CHAPTER II
STRUCTURAL ORGANIZATION
(tissue histology)
CHAPTER II
STRUCTURAL ORGANIZATION (Tissue Histology)
Tissue collections of similar cells that perform a common function.

- The various types of tissues are established during early embryonic development.

- As the embryo grows,
  - organs form from specific arrangements of tissues.
Fig. 24.2 Levels of organization within the vertebrate body

- **Organ**: Heart
- **Tissue**: Cardiac muscle
- **Cell**: Cardiac muscle cell

**Organ system**: Circulatory system
Pathology

study of abnormal tissues in diseased organs.

By knowing the normal tissues structure, can recognize the abnormal.

Histology

by a course in pathology.
Based on their structure and function, they may be classified into four basic categories:

- Epithelial tissue
- Connective tissue
- Muscular tissue
- Nervous tissue
Fig. 24.1
Vertebrate tissue types

- Epithelial tissues
  - Stratified epithelium in epidermis
  - Columnar epithelium lining stomach
  - Cuboidal epithelium in kidney tubules
- Nerve tissue
- Connective tissues
  - Bone
  - Blood
  - Loose connective tissue

- Muscle tissues
  - Smooth muscle in intestinal wall
  - Skeletal muscle in voluntary muscles
  - Cardiac muscle in heart
Characteristics of Membranous Epithelial Tissues

- epithelium
  - is located throughout the body &
  - forms such structures as
    - the outer layer of the skin,
    - the lining of the body cavities & vessels,
    - the covering of viscera, &
    - the secretory part of glands.
Epithelium always has one free surface (the apical surface) exposed to a body cavity, a lumen (hallow part of a body tube or duct), or to the skin surface.
Simple columnar epithelial cells in the digestive tract

- Apical surface
- Nucleus
- Basement membrane
- Basal surface
The deep surface bound to underlying tissue by a basement membrane.
Epithelium

Simple (one layer of cells)
- Squamous
- Cuboidal
- Columnar
- Pseudostratified
  - Ciliated

Stratified (more than one layer of cells)
- Squamous
  - Keratinized
  - Non keratinized
- Cuboidal
- Columnar
- Transitional
SIMPLE

Simple squamous

Simple cuboidal

Simple columnar

Pseudostratified

Stratified squamous

Keratinized stratified squamous

STRATIFIED

Stratified columnar

Stratified cuboidal

Transitional
Simple Epithelial Tissues

- Single cell layer.

- **diffusion, filtration, secretion** are principle functions

  size and shape

  from thin, flattened cells to tall, columnar cells.
Some have cilia

for the movement of materials across cell surfaces.
Other have microvilli - that increase the surface area for absorption.
Simple Squamous Epithelium

- flattened, irregularly shaped cells
  - tightly bound together for diffusion and filtrations.
It occurs
the lining of air sacs within the lungs (gaseous exchange),
- in the kidney (blood is filtered),
- walls of blood vessels,
- the lining of body cavities
- and covering of the viscera.
Simple Squamous Epithelium

ALVEOLI
Simple Cuboidal Epithelium

- a single layer - tightly fitted cube shaped cells,
- found linings small ducts and tubules

excretory, secretory, or absorptive functions.
It occurs on the surface of the **ovaries**, portion of the **kidneys**, ducts of the **salivary glands** and **pancreas**.
Simple columnar Epithelium

- Tall, narrow cells.

- Specialized **goblet cells**
  - are scattered through tissue.

- **Goblet cells**
  - secrete a lubricative & protective **mucus**
  
  along surface of the tissue.
- lining → inside walls of the stomach & small intestine,

(c) Diagram: Simple columnar

Photomicrograph: Simple columnar epithelium of the small intestine (575×).
where it forms a highly absorptive surface & also secretes certain digestive chemicals.
Simple Ciliated Columnar Epithelium

- **cilia along the free surfaces.**

  *wavelike movements*

  *that transport materials*

  *through tubes or passageways.*

- **in the female uterine tubes.**
Ciliated columnar epithelium
Uterine tube ~ urethra

- Cilia
- Columnar cell
- Nucleus
- Basement membrane
Pseudostratified Ciliated Columnar Epithelium

- Epithelium appears to be stratified, because of nuclei of the cells are located at different levels.
Numerous globet cells and a ciliated exposed surface are characteristic of this epithelium.

