Chapter 4

The Tissue Level of Organization

INTRODUCTION

- A ***tissue*** is a group of similar cells that are specialized for a particular function.

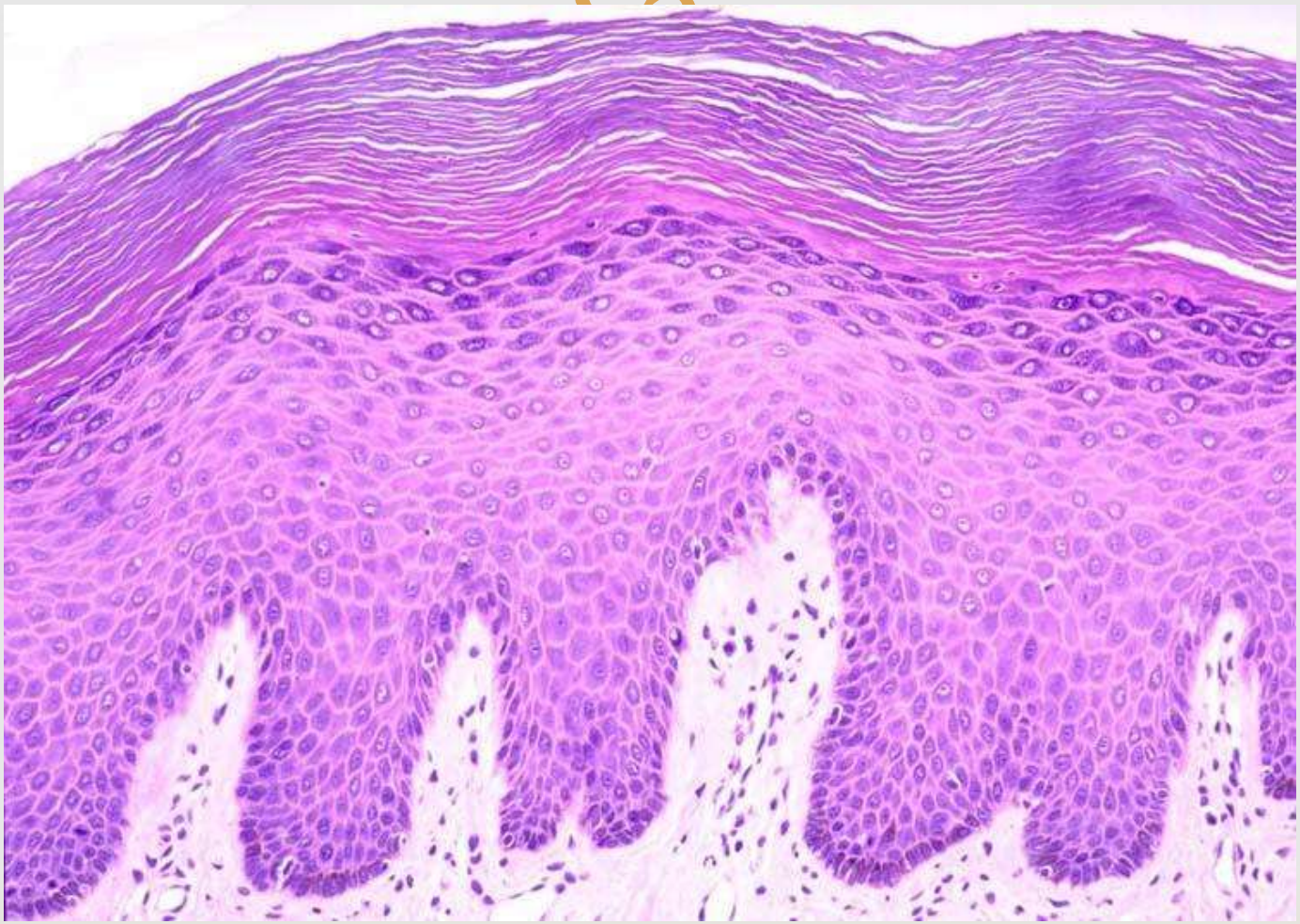
- The cells as well as the extracellular fluid in tissues determine its function

