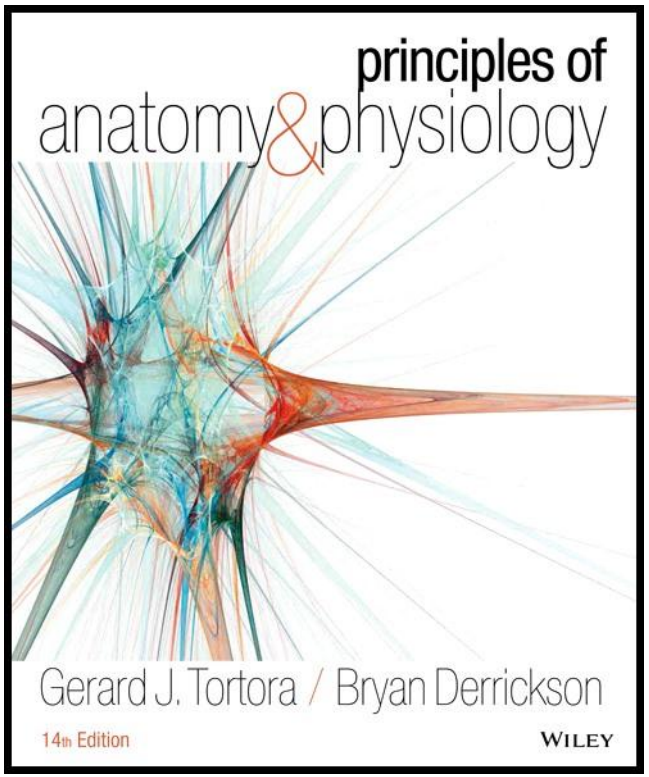

Principles of Anatomy and Physiology

CHAPTER 1

An Introduction to the Human Body

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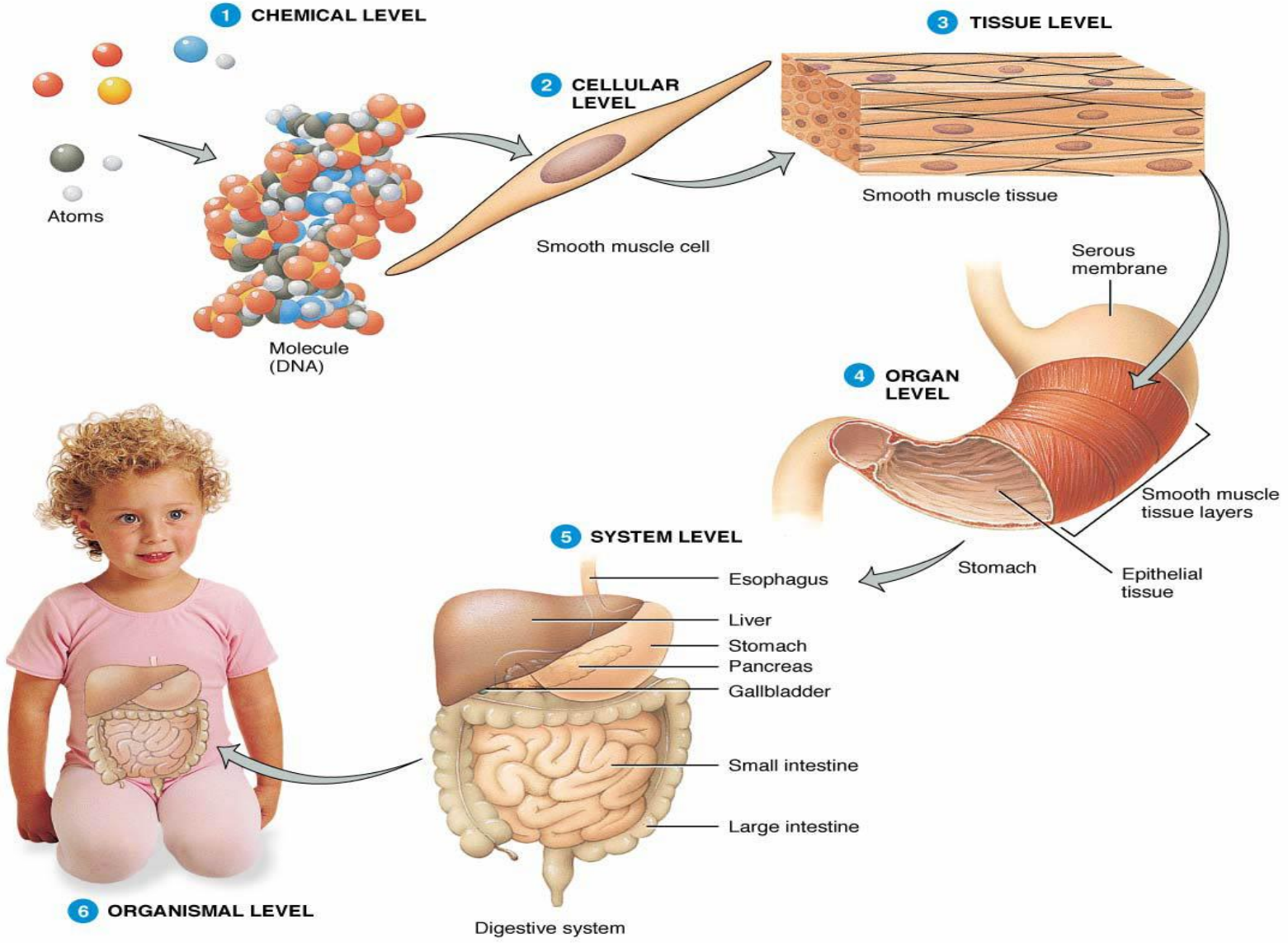
- Two branches of science—anatomy and physiology—provide the foundation for understanding the body's parts and functions.
- **Anatomy (** ***process of cutting)*** is the science of body *structures and the relationships among* them.
- **physiology** *is the science of body functions—how* the body parts work

- Because structure and function are so closely related, you will learn about the human body by studying its anatomy and physiology together.
- The structure of a part of the body allows performance of certain functions. For example, the bones of the skull join tightly to form a rigid case that protects the brain. The bones of the fingers are more loosely joined to allow a variety of movements.

- **Levels of structural organization**
- Exploration of the human body will extend from atoms and molecules to the whole person
- From the smallest to the largest, six levels of organization

1. Chemical level
2. Cellular level
3. Tissue level
4. Organ level
5. System level
6. Organismal level


1 CHEMICAL LEVEL
Atoms
Molecule (DNA)
2 CELLULAR LEVEL
Smooth muscle cell
3 TISSUE LEVEL
Smooth muscle tissue
Serous membrane
4 ORGAN LEVEL
Smooth muscle tissue layers
Epithelial tissue
Stomach
5 SYSTEM LEVEL
Esophagus
Liver
Stomach
Pancreas
Gallbladder
Small intestine
Large intestine
Digestive system
6 ORGANISMAL LEVEL

1.Chemical level.

- Includes **atoms, the smallest** units of matter that participate in chemical reactions, and **molecules, two or more atoms joined together.**
- **Certain** atoms, such as carbon (C), hydrogen (H), oxygen (O), nitrogen
- (N), phosphorus (P), calcium (Ca), and sulfur (S)

2.Cellular level.

- **Molecules combine to form cells, the basic** structural and functional units of an organism.
- Among the many kinds of cells in your body are muscle cells, nerve cells, and epithelial cells.

3. Tissue level

- **Tissues are groups of cells and the materials** surrounding them that work together to perform a particular function.
- There are just four basic types of tissue in your body: *epithelial tissue, connective tissue, muscular tissue,* and *nervous tissue.*
- *4.* **Organ level.**
- **At this level different types of tissues are** joined together.
- **organs are structures that are composed** of two or more different types of tissues; they have specific functions and usually have recognizable shapes.
- Examples of organs are the stomach, skin, bones, heart, liver, lungs, and brain.

- The stomach's outer covering is a *serous membrane, a layer of epithelial tissue and connective* tissue that reduces friction when the stomach moves and rubs against other organs.
- Underneath are the *smooth muscle tissue layers, which contract to churn and mix food and then* push it into the next digestive organ, the small intestine.
- The innermost lining is an *epithelial tissue layer that produces* fluid and chemicals responsible for digestion in the stomach.

- **System level**
- A **system consists** of related organs with a common function.
- An example of the system level, also called the **organ-system level, is the digestive system, which breaks down and absorbs** food.
- Its organs include the mouth, salivary glands, pharynx (throat), esophagus, stomach, small intestine, large intestine, liver, gallbladder, and pancreas

- **Organismal level.**
- All the parts of the human body functioning together constitute the total organism.

Systems of the Human Body

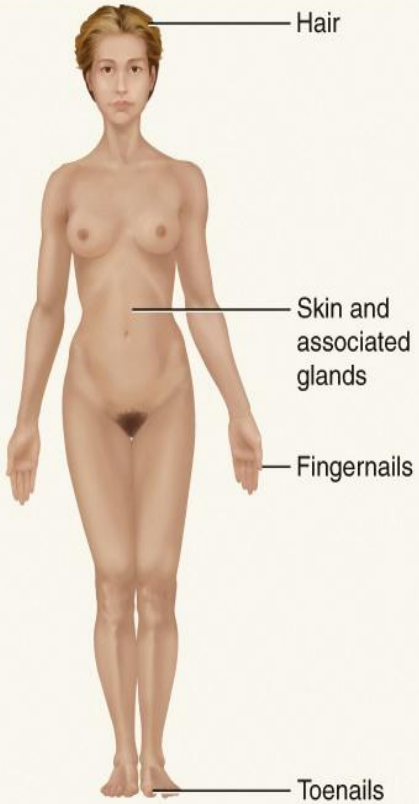
TABLE 1.2

The Eleven Systems of the Human Body

INTEGUMENTARY SYSTEM (CHAPTER 5)

Components: **Skin** and associated structures, such as **hair, fingernails** and **toenails, sweat glands**, and **oil glands**.

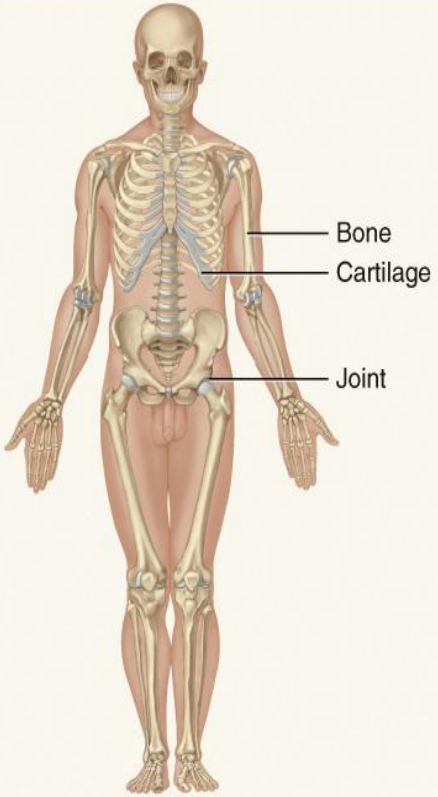
Functions: Protects body; helps regulate body temperature; eliminates some wastes; helps make vitamin D; detects sensations such as touch, pain, warmth, and cold; stores fat and provides insulation.



SKELETAL SYSTEM (CHAPTERS 6–9)

Components: **Bones** and **joints** of the body and their associated **cartilages.**

Functions: Supports and protects body; provides surface area for muscle attachments; aids body movements; houses cells that produce blood cells; stores minerals and lipids (fats).



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Systems of the Human Body

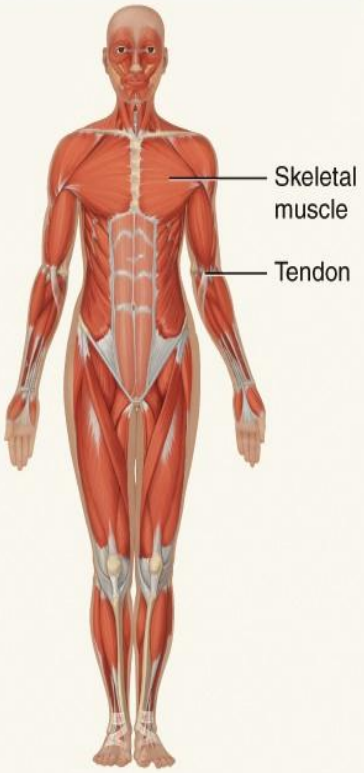
TABLE 1.2

The Eleven Systems of the Human Body

MUSCULAR SYSTEM (CHAPTERS 10, 11)

Components: Specifically, **skeletal muscle** tissue—muscle usually attached to bones (other muscle tissues include smooth and cardiac).

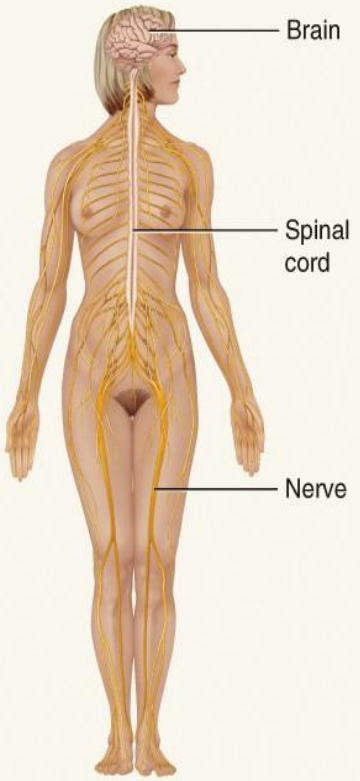
Functions: Participates in body movements, such as walking; maintains posture; produces heat.



NERVOUS SYSTEM (CHAPTERS 12–17)

Components: **Brain, spinal cord, nerves**, and special sense organs, such as **eyes** and **ears**.

Functions: Generates action potentials (nerve impulses) to regulate body activities; detects changes in body's internal and external environments, interprets changes, and responds by causing muscular contractions or glandular secretions.



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Systems of the Human Body

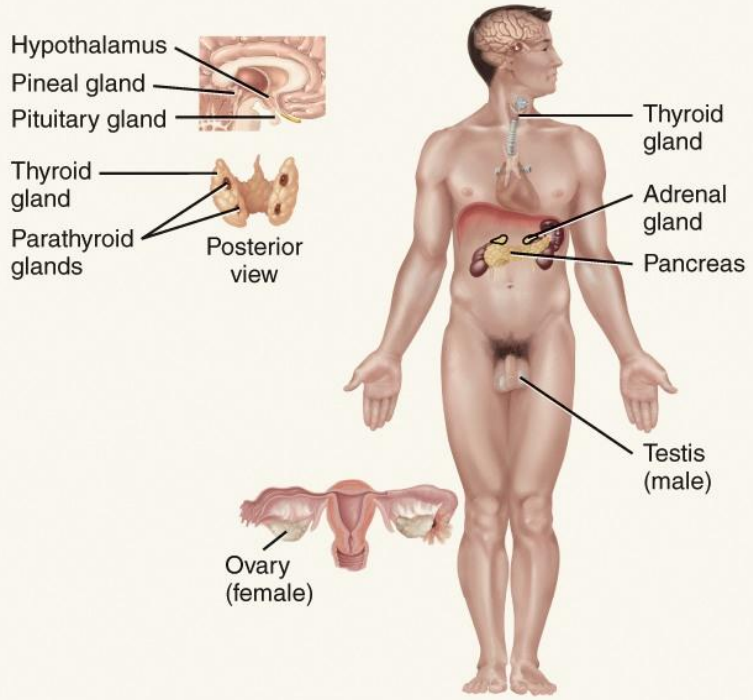
TABLE 1.2 CONTINUED

The Eleven Systems of the Human Body

ENDOCRINE SYSTEM (CHAPTER 18)

Components: Hormone-producing glands **(pineal gland, hypothalamus, pituitary gland, thymus, thyroid gland, parathyroid glands, adrenal glands, pancreas, ovaries**, and **testes)** and hormone-producing cells in several other organs.

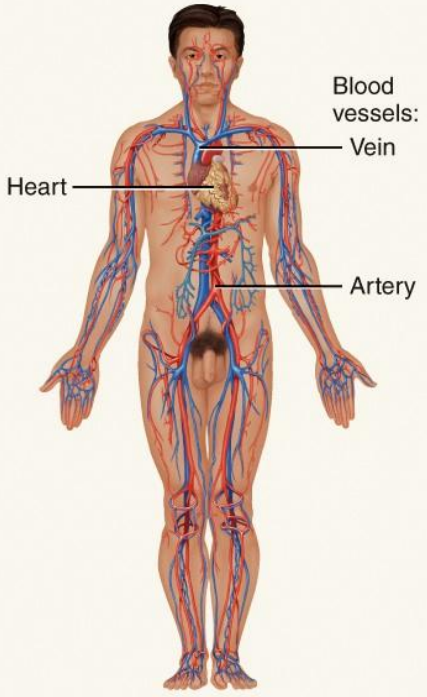
Functions: Regulates body activities by releasing hormones (chemical messengers transported in blood from endocrine gland or tissue to target organ).



CARDIOVASCULAR SYSTEM (CHAPTERS 19–21)

Components: **Blood, heart**, and **blood vessels**.

Functions: Heart pumps blood through blood vessels; blood carries oxygen and nutrients to cells and carbon dioxide and wastes away from cells and helps regulate acid–base balance, temperature, and water content of body fluids; blood components help defend against disease and repair damaged blood vessels.



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Systems of the Human Body

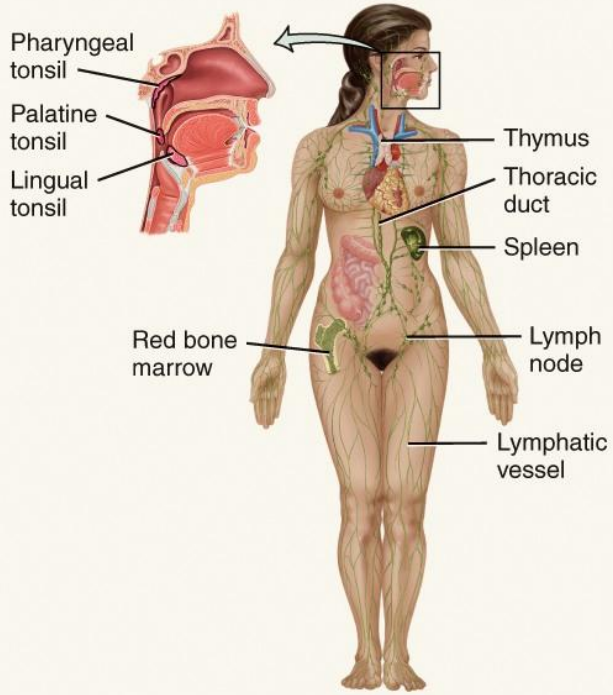
TABLE 1.2 CONTINUED

The Eleven Systems of the Human Body

LYMPHATIC SYSTEM AND IMMUNITY (CHAPTER 22)

Components: **Lymphatic fluid** and **vessels; spleen, thymus, lymph nodes,** and **tonsils**; cells that carry out immune responses (**B cells, T cells**, and others).

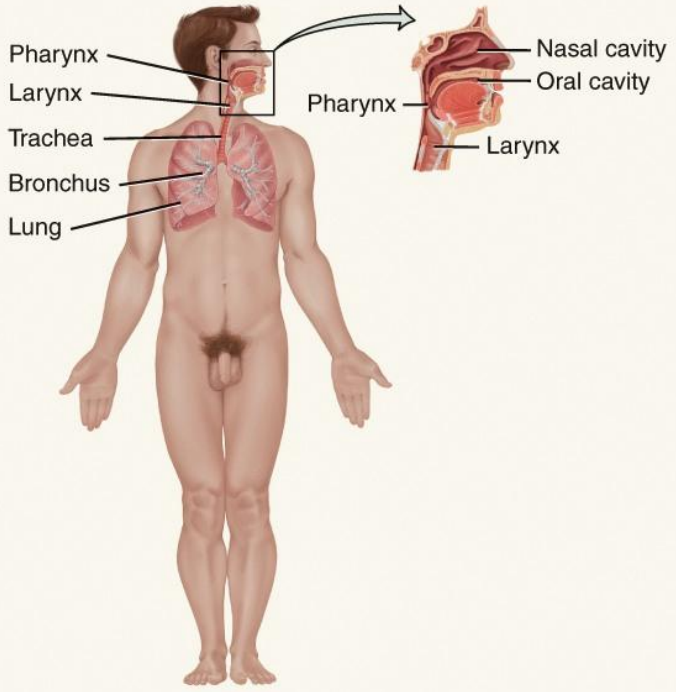
Functions: Returns proteins and fluid to blood; carries lipids from gastrointestinal tract to blood; contains sites of maturation and proliferation of B cells and T cells that protect against disease-causing microbes.



RESPIRATORY SYSTEM (CHAPTER 23)

Components: **Lungs** and air passageways such as the **pharynx** (throat), **larynx** (voice box), **trachea** (windpipe), and **bronchial tubes** leading into and out of lungs.

Functions: Transfers oxygen from inhaled air to blood and carbon dioxide from blood to exhaled air; helps regulate acid–base balance of body fluids; air flowing out of lungs through vocal cords produces sounds.



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Systems of the Human Body

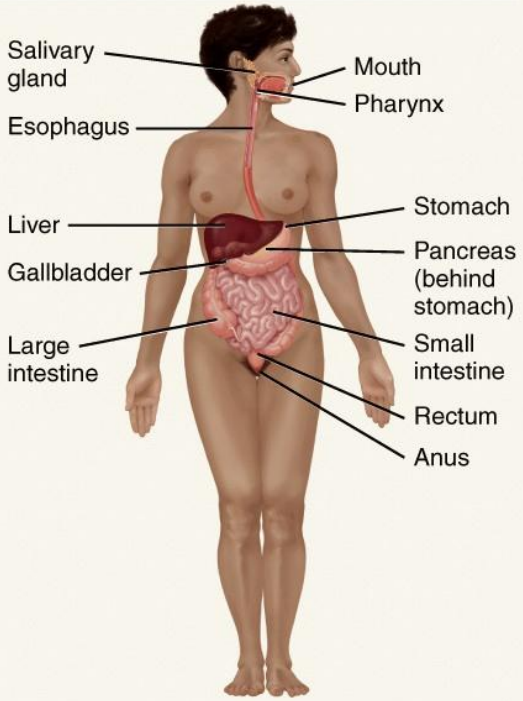
TABLE 1.2 CONTINUED

The Eleven Systems of the Human Body

DIGESTIVE SYSTEM (CHAPTER 24)

Components: Organs of gastrointestinal tract, a long tube that includes the **mouth, pharynx** (throat), **esophagus** (food tube), **stomach, small** and **large intestines**, and **anus**; also includes accessory organs that assist in digestive processes, such as **salivary glands, liver, gallbladder**, and **pancreas**.

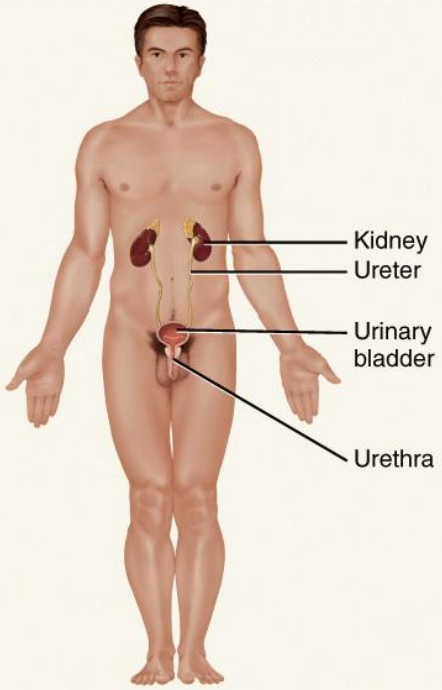
Functions: Achieves physical and chemical breakdown of food; absorbs nutrients; eliminates solid wastes.



URINARY SYSTEM (CHAPTER 26)

Components: **Kidneys, ureters, urinary bladder**, and **urethra**.

Functions: Produces, stores, and eliminates urine; eliminates wastes and regulates volume and chemical composition of blood; helps maintain the acid–base balance of body fluids; maintains body's mineral balance; helps regulate production of red blood cells.



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Systems of the Human Body

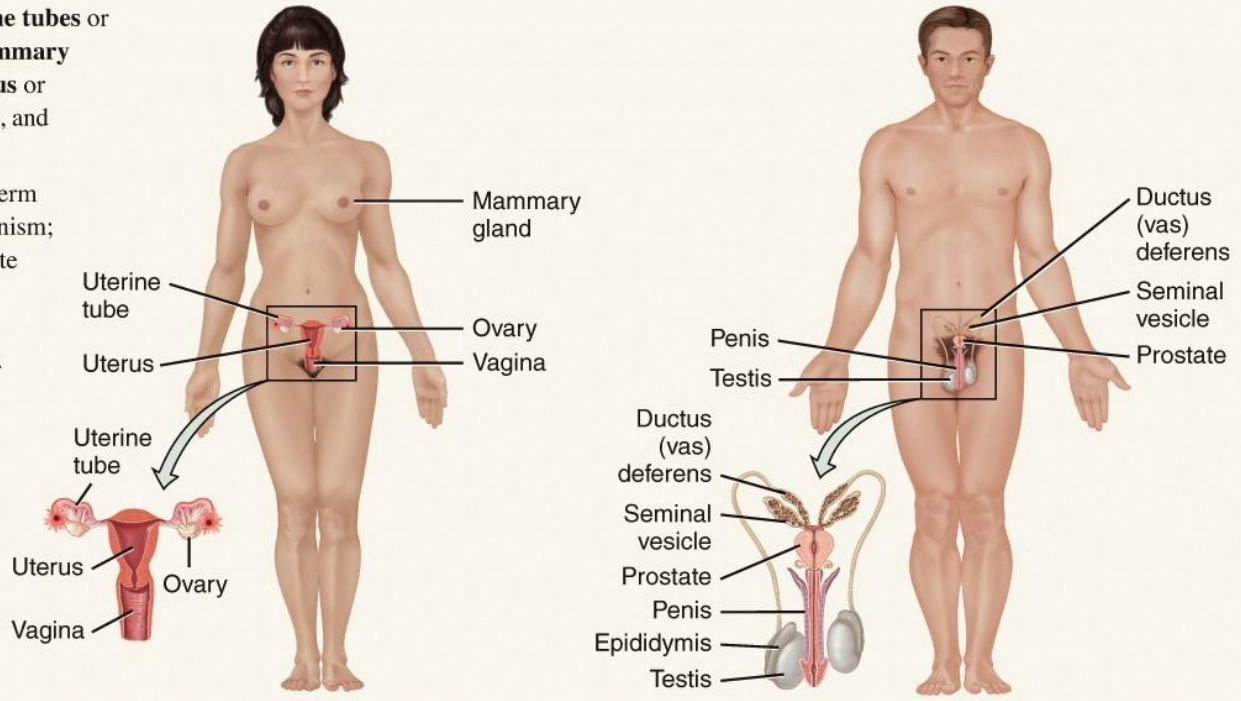
TABLE 1.2 CONTINUED

The Eleven Systems of the Human Body

REPRODUCTIVE SYSTEMS (CHAPTER 28)

Components: **Gonads** (**testes** in males and **ovaries** in females) and associated organs (**uterine tubes** or *fallopian tubes*, **uterus, vagina**, and **mammary glands** in females and **epididymis, ductus** or **vas deferens, seminal vesicles, prostate**, and **penis** in males).

Functions: Gonads produce gametes (sperm or oocytes) that unite to form a new organism; gonads also release hormones that regulate reproduction and other body processes; associated organs transport and store gametes; mammary glands produce milk.



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Basic Anatomical Terminology

- Body positions
- Regional names
- Directional terms
- Planes and sections
- Body cavities

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Body Positions

- Anatomical position is a standardized method of observing or imaging the body that allows precise and consistent anatomical reference
- Person stands erect, facing the observer, the upper extremities are places at the sides, the palms of the hands are turned forward, and the feet are flat on the floor

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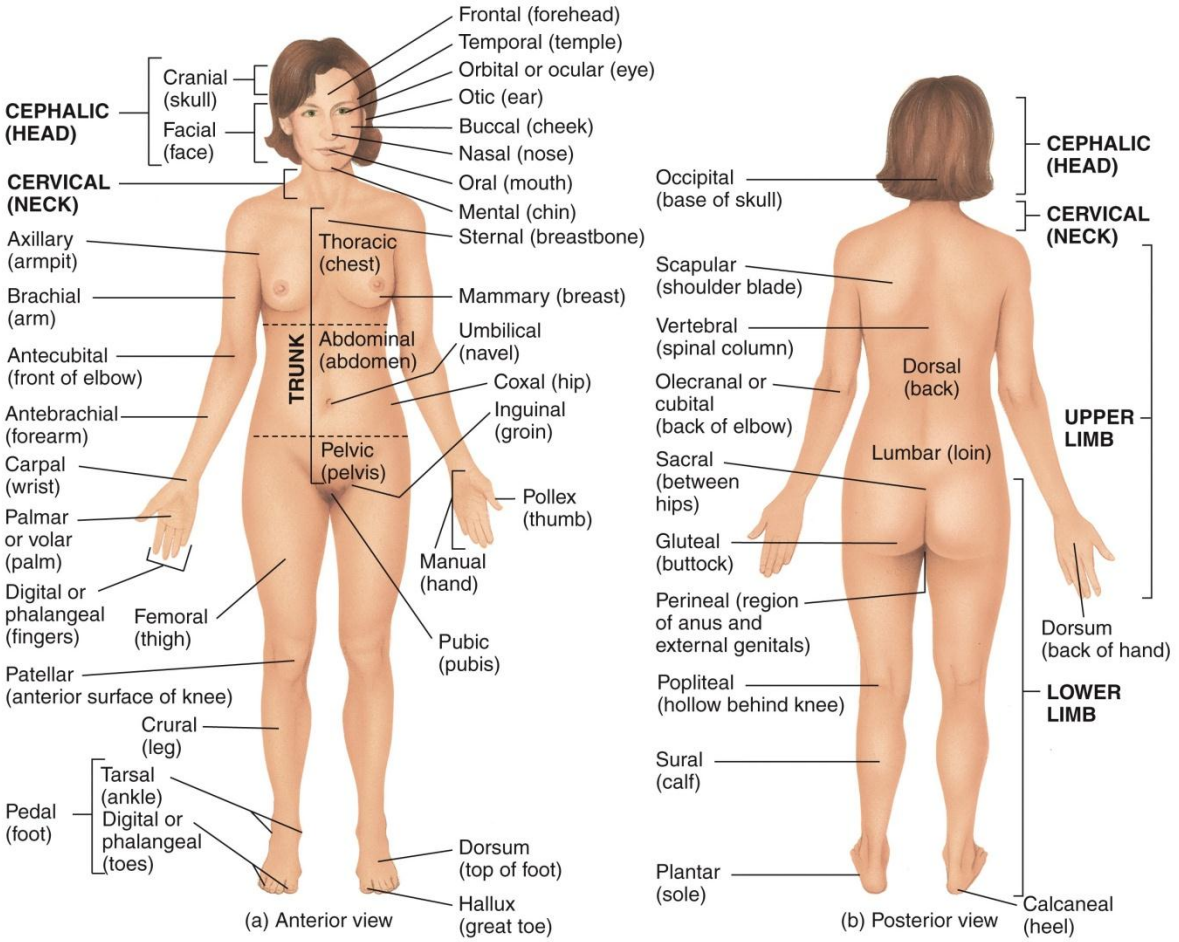
Regional Names

Regional names are names given to specific regions of the body for reference



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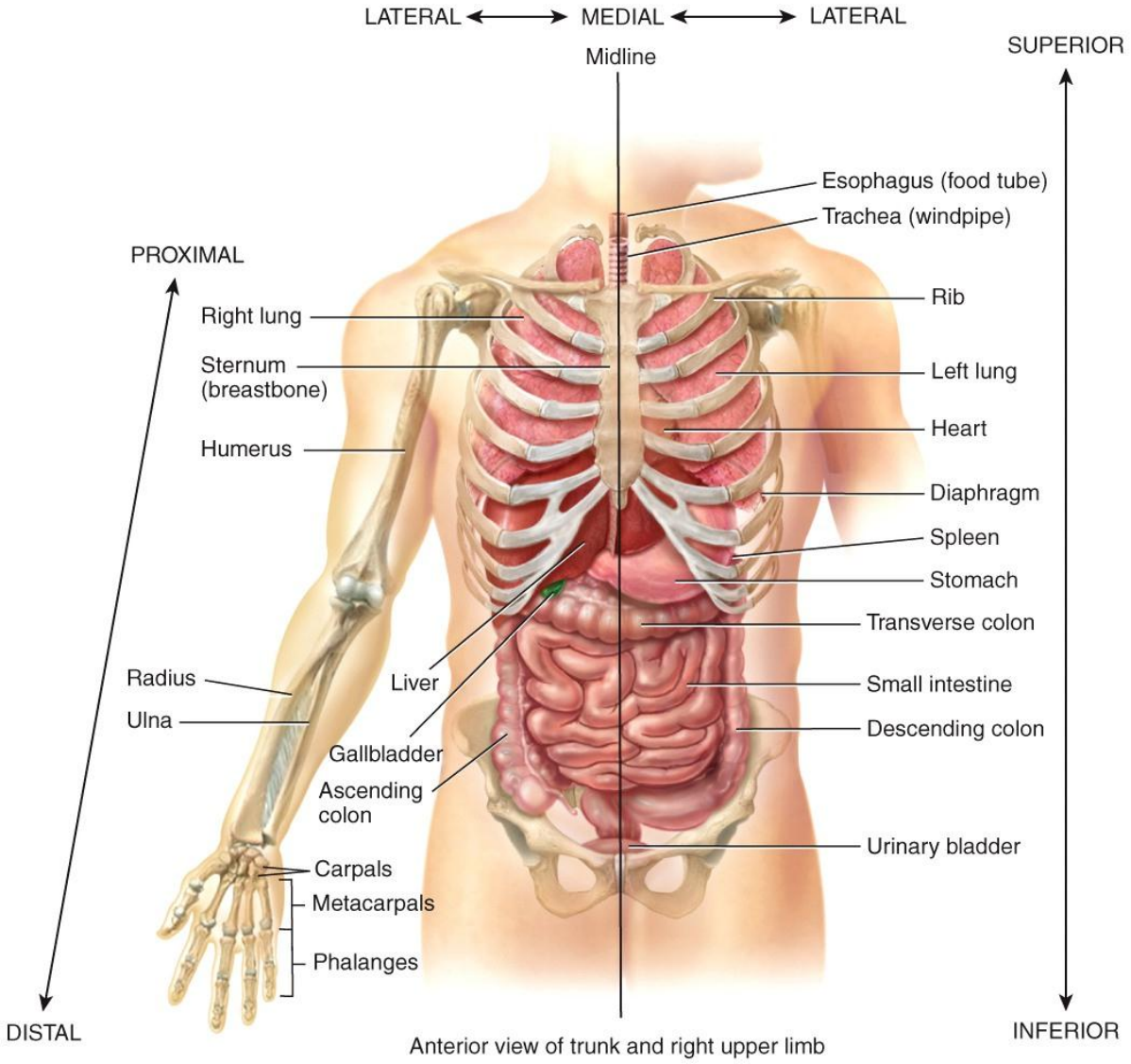
Directional Terms

Directional terms are used to precisely locate one part of the body relative to another



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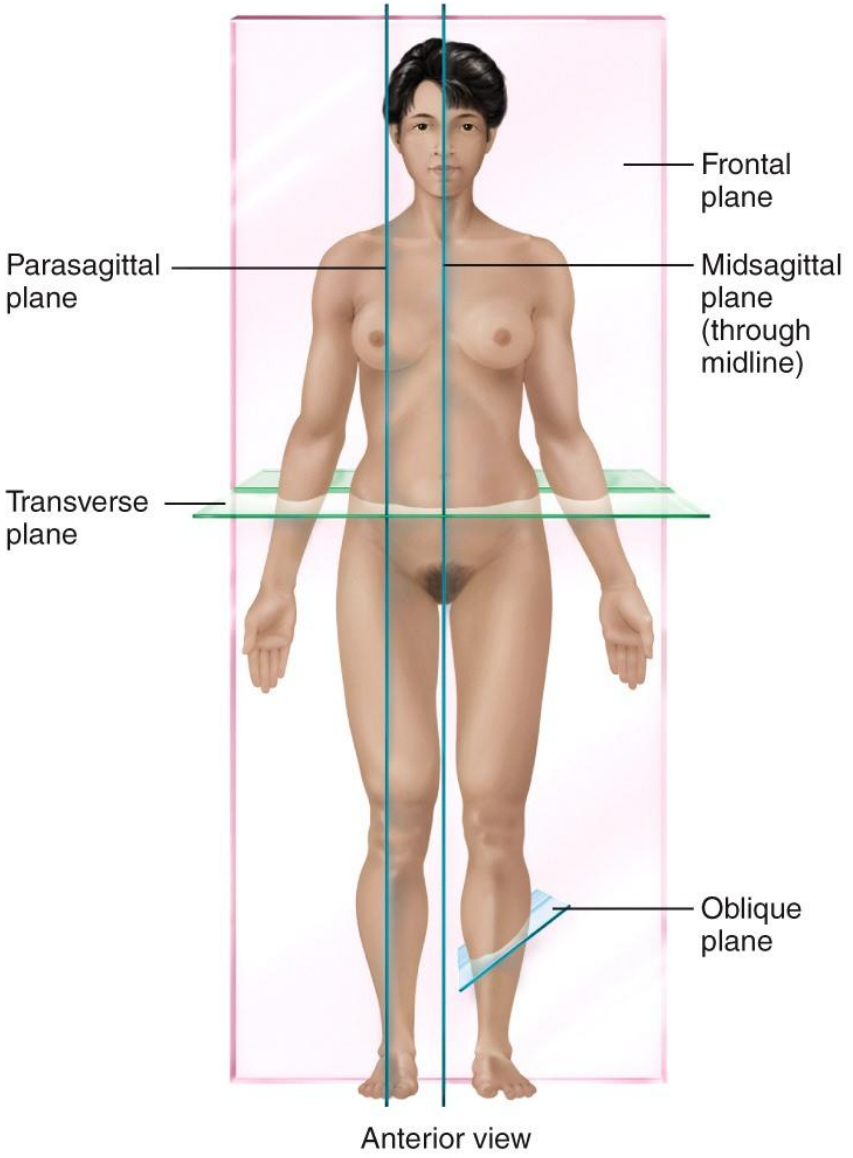
Planes & Sections

Planes are imaginary flat surfaces that are used to divide the body



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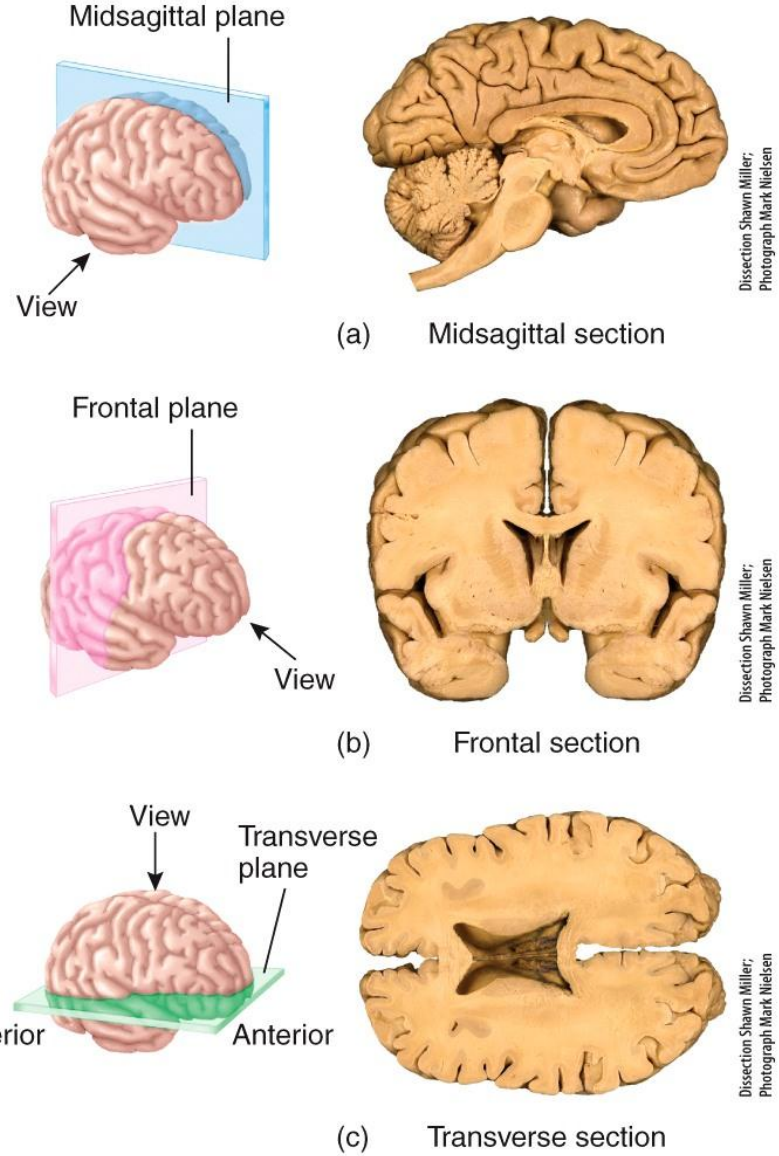
Practicing Planes & Sections



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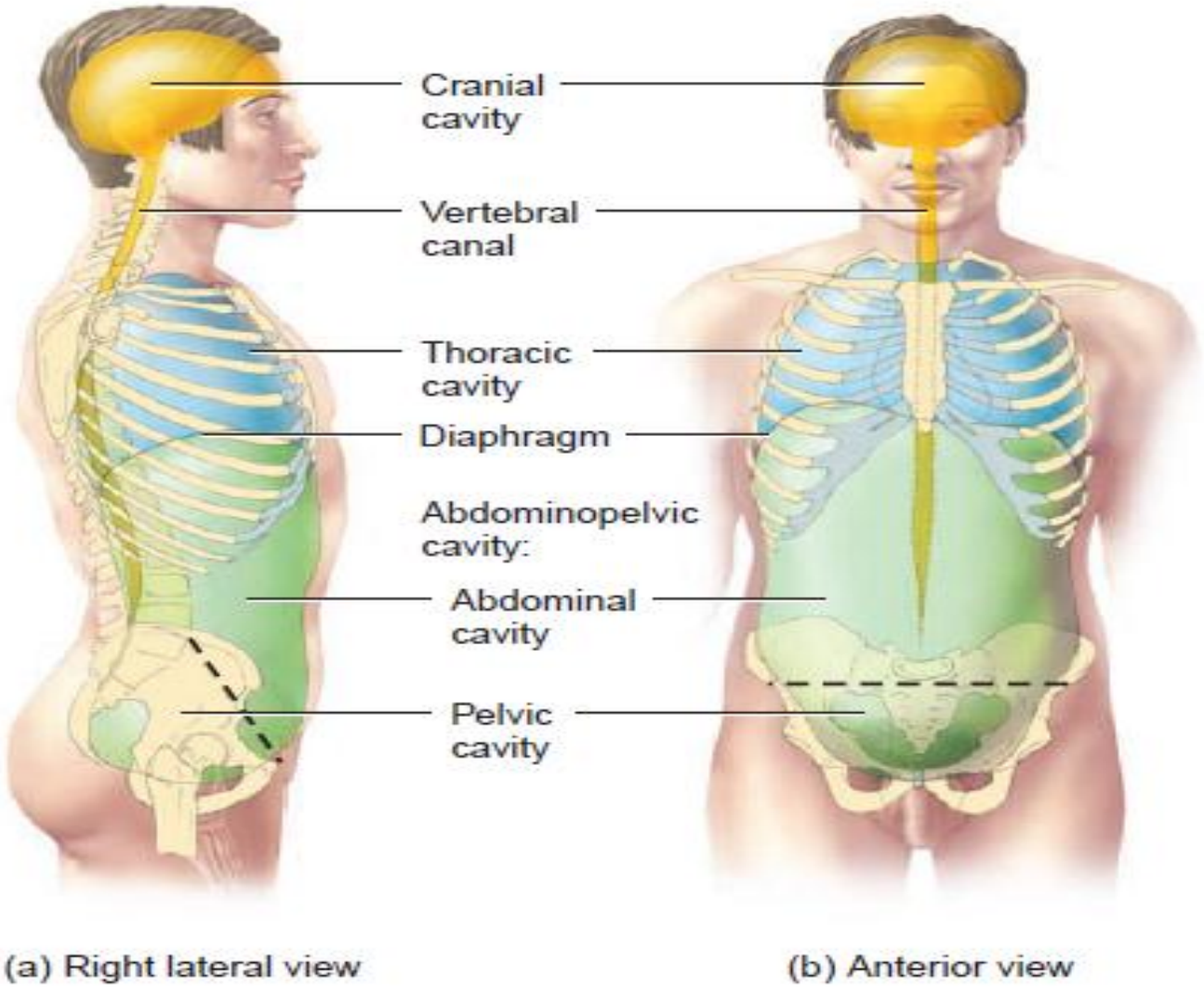
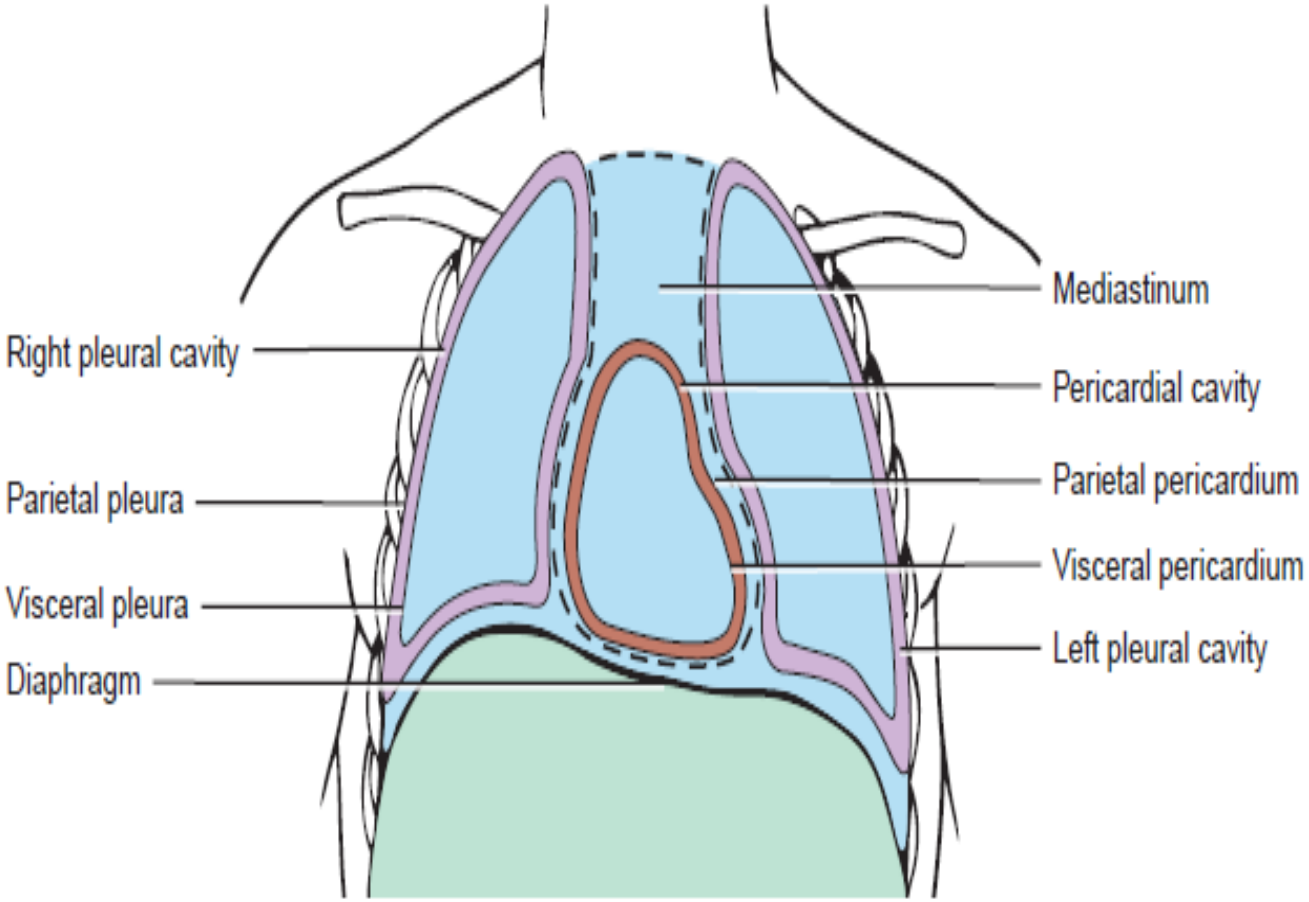
Body cavities

- **Body cavities are spaces within the body that help protect, separate,** and support internal organs.

