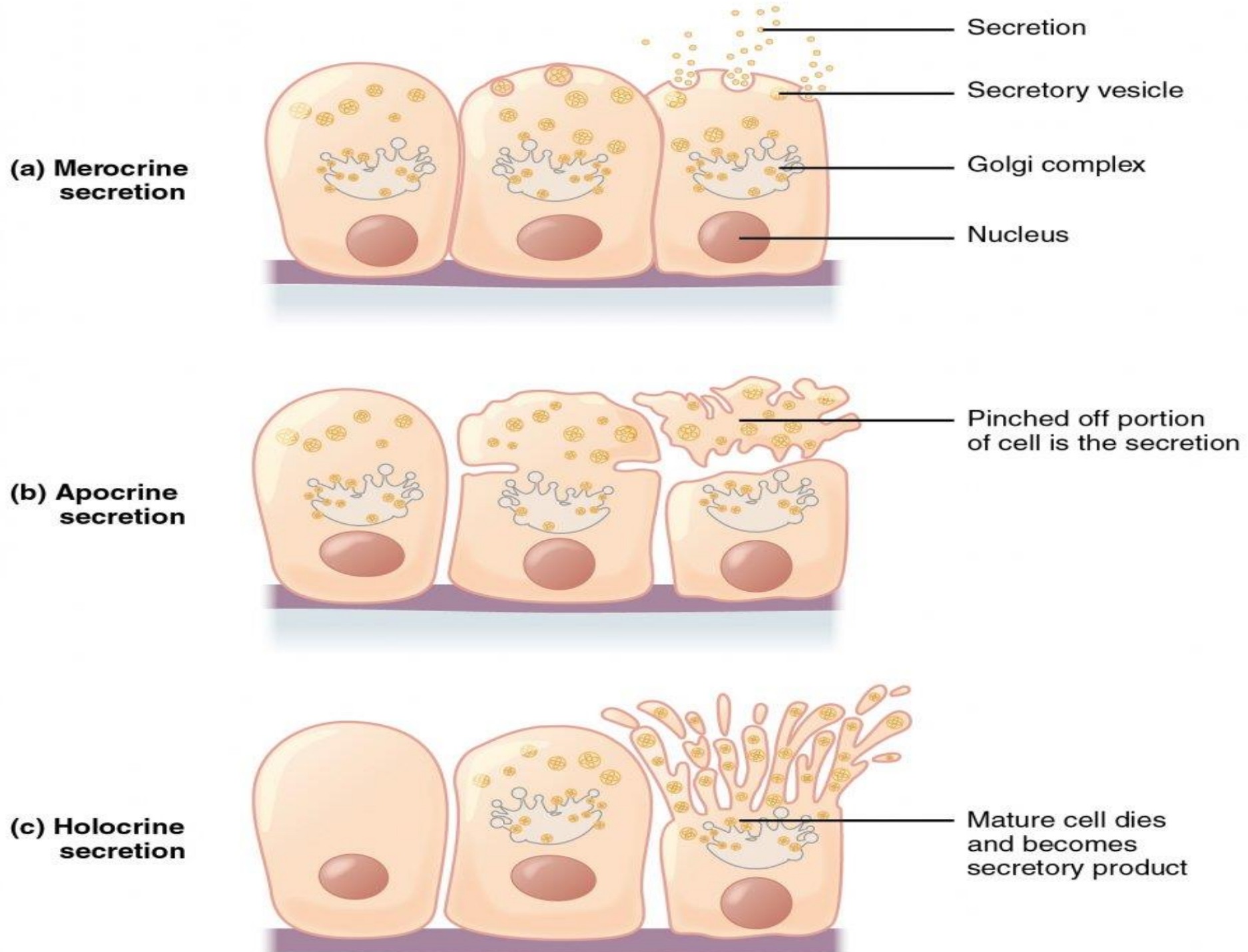
	Simple duct structure (duct does not branch)		Compound duct structure (duct branches)	
Tubular secretory structure	 **Simple tubular** ***Example*** Intestinal glands	 **Simple branched tubular** ***Example*** Stomach (gastric) glands	 **Compound tubular** ***Example*** Duodenal glands of small intestine	
Alveolar secretory structure	 **Simple alveolar** ***Example*** No important example in humans	 **Simple branched alveolar** ***Example*** Sebaceous (oil) glands	 **Compound alveolar** ***Example*** Mammary glands	 **Compound tubuloalveolar** ***Example*** Salivary glands

Surface epithelium Duct Secretory epithelium

Figure 4.5

- **Pancreas:** Special form of glandular tissue

The pancreas has the particular anatomical and physiological characteristic of having both types of glands. Its exocrine portion passes digestive enzymes through the pancreatic duct into the duodenum, while the endocrine portion (islets of Langerhans) produces the hormones insulin and glucagon and releases them into the body.


Secretion
Secretory vesicle
Golgi complex
Nucleus
(a) Merocrine secretion
Pinched off portion of cell is the secretion
(b) Apocrine secretion
Mature cell dies and becomes secretory product
(c) Holocrine secretion

Modes of Secretion

- Merocrine
  - Products are secreted by exocytosis (e.g., pancreas, sweat and salivary glands)
- Holocrine
  - Products are secreted by rupture of gland cells (e.g., sebaceous glands)

Special Epithelial Pathologies

- **Mechanical damage**
- In simple wounds, like cut, scrapes, the healing process is done by the proliferation and spread of epithelial cells in 24 hours. Deep burns (third degree) are largely corrected by epithelial regrowth.

Papillomas

- are benign epithelial tumors. They grow instratified squamous epithelium.The most frequent form is the wart (basal cell papilloma), a proliferation of epithelial cells from the stratum basale of the skin. The result is a compact organized epithelial node that can keratinize.

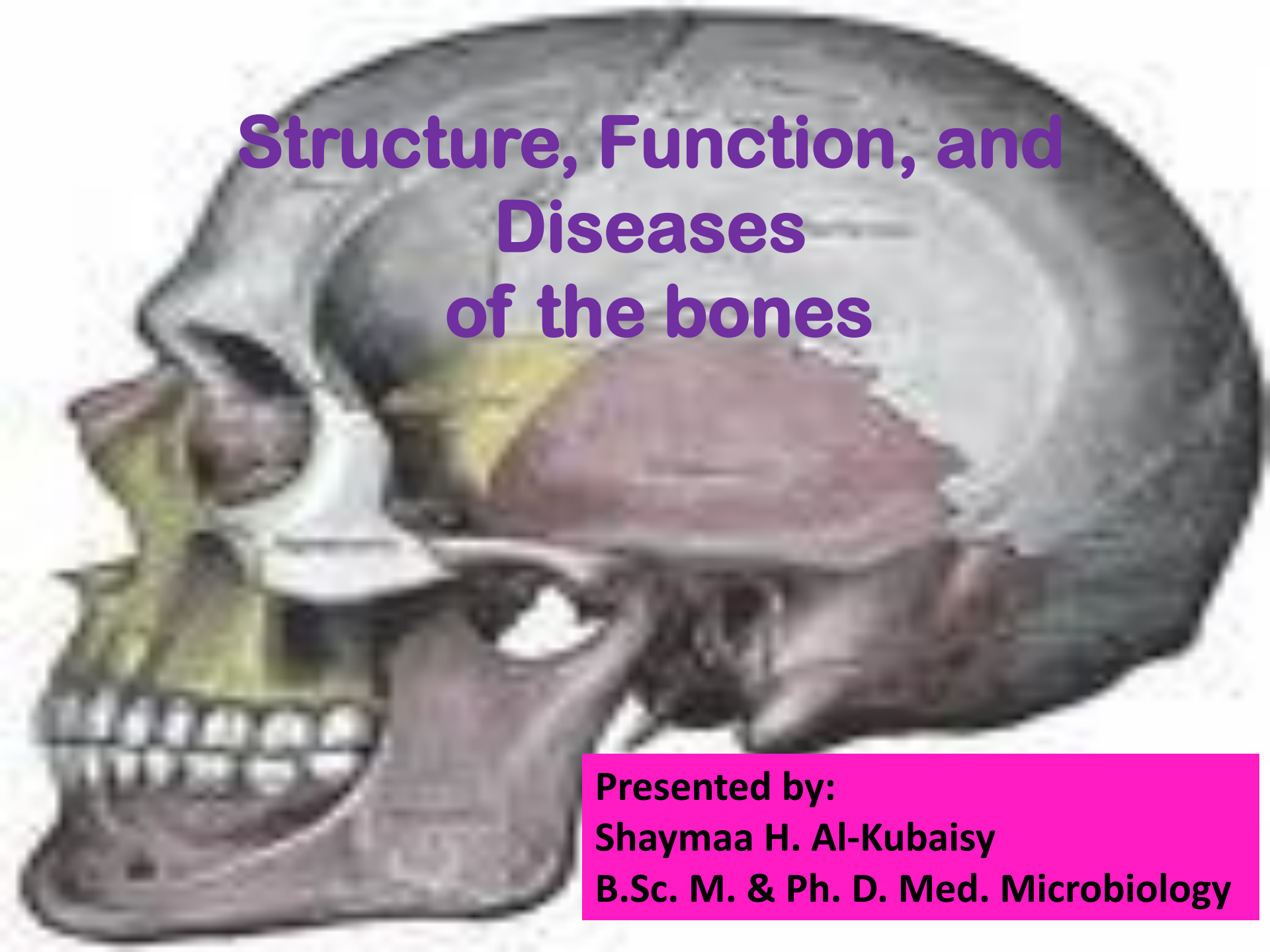
- Adenomas

- Like the papillomas, adenomas are also benign epithelial tumors that can grow in glands. Adenomas can develop into malignant tumors, the so-called adenocarcinomas.

Allergic contact dermatitis

- When in contact with a specific allergen, the skin epithelium is loosened up like a sponge by the formation of edema. This edema is an intercellular accumulation of fluid that can also converge into bubbles. Typical allergens that cause such eczema are, e.g., animal hair (epithelium allergy).

Thank you



Structure, Function, and Diseases of the bones

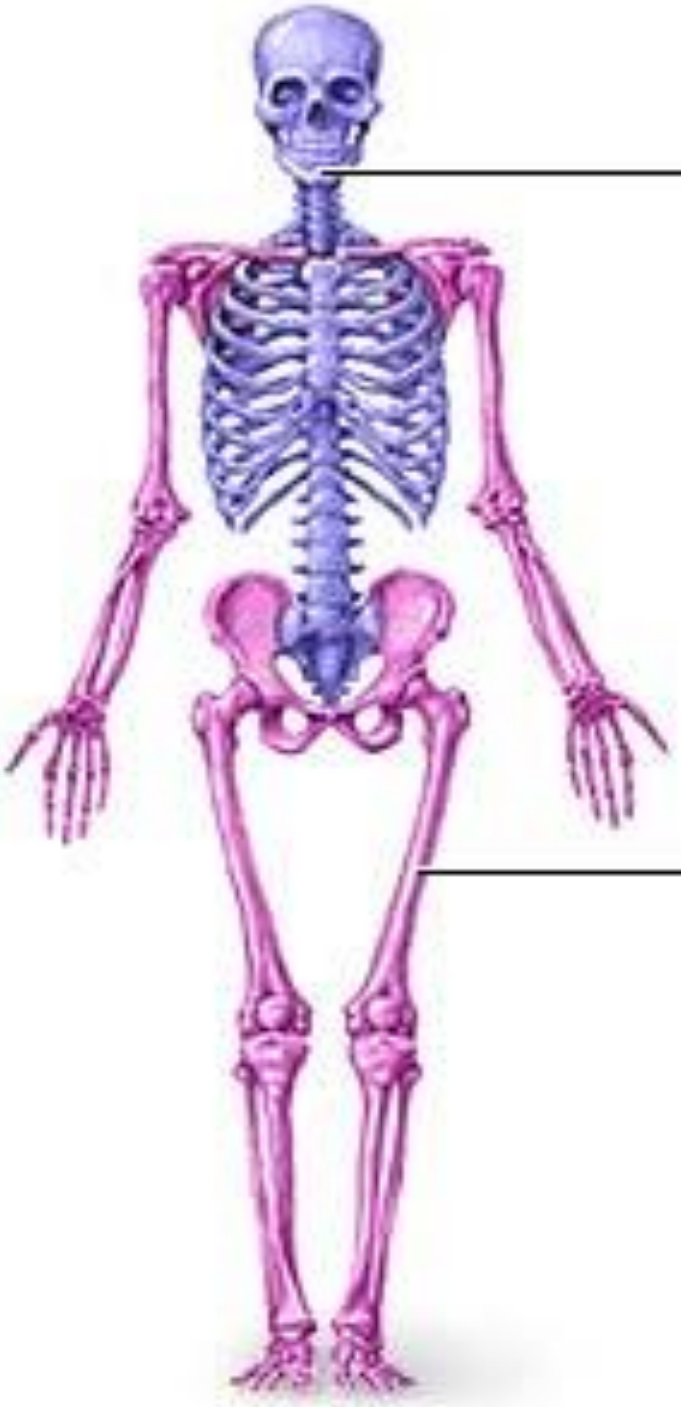
Presented by:
Shaymaa H. Al-Kubaisy
B.Sc. M. & Ph. D. Med. Microbiology

INTRODUCTION

- Bone is made up of several different tissues working together: bone, cartilage, dense connective tissue, epithelium, various blood forming tissues, adipose tissue, and nervous tissue.
- Each individual bone is an organ; the bones, along with their cartilages, make up the skeletal system.

The Skeletal System

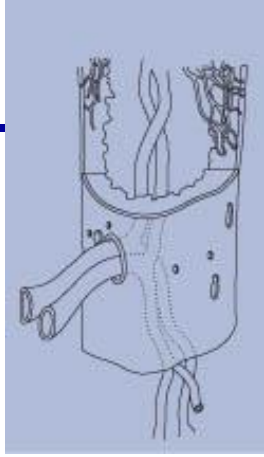
- Parts of the skeletal system
  - Bones (skeleton)
  - Joints
  - Cartilages
  - Ligaments (bone to bone)(tendon=bone to muscle)
- Divided into two divisions
  - **Axial skeleton-** skull, spinal column
  - **Appendicular skeleton** – limbs and girdle

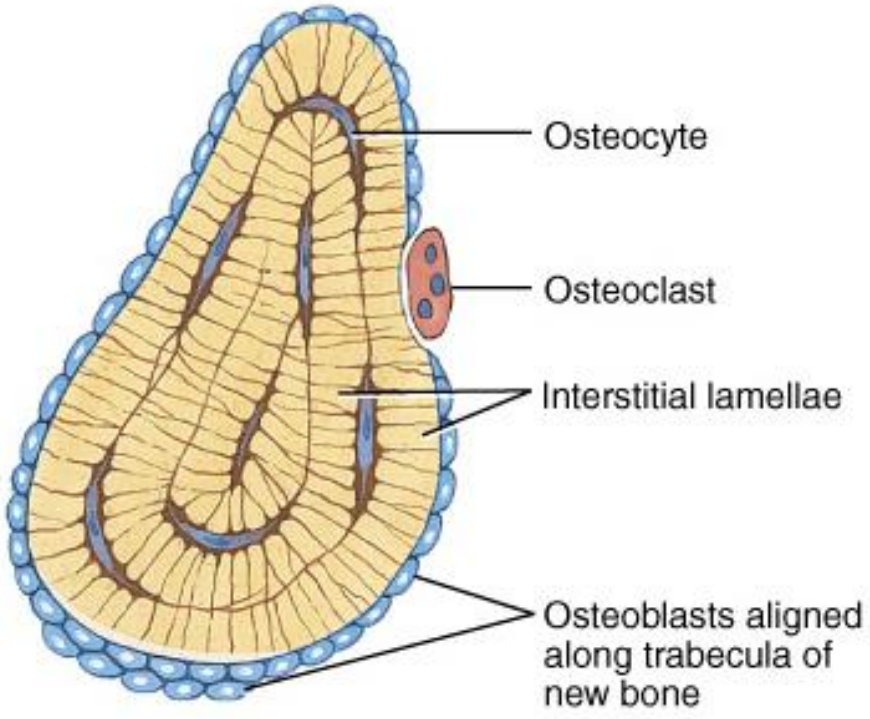


Axial skeleton (blue)

Appendicular skeleton (pink)

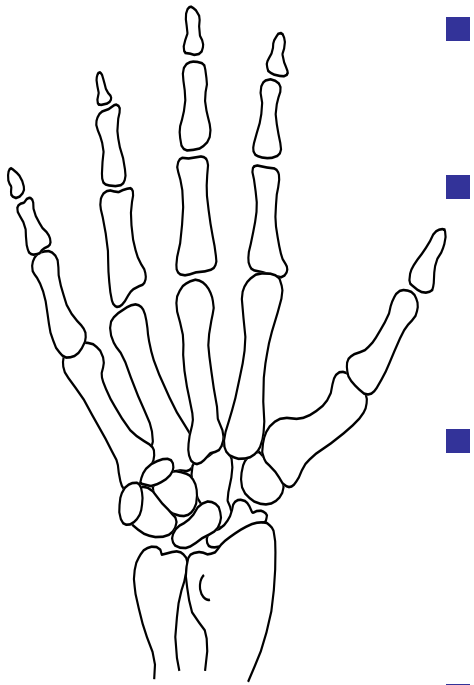
The Skeletal System: Bone Tissue





- Dynamic and ever-changing throughout life
- Skeleton composed of many different tissues
  - cartilage, bone tissue, epithelium, nerve, blood forming tissue, adipose, and dense connective tissue

Functions of Bone



- Supporting & protecting soft tissues
- Attachment site for muscles making movement possible
- Storage of the minerals, calcium & phosphate -- mineral homeostasis
- Blood cell production occurs in red bone marrow (hemopoiesis)
- Energy storage in yellow bone marrow

Importance of Ionic Calcium in the Body

- Calcium is necessary for:
  - Transmission of nerve impulses
  - Muscle contraction
  - Blood coagulation
  - Secretion by glands and nerve cells
  - Cell division

Bones of the Human Body

- The skeleton has **206** bones
- Two basic types of bone tissue
  - **Compact** bone
    - Homogeneous
  - **Spongy** bone
    - Small needle-like pieces of bone
    - Many open spaces

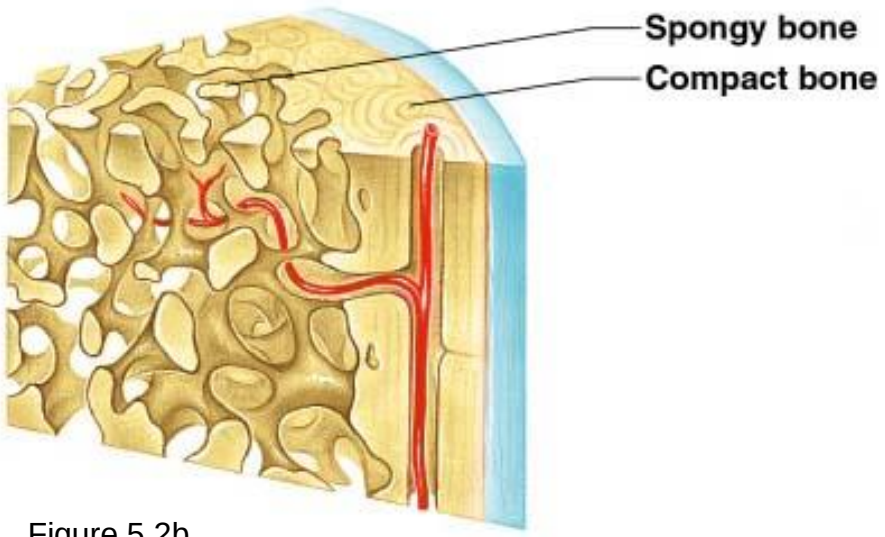


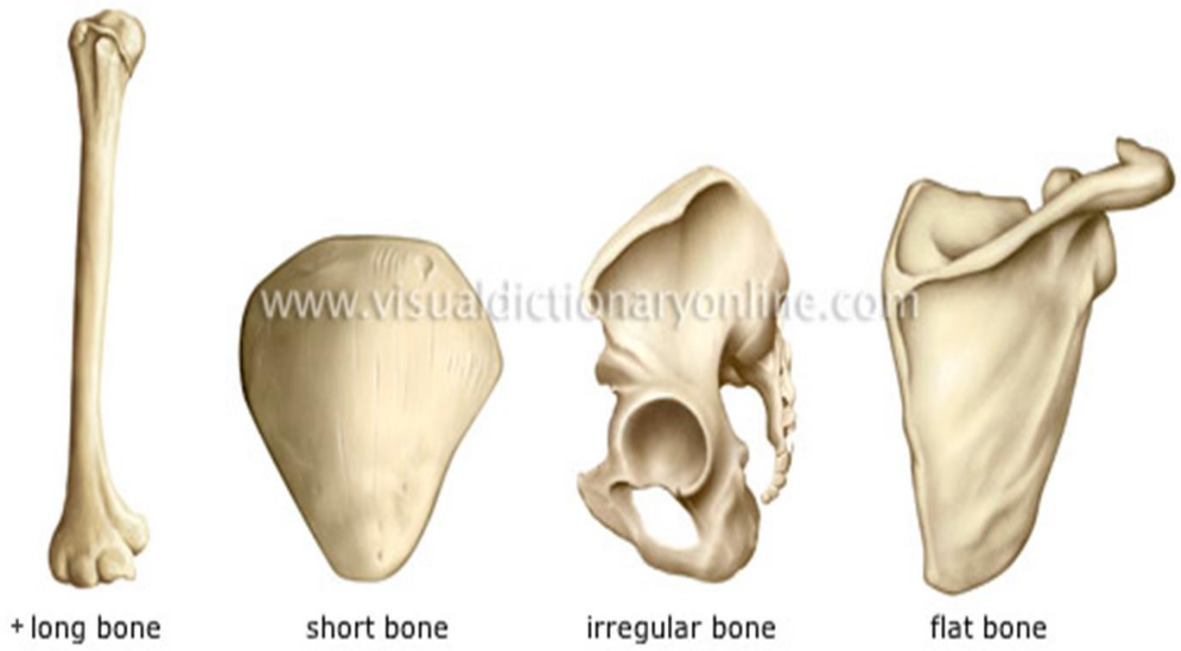
Figure 5.2b

Bones are classified by their shape:

1. **Long-** bones are longer than they are wide (arms, legs)
2. **Short-** usually square in shape, cube like (wrist, ankle)
3. **Flat-** flat , curved (skull, Sternum)
4. **Irregular-** odd shapes (vertebrae, pelvis)

What are the types of Bones?

- Long
- Short
- Flat
- Irregular



Long Bones

- Longer than they are wide
- Has a shaft and 2 ends
- Weight bearing bones (like steel beams)
- Provide the greatest structure and support

- ***Examples:***
  - All limb bones
  - Except…. Kneecap, Wrist and Ankle bones

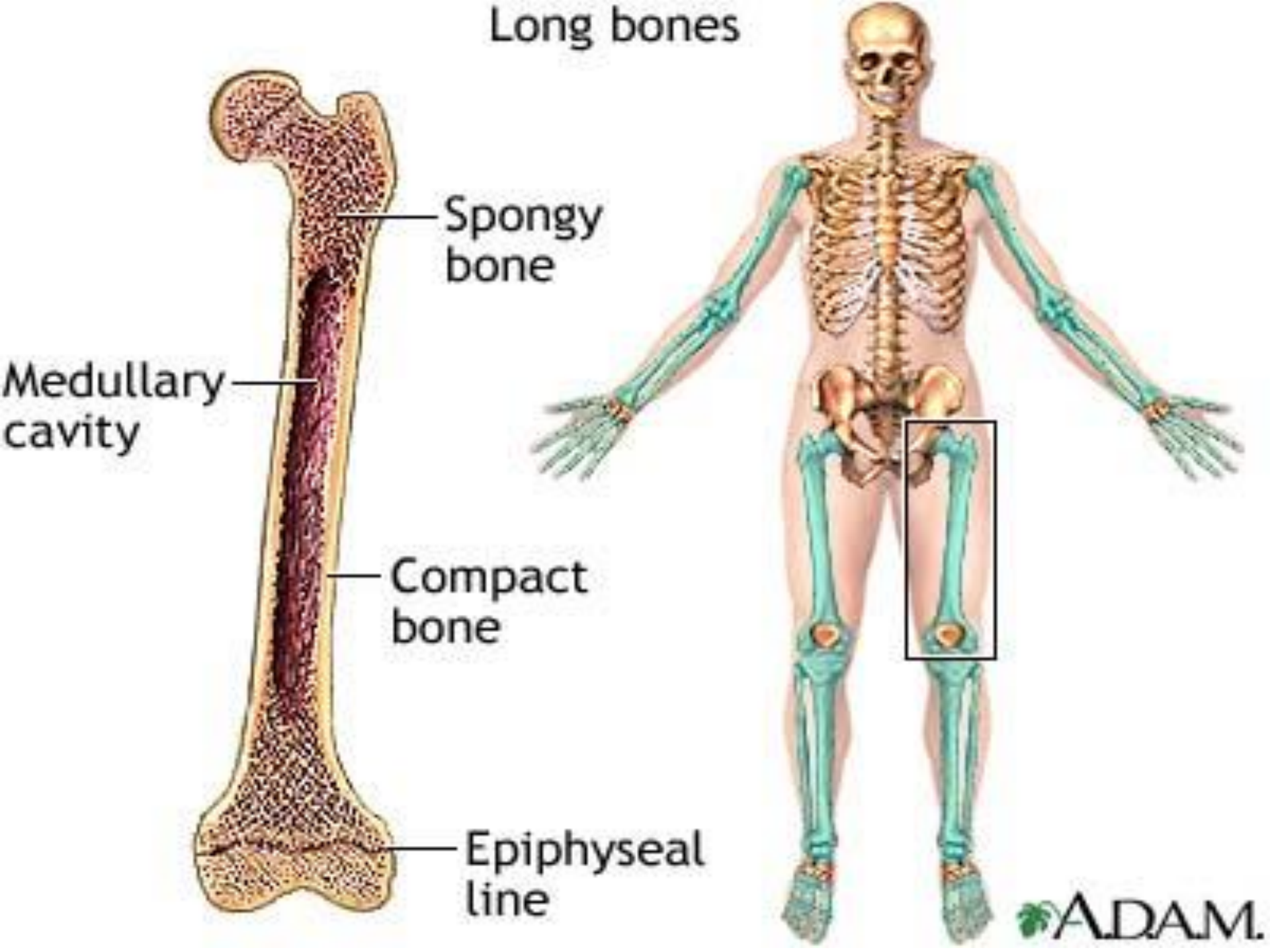
Structure of a Long Bone

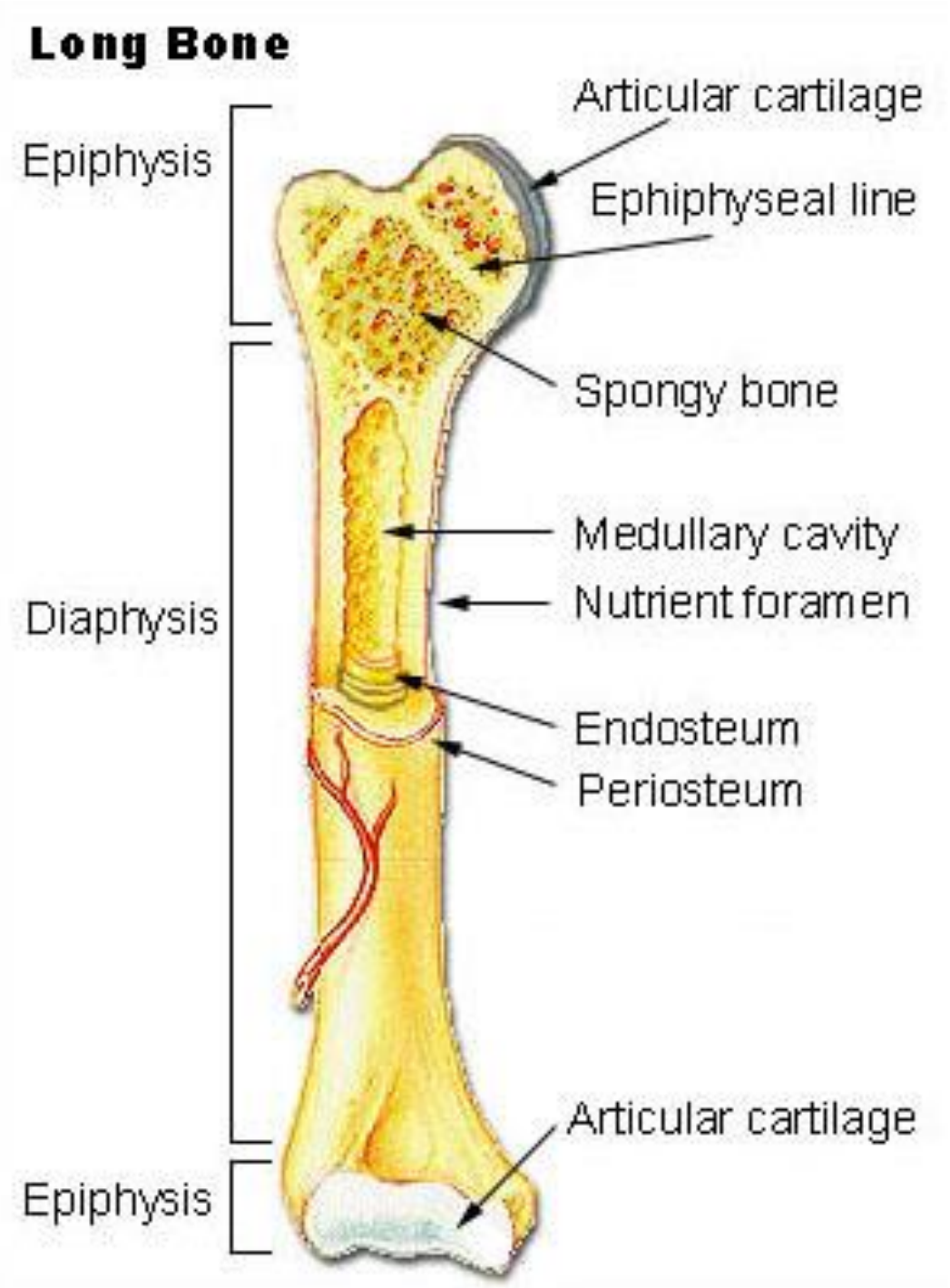
- ***Diaphysis:***
  - Center, main shaft
  - Long part of bone
  - Made of very thick compact bone surrounding a central marrow cavity

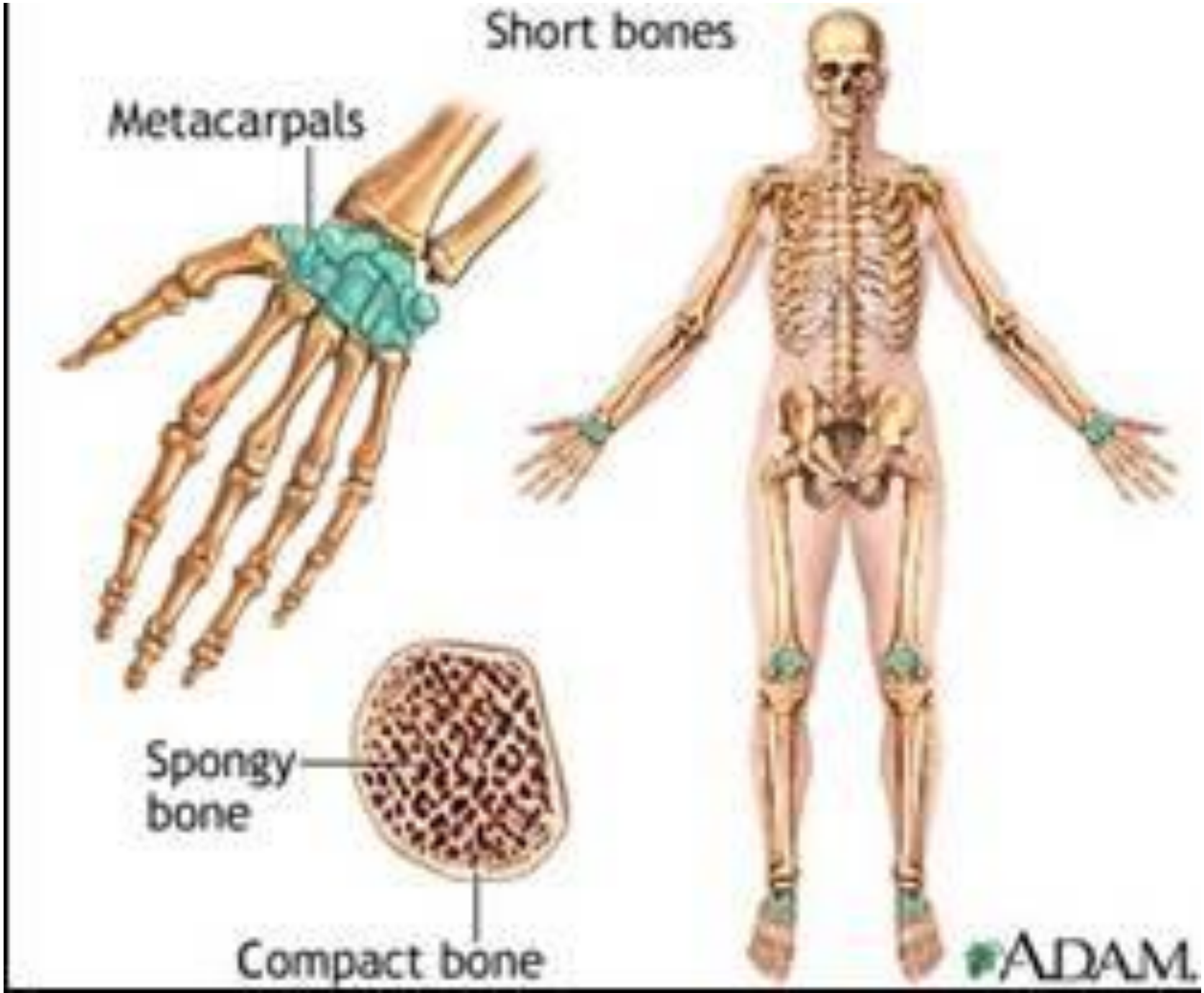
- ***Epiphysis:***
  - Ends of bone
  - Wider than diaphysis
  - Made of compact bone which surrounds spongy bone.
  - Joint surface of each epiphysis is covered with hyaline cartilage

- ***Epiphyseal Line:***
  - Remnant of Epiphyseal Plate
  - Found in adult bones
  - Shows amount of cartilage growth during adolescence

- ***Membranes:***
  - Periosteum = Around the outside
    - Richly supplied with nerve fibers, lymphatic vessels and blood vessels
    - Provides anchoring points for tendons and ligaments
  - Endosteum = Around the inside
    - Surrounds the spongy bone


Long bones
Spongy bone
Medullary cavity
Compact bone
Epiphyseal line
A.D.A.M.