BASIC TISSUE TYPES

Four principal types based on function and structure

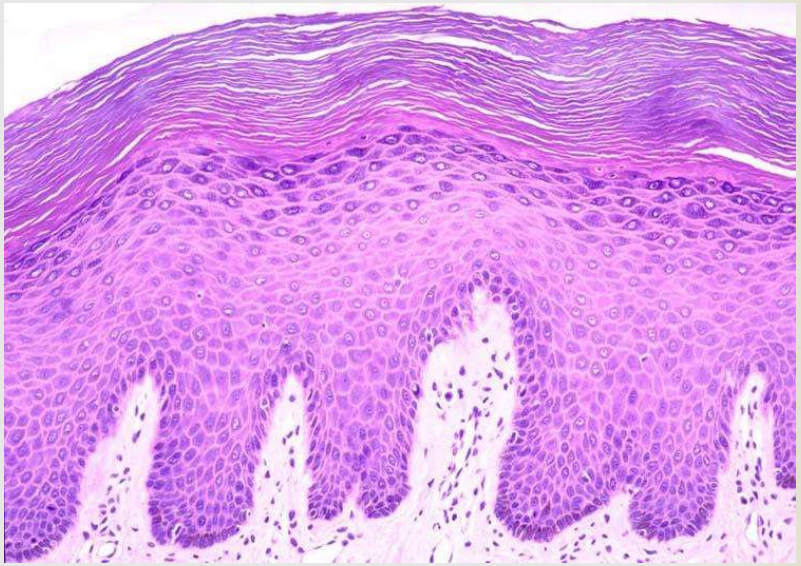
1. **Epithelial tissue**
   - covering, lining, and forms glands.
2. **Connective tissue**
   - protects and supports, binds tissues, stores energy, and provides immunity.
3. **Muscle tissue**
   - movement and generation of force.
4. **Nervous tissue**
   - communication and control