- The cranial bones form the **cranial cavity, which contains the** brain.
- The bones of the vertebral column (backbone) form the **vertebral (spinal) canal, which contains the spinal cord.**
- The major body cavities of the trunk are the thoracic and abdominopelvic cavities.


Cranial cavity
Vertebral canal
Thoracic cavity
Diaphragm
Abdominopelvic cavity:
Abdominal cavity
Pelvic cavity
(a) Right lateral view
(b) Anterior view

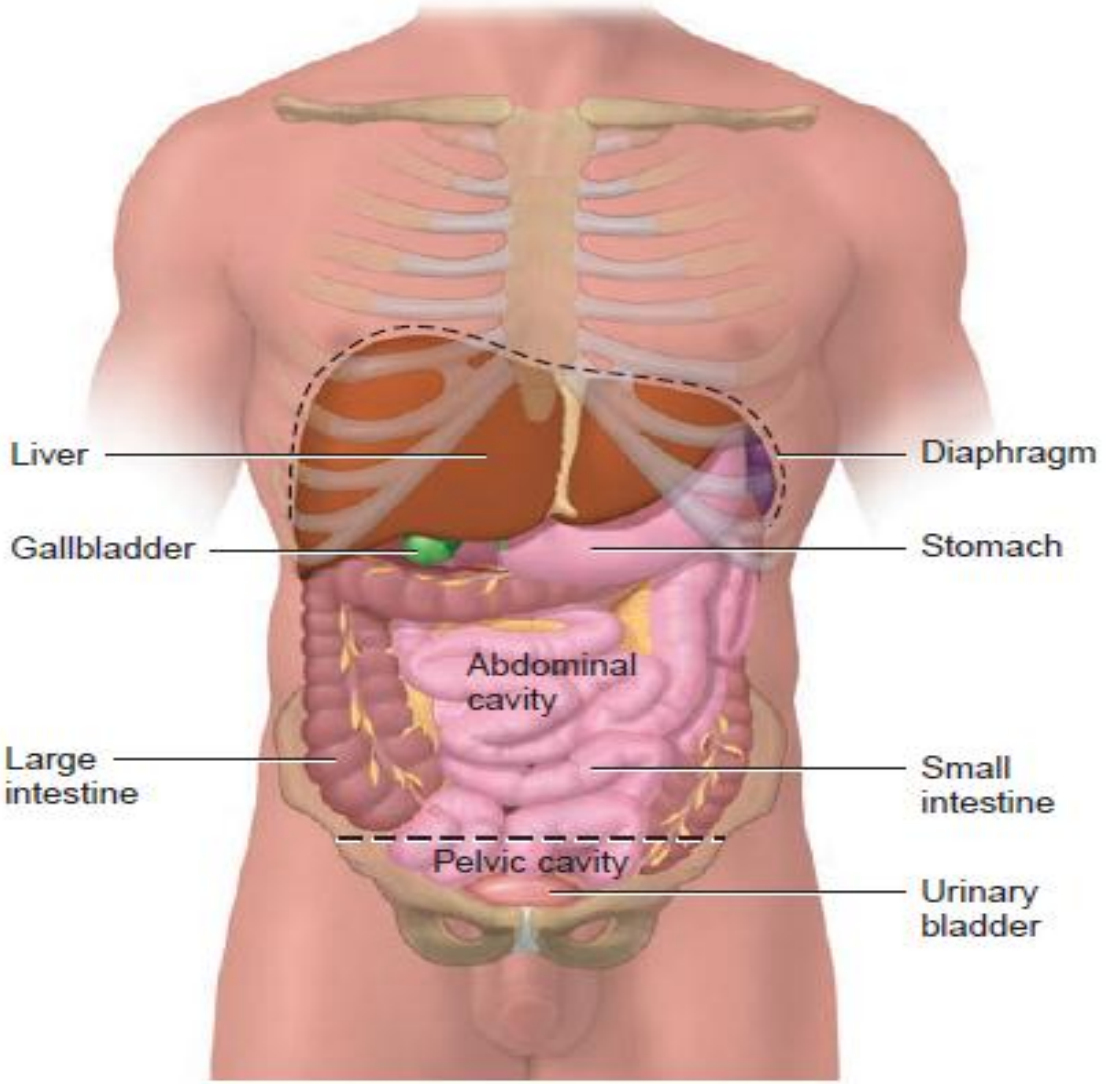
- The **thoracic cavity (thor-AS-ik;** *thorac- chest) or chest cavity is formed by the* ribs, the muscles of the chest, the sternum (breastbone), and the thoracic portion of the vertebral column (backbone).
- Within the thoracic cavity are the **pericardial cavity (per-i-KAR-de¯ -al;** *peri- around; -cardial heart), a fluid-filled space that surrounds* the heart, and two fluid-filled spaces called **pleural cavities** (PLOOR-al; *pleur- rib or side), one around each lung.*
- The central part of the thoracic cavity is an anatomical region called the **mediastinum (me¯ -de¯ -as-TI¯ -num;** ***media- middle;***



(a) Anterior view of thoracic cavity

- The **abdominopelvic cavity (ab-dom-i-no¯-PEL-vik;**) extends from the diaphragm to the groin and is encircled by the abdominal wall and the bones and muscles of the pelvis.
- the abdominopelvic cavity is divided into two portions,

- The superior portion, the **abdominal cavity** (*abdomin- belly), contains the stomach, spleen, liver, gallbladder,* small intestine, and most of the large intestine.
- The inferior portion, the **pelvic cavity (*pelv- basin), contains the*** urinary bladder, portions of the large intestine, and internal organs of the reproductive system.
- Organs inside the thoracic and abdominopelvic cavities are called **viscera (VIS-er-a).**



Anterior view

- The science that deals with why, when, and where diseases occur and how they are transmitted among individuals in a community is known as **epidemiology (ep-i-de¯-me¯-OL-o¯-je¯;** ***epi-*** upon; *-demi people).*
- ***Pharmacology (far-ma-KOL-o¯-je¯;*** *pharmac-* *drug) is the science that deals with the effects and* uses of drugs in the treatment of disease.

- **Diagnosis (dı -ag-NO-sis; *dia- through; -gnosis knowledge) is the*** science and skill of distinguishing one disorder or disease from another.
- The patient's symptoms and signs, his or her medical history, a physical exam, and laboratory tests provide the basis for making a diagnosis.
- Taking a *medical history consists of collecting information about* events that might be related to a patient's illness. These include the chief complaint (primary reason for seeking medical attention), history of present illness, past medical problems, family medical problems, social history, and review of symptoms.
- A *physical examination is an orderly* evaluation of the body and its functions. This process includes the noninvasive techniques of inspection.

- An **autopsy (AW-top-se͞ seeing with one's own eyes) is a postmortem** (after death) examination of the body and dissection of its internal organs to confirm or determine the cause of death.

LEVEL OF ORGANIZATION

INTRODUCTION TO HUMAN BODY

NEHAL PHARMACY EDUCATION

Chemical level

Atoms– the smallest units of matter that participate in chemical reactions

C, H, O, N, P, Ca, S

molecules, two or more atoms joined together

glucose

Cellular level

Molecules combine to form **cells,** the basic structural and functional units of an organism.

muscle cells, nerve cell

Tissue level

groups of cells and the material surrounding them that work together to perform a particular function

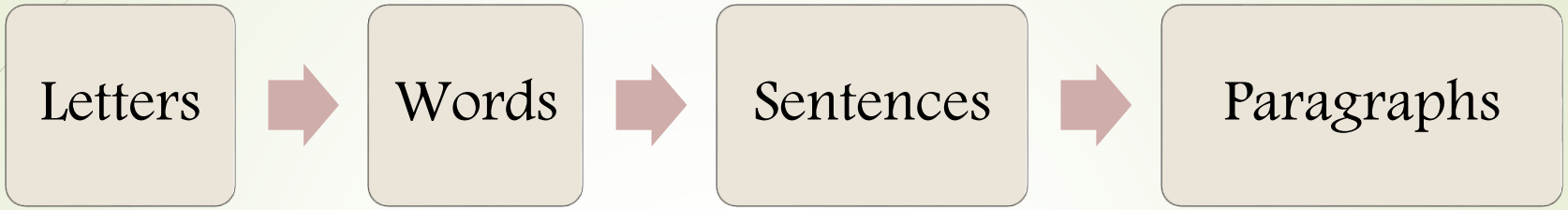
epithelial tissue, connective tissue, muscular tissue, and nervous tissue

Organ level

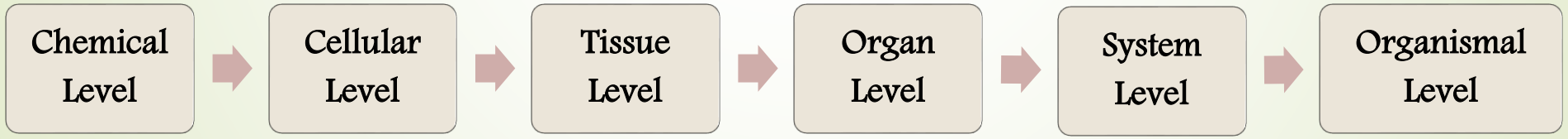
organs are structures that are composed of two or more different types of tissues

skin, bones, heart, liver, lungs, and brain

levels of organization of a language



levels of organization of the human body



System level

Consists of related organs with a common function

digestive system–breaks down and absorbs food

Its organs include the mouth, salivary glands, pharynx (throat), oesophagus, stomach, small intestine, large intestine, liver, gallbladder, and pancreas

Organismal level

All the parts of the human body functioning together constitute the total organism.

BASIC LIFE PROCESSES

INTRODUCTION TO HUMAN BODY

BASIC LIFE PROCESS–distinguish organisms, or living things, from non living things.

- Metabolism
- Responsiveness
- Movement
- Growth
- Differentiation
- Reproduction

Metabolism

Metabolism

sum of all the chemical processes

Catabolism–breakdown of complex chemical substances into simpler components

(digestive processes catabolize (split) proteins in food into amino acids)

Anabolism–the building up of complex chemical substances from smaller, simpler Components

(amino acids are then used to anabolize (build) new proteins that make up body structures such as muscles and bones.)

Responsiveness

- body's ability to detect and respond to changes.
- For example, a decrease in body temperature represents a change in the internal environment (within the body)

Movement

- motion of the whole body, individual organs, single cells, and even tiny structures inside cells.

- For example, the coordinated action of leg muscles moves your whole body from one place to another when you walk or run.

Growth

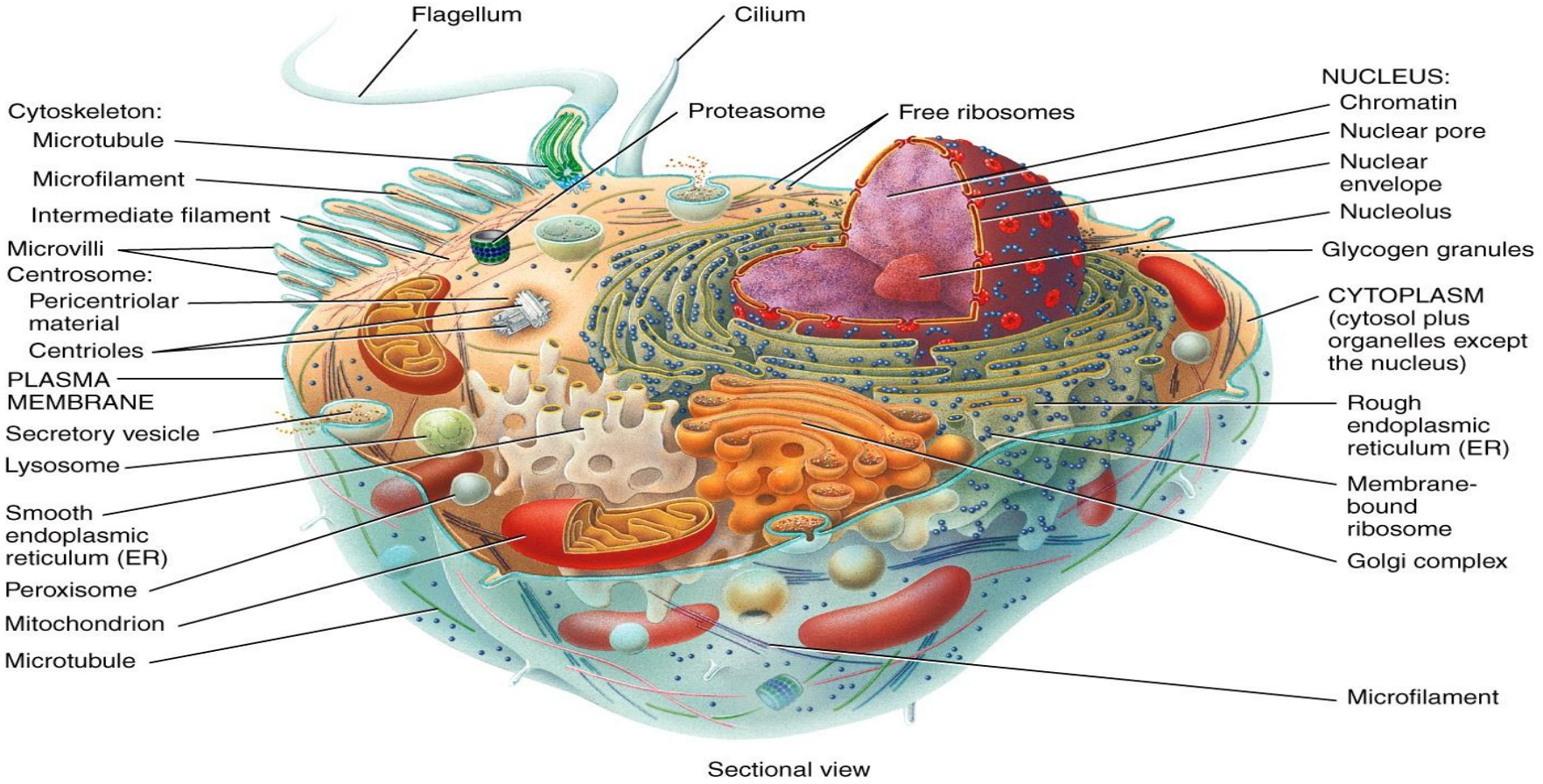
- an increase in body size that results from an increase in the size of existing cells, an increase in the number of cells, or both.

Differentiation

- is the development of a cell from an unspecialized to a specialized state.
- For example, red blood cells and several types of white blood cells all arise from the same unspecialized precursor cells in red bone marrow.
- Such precursor cells, which can divide and give rise to cells that undergo differentiation, are known as **stem cells**.

Reproduction

- either to the formation of new cells
  - for tissue growth,
  - repair, or
  - replacement,
- or to the production of a new individual.



The Cellular Level of Organization

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Parts of a Cell

The cell can be subdivided into 3 parts:

1. Plasma (cell) membrane
2. Cytoplasm
   - Cytosol
   - Organelles
3. Nucleus
   - Chromosomes
   - Genes

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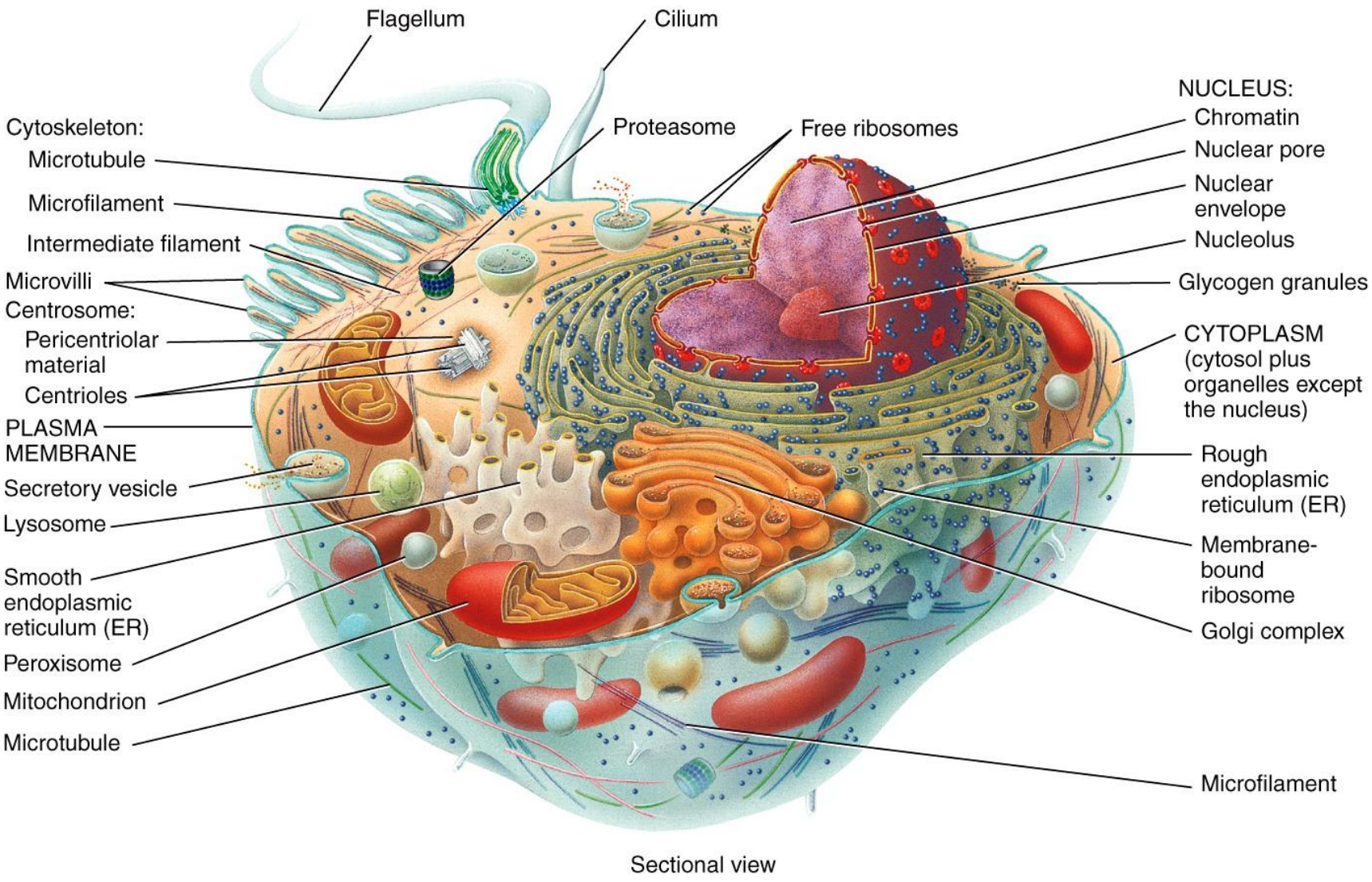
Parts of a Cell: Cytoplasm



Sectional view

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Cytoplasm

Cytosol is also known as the intracellular fluid portion of the cytoplasm

Organelles are the specialized structures that have specific shapes and perform specific functions

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- The cytoplasm consists of a clear liquid (cytosol), a supportive cytoskeleton, and networks of membranes and organelles.

Endoplasmic reticulum is made up of membranes, flattened sacs, and vesicles, and provides a tubular transport system inside the cell.

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- With ribosomes, endoplasmic reticulum (ER) is **rough ER**, and functions in protein synthesis.

- Without ribosomes, it is **smooth ER**, and functions in lipid synthesis

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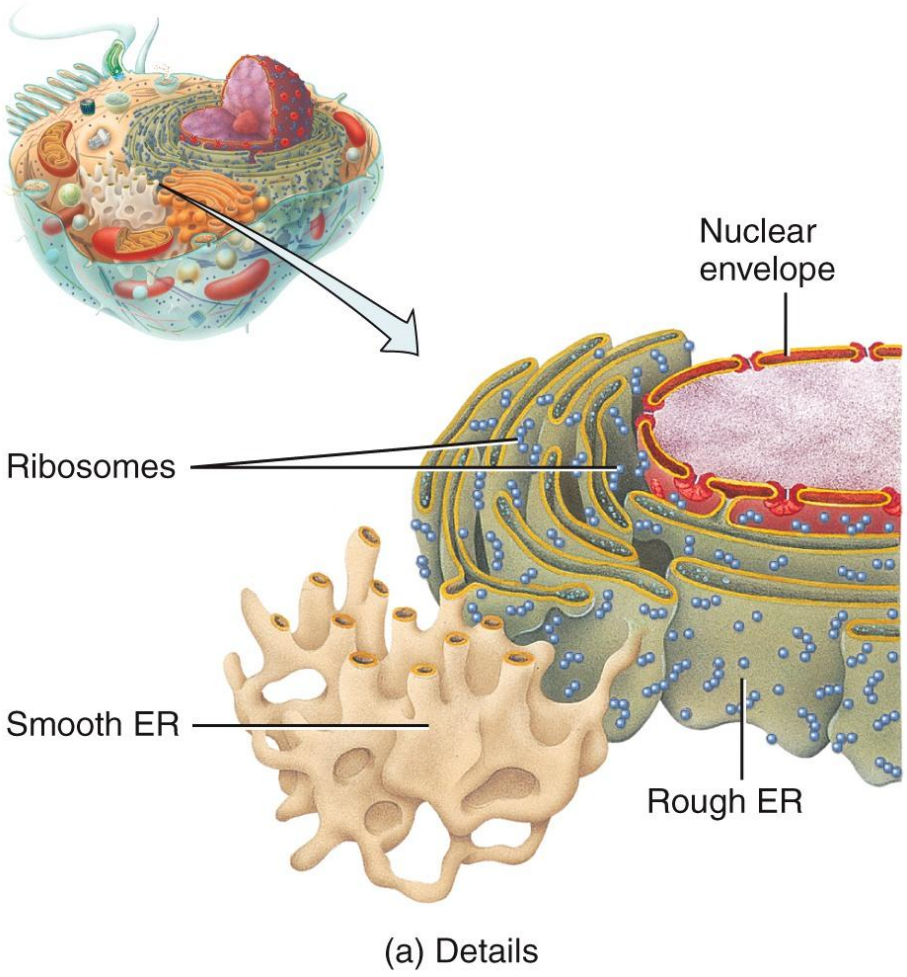
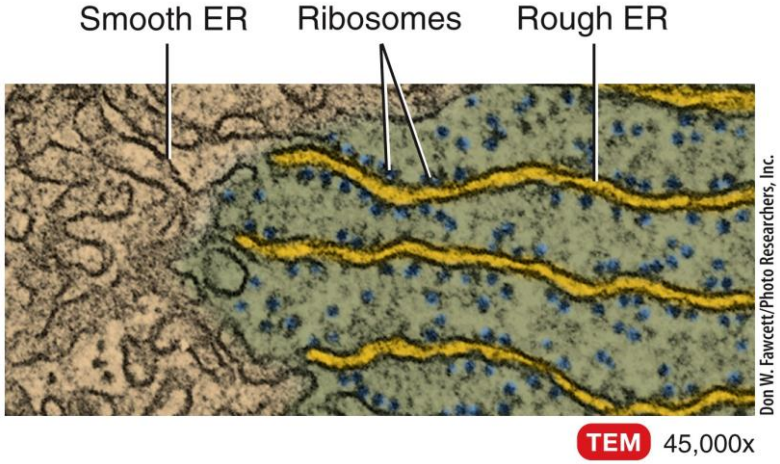
Endoplasmic Reticulum



(a) Details



(b) Transverse section

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Ribosomes

Ribosomes *are the sites of protein* synthesis.

The name of these tiny organelles reflects their high content of one type of ribonucleic acid, **ribosomal RNA**

Structurally, a ribosome consists of two subunits, one about half the size of the other.

Some ribosomes are attached to the outer surface of the nuclear membrane.

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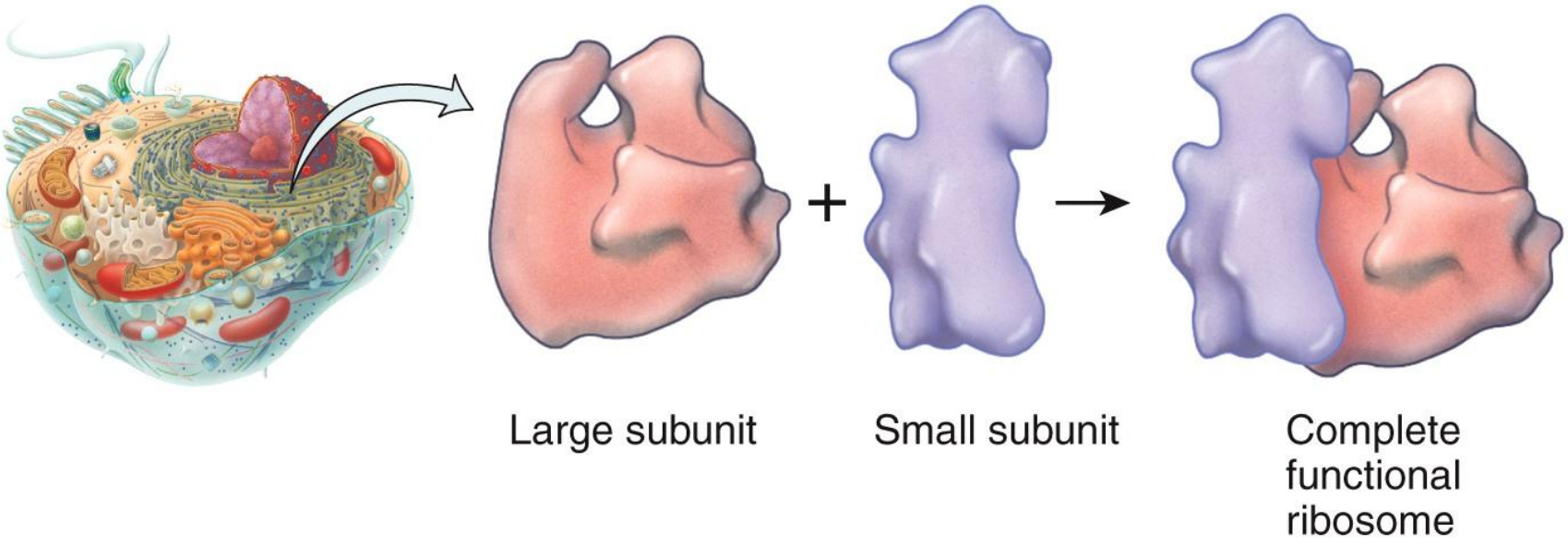
Ribosomes



Details of ribosomal subunits

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- **Mitochondria** are the powerhouses of the cell and contain enzymes needed for aerobic respiration.
- i. The inner membrane of the mitochondrion is folded into cristae which hold the enzymes needed in energy transformations to make ATP.
- ii. Very active cells contain thousands of mitochondria.

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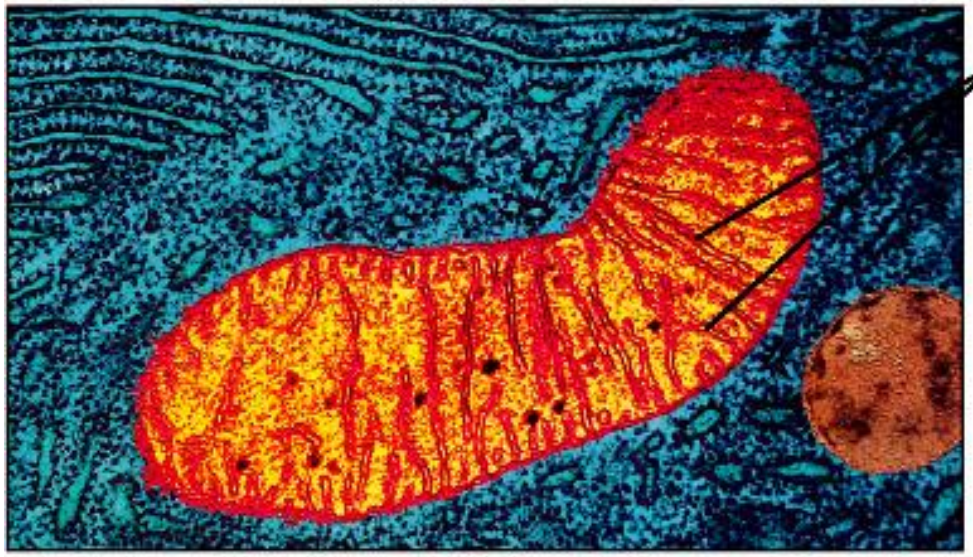
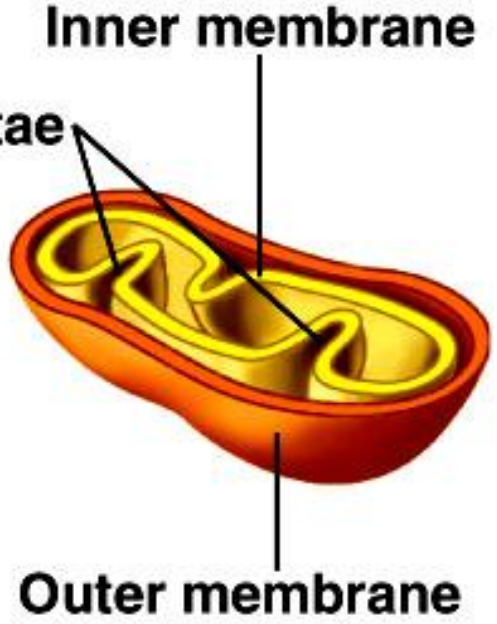


Cristae



A

B

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Lysosomes are the "garbage disposals" of the cell and contain digestive enzymes to break up old cell components and bacteria.

Peroxisomes contain enzymes that function in the synthesis of bile acids, breakdown of lipids, degradation of rare biochemicals, and detoxification of alcohol.

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MICROFILAMENTS These are the thinnest elements of the cytoskeleton.

They are composed of the protein *actin, and are most* prevalent at the edge of a cell. Microfilaments have two general functions: They help generate movement and provide mechanical support.

INTERMEDIATE FILAMENTS As their name suggests, these filaments

are thicker than microfilaments but thinner than microtubules They are found in parts of cells subject to mechanical stress, help stabilize the position of organelles such as the nucleus, and help attach cells to one another.

MICROTUBULES These are the largest of the cytoskeletal components and are long, unbranched hollow tubes composed mainly of the protein *tubulin. The assembly of microtubules begins in* an organelle called the centrosome

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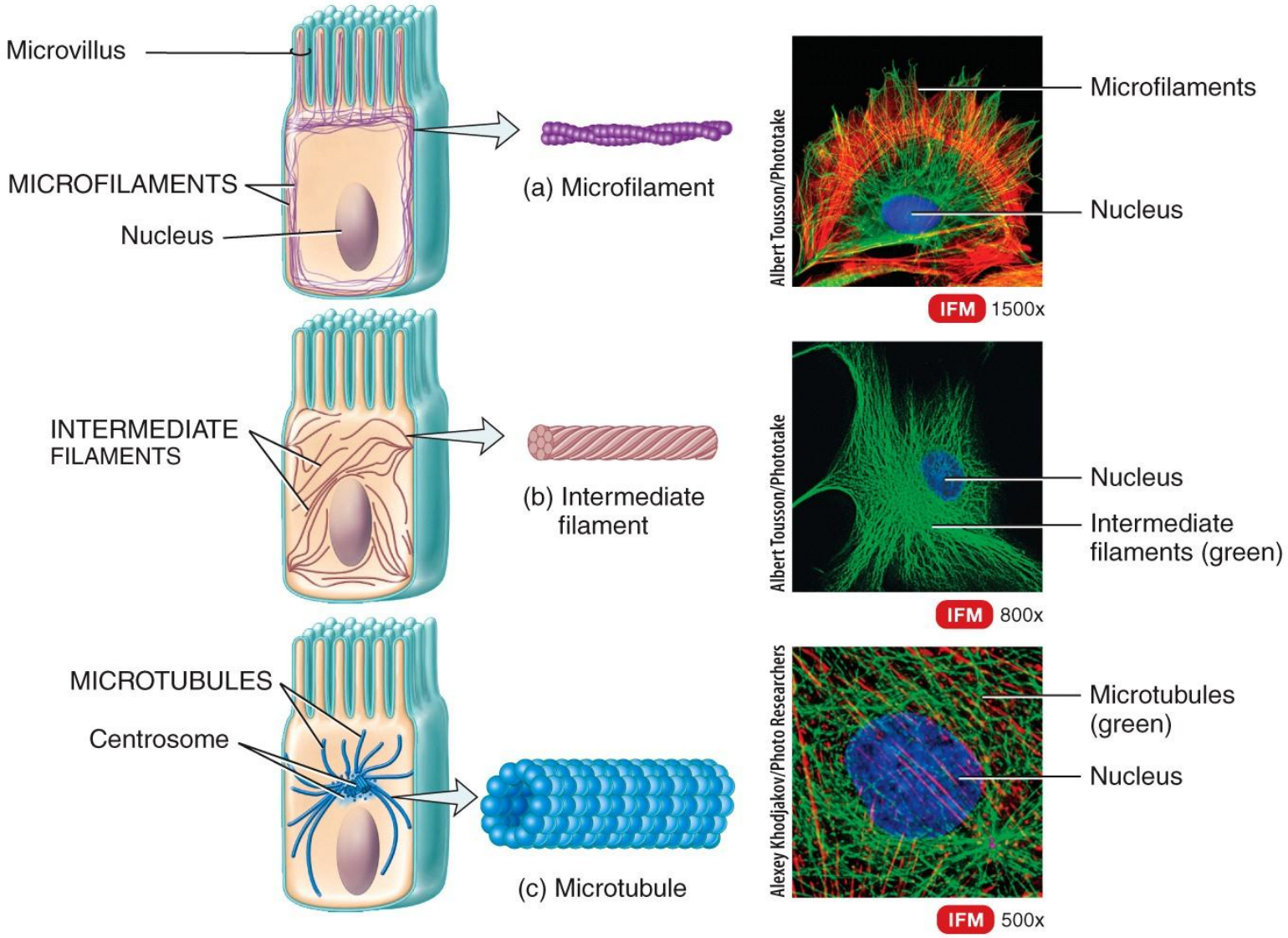
Cytoskeleton



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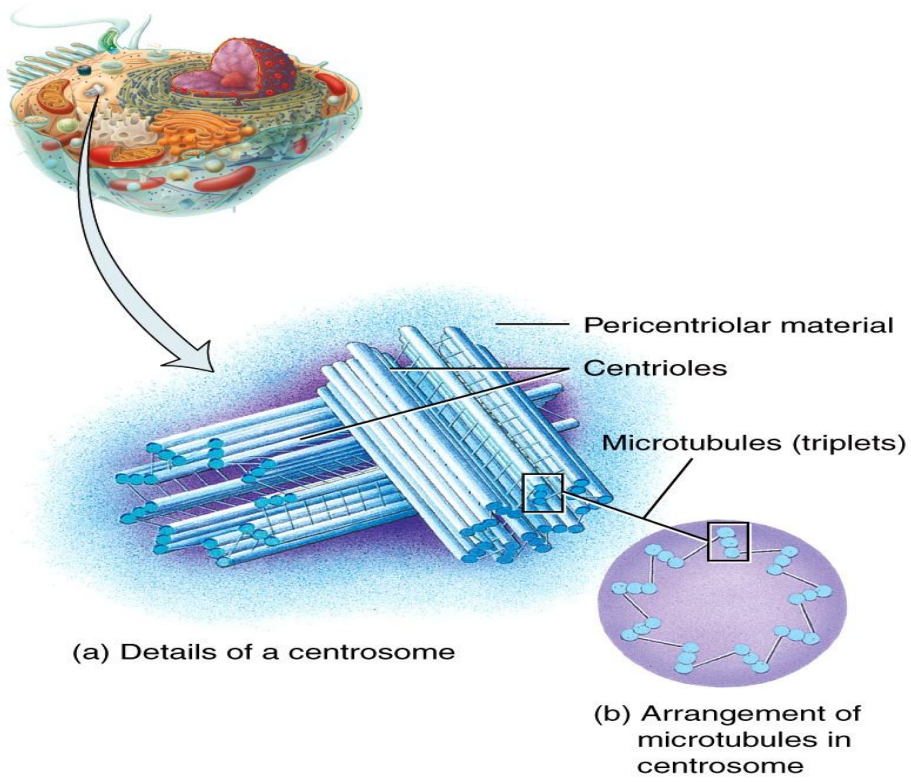
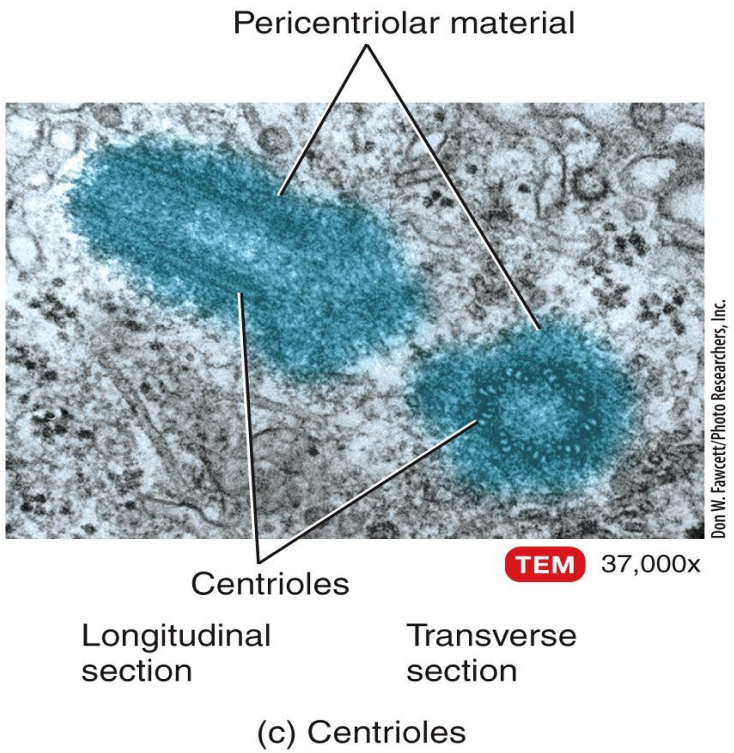
Centrosome/Centrioles





(c) Centrioles

The **centrosome, located near the nucleus, consists of two** components: a pair of centrioles and pericentriolar material

The pericentriolar material of the centrosome contains tubulins that build microtubules in nondividing cells and form the mitotic spindle during cell division.

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Cilia and Flagella

Microtubules are the dominant components of cilia and flagella, which are motile projections of the cell surface.

Cilia *are numerous,* short, hairlike projections that extend from the surface of the cell.

Many cells of the respiratory tract, for example, have hundreds of cilia that help sweep foreign particles trapped in mucus away from the lungs.

Flagella *are similar* in structure to cilia but are typically much longer. Flagella usually move an entire cell. A flagellum generates forward motion along its axis by rapidly wiggling in a wavelike pattern

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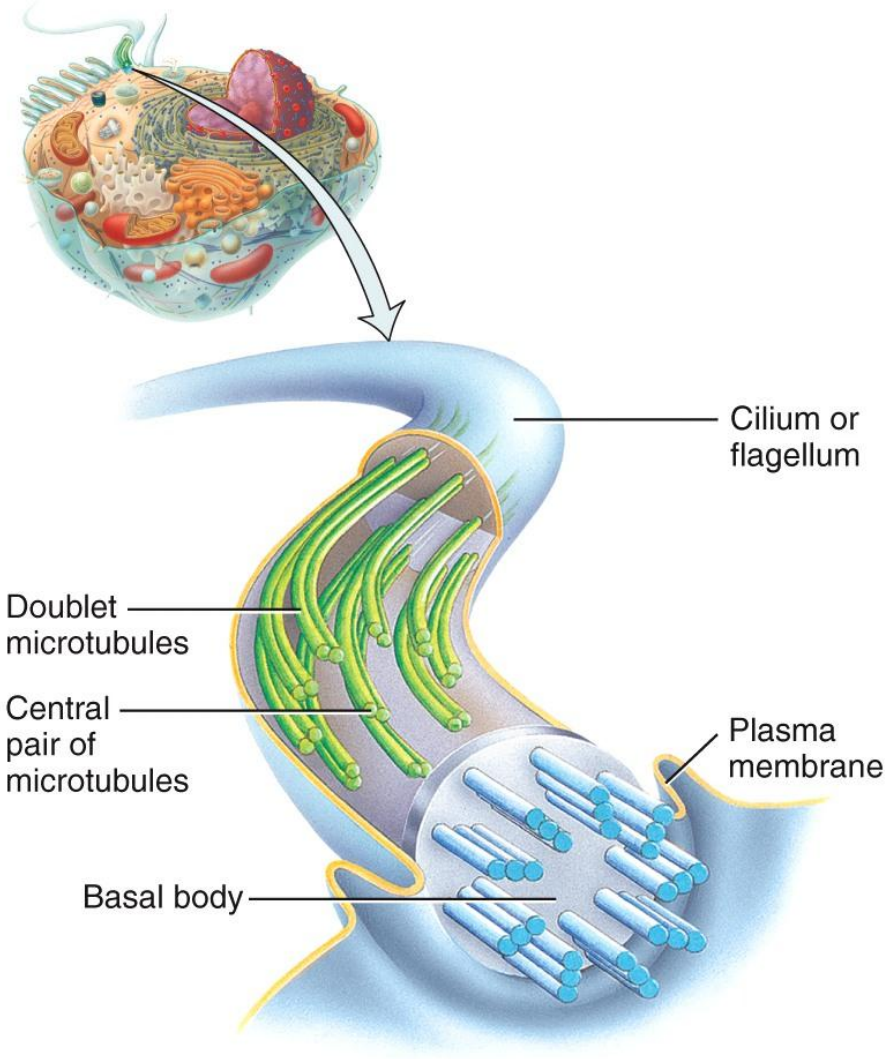
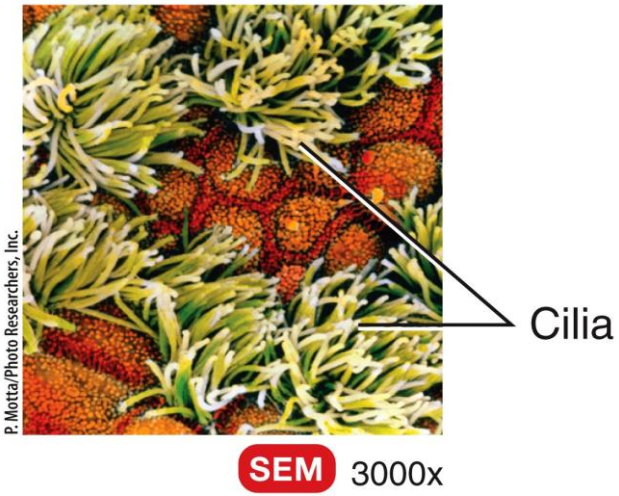
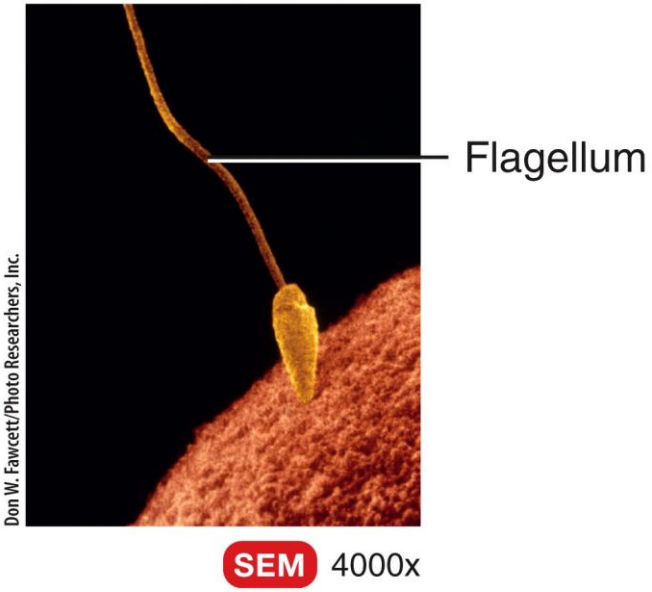
Cilia and Flagella



(a) Arrangement of microtubules in a cilium or flagellum



(b) Cilia lining the trachea



(c) Flagellum of a sperm cell

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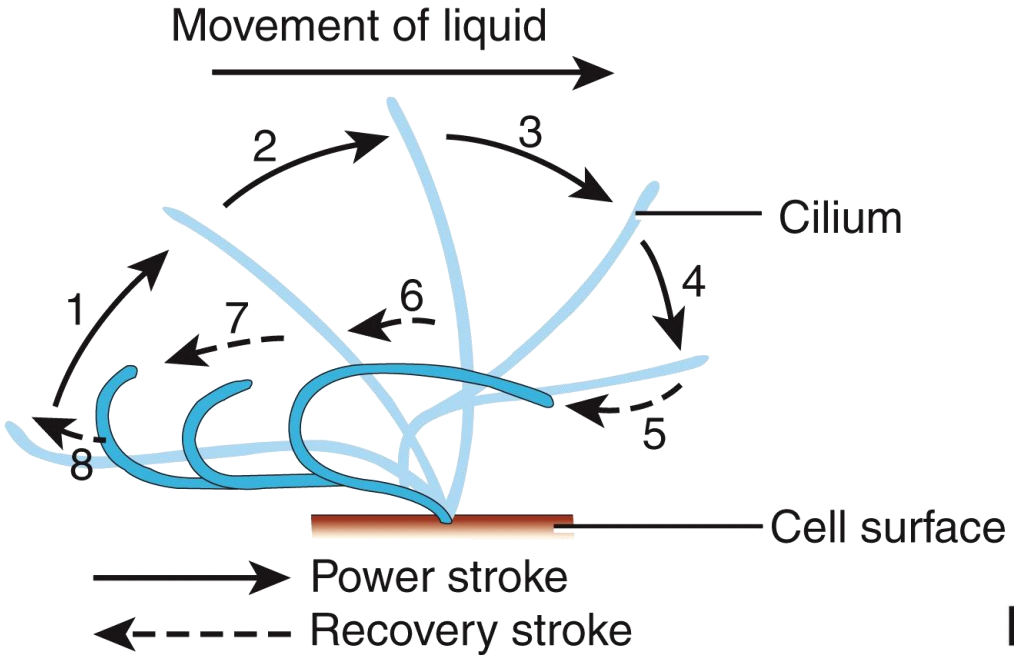
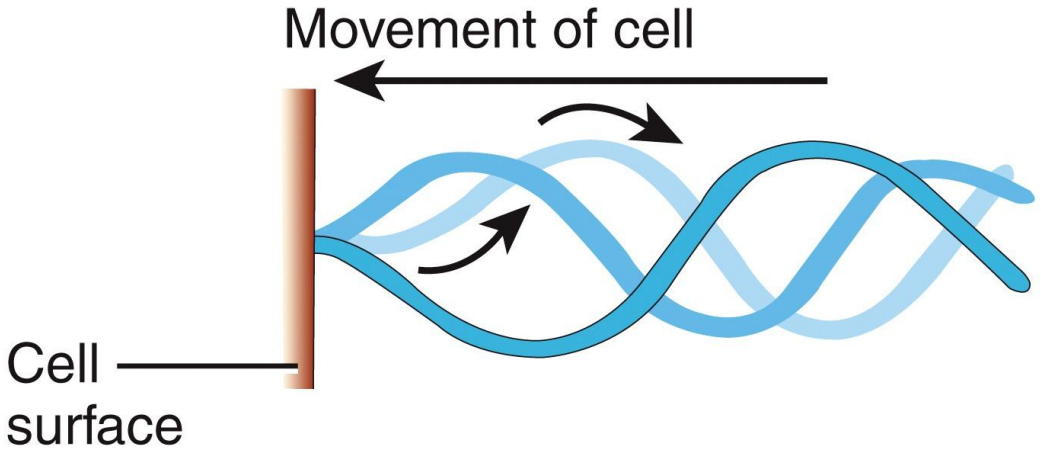
Cilia and Flagella