Long Bone
Articular cartilage
Epiphysis
Ephiphyseal line
Spongy bone
Medullary cavity
Diaphysis
Nutrient foramen
Endosteum
Periosteum
Articular cartilage
Epiphysis


Short bones
Metacarpals
Spongy bone
Compact bone
A.D.A.M.

Classification of Bones on the Basis of Shape

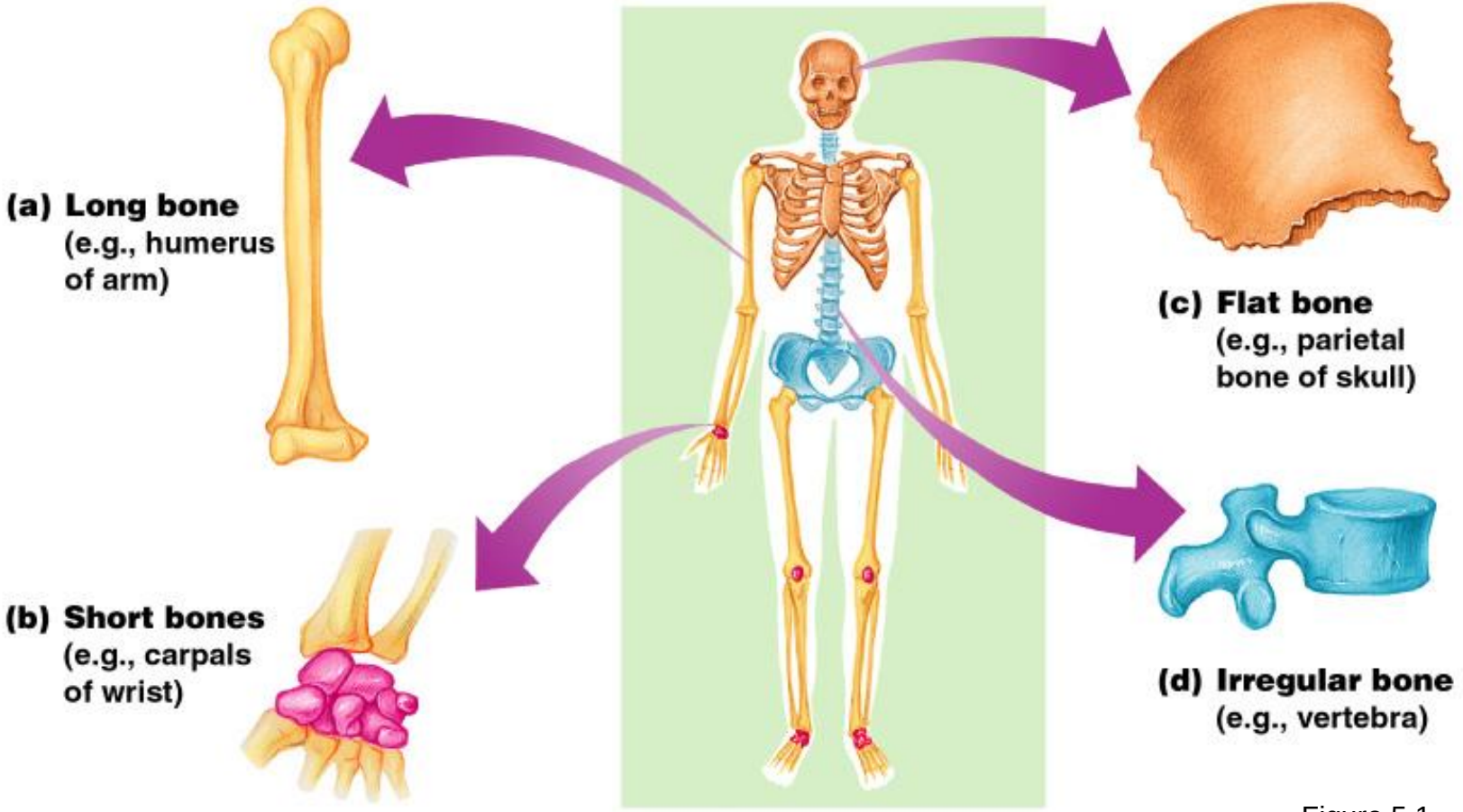
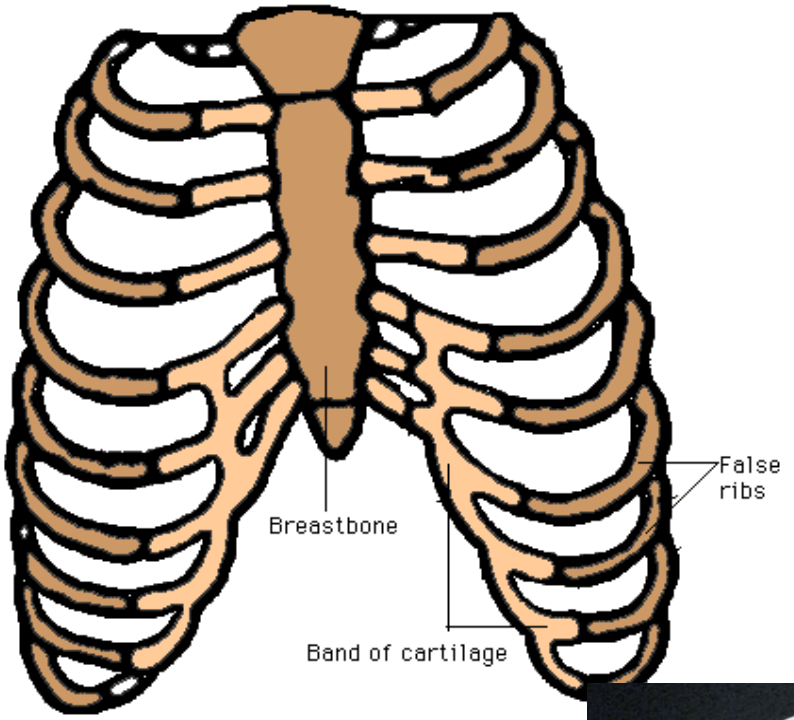
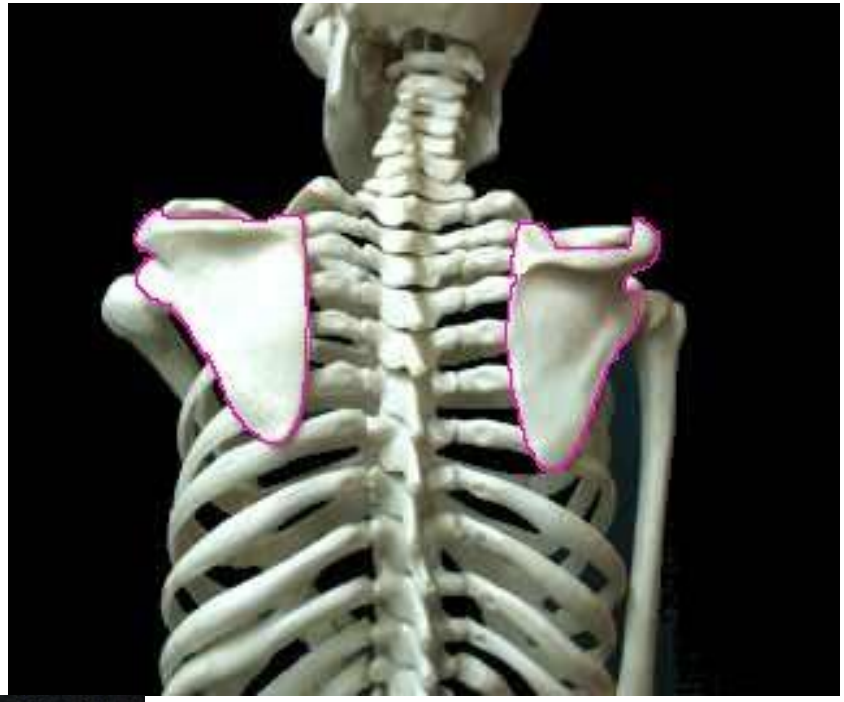
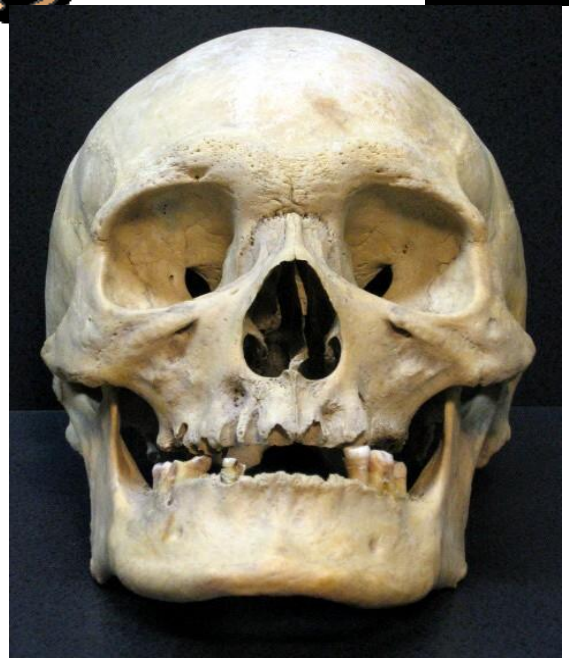


Figure 5.1


False ribs
Breastbone
Band of cartilage





Bone Structure

- **Unique based on location + bone type.**

- **Compact Bone (Outer Layer):**
  - Dense
  - Smooth and Solid to naked eye

- **Spongy Bone (Inner Layer):**
  - Hole-y (like a honeycomb)
  - Made of small needle-like, flat pieces called “trabeculae”
  - Open spaces between trabeculae are filled with red or yellow bone marrow

Chemical Composition of Bone

- **Contains organic & inorganic components**

- ***Organic:***
  - Cells (osteoblasts, osteocytes, osteoclasts)
  - Osteoid
    - Made of glycoproteins and collagen fibers
    - Secreted by osteoblasts
    - “filler matrix” around cells
  - Contribute to flexibility and tensile strength

- ***Inorganic:***
  - Mineral Salts (calcium phosphates)
  - Contribute to hardness of bone (allowing for compression resistance)

Types of Bone Cells

- **Osteocytes**
  - Mature bone cells
- **Osteoblasts**
  - Bone-forming cells
- **Osteoclasts**
  - Bone-destroying cells
  - Break down bone matrix for remodeling and release of calcium
- ***Bone remodeling is a process by both osteoblasts and osteoclasts***

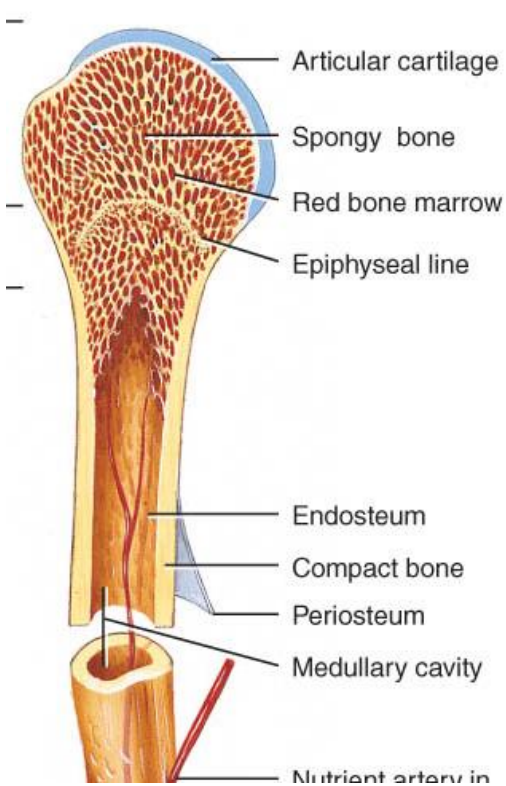
Matrix of Bone

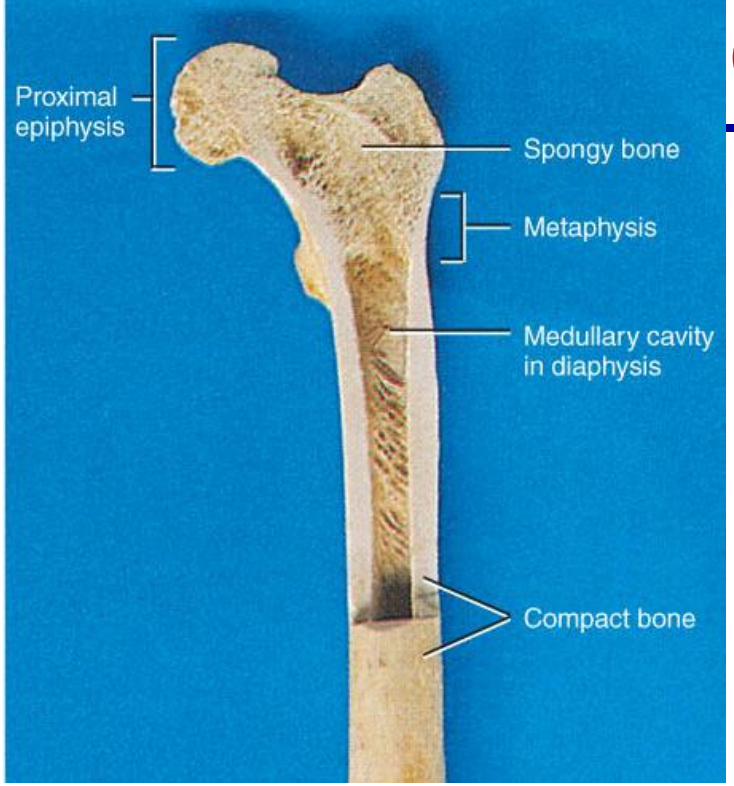
- Inorganic mineral salts provide bone's hardness
  - hydroxyapatite (calcium phosphate) & calcium carbonate
- Organic collagen fibers provide bone's flexibility
  - their tensile strength resists being stretched or torn
  - remove minerals with acid & rubbery structure results
- Bone is not completely solid since it has small spaces for vessels and red bone marrow
  - spongy bone has many such spaces
  - compact bone has very few such spaces

Compact Bone

- *Compact bone* is arranged in units called *osteons* or *Haversian systems* .
- Osteons contain blood vessels, lymphatic vessels, nerves, and osteocytes along with the calcified matrix.
- Osteons are aligned in the same direction along lines of stress. These lines can slowly change as the stresses on the bone changes.

Compact or Dense Bone

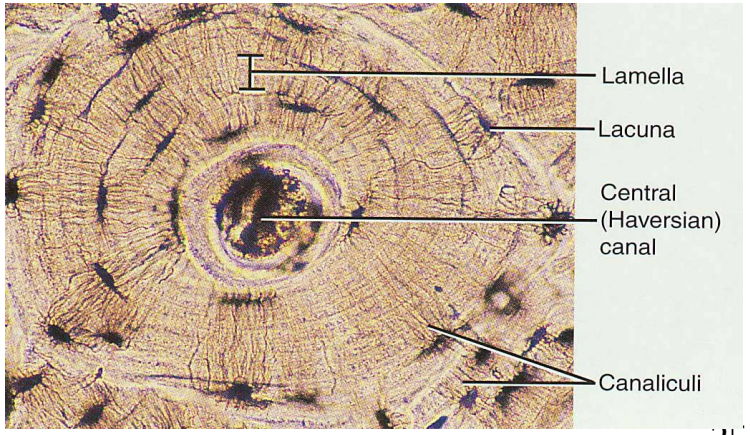


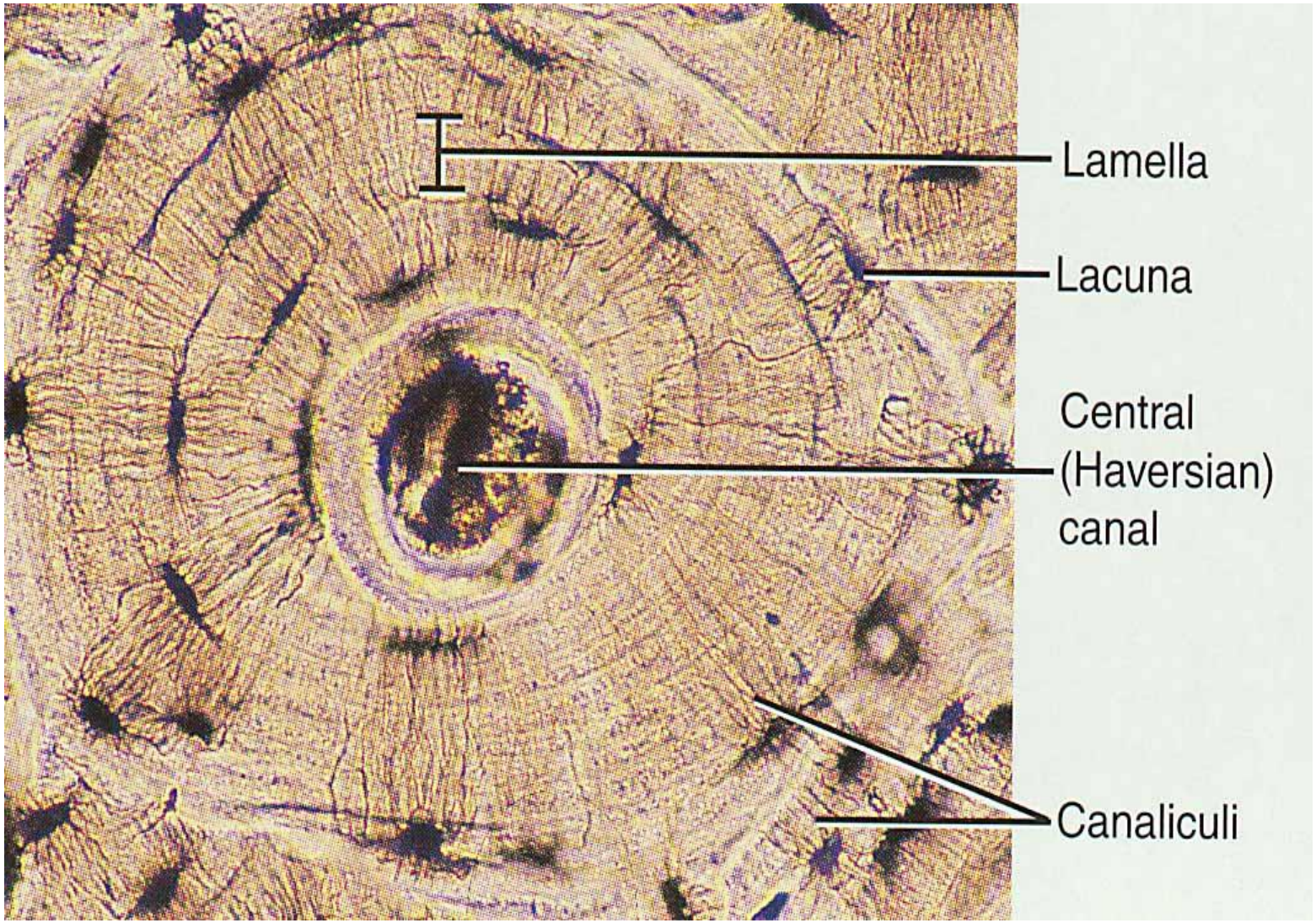


- Looks like solid hard layer of bone
- Makes up the shaft of long bones and the external layer of all bones
- Resists stresses produced by weight and movement

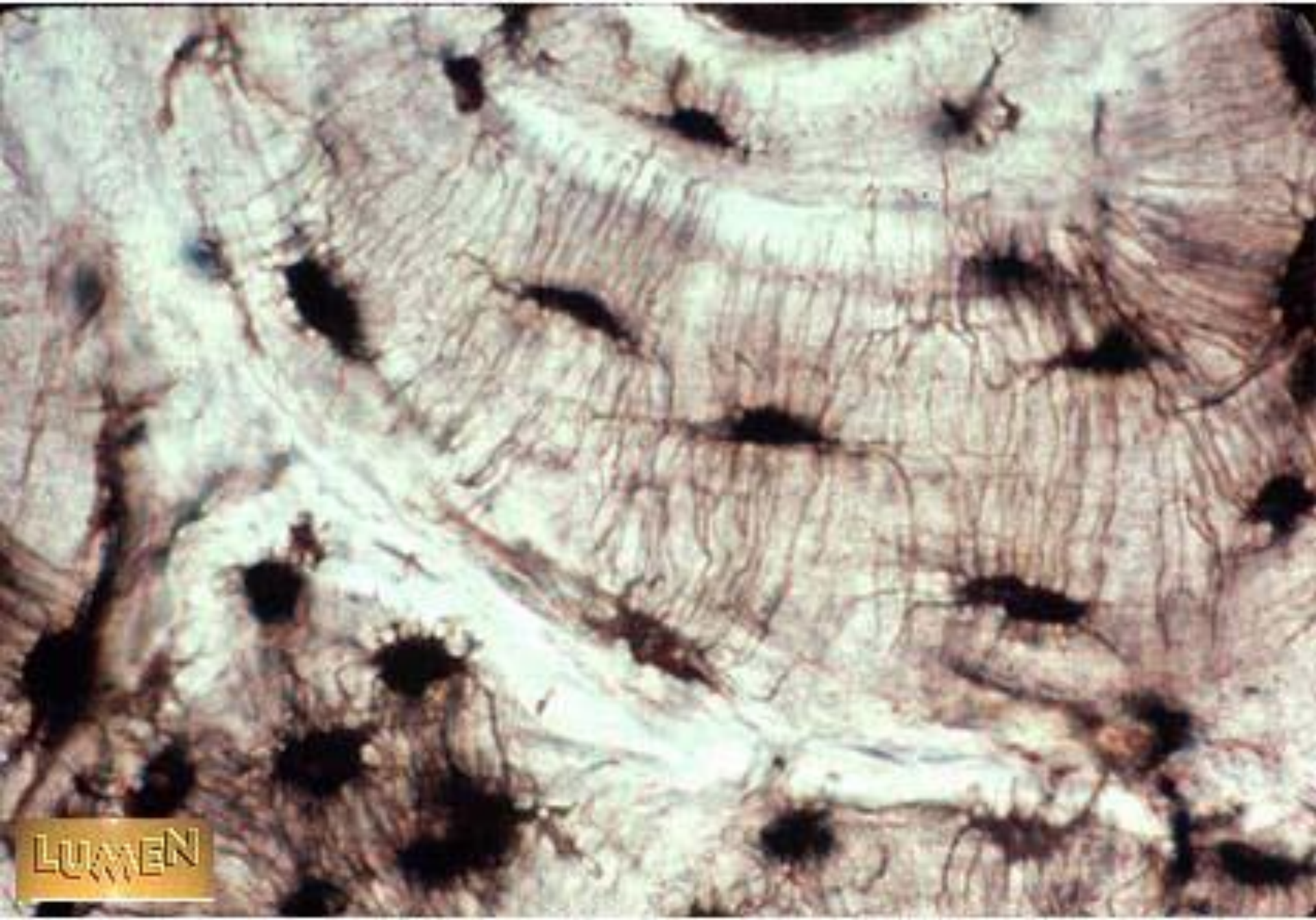
Histology of Compact Bone

- Osteon is concentric rings (lamellae) of calcified matrix surrounding a vertically oriented blood vessel
- Osteocytes are found in spaces called lacunae
- Osteocytes communicate through canaliculi filled with extracellular fluid that connect one cell to the next cell
- Interstitial lamellae represent older osteons that have been partially removed during tissue remodeling





Histology Lab Part 9: Slide 42



Spongy Bone

- Spongy (cancellous) bone does not contain osteons. It consists of trabeculae surrounding many red marrow filled spaces.
- It forms most of the structure of short, flat, and irregular bones, and the epiphyses of long bones.
- Spongy bone tissue is light and supports and protects the red bone marrow.

BONE FORMATION

- All embryonic connective tissue begins as mesenchyme.
- Bone formation is termed *osteogenesis* or *ossification* and begins when **mesenchymal** cells provide the template for subsequent ossification.
- Two types of ossification occur.
  - *Intramembranous ossification* is the formation of bone directly from or within fibrous connective tissue membranes.
  - *Endochondrial ossification* is the formation of bone from hyaline cartilage models.

Changes in the Human Skeleton

- In **embryos**, the skeleton is primarily hyaline ***cartilage***
- During development, much of this cartilage is replaced by bone
- Cartilage remains in isolated areas
  - Bridge of the nose
  - Parts of ribs
  - Joints

Factors Affecting Bone Growth

- Nutrition
  - adequate levels of minerals and vitamins
    - calcium and phosphorus for bone growth
    - vitamin C for collagen formation
    - vitamins K and B12 for protein synthesis
- Sufficient levels of specific hormones
  - during childhood need **insulinlike growth factor**
    - promotes cell division at epiphyseal plate
    - need hGH (growth), thyroid (T3 &T4) and insulin
  - sex steroids at puberty
  - At puberty the sex hormones, estrogen and testosterone, stimulate sudden growth and modifications of the skeleton to create the male and female forms.

Factors that affect Bone Growth

- EXERCISE: Within limits, bone has the ability to alter its strength in response to mechanical stress by increasing deposition of mineral salts and production of collagen fibers.
  - Removal of mechanical stress leads to weakening of bone through demineralization (loss of bone minerals) and collagen reduction.
    - reduced activity while in a cast
    - astronauts in weightless environment
    - bedridden person
  - Weight-bearing activities, such as walking or moderate weightlifting, help build and retain bone mass.

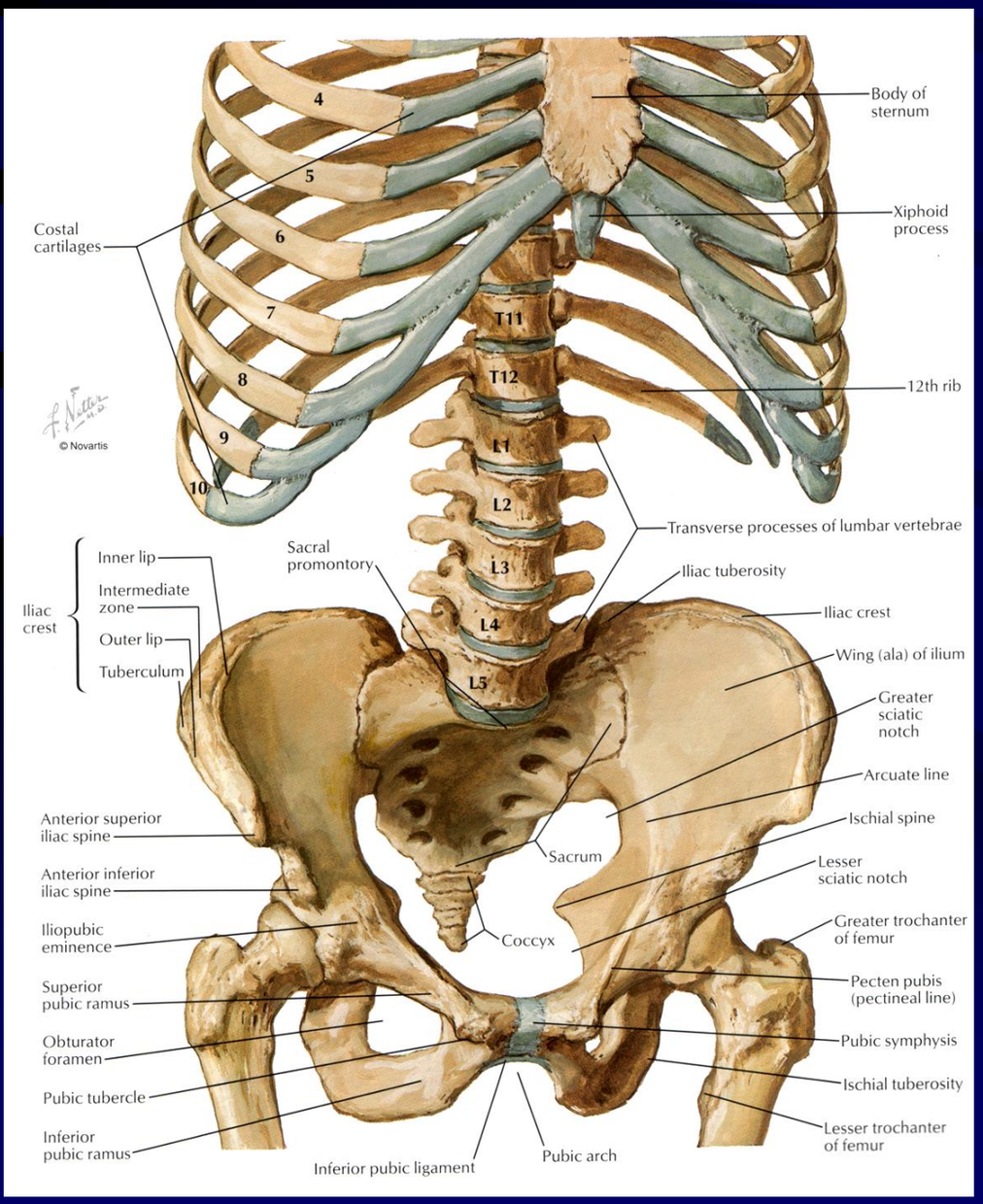
AGING AND BONE TISSUE

- By age 25, nearly all bones are completely ossified
- A single gene that codes for vitamin D docking determines both the tendency to accumulate bone mass early in life, and the risk for osteoporosis later in life

AGING AND BONE TISSUE

- In old age, bone resorption predominates
- Of two principal effects of aging on bone, the first is the loss of calcium and other minerals from bone matrix (demineralization), which may result in osteoporosis.
  - very rapid in women 40-45 as estrogens levels decrease
  - in males, begins after age 60
- The second principal effect of aging on the skeletal system is a decreased rate of protein synthesis
  - decrease in collagen production which gives bone its tensile strength
  - decrease in growth hormone
  - bone becomes brittle & susceptible to fracture

CARTILAGE



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B.Sc. M. & Ph. D. Med. Microbiology

CARTILAGE

Cartilage is a supportive tissue with firm ECM. The consistency of the tissue is hard, but bending.

In the adult this tissue is normally avascular, aneural and alymphatic.

It exists in the form of pieces of varied shape covered by the perichondrium.
The perichondrium supplies the piece of cartilage with nutrients and oxygen via diffusion.

Tissue components: cells (chondrocytes)
ECM: fibers, ground substance
Types: hyaline cartilage
elastic cartilage
fibrocartilage

CARTILAGE

A. Important for:

- support of soft tissues
- formation and growth of long bones
- durability of articular joints

B. Consists of an extracellular matrix (ground substance) containing,

- **chondroblasts** and **chondrocytes (cartilage cells)**
- **collagen and in some cases elastin fibers**
- **glycosaminoglycans**
- **proteoglycans*, proteoglycan agregates**
- **water**

***Collagen provides tensile strength and durability, however, proteoglycans are also important, e.g. if you inject papain (an enzyme that digests the protein cores of proteoglycans) into the ears of a rabbit, after a few hours the ears will loose their stiffness and droop.**

C. The qualities of the different types of cartilage depend on,

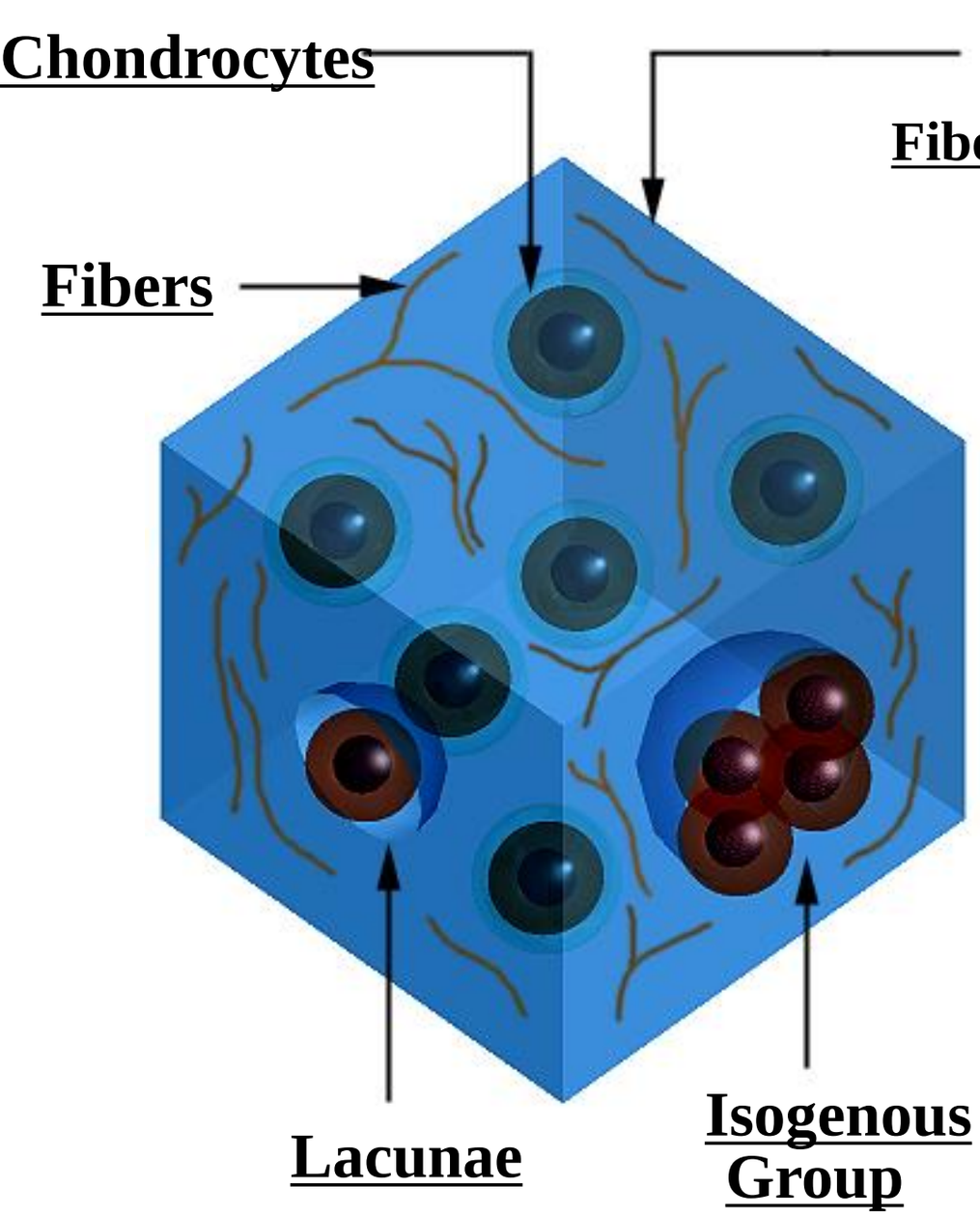
1. Differences in the type of collagen and concentration of collagen and elastin fibers in the extracellular matrix

2. The types of proteoglycan molecules that these fibers are associated with.

- D. Hyaline and elastic cartilage are surrounded by a connective tissue capsule called the perichondrium that is composed of fibroblasts and associated fibers and ground substance.
- E. The cartilage itself is devoid of blood vessels.