The trachea and the bronchial tubes frequently called respiratory epithelium.
Figure 3.18d Types of epithelia and their common locations in the body.

(d) **Diagram:** Pseudostratified (ciliated) columnar epithelium

**Photomicrograph:** Pseudostratified ciliated columnar epithelium lining the human trachea (560×).
Function is to remove dust and bacteria trapped in mucus.
Stratified Squamous Epithelium

- is composed of a number of cell layers
- that are flattest at the surface.
Cell divisions occur only within the deepest layer (the stratum basale)
As the newly produced cells grow in size
- they are pushed toward the surface
- where they will replace the cells
- that are sloughed off.

Movement of the epithelial cells away from the supportive basement membrane is accompanied by the production of keratin, progressive dehydration, and flattening.
Stratified squamous epithelial tissues:

- Two types
  - Keratinized
  - Non-keratinized.

• Location
  - Keratinized – forms epidermis
  - Non-keratinized – forms lining of esophagus, mouth, and vagina
Stratified Squamous Epithelium

non-keratinized

keratinized

Nucleated superficial squamous cells.

Basal cell

Basal lamina

Highly keratinized cells of the superficial layer lack nuclei.

Basal cell

Basal lamina
(a) Four principal cell types in epidermis

- Dead keratinocytes
- Lamellar granules
- Keratinocyte
- Langerhans cell
- Melanocyte
- Merkel cell
- Tactile disc
- Sensory neuron

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1. **Stratum basale**
   - Cells divide by mitosis and some of the newly formed cells become the cells of the more superficial strata.

2. **Stratum spinosum**
   - Keratin fibers and lamellar bodies accumulate.

3. **Stratum granulosum**
   - Keratohyalin and a hard protein envelope form; lamellar bodies release lipids; cells die.

4. **Stratum lucidum**
   - Dead cells containing dispersed keratohyalin.

5. **Stratum corneum**
   - Dead cells with a hard protein envelope; the cells contain keratin and are surrounded by lipids.
C. Layers

3. Stratum Granulosum

- Granular layer
- Keratinization begins
- Cells begin to die
- Thin layer 3-5 cell layers
Mucogingival junction

- Keratinized tissue, often “bound” to bone and less vascular in appearance in healthy tissue
  - Gingiva
  - Hard palate

- Non-keratinized tissue, “non-bound” to bone and more vascular in appearance
  - Buccal mucosa
  - Soft palate
  - Floor of mouth
Slide 95 Lip

Nonkeratinized stratified squamous epithelium of the oral mucosa

Keratinized stratified squamous epithelium of the red margin
1. Keratinized stratified squamous epithelium contain keratin, a protein that strengthens the tissue.

Keratin makes the epidermis (outer layer) of the skin somewhat waterproof and protects it from bacterial invasion.

The outer layer of the skin are dead, but glandular secretions keep them soft.
2. Nonkeratinized stratified squamous epithelium lines the mouth and throat, nasal cavity, vagina and anal canal, cornea, oesophagus, called mucosa.

- is well adapted to withstand moderate abrasion but not fluid loss.
- The cells on the exposed surface of this tissue are alive and are always moistened.
non-keratinized stratified squamous

living, nucleated cells at surface

cells flatten toward surface

mitotic divisions
Glandular Epithelium

**Exocrine glands** (With duct)
- cells that secrete---sweat, ear wax, saliva, digestive enzymes onto free surface of epithelial layer
- connected to the surface by tubes (ducts)
- unicellular glands or multicellular glands

**Endocrine glands** (Ductless)
- secrete hormones into the bloodstream
- hormones help maintain homeostasis
As tissues develop in the embryo, certain epithelial cells migrate into the underlying connective tissue, forming secretory structures called exocrine glands.
The secretions from **exocrine glands**

- pass through ducts **onto body surface** or **into body cavities**.

These glands should not be confused with **endocrine glands**, - which are **ductless**, - and which secrete their products (**hormones**) - in to the blood or surrounding extracellular fluid.
Exocrine glands within the skin --

- include oil (sebaceous) glands,
sweat glands, &
mammary glands.

Exocrine glands within the digestive system

include the salivary gland &
pancreatic gland.
Exocrine glands are classified according to their structure & how they discharge their products.

Classified according to structure, two types: unicellular glands & multicellular glands.
1. Unicellular glands are

- single-celled glands, (goblet cells)

- interspersed within most columnar epithelial tissues.
Goblet cells are found in the epithelial lining of - the respiratory, 
- digestive, 
- urinary & 
- reproductive system.