EPITHELIAL TISSUES

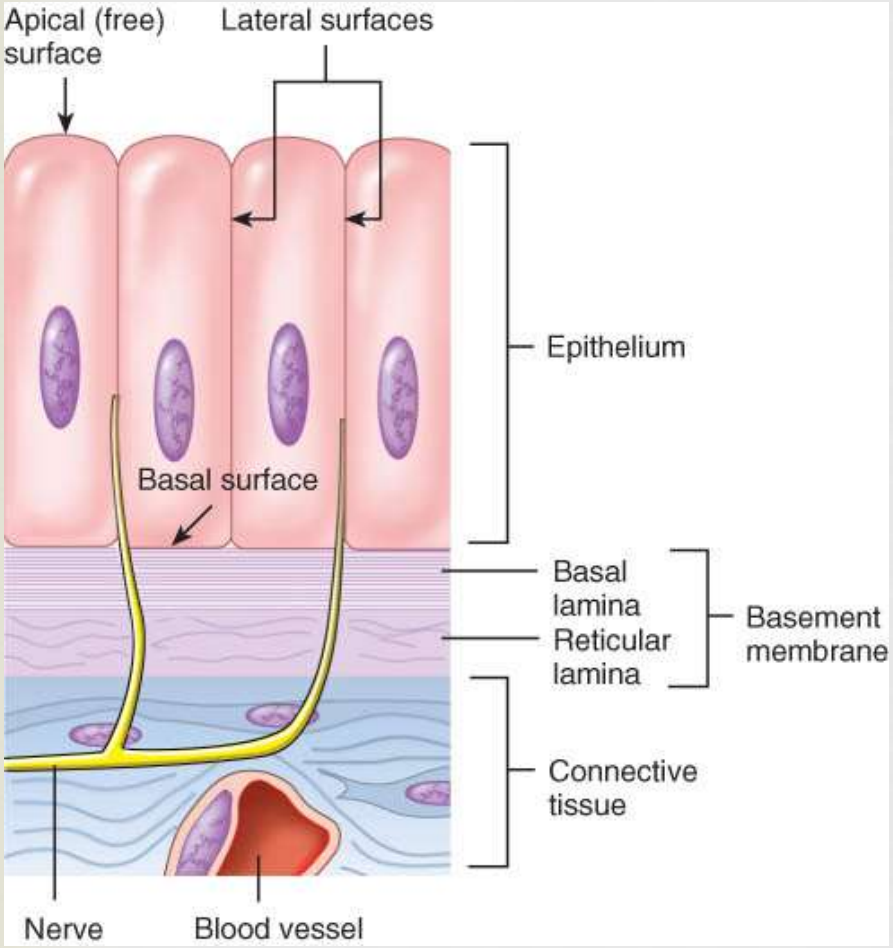


Epithelial Tissue -- General Features

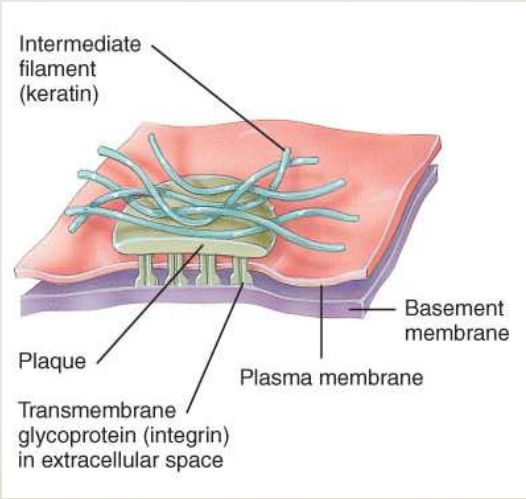
- Closely packed cells with little extracellular material
- Polarity
  - **Apical** (upper) free surface
  - **Basal** surface against basement membrane
- Avascular---without blood vessels
  - nutrients and waste must move by diffusion
- Good nerve supply
- Rapid cell division (high mitotic rate)



Basement Membrane



- Basal lamina
  - from epithelial cells
  - collagen fibers
- Reticular lamina
  - secreted by connective tissue cells
  - reticular fibers



Epithelial Tissue either

1. Covering and lining epithelium
   - These are the types we saw in lab
   - May be "simple" or multi-layered

2. Glandular epithelium
   - Two types:
     - **Exocrine** - connected to the surface by tubes (ducts)
       - May be classified either by structure or function
       - Eg. sweat, ear wax, saliva, digestive enzymes
     - **Endocrine** - secrete hormones into the bloodstream
       - Eg. Thyroid, adrenal, anterior pituitary

Specific Types of Simple Epithelium

- **Simple Squamous Epithelium –flat cells**
  - very thin --- controls diffusion, osmosis and filtration
  - Examples: alveoli, outer layer of intestine
- **Simple Cuboidal Epithelium – square-ish**
  - adapted for absorption or secretion
  - Examples: tubules, ducts, glands
- **Simple Columnar Epithelium – rectangular**
  - Include unicellular glands (goblet cells) secrete mucus
  - Cells often have Microvilli – adapted for absorption
  - Examples: lining the inside of the GI, respiratory, reproductive and urinary systems
- **Ciliated Simple Columnar Epithelium**
  - Cilia (motile membrane extensions) move mucous
  - Examples: found in respiratory system and in uterine tubes
- **Pseudostratified Ciliated Columnar Epithelium**
  - Single cell layer of cells with nuclei located at varying depths (appear layered.)
  - Examples: trachea, male urethra & epididymis

Specific Types of Multi-layered Epithelium

- Non-keratinized stratified squamous epithelium - Cells on surface are flat
  - Mitosis occurs at the basal layer
  - E.g. Inside of cheek, vagina, esophagus
- Keratinized stratified squamous epithelium - Cells on surface are flat
  - Mitosis occurs at the basal layer
  - Cells (especially at the top layer) are filled with keratin
  - E.g. epidermis
- Transitional epithelium – variable shape
  - surface cells varying in shape - round to flat (if stretched)
  - E.g. – urinary bladder, ureter
- Stratified cuboidal epithelium
- Stratified columnar epithelium