- Nutrition of cells within the cartilage matrix is dependent on the diffusion of nutrients from blood capillaries in perichondrium and/or adjacent tissues.

Cartilage



Fibers
(collagen Type II, elastic)

Ground Substance
(hyaluronic acid, chondroitin sulfate, keritin sulfate, 60-70% H_2O)

Properties of Cartilage

1. **Avascular**
2. **Permeable**
   (conducts nutirents and water)
3. **Flexible but Weight-Bearing**
   (resistance to compression)
4. **Elasticity and Resiliency**
5. **Resistance to Shear Forces**
6. **Slippery**
   (low friction at articular joints)
7. **Poor Regenerative Capacity**

Hyaline Cartilage

Matrix (amorphous & glassy)

- hyaluronic acid
- chondroitin sulfate
- keratin sulfate
- H_2O (60-78%)

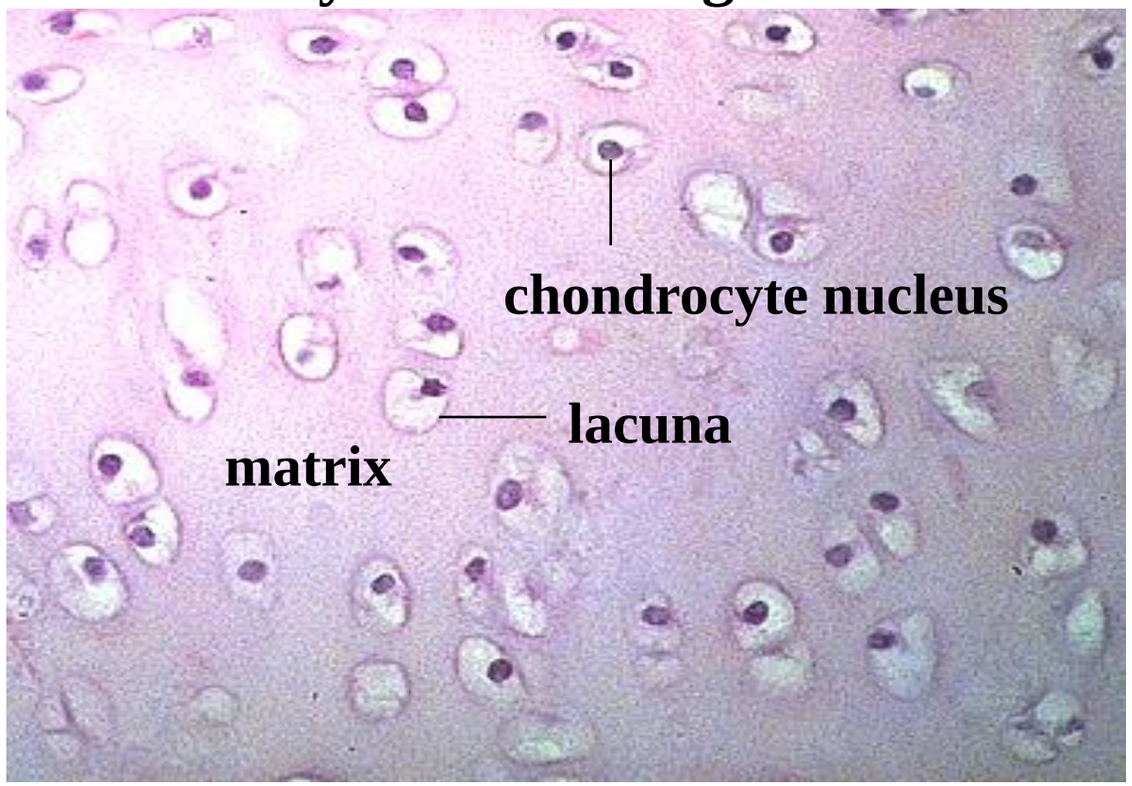
Fibers- collagenous

(invisible due to same refractive index as matrix)

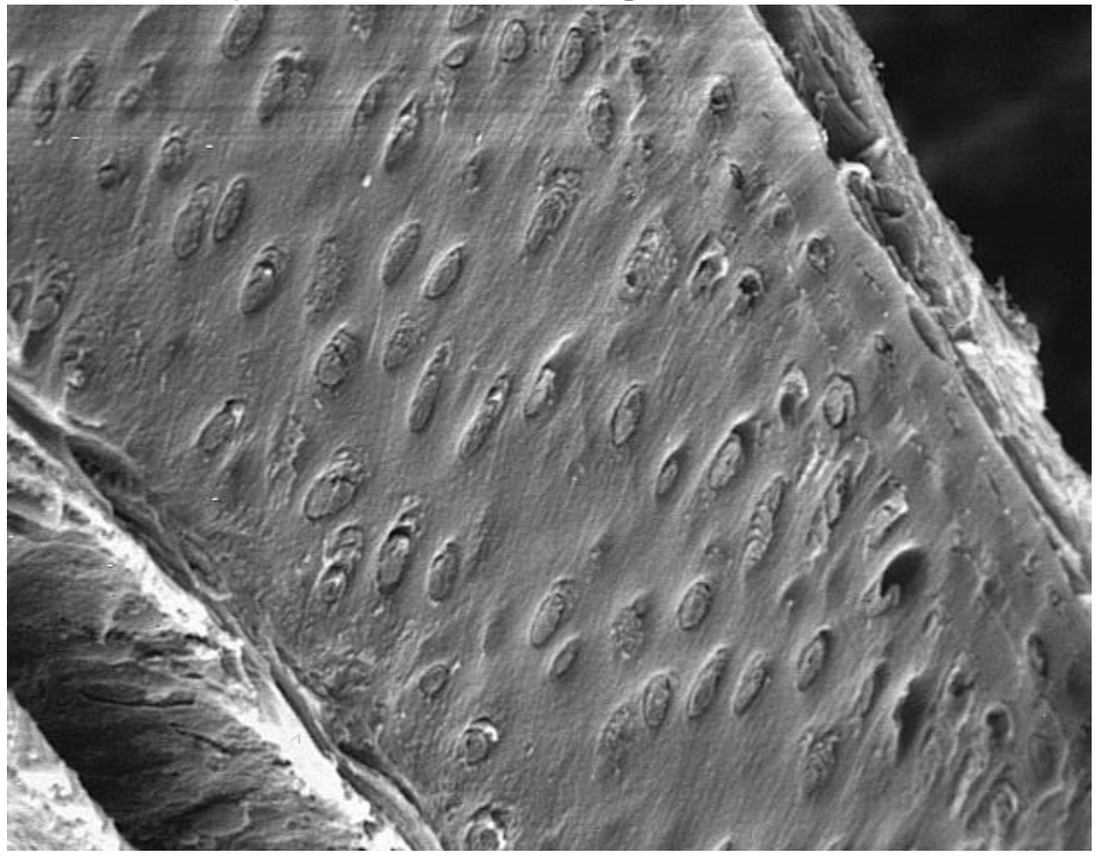
Typical Locations

- intercostals (connect ribs to the sternum)
- wall of trachea & bronchii
- articular cartilage of bone
- epiphyseal plate
- fetal axial skeleton

Hyaline Cartilage



Hyaline Cartilage (SEM)



Fibrocartilage

Matrix

hyaluronic acid
chondroitin sulfate
keratin sulfate

Fibers

dense collagenous bundles

Typical Locations

intervertebral discs
pubic symphysis

meniscus of knee joint

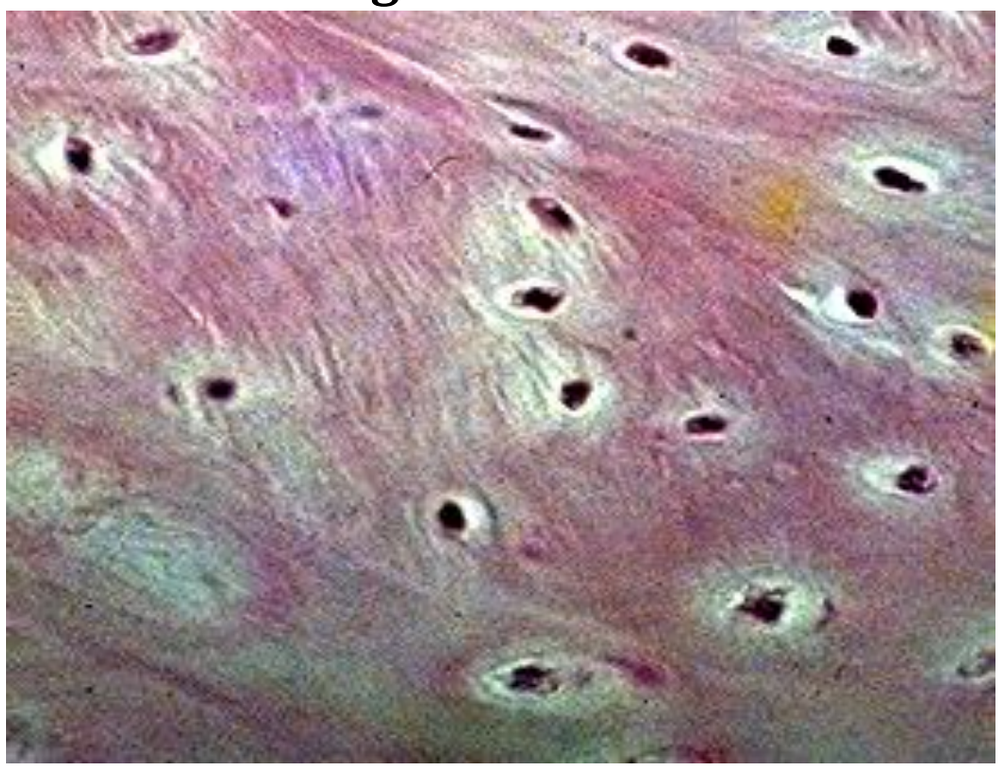
attach tendons to bone

Properties

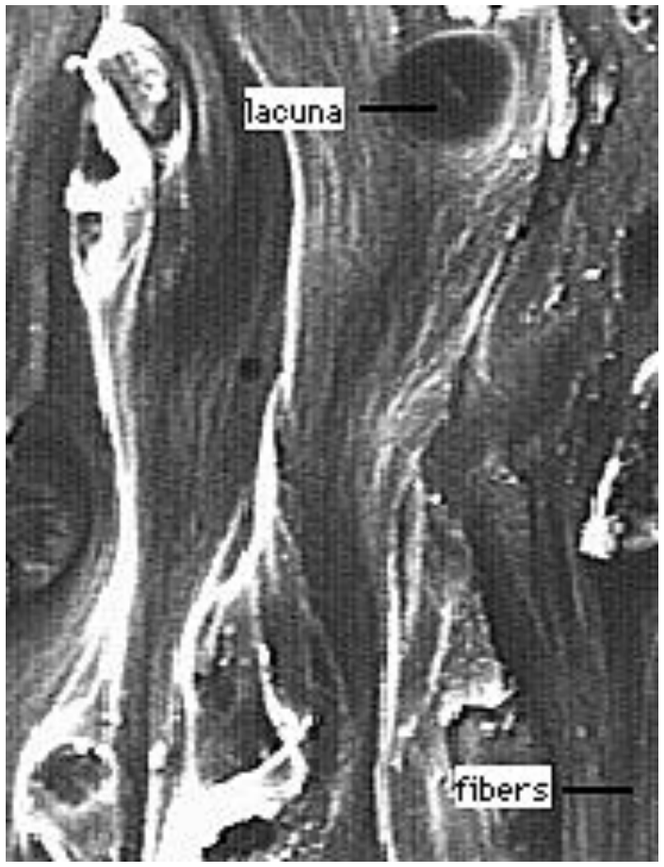
resistance to compression and shear forces

Fibrocartilage- longitudinal section

Fibrocartilage- transverse section

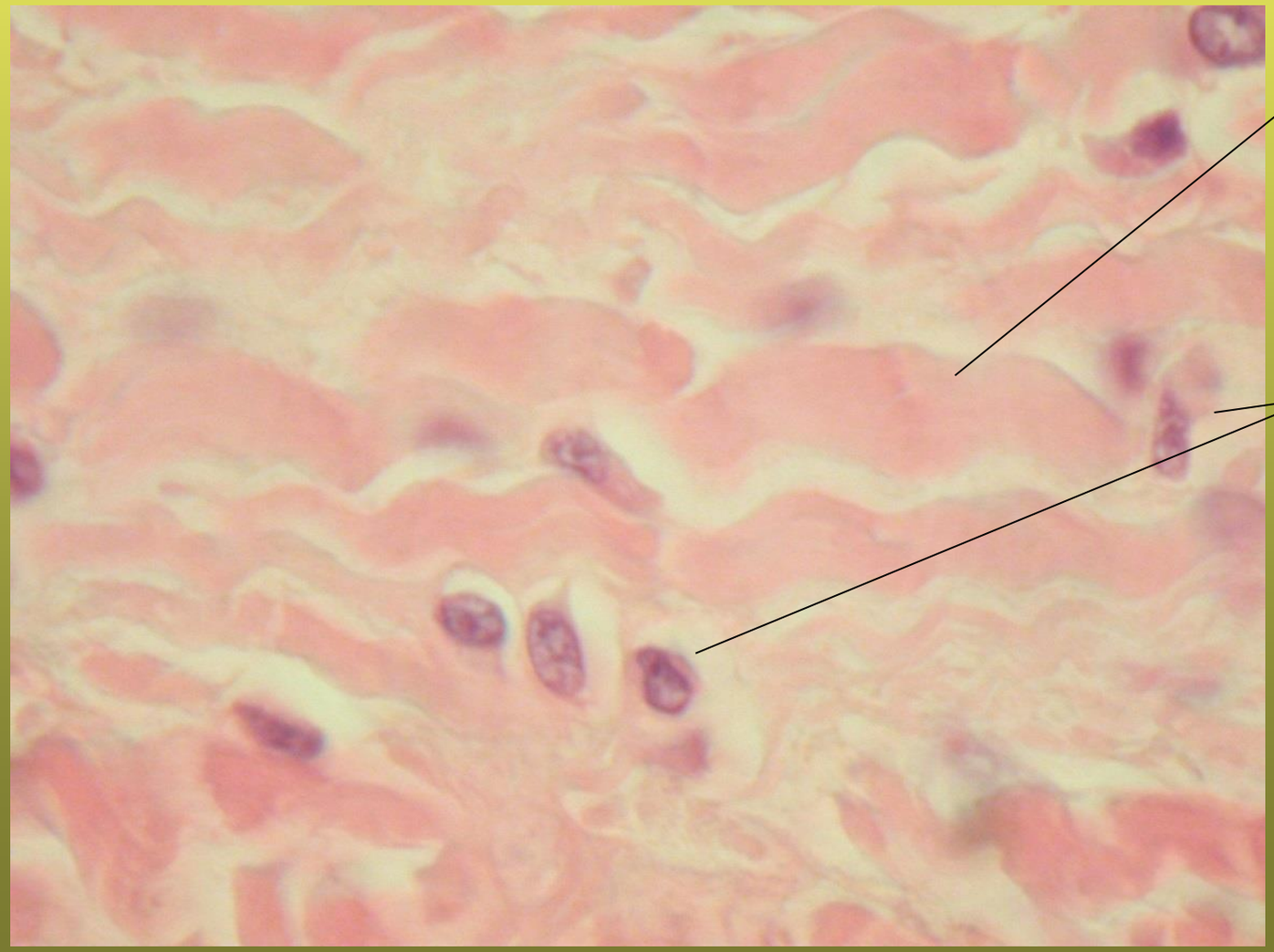


Fibrocartilage- SEM



Fibrocartilage

Occurrence: **intervertebral disks**
menisci of stifle joints
meeting of tendons and ligaments with the cartilage
dog: between the atrial and ventricular heart muscles



Elastic Cartilage

Matrix

hyaluronic acid
chondroitin sulfate
kertatin sulfate

Fibers

elastic (elastin)

Typical Locations

external ear

walls of external auditory canal and eustachian tubes

epiglottis & larynx

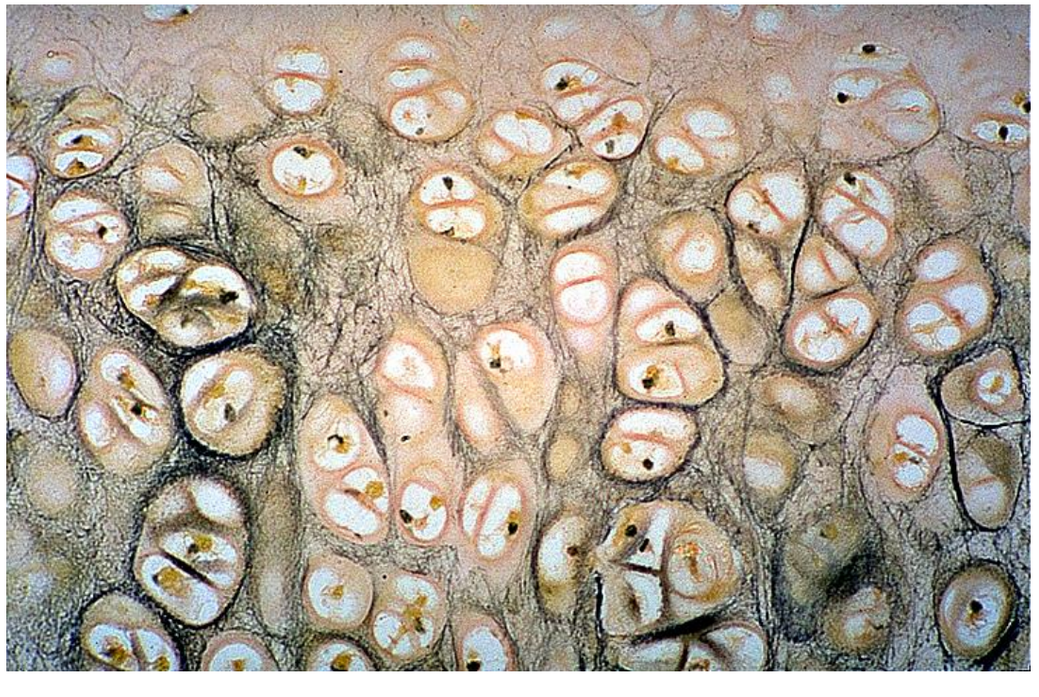
bridge of nose

Properties

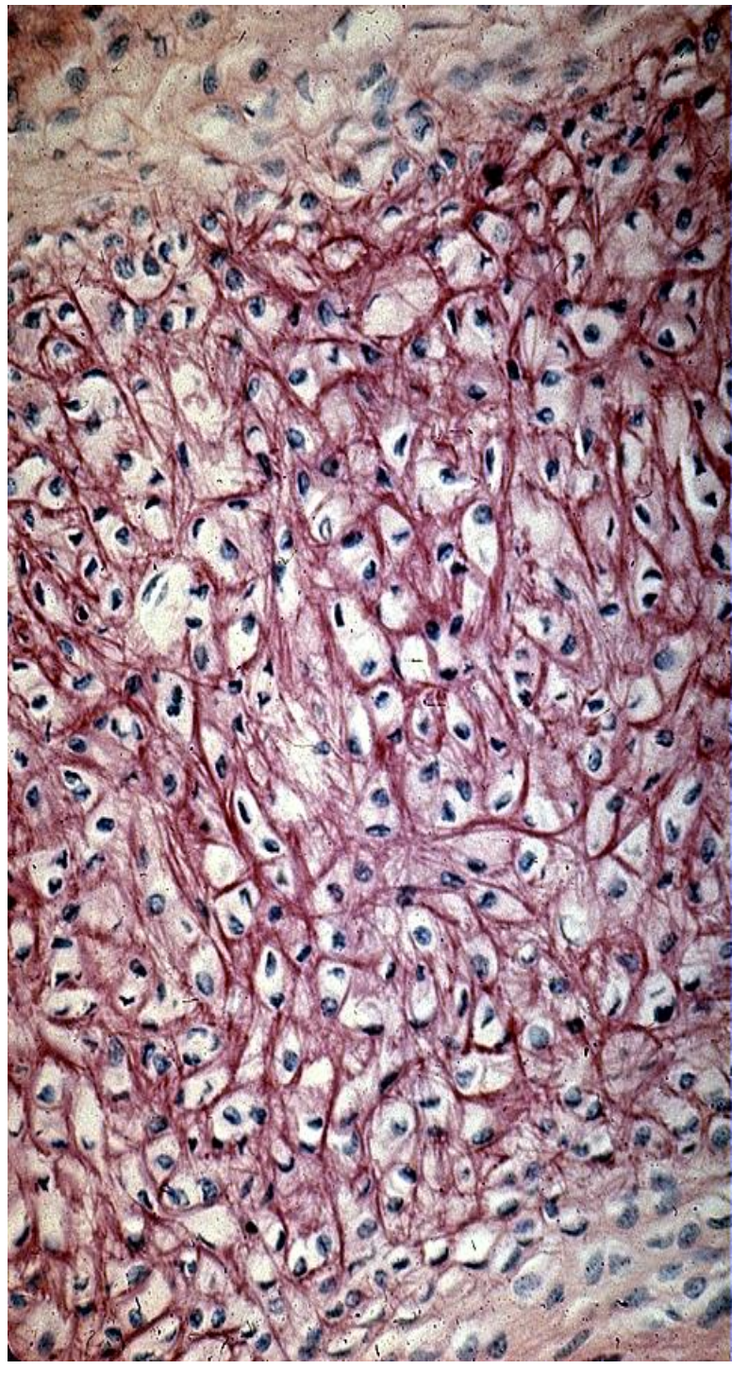
resiliency and pliability

Elastic Cartilage- pinnae of ear

Elastic Cartilage- silver stain

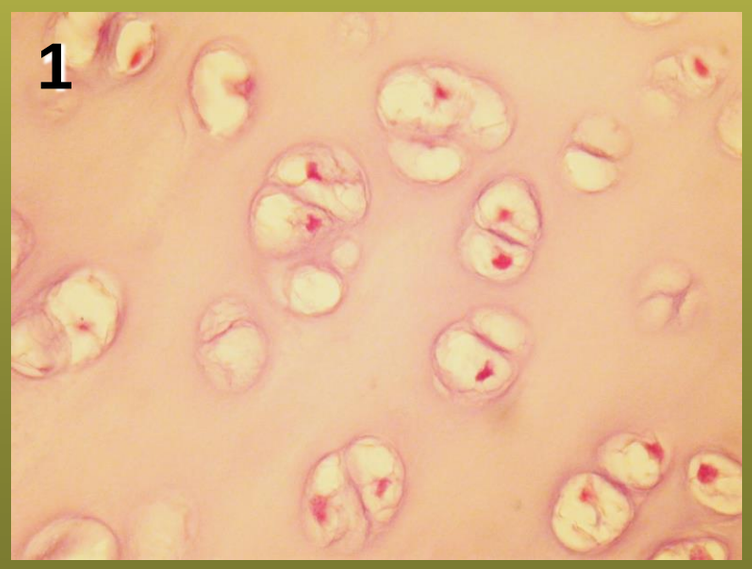


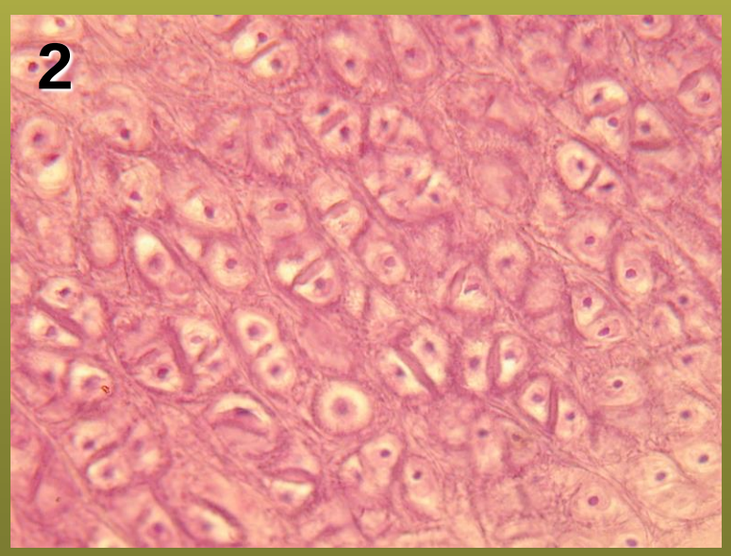
Elastic Fibers
(resorcin-fuchsin stain)

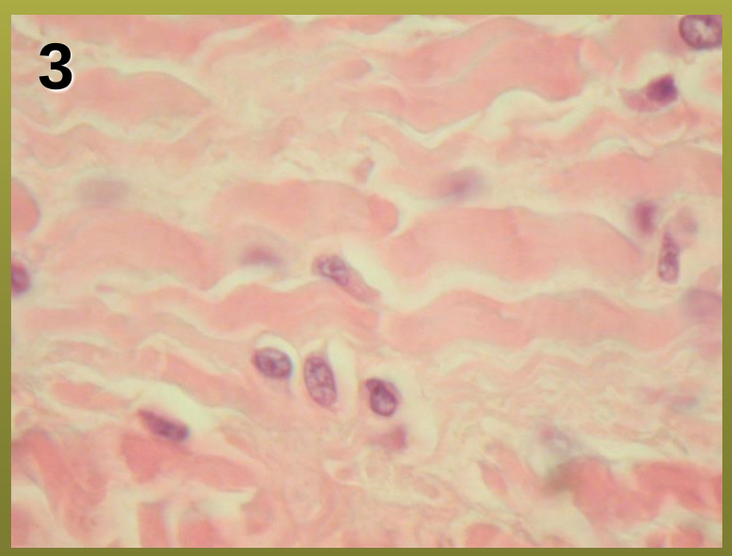


Comparison of the three cartilage-types:

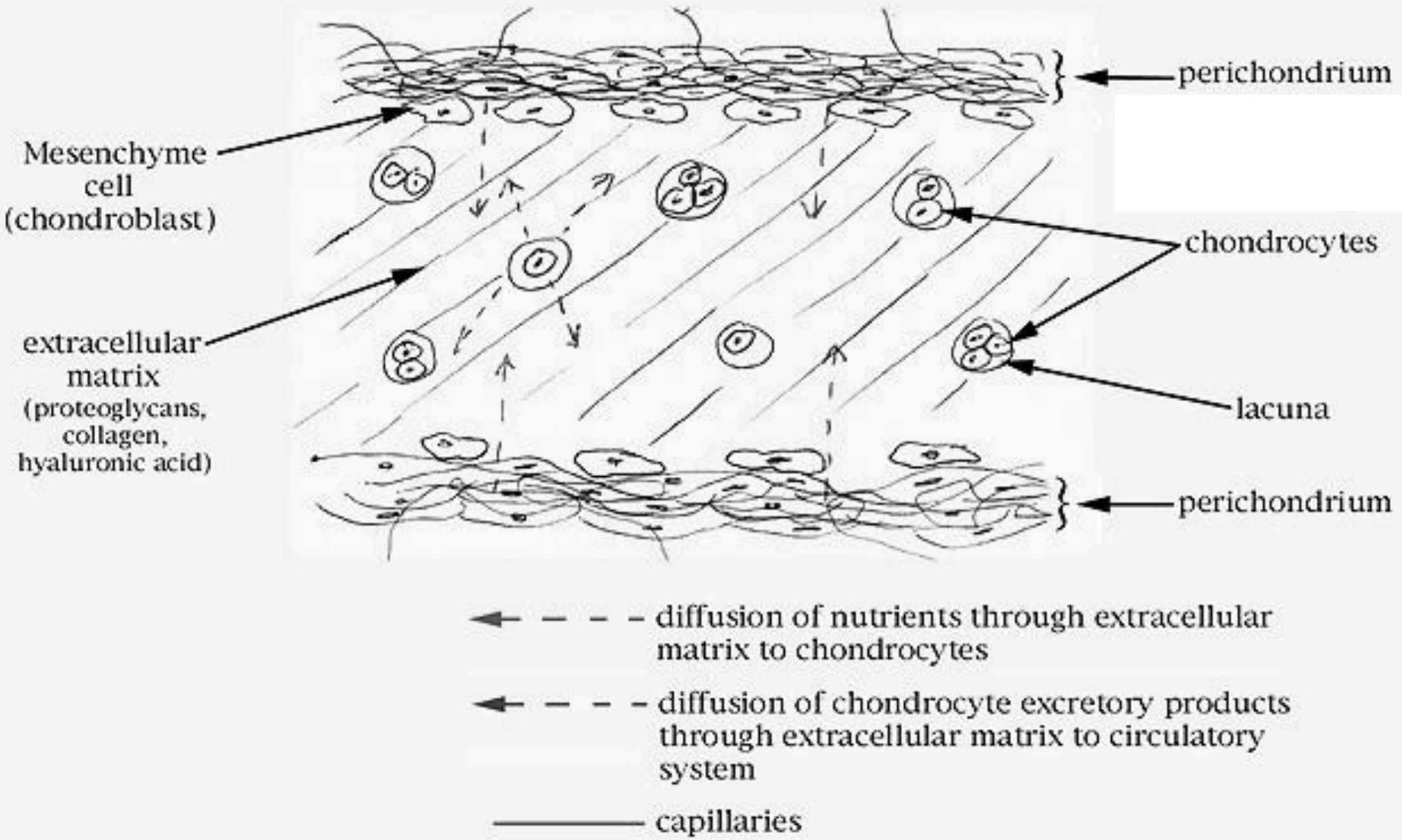
	Dominating tissue component:	Physical property:
1. Hyaline cartilage:	ground substance chondrons with many cells	tensile strength
2. Elastic cartilage:	elastic fibers chondrons with single cells	elasticity
3. Fibrocartilage:	collagen fibers very few chondrocytes	great tensile strength against pulling forces



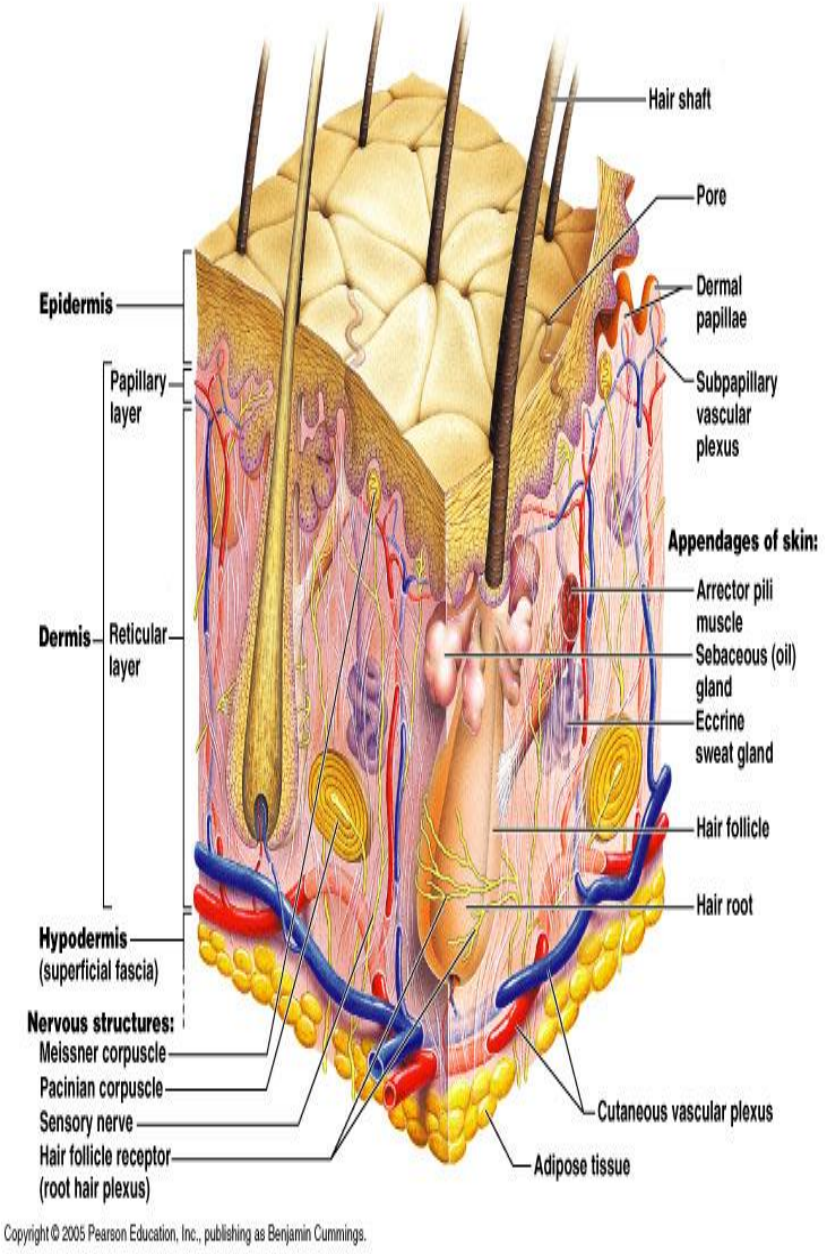




Components of Cartilage



Skin (Integumentary System)