The mucous secretion of these cells lubricates and protects the surface linings.
2. Multicellular glands, as their name implies, are composed of both secretory cells and cells that form the walls of the ducts.

Multicellular glands are classified as simple glands or compound glands. Simple glands do not branch, while compound glands do branch.
Multicellular glands are also classified according to the shape of their secretory portion.

- They are identified as:
  - tubular glands
  - acinar glands
  - tubulo-acinar glands
as tubular glands - if the secretory portion resembles = a tube
as acinar glands
- if the secretory portion resembles a flask
both a tube & a flask
tubuloacinar glands
Compound tubulo-acinar
(a) Unicellular (goblet cells in large and small intestine and respiratory passages)
(b) Simple straight tubular (glands in stomach and colon)
(c) Simple branched tubular (glands in lower portion of stomach)
(d) Simple coiled tubular (lower portion of stomach and small intestine)
(e) Simple acinar (sebaceous glands of skin)
(f) Simple branched acinar (sebaceous glands of skin)
(g) Compound tubular (mucous glands of duodenum)
(h) Compound acinar (mammary glands)
(i) Compound tubuloacinar (pancreas)
Multicellular glands are also classified according to the means by which they release their product.

They are:

- Merocrine glands,
- Apocrine glands,
- Holocrine glands.
(a) Merocrine gland  
(b) Apocrine gland  
(c) Holocrine gland
1. Merocrine glands

- are those that secrete a **watery substance** through the cell membrane of the secretory cells.

➢ **Salivary glands**, **pancreatic glands**, and certain **sweat glands** are of this type.
2. Apocrine glands are those in which the secretion accumulates on the surface of the secretory cells; then, a portion of the cell and the secretion is pinched off and discharged.

An example of a apocrine gland is mammary gland.
3. Holocrine glands are those in which the entire secretory cell and its product are discharged.

An example of a holocrine glands is an oil secreting (sebaceous) glands of the skin.
Connective Tissue

- is divided into subtypes –
  - according to the characteristics of the matrix
  - that binds the cells.

- Connective Tissue provides
  - structural support
  - metabolic support

for other tissues and organs of the body.
- the **most abundant tissue** in the body.

- more **matrix** than cells.

➢ rarely touch another at all.
Connective Tissues

- Cells rarely touch due to usually large amount of intercellular material (extracellular matrix)
- Matrix (fibers & ground substance) secreted by cells
- Consistency varies from liquid or gel to solid
- Function is to support, connect, protect, and insulate
- Good nerve & blood supply except cartilage & tendons

What are the three major cell types often found in connective tissues, and what are their functions?
Connective Tissue

1. Connective Tissue proper
   - loose
     - (Adipose tissue)
   - dense
     - (ligament, tendon)

2. Special connective tissue
   - Fluid connective tissue
     - Blood
       - Flows within cardiovascular system
     - Lymph
       - Flows within lymphatic system
   - Supporting connective tissues
     - Cartilage
       - Solid, rubbery matrix
     - Bone
       - Solid, crystalline matrix
Connective tissue proper

- a loose, flexible matrix,
- frequently called ground substance.

➢ The most common cell is called a fibroblast.
Extracellular matrix

Ground substance

Protein fibers
- Elastic fiber
- Collagen fiber
- Reticular fiber

Blood vessel

Resident cells
- Mesenchymal cell
- Macrophage
- Adipocyte
- Fibroblast
Collagenous fibers - collagen protein
tremendous strength

Elastic fiber - elastin protein
elasticity & extensibility
Reticular fibers - reticulin protein form a lattice-like framework.
Adipose Tissue

- Contain large number of adipose cells, **adipocytes**.
- The cell store fat within their cytoplasm, causing swell and forcing their **nuclei** to one side.

![Adipose tissue image with labeled parts: Adipocyte containing fat, Nucleus, Reticular fibers, Connective tissue.](image-url)
(b) Connective tissue proper: loose connective tissue, 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 reserve food fuel; insulates against heat loss; supports and protects organs.

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

**Photomicrograph:** Adipose tissue from the subcutaneous layer under the skin (350x).
Adipose tissue is found

- beneath the skin,
- around the kidneys,
- on the surface of the heart,
- surrounding joints,
- in the breast of mature females.
Functions not only as a food reserve, but also to support and protect various organs.