(d) Ciliary movement



(e) Flagellar movement

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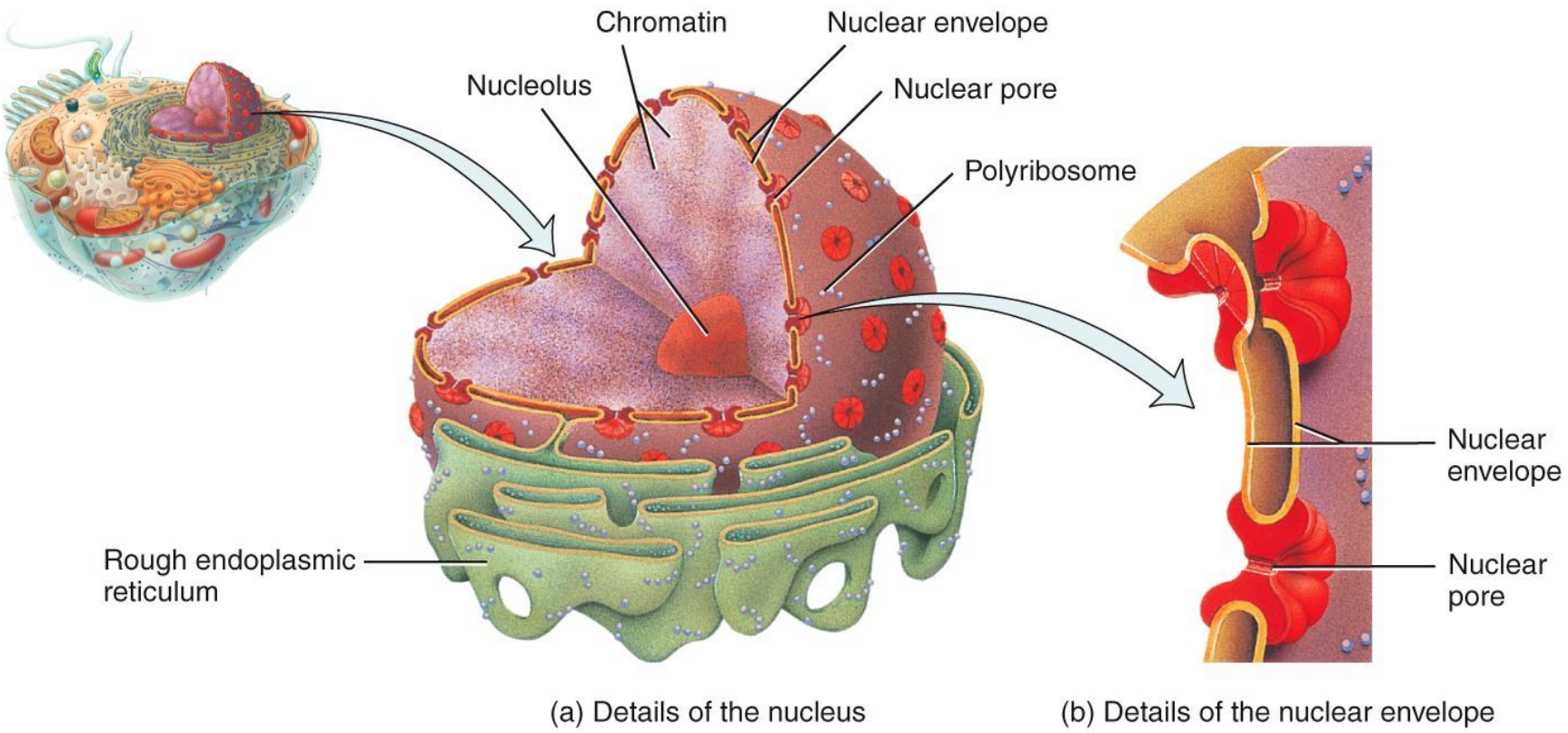
Nucleus



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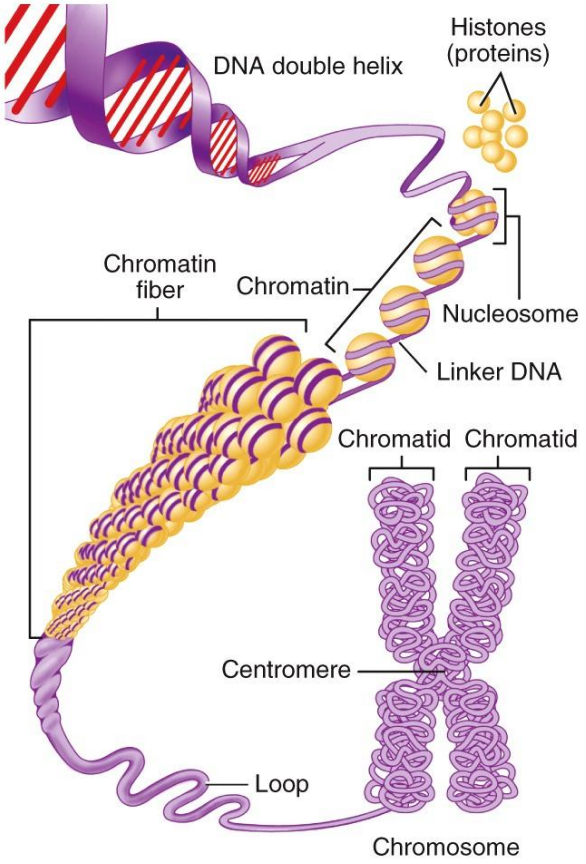
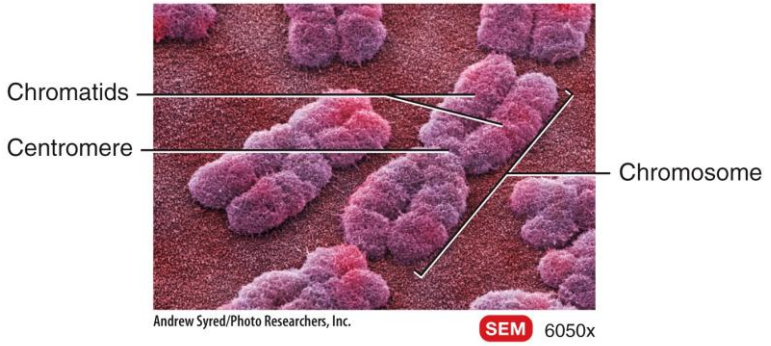
Nucleus

The nucleus contains the cell's hereditary units, called genes, which are arranged in chromosomes



(a) Illustration



(b) Chromosome

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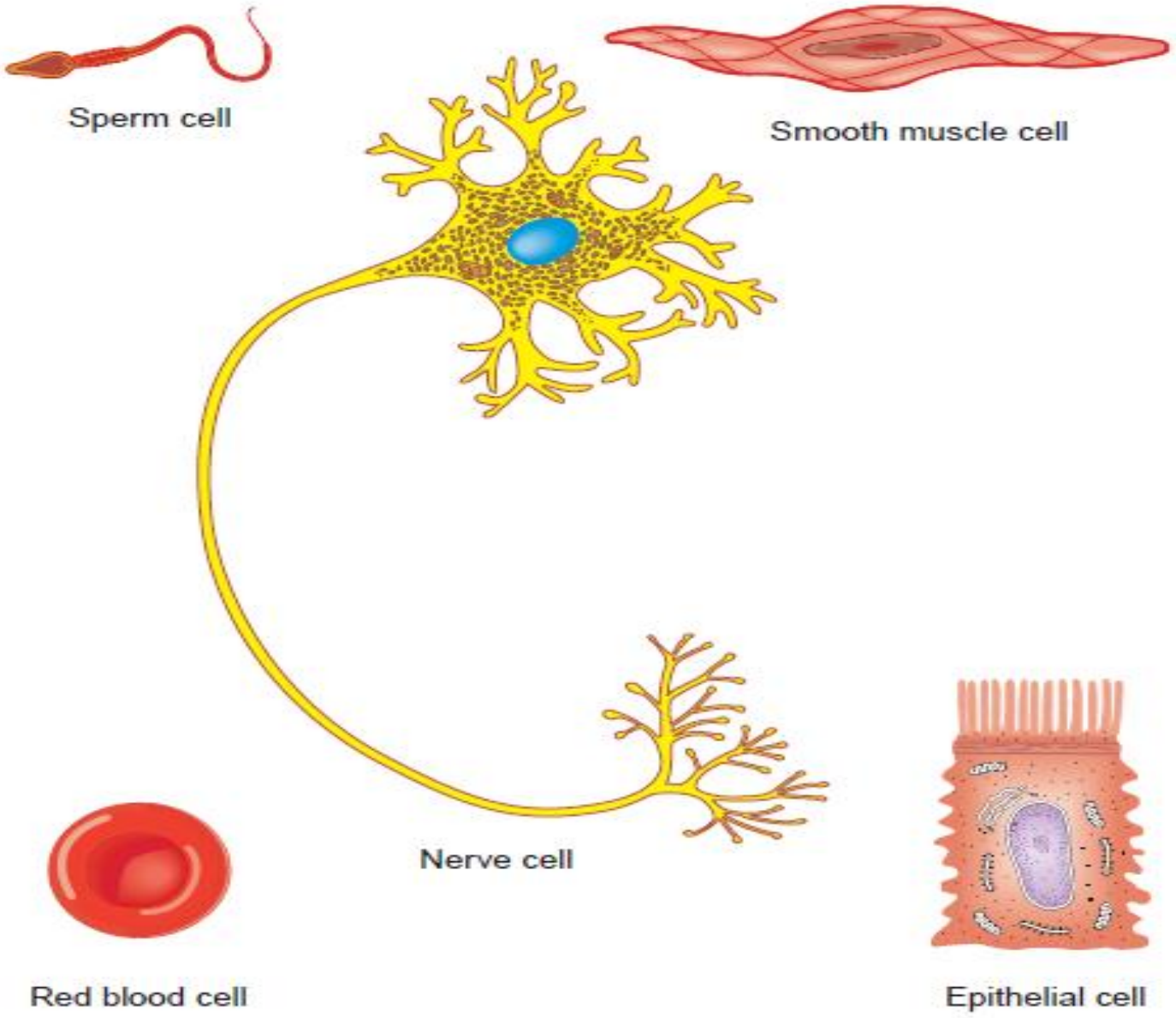
CELLULAR DIVERSITY

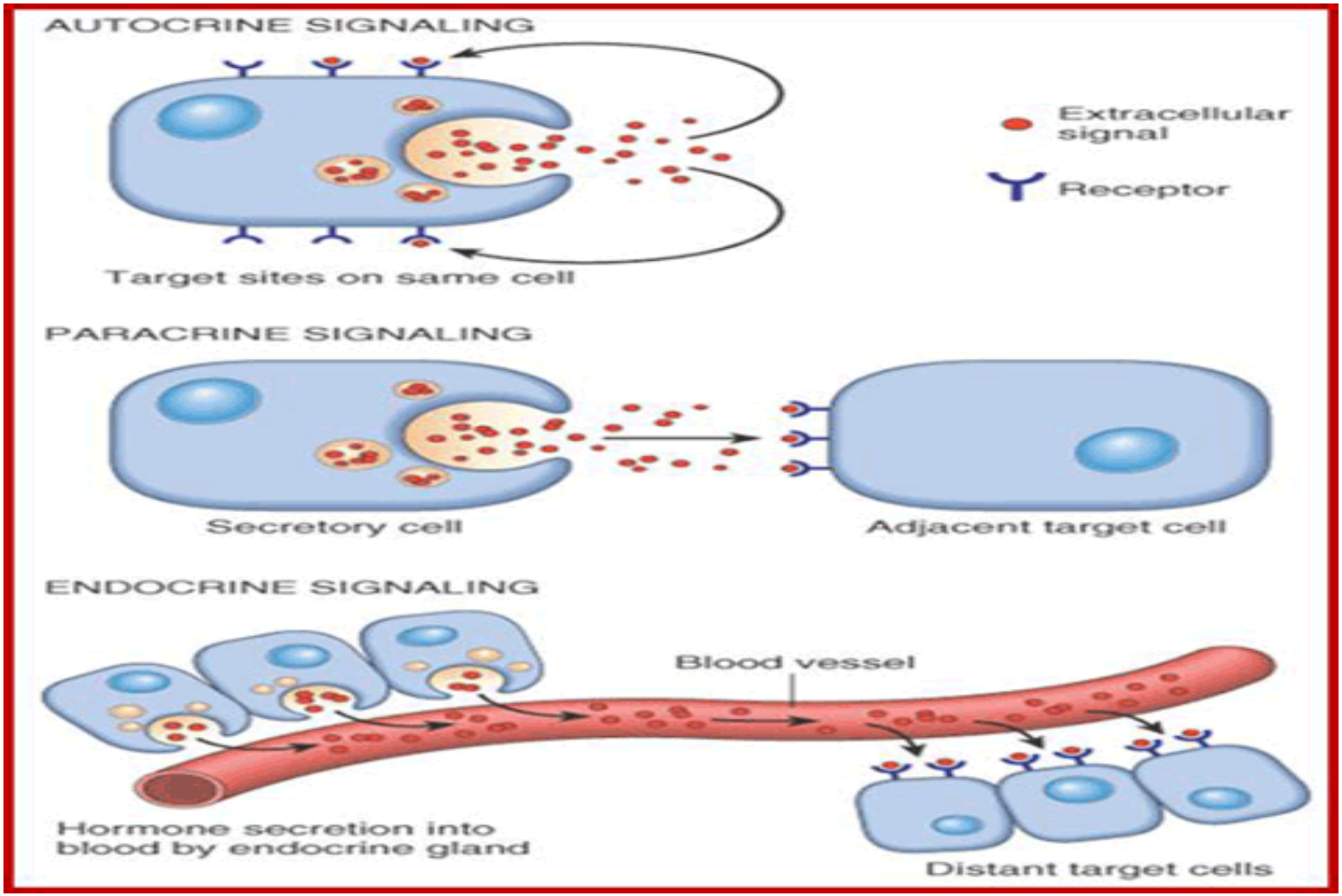
- The body of an average human adult is composed of nearly 100 trillion cells.
- All of these cells can be classified into about 200 different cell types.
- Cells vary considerably in size.
- The sizes of cells are measured in units called *micrometers*.

- The shapes of cells also vary considerably.
- They may be round, oval, flat, cube-shaped, column-shaped, elongated, star-shaped, cylindrical, or disc-shaped.
- A cell's shape is related to its function in the body.
- For example, a sperm cell has a long whiplike tail (flagellum) that it uses for locomotion.
- The disc shape of a red blood cell gives it a large surface area that enhances its ability to pass oxygen to other cells.

- The long, spindle shape of a relaxed smooth muscle cell shortens as it contracts. This change in shape allows groups of smooth muscle cells to narrow or widen the passage for blood flowing through blood vessels.
- Some cells contain microvilli, which greatly increase their surface area.
- Microvilli are common in the epithelial cells that line the small intestine, where the large surface area speeds the absorption of digested food.
- Nerve cells have long extensions that permit them to conduct nerve impulses over great distances.


Sperm cell
Smooth muscle cell
Nerve cell
Red blood cell
Epithelial cell

Cellular signaling



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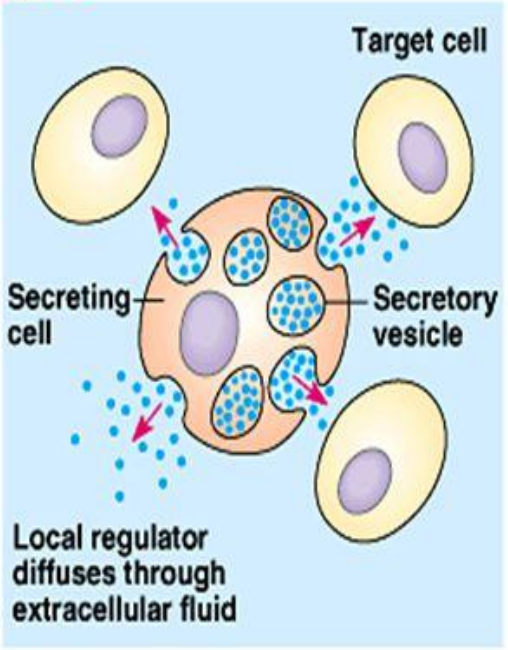
Local and Long Distance Signaling Examples

Growth Factor

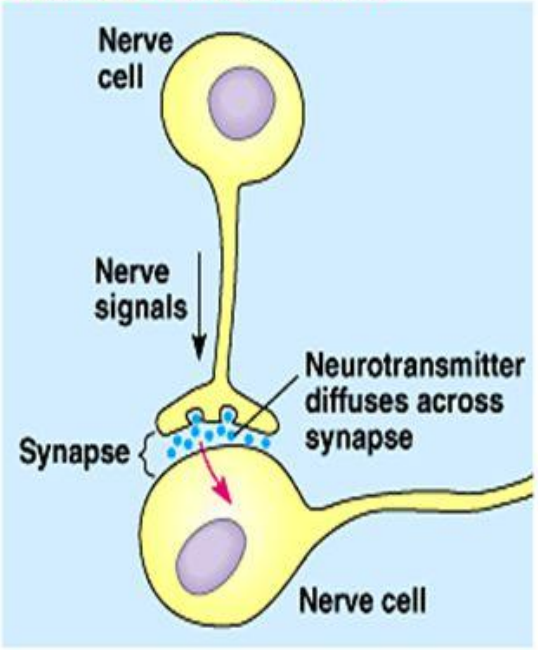
Cell secretes molecule ("local regulator") into extracellular fluid to influence neighboring cells



Paracrine signaling

Nervous System

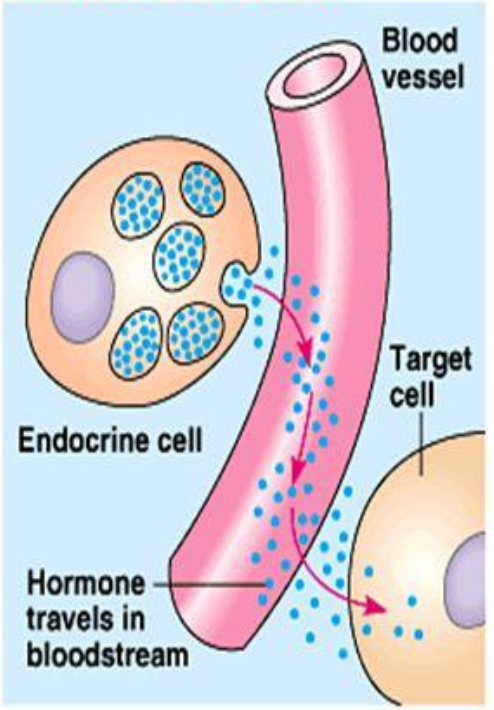
More specialized than paracrine. Nerve cell releases a neurotransmitter that stimulates the target cell.



Synaptic signaling

Hormones

Specialized cells release hormones into circulatory system that carries them to target cells in other parts of the body.



(b) Long distance (hormonal) signaling

(a) Local signaling

AKA – "endocrine signaling"

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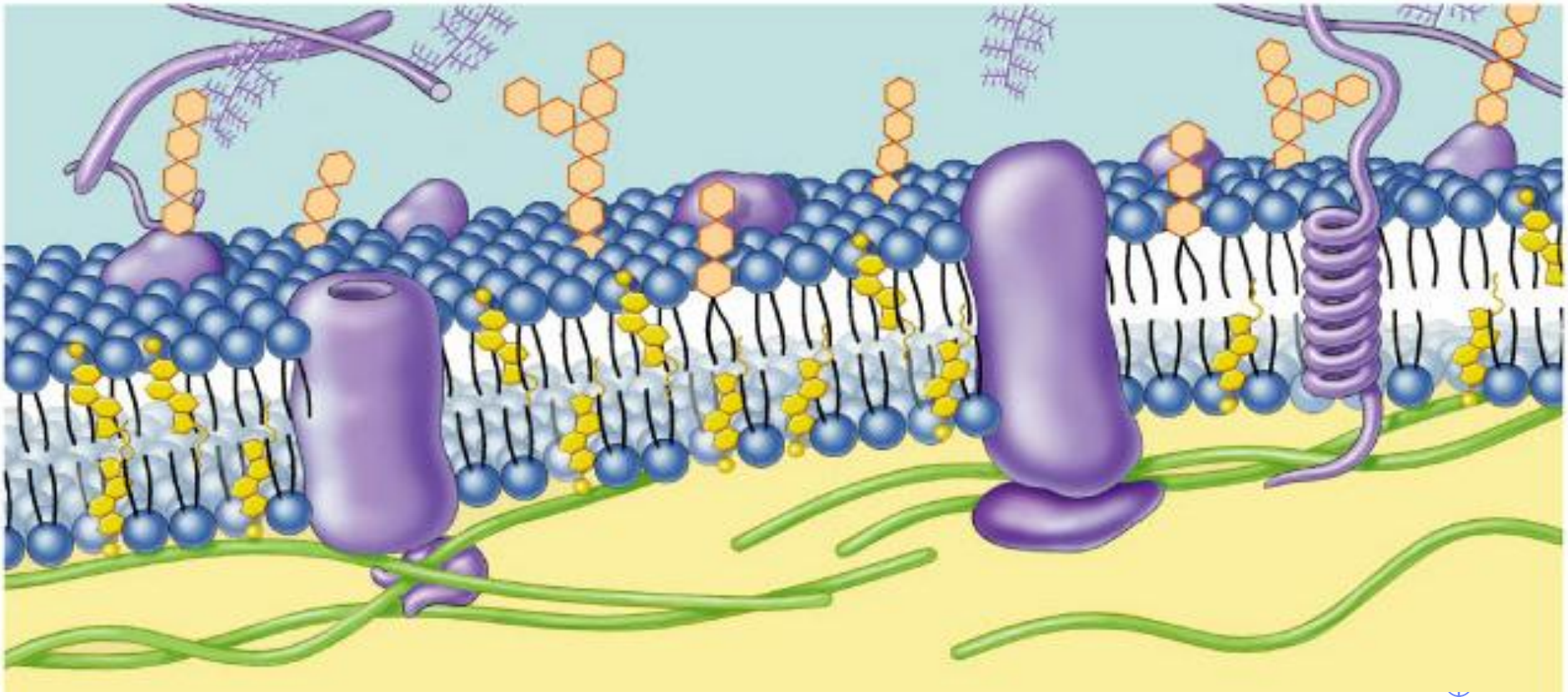
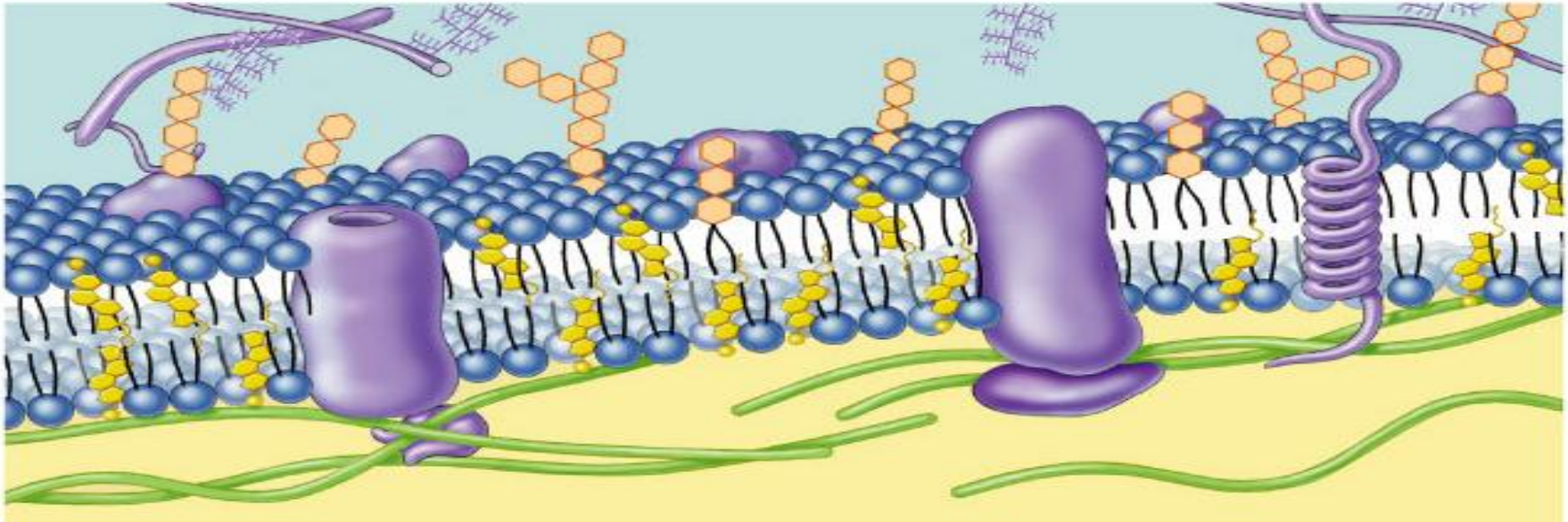
The Cell Membrane



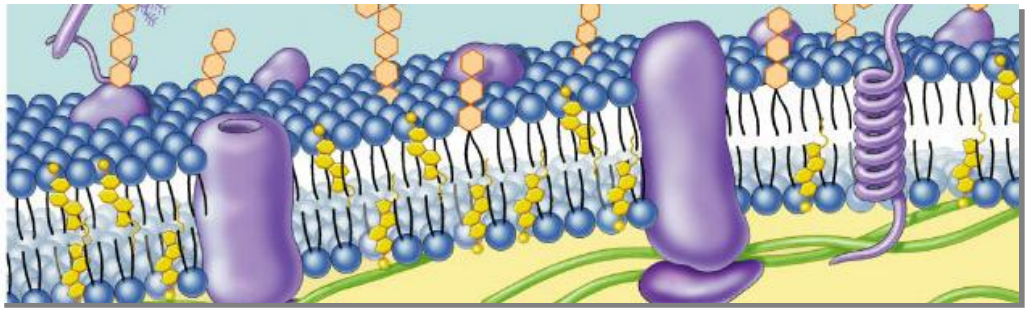
Nehal V. Trambadiya
Asst. Prof.
Smt N.M.Padalia Pharmacy College,
Ahemdabad

The cell membrane is a thin semi-permeable membrane that surrounds the cytoplasm of a cell, enclosing its contents



Overview

- Cell membrane separates living cell from nonliving surroundings
  - thin barrier = 8nm thick
- Controls traffic in & out of the cell
  - selectively permeable
  - allows some substances to cross more easily than others
    - hydrophobic vs hydrophilic
- Made of phospholipids, proteins & other macromolecules



MEMBRANE FUNCTION :-

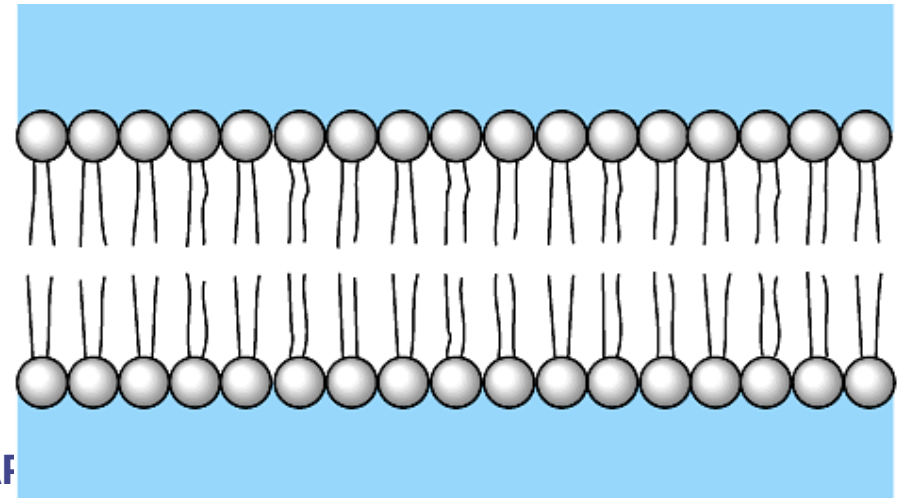
- **The outer plasma membrane**
  - forms a boundary between a living cell and its surroundings
  - Exhibits selective permeability
    - Controls traffic of molecules in and out

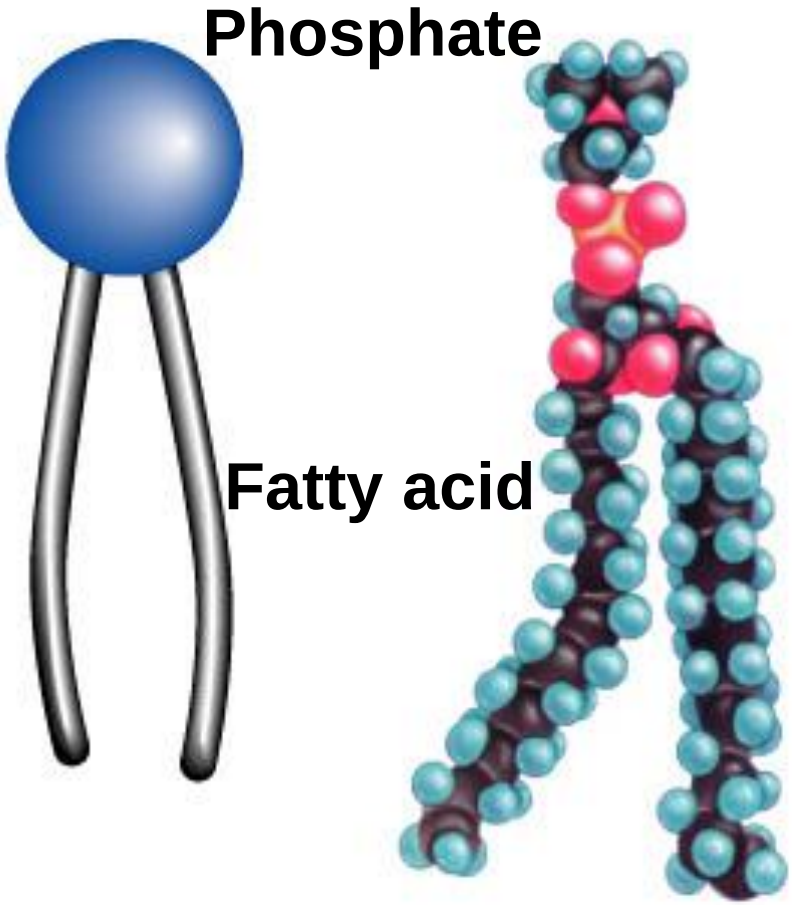
MEMBRANE FUNCTION:-

- Internal membranes provide structural order for metabolism
  - Form the cell's organelles

Phospholipids

- Fatty acid tails
  - hydrophobic
- Phosphate group head
  - hydrophilic
- Arranged as a bilayer





ARRANGED AS BILAYER :-

- The fatty acid "tails" of the two phospholipid layers are oriented towards each other so that the hydrophilic "heads", which contain the phosphate portion, face out to the environment as well as into the cytoplasm of the cell's interior, where they form hydrogen bonds with surrounding water molecule.

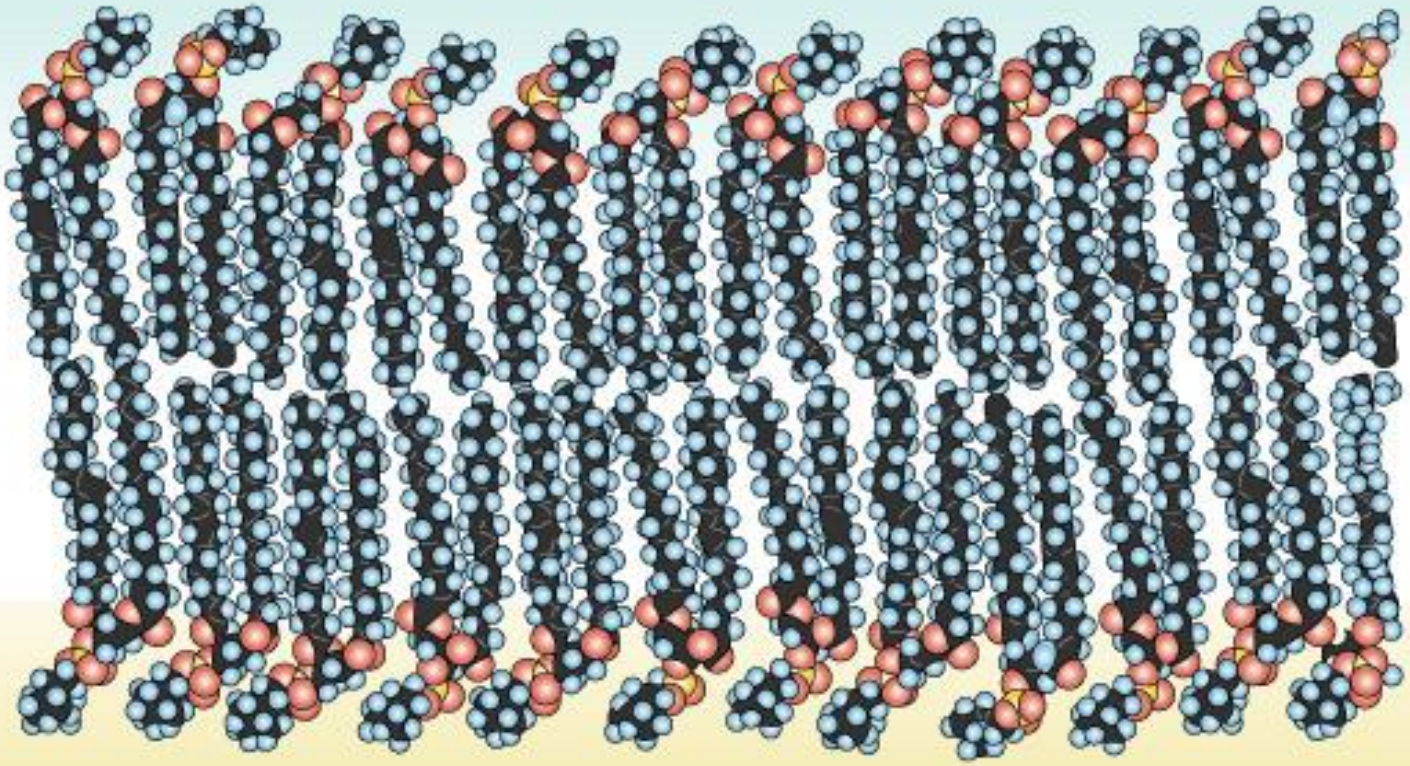
- Because the individual phospholipid molecules are not bonded to each other, a membrane is flexible (or“fluid”), something which is pretty important to its functions.

Phospholipid bilayer

polar hydrophilic heads

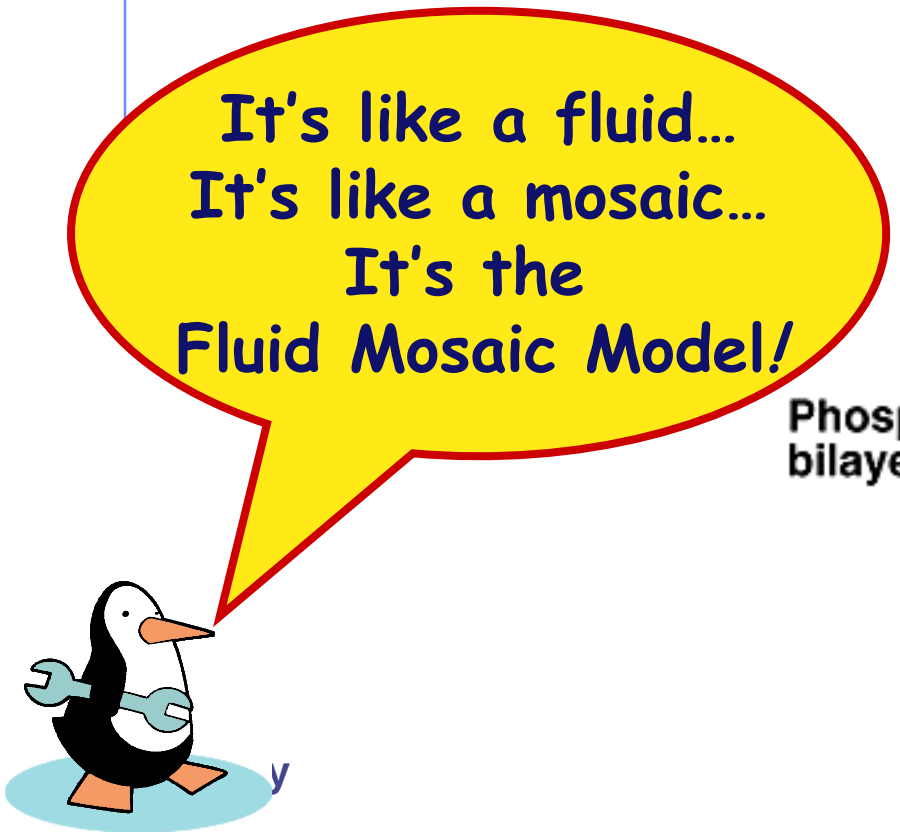
nonpolar hydrophobic tails

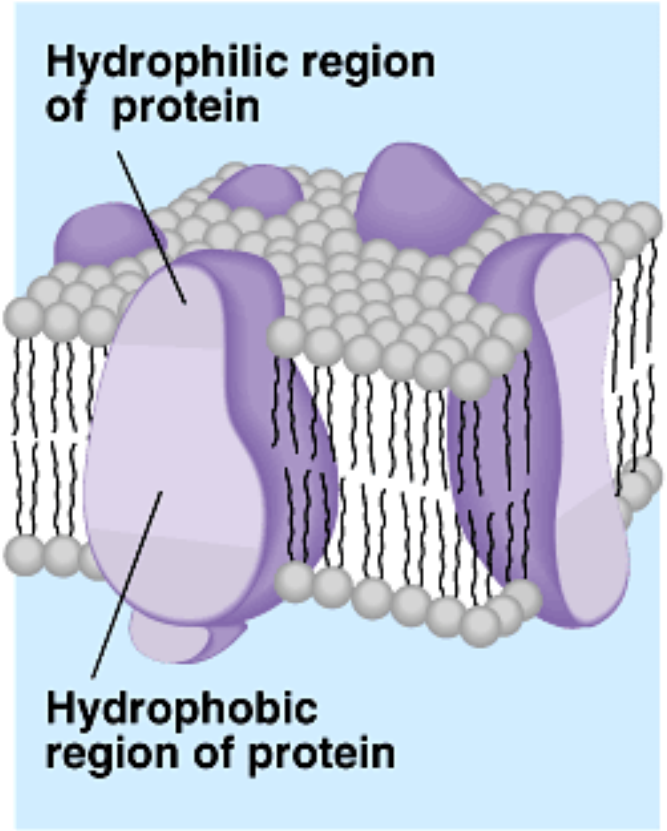
polar hydrophilic heads



More than lipids…

- In 1972, S.J. Singer & G. Nicolson proposed that membrane proteins are inserted into the phospholipid bilaver

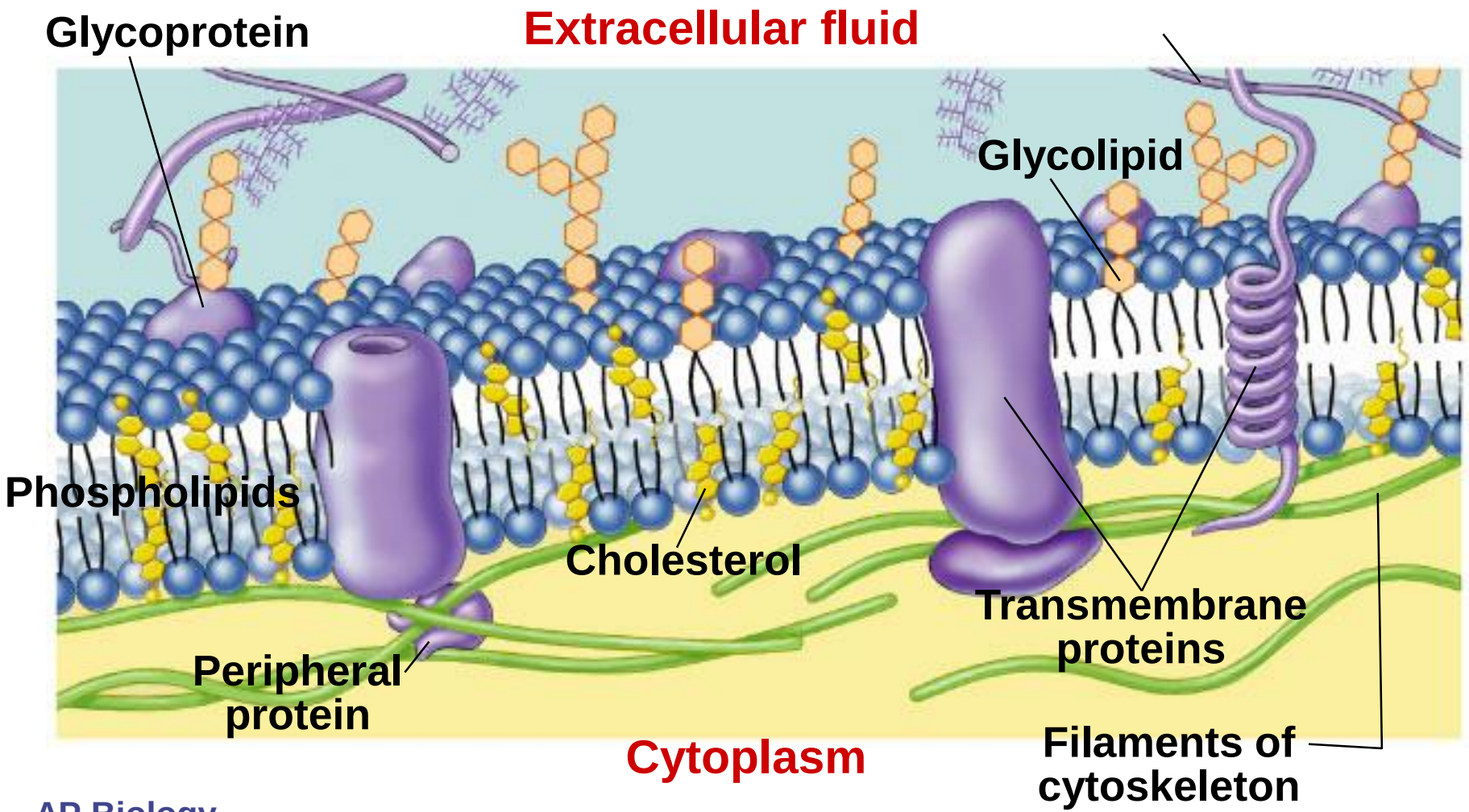




FLUID MOSAIC MODEL :-

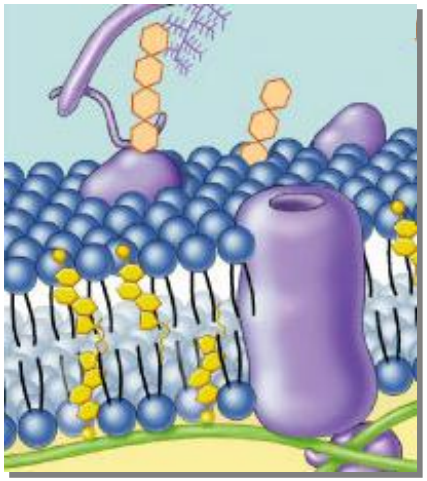
- **A membrane is a mosaic**
  - Proteins and other molecules are embedded in a framework of phospholipids
- **A membrane is fluid**
  - Most protein and phospholipid molecules can move laterally

Membrane is a collage of proteins & other molecules embedded in the fluid matrix of the lipid bilayer

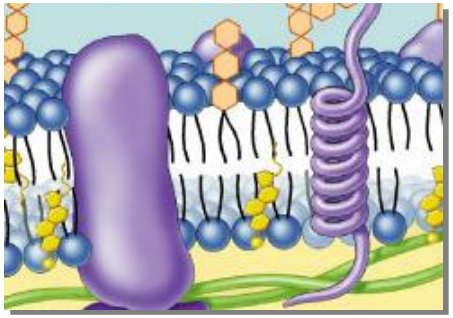


Membrane Proteins

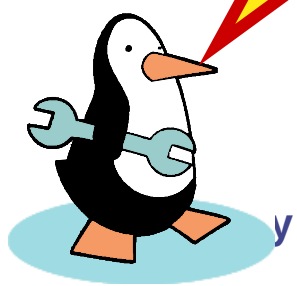
- Proteins determine membrane's specific functions
  - cell membrane & organelle membranes each have unique collections of proteins

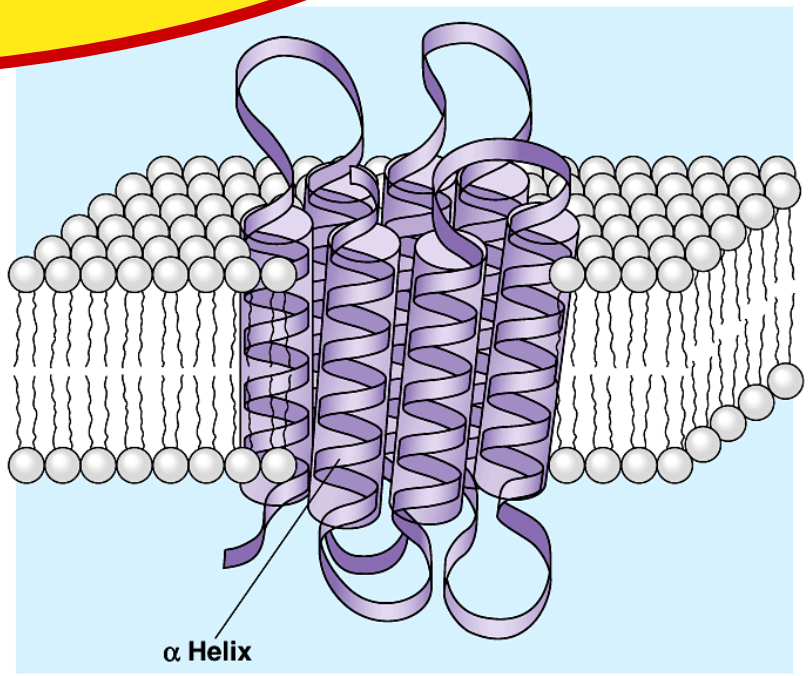


- Membrane proteins:
  - peripheral proteins
    - loosely bound to surface of membrane
    - cell surface identity marker (antigens)
  - integral proteins
    - penetrate lipid bilayer, usually across whole membrane
    - transmembrane protein
    - transport proteins
      - channels, permeases (pumps)



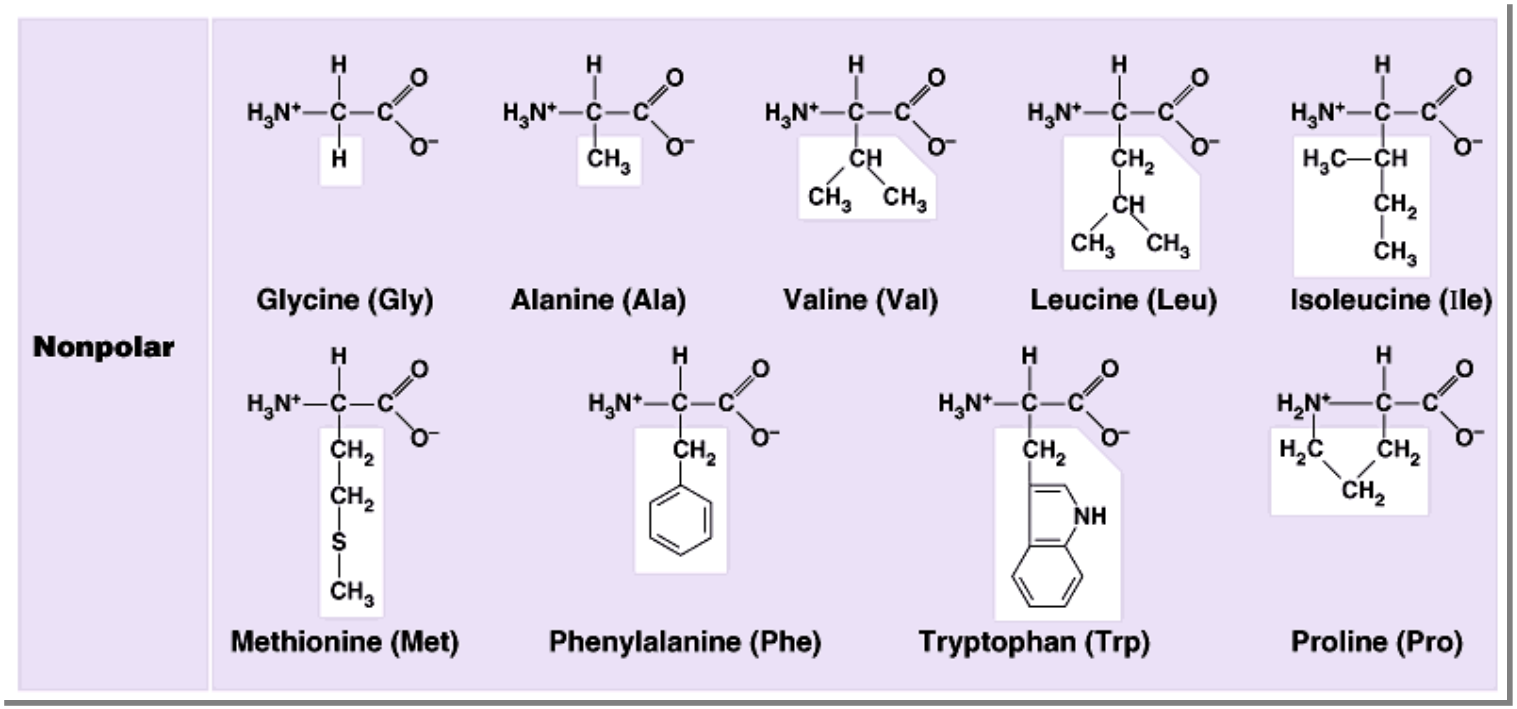
Why are
proteins the perfect
molecule to build structures
in the cell membrane?