Goals

To Describe:

the basic functions and types of skin

the layers of the epidermis and how their characteristics contribute to skin function

the cell types of the epidermis and their role in skin function

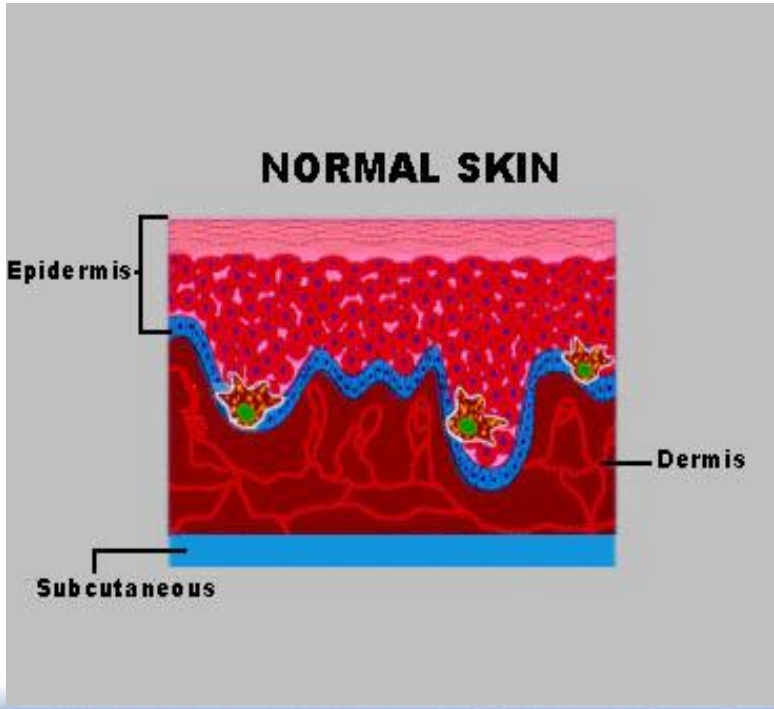
the tissues of the dermis and hypodermis and how they contribute to skin function

the morphology and function of nerve endings of the skin

the morphology and function of epidermal appendages

Skin

- Covers entire surface of body
- Consists of three layers
  - Epidermis: thin outer layer
  - Dermis: thick underlying layer
  - Hypodermis: fatty layer



Epidermis

- Consists of five sub-layers
- Basal cell layer
  - Innermost layer of epidermis
  - Contains basal cells
  - Contains melanocytes that produce melanin
    - Melanoma develops when melanocytes undergo malignant transformation
  - Contains Merkel cells

Epidermis

- Squamous cell layer
  - Resides above basal layer
  - Called stratum spinosum
  - Contains keratinocytes
  - Contains Langerhans cells
  - Is the thickest part of epidermis

Dermis

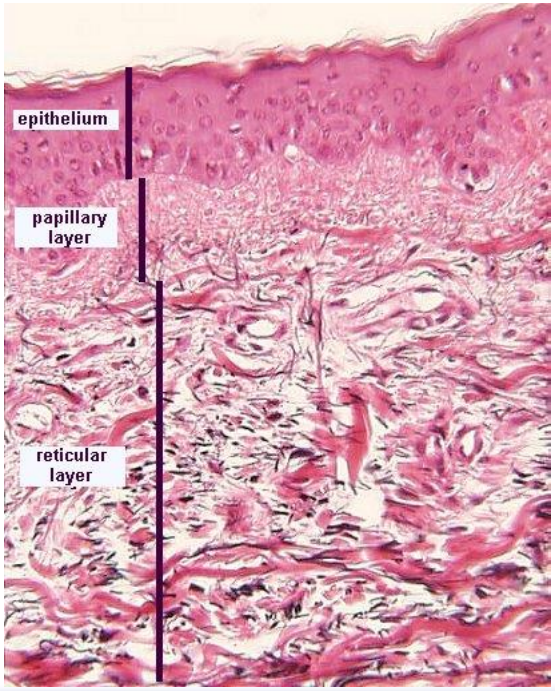
- Thickest of the three layers
- Main functions are:
  - Stores much of the body's supply of water
  - Supplies nutrients to the epidermis
  - Regulates body temperature

Dermis

- Contains specialized cells and structures
  - Blood vessels
  - Lymph vessels
  - Hair follicles
  - Sweat glands
  - Sebaceous glands
  - Nerve endings
  - Collagen

Dermis

- Papillary layer
  - Regulates body temperature
  - Supplies epidermis with nutrient-filled blood
- Reticular layer
  - Provides structure and elasticity
  - Supports components of skin



Hypodermis

- Network of fat and collagen
- Functions as:
  - Shock-absorber for body
  - Insulator
  - Stores fat as energy reserve

Functions of Skin – largest organ

Protection – barrier against UV light, mechanical force, dehydration, microbes

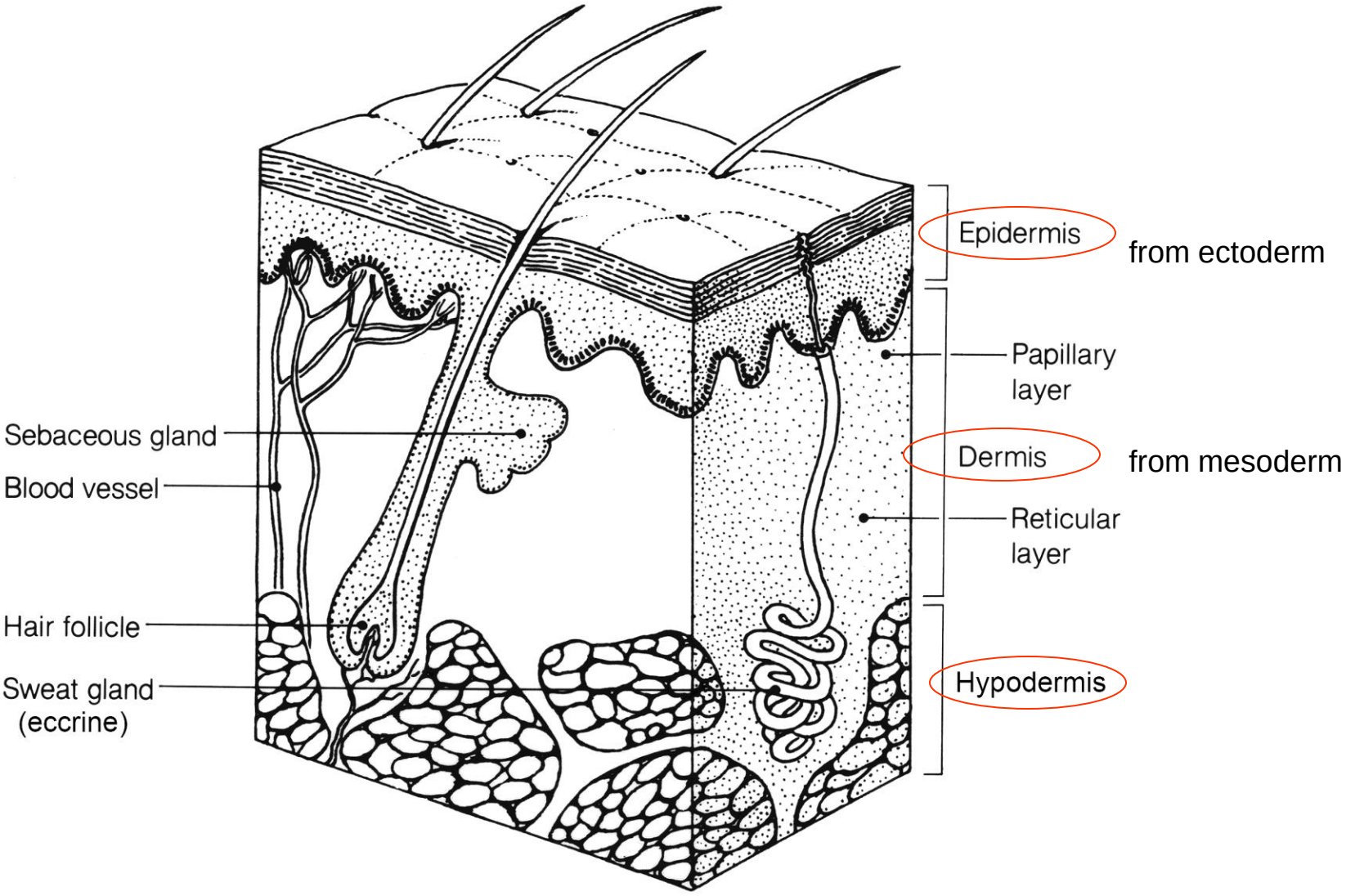
Sensation – temperature, pressure, pain, touch

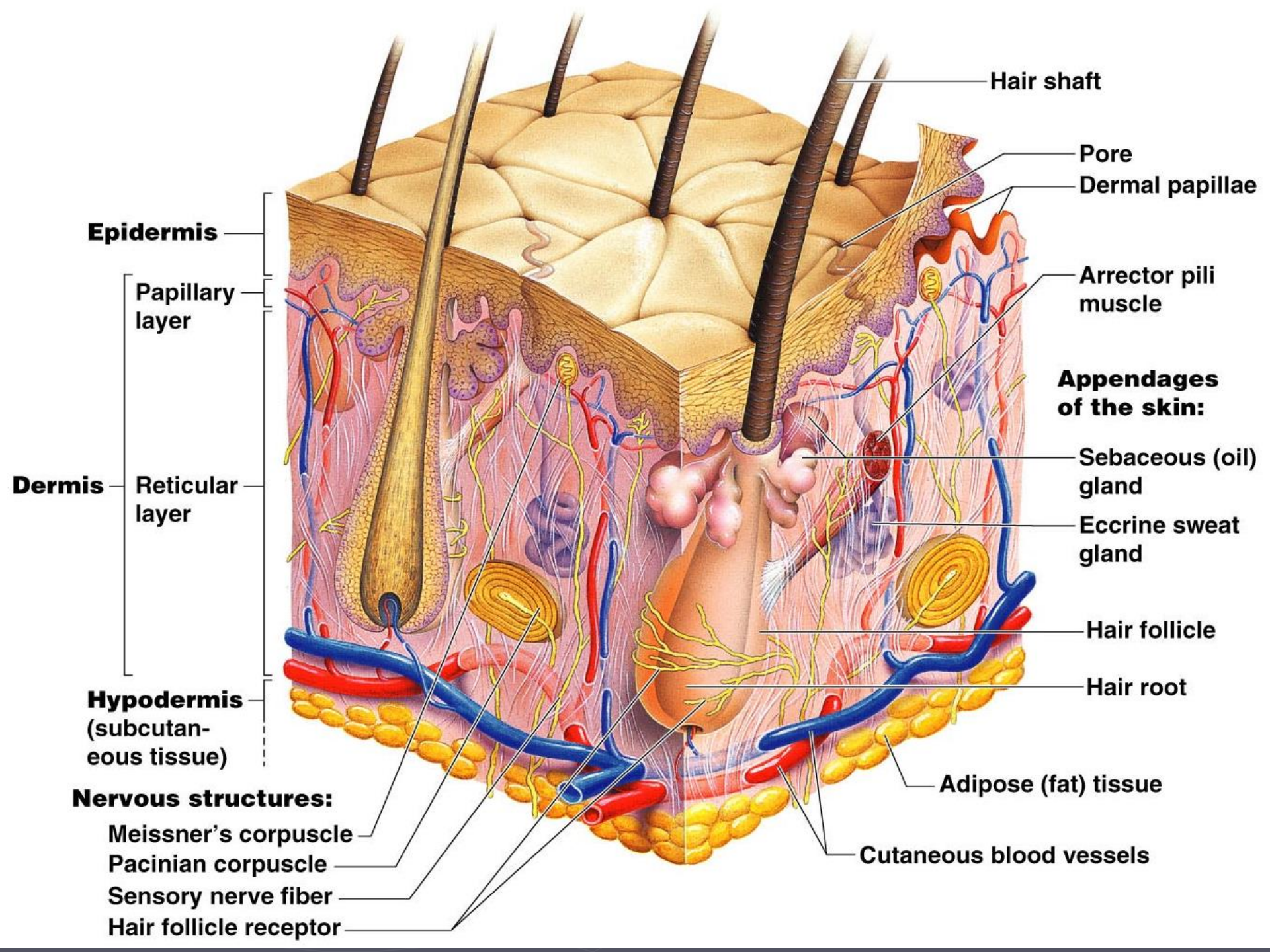
Thermoregulation – insulated by hair and adipose tissue, sweat, changes in blood flow

Metabolism – storage of fat in adipose tissue, vitamin D production, milk production

Communication – blushing, apocrine sweat glands, raising of hairs (animals)

Layers of Skin



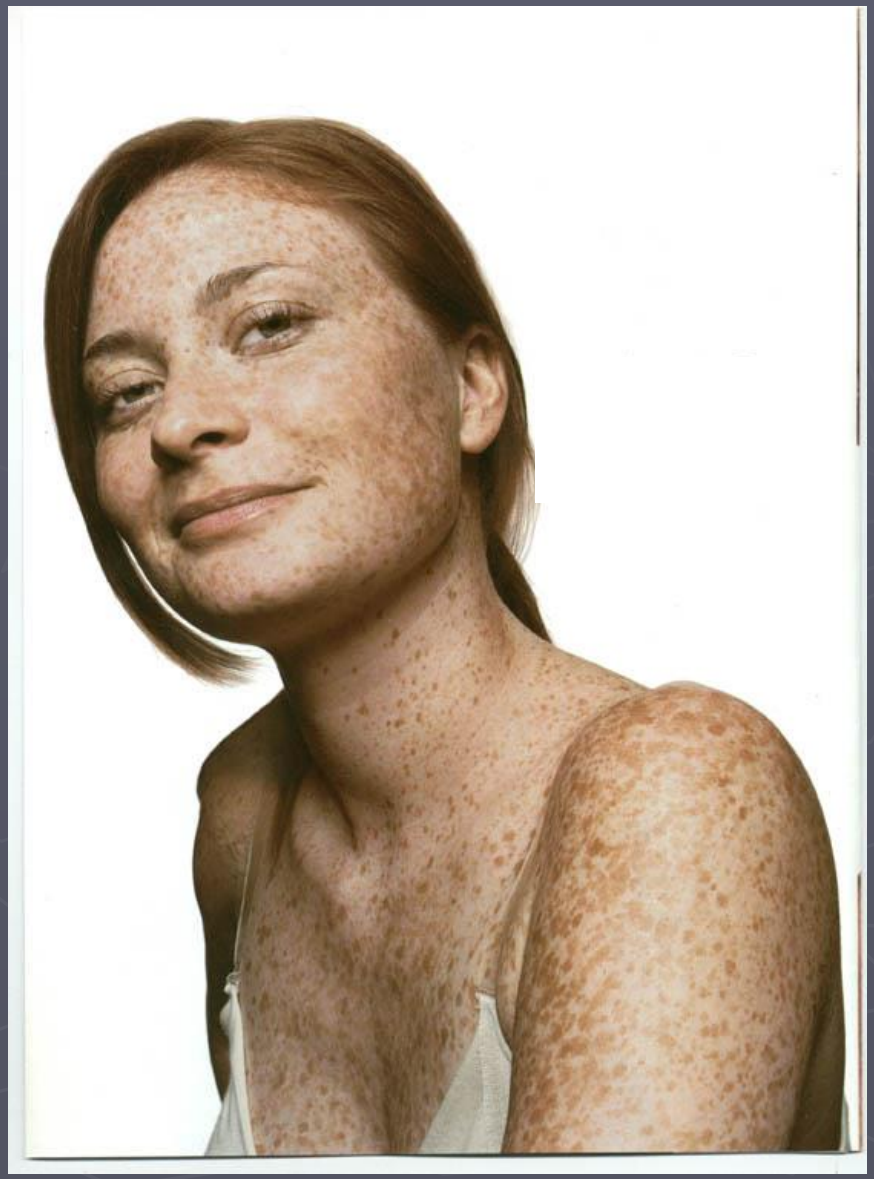

Hair shaft
Pore
Dermal papillae
Epidermis
Papillary layer
Arrector pili muscle
Appendages of the skin:
Dermis
Reticular layer
Sebaceous (oil) gland
Eccrine sweat gland
Hair follicle
Hypodermis (subcutaneous tissue)
Hair root
Adipose (fat) tissue
Nervous structures:
Meissner's corpuscle
Pacinian corpuscle
Sensory nerve fiber
Hair follicle receptor
Cutaneous blood vessels

Melanin

- Pigment (melanin) produced by melanocytes
- Melanocytes are mostly in the stratum basale
- Color is yellow to red to brown to black
- Amount of melanin produced depends upon genetics and exposure to sunlight

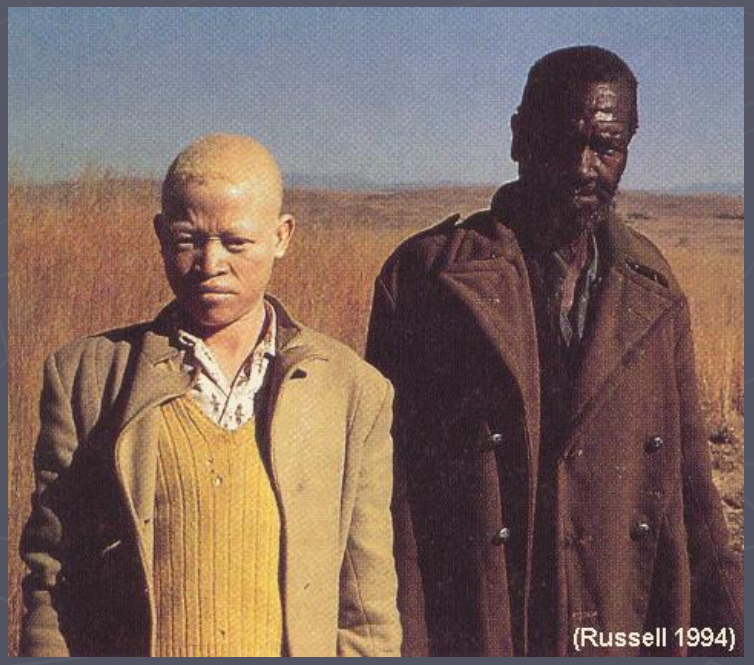
Melanin continued….

- Large amounts of melanin occur in some regions like freckles, moles, and nipples.
- Less melanin occurs in the lips, hands, and soles of the feet.
- All races have the same number of melanoctyes! The amount of melanin produced is determined by genetics.



Albinism

- A single mutation can cause a deficiency or complete absence of melanin.
- Albinos have fair skin, white hairs, and unpigmented eyes

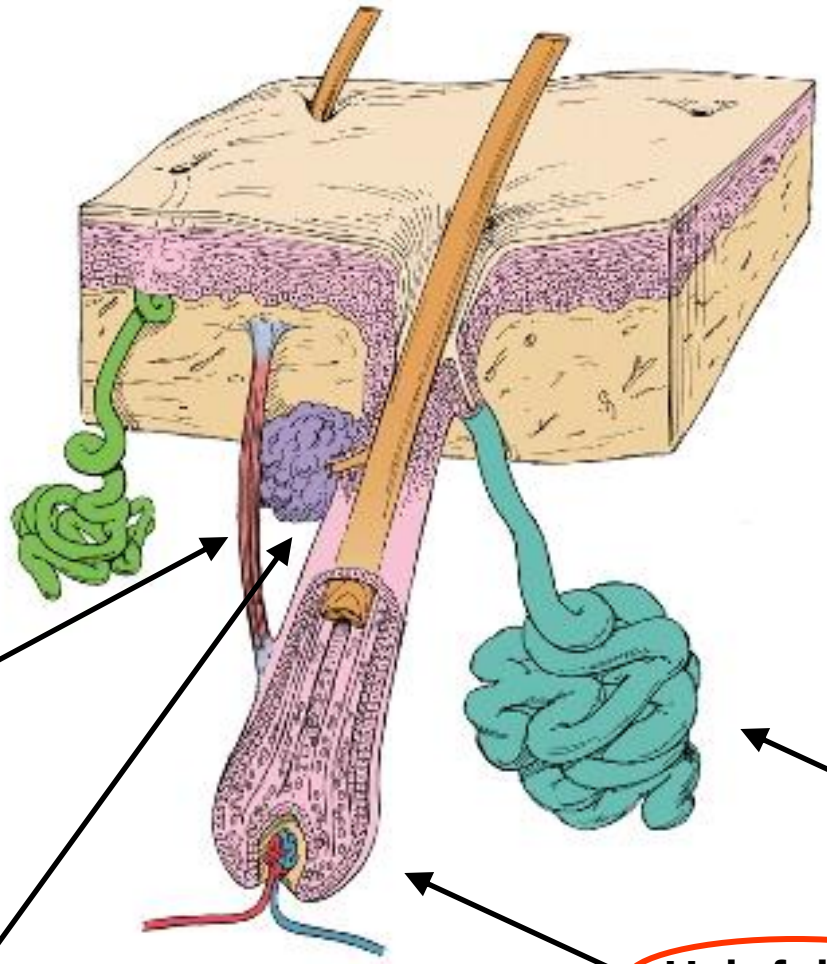


Skin appendages

- Derived from epidermis but extend into dermis
- Include
  - Hair and hair follicles
  - Sebaceous (oil) glands
  - Sweat (sudoiferous) glands
  - Nails

Epidermal Appendages

***also nails and mammary glands**



Eccrine Sweat gland

Arrector pili muscle

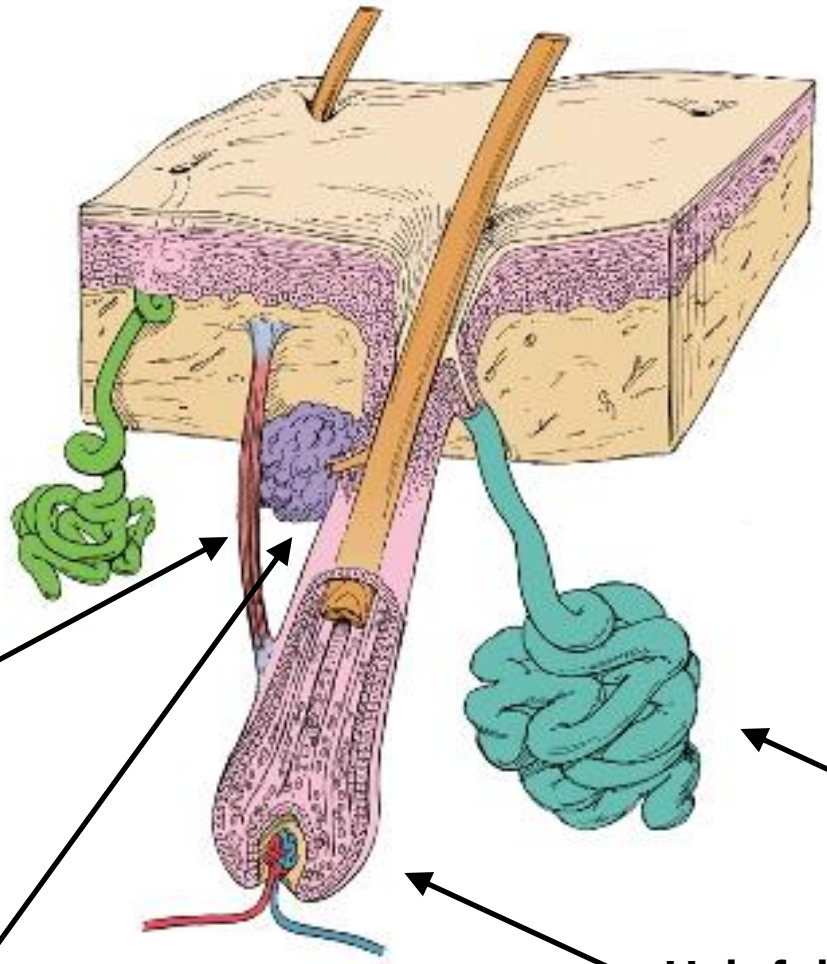
Sebaceous gland

Hair follicle

Apocrine Sweat gland

Epidermal Appendages

***also nails and mammary glands**



Eccrine Sweat gland

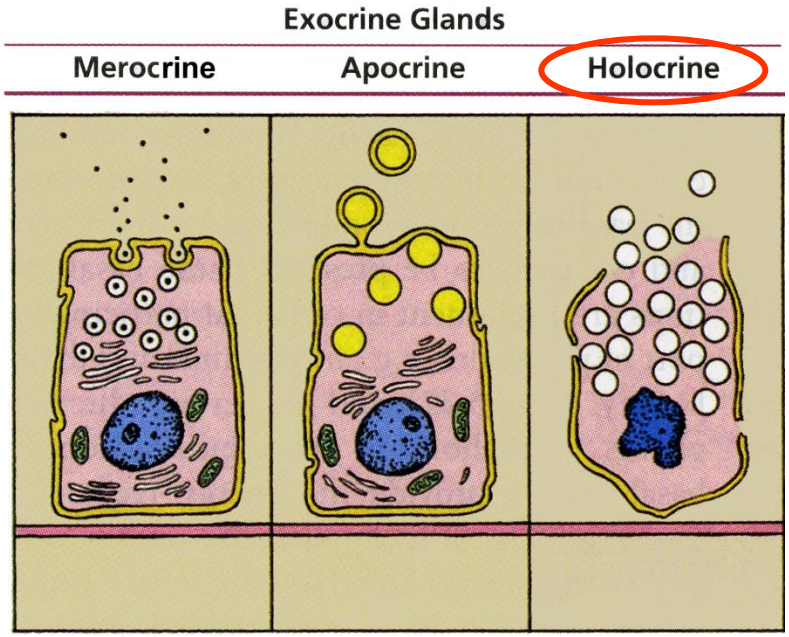
Arrector pili muscle

Sebaceous gland

Hair follicle

Apocrine Sweat gland

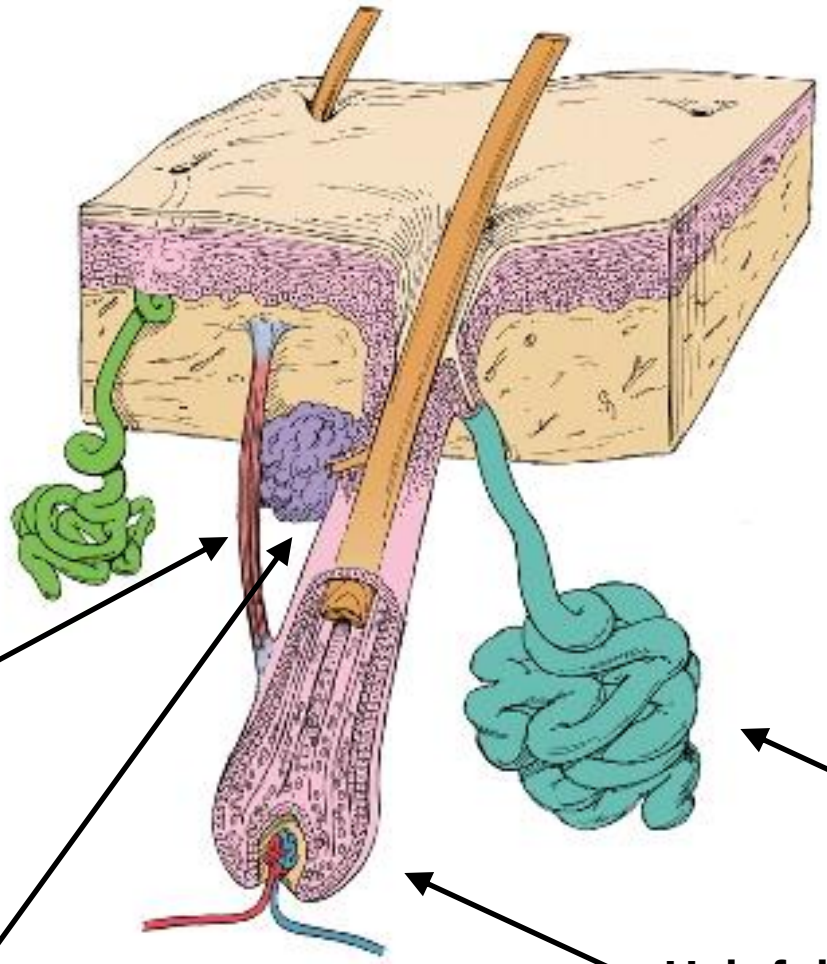
Sebaceous glands



sebocytes secrete sebum: triglycerides, fatty acids, waxes

Epidermal Appendages

***also nails and mammary glands**



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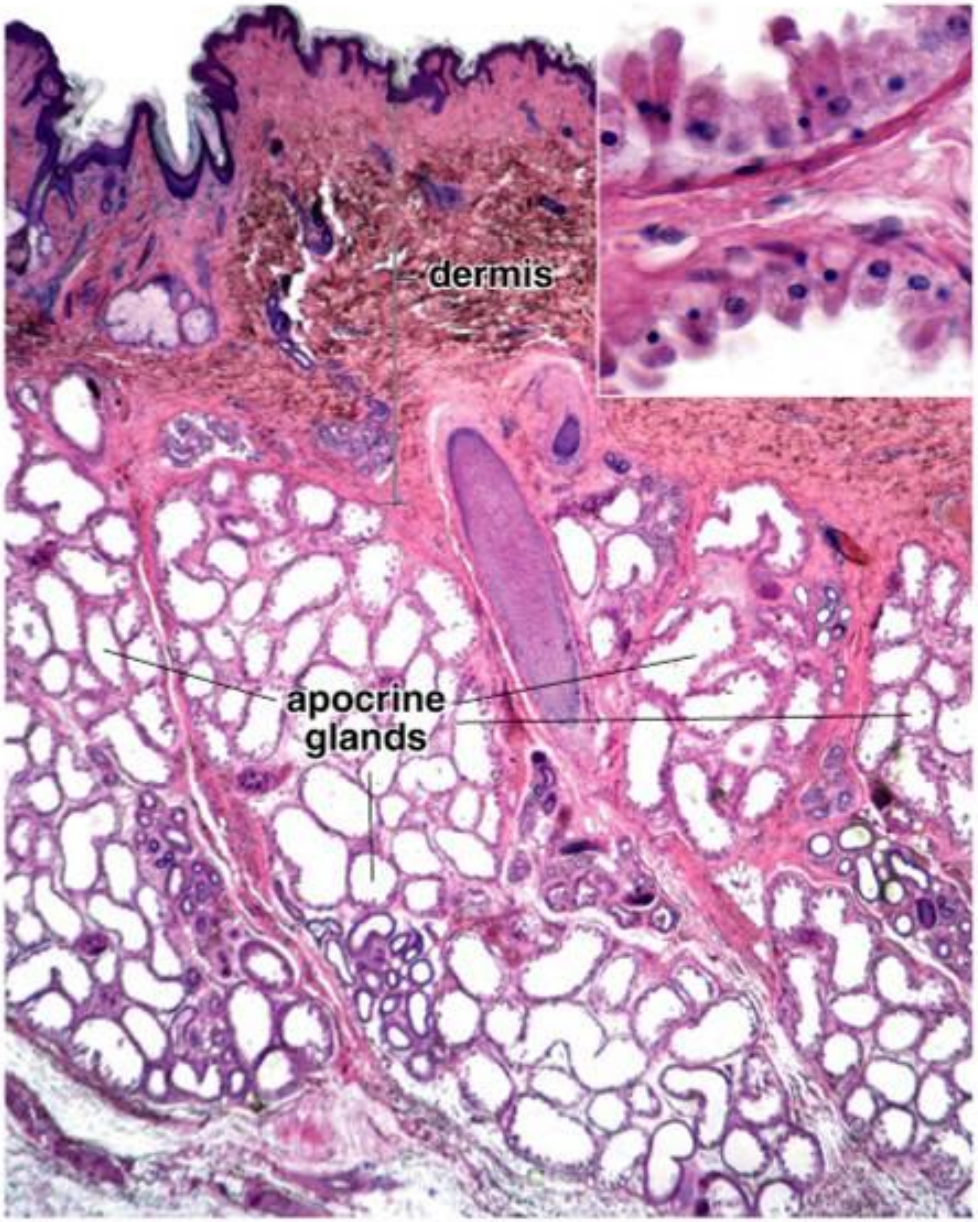
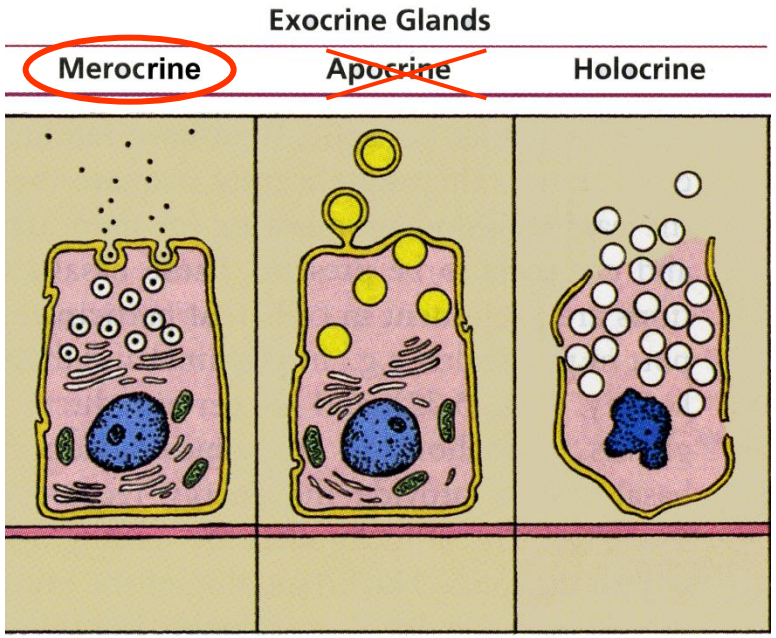
Sebaceous gland