It helps to keep the body warm.
2. Cartilage

Structure - Cartilage cells (chondrocytes)
- Tiny spaces (lacunae)

Function - Support and protection

Three Types of cartilage
(type & amount of fibers embedded within the matrix)

a. Hyaline cartilage
b. Fibrocartilage
c. Elastic Cartilage
Hyaline cartilage

- Hyaline cartilage has matrix that gives it a glassy appearance.
- Located in
  - the respiratory tract,
  - rib cage, and
  - developing bone.
Step 5: Capillaries and osteoblasts migrate into the epiphyses to create secondary ossification centers.

Step 6: Soon each epiphysis is filled with spongy bone. An articular cartilage remains exposed to the joint cavity; over time it will be reduced to a thin superficial layer. At each metaphysis, an epiphyseal cartilage separates the epiphysis from the diaphysis.
Bone Growth

- Medullary cavity
- Articular cartilage
- Spongy bone
- Secondary ossification center
- Epiphyseal plate
- Periosteum
- Compact Bone
- Primary ossification center
- Bone collar
- Hyaline cartilage "model"
- Blood vessels
- Periosteum
Figure 3.19b Connective tissues and their common body locations.

**Photomicrograph:** Hyaline cartilage from the trachea (400×)

**Diagram:** Hyaline cartilage

- Chondrocyte (cartilage cell)
- Lacunae
- Chondrocyte in lacuna
- Matrix
Fibrocartilage

- a matrix reinforced with many collagenous fibers.

-a durable tissue

-adapted to withstand tension & compression bone.
Fibrocartilage

- Fibrocartilage is quite similar to hyaline cartilage but its matrix contains many coarse collagen fibers running parallel to each other.
- It is found in pubic symphysis, intervertebra discs and the menisci of knees.

**Functions:**

1. Resists compression
2. Prevents bone-to-bone contact
Elastic cartilage

- Elastic cartilage, abundant elastic fibers, very flexible and strong

found in

- the outer ear (Pinnae),
- portions of the larynx &
- auditory canal.
Fig. 24.12 Axial and appendicular skeletons
Bone (Osseous) Tissue

- Most rigid of all connective tissues,
- bone has a rich blood supply.
- The hardness of bone is due to the calcium phosphate located within the matrix.
- Bone tissue is classified
  - compact bone
  - spongy bone
Articular cartilage

Head

Blood supply to bone: nutrient arteriole entering nutrient foramen

Compact bone

Cortex of compact bone covered by periosteum

Periosteum

Medullary cavity

Shaft

Neck

Trabeculae of spongy bone
Compact bone tissue constitutes the hard outer portion of a bone,

- spongy bone tissue constitutes the porous, highly vascular inner portion.
In compact bone tissue uniform structural arrangement can be seen.

Bone cells, **osteocyes** are arranged in rings around a central (Haversian) canal, which contains blood vessels and a nerve.
Bone cells (osteocyte) - in tiny space (lacuna)

Canaliculi - Radiating from lacuna
- Nutrients diffuse through the canaliculi

Bone matrix – called lamellae
Ground bone X.S.

Haversian system

- Bone matrix
- Bone cell in lacuna
- Haversian canal
- Concentric lamella
Figure 3.19a Connective tissues and their common body locations.

(a) Diagram: Bone

Photomicrograph: Cross-sectional view of ground bone (165 × )
Compact Bone

Lamellae: 3 types

1. Concentric: surrounds Haversian canal
2. Interstitial: lie between osteons
3. Circumferential: flat plates extend around the bone

See Figure 6.4b opposite for details

(a) Osteons (haversian systems) in compact bone and trabeculae in spongy bone

Figure 06.04a Tortora - PHA 11/e
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Composition of Blood

• Blood is responsible for.....
  – Transporting gases (oxygen & carbon dioxide)
  – Transporting waste products
  – Transporting nutrients
  – Helping remove toxins from the body
RBC Structure And Function

• Have no organelles or nuclei
• Hemoglobin – oxygen carrying protein
  – Each RBC has about 280 million hemoglobin molecules
• Biconcave shape – 30% more surface area
Blood (Vascular) Tissue

- Blood, or vascular tissue,
- is specialized fluid connective tissue
- that plays a vital role in maintaining internal body homeostasis.
Homeostasis