Classes of amino acids

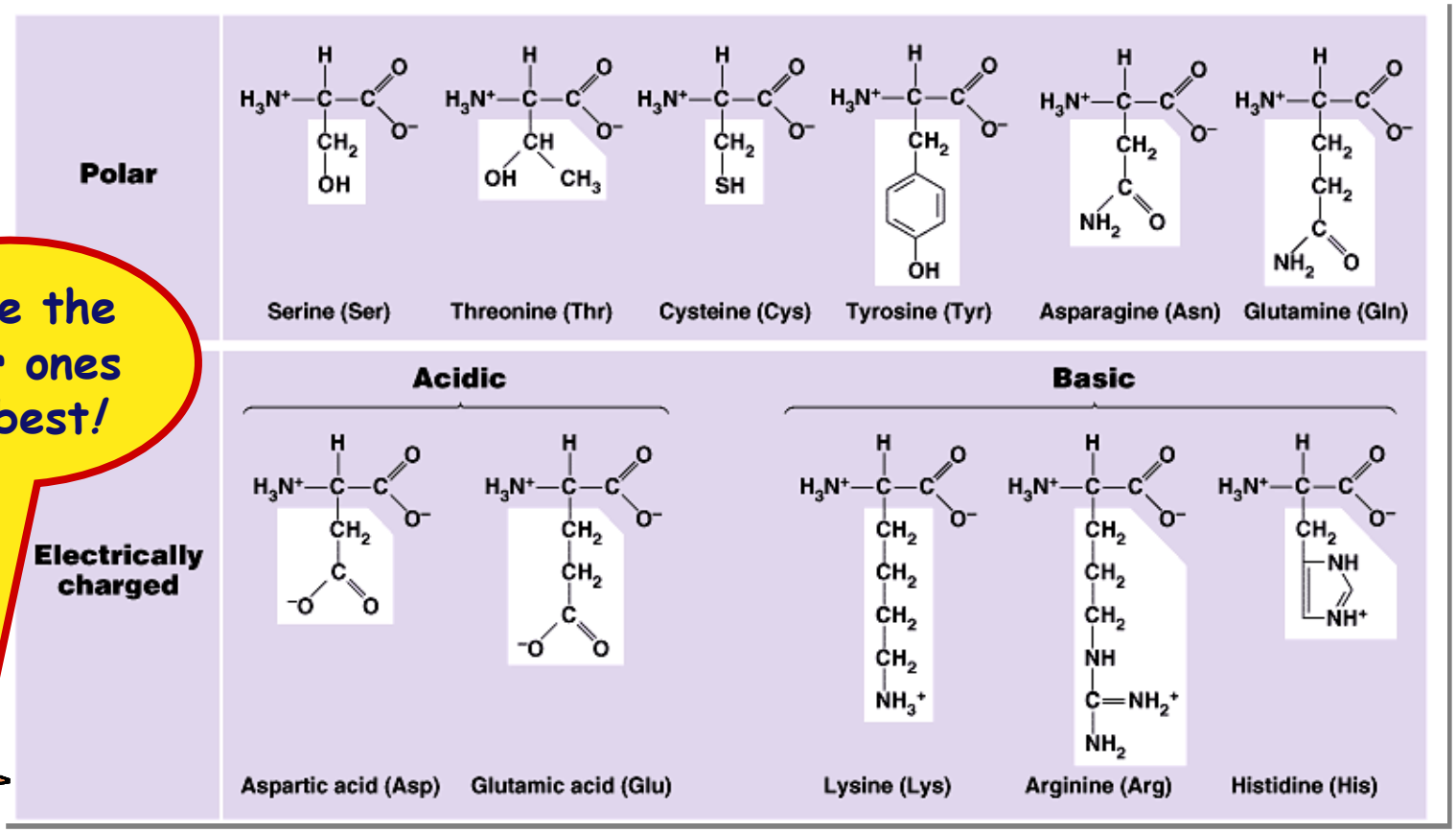
What do these amino acids have in common?



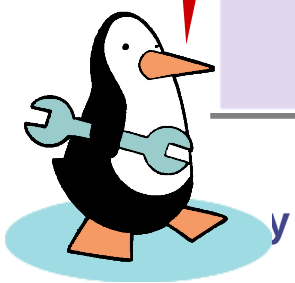
nonpolar & hydrophobic

Classes of amino acids

What do these amino acids have in common?



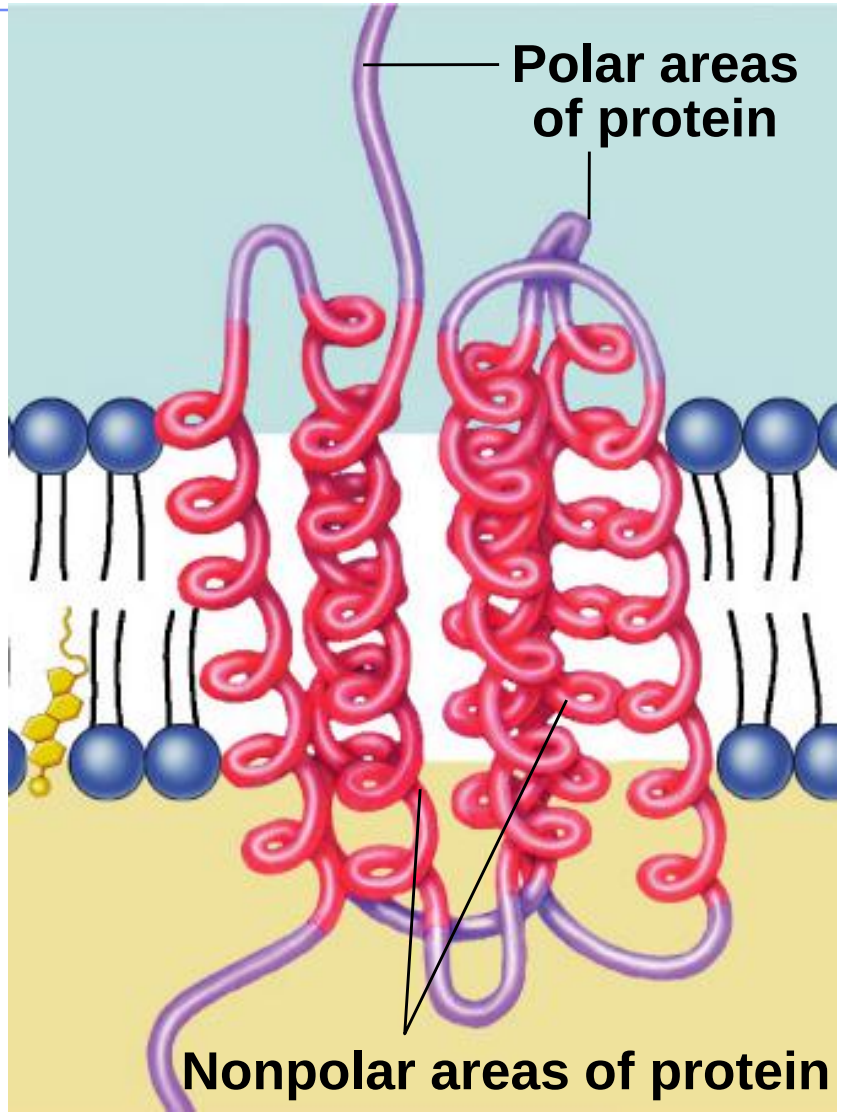
I like the polar ones the best!



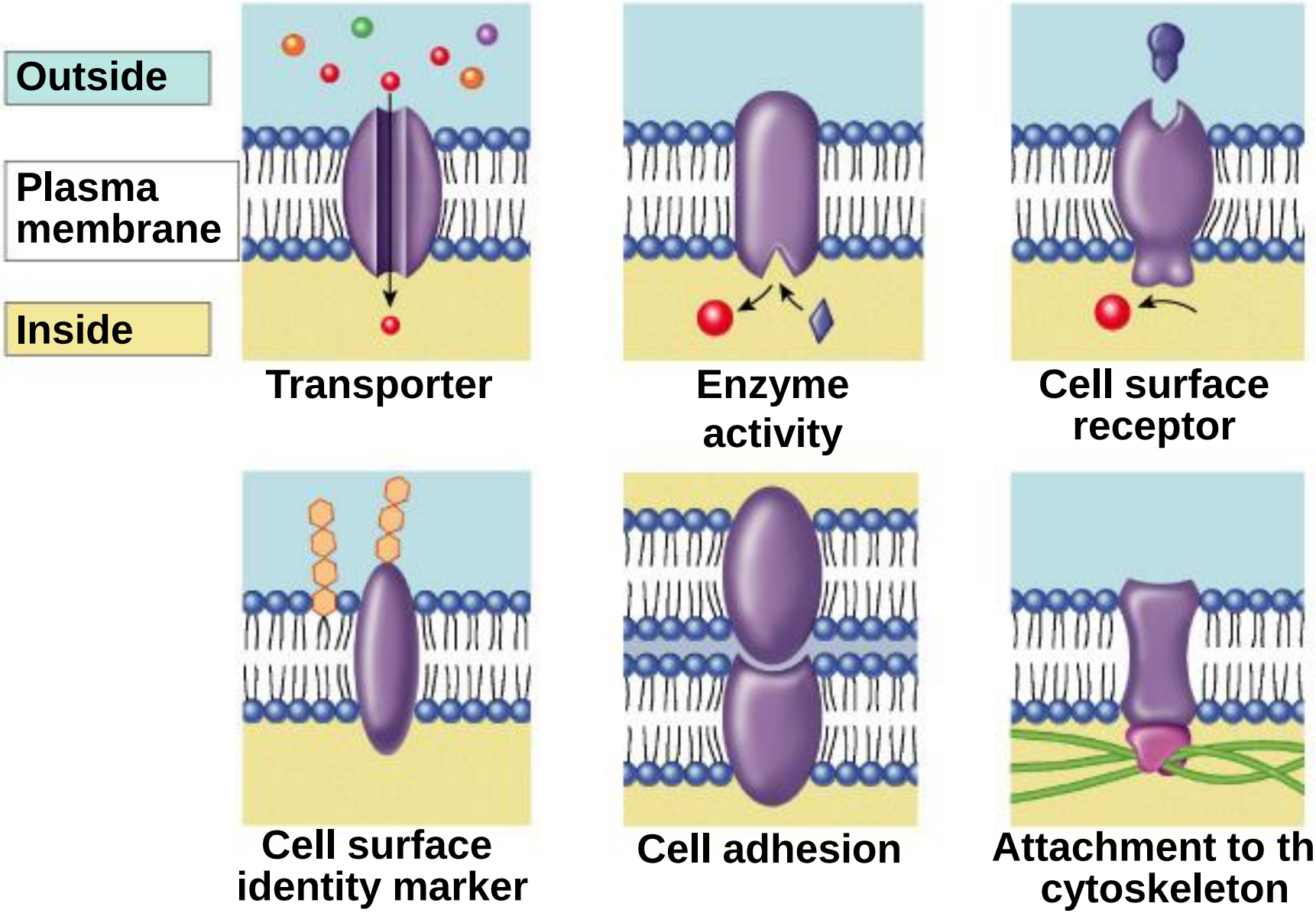
polar & hydrophilic

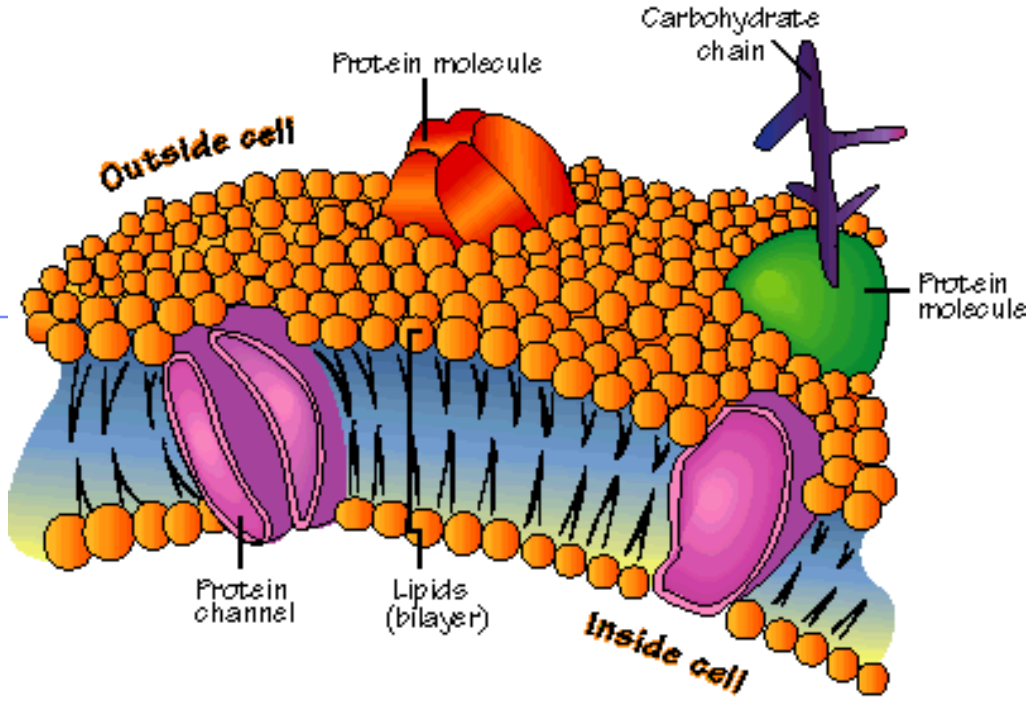
Proteins domains anchor molecule

- Within membrane
  - nonpolar amino acids
    - hydrophobic
    - anchors protein into membrane
- On outer surfaces of membrane
  - polar amino acids
    - hydrophilic
    - extend into extracellular fluid & into cytosol

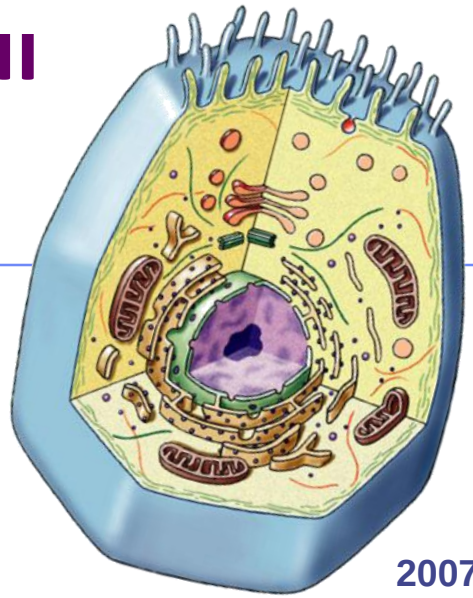


Many Functions of Membrane Proteins





Movement across the Cell Membrane



MOVEMENT ACROSS THE MEMBRANE -

(A) SOLUTE FLOW :-Physical principles governing movement of solutes

1. Diffusion or Passive transport
2. Active transport

(B) SOLVENT FLOW :-Physical principles governing movement of solvents

1. osmosis

(C) VESICULAR TRANSPORT

1.Endocytosis

2.Exocytosis

DIFFUSION :-

- Diffusion means random molecular movement of substances molecule by molecule, either through intermolecular spaces in the membrane or in combination with carrier proteins
- The energy that causes diffusion is the energy of normal Kinetic Motion of matter
- IT IS OF TWO TYPES

  (A).Simple diffusion

  (B).facilitated diffusion

SIMPLE DIFFUSION :-

- means kinetic movement of molecules or ions occurs through a membrane opening or through intermolecular spaces without any interaction with carrier proteins in membrane
- THE RATE OF DIFFUSION IS DETERMINED BY

  1.Amount of substance available

  2. velocity of kinetic motion

  3.The number and sizes of opening in cell membrane
- Simple Diffusion can occur through the cell membrane by two path ways

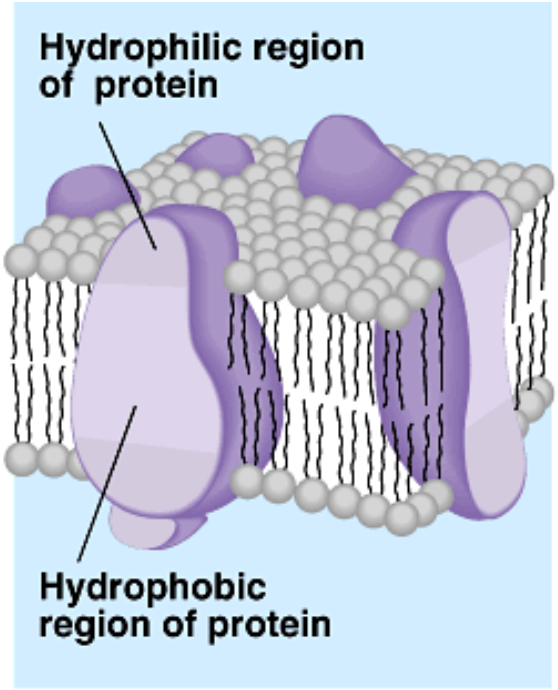
  1.Through the interstices of lipid bilayer (if the diffusing substance is lipid soluble)

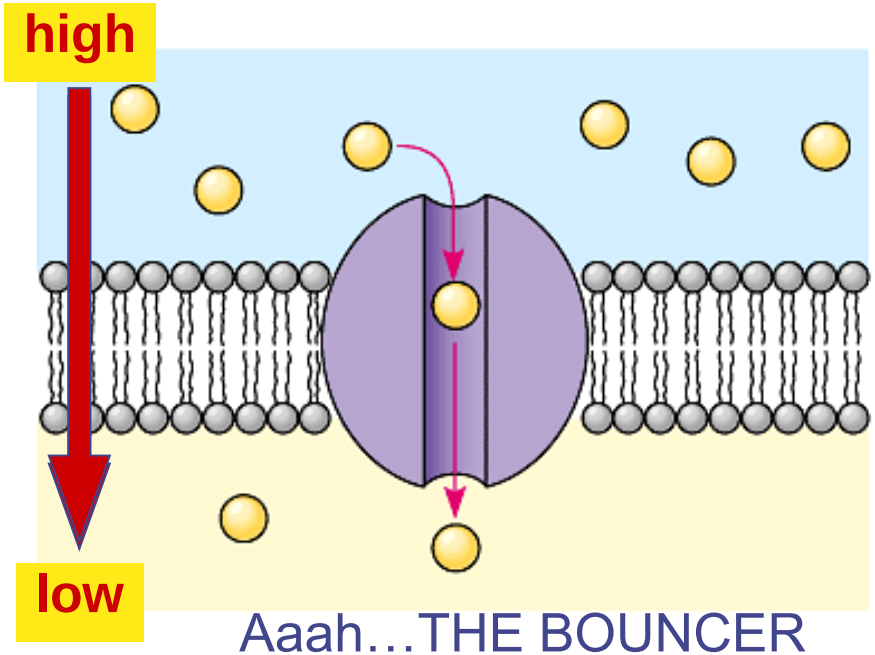
  2. Through watery channels that penetrate all the way through some of the large transport proteins

facilitated = with help

FACILITATED DIFFUSION :-

- Diffusion through protein channels
  - channels move specific molecules across cell membrane
  - no energy needed





Aaah…THE BOUNCER

ACTIVE TRANSPORT :-

"When cell membrane moves molecule or ions uphill against a Concentration gradient (or uphill against an Electrical or Pressure gradient), the process is called ACTIVE TRANSPORT"

OR

"Movement of molecules from a region of lower to higher concentration with expenditure of energy"

ACTIVE TRANSPORT IS DIVIDED INTO TWO TYPES ACCORDING TO SOURCE OF ENERGY USED TO EFFECT THE TRANSPORT.

In both the instances, transport depends on carrier proteins that penetrate membrane.

1.1.PRIMARY ACTIVE TRANSPORT

2.2.SECONDARY ACTIVE TRANSPORT

PRIMARY ACTIVE TRANSPORT :-

- In this transport the energy is derived directly from breakdown of ATP or some high energy phosphate compound
- EXAMPLES:

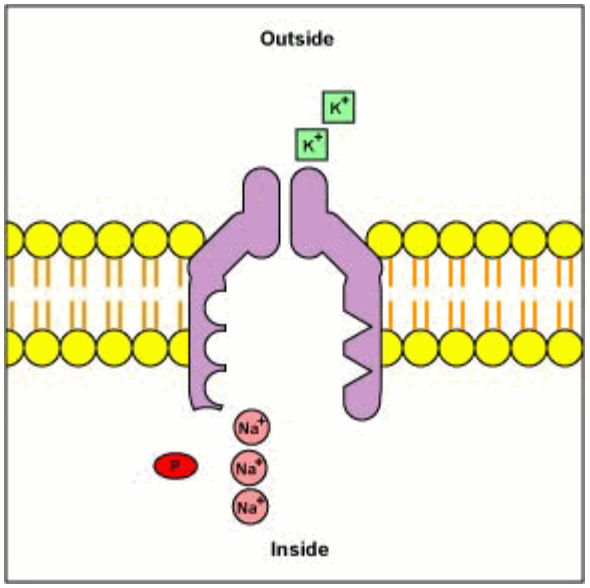
  NA+,K+-ATPase PUMP (or NA+_K+ PUMP)

  Present in all the cells of the body, maintains low intracellular [NA+] and high intracellar [K+]

  By transporting 3 NA+ from intracellular to extra cellular fluid

  And 2 K+ from extra cellular to intracellular fluid

  Both NA+ and K+ are transported against their electrochemical gradients



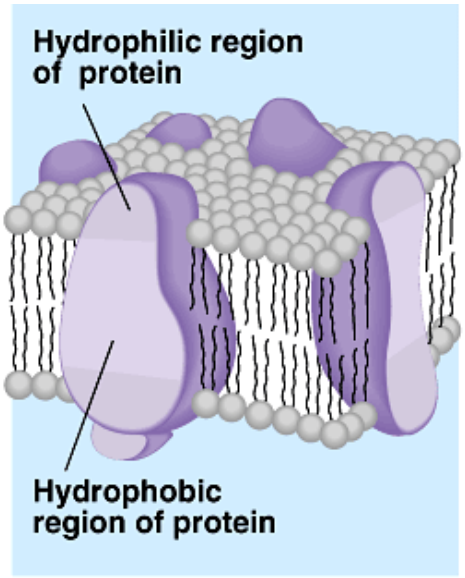
SECONDARY ACTIVE TRANSPORT :-

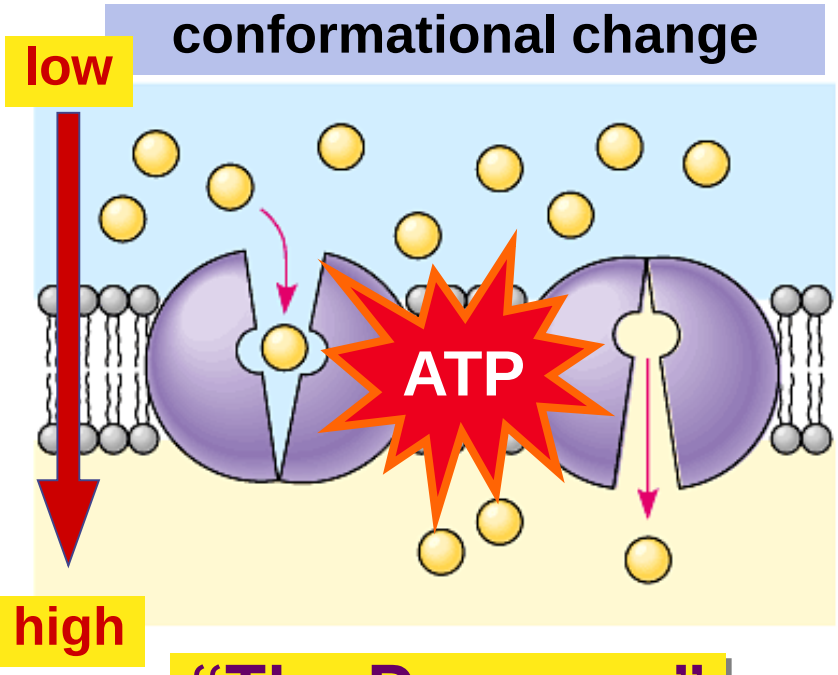
- In secondary active transport, the energy is derived secondarily from the energy that has been stored in the form of ionic concentration differences of secondary molecular or ionic substances b/w the two sides of the cell membrane, created originally by primary active transport
- The transport of two or more solutes is coupled
- One of the solutes (usually NA+) is transported downhill and provides energy for the uphill transport of other solute
-

Ex:-**CO-TRANSPORT OF GLUCOSE AND AMINO ACIDS ALONG WITH SODIUM IONS**

Active Transport

- Cells may need to move molecules ***against*** concentration gradient
  - shape change transports solute from one side of membrane to other
  - protein "pump"
  - "costs" energy = ATP

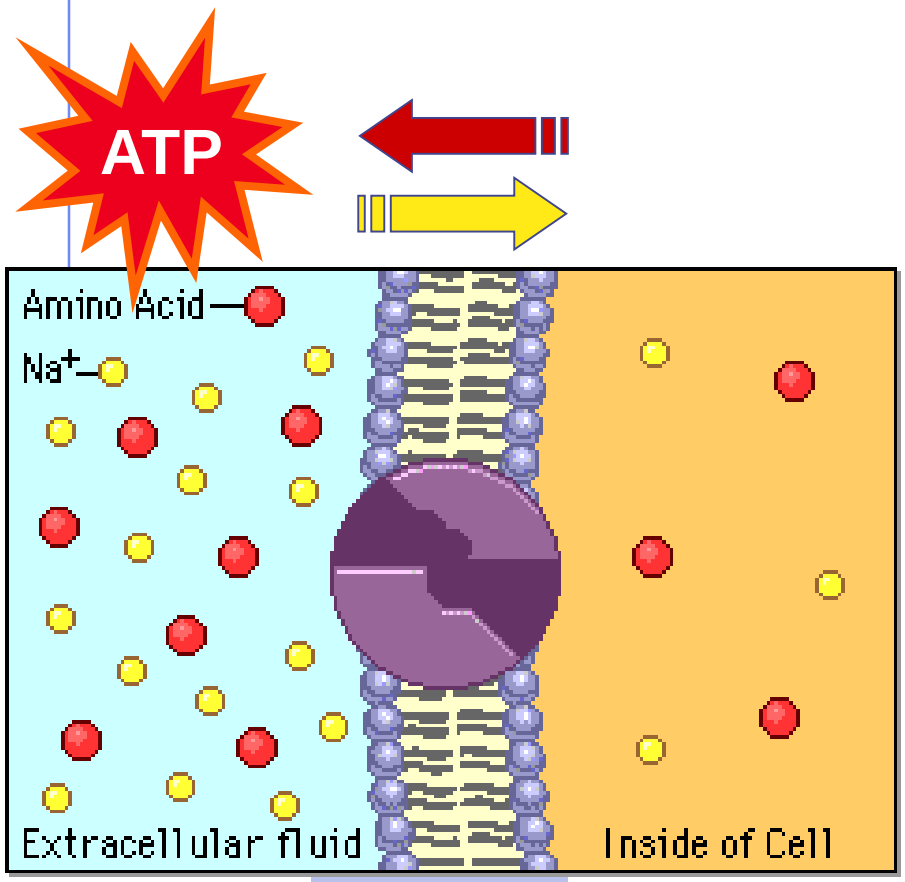




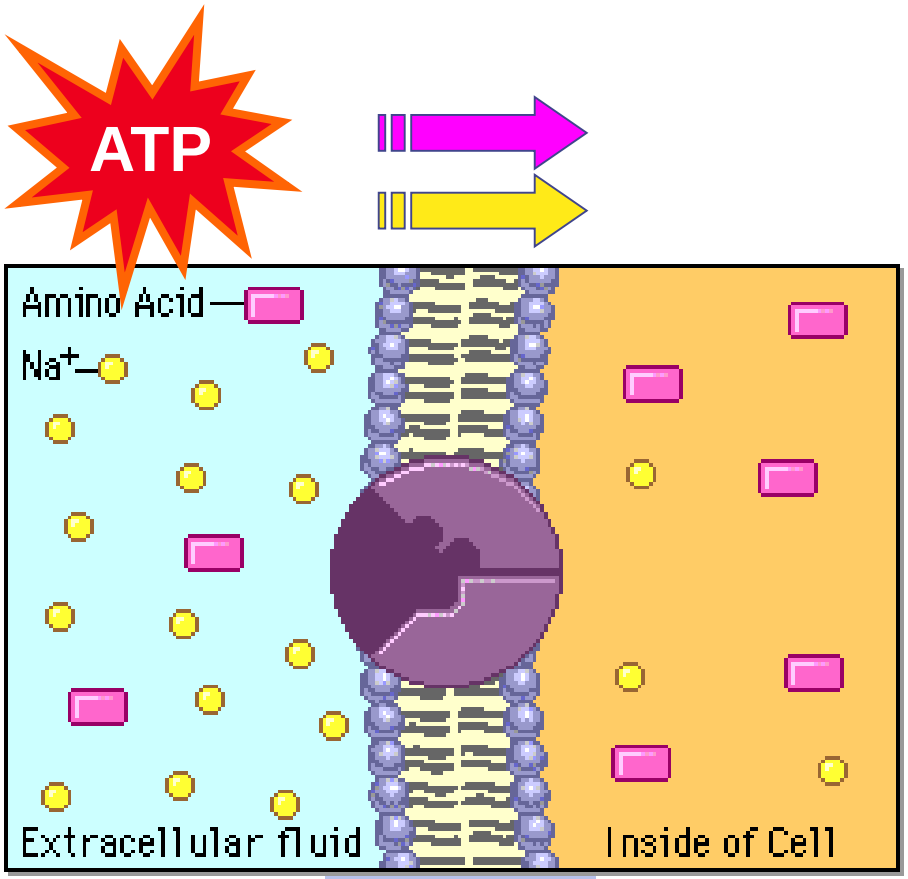
"The Doorman"

Active transport

- Many models & mechanisms



antiport

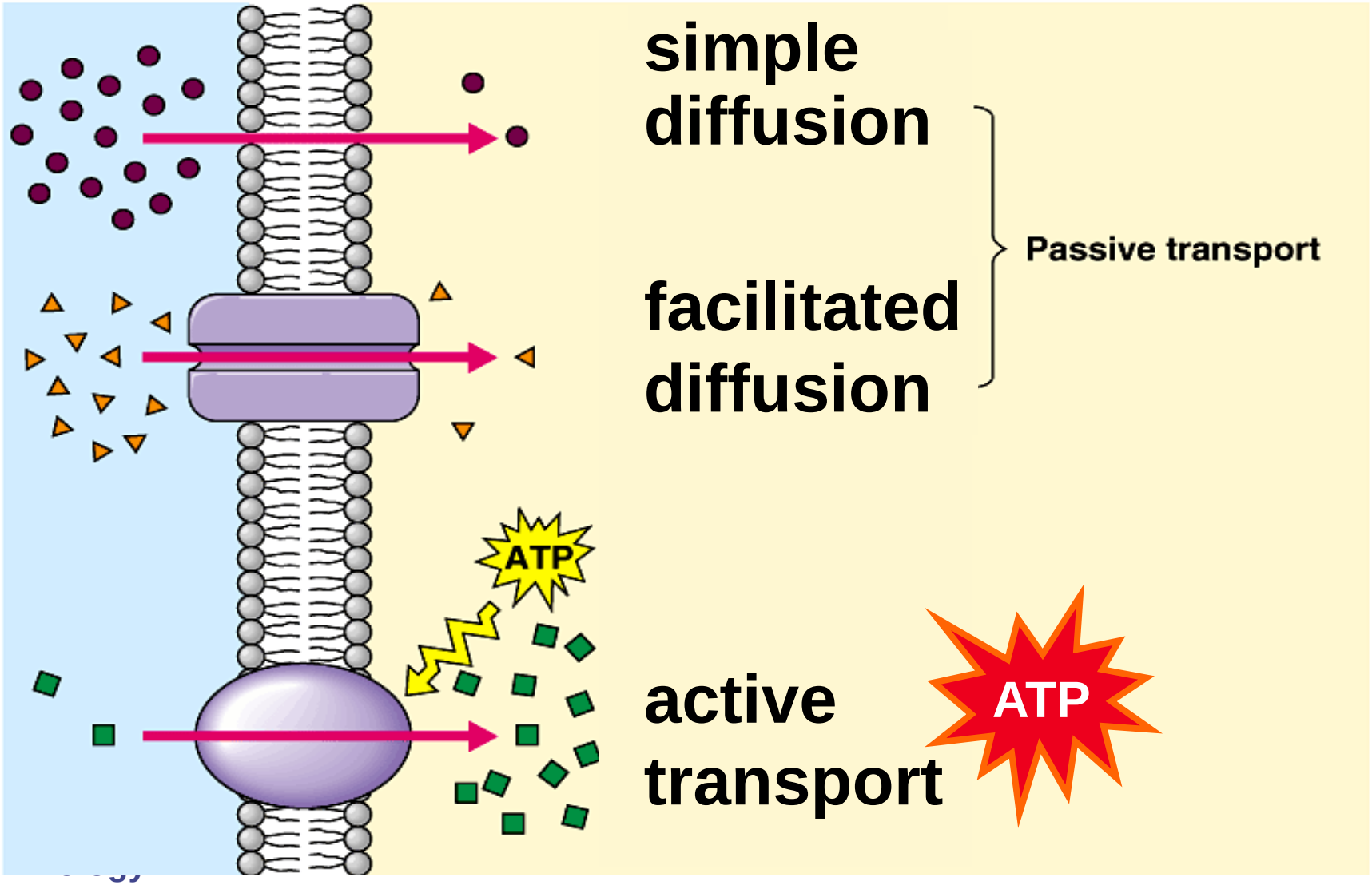


symport

PASSIVE V/S ACTIVE :-

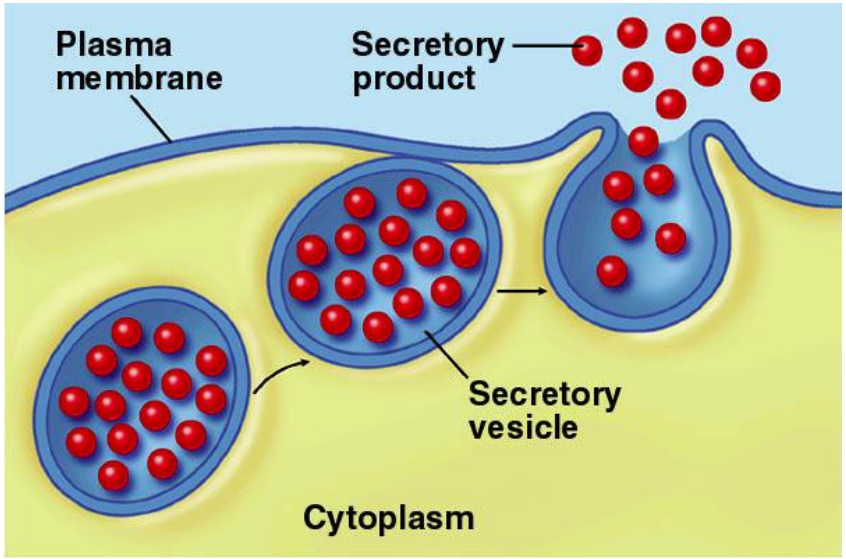
- **Passive Transport**
  - **Simple diffusion**
    - diffusion of nonpolar, hydrophobic molecules
      - lipids
      - high → low concentration gradient
  - **Facilitated transport**
    - diffusion of polar, hydrophilic molecules
    - through a protein channel
      - high → low concentration gradient
- **Active transport**
  - diffusion *against* concentration gradient
    - low → high
  - uses a protein pump
  - requires ATP

Transport summary



How about large molecules?

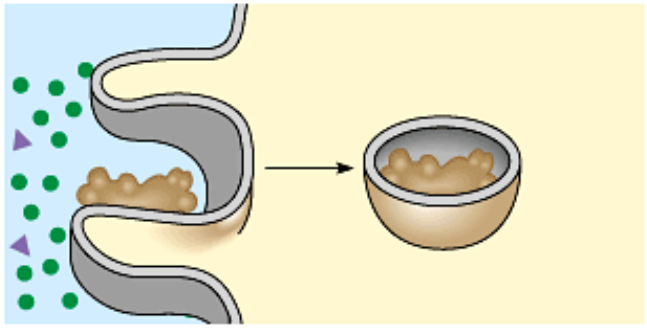
- Moving large molecules into & out of cell
  - through vesicles & vacuoles
  - endocytosis
    - phagocytosis = "cellular eating"
    - pinocytosis = "cellular drinking"
  - exocytosis



exocytosis

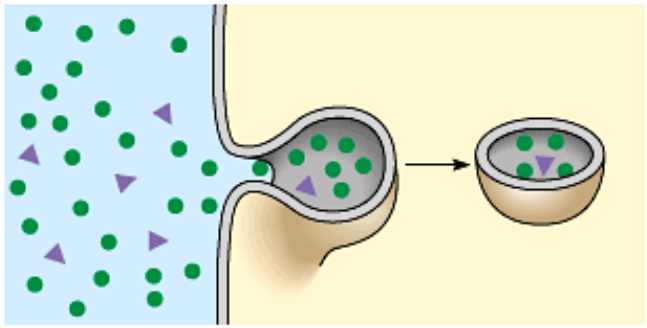
Endocytosis

phagocytosis



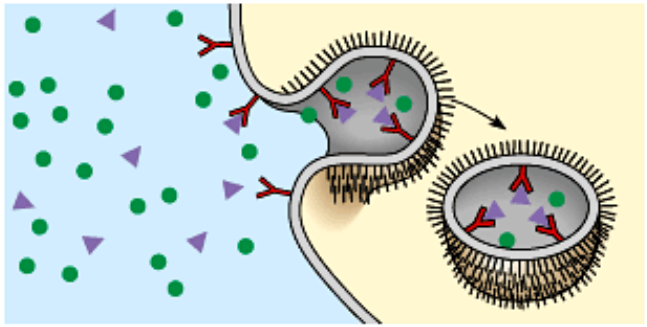
fuse with lysosome for digestion

pinocytosis



non-specific process

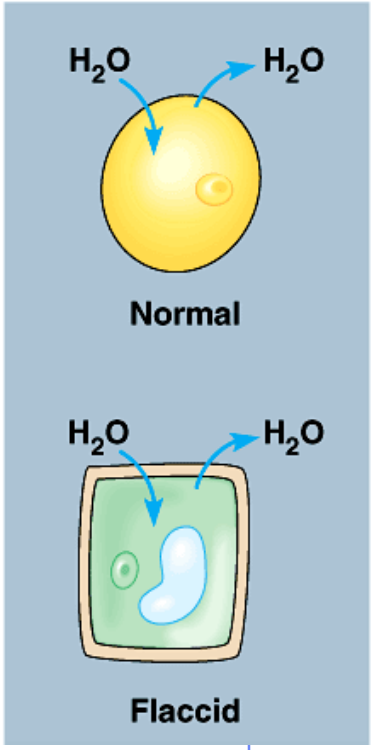
receptor-mediated endocytosis

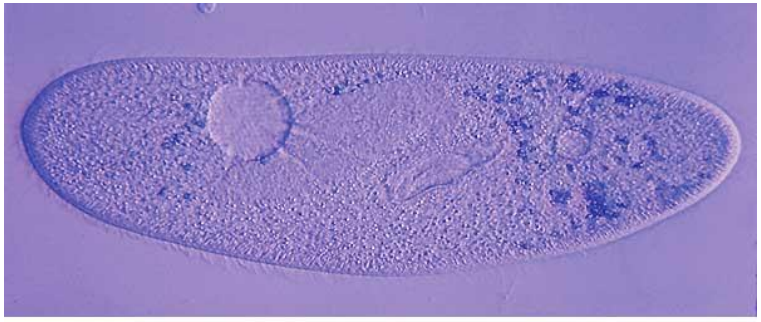


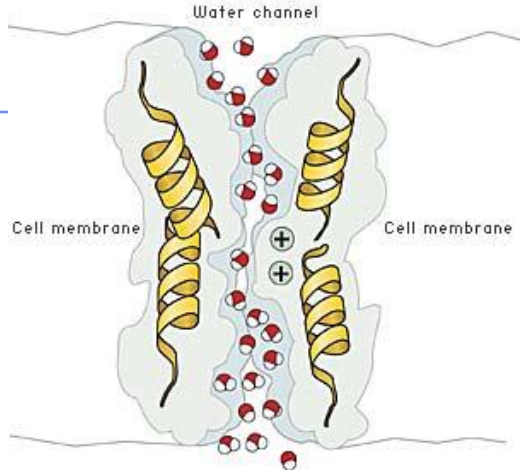
triggered by molecular signal

The Special Case of Water

Movement of water across the cell membrane





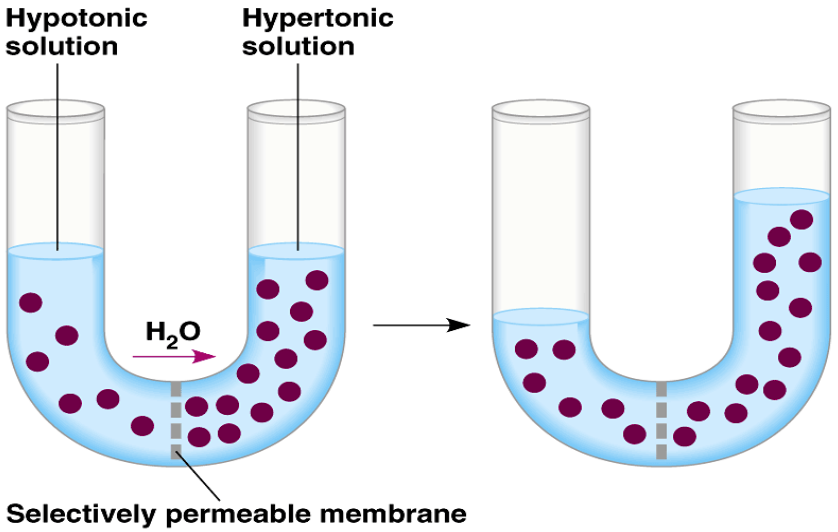


Osmosis is diffusion of water

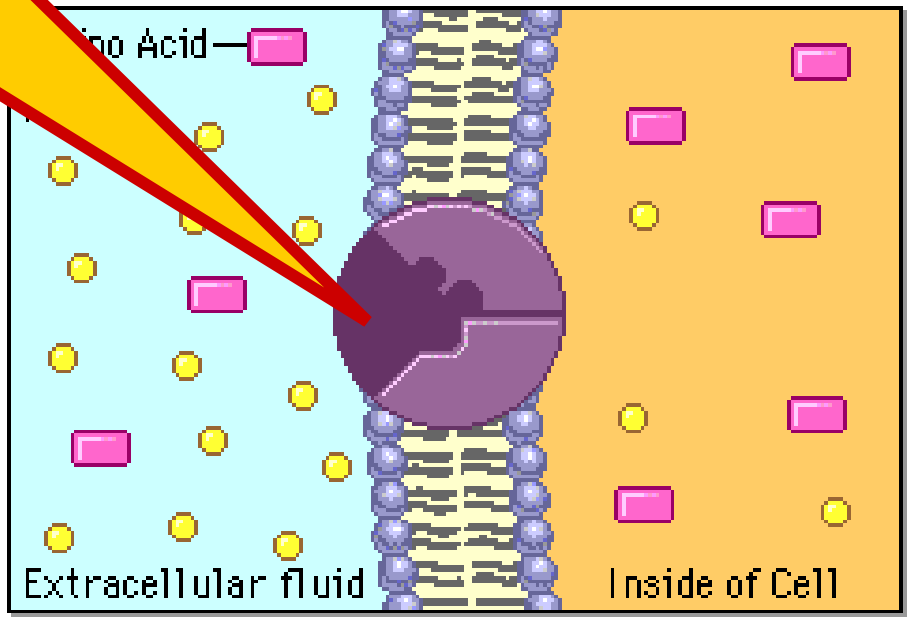
It is a physical process in which a solvent moves, without input of energy, across a semi-permeable membrane

The osmotic pressure is defined to be the pressure required to maintain an equilibrium, with no net movement of solvent.