Hair follicle

Apocrine Sweat gland

Apocrine Sweat Glands

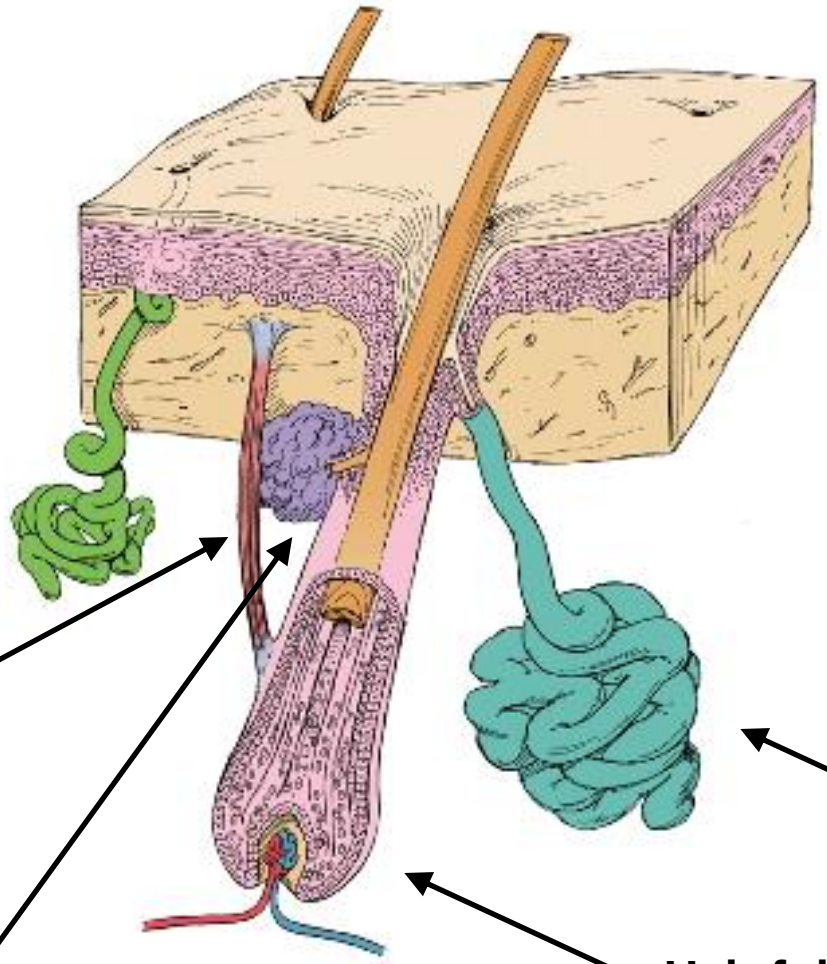




secrete a mixture of carbs, lipids, protein and ammonia

Epidermal Appendages

***also nails and mammary glands**



Eccrine Sweat gland

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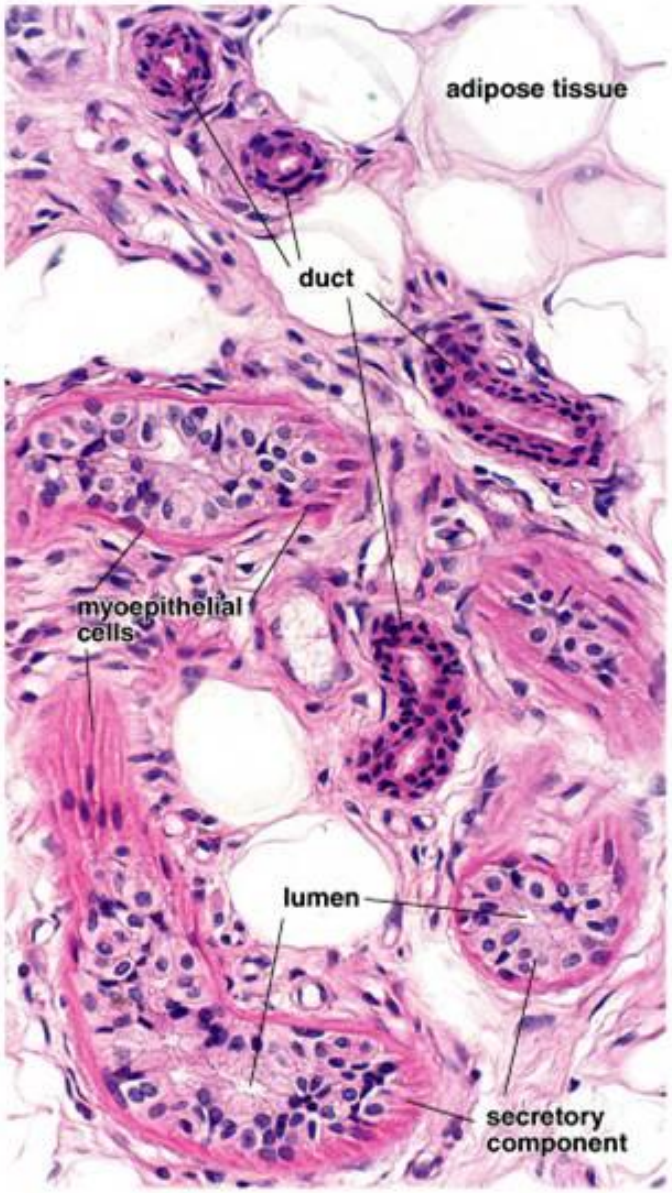
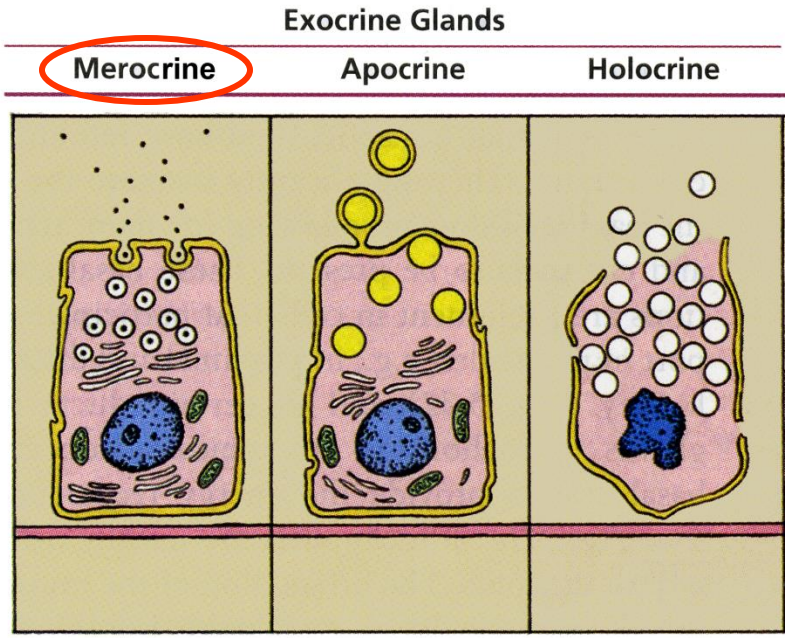
Apocrine Sweat gland

Eccrine Sweat Glands





Major Points

The dermis is a dense irregular connective tissue with dermal papillae that contain capillaries

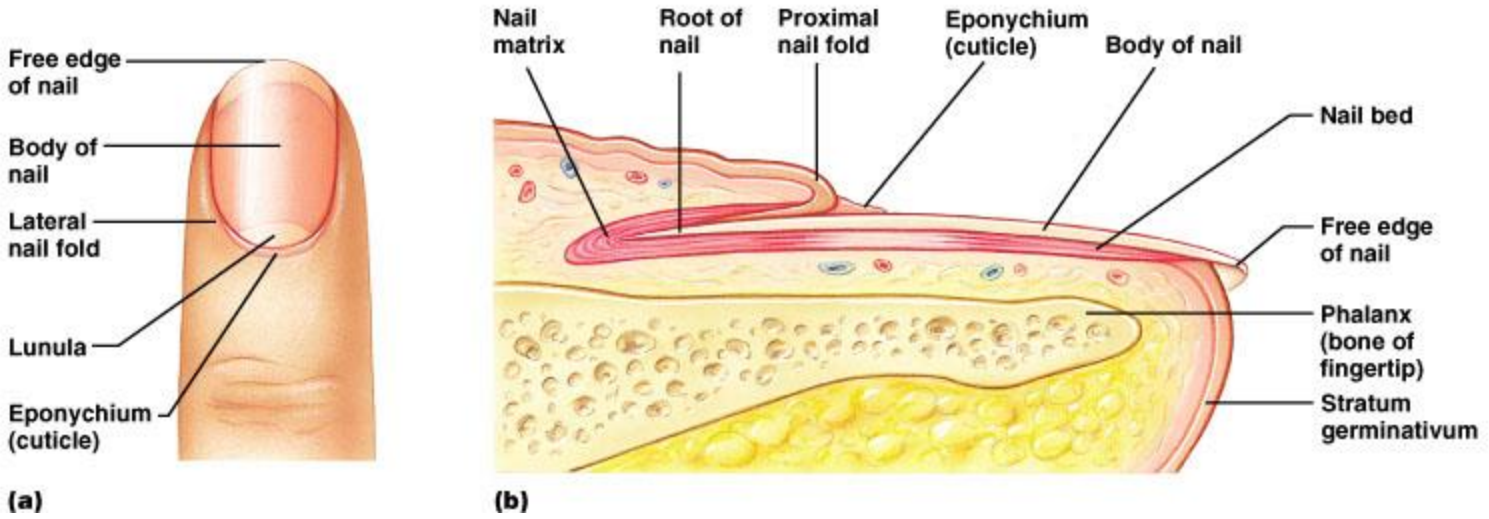
Many types of nerve endings are found in different parts of the skin

Epidermal appendages are derived from the epidermis and include hair follicles, apocrine sweat glands, eccrine sweat glands, and sebaceous glands

The hypodermis is a fatty connective tissue layer that surrounds some epidermal appendages

Nails

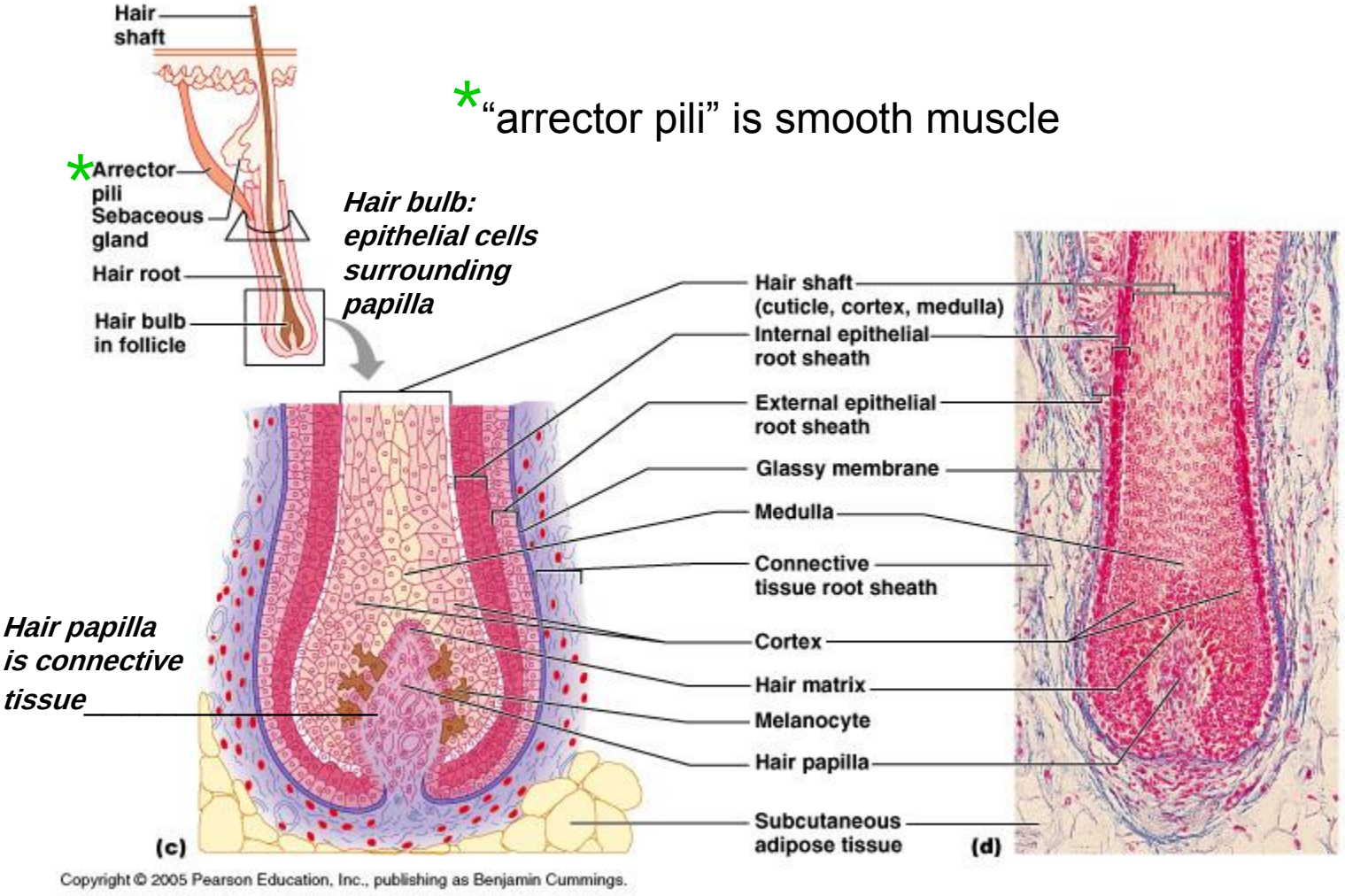
- Of hard keratin
- Corresponds to hooves and claws
- Grows from nail matrix



Hair and hair follicles: complex

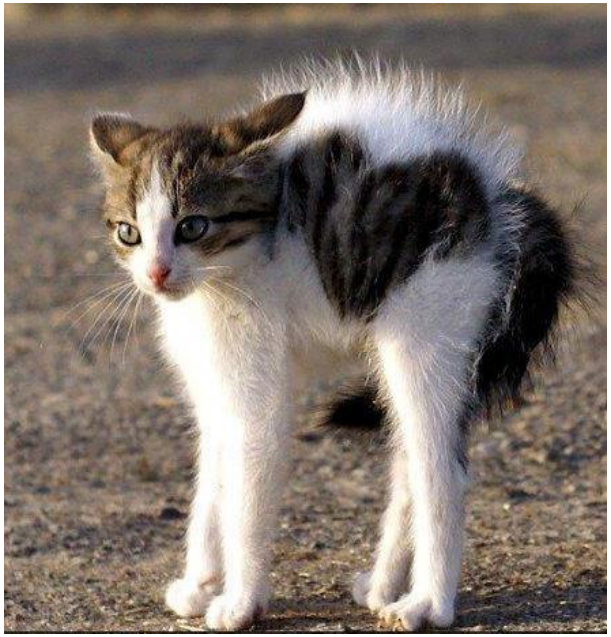
Derived from epidermis and dermis

Everywhere but palms, soles, nipples, parts of genitalia



*"arrector pili" is smooth muscle

Arrector Pili Muscle



Disorders of the integumentary system

- Burns
  - Threat to life
    - Catastrophic loss of body fluids
    - Dehydration and fatal circulatory shock
    - Infection
  - Types
    - First degree – epidermis: redness (e.g. sunburn)
    - Second degree – epidermis and upper dermis: blister
    - Third degree - full thickness
- Infections
- Skin cancer

Burns

First-degree
(epidermis only; redness)

(b)

Second-degree
(epidermis and dermis,
with blistering)

(c)

Third-degree
(full thickness, destroying
epidermis, dermis, often part
of hypodermis)

(d)

Tumors of the skin

- Benign, e.g. warts
- Cancer – associated with UV exposure (also skin aging)
  - Aktinic keratosis - premalignant
  - Basal cell - cells of stratum basale
  - Squamous cell - keratinocytes
  - Melanoma – melanocytes: most dangerous; recognition:
    - A - **A**symmetry
    - B - **B**order irregularity
    - C - **C**olors
    - D - **D**iameter larger than 6 mm

Skin Cancer

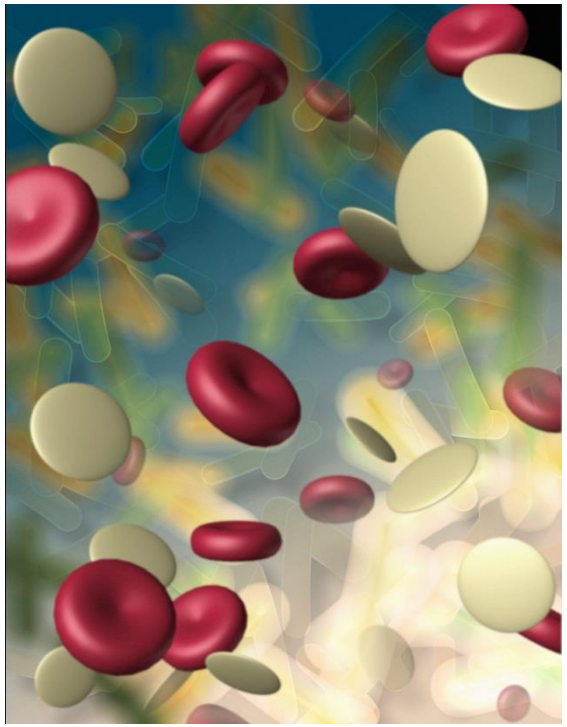
(a) Basal cell carcinoma

(b) Sqaumous cell carcinoma

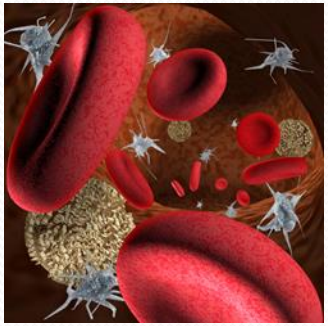
(c) Melanoma

BLOOD

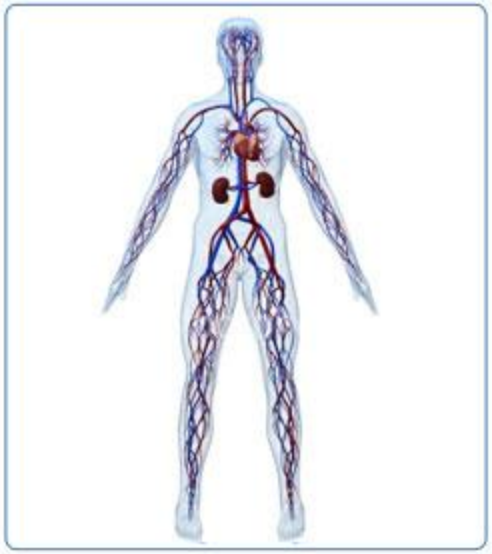
The Structure and Function of Blood

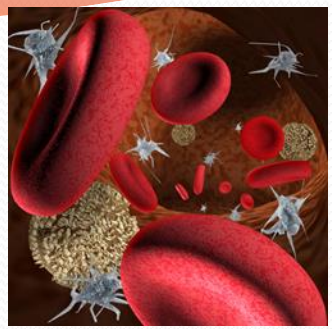


Composition of Blood



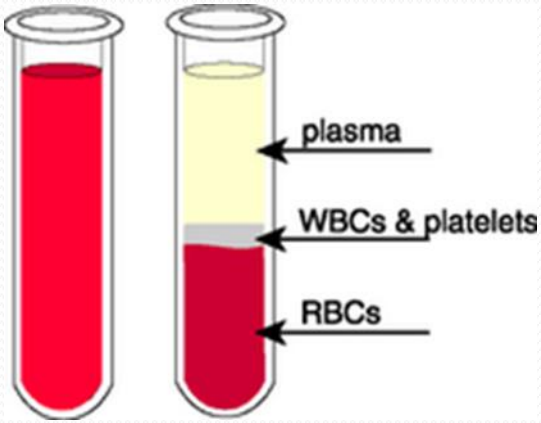
- Blood is responsible for…..
  - Transporting gases (oxygen & carbon dioxi
  - Transporting waste products
  - Transporting nutrients
  - Helping remove toxins from the body

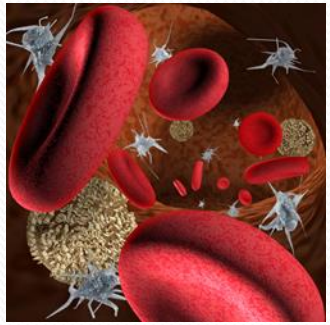




- Blood makes up 6–8% of our total body weight.

- Normal adult blood volume is 5 L.
- Blood is made up of cellular material in a fluid called plasma.

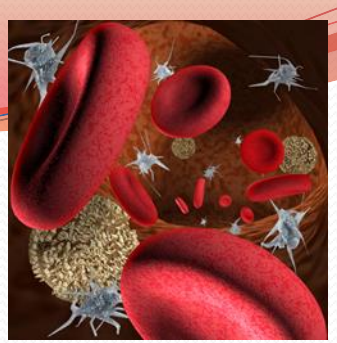




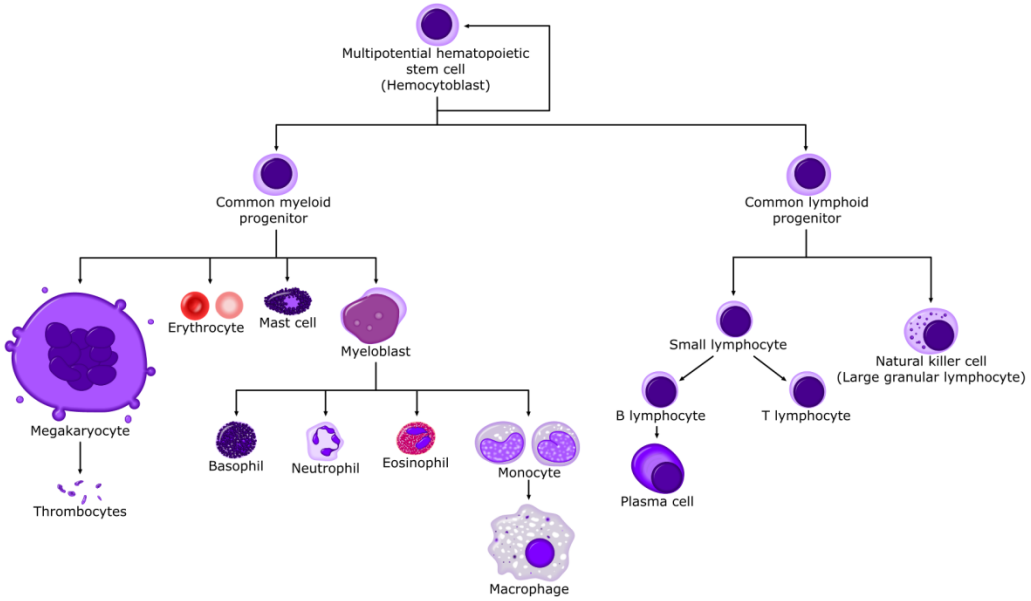
- Blood is a circulating tissue consisting of three types of cells.
  1. Red Blood Cells → Erythrocytes
  2. White Blood Cells → Leukocytes
  3. Platelets → Thrombocytes

- The cells listed above are suspended in a liquid known as plasma.

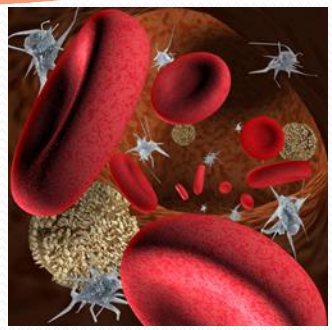
Formation of Blood



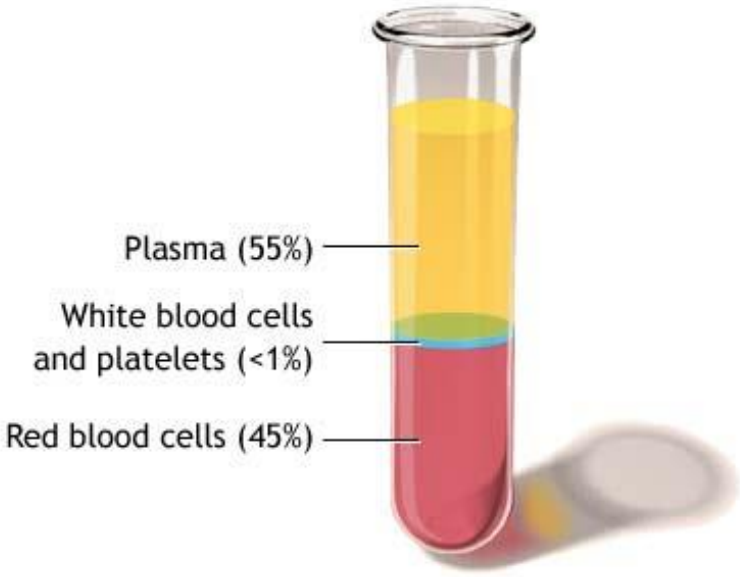
- Hematopoiesis → the formation and development of blood cells
- In adults the cellular elements are produced in the bone marrow.
- Some WBCs are produced in the lymphatic tissue and bone marrow.
- Blood cells need certain nutrients to form properly.
- Examples include…..
  - Iron
  - Folic acid
  - Vitamin B12
- All blood cells formed come from a hematopoietic stem cel
- These cells can become any blood cell.



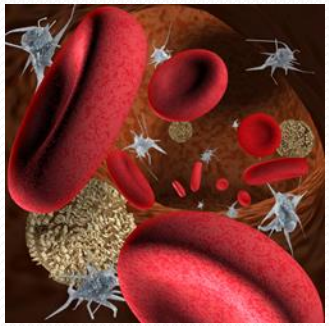
Composition of Blood



- The blood is made up of cells that are suspended in liquid called plasma.
- Plasma makes up 55% of the blood.
- Plasma is made of 90% water and 10% proteins, lipids, carbohydrates, amino acids, antibodies, hormones, electrolytes, waste, salts, and ions
- Blood cells make up the remaining 45% of the blood.



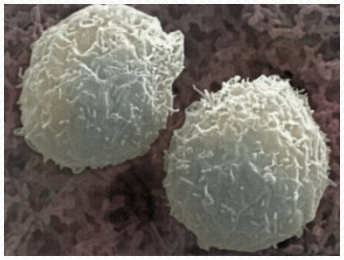
- Red blood cells make up 99% of the blood cells.
- White blood cells and platelets make up the other 1%.



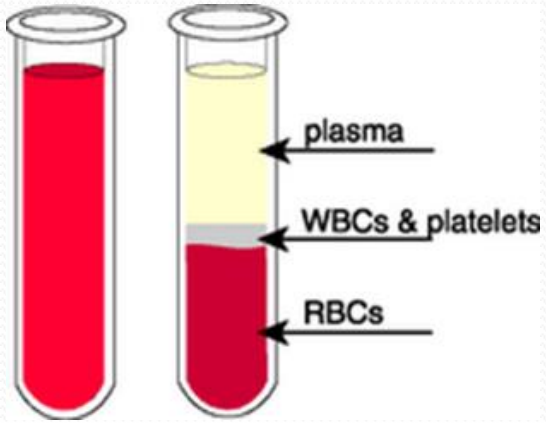
- Each type of blood cell performs a different function.

- Red blood cells (Erythrocytes)

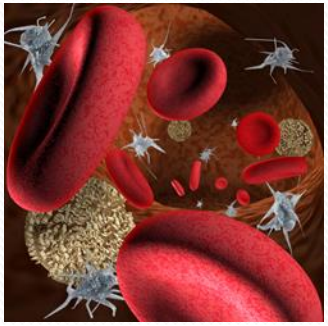
- White blood cells (Leukocytes)

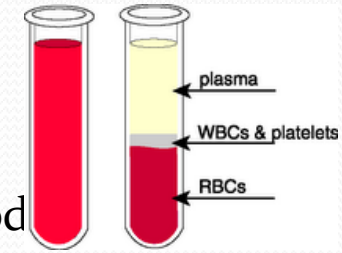


- Platelets (Thrombocytes)

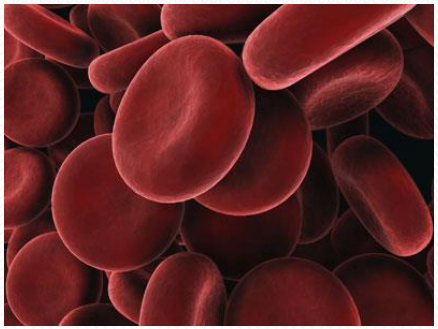


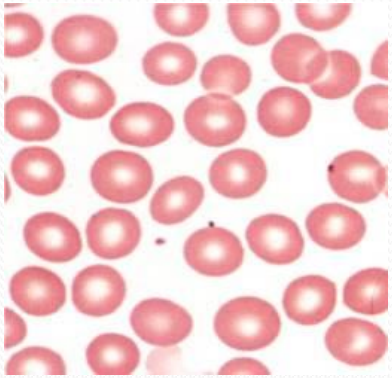
Red Blood Cells



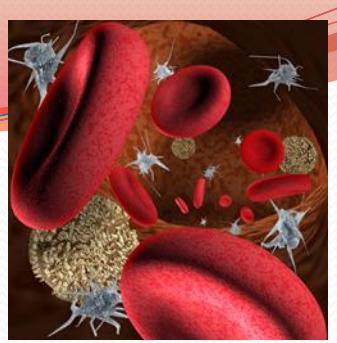


- Erythrocytes or RBCs
  - Most abundant cell in the blood (4 million – 6 million per microliter of blood
  - Formed in the bone marrow
  - Mature forms do NOT have a nucleus
  - Shaped as biconcave disks
  - 6-8 micrometers in diameter
  - Life span of about 120 days
  - Hemoglobin (iron protein)is found in the RBC
  - Hemoglobin carries oxygen from the lungs to the rest of the body and carbon dioxide binds to the RBC and is taken to the lungs to be exhaled.



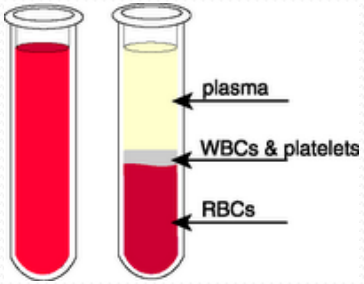


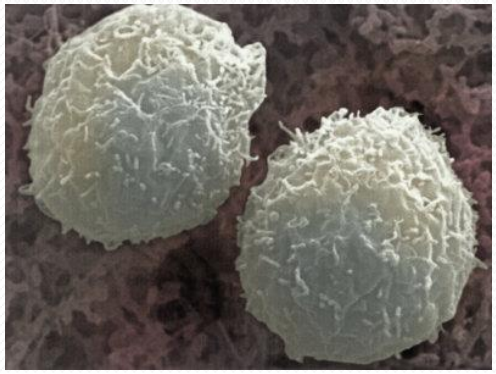
White Blood Cells

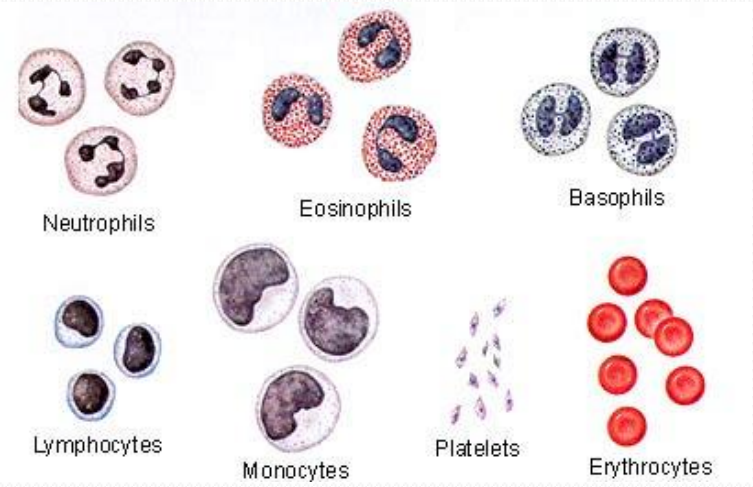


- Leukocytes or WBCs
- Largest sized blood cells
- Lowest numbers in the blood (4,500 – 11,000 per microliter)
- Formed in the bone marrow and some in lymph glands
- Primary cells of the immune system
- Fights disease and foreign invaders
- Contain nuclei with DNA, the shape depends on type of cell
- Certain WBCs produce antibodies
- Life span is from 24 hours to several years
- Size is 8-20 micrometers in diameter
- There are five different types of WBCs

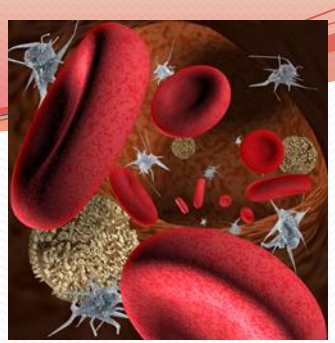
1. Neutrophils
2. Eosinophils
3. Basophils
4. Lymphocytes
5. Monocytes

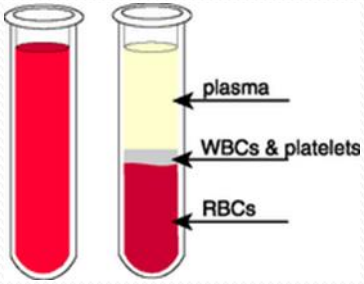




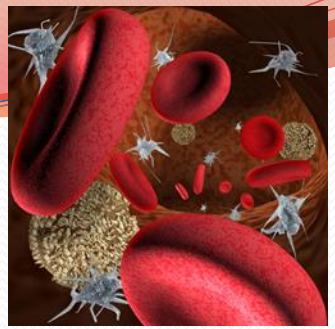


Platelets

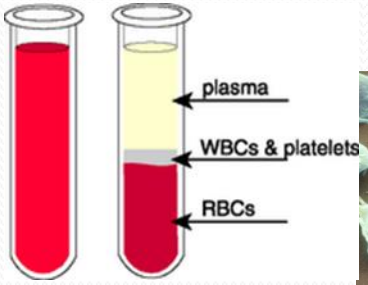


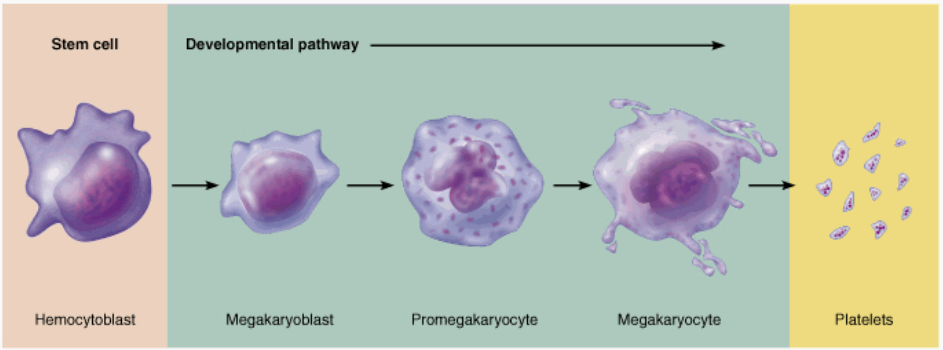


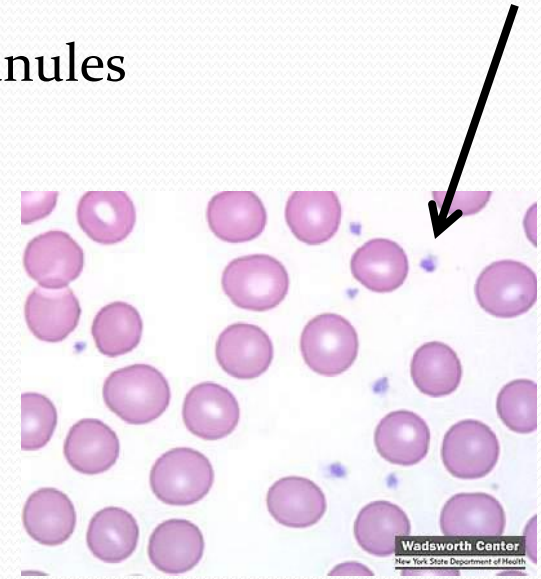
- Thrombocytes or PLTs
- Formed in the bone marrow
- Fragments from the cytoplasm of megakaryocytes
- Smallest of the blood cells
- 1-4 micrometers in diameter
- Shape can be round, oval, or appear spiky
- Life span of around 8-12 days