- Definition
  - Maintaining stable internal conditions
  - Keeping everything in the body “normal”

- Examples:
  - Body temperature
  - Blood sugar
  - Blood pressure
Sample of whole blood

doesn't consist of

<table>
<thead>
<tr>
<th>FORMED ELEMENTS</th>
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<tbody>
<tr>
<td>Platelets</td>
</tr>
<tr>
<td>White blood cells</td>
</tr>
<tr>
<td>Red blood cells</td>
</tr>
</tbody>
</table>

Plasma (46–63%)

+ Formed elements (37–54%)

WHITE BLOOD CELLS

- Neutrophils (50–70%)
- Eosinophils (2–4%)
- Basophils (<1%)
- Lymphocytes (20–30%)
- Monocytes (2–8%)
Blood tissue
1. Erythrocytes or red blood cells (RBCs), tiny biconcave discs that lack nuclei,

- Their red color is due to the protein hemoglobin.
- Oxygen attaches to and is transported on the hemoglobin molecules.
- The life span of erythrocytes is between 90 and 120 days.
Red Blood Cells

Oxygen (O₂)

Hemoglobin

Iron (Fe)
Hemoglobin carries oxygen and carbon dioxide.

Carbon monoxide binds very tightly to hemoglobin.

Hemoglobin

Red blood cell

Oxygen

Carbon dioxide

Carbon monoxide
2. Leukocytes or white blood cells (WBCs), - nucleated, exhibit amoeboid movement by forming cytoplasmic extensions and serve to protect the body against invasions by microorganisms.
They are produced in bone marrow & lymphatic tissue - & have a life span ranges from 3 to 300 days.

There are five kinds of leukocytes:

- neutrophils,
- eosinophils, granulocyte
- basophils ,
- lymphocytes
- monocytes, agranulocyte
<table>
<thead>
<tr>
<th></th>
<th>Blood cell type</th>
<th>Lifespan in blood</th>
<th>Function</th>
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<tbody>
<tr>
<td>1</td>
<td>Neutrophil</td>
<td>7 hours</td>
<td>Immune defenses</td>
</tr>
<tr>
<td>2</td>
<td>Eosinophil</td>
<td>8 to 12 days</td>
<td>Defense against parasites</td>
</tr>
<tr>
<td>3</td>
<td>Basophil</td>
<td>a few hours to a few days</td>
<td>Inflammatory response</td>
</tr>
<tr>
<td>4</td>
<td>Monocyte</td>
<td>3 days</td>
<td>Immune surveillance</td>
</tr>
<tr>
<td>5</td>
<td>B-lymphocyte</td>
<td>memory cells may live for years</td>
<td>Antibody production</td>
</tr>
<tr>
<td>6</td>
<td>T-lymphocyte</td>
<td>memory cells may live for years</td>
<td>Cellular immune response</td>
</tr>
</tbody>
</table>
**Neutrophils**

- 40%-70% WBCs
- Nucleus multilobed
- Duration of development: 6-9 days
- Life Span: 6 hours to a few days
- Function: phagocytize bacteria
- **Eosinophils**

- 1%-4% WBCs
- Nucleus bilobed
- Development: 6-9 days
- Life Span: 8-12 days
- Function:
  1) Kill parasitic worms
  2) destroy antigen-antibody complexes
  3) inactivate some inflammatory chemical of allergy
Basophils

- 0.5% WBCs
- Nucleus lobed
- Development: 3-7 days
- Life Span: a few hours to a few days
- Function:
  1) Release histamine and other mediators of inflammation
  2) contain heparin, an anticoagulant
**Lymphocytes**

- T cells and B cells
- 20%-45% WBCs
- Nucleus spherical or indented
- Development: days to weeks
- Life Span: hours to years
- Function

  Mount immune response by direct cell attack (T cells) or via antibodies (B cells)
Monocytes

- 4%-8% WBCs
- Nucleus U-shaped
- Development: 2-3 days
- Life Span: months
- Function:
  - Phagocytosis
  - develop into *macrophages* in tissues
Thrombocytes or platelets
- along with the protein fibrinogen
- found in the plasma,
- play a role in blood clotting.

Platelets have a life span between 5 and 7 days.
Hemostasis — Blood Clot

Fibrin
Fig. 24.13 Muscles and How They Work

- Pectoralis major
- Biceps
- Rectus abdominis
- Sartorius
- Quadriceps
- Gastrocnemius
• Muscle Tissue

Muscle tissue is unique because it is able to contract, thus making movement possible.