Osmosis is the diffusion of water through a semi-permeable membrane. More specifically, it is the movement of water across a semi-permeable membrane from an area of high water potential (low solute concentration) to an area of low water potential (high solute concentration).



Any Questions??



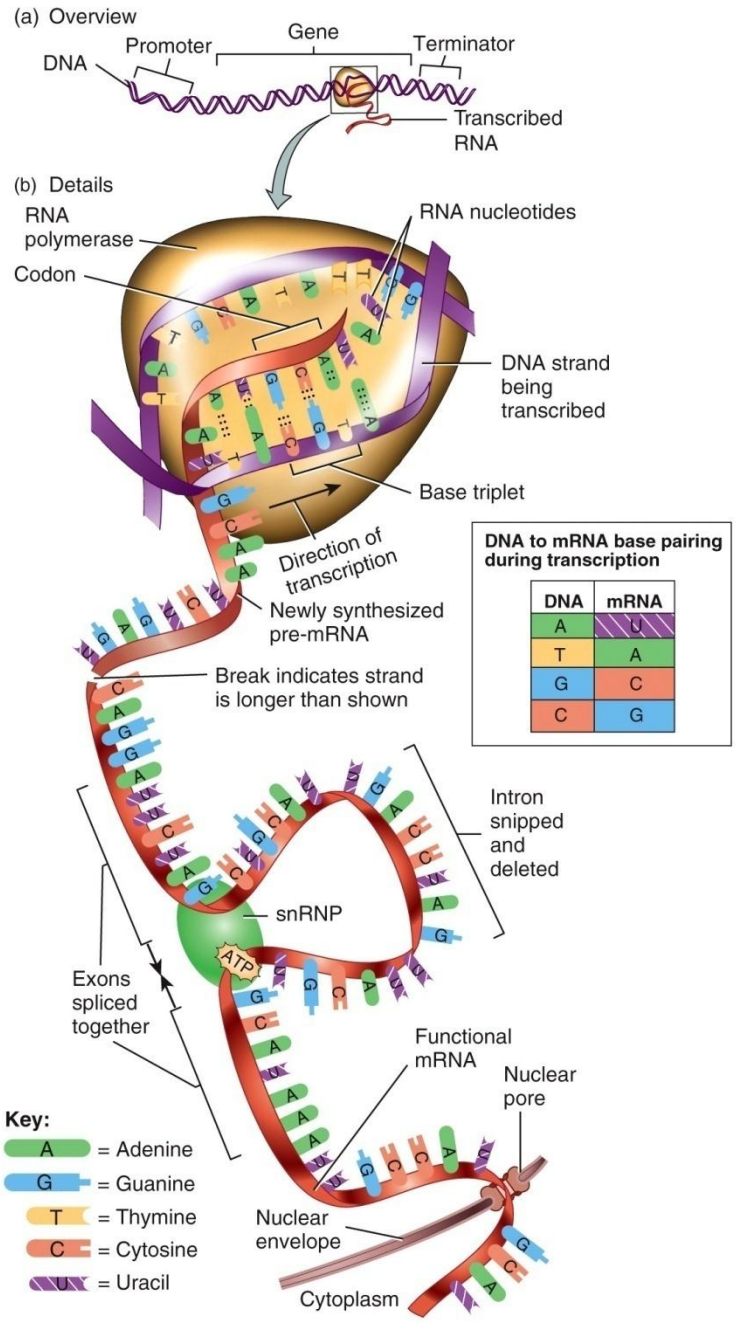

Thank you

Protein Synthesis & Cell division

Nehal V. Trambadiya
Asst. Professor
Smt. N. M. Padalia Pharmacy College, Ahemdabad

Protein Synthesis: Transcription

Transcription occurs in the nucleus and is the process by which genetic information encoded in DNA is copied onto a strand of RNA to direct protein synthesis



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- Three types of RNA are made from the DNA template:
- **1.Messenger RNA (mRNA**) directs the synthesis of a protein.
- **2. Ribosomal RNA (rRNA) joins with ribosomal proteins to** make ribosomes.
- **3. Transfer RNA (tRNA) binds to an amino acid and holds it** in place on a ribosome until it is incorporated into a protein during translation.

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- The enzyme **RNA polymerase catalyzes** transcription of DNA.
- The segment of DNA where transcription begins, a special nucleotide sequence called a **promoter, is located near the** beginning of a gene. This is where RNA polymerase attaches to the DNA
- Only one of the two DNA strands serves as a template for RNA synthesis.
- During transcription, bases pair in a complementary manner: The bases cytosine (C), guanine (G), and thymine (T) in the DNA template pair with guanine, cytosine, and adenine (A), respectively, in the RNA strand
- However, adenine in the DNA template pairs with uracil (U), not thymine, in RNA:

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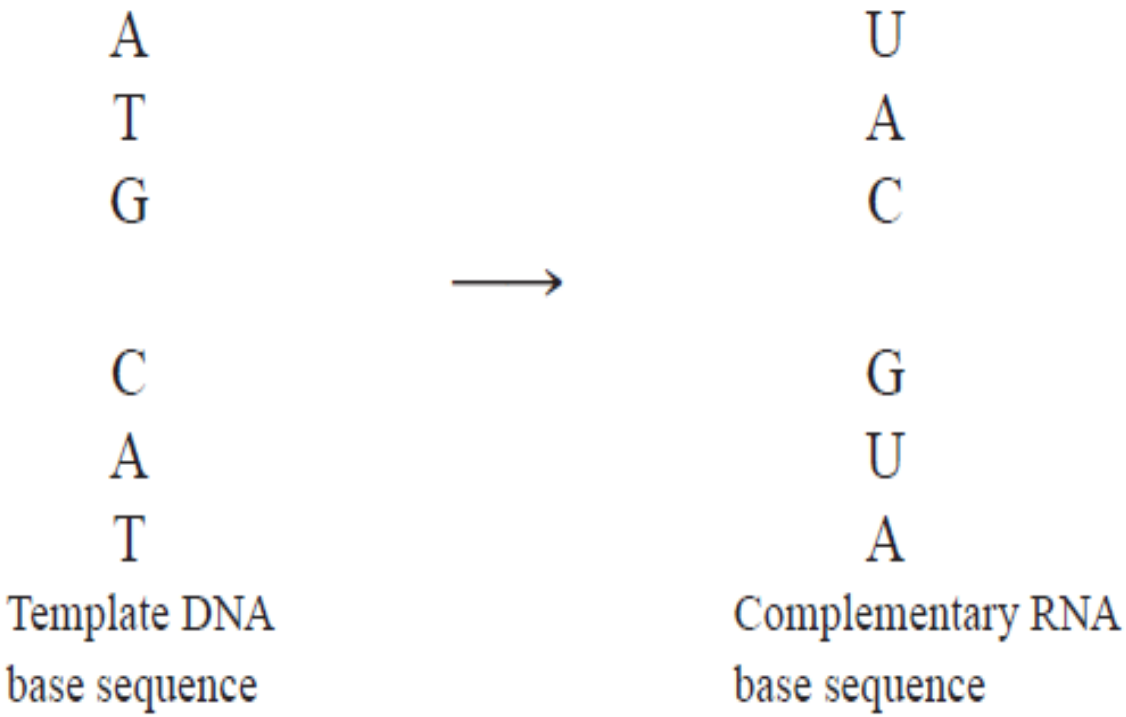

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- Transcription of the DNA strand ends at another special nucleotide sequence called a **terminator, which specifies the** end of the gene.
- When RNA polymerase reaches the terminator, the enzyme detaches from the transcribed RNA molecule and the DNA strand.

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Protein Synthesis: Translation

Translation occurs in the cytoplasm and is the process of reading the mRNA nucleotide sequence to determine the amino acid sequence of the newly formed protein.

- Ribosomes in the cytoplasm carry out translation.
- The small subunit of a ribosome has a *binding site for mRNA; the large subunit* has two binding sites for tRNA molecules, a *P site and an A site*.
- The first tRNA molecule bearing its specific amino acid attaches to mRNA at the P site.
- The A site holds the next tRNA molecule bearing its amino acid.
- Translation occurs in the following way

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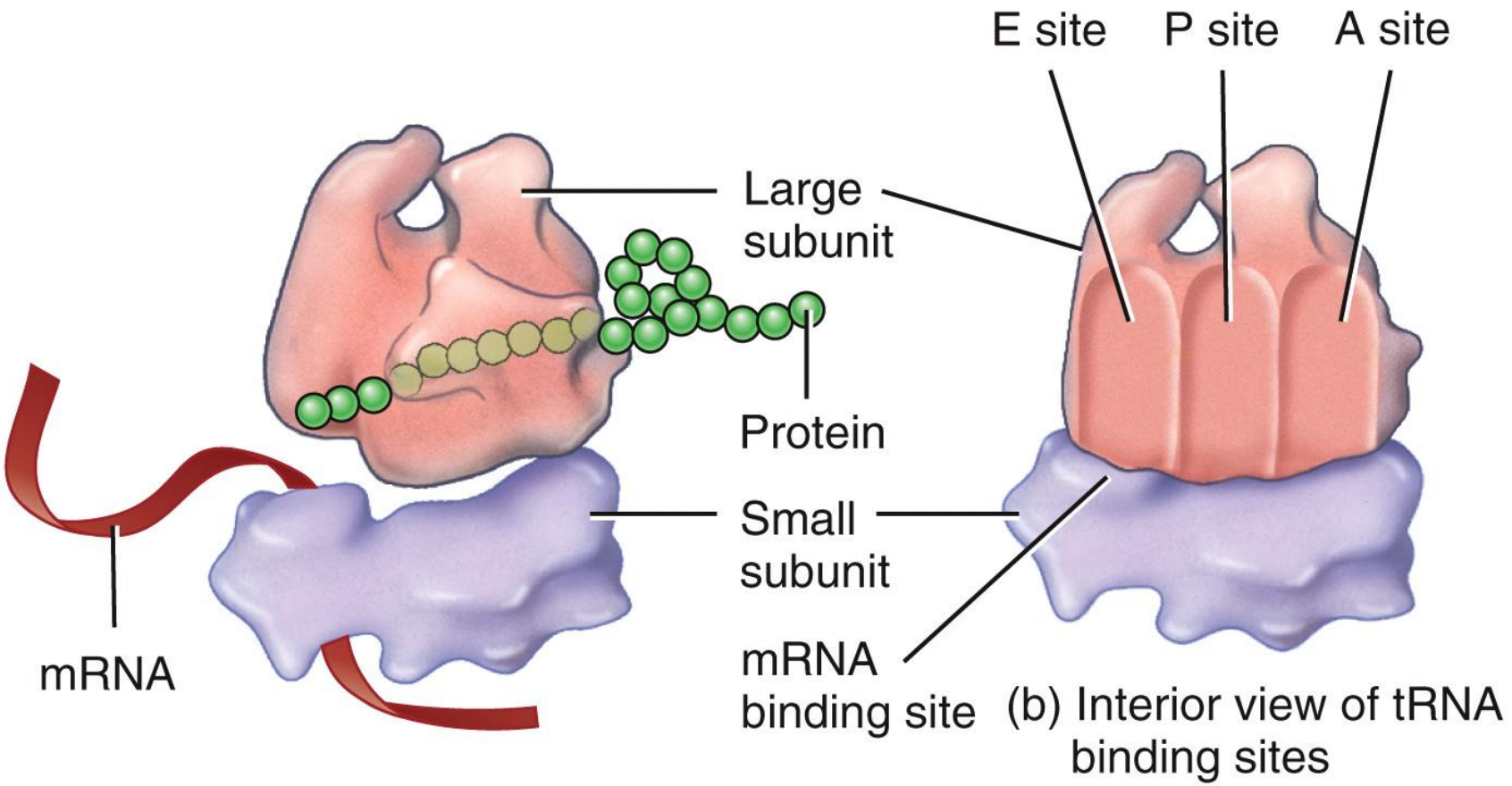

(a) Components of a ribosome and their relationship to mRNA and protein during translation

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- **●1 An mRNA molecule binds to the small ribosomal subunit at** the mRNA binding site. A special tRNA, called *initiator tRNA, binds to the start codon (AUG) on mRNA, where* translation begins. The tRNA anticodon (UAC) attaches to the mRNA codon (AUG) by pairing between the complementary bases. Besides being the start codon, AUG is also the codon for the amino acid methionine. Thus, methionine is always the first amino acid in a growing polypeptide.

- 2. Next, the large ribosomal subunit attaches to the small ribosomal subunit–mRNA complex, creating a functional ribosome. The initiator tRNA, with its amino acid (methionine), fits into the P site of the ribosome.

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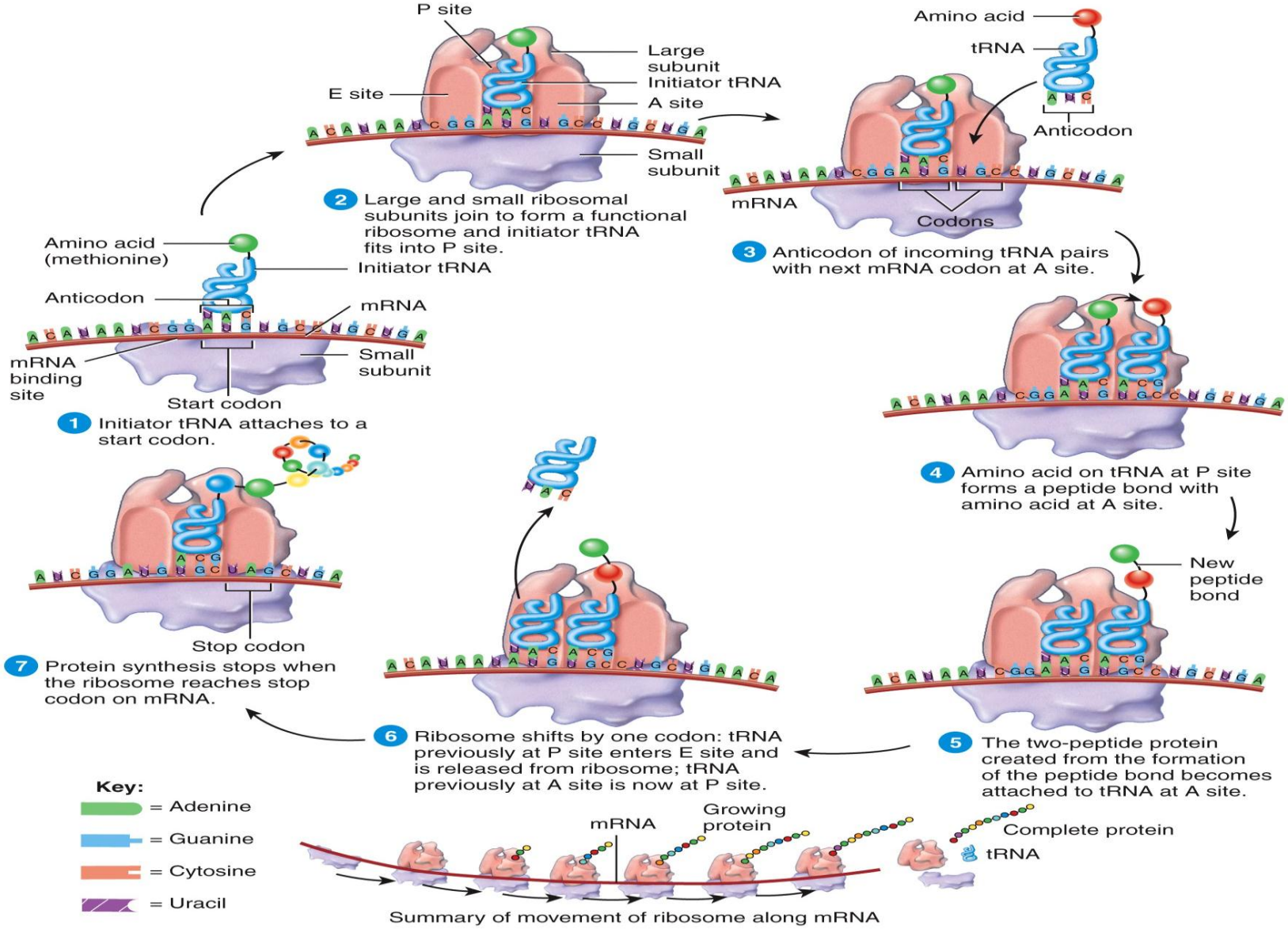
Protein Synthesis During Transcription



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- **●3 The anticodon of another tRNA with its attached amino acid** pairs with the second mRNA codon at the A site of the ribosome.
- **●4 A component of the large ribosomal subunit catalyzes the f**ormation of a peptide bond between methionine, which separates from its tRNA at the P site, and the amino acid carried by the tRNA at the A site.

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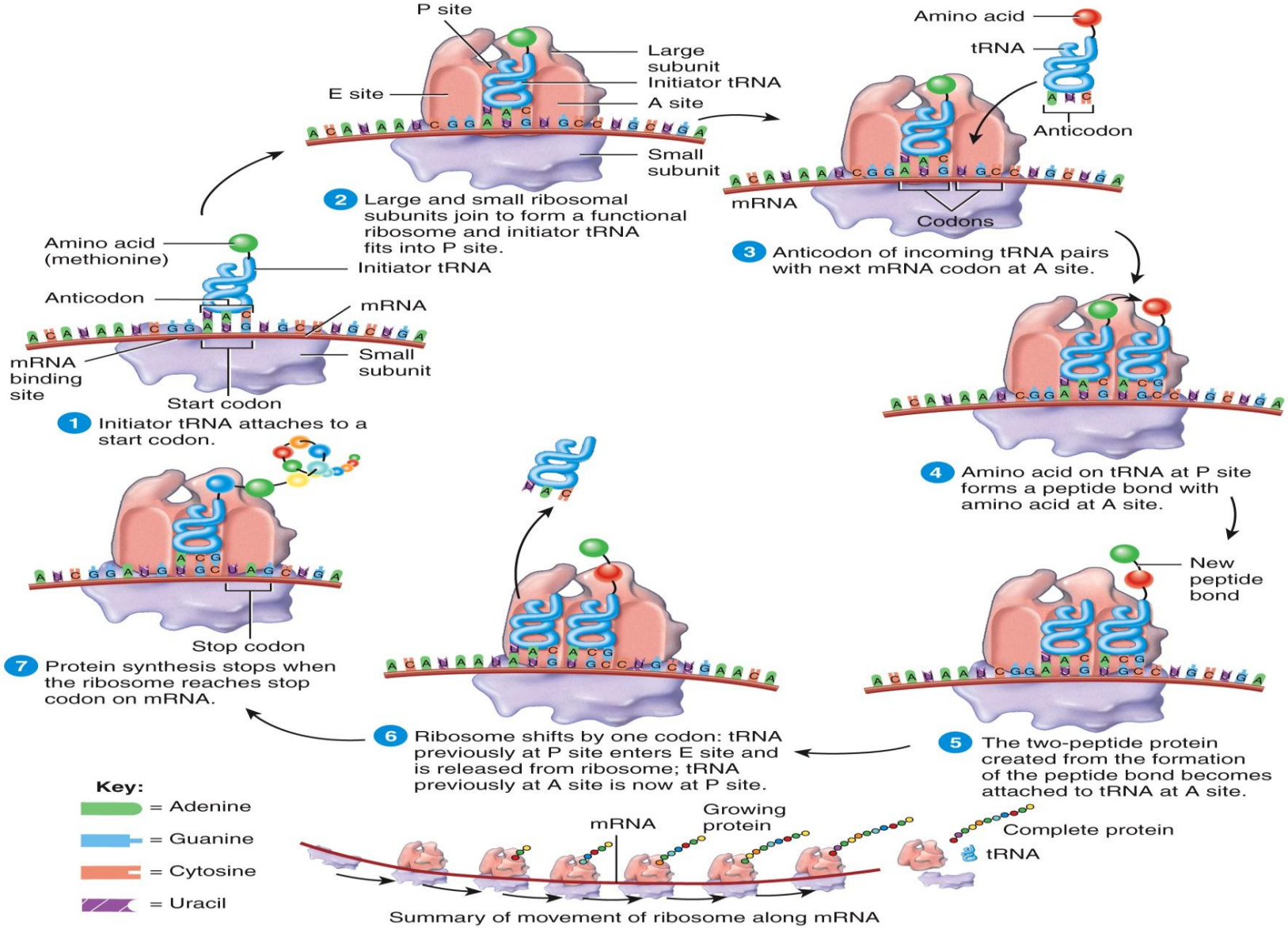
Protein Synthesis During Transcription



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- **●5 After peptide bond formation, the tRNA at the P site** detaches from the ribosome, and the ribosome shifts the mRNA strand by one codon. The tRNA in the A site bearing the two-peptide protein shifts into the P site, allowing another tRNA with its amino acid to bind to a newly exposed codon at the A site. Steps**●3 through●5 occur** repeatedly, and the protein lengthens progressively.

- **●6 Protein synthesis ends when the ribosome reaches a stop** codon at the A site, which causes the completed protein to detach from the final tRNA. When the tRNA vacates the A site, the ribosome splits into its large and small subunits.

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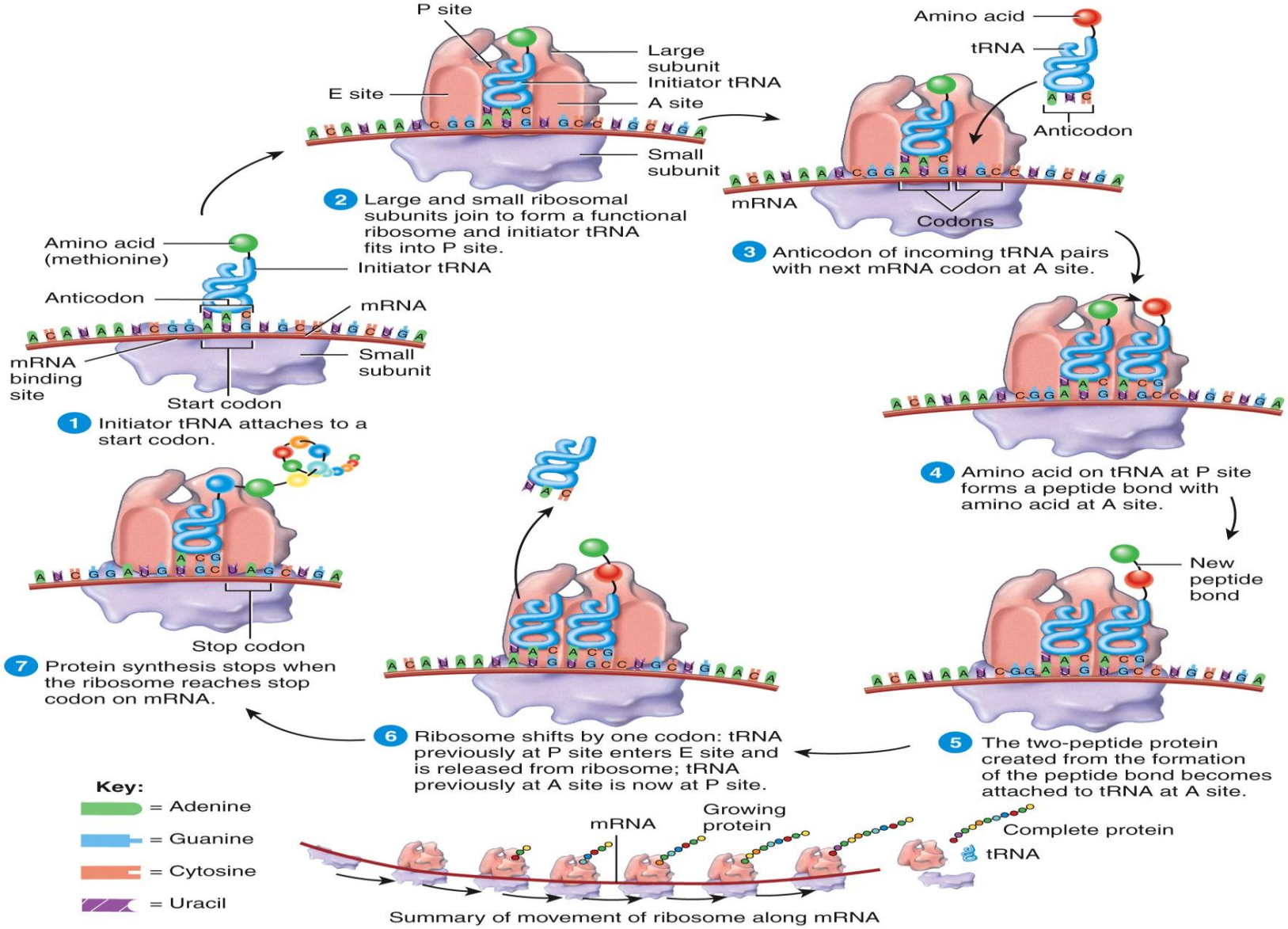
Protein Synthesis During Transcription



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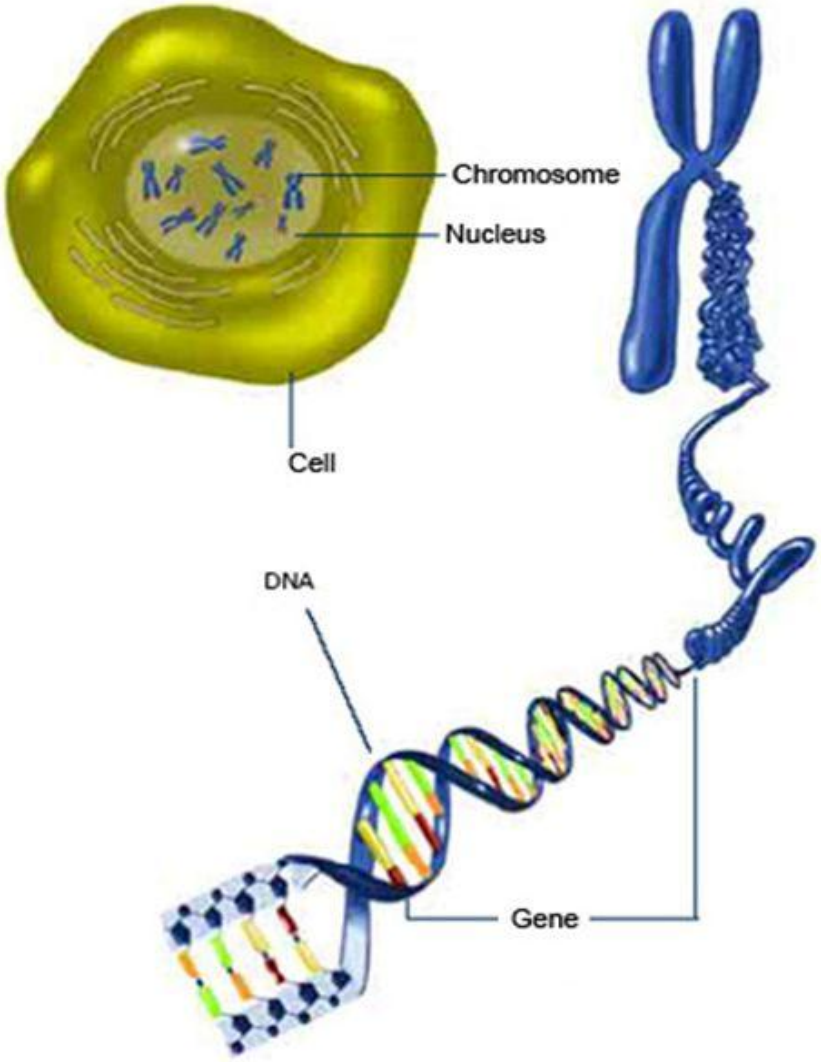
2

NUCLEUS vs CHROMOSOME vs GENE vs DNA

The **NUCLEUS** is where DNA is stored in eukaryotic cells.



The term **CHROMOSOME** is tightly wound DNA.

DNA is the material that makes up genes and chromosomes. Stretched and unwound it looks like a double helix.

.

The term refers to a **GENE** small section of the DNA, it codes for a particular trait

Cell Division

Cell division is a process by which cells reproduce themselves

The two types of cell division—somatic cell division and reproductive cell division

A **somatic cell *is any cell of the body other*** than a germ cell.

A **germ cell is a gamete or** any precursor cell destined to become a gamete.

In **somatic cell division, a cell undergoes a nuclear division called mitosis** (mı¯-TO - -sis; *mitos thread) and a cytoplasmic division called* **cytokinesis**

The **cell cycle is an orderly sequence of events by which a** somatic cell duplicates its contents and divides in two. Human cells, such as those in the brain, stomach, and kidneys, contain 23 pairs of chromosomes, for a total of 46.

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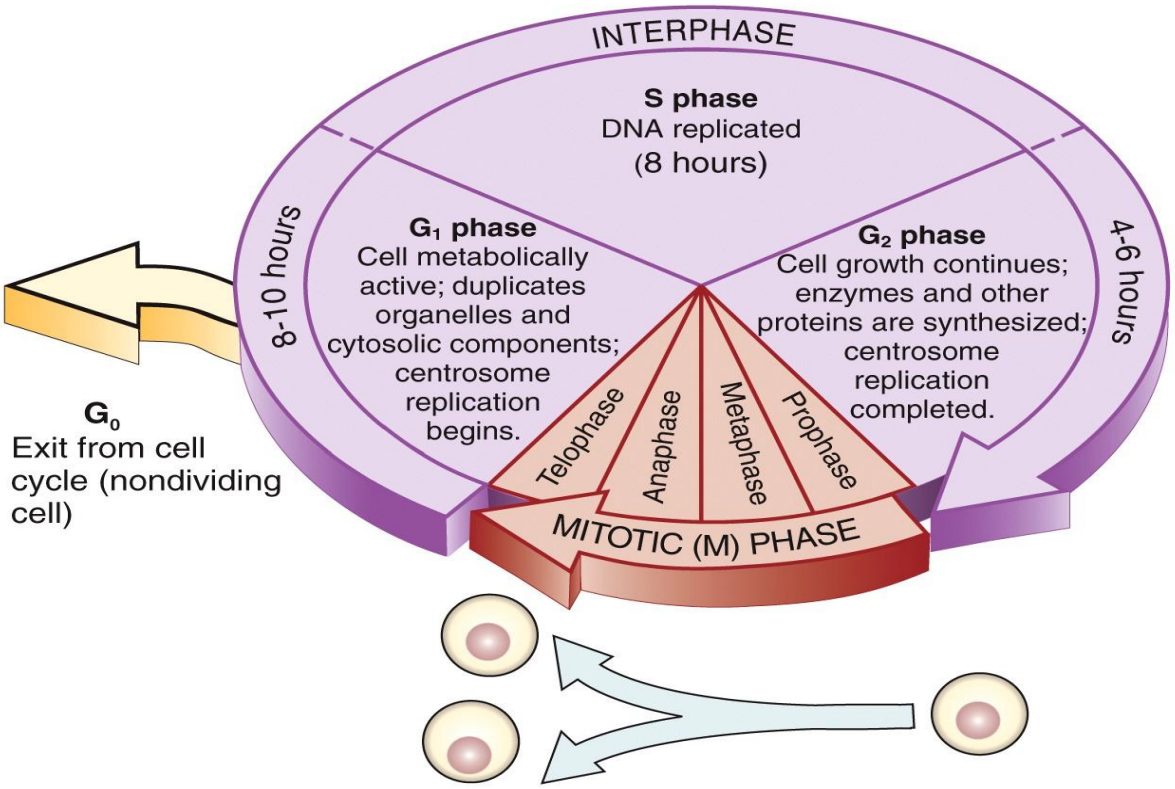
The cell cycle consists of two major periods: interphase, when a cell is not dividing, and the mitotic (M) phase, when a cell is dividing



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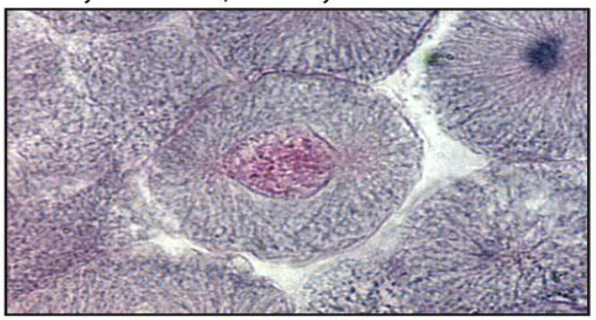
Interphase

G_1 phase-the cell is metabolically active; it replicates most of its organelles and cytosolic components but not its DNA

S-DNA replication occurs

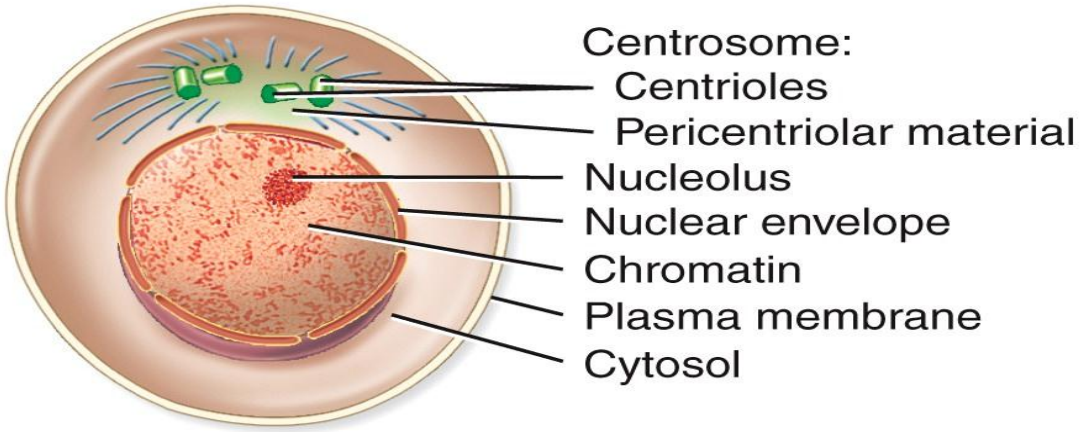
G_2 phase-cell growth continues, enzymes and other proteins are synthesized in preparation for cell division, and replication of centrosomes is completed.

Courtesy Michael Ross, University of Florida



LM all at 700x

(a) INTERPHASE



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The **mitotic (M) phase of the cell cycle consists of a nuclear** division (mitosis) and a cytoplasmic division (cytokinesis) to form two identical cells.

M phase consiss of four phase

Prophase.

Metaphase.

Anaphase.

Telophase.

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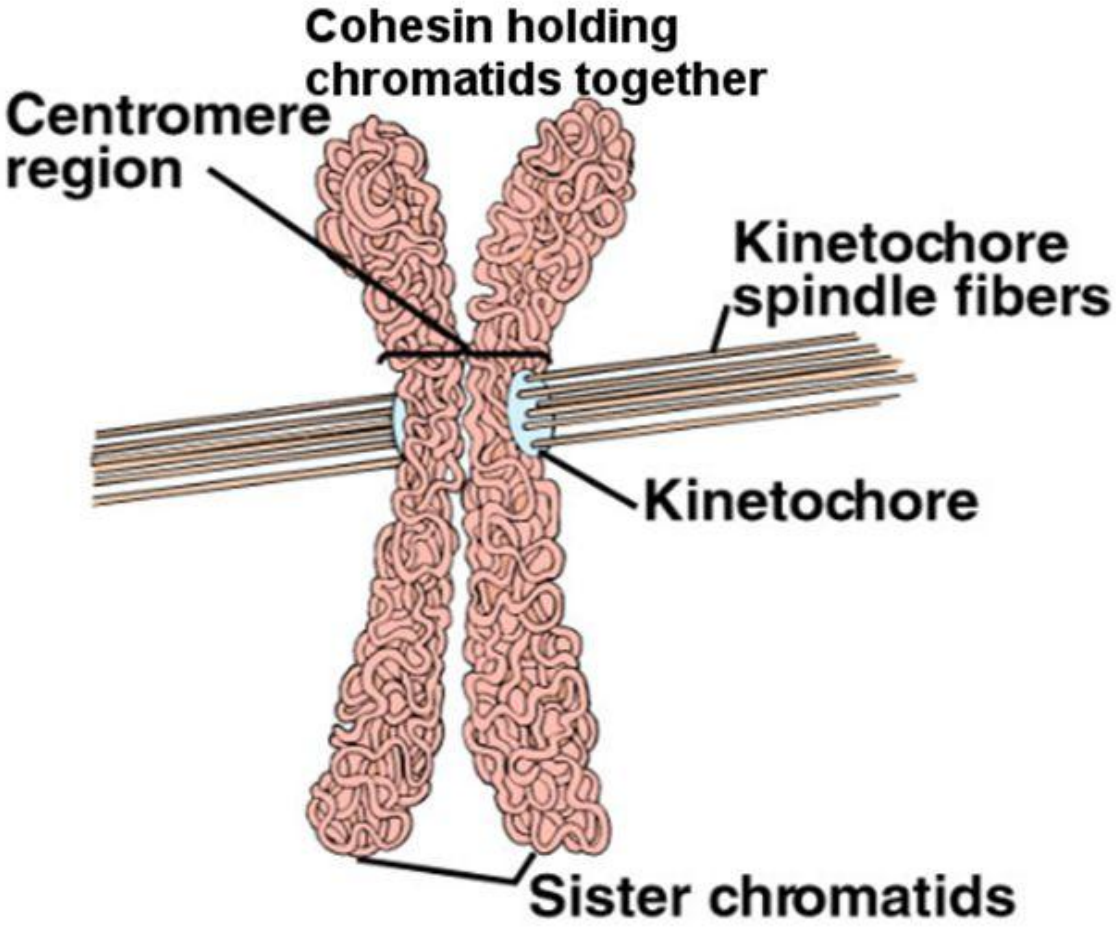
Centromere vs. Kinetochore



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Mitotic Phase: Prophase

During prophase chromatin(complex of DNA, RNA and protein) condenses into chromosomes the chromatin fibers condense and shorten into chromosomes

A constricted region called a **centromere holds the chromatid pair together.**

At the outside of each centromere is a protein complex known as the **kinetochore (ki-NET-o¯-kor).**

Later in prophase, tubulins in the pericentriolar material of the centrosomes start to form the **mitotic spindle, a football-shaped assembly of microtubules that** attach to the kinetochore .

As the microtubules lengthen, they push the centrosomes to the poles (ends) of the cell so that the spindle extends from pole to pole.

The mitotic spindle is responsible for the separation of chromatids to opposite poles of the cell.

Then, the nucleolus disappears and the nuclear envelope breaks down.

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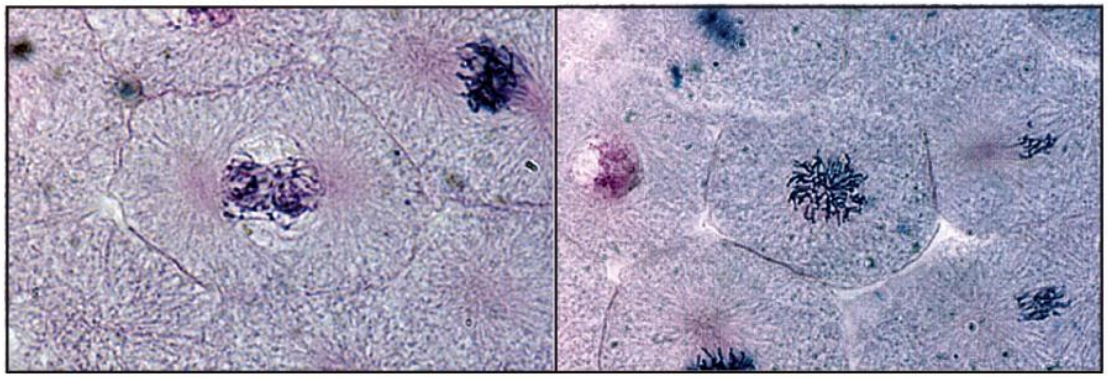
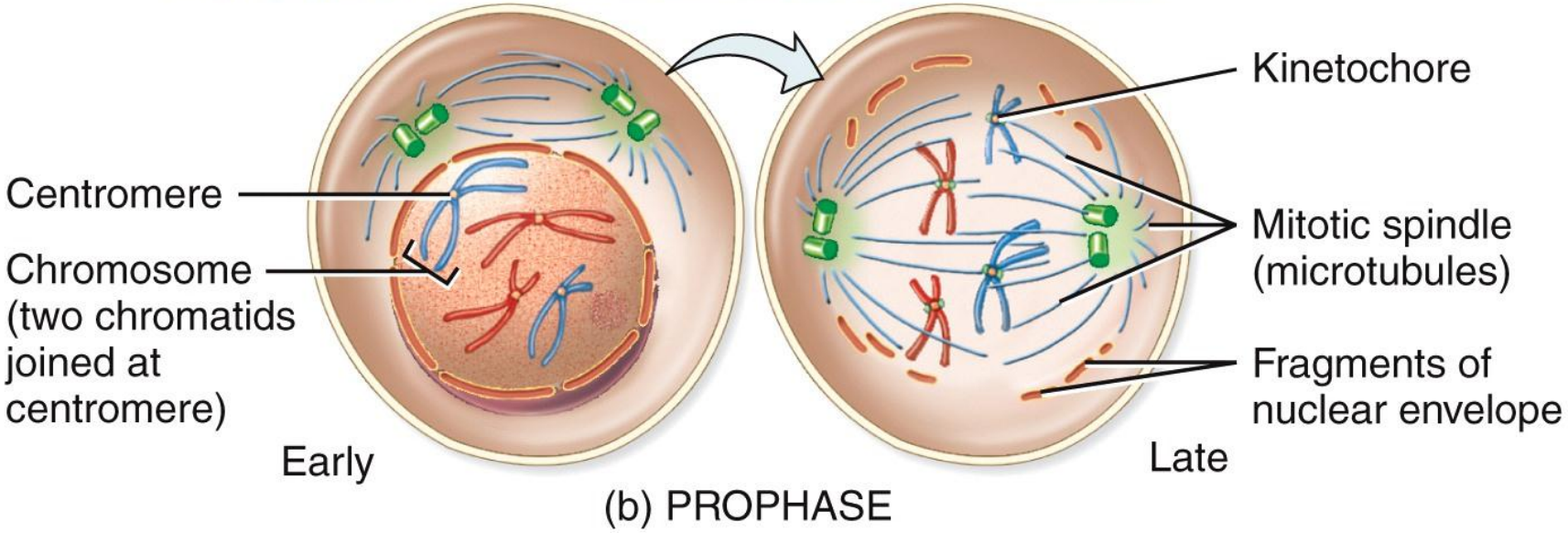
Mitotic Phase: Prophase

Courtesy Michael Ross, University of Florida





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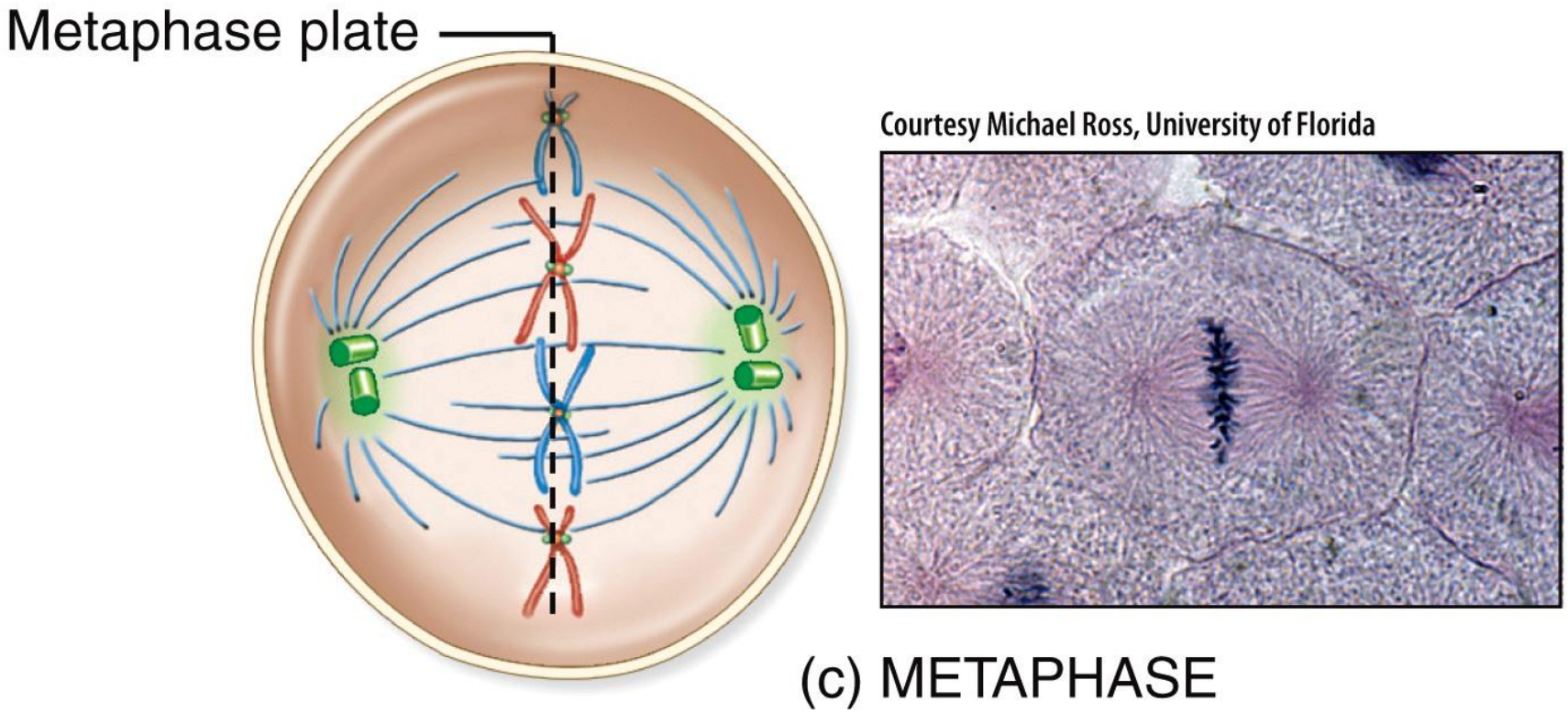
Mitotic Phase: Metaphase