- Platelets
  - Involved in the clotting process
  - Seal wounds and prevent blood loss
  - Help repair damaged vessels
  - 150,000 – 400,000 per microliter of blood
  - Platelets stain bluish with reddish or purple granules







THE BODY'S DEFENSES

Immunity

- Immunity-state of being resistant or not susceptible to a specific disease
- Acquired immunity-any form of immunity NOT present at birth and obtained during life

Factors That Influence Immune System

- Health
- Age
- Heredity

The Nature of Disease

- Pathogenic Organisms
- Genetic Disorders
- Toxic Chemicals
- Other Environmental Factors
- Physical Damage to Organs
- Nutritional Disorders

Types of Pathogenic Organisms

- Viruses
- Bacteria
- Protozoan
- Fungi
- Animal
- Parasites

Functions of the Immune System

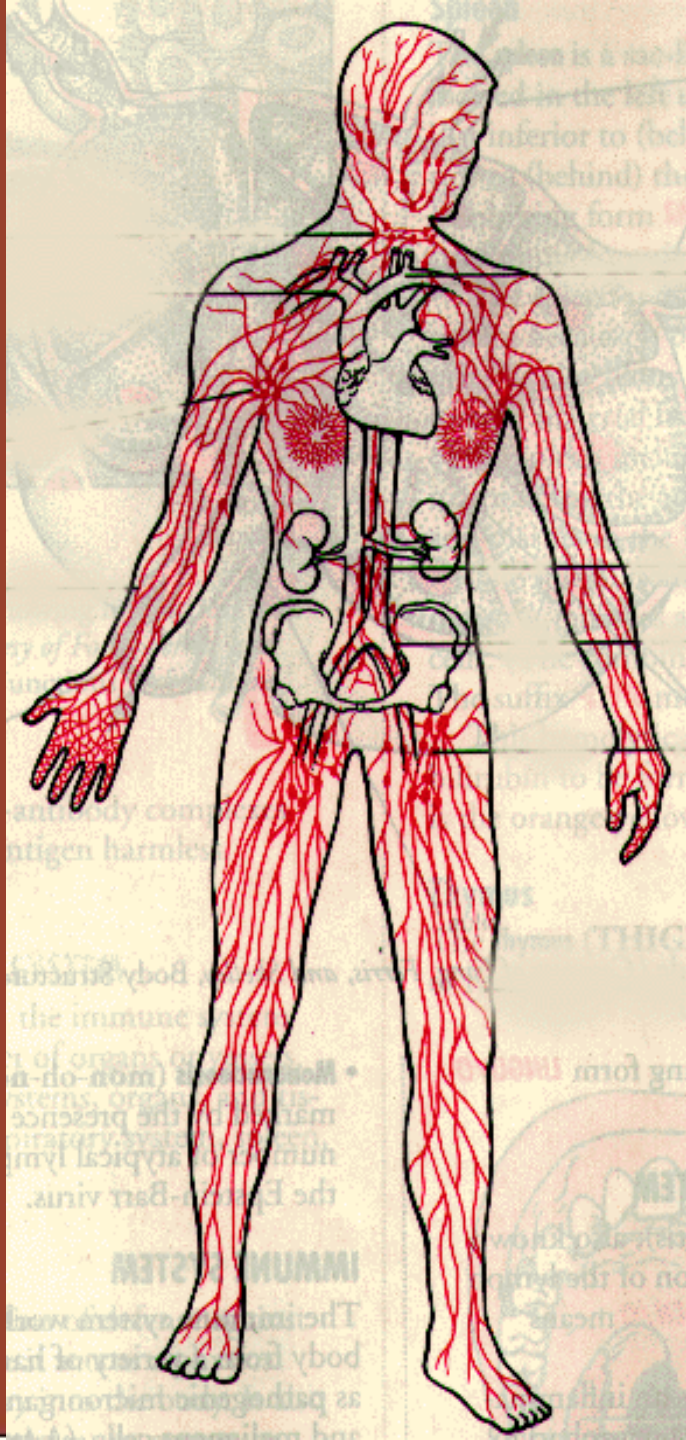
- To protect the entire body from a variety of harmful substances
  - pathogenic microorganisms
  - allergens
  - toxins
  - malignant cells

Structures of the Immune System

- Unlike other body systems, Immune System is NOT contained within a single set of organs or vessels
- Action depends on structures from lymphatic, cardiovascular, and Integumentary systems
- Works primarily through antigen-antibody reaction

Lymphatic System

- Major structures
  - lymph vessels
  - lymph nodes
  - lymph fluid
  - tonsils
- Also
  - spleen
  - thymus

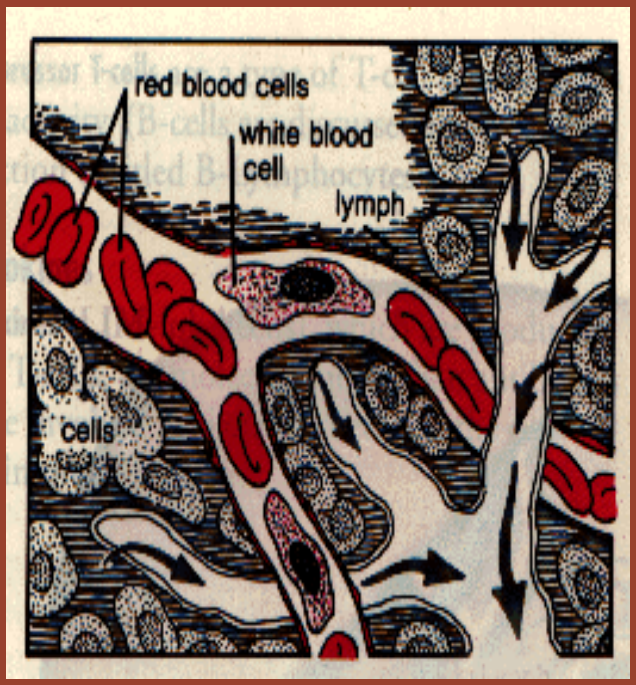


Functions of the Lymph System

- lymph/o
- drain fluid from tissue spaces and return to it to the blood
- transport materials (nutrients, hormones and oxygen) to body cells
- carry away waste products to the blood
- transport lipids away from digestive system
- control of infection

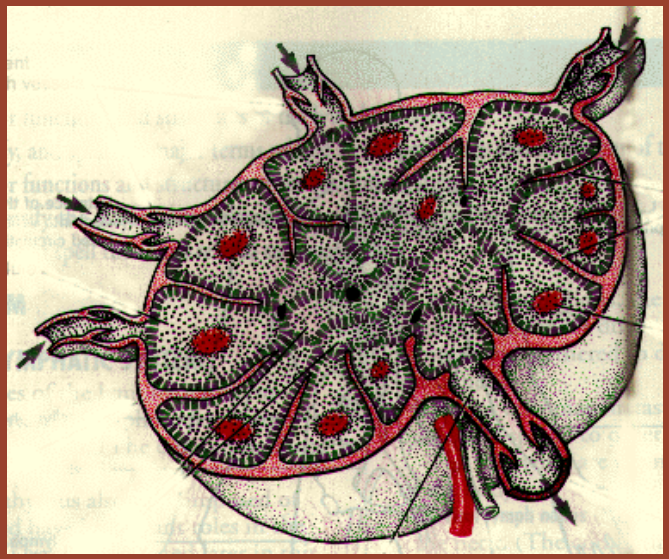
Lymph System

- Lymph originates in blood plasma
- Interstitial fluid
- cleans and nourishes body tissues
- collects cellular debris, bacteria
- return to blood or lymph capillaries



Lymph Nodes

- located in lymph vessels
- small round or oval structures (filters)
- depositories for cellular debris
- bacteria and debris phagocytized

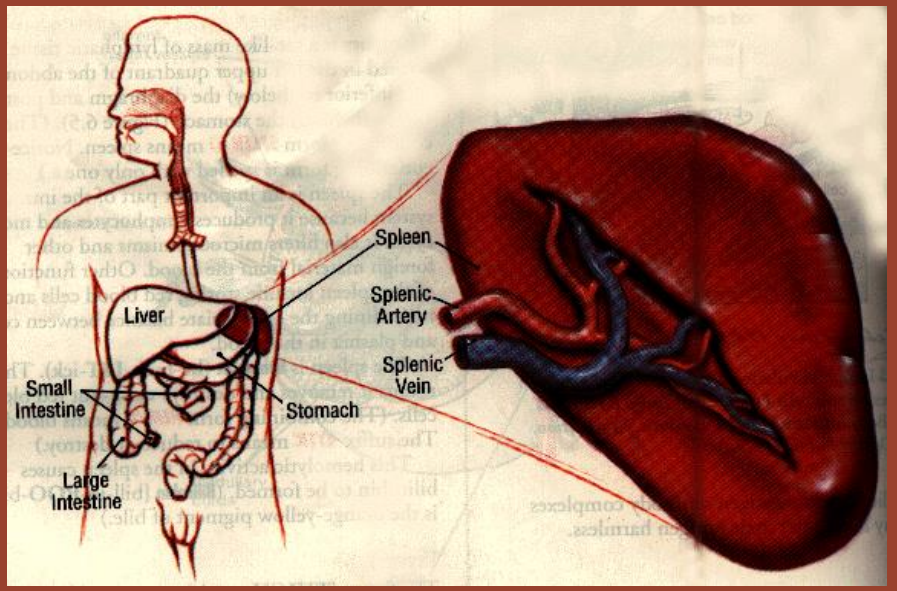


Lymph Nodes

- inside are masses of tissue which contain WBCs (lymphocytes)
- almost always grouped 2 or 3 to 100
- invading cells destroyed in nodes and often swell as an indicator of the disease process

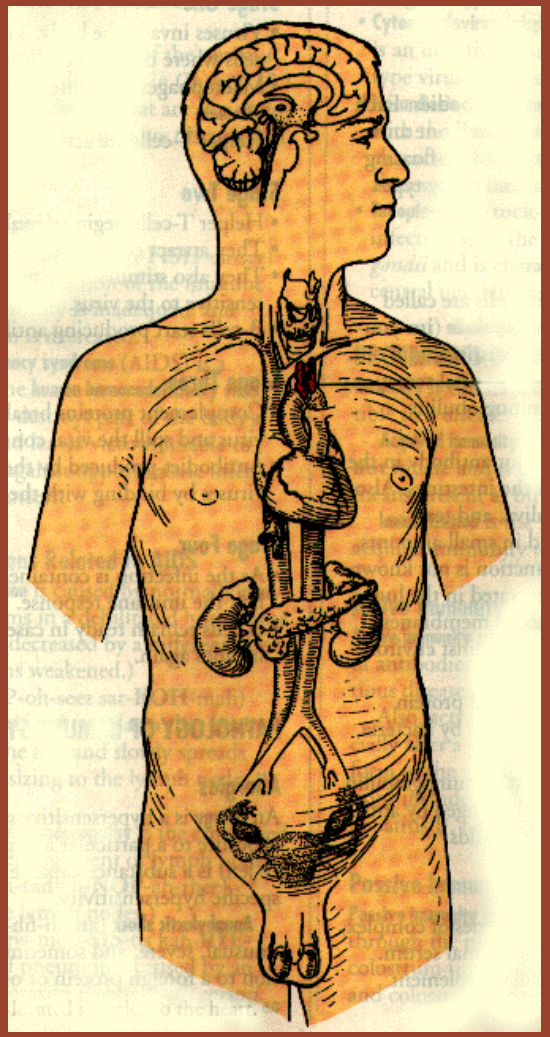
Spleen

- sac-like mass of lymphatic tissue
- filter for lymph
- phagocytic cells
- hemolytic



Thymus

- lymphatic tissue
- mediastinum
- primary role: changes lymphocytes to T cells for cellular immunity



Tonsils

- masses of lymph tissue designed to filter tissue fluid, not lymph
- located beneath certain areas of moist epithelium exposed to outside and hence to contamination
- any or all may become so loaded with bacteria that the pathogens gain dominance
- should not be removed unless absolutely necessary.

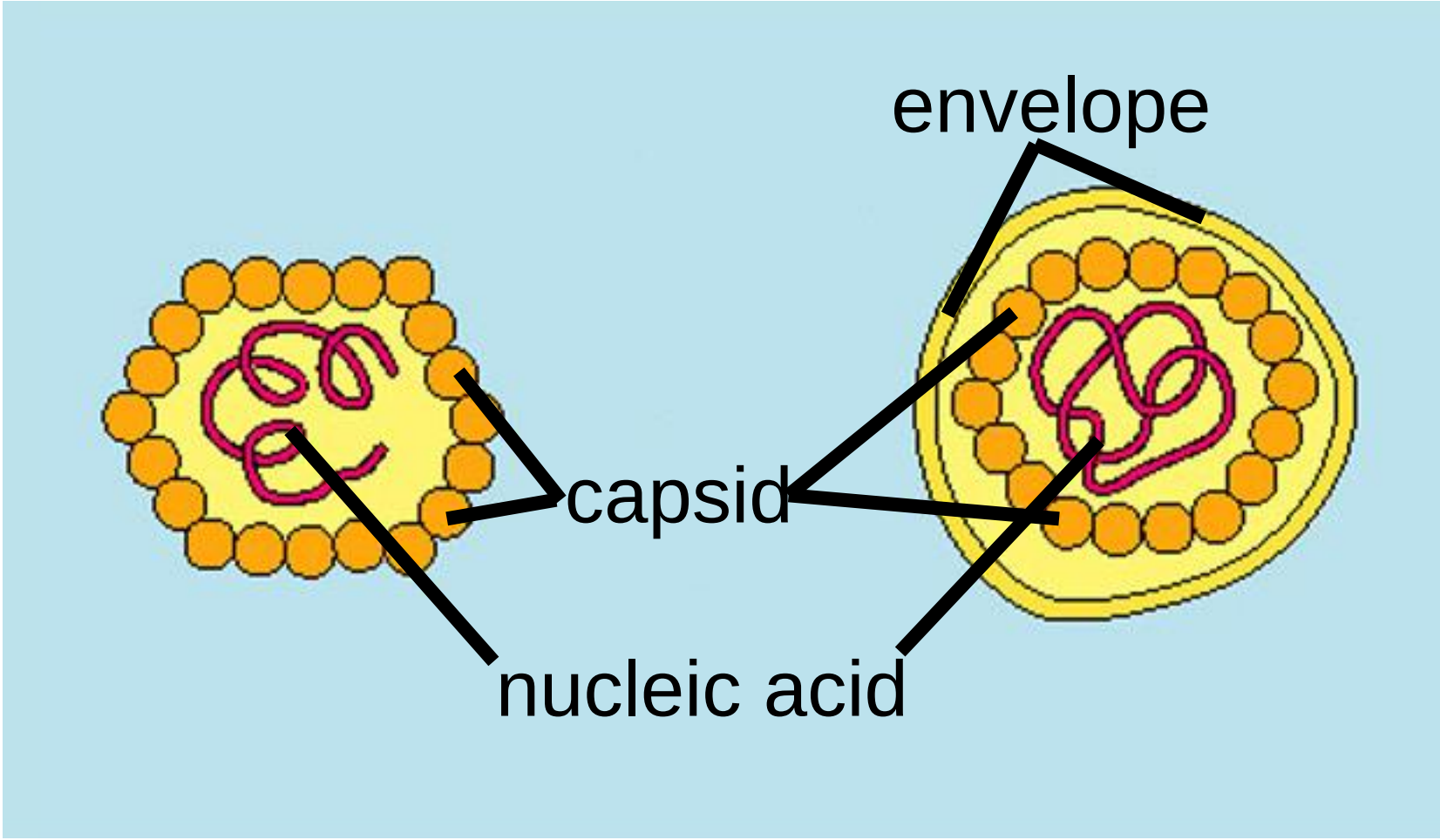
WBCs for Immune Reactions

- monocytes - type of lymphocytes
  - formed in bone marrow/transported where needed by body
  - become macrophages
- macrophage - phagocytic cell that protects body by ingesting invading cells
- lymphocytes - major class of WBCs
  - formed in lymphatic tissue

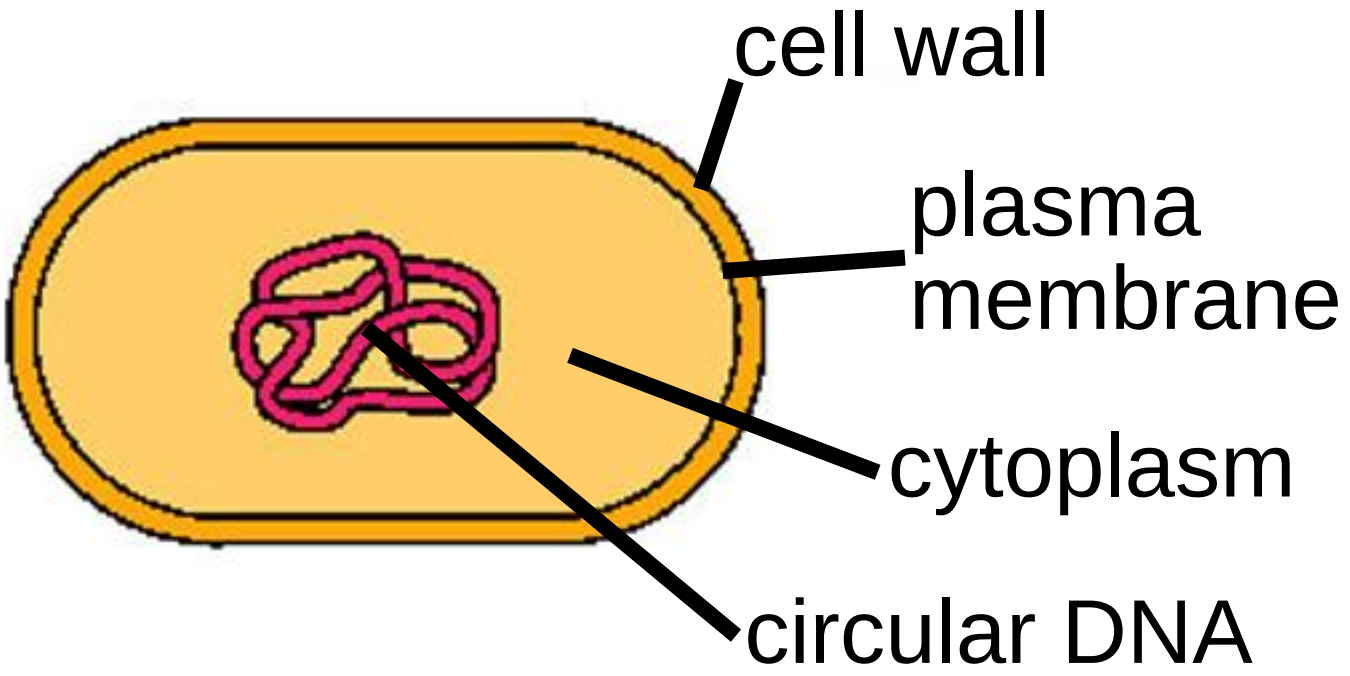
Mechanisms of Disease by Pathogens

- Utilization of host nutritional resources
- Physical damage to host tissues
- Production of toxic substances
- Chromosomal and gene damage
- Body cells behave abnormally

Viruses



Bacteria



Defense Mechanisms

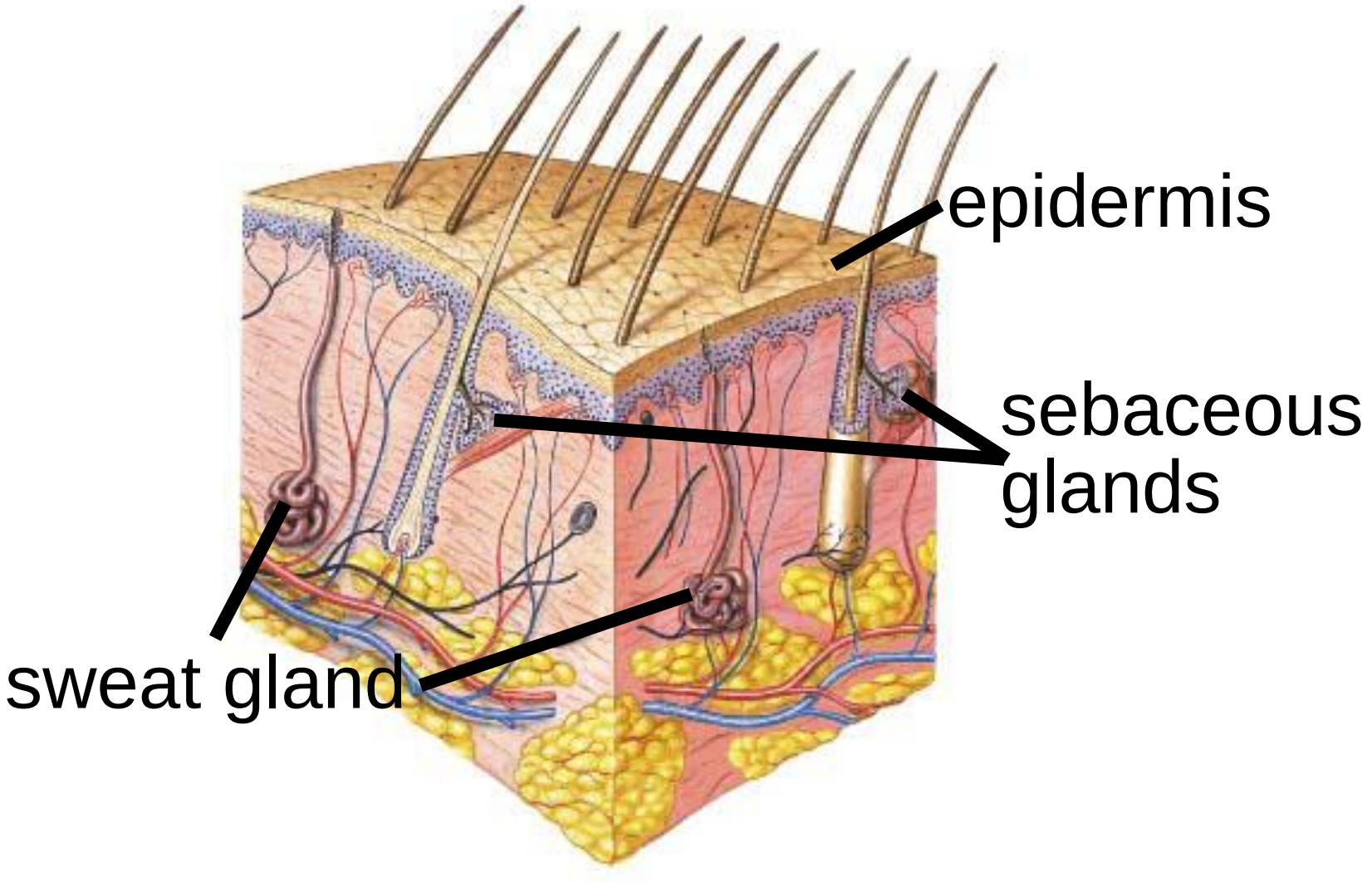
1. External defense
2. Internal Defense
3. Immune Defense

Nonspecific defense mechanisms		Specific defense mechanisms (immune system)
First line of defense	Second line of defense	Third line of defense
• Skin • Mucous membranes • Secretions of skin and mucous membranes	• Phagocytic white blood cells • Antimicrobial proteins • The inflammatory response	• Lymphocytes • Antibodies

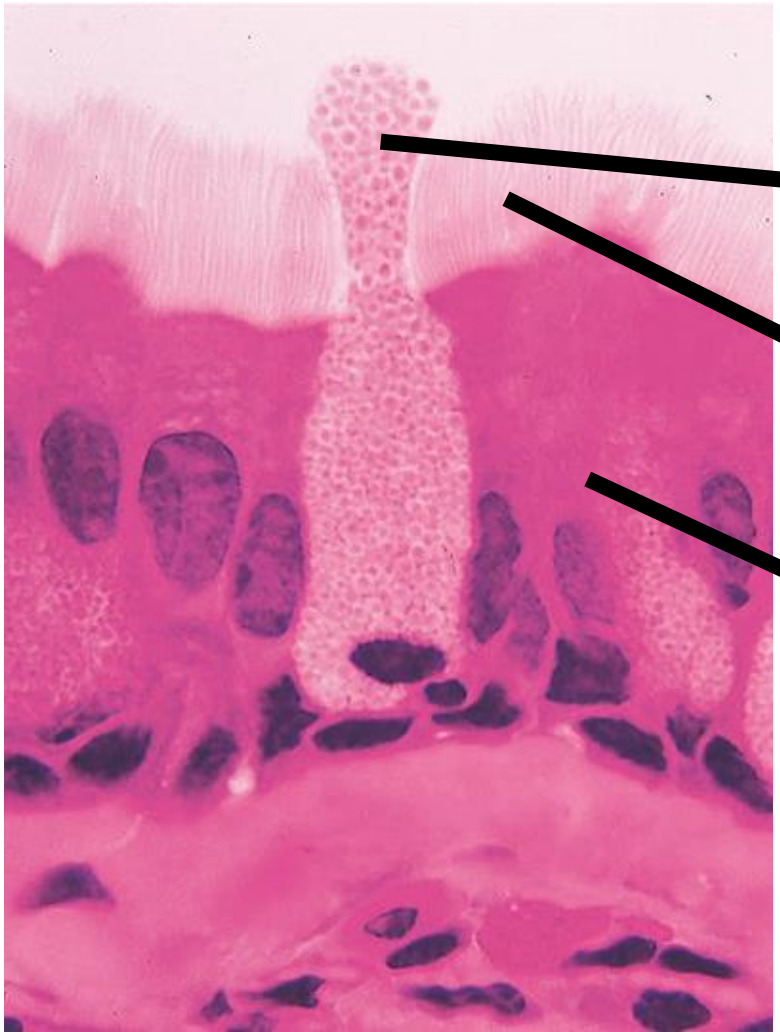
1st Line of Defense

- Skin acts as barrier to microbes and viruses
  - sweat has a low pH
- Mucus traps foreign particles
- Tears
  - Lysozyme has antimicrobial action
- Gastric stomach acid

Body Coverings: The Skin



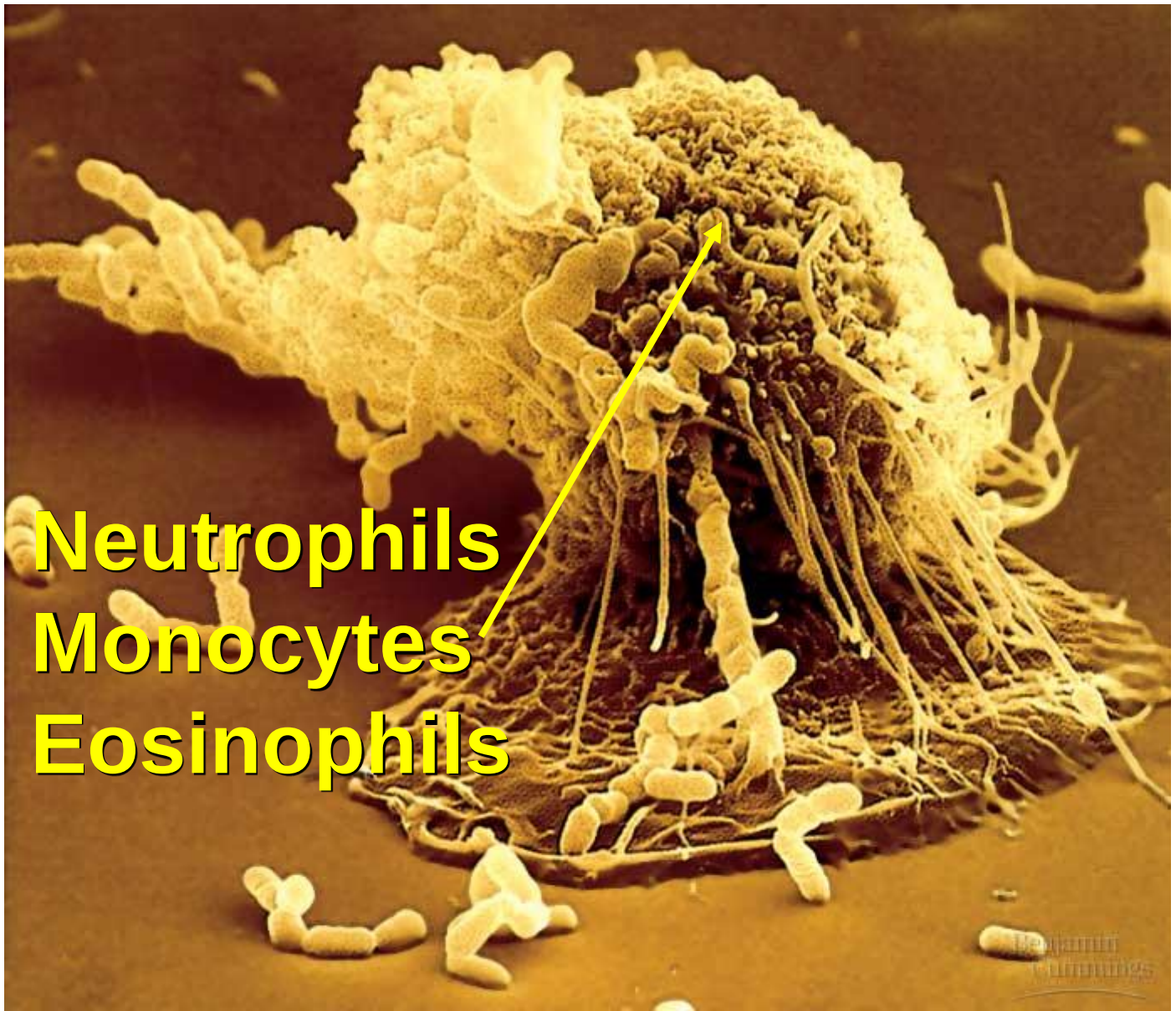
Body Coverings: Mucous Membranes



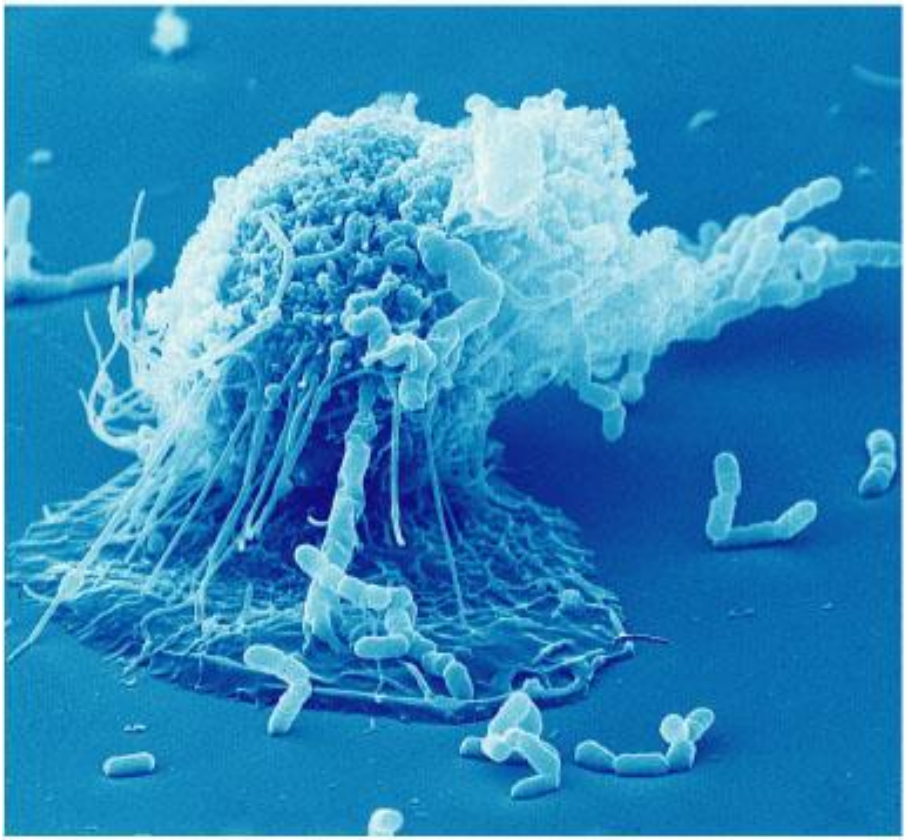
2nd Line of Defense

- Phagocytic cells (WBCs)
  - N L M E B
  - Natural Killer (NK) Cells: attack virus infected cells
- Inflammatory Response
- Antimicrobial proteins
  - Lysozyme
  - Interferon
  - Antibodies

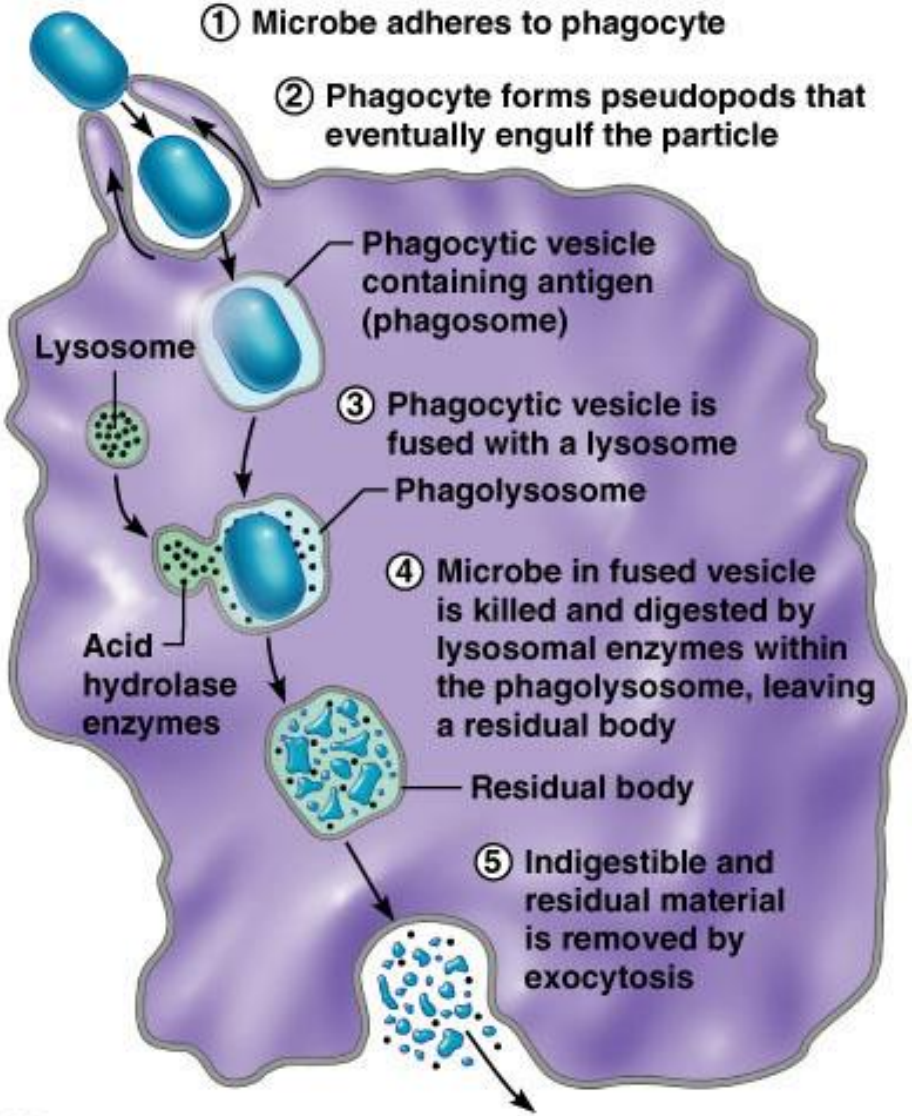
Nonspecific Phagocytosis



Mechanism of Phagocytosis



(a)