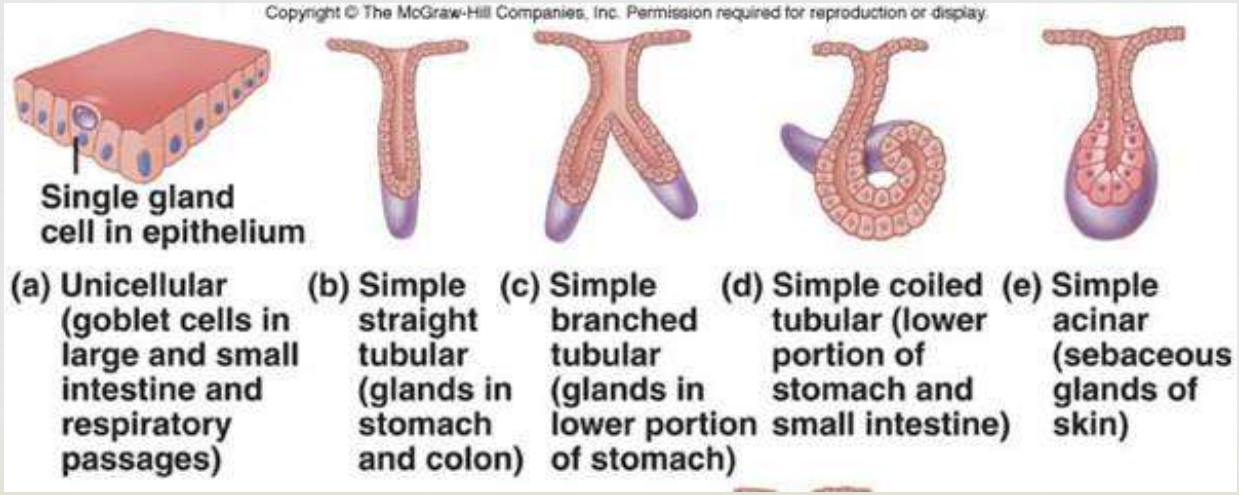
Glandular Epithelium

- Exocrine Glands
  - Secrete ---sweat, ear wax, saliva, digestive enzymes onto free surface of epithelial layer

- Endocrine Glands
  - Secrete hormones into the bloodstream

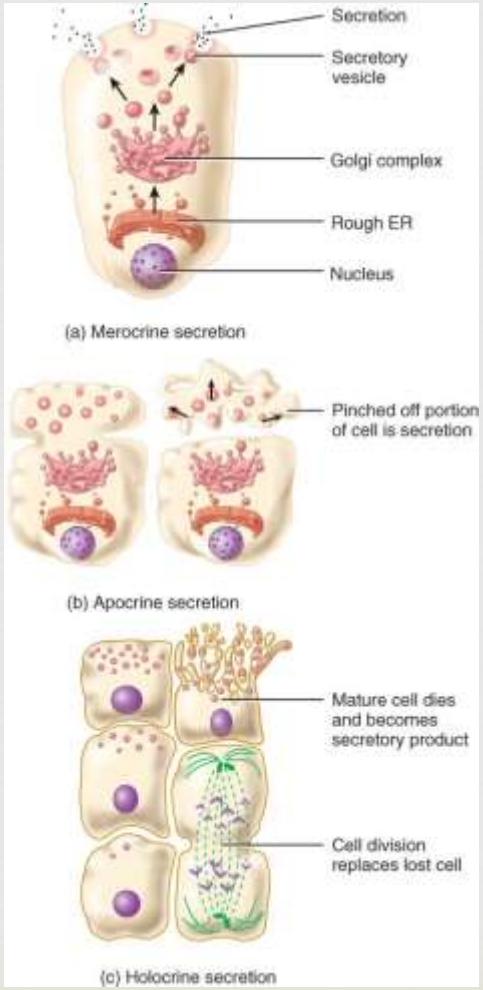
Exocrine Glands

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



Exocrine Glands – Functional Classification

- **Merocrine glands:** The most common subtype, merocrine gland secretions exit the cell via exocytosis. This method of secretion does not damage the cell. An example of merocrine secretion is the eccrine sweat gland.
- **Apocrine glands:** These form buds of the membrane that break off into the duct, losing part of the cellular membrane in the process. A well-known apocrine gland is the breastmilk-producing mammary gland.
- **Holocrine glands:** The cellular membrane of holocrine glands ruptures to release its product into the duct. Sebaceous (oil) glands represent holocrine secretion.