During metaphase centromeres of chromosomes line up at the metaphase plate



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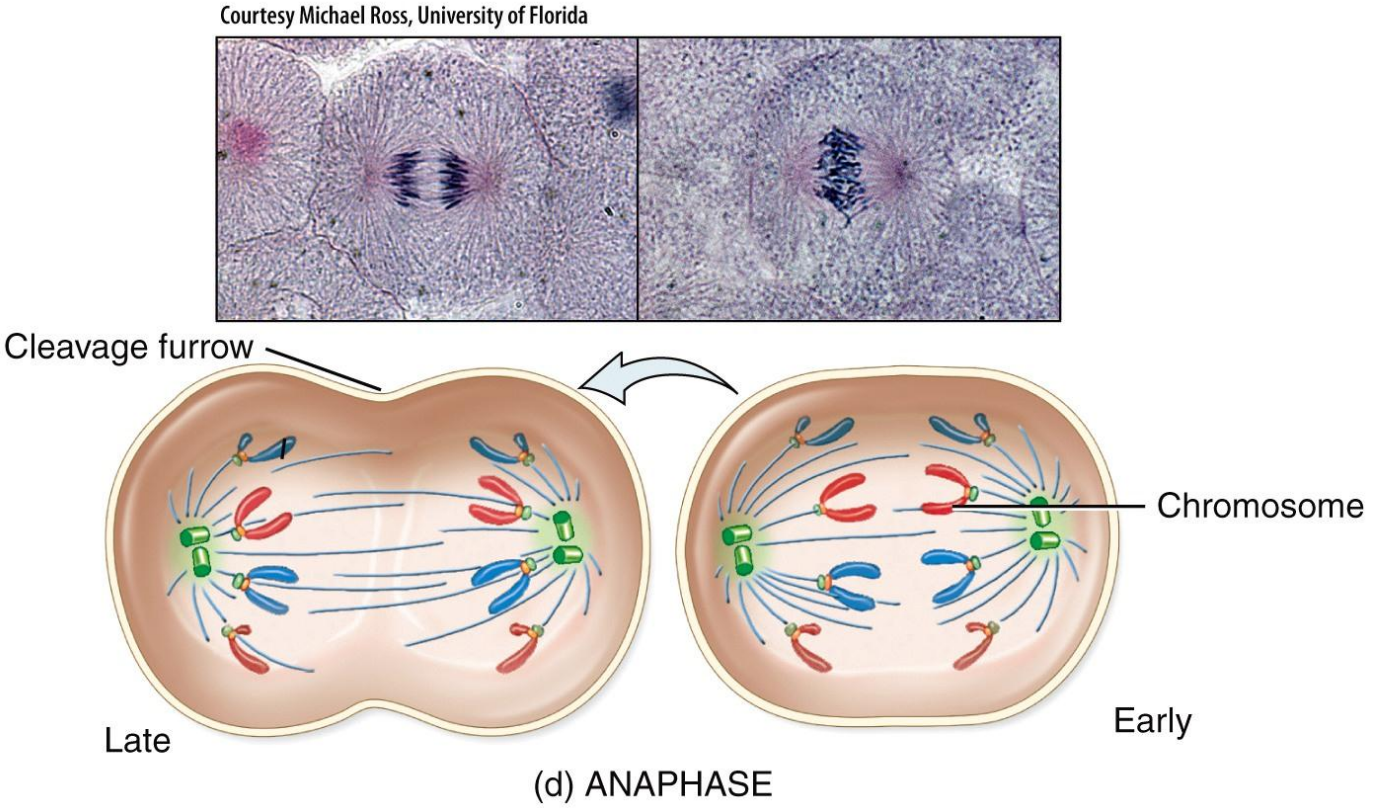
Mitotic Phase: Anaphase

During anaphase centromeres of chromosomes split and sister chromatids move toward opposite poles of the cell



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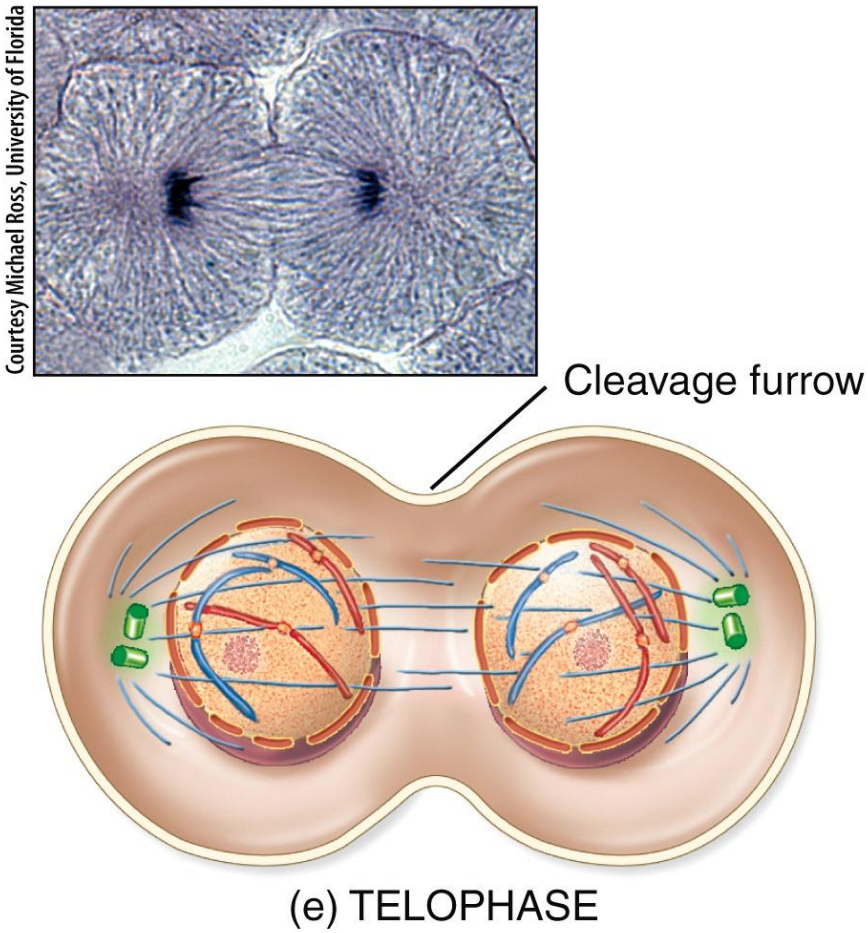
Mitotic Phase: Telophase

During telophase the mitotic spindle dissolves, chromosomes regain their chromatin appearance, and a new nuclear membrane forms



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Cytokinesis

During cytokinesis a cleavage furrow forms and eventually the cytoplasm of the parent cell fully splits

- When this is complete, interphase begins

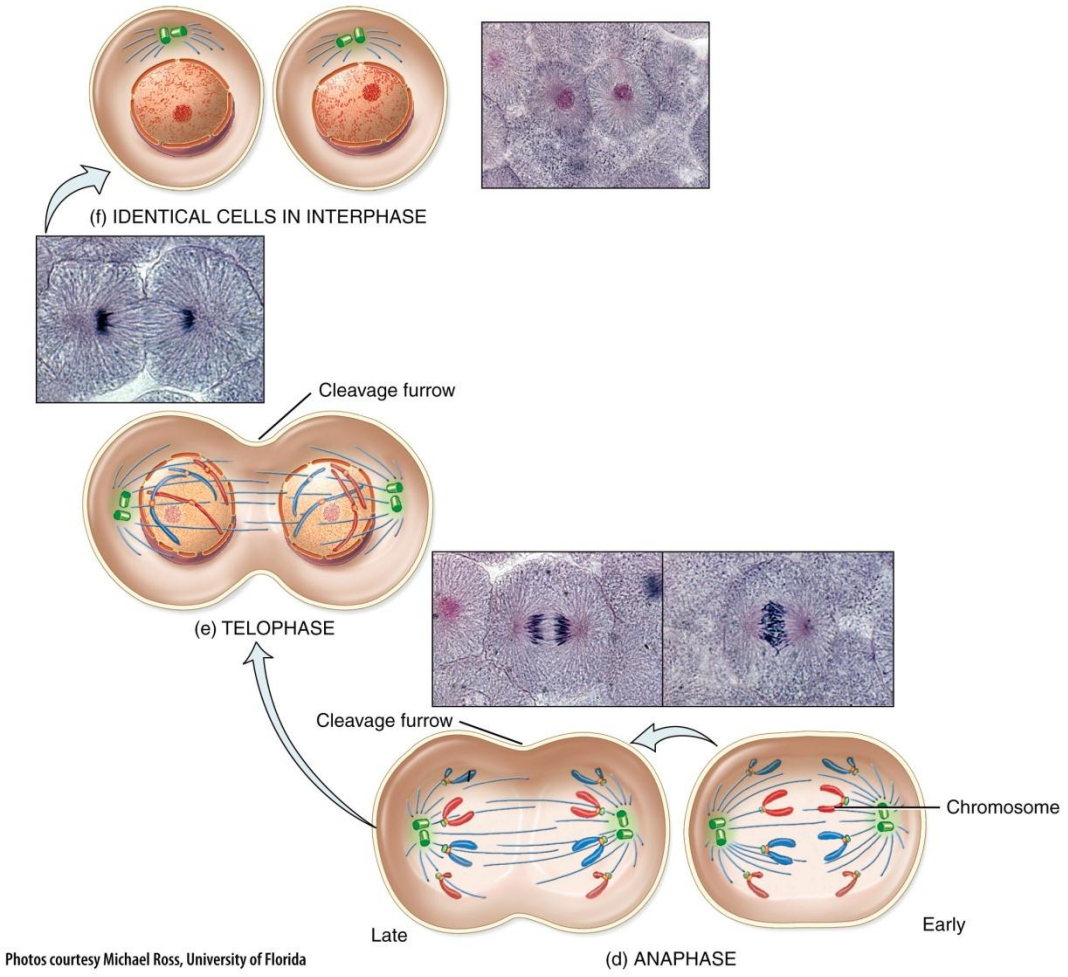

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TABLE 3.3

Events of the Somatic Cell Cycle

PHASE	ACTIVITY
Interphase	Period between cell divisions; chromosomes not visible under light microscope.
G_1 phase	Metabolically active cell duplicates most of its organelles and cytosolic components; replication of chromosomes begins. (Cells that remain in the G_1 phase for a very long time, and possibly never divide again, are said to be in the G_0 phase.)
S phase	Replication of DNA and centrosomes.
G_2 phase	Cell growth, enzyme and protein synthesis continue; replication of centrosomes complete.
Mitotic phase	Parent cell produces identical cells with identical chromosomes; chromosomes visible under light microscope.
Mitosis	Nuclear division; distribution of two sets of chromosomes into separate nuclei.
Prophase	Chromatin fibers condense into paired chromatids; nucleolus and nuclear envelope disappear; each centrosome moves to an opposite pole of the cell.
Metaphase	Centromeres of chromatid pairs line up at metaphase plate.
Anaphase	Centromeres split; identical sets of chromosomes move to opposite poles of cell.
Telophase	Nuclear envelopes and nucleoli reappear; chromosomes resume chromatin form; mitotic spindle disappears.
Cytokinesis	Cytoplasmic division; contractile ring forms cleavage furrow around center of cell, dividing cytoplasm into separate and equal portions.

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Control of Cell Destiny

3 possible destinies:

1. Remain alive and functioning without dividing
2. Grow and divide
3. Die

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Reproductive Cell Division: Meiosis I

meiosis occurs in two successive stages: meiosis I and meiosis II.

During the interphase that precedes meiosis I, the chromosomes of the diploid cell start to replicate.

As a result of replication, each chromosome consists of two sister (genetically identical) chromatids, which are attached at their centromeres.

This replication of chromosomes is similar to the one that precedes mitosis in somatic cell division.

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MEIOSIS I

Meiosis I, which begins once chromosomal replication is complete, consists of four phases: prophase I, metapahase I, anaphase I, and telophase I.

Prophase I is an extended phase in which the chromosomes shorten and thicken, the nuclear envelope and nucleoli disappear, and the mitotic spindle forms

Two events that are not seen in mitotic prophase occur during prophase I of meiosis.

First, the two sister chromatids of each pair of homologous chromosomes pair off, an event called synapsis.

The resulting four chromatids form a structure called a tetrad. Second, parts of the chromatids of two homologous chromosomes may be exchanged with one another. Such an exchange between parts of nonsister (genetically different) chromatids is termed crossing-over

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In metaphase I, the tetrads formed by the homologous pairs of chromosomes line up along the metaphase plate of the cell, with homologous chromosomes side by side.

During anaphase I, the members of each homologous pair of chromo somes separate as they are pulled to opposite poles of the cell by the microtubules attached to the centromeres.

The paired chromatids, held by a centromere, remain together.

Telophase I and cytokinesis of meiosis are similar to telophase and cytokinesis of mitosis.

The net effect of meiosis I is that each resulting cell contains the haploid number of chromosomes because it contains only one member of each pair of the homologous chromosomes present in the starting cell

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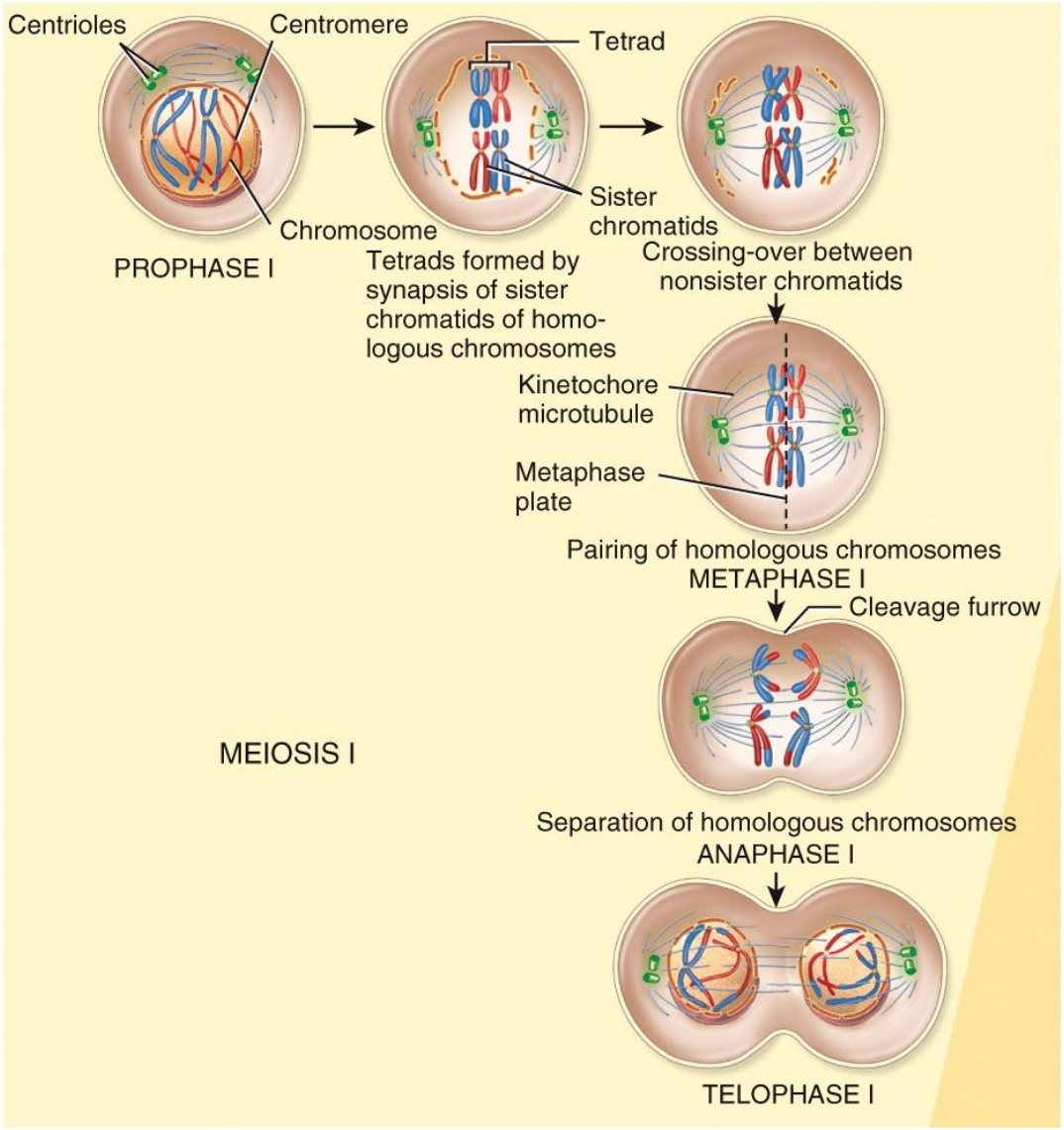
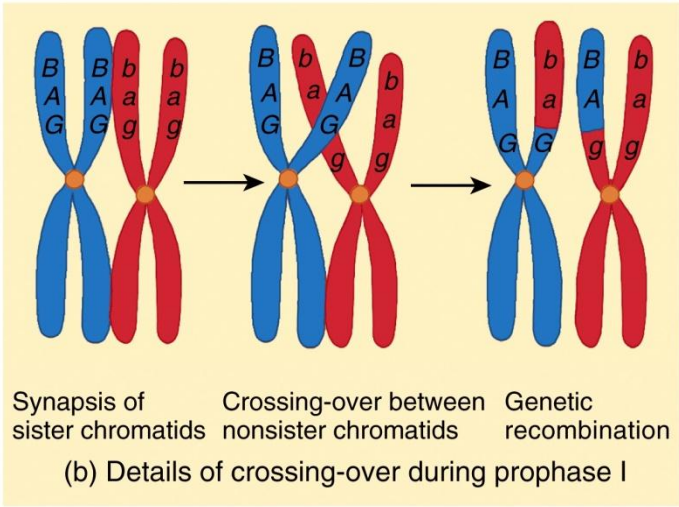
Reproductive Cell Division: Meiosis I





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MEIOSIS II

The second stage of meiosis, meiosis II, also consists of four phases: prophase II, metaphase II, anaphase II, and telophase II.

These phases are similar to those that occur during mitosis; the centromeres split, and the sister chromatids separate and move toward opposite poles of the cell.

In summary, meiosis I begins with a diploid starting cell and ends with two cells, each with the haploid number of chromosomes.

During meiosis II, each of the two haploid cells formed during meiosis I divides; the net result is four haploid gametes that are genetically different from the original diploid starting cell.

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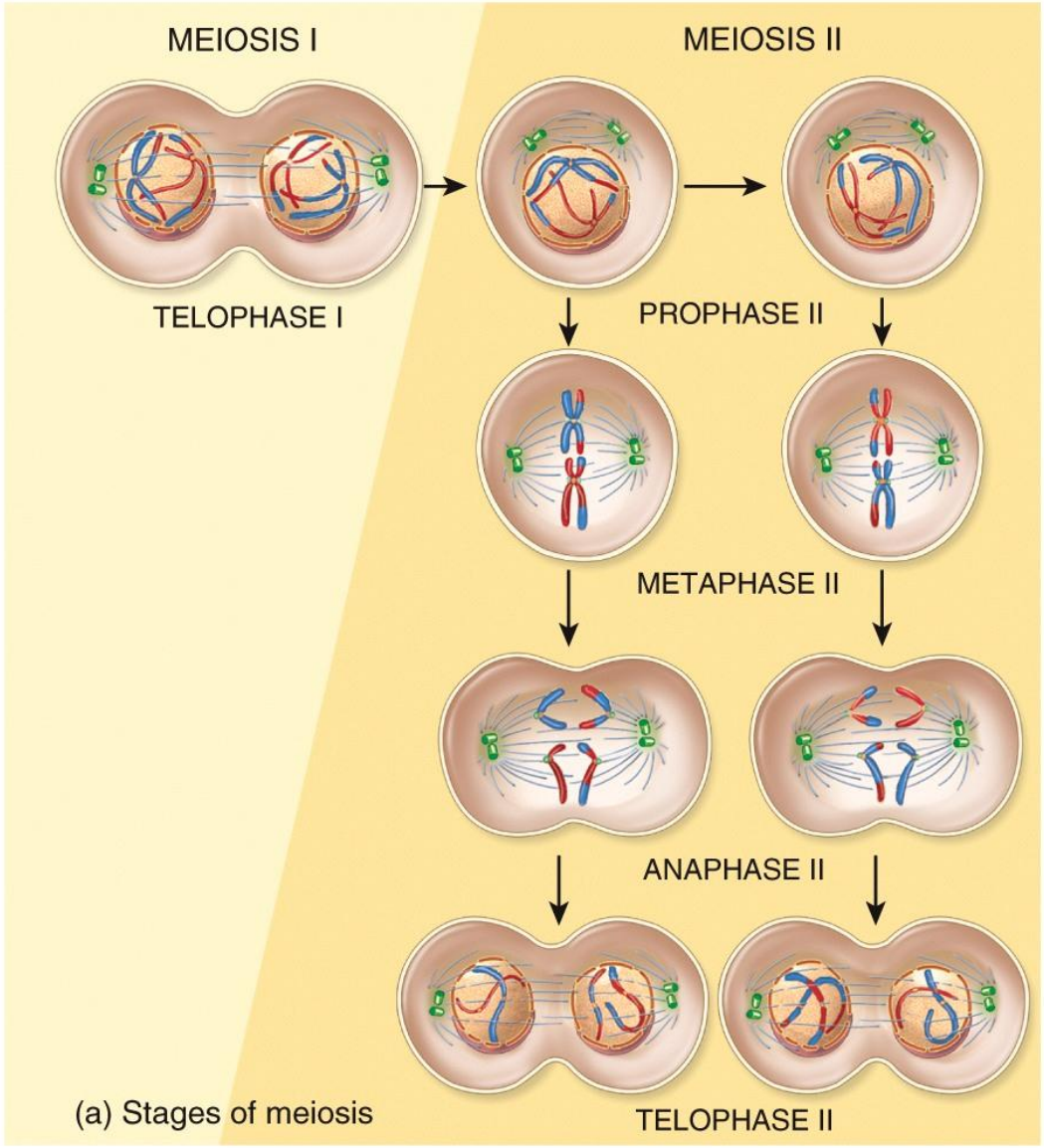
Reproductive Cell Division: Meiosis II



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TISSUE

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Smt. N. M. Padalia Pharmacy College

Definition of Tissues

Biological tissue is a collection of interconnected cells that perform a similar function within an organism.

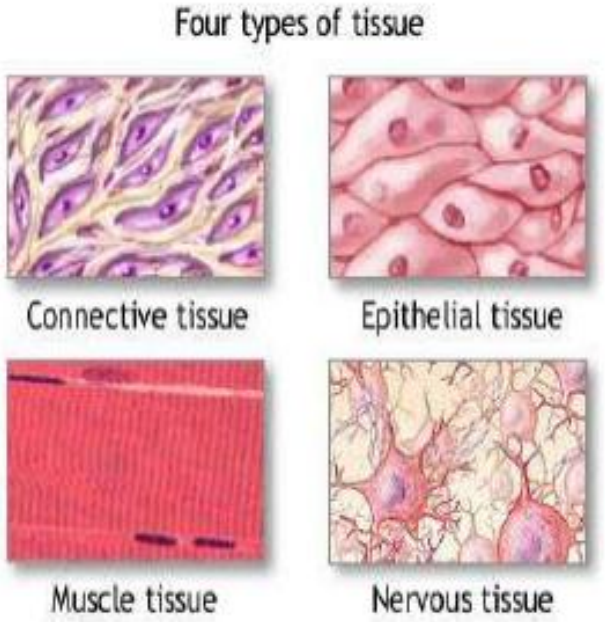
In other words, it is a group of cells working together mainly inside an organ.

Classification of Tissues

Human body is composed of

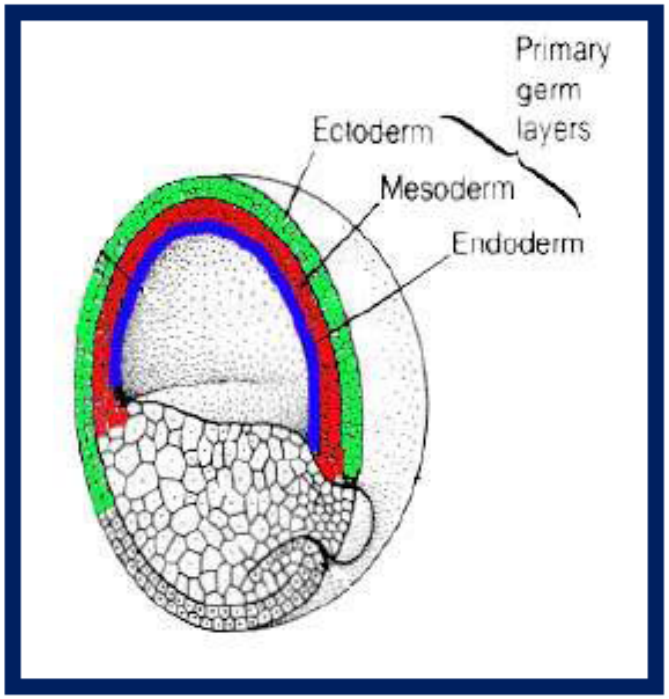
4 basic types of tissue:

- Epithelial tissue
- Connective tissue
- Muscular tissue
- Nervous tissue



Origin of Tissue

A fertilized egg divides to produce 3 primary germ cell layers. These layers differentiate to form the tissues of the body.



Epithelial Tissue

Epithelial cells cover or line all body surfaces, cavities and tubes. So, These are called *covering epithelia*.

Epithelial cells form the functional units of secretory glands. So, These are called *glandular epithelia*.

General Characteristic

- ✓ Closely attached to each other forming a protective barrier.
- ✓ Always has one free (apical) surface open to outside the body or inside (cavity) an internal organ.
- ✓ Always has one fixed (basal) section attached to underlying connective tissue.
- ✓ Has no blood vessels but can soak up nutrients from blood vessels in connective tissue underneath.
- ✓ Can have lots of nerves in it (innervated).
- ✓ Very good at regenerating (fixing itself). i.e. sunburn, skinned knee.

Functions

- To protect the tissues that lie beneath it from radiation, desiccation, toxins, invasion by pathogens, and physical trauma.
- The regulation and exchange of chemicals between the underlying tissues and a body cavity.
- The secretion of hormones into the blood vascular system, and/or the secretion of sweat, mucus, enzymes, and other products that are delivered by ducts glandular epithelium.
- To provide sensation.
- Absorbs stomach and intestinal lining (gut).
- Filters the kidney.
- Forms secretary glands.

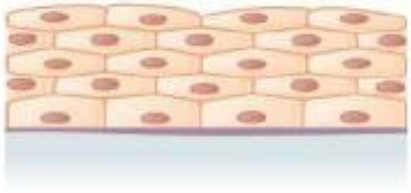
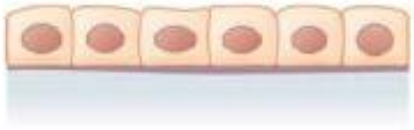
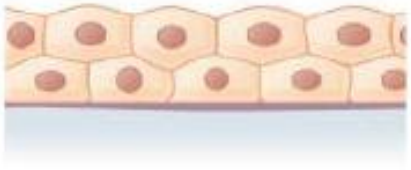
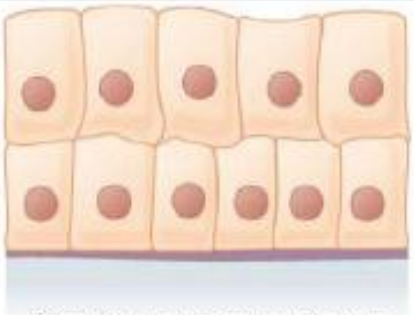
Classification of Epithelia

According to thickness

- ✓ "simple" - one cell layer
- ✓ "stratified" – more than one layer of cells (which are named according to the shape of the cells in the apical layer)

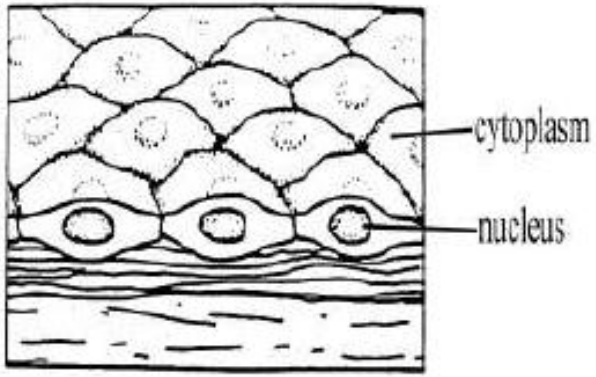
According to shape

- ✓ "squamous" – wider than tall
- ✓ "cuboidal" – as tall as wide
- ✓ "columnar" - taller than wide

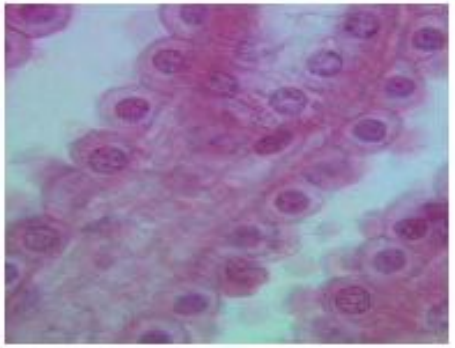
	Simple	Stratified	
Squamous	 Simple squamous epithelium	 Stratified squamous epithelium	
Cuboidal	 Simple cuboidal epithelium	 Stratified cuboidal epithelium	**Pseudostratified**
Columnar	 Simple columnar epithelium	 Stratified columnar epithelium	 Pseudostratified columnar epithelium

Simple squamous epithelium

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



Function: Passive transport of gases and fluids.



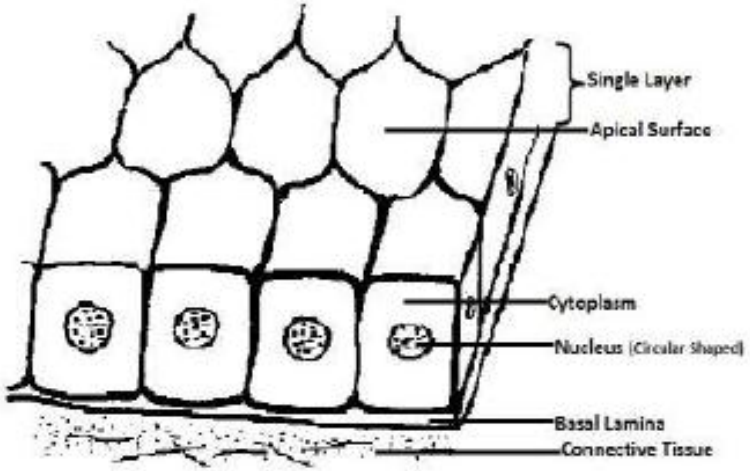
Location:Alveoli of lungs, lining body cavities (mesothelium), lining blood vessels (endothelium)

Simple cuboidal epithelia

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.



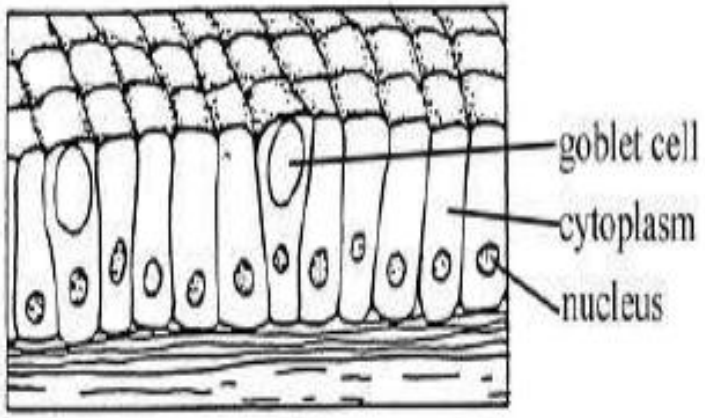
Simple columnar epithelia

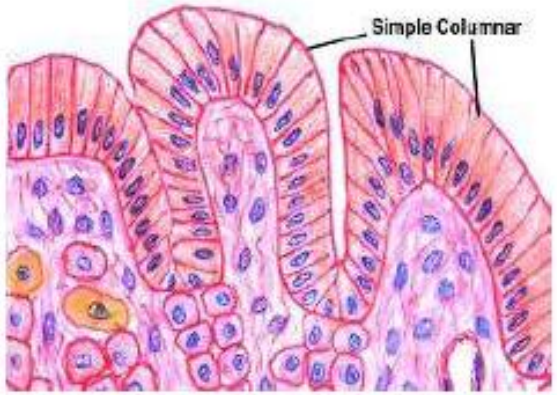
Description: Single layer of tall cells with round to oval nuclei.

Types: (i)Ciliated columnar epithelia.
(ii)Non-ciliated columnar epithelia.

Function: Absorption; secretion of mucus, Enzymes and other substances.

Location: Digestive tract, gall bladder etc.



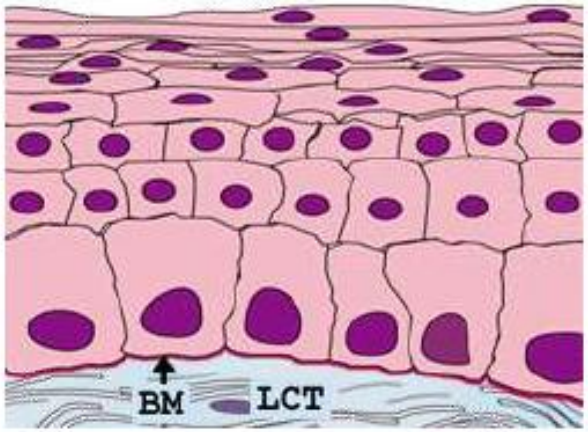


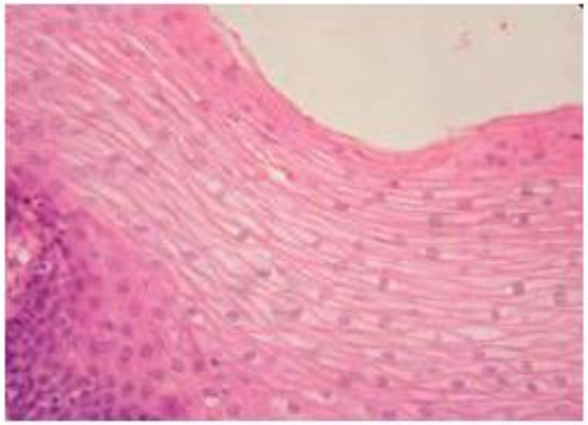
Stratified squamous epithelia

Description:
Multilayered, surface cell are squamous, basal cells are cuboidal and divided constantly.

Function: Protection.

Location: Oral cavity, cervix, anal canal.



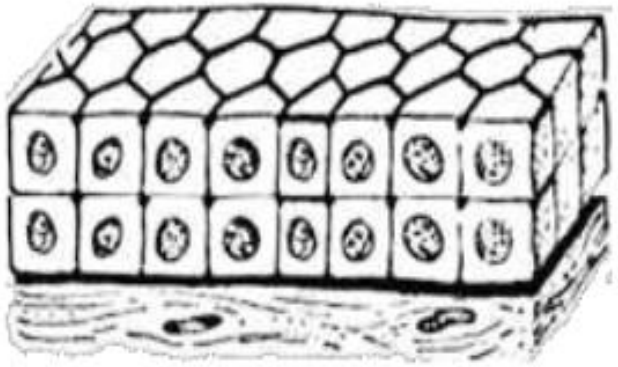


Stratified cuboidal epithelia

Description: Generally two layers of cube-like cells.

Function: Protection.

Location: Large ducts of sweat glands, mammary glands, and salivary glands.

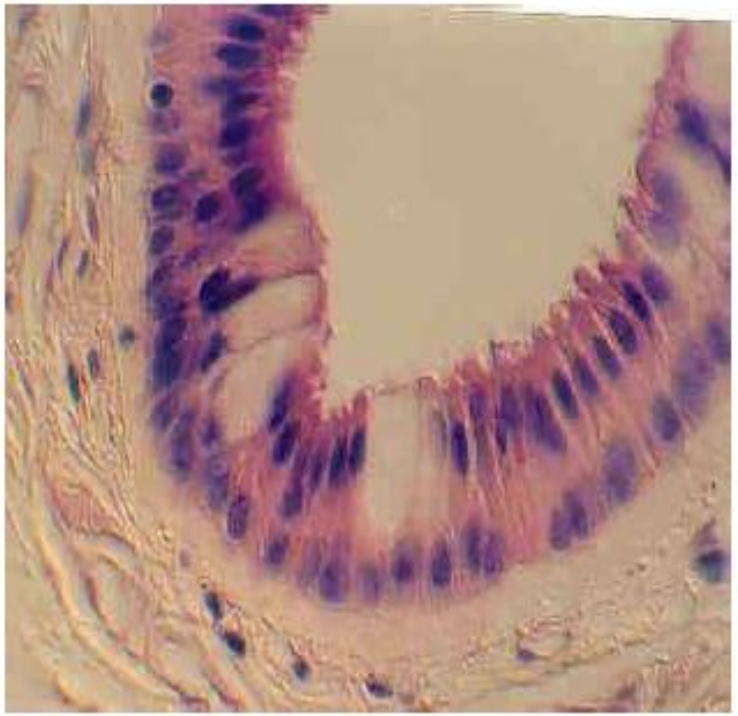


Stratified columnar epithelia

Description:
Multilayered, superficial cells elongated and columnar.

Function: Protection; secretion.

Location: Rare in the body; small amount in the male urethra.

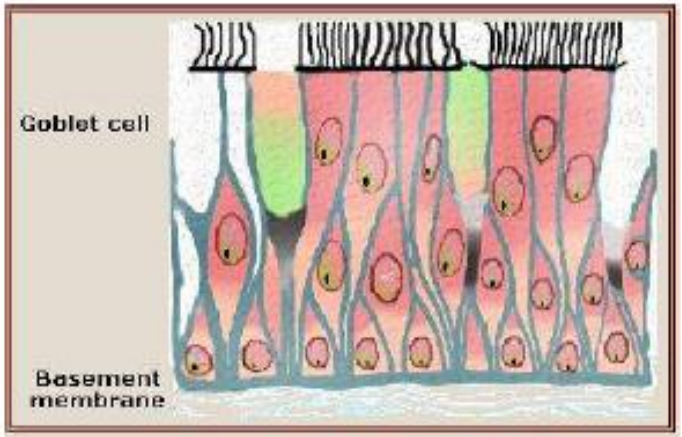


Pseudo stratified columnar epithelia

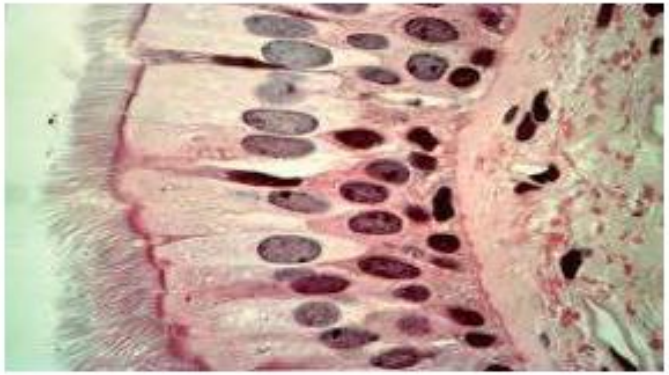
Description: Single cell layered, all cell attach to the basement membrane but not all reach the free surface. Nuclei at varying depth.

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

Location: Lines of trachea.



Pseudostratified columnar ciliated

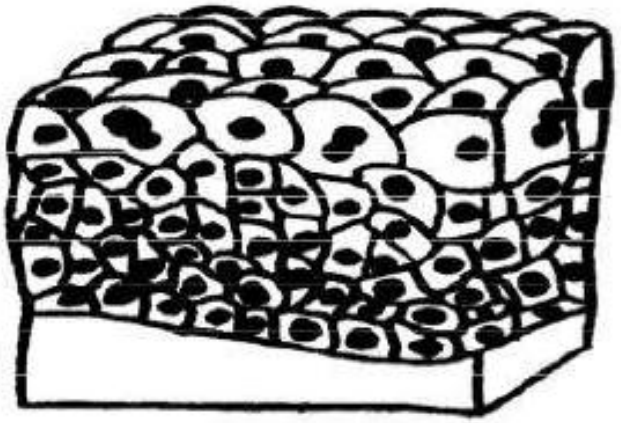


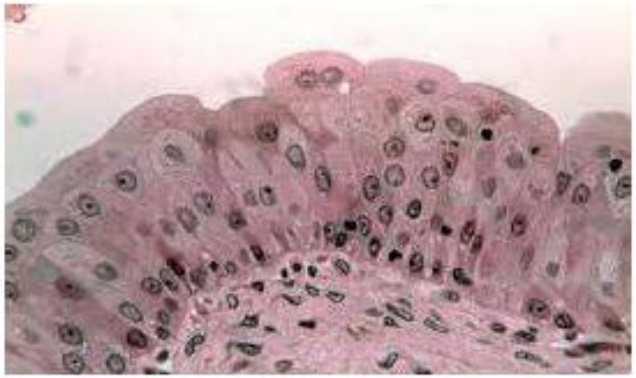
Transitional epithelia

Description: Characterized by domelike cells that are neither squamous nor columnar. The form of the cells changes.

Function: Stretching and protection.

Location: Bladder and part of urethra.





Connective Tissues

The tissues that connect the different parts of the body together are called connective tissues.

- Connective tissue consists of two basic elements: extracellular matrix and cells.
- A connective tissue's **extracellular matrix is** the material located between its widely spaced cells.
- The extracellular matrix consists of protein fibers and ground substance, the material between the cells and the fibers.
- Within matrix lies two kinds of fibres: yellow or elastic fibre and white or collagenous fibre.
- Various types of cells are: fibroblast, histocytes, basophils, plasma cells, pigment cells, mast cell, monocytes, lumphocytes etc.
- yellow or elastic fibre: made up of yellowish, thick, branched fibres running singly and in loose bundle. Chemically they are composed of protein elastin.
- white or collagenous fibre : made up of white, thin, unbranched fibres running in bundle.
- Chemically they are composed of protein collangen.

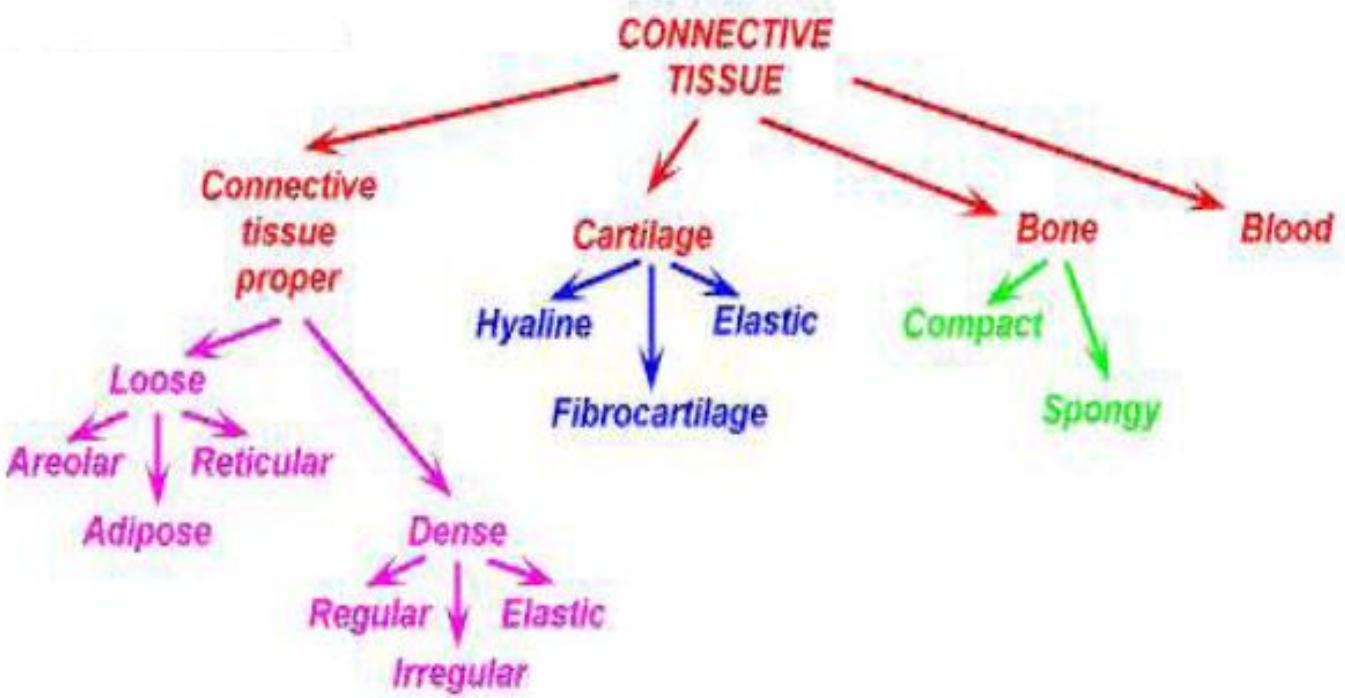
General characteristic

- ✓ The intercellular material is maximum where as the cellular component is minimum.
- ✓ Unlike the other tissues, (e.g. epithelium, muscle and nerve) which are formed mainly by cells, the major constituent of connective tissue is ECM (Extra-cellular matrix).
- ✓ Possess cells, fibers and ground substances.

Basic Functions

- Support and binding of other tissues
- Holding body fluids
- Defending the body against infection
  - macrophages, plasma cells, mast cells, WBCs
- Storing nutrients as fat

Classification of connective tissues

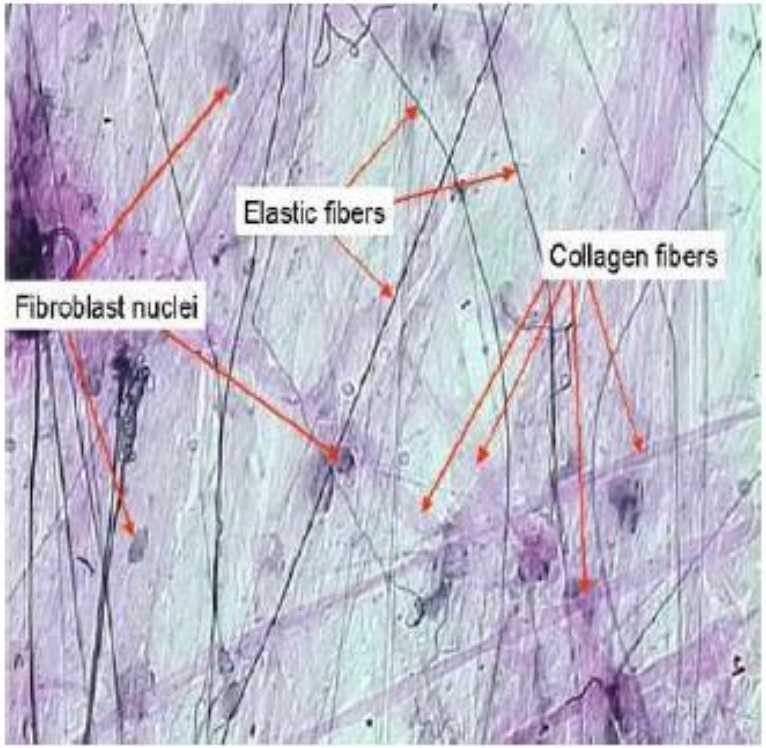


Connective tissue proper : Loose CT ; Areolar

Description: Gel like matrix with all three fiber types ; cells: fibroblasts, macrophages, mast cells, and white blood cells.

Function: Its macrophages phagocytize bacteria ; plays important role in inflammation ; holds and conveys tissue fluid.

Location: Distributed under epithelia of body; surrounds capillaries.

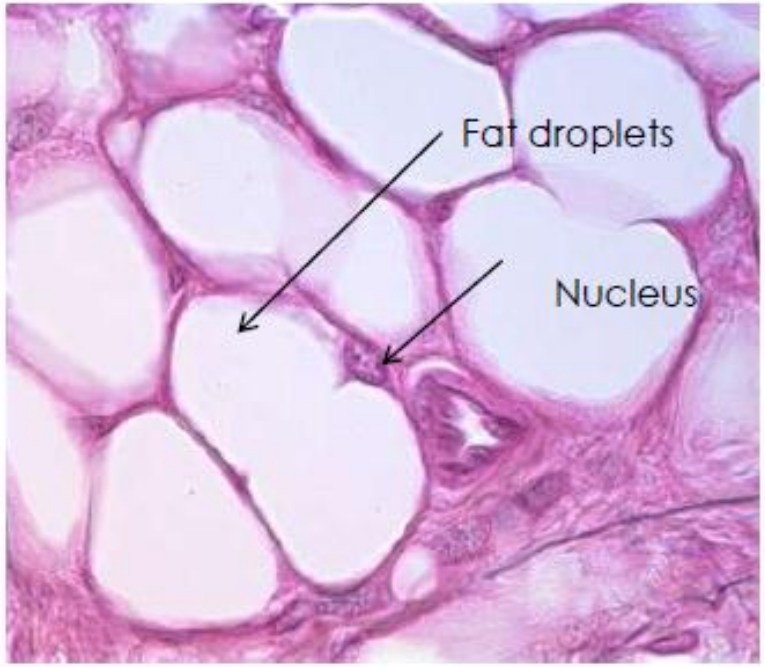


CT proper : Loose CT ; Adipose

Description: Matrix as in areolar, but very sparse; closely packed adipocytes, or fat cells , have nucleus pushed to the side by large fat droplet.