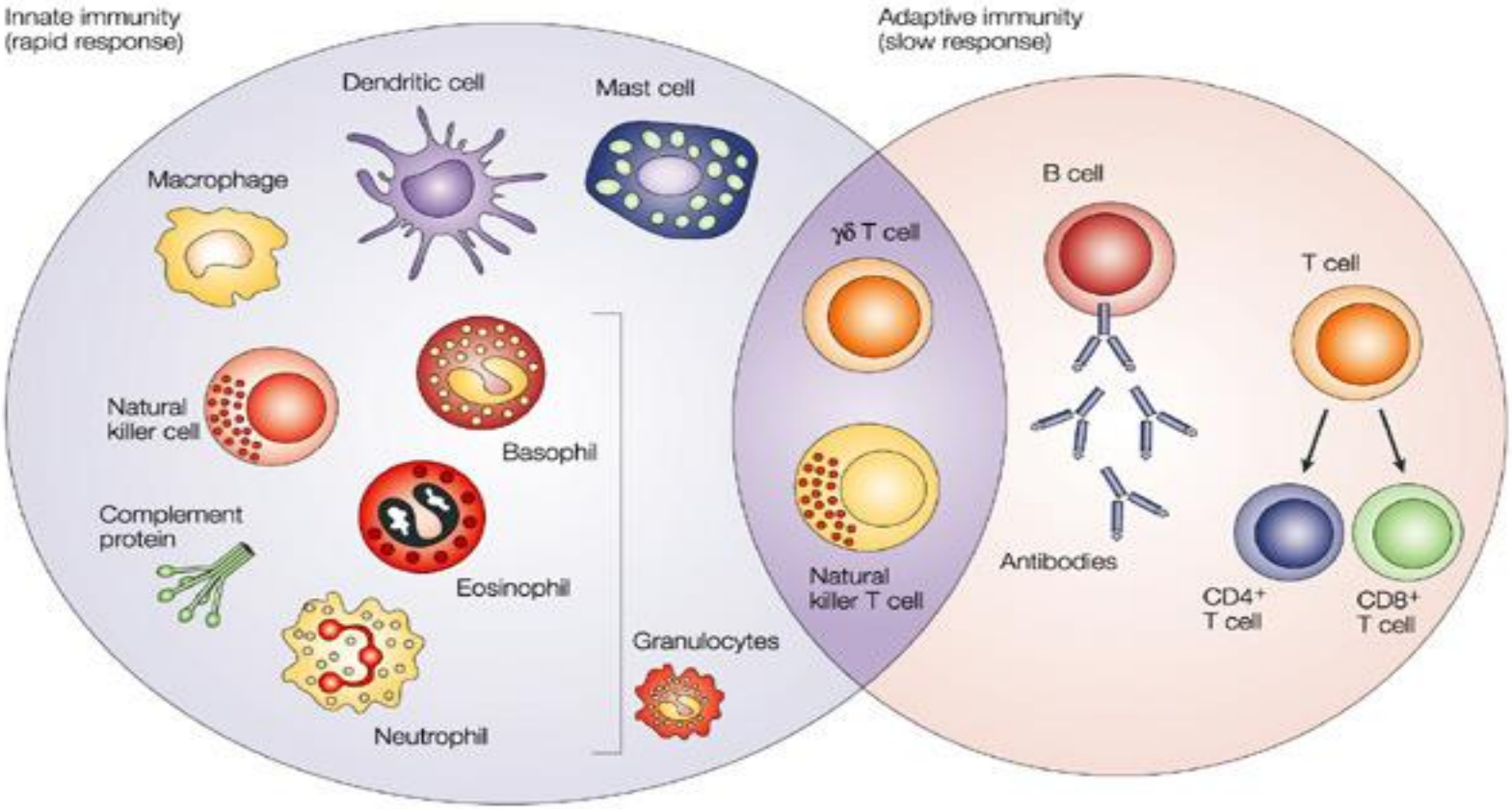


(b)

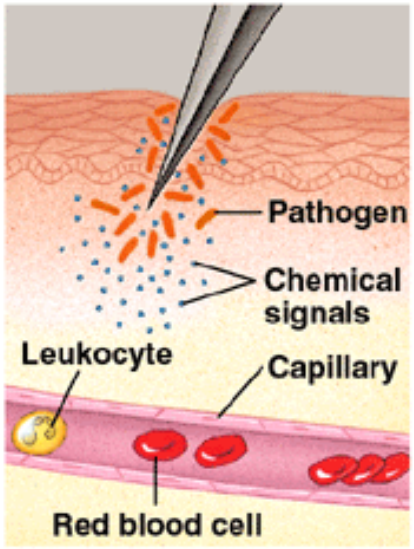
Macrophage

The Immune System

- The function of the immune system is to fight infection through the production of cells that inactivate foreign substances or cells which is called Immunity



Inflammatory Response



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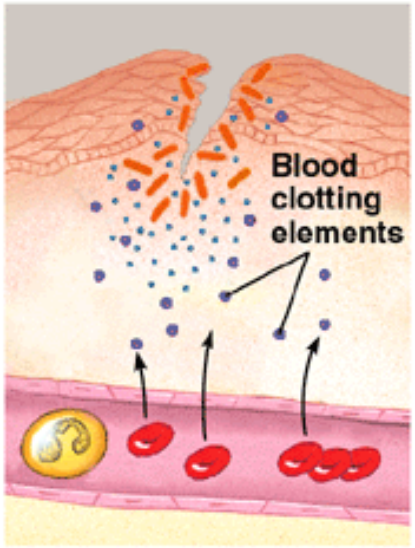
Histamine & prostaglandins released



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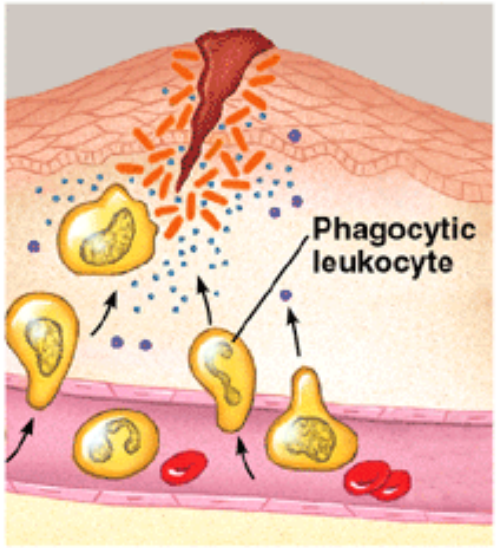
Capillaries dilate
Clotting begins



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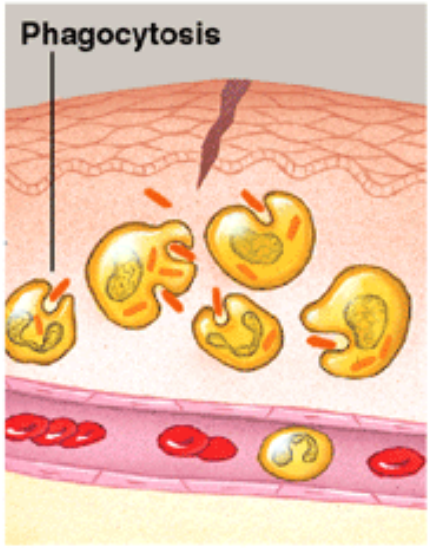
Chemotactic factors attract phagocytic cells



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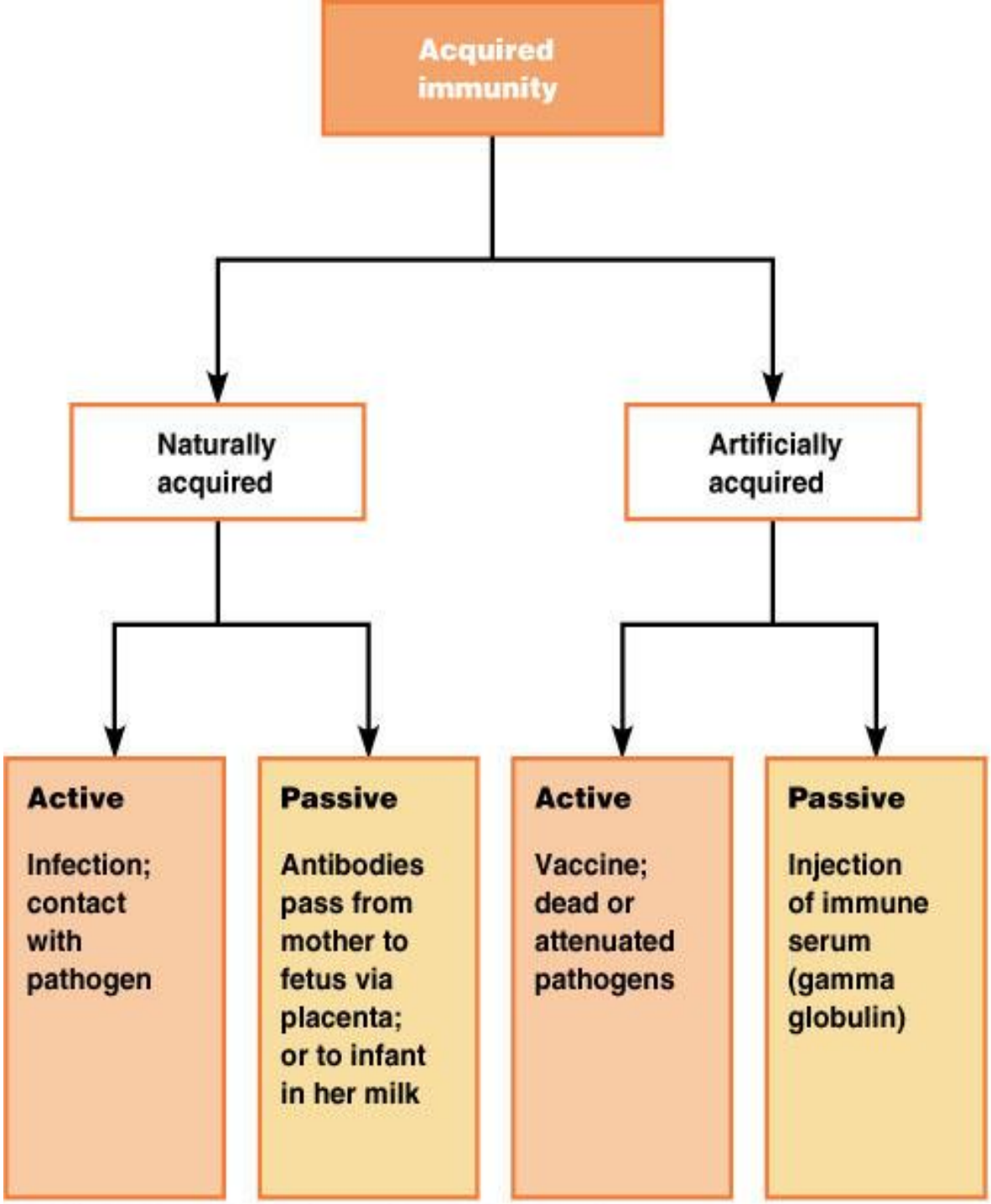
Phagocytes consume pathogens & cell debris

Types of Immunity

- **Active Immunity**
- Naturally-Acquired Active Immunity
- Artificially-Acquired Active Immunity

- **Passive Immunity**
- Naturally-Acquired Passive Immunity
- Artificially-Acquired Passive Immunity

Types of Acquired Immunity



Active Immunity

- The production of antibodies against a specific disease by the immune system.
- Naturally acquired through disease
- Artificially acquired through vaccination
  - Vaccines include inactivated toxins, killed microbes, parts of microbes, and viable but weakened microbes.
- Active immunity is usually permanent

- A vaccinated person has a secondary response based on memory cells when encountering the specific pathogen.
  - Routine immunization against infectious diseases such as measles and whooping cough, and has led to the eradication of smallpox, a viral disease.
  - Unfortunately, not all infectious agents are easily managed by vaccination.
    - HIV vaccine in the works

Passive Immunity

- **Passive Immunity**- Protection against disease through antibodies produced by another human being or animal.
- Effective, but temporary
- Ex. Maternal antibodies
- Colostrum.

- Passive immunity can be transferred artificially by injecting antibodies from an animal that is already immune to a disease into another animal.
  - Rabies treatment: injection with antibodies against rabies virus that are both **passive immunizations** (the immediate fight) and **active immunizations** (longer term defense).

Lymphocytes

- T cells or T Lymphocytes
  - mature in thymus gland
  - Cell mediated immunity
- B cells or B Lymphocytes
  - mature in bone marrow
  - antibody-mediated immunity

T Cell or T Lymphocyte (Cell Mediated Immunity)

- T Cell (cell mediated immunity)
  - circulating lymphocytes
  - produced in bone marrow
  - matures in thymus
  - live for years
  - primary function: coordinate immune defenses and kill organisms

Lymphocyte: T Cells

- helper T cells - essential to proper functioning of immune system
- Memory cells- remember antigens and stimulate a faster response if same antigen introduced at a later time

Immune System Response to Antigens

Humoral Immunity

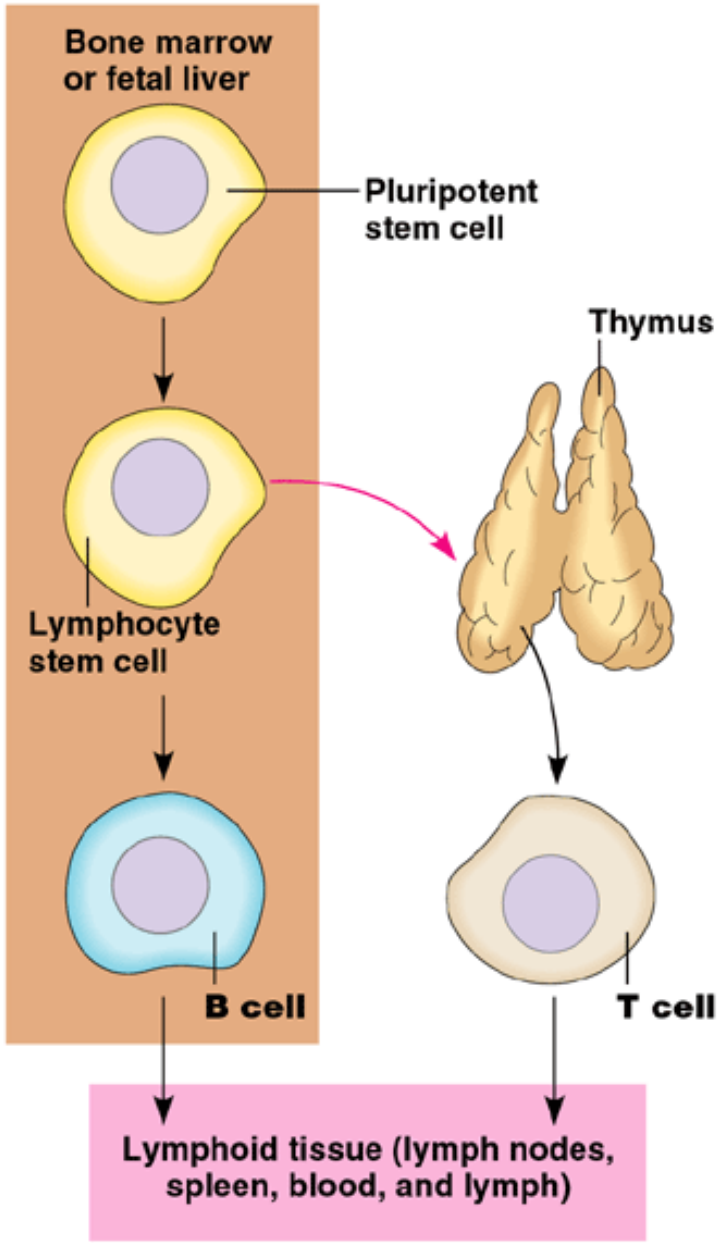
- Involves antibodies (secreted from B cells) dissolved in the blood plasma.
- Demonstrated as a immune response using only the blood serum.
- Defense against bacteria, bacterial toxins, & viruses.

Immune System Response to Antigens

Cell-Mediated Immunity

- Involves the activities of specific white blood cells (T cells).
- Defense against cancer cells, virus-infected cells, fungi, animal parasites, & foreign cells from transplants.

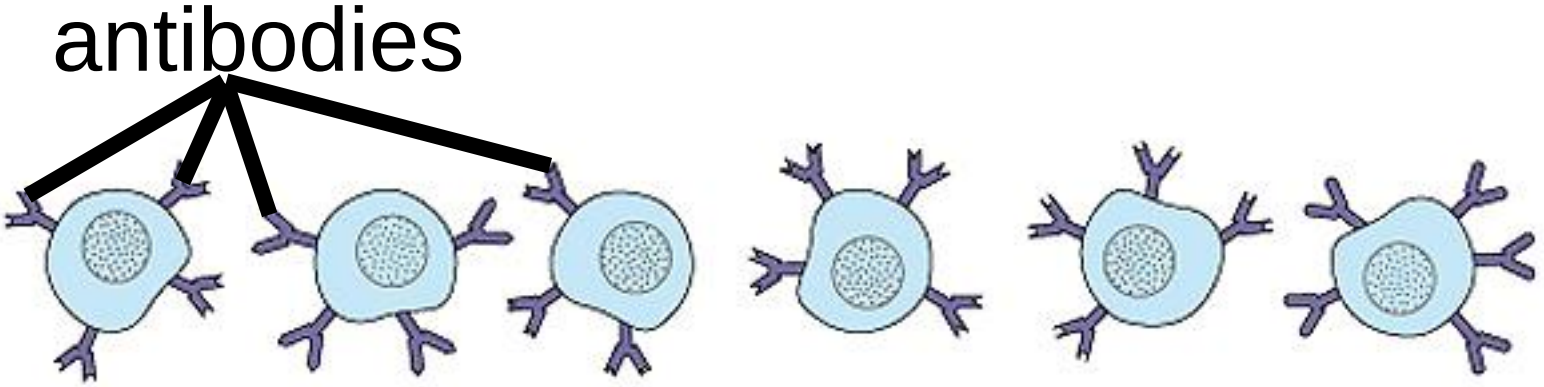
Lymphocyte Formation



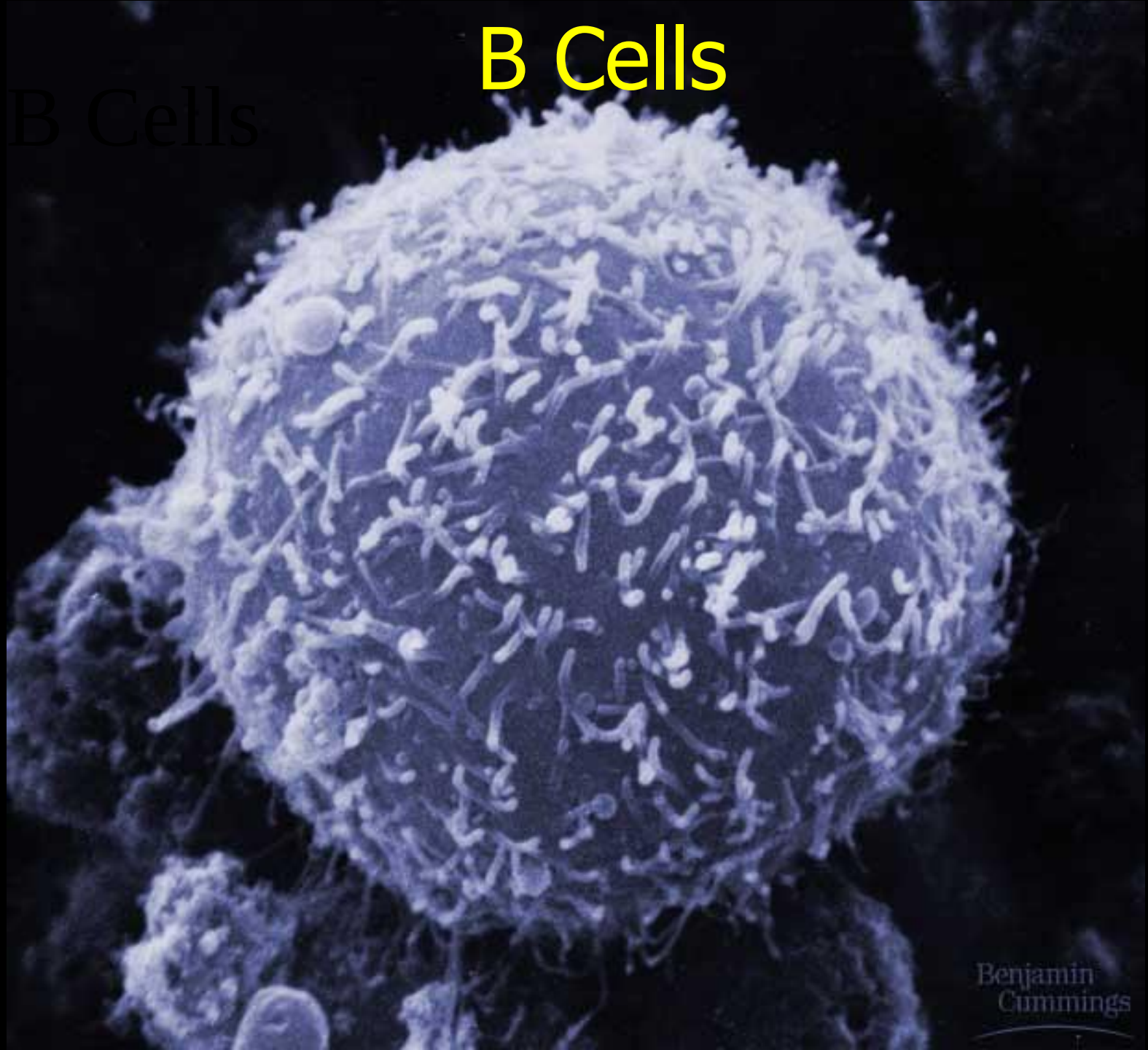
B Cells

- Mature in bone marrow
- Involved in humoral immunity
- Once activated by antigen, proliferate into two clones of cells: plasma cells that secrete **antibodies** and **memory cells** that may be converted into plasma cells at a later time

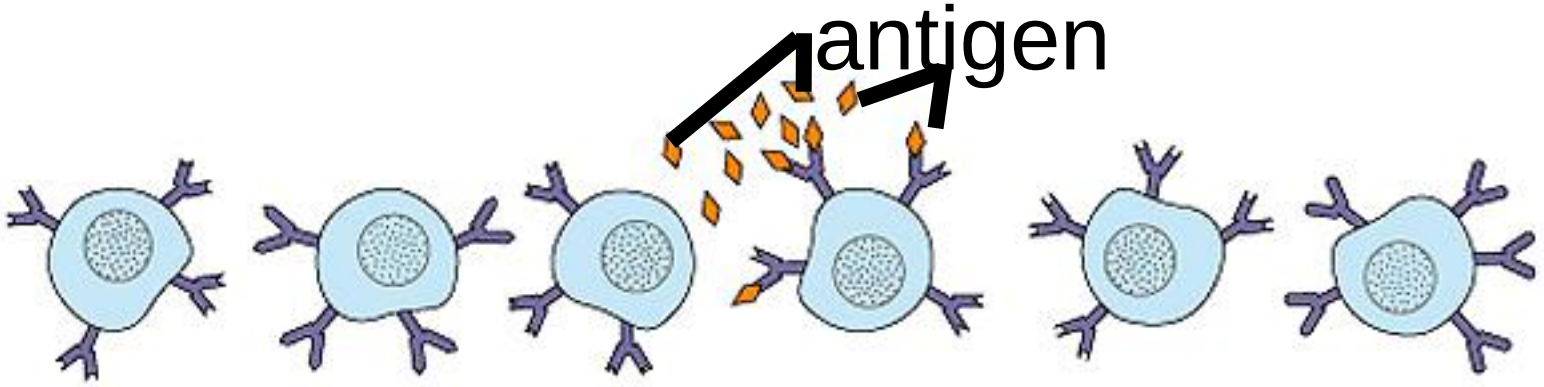
B Cells



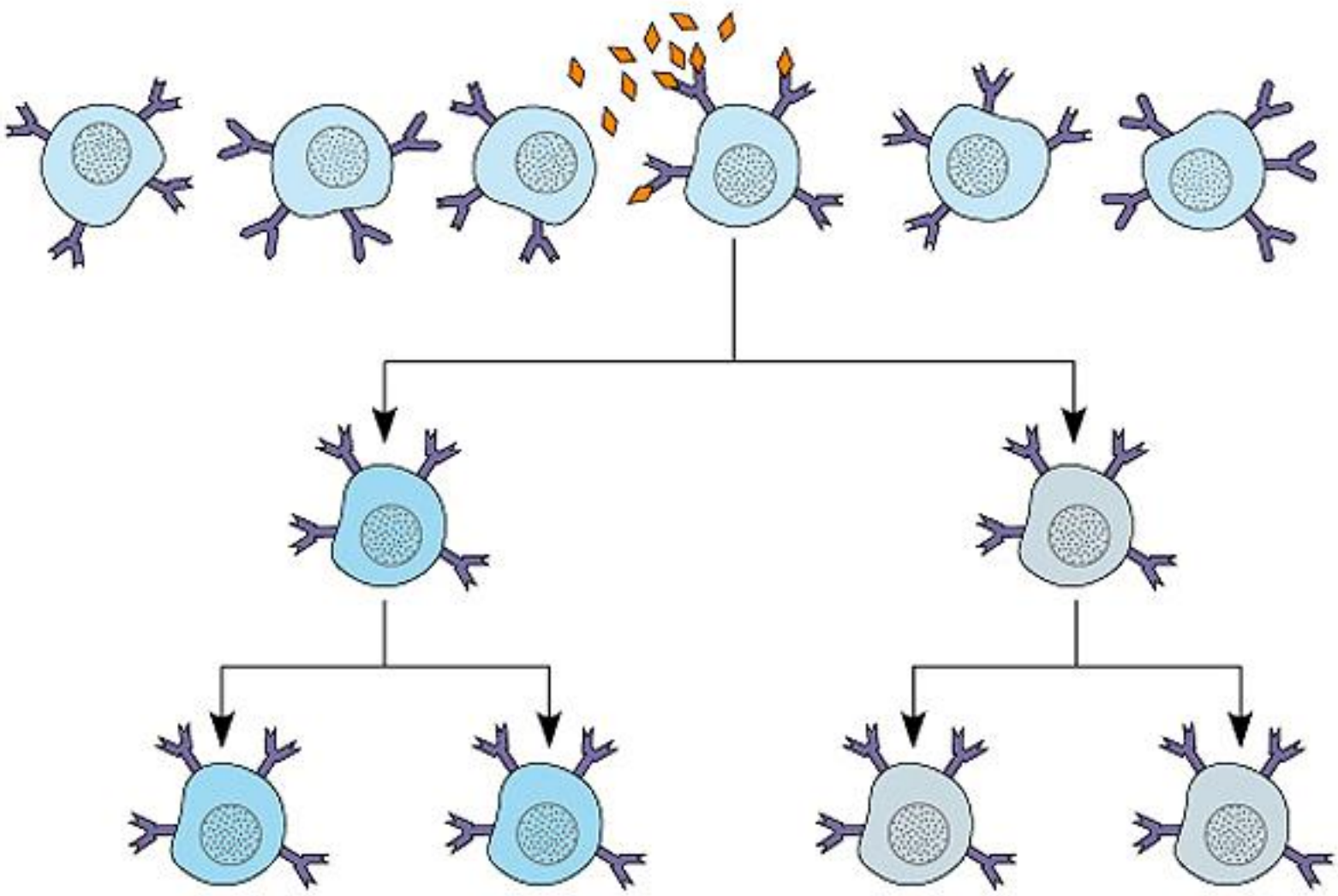
B Cells



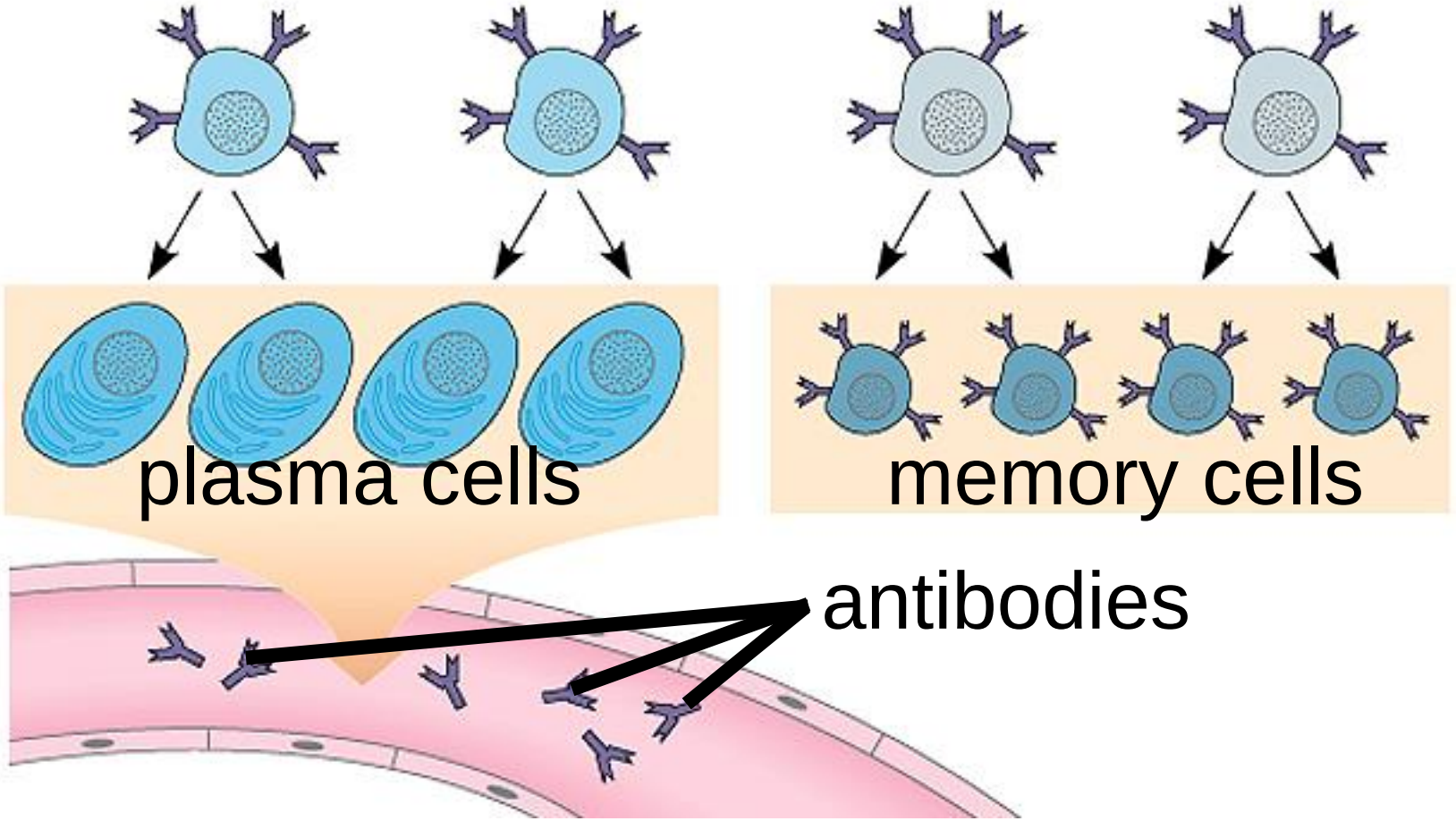
Activation of B Cells by Antigen



Clonal Selection

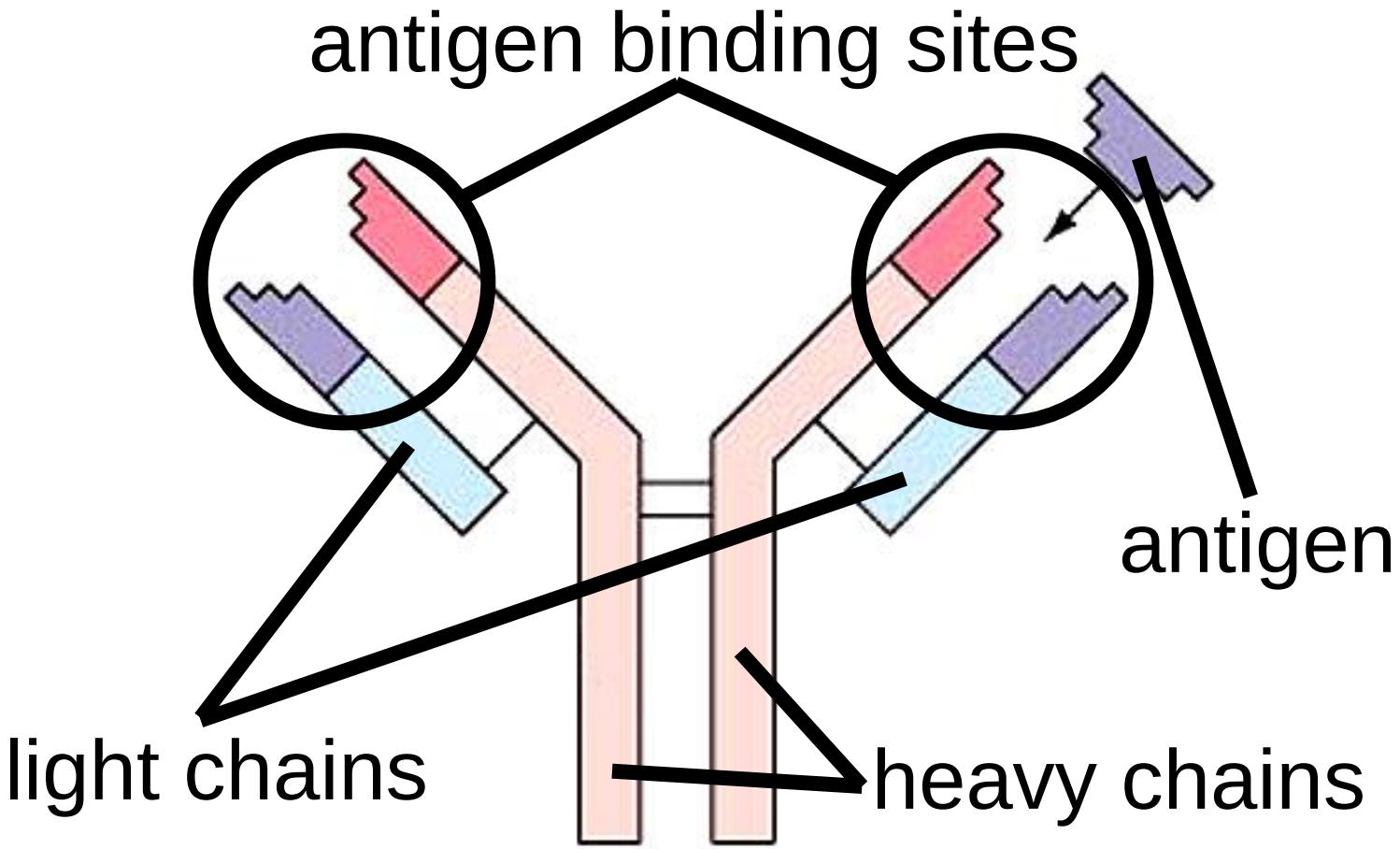


Clonal Selection



- Antibodies constitute a group of globular serum proteins called **immunoglobins** (**Igs**).
  - A typical antibody molecule has two identical antigen-binding sites specific for the epitope that provokes its production.