The muscle cells, or fibers, are long and cylindrical.

Three types of muscle are

- smooth muscle tissue
- cardiac muscle tissue
- skeletal muscle tissue.
Smooth Muscle Tissue

Cardiac Muscle Tissue

Skeletal Muscle Tissue

Involuntary Control

Involuntary Control

Voluntary Control
The structure and function of the three types of muscle tissue

Skeletal muscles move or stabilize the position of the skeleton; guard entrances and exits to the digestive, respiratory, and urinary tracts; generate heat; and protect internal organs.

Cardiac muscle moves blood and maintains blood pressure.

Smooth muscle moves food, urine, and reproductive tract secretions; controls diameter of respiratory passageways and regulates diameter of blood vessels.
- Smooth muscle

- Smooth muscle fibers are long, spindle-shaped cells that contains a single nucleus.

- These cells are usually grouped together in flattened sheets, forming the muscular portion of the wall around a lumen.
Smooth muscle tissue is common throughout the body.

Smooth muscle is also found in

- the walls of blood vessels,
- the walls of respiratory passage, and
- in the urinary and reproductive duct.

The contraction of smooth muscle is under involuntary (unconscious) nervous control.
Smooth muscle

Wall of blood vessel

- Smooth muscles in longitudinal layer
- Blood cells RBC
- Smooth muscles in circular layer
- Nucleus
• Cardiac muscle
  ➢ Make up most of the wall of the heart
    - characterized by
      -- branching fibers,
      -- a central nucleus,
      -- banding patterns called striations.
  ➢ The cardiac muscle fibers are joined by intercalated discs.
Intercalated discs help to hold neighboring cells together and spread the contract from cell to cell - also contracts involuntarily.
Cardiac muscle

- Light striation
- Connective tissue
- Branch of muscle
- Nucleus of muscle cell
- Intercalated disc
- Nucleus of connective
• Skeletal Muscle (Striated muscle)

- Makes up the skeletal muscle that attached to the bones of the skeleton.

- Contraction of results in voluntary or involuntary body movements.

- Skeletal muscle fibers are long and multinucleate.

- The striations easily seen through a microscope.
Striated muscle

- Transverse striation
- Sarcolemma
- Sarcoplasm
- Collagen fibres
- Nucleus
- Muscle cell
Photomicrograph: Skeletal muscle (300×). Notice the obvious banding pattern and the fact that these large cells are multinucleate.
Skeletal Muscle

- Human body contains over 400 skeletal muscles
  - 40-50% of total body weight
- Functions of skeletal muscle
  - Force production for locomotion and breathing
  - Force production for postural support
  - Heat production during cold stress
(4) Somatic Reflexes

- Involuntary Movement of Skeletal Muscle

- **Examples:**
  - Touching a Hot Stove
  - Knee-Jerk Reflex
  - Touching a Sharp Object
A Simple Nerve Circuit – the Reflex Arc.

- A reflex is an autonomic response.
• Nervous Tissue

➤ Nervous Tissue, contained within

- the brain,

- spinal cord, and

➤ composed of two kinds of cells-

- neurons and

- neuroglial cells.
• Neurons, or nerve cells are
  - the basic structural and
  - functional units,

- specialized to respond to \{ physical stimuli and
  
  chemical stimuli &

- to generate impulses and

- conduct impulses to and from the various body organs.
Neuroglial Cells

- Nuerons
- Oligodendrocyte
- Capillary
- Astrocyte
- Ependymal cell
- Fluid-filled cavity of the brain or spinal cord

(a) Microglial cell
(b) Oligodendrocyte
(c) Astrocyte
(d) Ependymal cell

Axon
A neuron has three principal components.

1. The cell body contains the nucleus and specialized organelles and microtubules.

2. The dendrites function to receive a stimulus and conduct the impulse toward the cell body.

3. The axon is a long extension that conducts an impulse away from the cell body.
The term nerve fiber usually refers to an axon and the myelin sheath that surrounds it.
Neuroglial cells (glial cells)

- about five times as abundant as neurons
- do not transmit impulses
- support and bind neurons together.
- phagocytic
- assist providing nourishment for the neurons
Enjoy Your Learning &
Your University Student Life
Good Luck