Function: Provides reverse food fuel; insulates against heat loss; supports and protects organs.

Location: Under skin; around kidneys and eyeballs; within abdomen; in breasts.

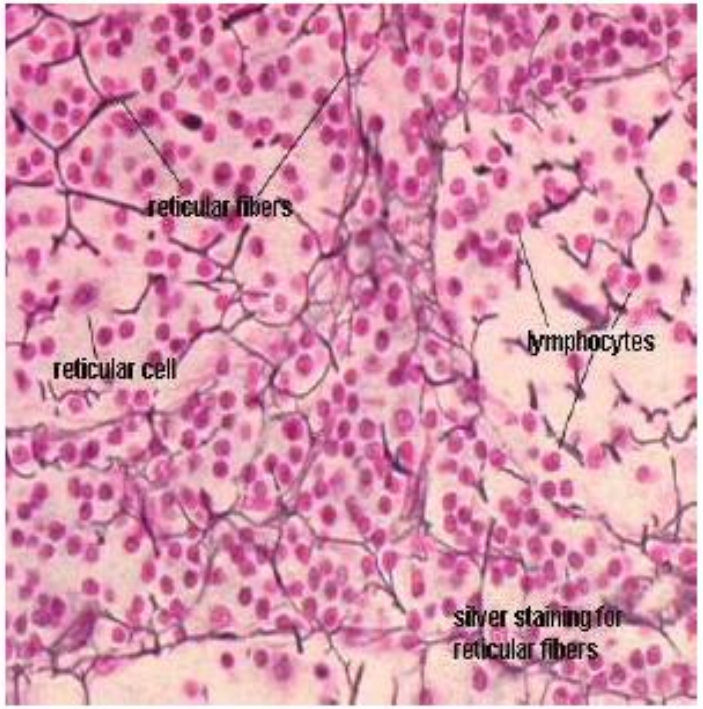


CT proper: Loose CT; reticular

Description: Network of reticular fibers in a typical loose ground substance; reticular cells lie on the network.

Function: Fibers form a soft internal skeleton that supports other cell types including white blood cells, mast cells, and macrophages.

Location: Lymphoid organs(lymph nodes, bone marrow, and macrophages.

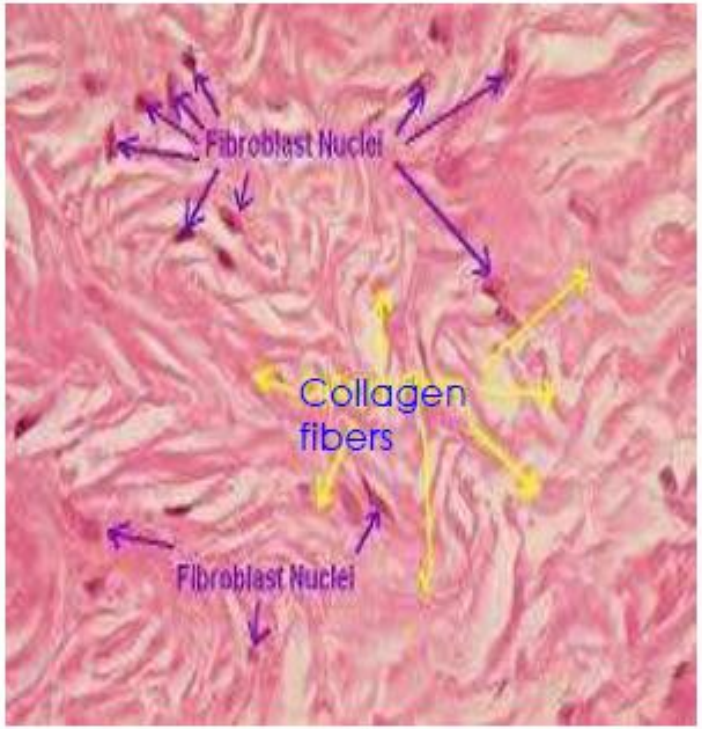


CT proper: dense CT; Irregular

Description: Primarily irregularly arranged collagen fibers; some elastic fibers; major cell type is the fibroblast.

Function: Elasticity and structural support.

Location: Dermis of the skin; submucosa of digestive tract and joints.

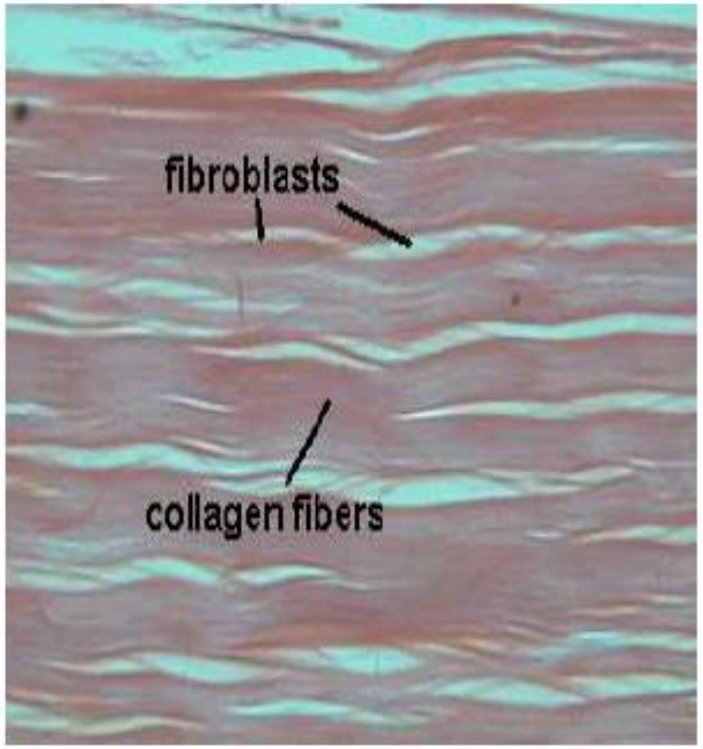


CT proper: dense CT; Regular

Description: Primarily parallel collagen fibers; a few elastin fibers; major cell type is the fibroblast.

Function: Attaches muscles to bones and bones to bones.

Location: Tendons and in most ligaments.

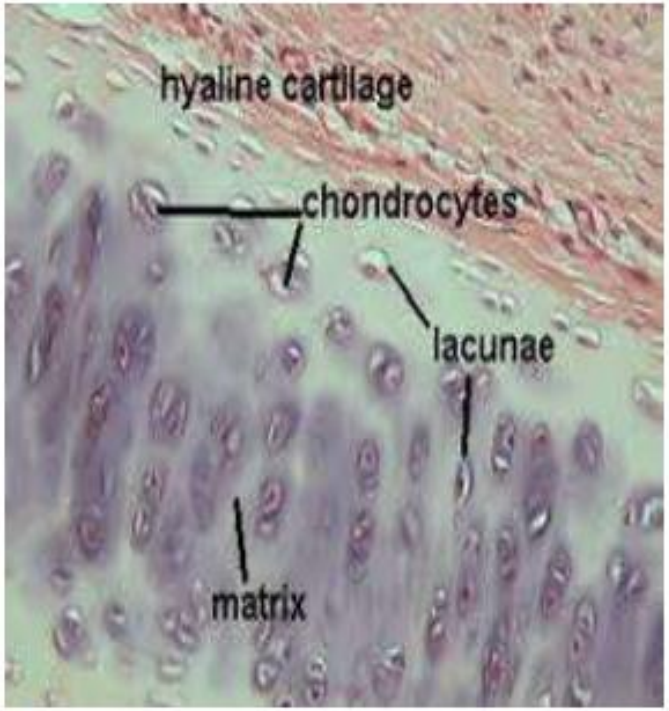


Cartilage: Hyaline

Description: Amorphous but firm matrix; chondroblasts produce the matrix and when mature lie in lacunae.

Function: Supports and reinforces; resists compressive stress.

Location: Forms most of the embryonic skeleton; ends of long bones; cartilages of nose.

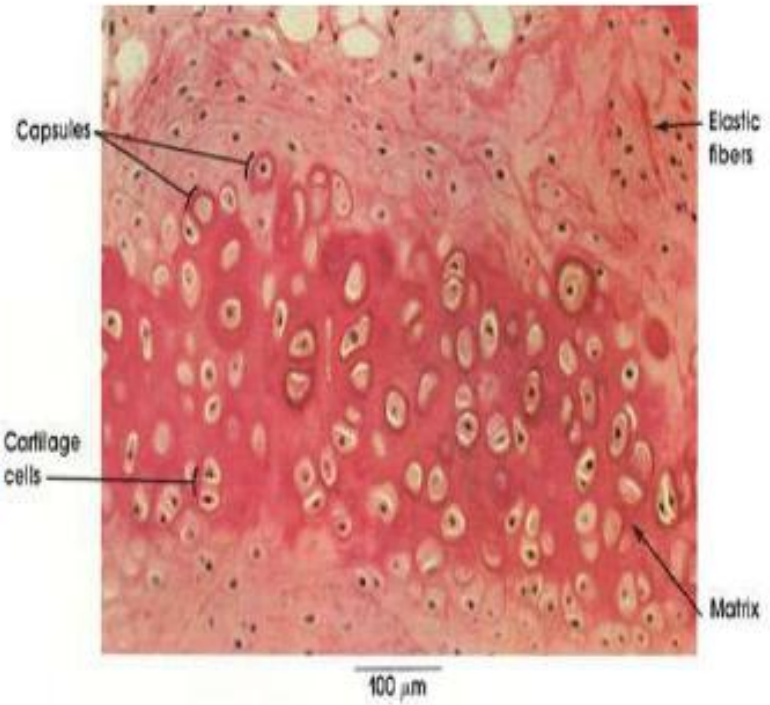


Cartilage: Elastic

Description: Similar to hyaline cartilage, but more elastic fibers in matrix.

Function: Maintains the shape and allows flexibility.

Location: Supports the external ear(pinna).

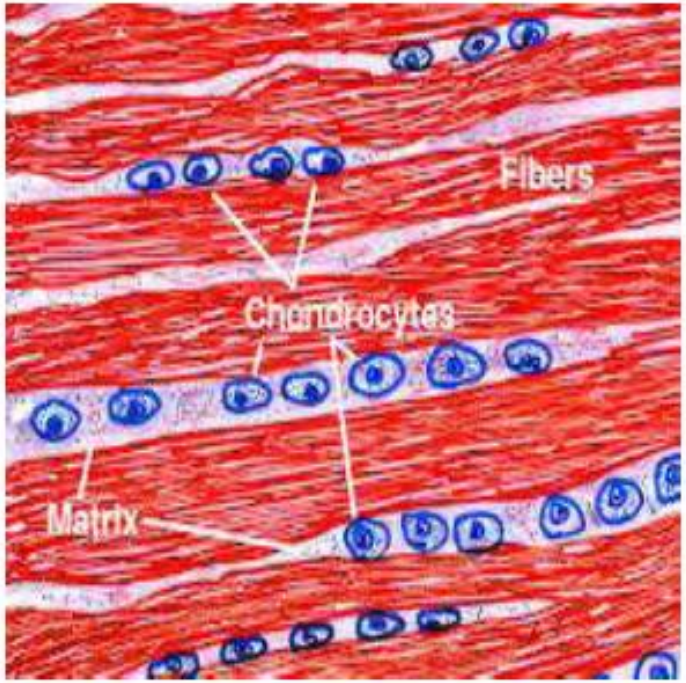


Cartilage : Fibrocartilage

Description : Collagen fibers are predominant ; matrix is as hyaline but less firm.

Function: High tensile strength, absorb compressive shock.

Location: Intervertebral disc; discs of knee joint.

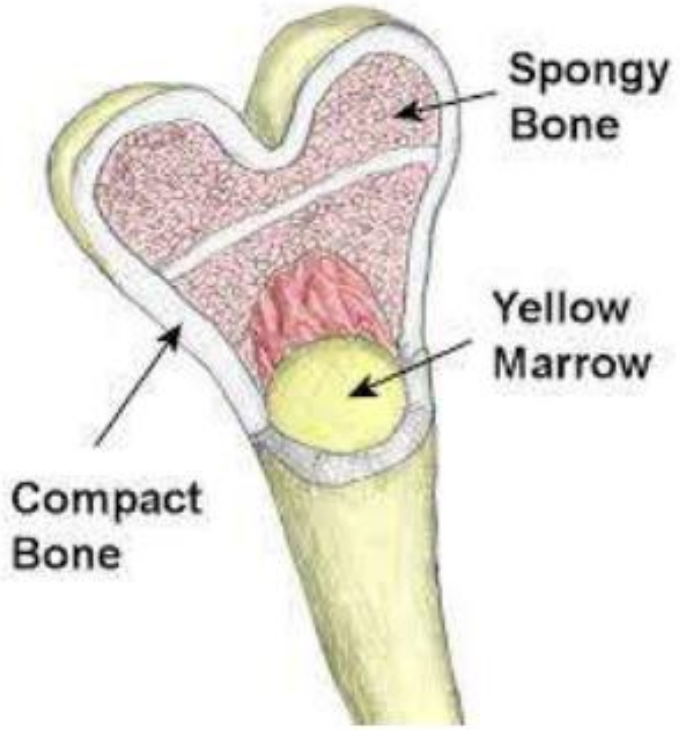


Bone

Description: Hard, calcified matrix containing many collagen fibers. Very well vascularized.

Function: Bone supports and protects; provides levers for the muscles to act on; stores calcium and other minerals and fat; bone marrow is the site of blood cell formation.

Location: Skeleton.

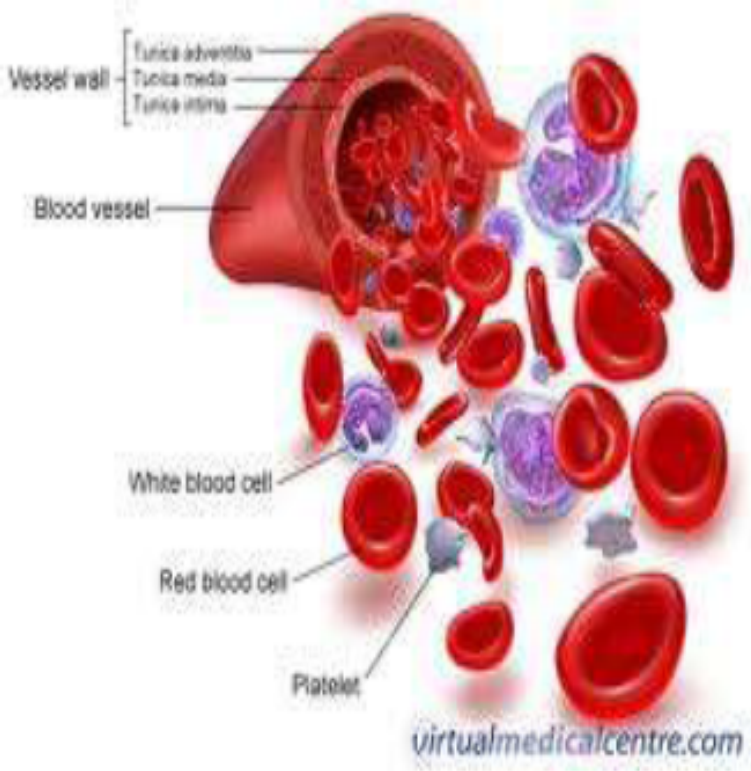


Blood

Description: Liquid connective tissue, red and white blood cells in fluid matrix.

Function: Transport respiratory gases, nutrients, wastes and other substances.

Location: In the blood vessels.



Muscle Tissue

- Muscle is one of our 4 tissue types and muscle tissue combined with nerves, blood vessels, and various connective tissues.
- Muscles are quite complex and as we'll find out, they are a marvel of both biology and physics.

General characteristics

1. Excitability
   - The ability to receive and respond to a stimulus
     - In skeletal muscle, the stimulus is a neurotransmitter (chemical signal) release by a neuron (nerve cell).
     - In smooth muscle, the stimulus could be a neurotransmitter, a hormone, stretch, ΔpH, ΔPco_2, or ΔPo_2.
     - In cardiac muscle, the stimulus could be a neurotransmitter, a hormone, or stretch.
   - The response is the generation of an electrical impulse that travels along the plasma membrane of the muscle cell.

2. Contractility

- The ability to shorten forcibly when adequately stimulated.
- This is the defining property of muscle tissue.

2. Extensibility

- The ability to be stretched (Extended)

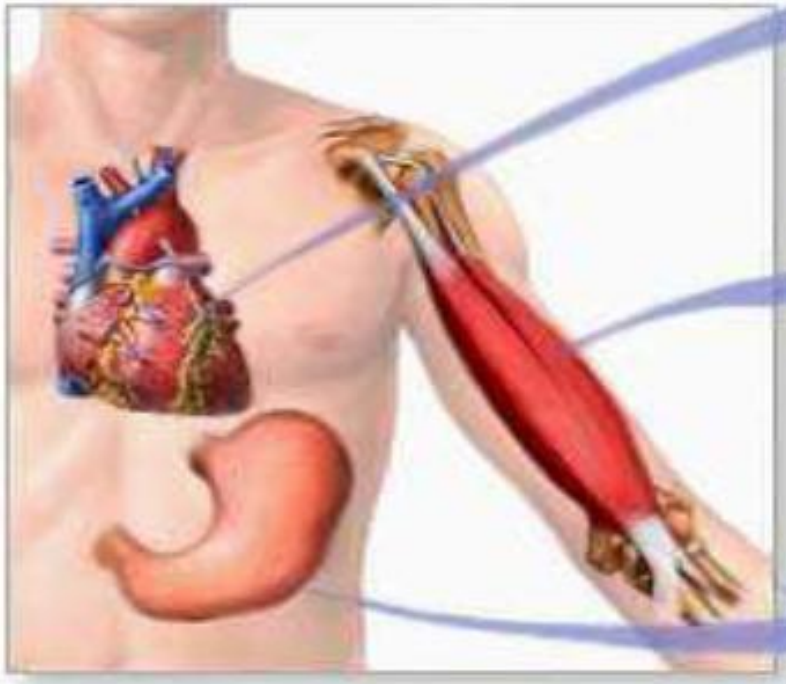
4. Elasticity

- The ability to recoil and resume original length after being stretched.

Functions

- Movement
- Locomotion
- Maintains posture
- Produces heat
- Facial expressions
- Pumps blood
- Peristalsis

3 Types of Muscle Tissue



Cardiac muscle cell

Skeletal muscle cell

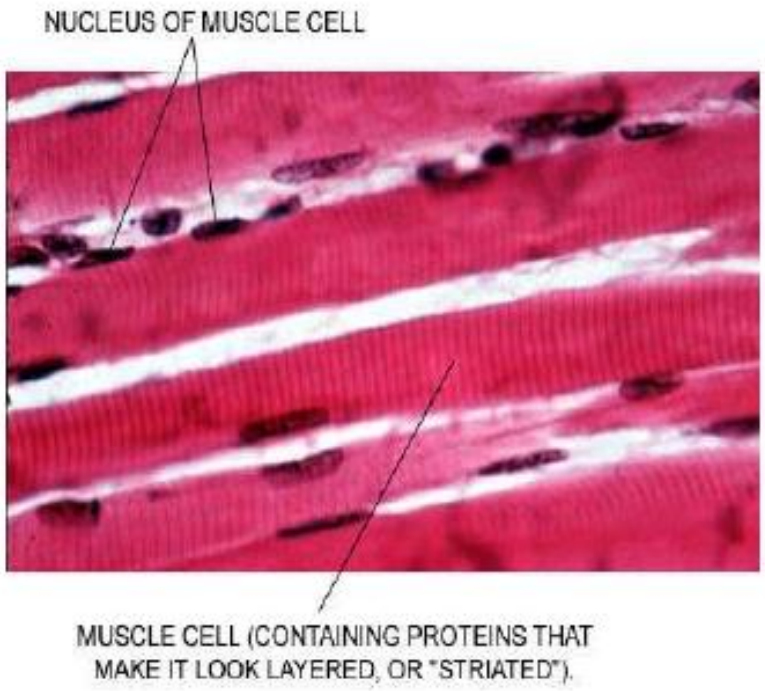
Smooth muscle cell

Skeletal Muscle Tissue

Description: Long striated cells with multiple nuclei.

Function: Contraction for voluntary movements.

Location: In skeletal muscle.

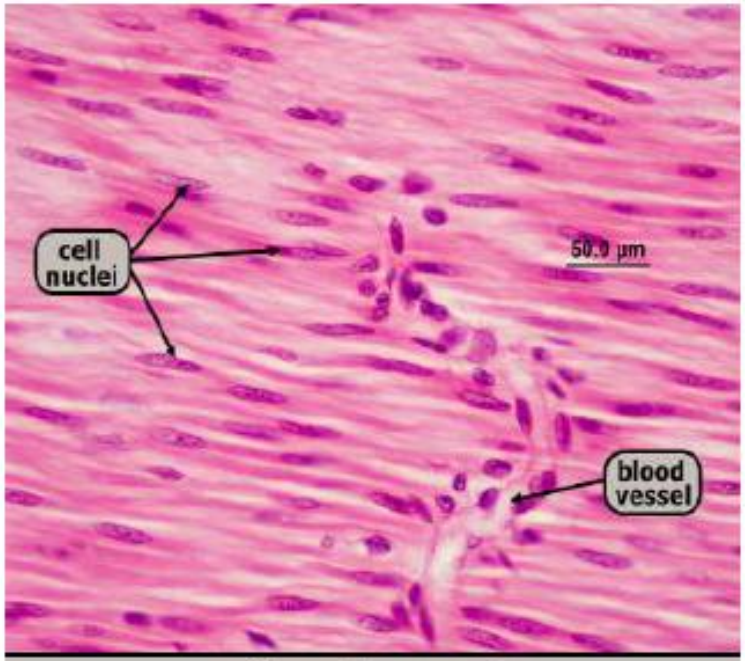


Smooth Muscle Tissue

Description: Long, spindle-shaped cells, each with a single nucleus.

Function: Propulsion of substances along internal passageways.

Location: In hollow organs(e.g. stomach)



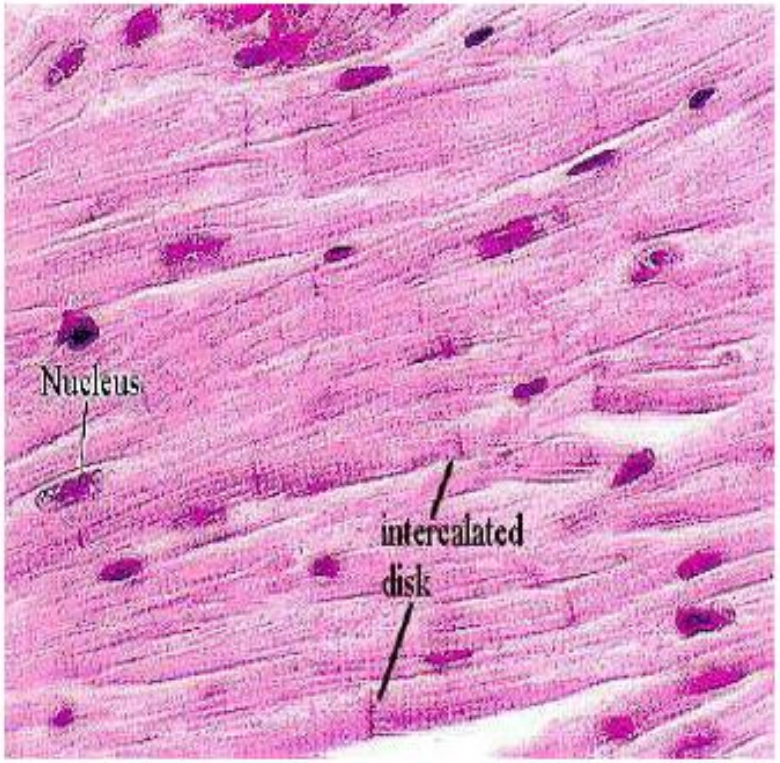
Smooth muscle

Cardiac Muscle tissue

Description:
Branching, striated cells fused at plasma membranes.

Function: Pumping of blood in the circulatory system.

Location: Wall of heart.



Nerve Tissue

By far the most complex tissue in the human body is nerve tissue.

Formed by a network of more than 100 million nerve cells, assisted by many more glial cells.

Each neuron has, on an average , at least a thousand interconnection with other neurons forming a very complex nervous system.

Functions

- ✓ Regulates & controls body functions
- ✓ Generates & transmits nerve impulses
- ✓ Supports, insulates and protects impulse generating neurons.

Composition of Nerve Tissue

The nerve tissue is composed of two elements:

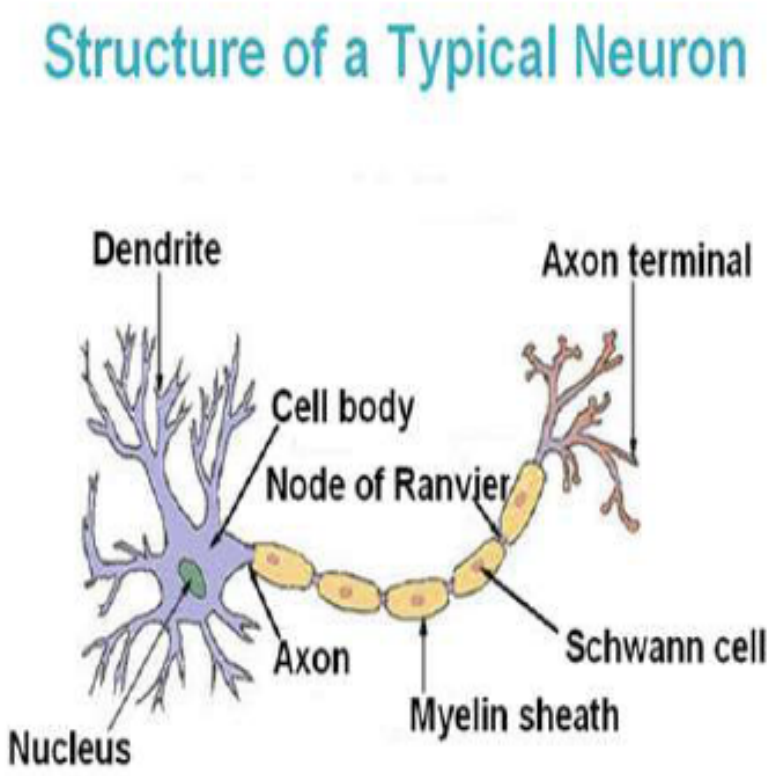
1. The nerve cell or neuron
2. The neuroglia

Neuron

Description: Neurons are branching cells; cell processes that may be quite long extend from the nucleus-containing cell body.

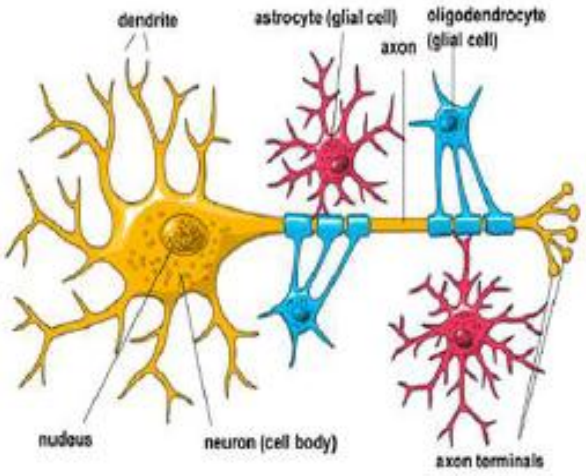
Function: Transmit electrical signals from sensory receptors and to effectors(muscles and glands) that control their activity.

Location: Brain, spinal cord and nerves.

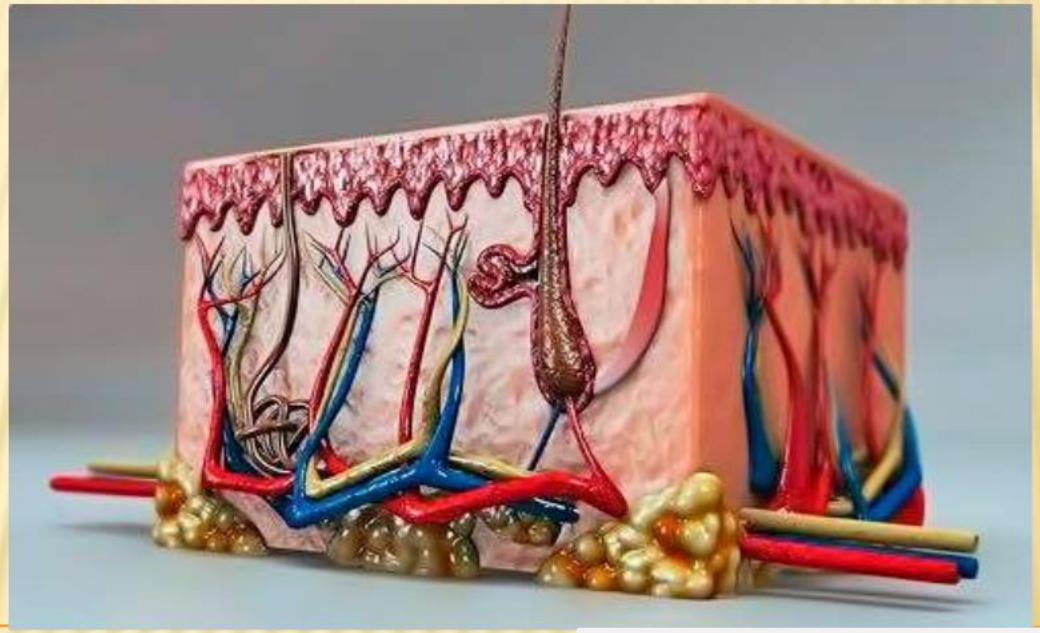


Glial cells

Glia carry nutrients, speed repair, provide myelin for axons, support the blood-brain barrier, and may form their own communication network. They are also involved in neurogenesis.



The Integumentary System



Nehal V. Trambadiya
Asst. Prof
Smt N M Padalia Pharmacy College,
Ahemdabad

INTRODUCTION

- The organs of the **integumentary system** include the skin and its accessory structures including hair, nails, and glands, as well as blood vessels, muscles and nerves
- **Dermatology** is the medical specialty for the diagnosis and treatment of disorders of the integumentary system.

STRUCTURE OF THE SKIN

- The skin (**cutaneous membrane)** covers the body and is the largest organ of the body by surface area and weight
- Its area is about 2 square meters (22 square feet) and weighs 4.5-5kg (10-11 lb), about 7% of body weight
- It is 0.5 – 4 mm thick, thinnest on the eyelids, thickest on the heels; the average thickness is 1 – 2 mm

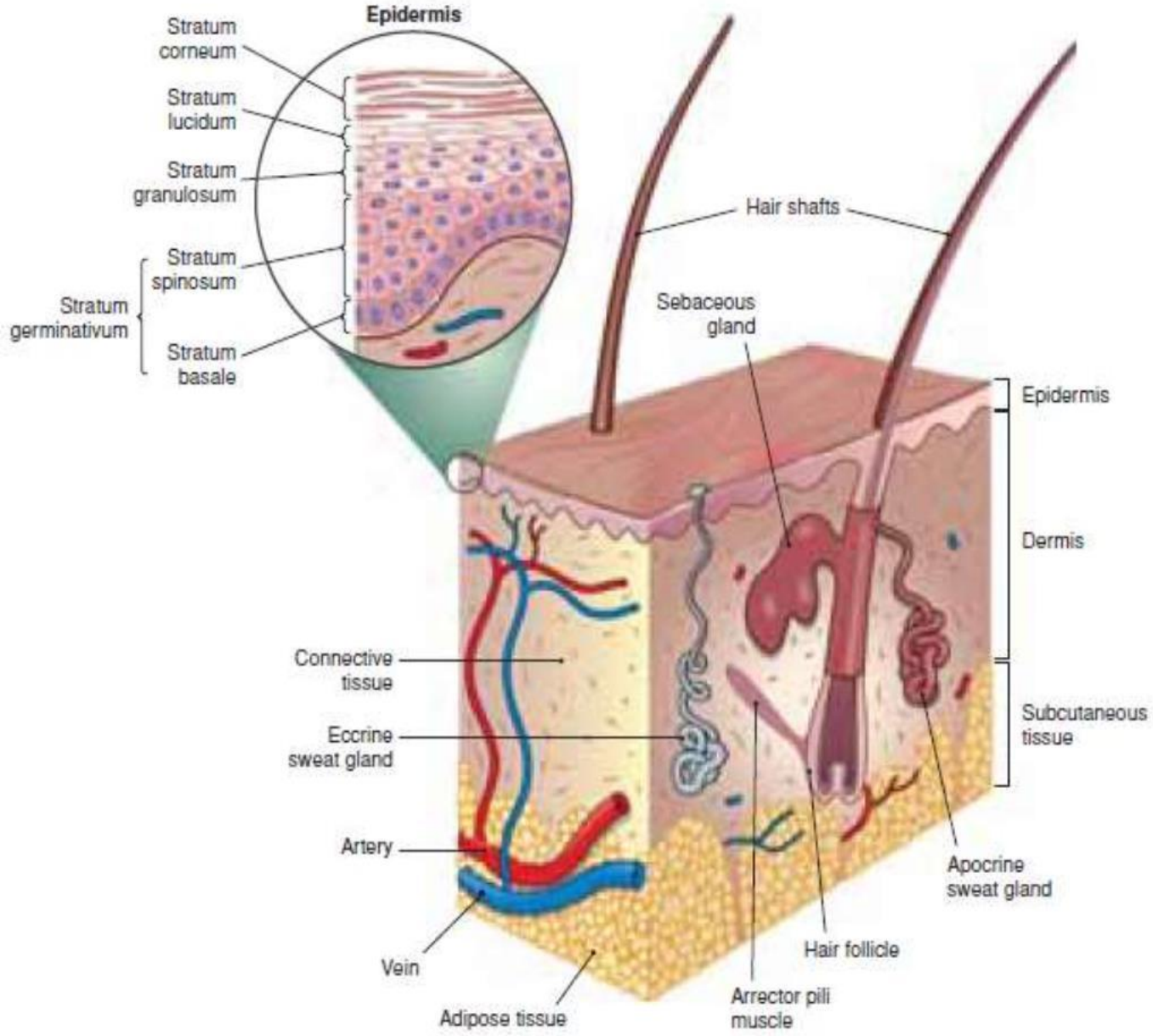


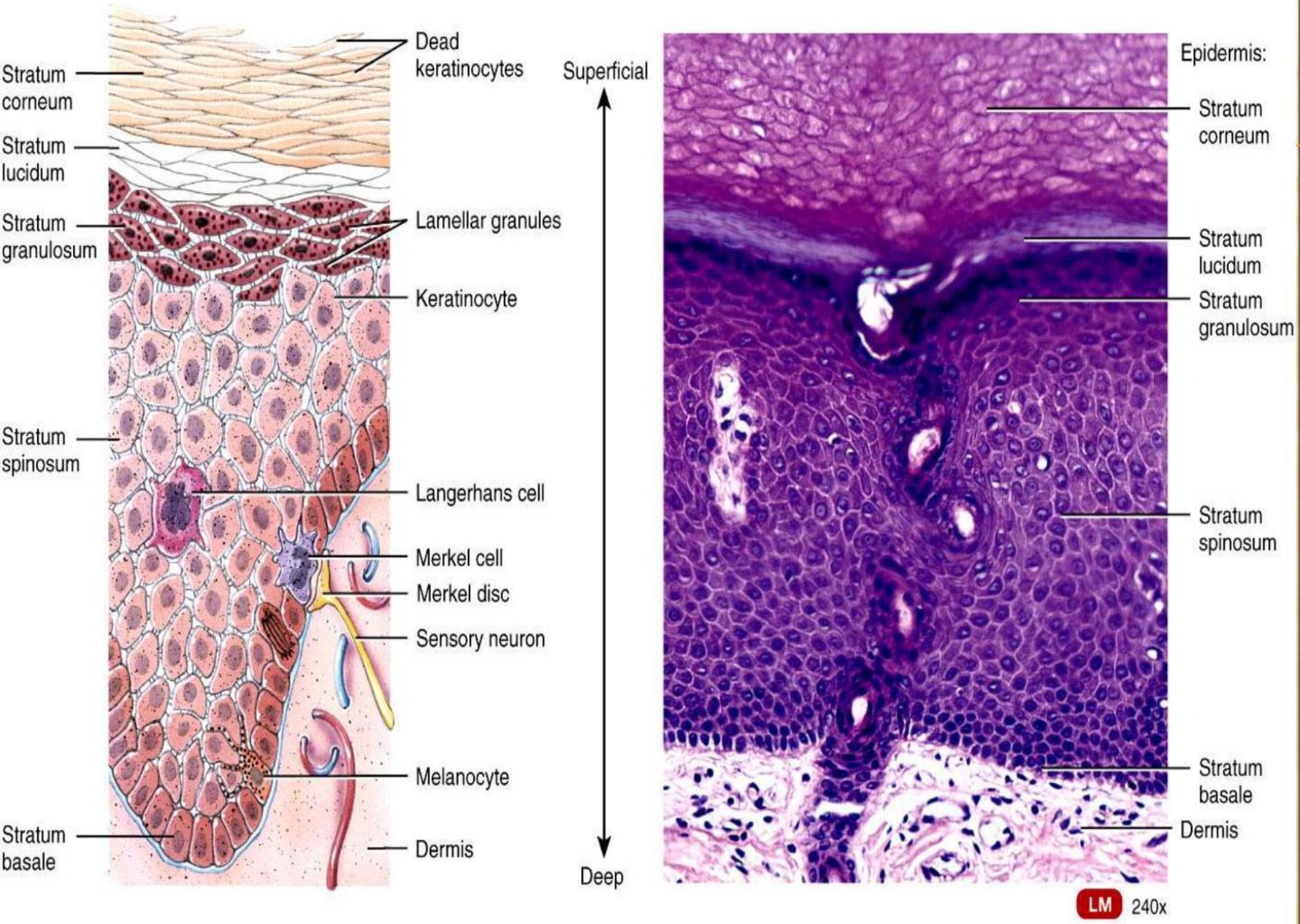
FIGURE 10.1. Structures of the skin.

STRUCTURE OF THE SKIN

- It consists of *two* major layers:
  - outer, thinner layer called the **epidermis**, consists of epithelial tissue (see video)
  - inner, thicker layer called the **dermis**
  - Beneath the dermis is **a subcutaneous (subQ) layer** (also called **hypodermis**) which attaches the skin to the underlying tissues and organs.

EPIDERMIS

- Covers, protects, and waterproofs.
- Contains four main layers:
  - **Stratum corneum**: Keratinized layer. Prevents loss or entry of water; protects against pathogens and chemicals.
  - **Stratum lucidum:** Found only on palms of hands and soles of feet; protects against UV sunrays to prevent sunburn.
  - **Stratum granulosum**
  - **Stratum germinativum:** The innermost layer of epidermis, is the only layer that undergoes cell division & contains melanin & keratin-forming cells.

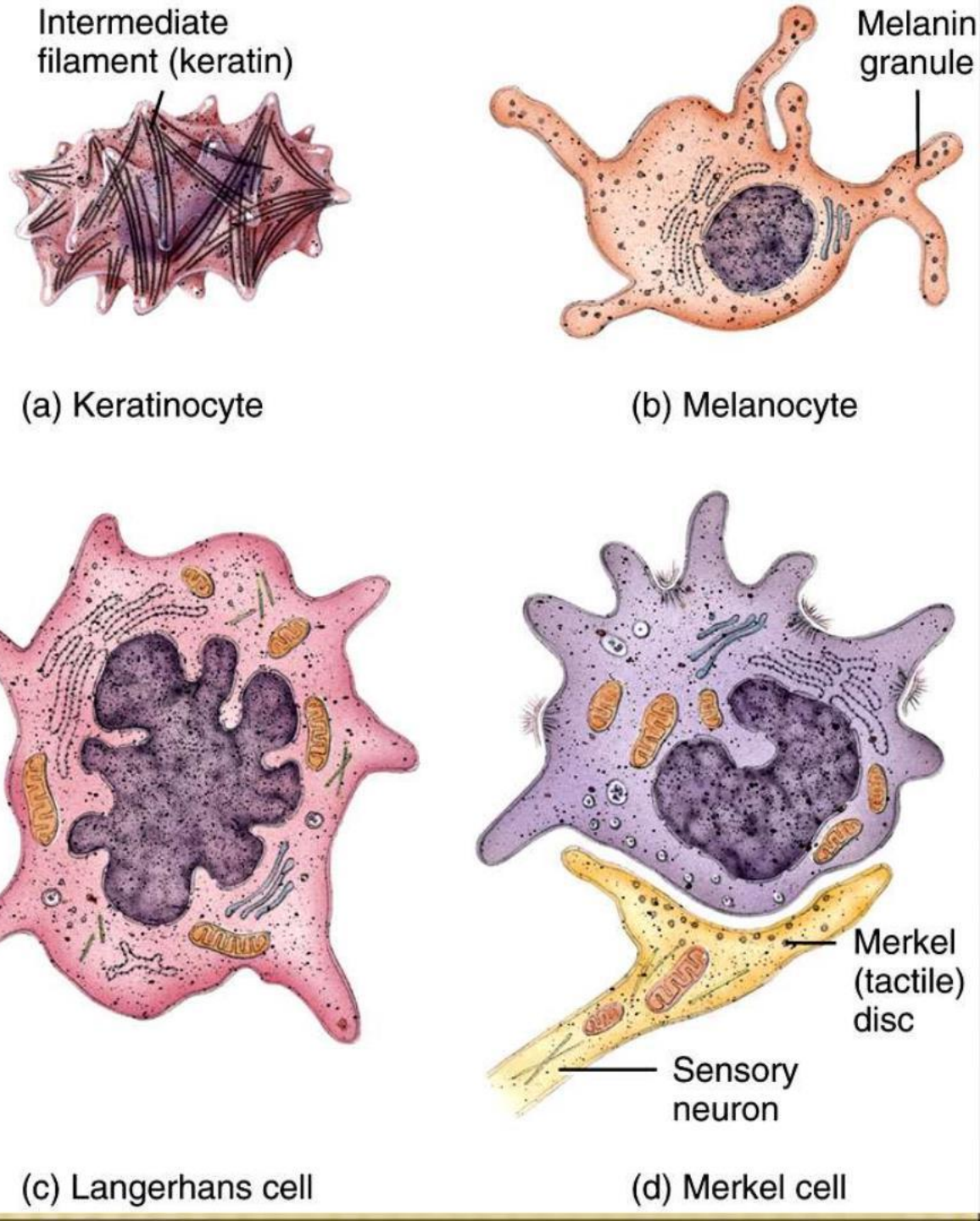


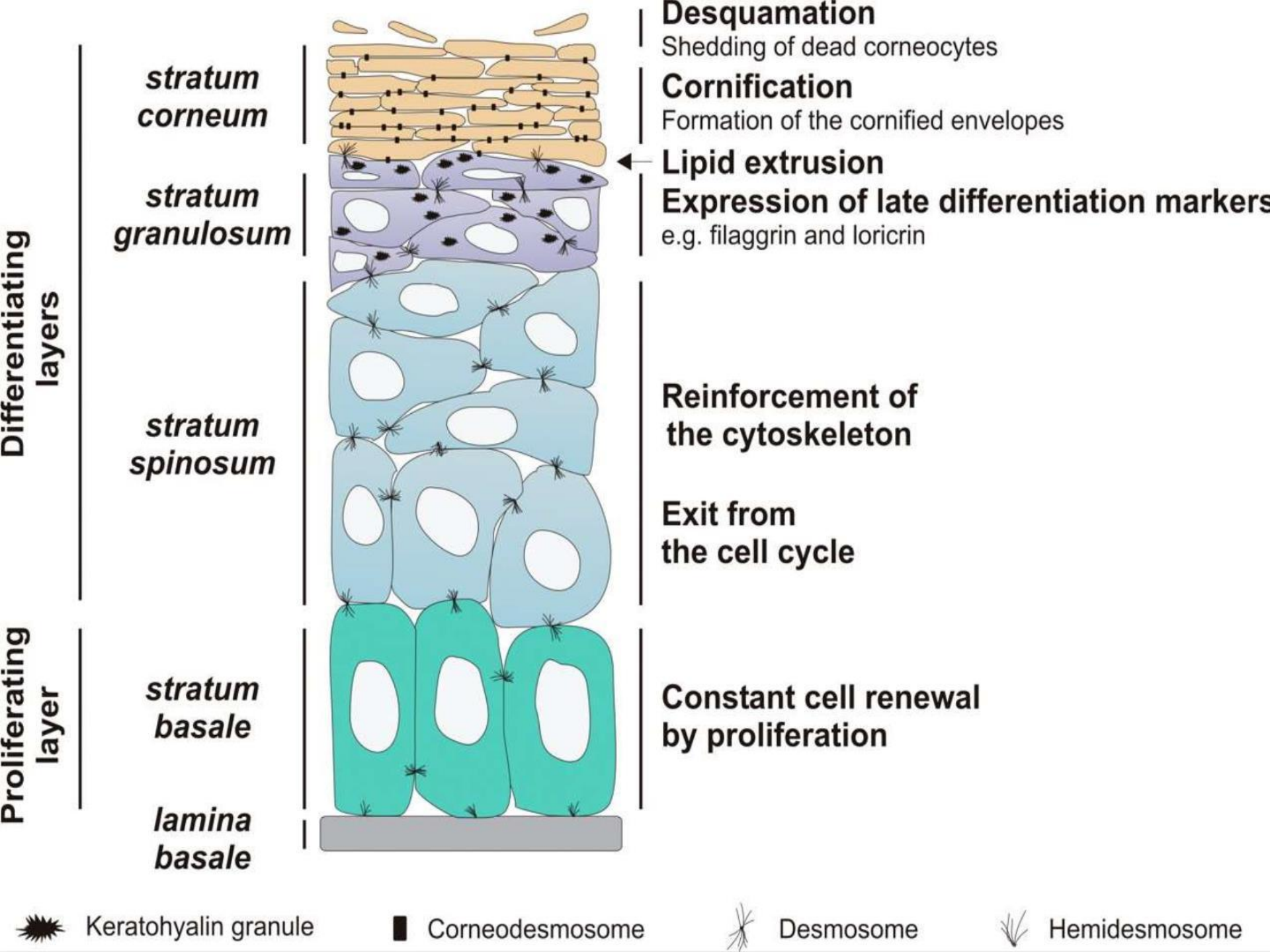
(a) Four principal cell types in epidermis

(b) Photomicrograph of a portion of thick skin

- The **epidermis** has a number of important characteristics:
  - the epidermis is composed of keratinized stratified squamous epithelium
  - it contains four major types of cells:
    - **Keratinocytes** (90% of the cells) produce keratin which is a tough fibrous protein that provides protection.
    - **Melanocytes**: which produce the pigment **melanin** that protects against damage by ultraviolet radiation
    - **Langerhans cells:** involved in immune responses, arise from red bone marrow
    - **Merkel cells:** which function in the sensation of touch along with the adjacent **tactile discs**

TYPES OF CELLS IN THE EPIDERMIS




Desquamation
Shedding of dead corneocytes
Cornification
Formation of the cornified envelopes
Lipid extrusion
Expression of late differentiation markers
e.g. filaggrin and loricrin
Reinforcement of the cytoskeleton
Exit from the cell cycle
Constant cell renewal by proliferation
Differentiating layers
Proliferating layer
stratum corneum
stratum granulosum
stratum spinosum
stratum basale
lamina basale
Keratohyalin granule
Corneodesmosome
Desmosome
Hemidesmosome

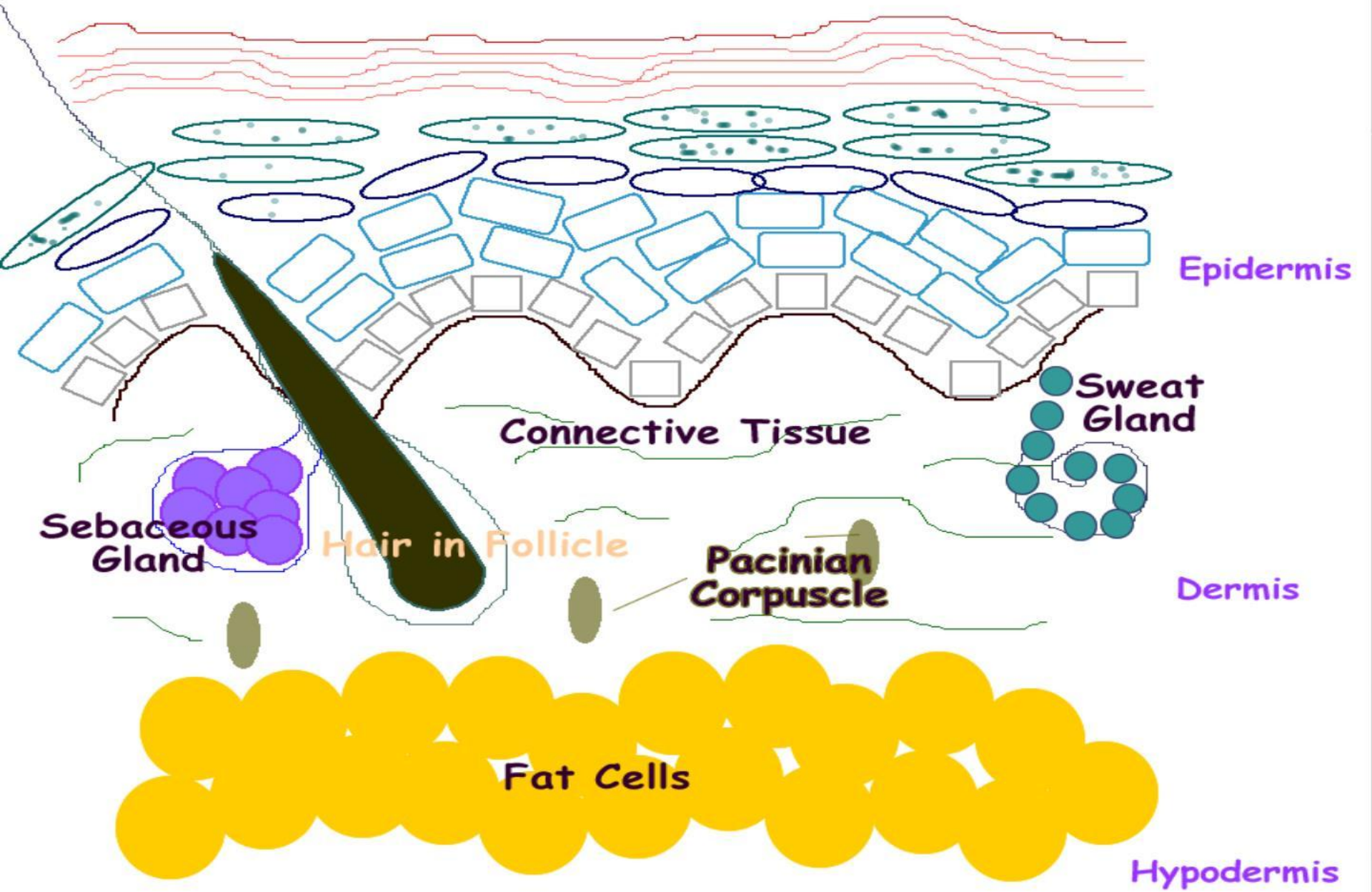
- The epidermis, hair, nail, dental enamel, & horny tissues are composed of keratin.
- It is replaced every 3-4 weeks.
- **Skin color** depends on:

1. The amount of melanin & carotene" yellow pigment" contained in the skin
2. The volume of blood containing hemoglobin
3. The oxygen-binding pigment that circulates in the dermis.