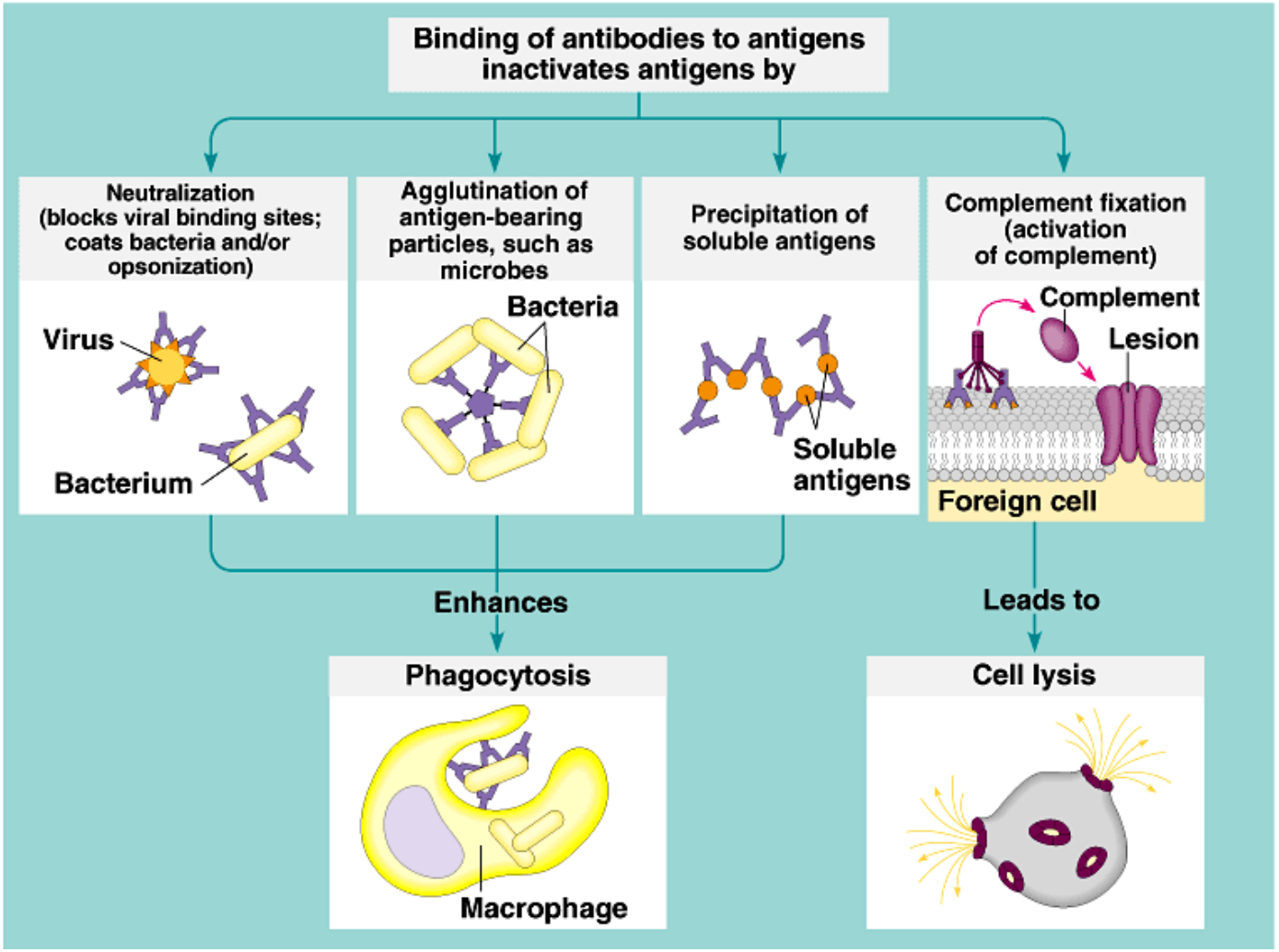
Antibody Molecule



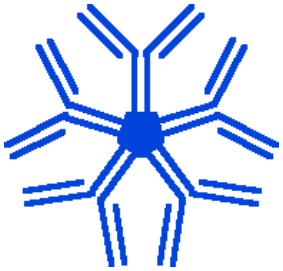
Mechanisms on Antibody Action

- Precipitation of soluble antigens
- Agglutination of foreign cells
- Neutralization
- Enhanced phagocytosis
- Complement activation leading to cell lysis
- Stimulates inflammation

- The binding of antibodies to antigens to form antigen-antibody complexes is the basis of several antigen disposal mechanisms.



Immunoglobin Classes



IgM

- 1st response to antigen
- Effective in agglutination
- Can't cross placenta

IgD

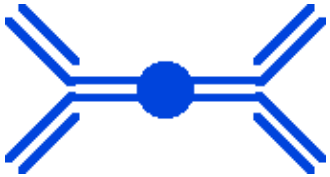
- B cell activation
- Can't cross placenta

IgG

- Most common form
- Crosses blood vessels
- Crosses placenta (passive immunity to fetus)

IgE

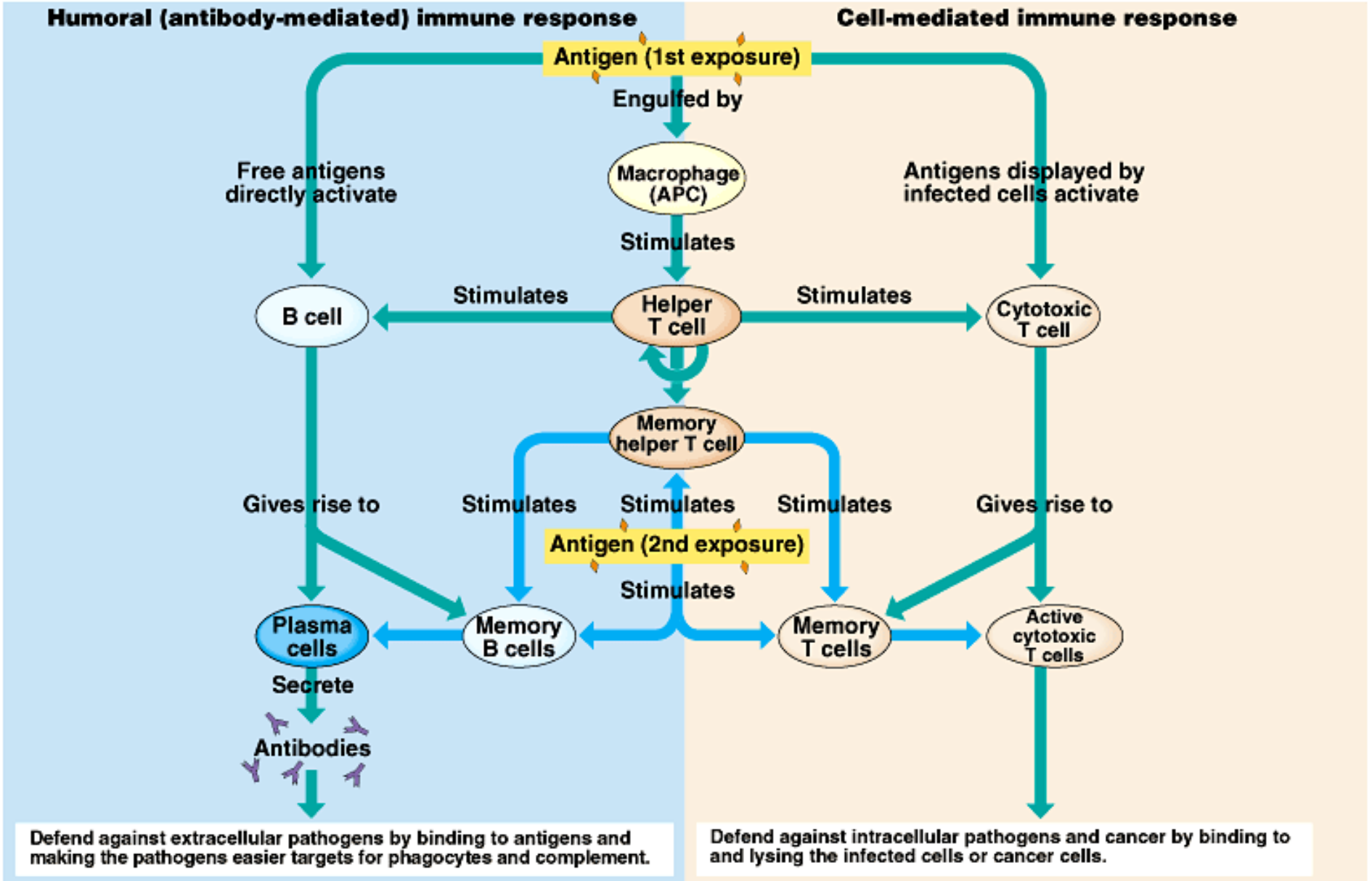
- Histamine reactions and allergies



IgA

- Secreted from mucus membranes
- Prevents attachment of bacteria to epithelial surface
- In colostrum

Overview of Immune System Responses



T Cells

- Mature in thymus
- Involved in cell-mediated immunity
- Activated when another cell presents antigen to them
- Several types of T cells: cytoxic T cells, helper T cells, suppressor T cells, and memory T cells

T Cells

- There are two main types of T cells, and each responds to one class of MHC molecule.
  - **Cytotoxic T cells** ($\mathbf{T_C}$) have antigen receptors that bind to protein fragments displayed by the body's class I MHC molecules.
  - **Helper T cells** ($\mathbf{T_H}$) have receptors that bind to peptides displayed by the body's class II MHC molecules.

NUTRITION

Presented by:
Shaymaa H. Al-Kubaisy
Ph. D. of Med. Microbiology

NUTRITION

The study of food, its composition, the amounts needed by the body and its effects on the body

*** Nutrition is the process by which body utilizes food for growth and maintenance and healthy living.

What is a Nutrient

- A nutrient is a chemical substance in food that helps maintain the body. Some provide energy. All help build cells and tissues, regulate bodily processes such as breathing. No single food supplies all the nutrients the body needs to function.

OBJECTIVE OF NUTRITION

1. To promote the physical and mental growth and development of human beings
2. Building and repairing of tissues and cell damaged by infection and injuries.
3. To provide energy for doing works.
4. To protect the human beings from infections and deficiency disorders.

Classes of Nutrients

- These are the 6 classes of nutrients. Each nutrient plays a different role and is required for life.

❖ Carbohydrates

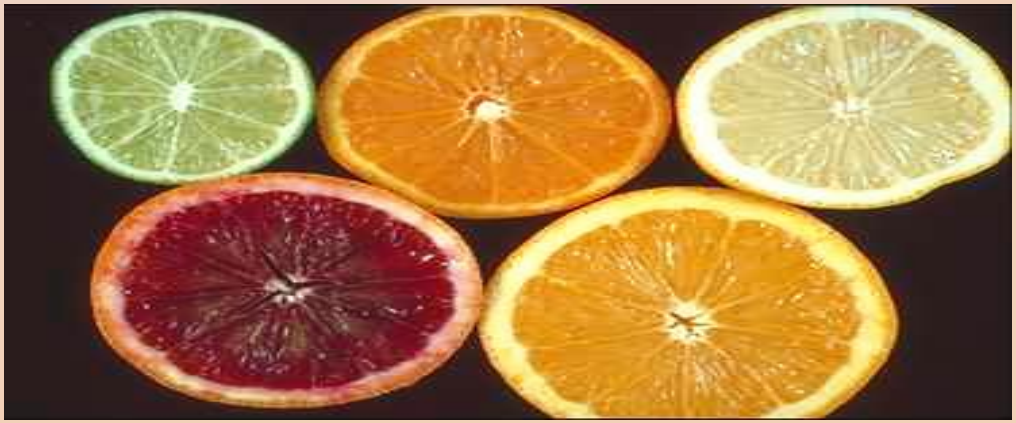
❖ Fats

❖ Proteins

❖ Vitamins

❖ Minerals

❖ Water



Nutrients

Nutrients are divided into two parts mainly as Macro-nutrients and Micronutrients.

Macronutrients: needed in large amounts by the body i.e. protein, fat and carbohydrate.

- Micronutrients: Needed in small amounts by the body i.e. vitamins, minerals

- They contribute to the total energy intake as:
  - Carbohydrates 60-80 %
  - Fats 10 - 30 %
  - Proteins 7-15 %

MICRONUTRIENTS

- The quantity of nutrients required depends upon age, sex, weight, physical activity and health status of the body.
- Requires in small quantity and so called micro-nutrients i.e. vitamins and minerals.

Nutrients that Provide Energy

• A food **Calorie** is actually a kilocalorie, which is equal to 1000 calories. Calorie is useful in comparing the energy available from different foods when we are deciding what food to eat. For example, a small apple contains only 80 Calories, while a slice of apple pie contains almost 350 Calories.

- **Carbohydrates, fats,** and **proteins** provide **energy** and perform other important functions.
- We need energy for all activities. When our body uses carbohydrates, fats, and proteins, energy is released: **calories.**

Carbohydrates

- Athletes are not the only people who need carbohydrates. Everyone needs them.
- Carbohydrates are the **sugars** and **starches** found in foods. They are made up of **carbon, hydrogen,** and **oxygen**.
- There are two general types of carbohydrates: **simple** and **complex**.

CARBOHYDRATE

Major component of food which is the main source of energy; providing 4 Kcal/gm

- In balanced diet, carbohydrates provide 50-60% of total calories taken.
- In excess, the carbohydrates are converted into body fat.

Functions: energy production in the body; Useful in oxidation of fat, growth of useful bacteria, synthesis of vitamin B complex, absorption of minerals, prevention of constipation.

Simple Carbohydrates

- Simple carbohydrates are the different forms of sugar, which are easy for the body to process. These sugars are **fructose** and **glucose** (found in fruits and vegetables, **lactose** (found in milk), and **sucrose** (refined and purified to produce table sugar).
- The most important to the body is **glucose** – the form of the sugar that goes directly to the bloodstream and provides quick energy. All other sugars must be changed into glucose by the body before the cells can use them. The cells use glucose as their primary source of energy. Glucose that is not needed immediately is converted by body to **glycogen**, a form of starch stored in the muscles and liver, or it is converted to and stored as body fat.

Complex Carbohydrates

- **Starches are complex carbohydrates that are made up of many units of glucose or other sugars, which form long chains. These chains must be broken down by the body into single units of glucose before they can be used. Starches take longer than sugars to be broken down into glucose. Starches provide energy to the body over longer periods than do simple sugars. Breads, cereals, pasta, and potatoes contain starch.**

- **Dietary Fiber is another complex carbohydrate, which comes from non-digestible part of plants. There two types of dietary fiber: soluble and insoluble. Soluble fiber combines with waste and other substances to assist in their removal from the body. (Found in: oat bran, beans, apples, carrots, and other vegetables). Insoluble fiber absorbs water and helps to provide needed bulk to the diet. (Found in: whole grains and the skins and seeds of fruits and vegetables).**

Fats (Lipids)

- **Fats** are the nutrients that contains the most concentrated form of energy. Fats are type of lipid.
- **Lipids** are substances that are somewhat similar to carbohydrates, but they contain less oxygen and they do not dissolve in water.
- Fat is one of essential nutrients important for properly body function. A small daily intake of fat is required. One gram of fat provides more than twice as much energy as one gram of carbohydrate.
- Fats are part of many body tissues and are important as carriers of other nutrients, such as vitamins. Fats also carry the flavor of foods – making foods tastier, but consumption of fat should be closely monitored.

Types of Fates

- **Saturated fats** are usually solid at room temperature. They contain maximum number of hydrogen atoms. Tropical oils, butter, and animal fats tend to be high in saturated fats.
- A diet high in saturated fats can lead to an increased chance of heart and blood vessel disease, obesity, and some types of cancer.

- **Unsaturated** fats are those fats that are liquid at room temperature.
- Olive oil and peanut oil are called **monounsaturated fats** because they lack one pair of hydrogen atoms.
- Fish oils and most vegetables oils, such as corn, soybean, and sunflower oils, are called **polyunsaturated fats** because they lack two or more pairs of hydrogen atoms.

Cholesterol

- Eating foods high in fats, especially saturated fats may increase the level of **cholesterol**, a waxy, fat-like substance produced by body.
- Cholesterol is part of cell membranes and nerve tissues. It is used by body to form vitamin D and other hormones. It is found *only* in foods that come from animals, such as butter, eggs, and meats. It is not an essential nutrient because the body produces cholesterol in liver.
- As cholesterol levels in the body increase, the risk of heart and artery diseases increase. Some of the cholesterol tends to be deposited on the walls of the arteries, thereby reducing the flow of blood to the cells supplied by those arteries.

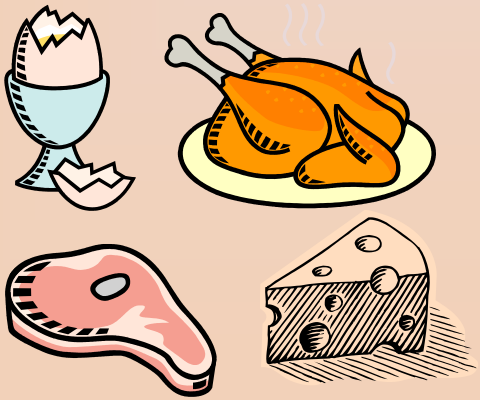
Two Forms of Cholesterol

- Cholesterol is transported in the blood in two forms. LDL is the “bad” form that tends to deposit cholesterol on the walls of the blood vessels.
- HDL is the “good” form that removes cholesterol from the cells and brigs it back to the liver and intestines to be recycled or excreted.
- Exercise has been proven to raise HDL, low-fat diets lower LDL.

Protein

- **Proteins** are substances found in every cell. The body needs proteins to build and repair all body tissues. Protein is an important part of blood cells. Proteins are made up of carbon, hydrogen, oxygen, and nitrogen atoms that are formed into basic units called amino acids.
- There are 20 different amino acids. Nine of them are essential, and the other eleven amino acids can be produced by the body.

Complete proteins



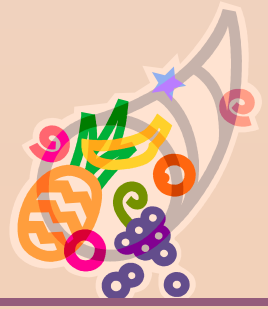
Incomplete proteins

Legumes

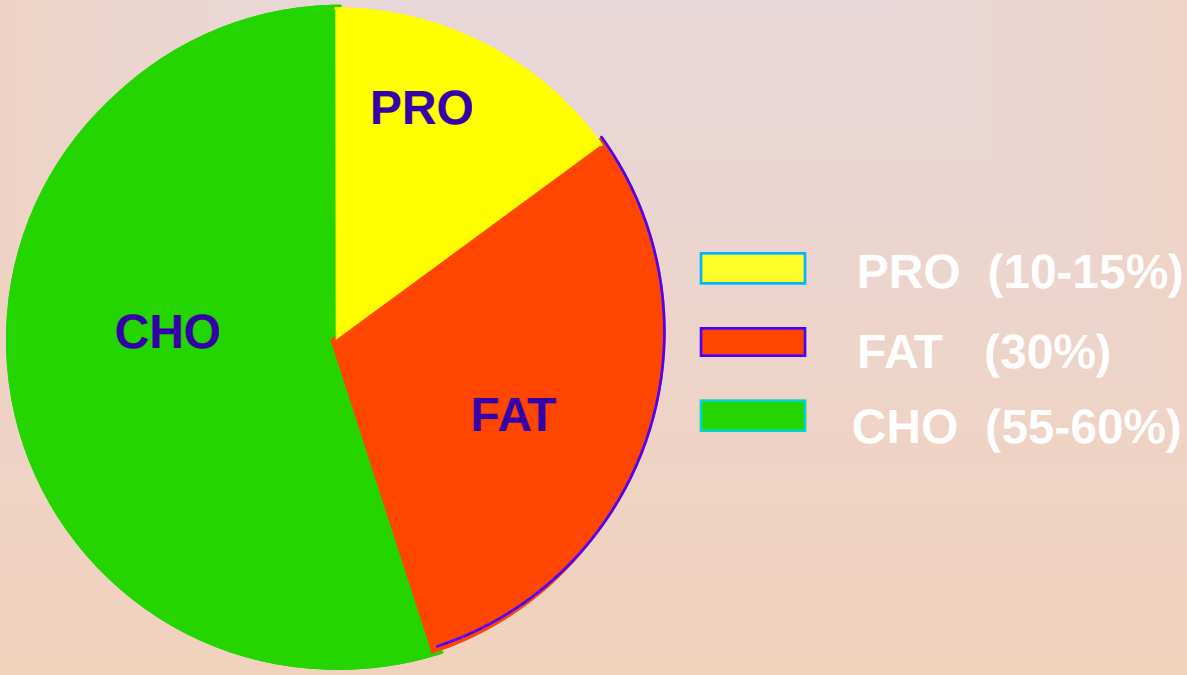
Nutrients that Regulate

- **Vitamins, minerals,** and **water** are nutrients that work with the energy-providing nutrients to be sure that the body functions properly.
- Water is the most vital nutrient because it provides the means for all other nutrients to be carry throughout the body.
- Eating a variety of foods in the right amounts is usually all that is needed to get daily supply of vitamins and minerals.

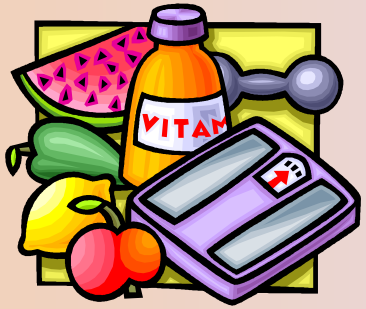
- Vitamins, minerals, and water are not digested by our body, and they do not provide Calories. Instead vitamins, minerals, and water are released from foods we eat and are absorbed by the body's tissues. They work with carbohydrates, fats, and proteins to promote growth and regulate body processes.



Recommended Dietary Intake



Vitamins

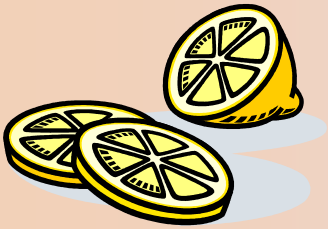


- Some diseases can develop because of lack of a particular vitamin.
- **Vitamins** are compounds found in living things and are needed in small amounts for life and growth and to prevent diseases.

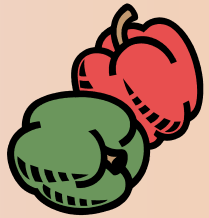
- Vitamins help build bones and tissues, and they also help change carbohydrates and fats into energy.
- Because the body cannot make most vitamins, they must be supplied by the foods we eat.

Fat-soluble Vitamins - dissolve fat and can be stored in the body.

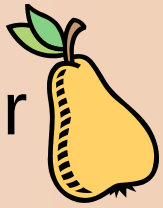
Vitamin	Sources	Functions in Body	Signs of Toxicity	Signs of deficiency
Vitamin **A**	Orange, yellow, green vegetables, liver, margarine, and egg yolk	Maintains healthy eyes, skin, bone growth and tooth development, possible aid in cancer protection	Nausea, vomiting, dry skin, rashes, hair loss, headache, fatigue	Night blindness, eye-infections, rough skin, respiratory infections
Vitamin **D**	Milk, eggs, liver, exposure of skin to sun's ultraviolet rays	Promotes absorption of phosphorus and calcium to build and maintain bones	Loss of appetite, headache, nausea, weakness, calcification of bone and soft tissue	Rickets (poor bone development), malformation of teeth
Vitamin **E**	Wheat germ, whole grains, vegetable oils, legumes, nuts, dark green leafy vegetables	Protects red blood cells; stabilizes cell membranes	General digestive discomfort	Rupture of red blood cells, anemia, nerve abnormalities
Vitamin **K**	Green leafy vegetables, liver, kale, cabbage; made in body by intestinal bacteria	Assists in normal clotting of blood	Anemia	Slow clotting of blood, hemorrhage especially in newborns



Water-soluble Vitamins



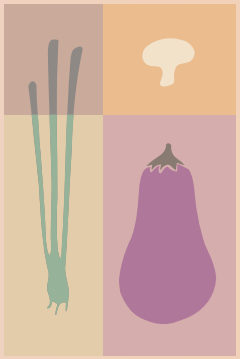
- Water-soluble vitamins dissolve in water. Because water-soluble vitamins are not stored by the body to any extent, foods reach in these vitamins must be eaten more often than foods with fat-soluble vitamins.
- Fruits and vegetables are good source of water soluble vitamins.
- Water-soluble vitamins are: Thiamin (B1), Riboflavin (B2), Niacin, Vitamin B6, Folacin (Folic acid), Vitamin B12, Pantothenic acid, biotin, Vitamin C (Ascorbic acid).



Vitamin Supplementation?

- Not necessary if diet is healthy
- Multivitamins are safe (100% RDA)
- Not all vitamins are “pure”
- Can be toxic at high doses

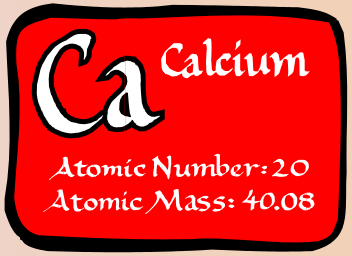
Minerals

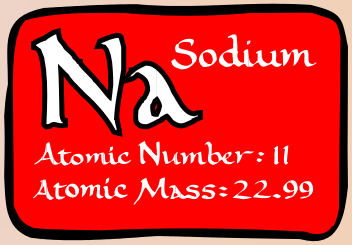


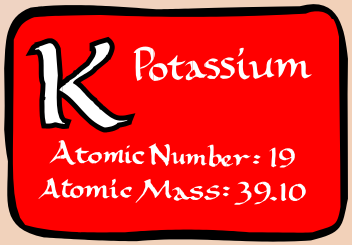
- Minerals are simple substances found in the environment that are essential to the body's functioning.
- Minerals are used to regulate a wide range of body processes, from bone formation to blood clotting, and they are important for the body structure.
- Most minerals are either quickly used or lost in waste products, therefore we must eat mineral-rich foods daily to replenish our supply. Iron is an exception –it tends to be kept and recycled by the body, except when there is a blood loss.

Major Minerals: calcium, phosphorus, magnesium, potassium, sulfur, sodium, and chlorine

- Calcium keeps the nervous system working well and is needed for blood clotting. Osteoporosis is disease caused by calcium deficiency.
- Sodium and potassium help regulate the passage of fluids in and out of cells. Too much sodium in the diet may aggravate high blood pressure or hypertension, increasing the risk of heart attack, stroke or kidney disease. Table salt is one source of sodium in the diet. Most sodium comes in food.
- Deficiency of potassium can lead to muscle weakness and abnormal heart beat.





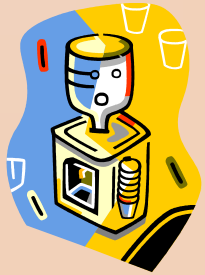


Trace Minerals: iron, iodine, manganese, zinc, copper, and fluorine

- The majority of the minerals needed for the body to function are only required in very small, or trace amounts.
- Iron is a vital part of hemoglobin – a substance in red blood cells that carries oxygen to all parts of the body. Insufficient iron may cause anemia, a disease in which the body has either too few red blood cells or too little hemoglobin. As result too little oxygen is carried to cells of the body.
- Iodine is needed for the thyroid gland to function properly. The thyroid gland produces hormones that control how quickly chemical reactions occur in our body. Too little iodine – thyroid gland enlarged. The primary sources are seafood and iodized table salt.

Water

- Water is found in every cell, in the spaces around the cells, in the fluid tissues of the body, and in body cavities
- Water carries dissolved nutrients throughout our body and assists in all of its functions such as: digesting foods, removing wastes, regulating temperature, and cushioning sensitive parts of our body.
- Each day we lose two to three quarts of water and if this water is not replaced the body can dehydrate.
- When minerals are dissolved, they break apart into ions. The ions formed in body fluids are called electrolytes. These ions play a central role in water balance in the body.

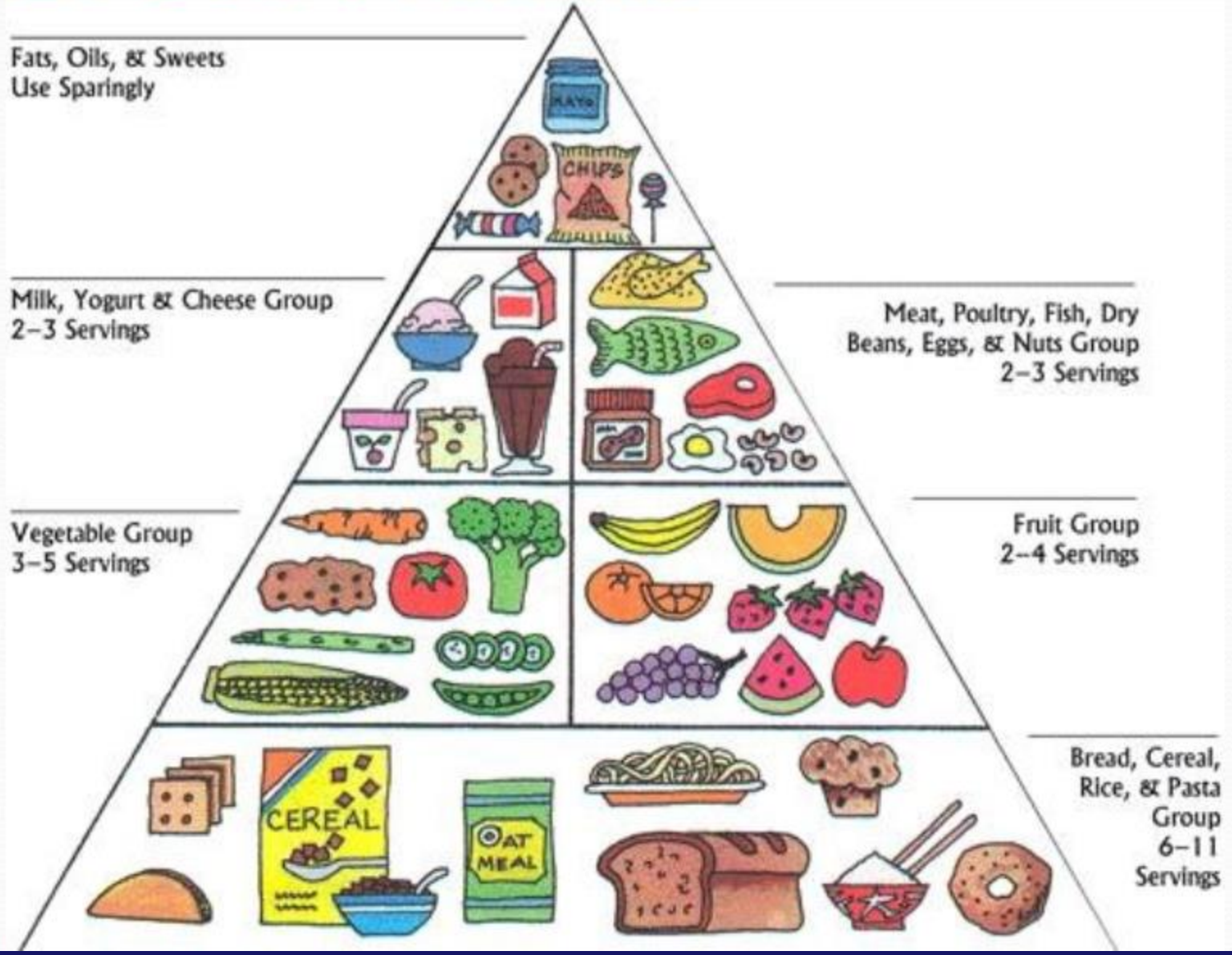


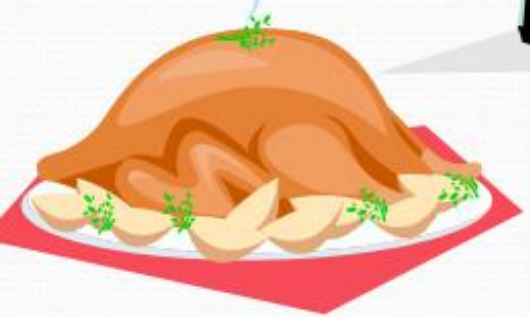
Return to presentation

Functions of Water

- Comprises about 60% of body weight
- Chief component of blood plasma
- Aids in temperature regulation
- Lubricates joints
- Shock absorber in eyes, spinal cord, and amniotic sac (during pregnancy)
- Active participant in many chemical reactions

THE FOOD PYRAMID





Thank You...