Connective Tissue

Connective Tissues – General Features

- Cells rarely touch due to "extracellular matrix."
- Matrix (fibers & ground substance) is secreted by cells
  1. **Collagen fibers**
     - composed of the protein collagen
     - tough and resistant to stretching
  2. **Elastic fibers**
     - composed of the protein elastin
     - provide strength and stretching capacity
  3. **Reticular fibers**
     - composed of collagen and glycoprotein
     - supporting network

- Good nerve & blood supply except in cartilage & tendons

Types of Mature Connective Tissue

I. Proper connective tissue
II. Cartilage
   - Hyaline, elastic, and fibrocartilage
III. Bone tissue
   - Compact and spongy (sometimes called trabecular)
IV. Blood and Lymph

I. Proper Connective Tissue

- **Loose connective tissue** - Loosely woven fibers throughout tissues
  - Areolar connective tissue
    - Elastic and collagen fibers
    - eg. Subcutaneous layer
  - Adipose – fat
    - Yellow fat - Example: Deeper layer of skin, organ padding, yellow marrow
      - Peripheral nuclei due to large fat storage droplet
    - Brown fat – found in infants
  - Reticular connective tissue
    - Network of fibers & cells that produce framework of organ
    - Holds organ together
    - Examples: liver, spleen, lymph nodes, bone marrow

I. Proper Connective Tissue

- **Dense connective tissue** – Densely woven fibers throughout tissues
  - Dense regular connective tissue – eg. Tendons and ligaments
  - Dense irregular connective tissue – eg. White of eyeball, dermis of skin
  - Elastic connective tissue
    - Branching elastic fibers and fibroblasts
    - Can stretch & still return to original shape
    - Examples: Lung tissue, vocal cords, ligament between vertebrae

II. Cartilage

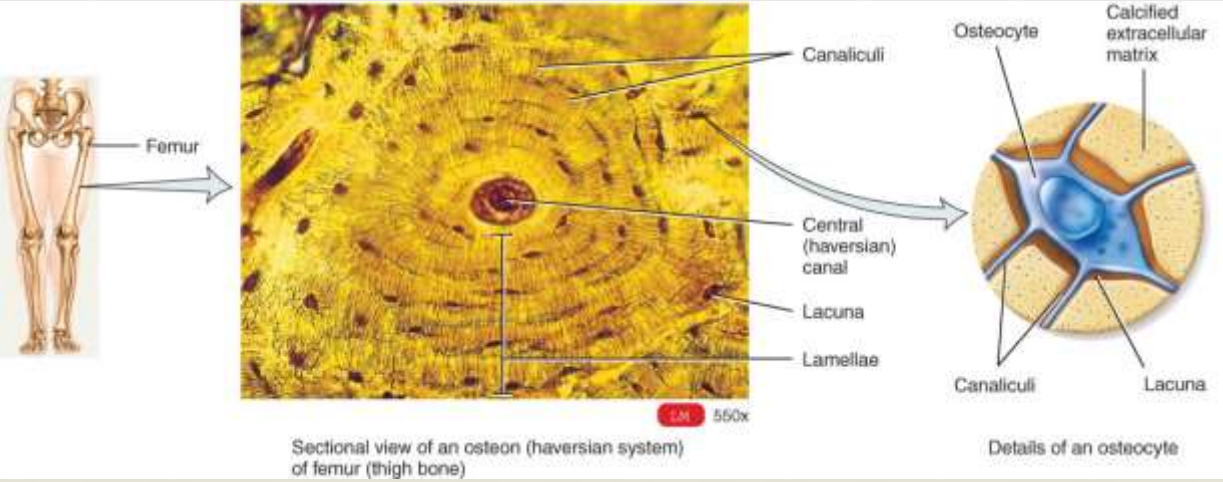
- ***Cartilage*** consists of a dense network of collagen fibers and elastic fibers embedded in chondroitin sulfate.
  - Chondrocytes occur with spaces called lacunae in the matrix.
- It is surrounded by *perichondrium.*
- Unlike other connective tissues, cartilage has no blood vessels or nerves (except in the perichondrium).
- 3 types:
  - Hyaline cartilage - Reduces friction at joints as articular cartilage
  - Elastic cartilage
    - Elastic fibers help maintain shape
    - Ear, epiglottis, eustachian tube
  - Fibrocartilage
    - Many more collagen fibers causes rigidity & stiffness
    - Strongest type of cartilage (intervertebral discs)