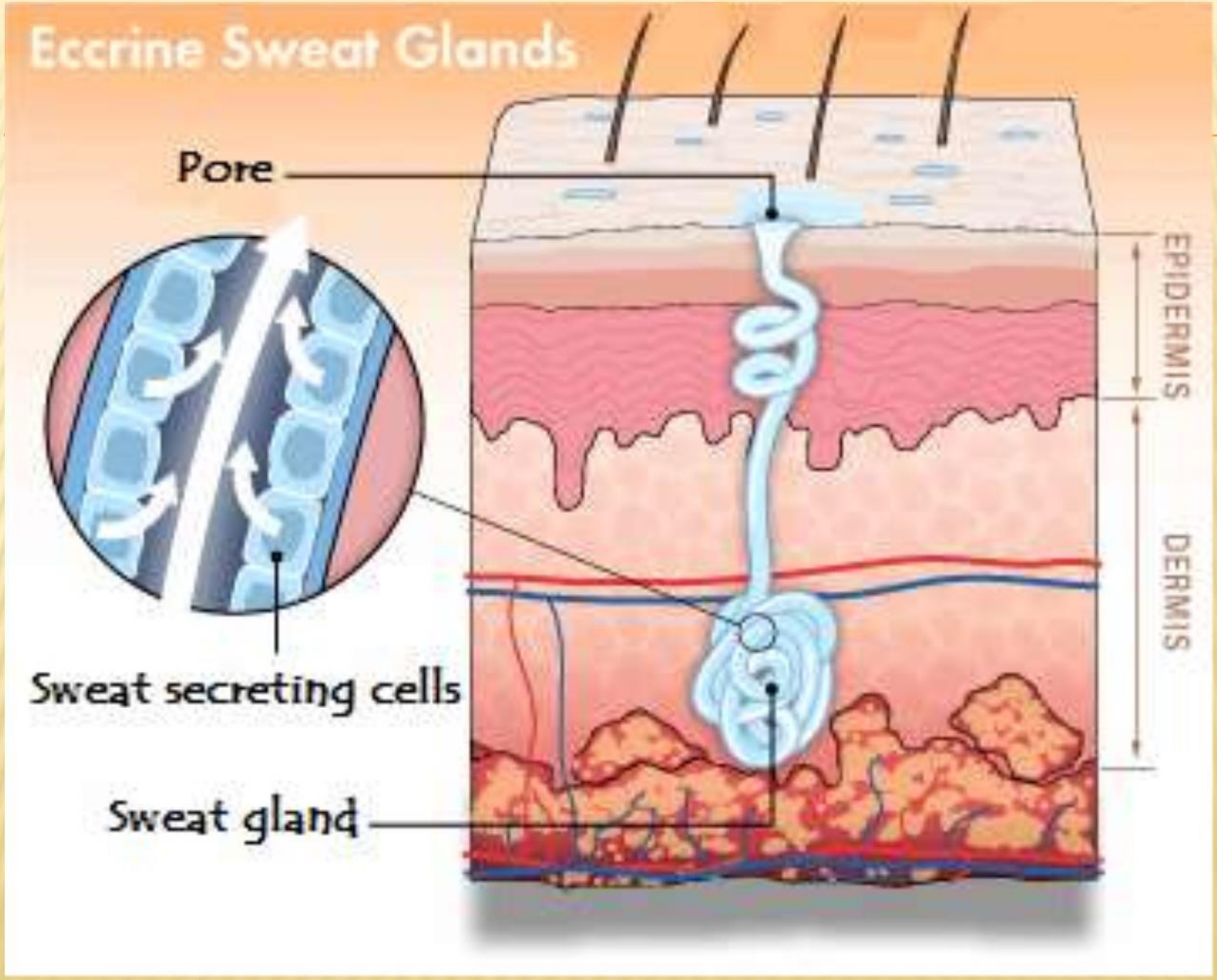
DERMIS

- The **dermis** has several important characteristics:
- is composed of connective tissue containing collagen and elastic fibers
- contains **two** layers
  - the outer **papillary region** consists of areolar connective tissue containing thin collagen and elastic fibers, **dermal papillae** (including **capillary loops**), **corpuscles of touch** and **free nerve endings**

- The deeper **reticular region** consists of dense irregular connective tissue containing collagen and elastic fibers adipose cells, hair follicles, nerves, sebaceous (oil) glands, and sudoriferous (sweat) glands
  - **Striae** or **stretch marks** can appear if the skin is stretched too much

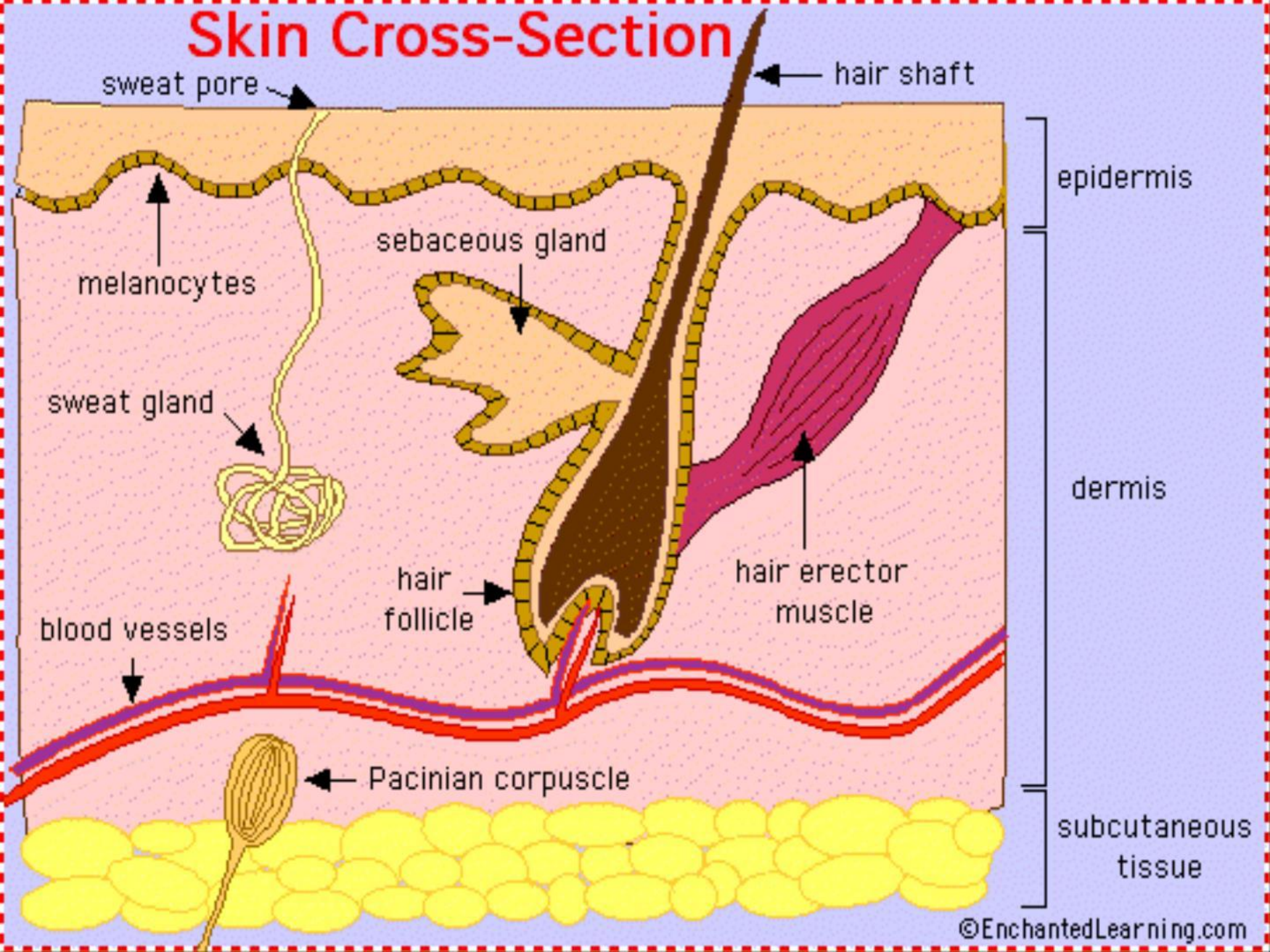

Epidermis
Sweat Gland
Connective Tissue
Sebaceous Gland
Hair in Follicle
Pacinian Corpuscle
Dermis
Fat Cells
Hypodermis

- ***Sweat Glands (Sudoriferous):*** Most numerous on palms of hands and soles of feet.
- **Two types** are eccrine and apocrine glands.
- **Eccrine Glands:** Respond to external temperature and psychological stress.
  - Found over most of body but most numerous on palms of hands and soles of feet; secrete sweat, which helps regulate body temperature and, to a lesser degree, excretes wastes such as urea.


Eccrine Sweat Glands
Pore
Sweat secreting cells
Sweat gland
EPIDERMIS
DERMIS

- ***Apocrine or Odoriferous Glands:***
  - Found in axilla and genital area.
  - Respond to stress; secrete pheromones, a substance with a barely perceptible odor; when apocrine secretions react with bacteria, body odor results.
  - Ceruminous glands are a type of apocrine gland found in the external ear canal.
  - They secrete cerumen, which prevents drying of the ear drum and traps foreign substances.

- ***Sebaceous Glands:*** Produce sebum, which lubricates and protects skin and hair.
- ***Cholesterol:*** Converts to vitamin D when exposed to UV lights.
- ***Arterioles:*** Dilate when hot to increase heat loss and constrict when cold to conserve heat.
  - Constrict in response to stressful situations to shunt blood to vital organs.


Skin Cross-Section
sweat pore
hair shaft
epidermis
melanocytes
sebaceous gland
sweat gland
dermis
hair
follicle
hair erector
muscle
blood vessels
Pacinian corpuscle
subcutaneous
tissue
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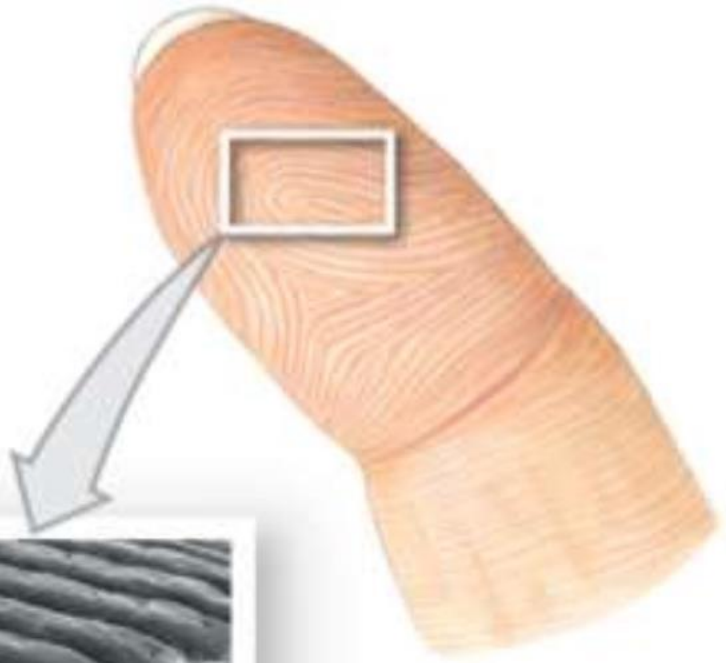
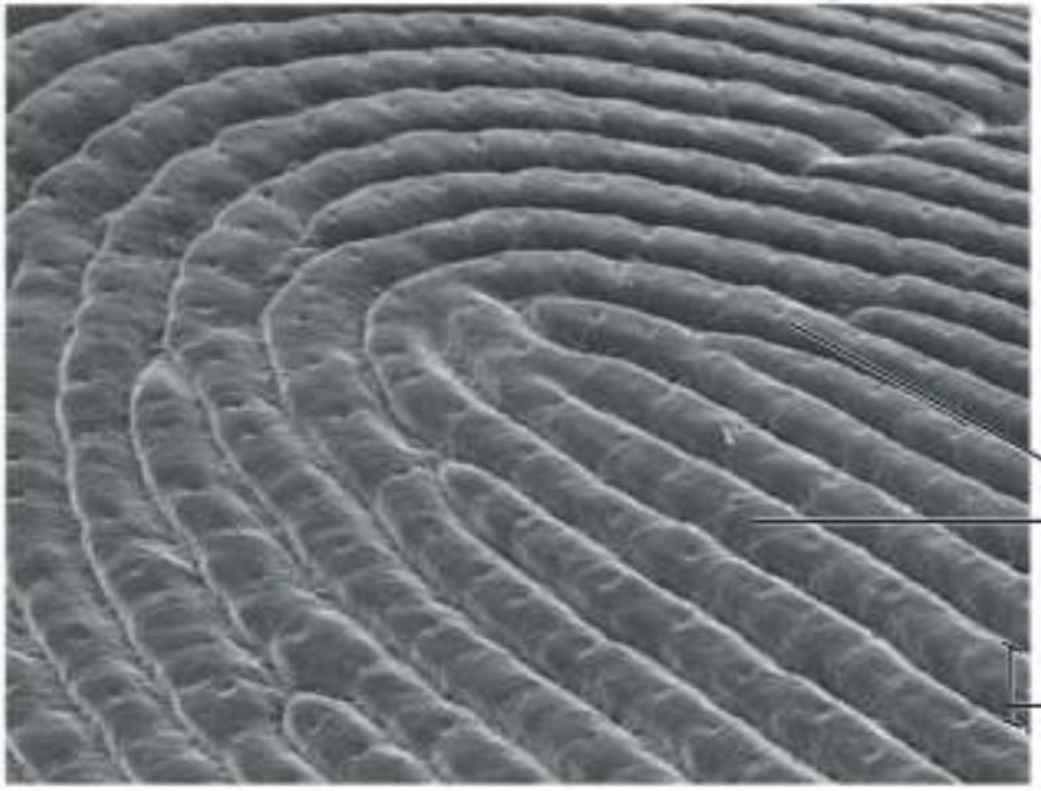
Ridge patterns on skin increases surface area and friction, ensuring a secure grip





Thick skin SEM × 25

HYPODERMIS / SUBCUTANEOUS

- ***Connective Tissue:*** Connects skin to muscles; contains white blood cells.
- ***Adipose Tissue:*** Contains stored energy, cushions bony prominences, provides insulation.

ACCESSORY STRUCTURES OF THE SKIN

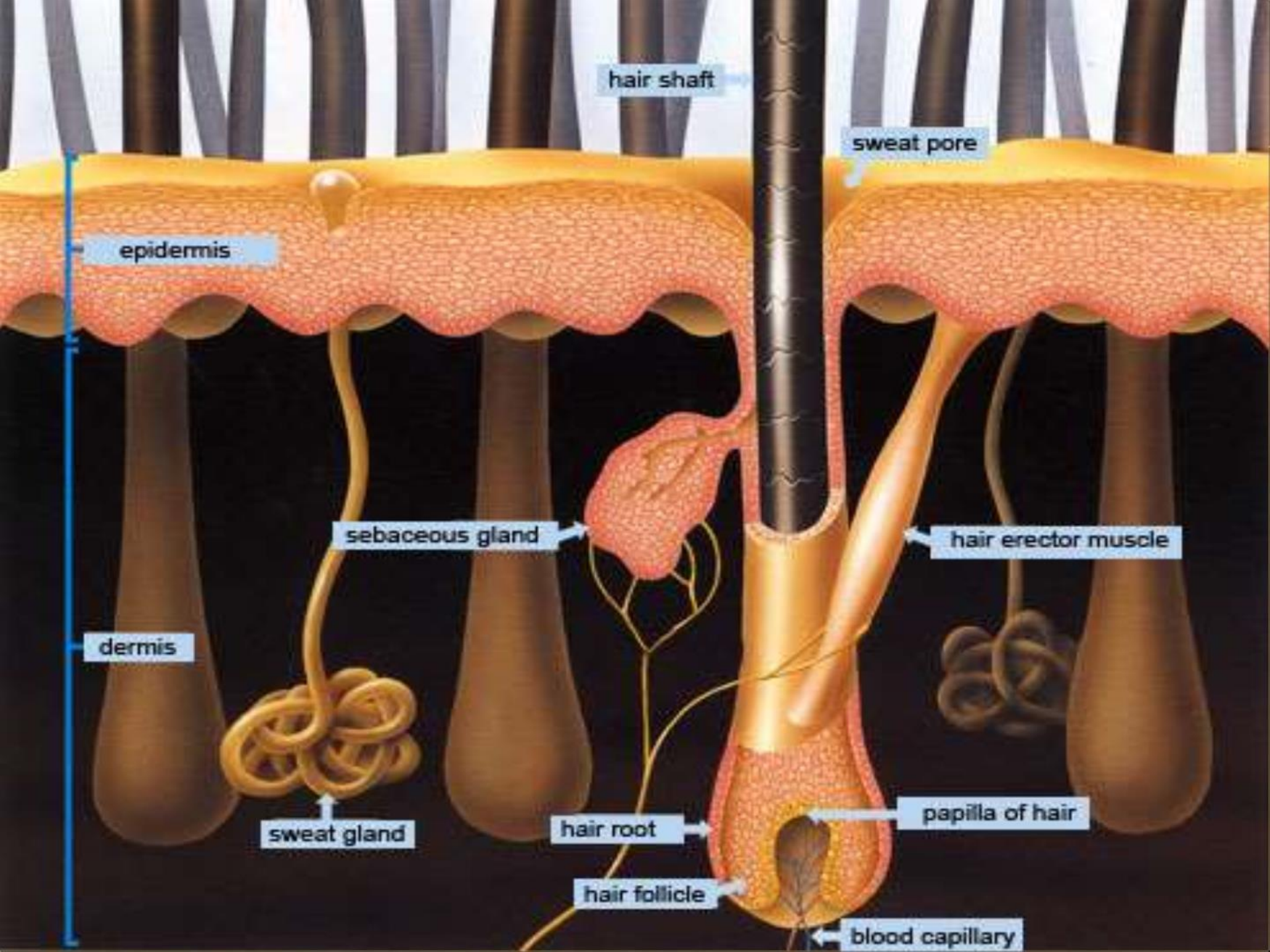
- include hair, and nails
- **Hairs (pili)** have a number of important functions:
  - protection
  - reduction of heat loss
  - sensing light touch

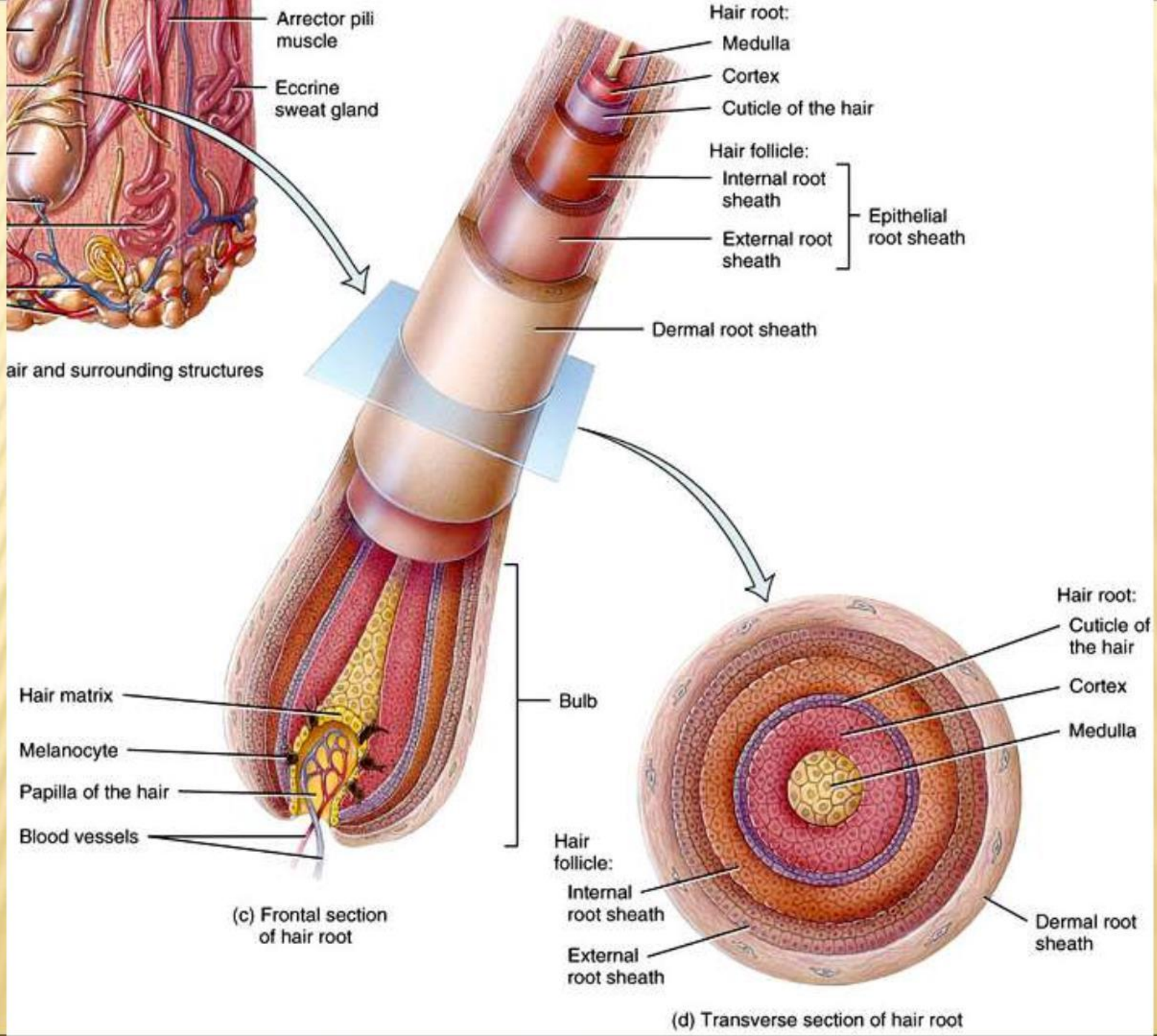
THE HAIR

The **hair is also made up of keratinized cells.**

1. **Vellus,** which is short, pale, and fine hair, is located over all of the body.
2. **Terminal hairs,** which are dark and coarse, are found on the scalp, brows, and, after puberty, on the legs, axillae, and perineum.

- Hair is composed of dead, keratinized epidermal cells
- Hair consists of:
  - **shaft** which mostly projects above the surface of the skin
  - **root** which penetrates into the dermis
  - **hair follicle**
  - **epithelial root sheath – (downward continuation of the epidermis)**
  - **dermal root sheath**

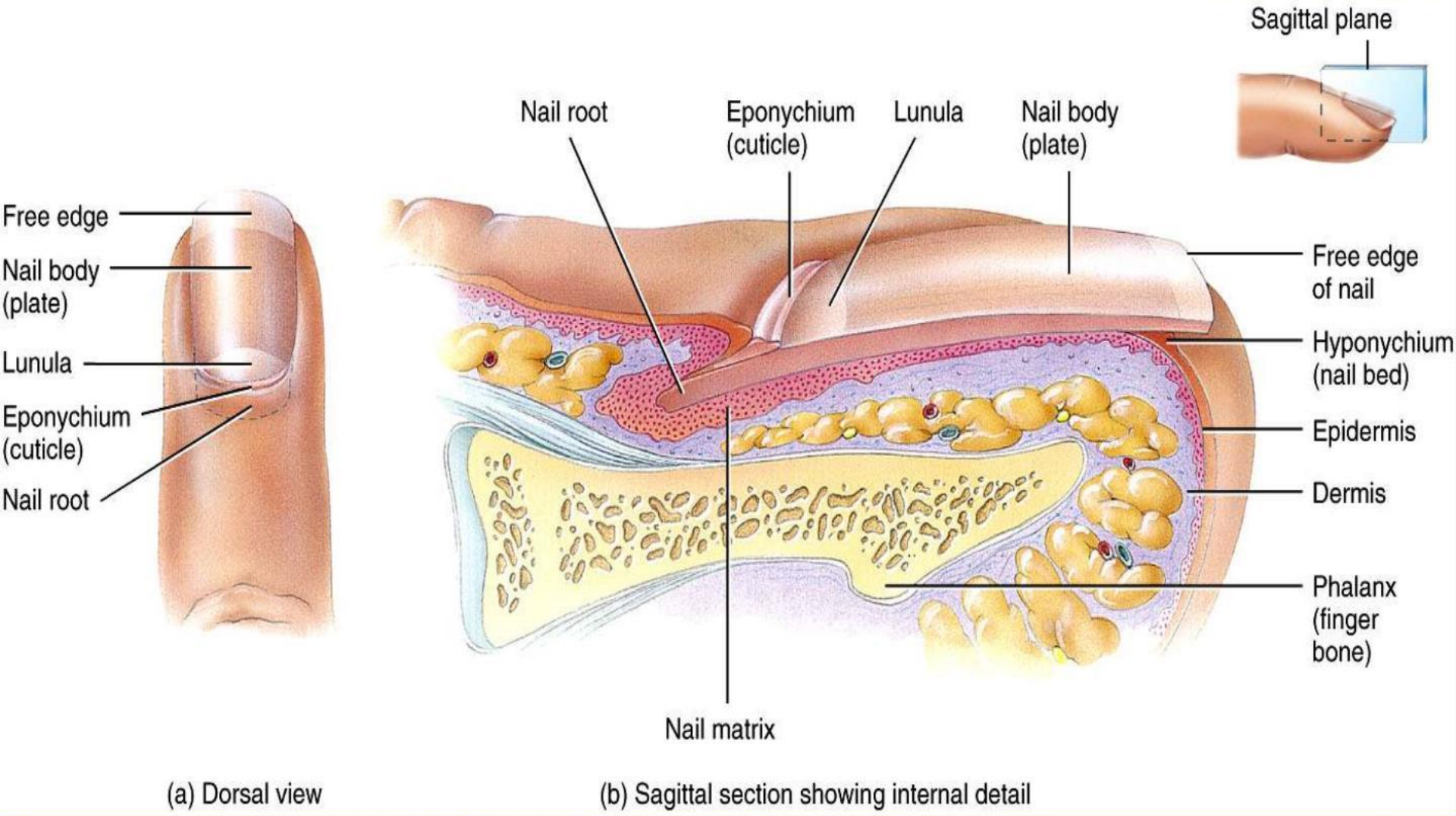

hair shaft
sweat pore
epidermis
sebaceous gland
hair erector muscle
dermis
sweat gland
hair root
papilla of hair
hair follicle
blood capillary


Arrector pili muscle
Eccrine sweat gland
air and surrounding structures
Hair root:
Medulla
Cortex
Cuticle of the hair
Hair follicle:
Internal root sheath
External root sheath
Epithelial root sheath
Dermal root sheath
Hair matrix
Melanocyte
Papilla of the hair
Blood vessels
Bulb
(c) Frontal section of hair root
Hair root:
Cuticle of the hair
Cortex
Medulla
Hair follicle:
Internal root sheath
External root sheath
Dermal root sheath
(d) Transverse section of hair root

NAILS

- Nails are composed of hard, keratinized epidermal cells located over the dorsal surfaces of the ends of fingers and toes
- Each nail consists of:
  - **free edge**
  - transparent **nail body (plate)** with a whitish **lunula** at its base
  - **nail root** embedded in a fold of skin

NAILS

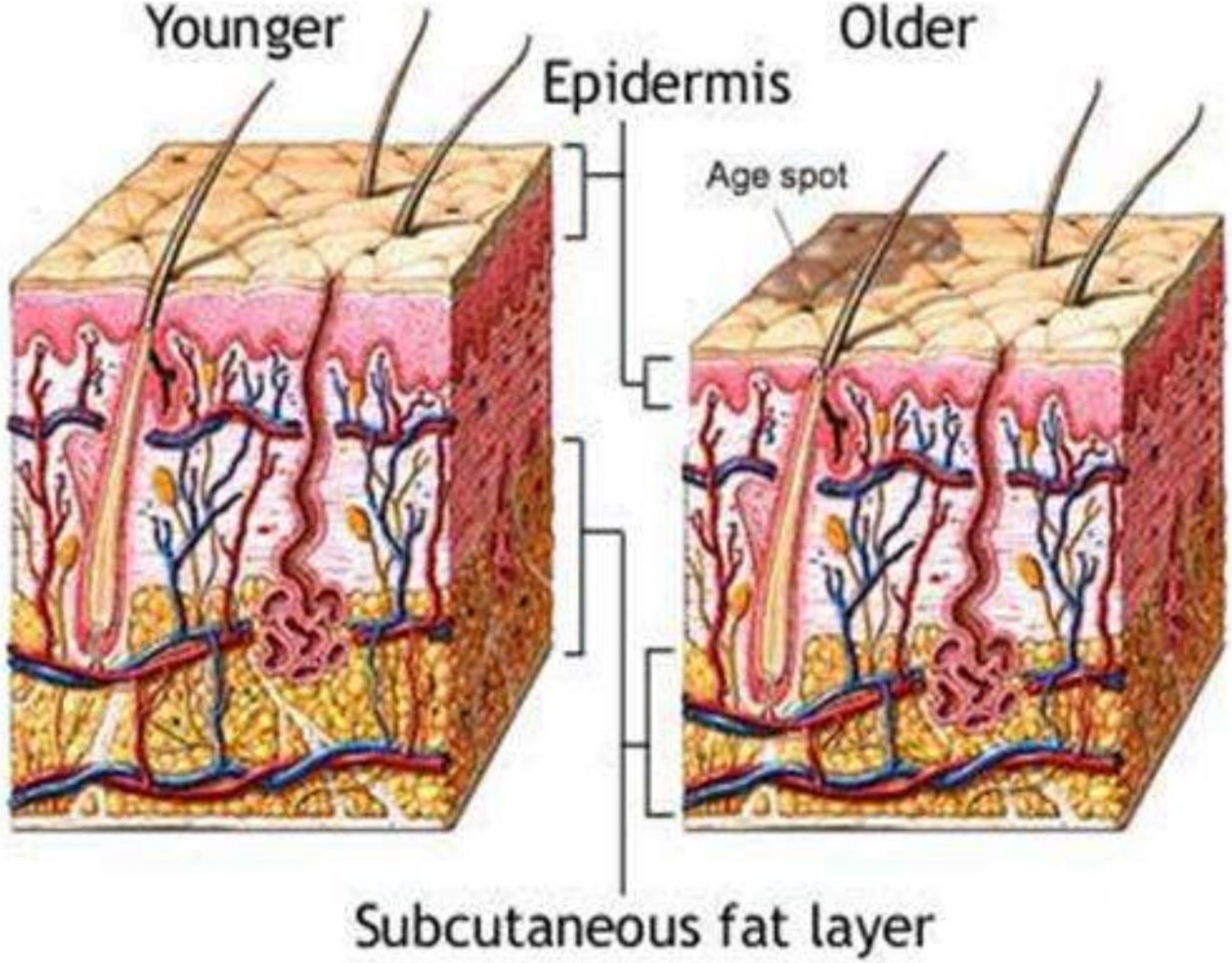

Sagittal plane
Nail root
Eponychium (cuticle)
Lunula
Nail body (plate)
Free edge
Nail body (plate)
Lunula
Eponychium (cuticle)
Nail root
Free edge of nail
Hyponychium (nail bed)
Epidermis
Dermis
Phalanx (finger bone)
Nail matrix
(a) Dorsal view
(b) Sagittal section showing internal detail

TYPES OF SKIN

- There are two major types of skin:
- **thin (hairy) skin** covers all body regions except the palms, palmar surfaces of digits, and soles
- **thick (hairless) skin** covers the palms, palmar surfaces of digits, and soles

AGING EFFECTS

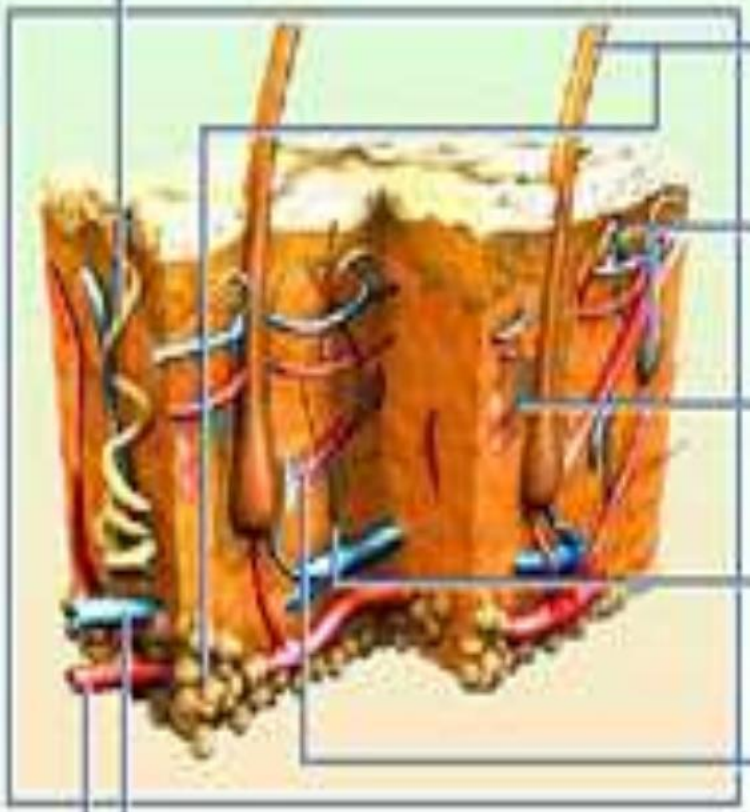
- wrinkling
- decrease of skin's immune responsiveness
- dehydration and cracking of the skin
- decreased sweat production
- decreased numbers of functional melanocytes resulting in gray hair and atypical skin pigmentation
- loss of subcutaneous fat
- a general decrease in skin thickness
- an increased susceptibility to pathological conditions
- Growth of hair and nails decreases; nails may also become more brittle with age.


Younger
Older
Epidermis
Age spot
Subcutaneous fat layer

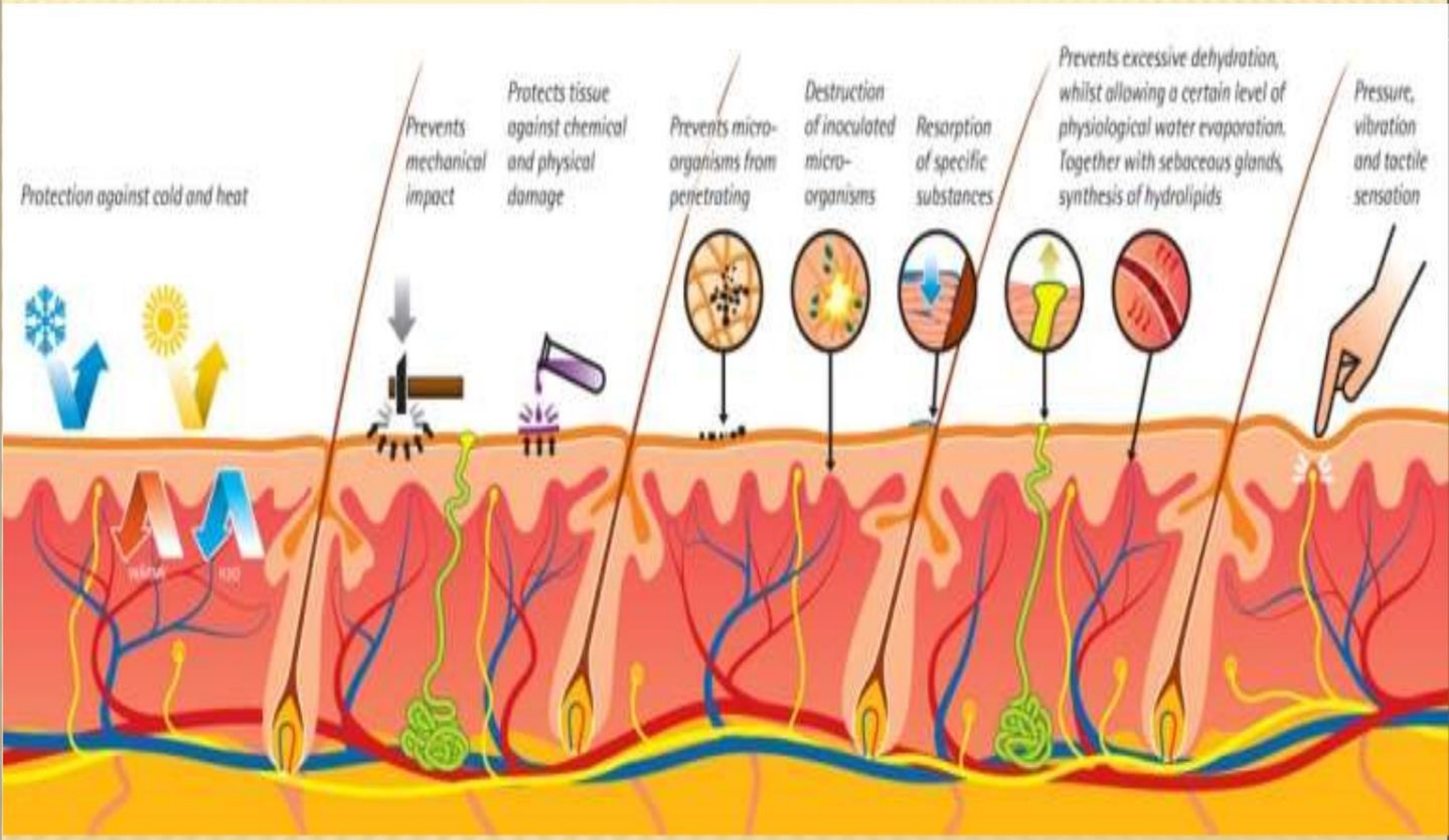
FUNCTIONS OF THE SKIN

- regulation of body temperature
- blood reservoir
- protection
- cutaneous sensations
- excretion and absorption
- synthesis of vitamin D

The skin structures and their functions



- insulation and protection
- raise hairs on the skin
- release heat through evaporation of sweat
- secrete sebum, which covers the hairs
- transmit heat
- transmit information to the nervous system
- detect temperature changes on the skin's surface


Protection against cold and heat
Prevents mechanical impact
Protects tissue against chemical and physical damage
Prevents micro-organisms from penetrating
Destruction of inoculated micro-organisms
Resorption of specific substances
Prevents excessive dehydration, whilst allowing a certain level of physiological water evaporation. Together with sebaceous glands, synthesis of hydrolipids
Pressure, vibration and tactile sensation

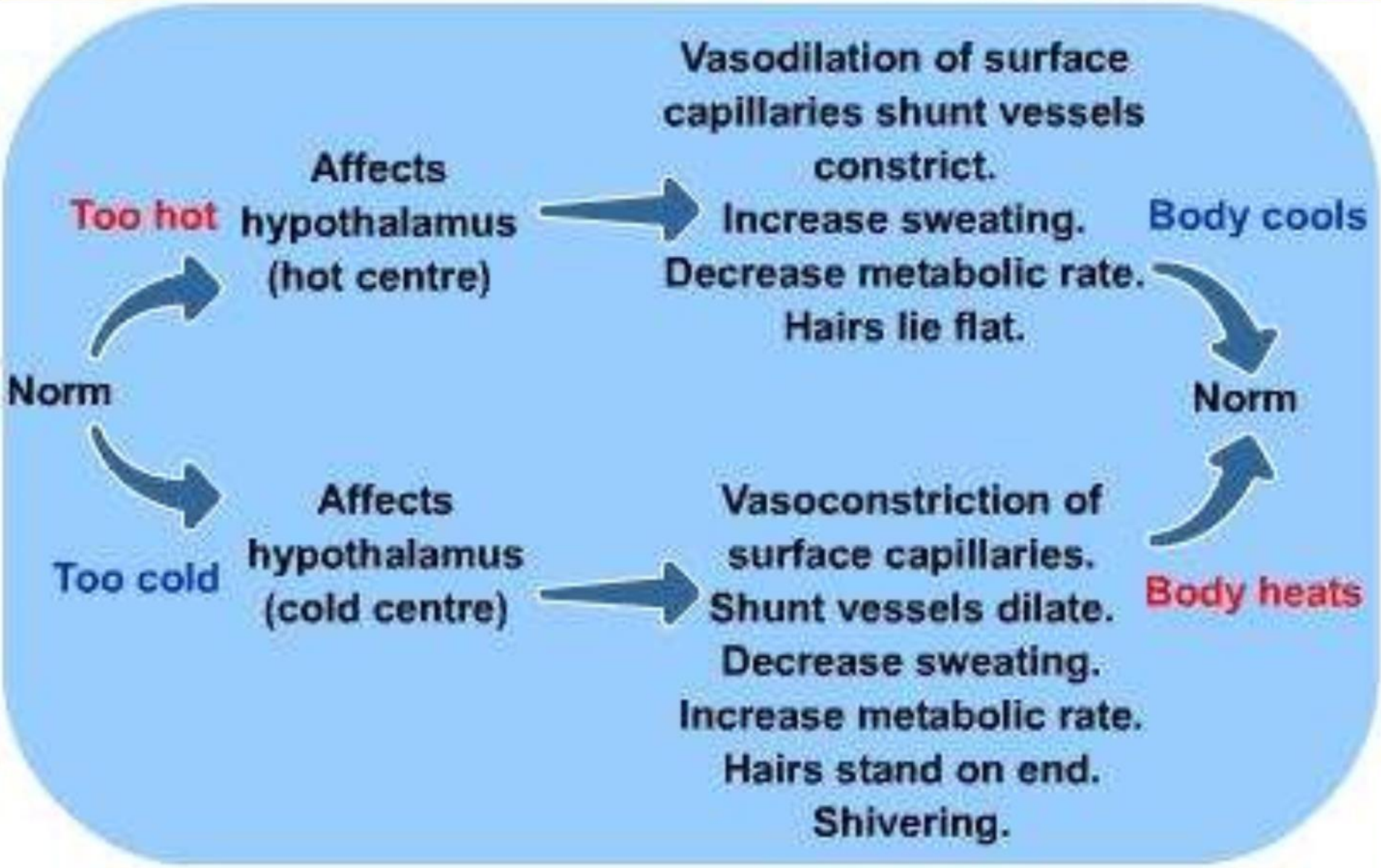

Too hot
Affects hypothalamus (hot centre)
Vasodilation of surface capillaries shunt vessels constrict.
Increase sweating.
Decrease metabolic rate.
Hairs lie flat.
Body cools
Norm
Norm
Too cold
Affects hypothalamus (cold centre)
Vasoconstriction of surface capillaries.
Shunt vessels dilate.
Decrease sweating.
Increase metabolic rate.
Hairs stand on end.
Shivering.
Body heats

Table 5.1 Summary of the Physiology of the Skin

Function	Site
Protects against: Dehydration Mechanical injury Pathogens Ultraviolet light	Epidermis
Blood loss	Epidermis and dermis
Synthesis of pigments and vitamin D	Epidermis and dermis
Temperature regulation via vasodilation, vasoconstriction, sweating and shivering	Dermis and hypodermis
Absorption of some O_2, CO_2, fat-soluble vitamins (A, D, E, and K); certain steroid hormones and some toxic substances	Epidermis, dermis, and hypodermis
Elimination of wastes: salts, water, and urea	Epidermis and dermis
Sensory reception for touch, temperature, pain, pressure, and stretch.	Epidermis, dermis, and hypodermis