Growth & Repair of Cartilage

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

III. Bone (Osseous) Tissue

- Protects, provides for movement, stores minerals, site of blood cell formation
- consists of a matrix containing mineral salts and collagenous fibers and cells called **osteocytes**.
  - **Spongy bone**
    - sponge-like with spaces and trabeculae
  - **Compact bone**
    - solid, dense bone
    - basic unit of structure is **osteon** (Haversian system)



IV. Liquid connective tissue

- *Blood*
  - liquid matrix called plasma
  - Cell types:
    - Red blood cells (erythrocytes) – Oxygen transport
    - White blood cells (leukocytes) – Immune response
    - Platelets (thrombocytes) – blood clotting

- *Lymph* is interstitial fluid flowing in lymph vessels.
  - Contains less protein than plasma
  - Move cells and substances (eg., lipids) from one part of the body to another

MEMBRANES

Membranes are flat sheets of pliable tissue that cover or line a part of the body.

Epithelial membranes include

- **Mucous membranes** - line cavities that open to the exterior (e.g. mouth, stomach, vagina, urethra)
- **Serous membranes (serosa)** - Lines a body cavity that does not open to the outside such as chest or abdominal cavity

  - Examples: pleura, peritoneum and pericardium

  Serous membrane is a thin, double-layered membrane that has two layers:

  - Parietal layer (membrane) – lines the cavity walls
  - Visceral layer (membrane) – covers the organs
  - **Cutaneous membrane** – skin (epidermis and dermis)

MEMBRANES

Connective tissue membranes include:

- **Synovial membranes -** line joints and contain only connective tissue (no epithelial tissue).

MUSCLE TISSUE

- consists of fibers (cells) that are modified for contraction (provide motion, maintenance of posture, and heat.)

- Three types.
  1. **Skeletal muscle**
     - Cells are long cylinders with many peripheral nuclei
     - Visible light and dark banding (looks striated)
     - Voluntary (conscious control)

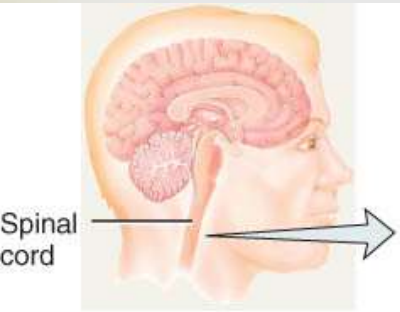
  2. **Cardiac muscle**
     - Cells are branched with one central nucleus
     - Involuntary and striated
     - intercalated discs contain desmosomes and gap junctions

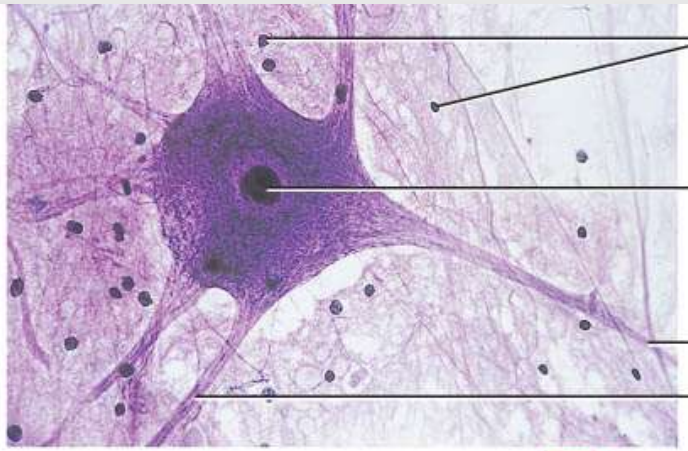
  3. **Smooth muscle**
     - Spindle shaped cells with a single central nuclei
     - Walls of hollow organs (blood vessels, GI tract, bladder)
     - Involuntary and nonstriated

NERVOUS TISSUE

- The nervous system is composed of only two principal kinds of cells:
  1. neurons - nerve cells
  2. neuroglia - protective and supporting cells

Nerve Tissue





Neuron of spinal cord

Nerve cell structure

- nucleus & long cell processes conduct nerve signals
  - dendrite(s) --- signal travels toward the cell body
  - axon ---- signal travels away from cell body