

## Vertebrate Body Organization

Digestive tube suspended  
in coelom from mouth to  
anus

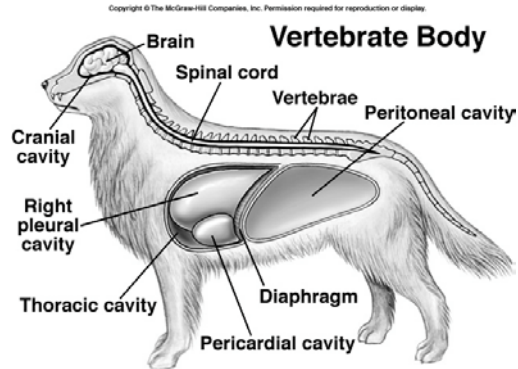
Body supported by internal  
skeleton of jointed bones

Vertebrae and Cranium  
protects nervous system

Diaphragm divides coelom into two parts

Thoracic cavity: Heart and lungs

Peritoneal (abdominal) cavity: Stomach, intestines and liver

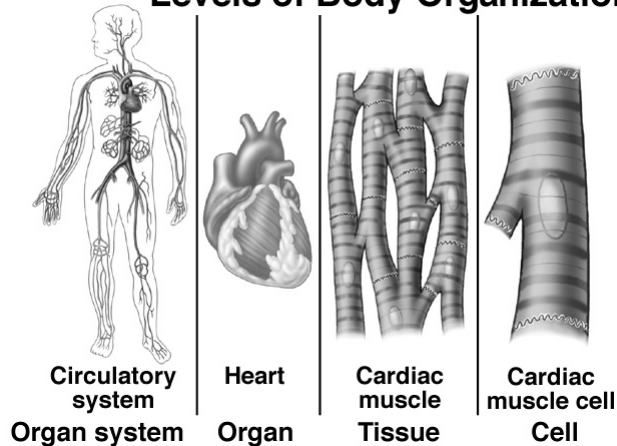


Levels of organization -

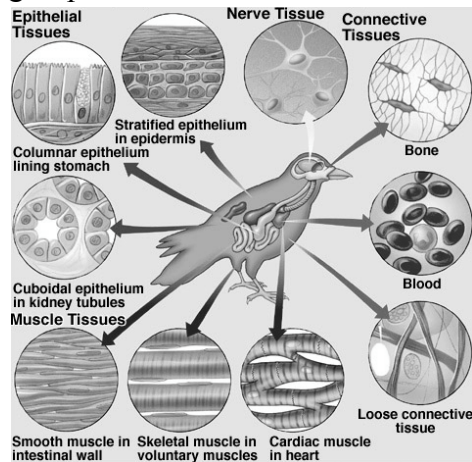
cells are organized into tissues, multiple types of tissues are  
organized into organs, organs are “organized” into systems

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### Levels of Body Organization



Tissue - a group of cells with similar structure and functions



Three fundamental embryonic tissues

Endoderm, mesoderm, ectoderm

Four adult primary tissues

Epithelial, connective, muscle, nerve

Organ - a structural and functional unit composed of different tissues

Example - Heart

Contains cardiac muscle, connective tissue, epithelial tissue

Laced with nerves to regulate heart beat



Organ system- A group of organs that function together to carry out body activities

Example: Digestive system composed of digestive tract, liver, gall bladder, pancreas

Humans contain eleven principal organ systems

**Table 49.1 The Major Vertebrate Organ Systems**

System	Functions	Components
Circulatory	Transports cells, respiratory gases, and chemical compounds throughout the body	Heart, blood vessels, lymph, and lymph structures
Digestive	Captures soluble nutrients from ingested food	Mouth, esophagus, stomach, intestines, liver, and pancreas
Endocrine	Coordinates and integrates the activities of the body	Pituitary, adrenal, thyroid, and other ductless glands
Integumentary	Covers and protects the body	Skin, hair, nails, scales, feathers, and sweat glands
Lymphatic/ Immune	Vessels transport extracellular fluid and fat to circulatory system; lymph nodes and lymphatic organs provide defenses to microbial infection and cancer	Lymphatic vessels, lymph nodes, thymus, tonsils, spleen
Muscular	Produces body movement	Skeletal muscle, cardiac muscle, and smooth muscle
Nervous	Receives stimuli, integrates information, and directs the body	Nerves, sense organs, brain, and spinal cord
Reproductive	Carries out reproduction	Testes, ovaries, and associated reproductive structures
Respiratory	Captures oxygen and exchanges gases	Lungs, trachea, gills, and other air passageways
Skeletal	Protects the body and provides support for locomotion and movement	Bones, cartilage, and ligaments
Urinary	Removes metabolic wastes from the bloodstream	Kidney, bladder, and associated ducts



**Skeletal system**



**Circulatory system**



**Endocrine system**

Skull

Sternum

Pelvis

Femur

Heart

Arteries

Veins

Pituitary

Thyroid

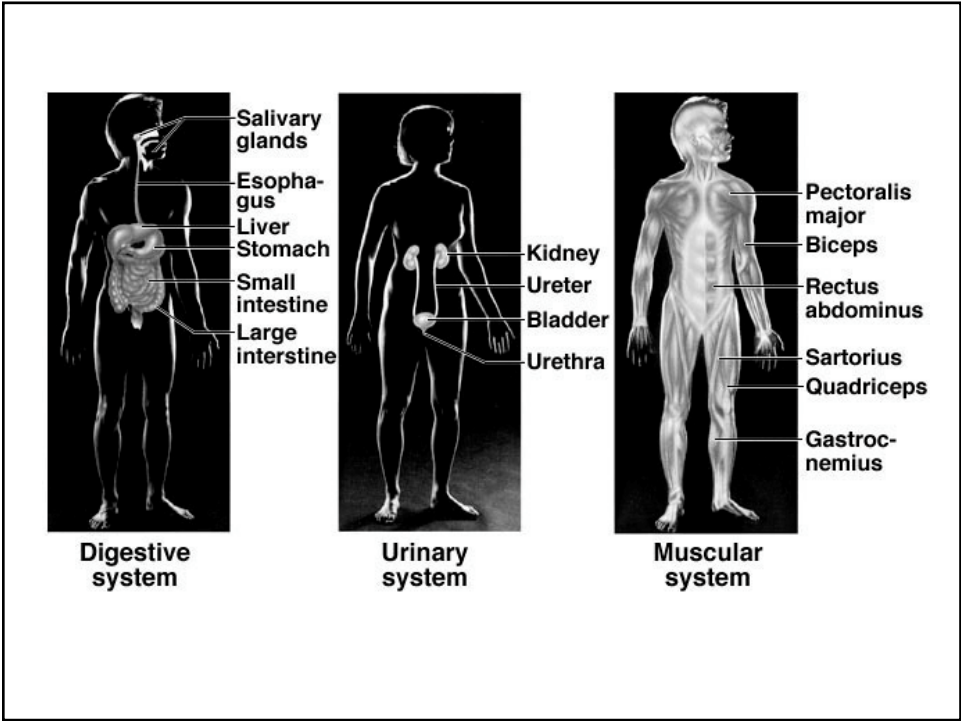
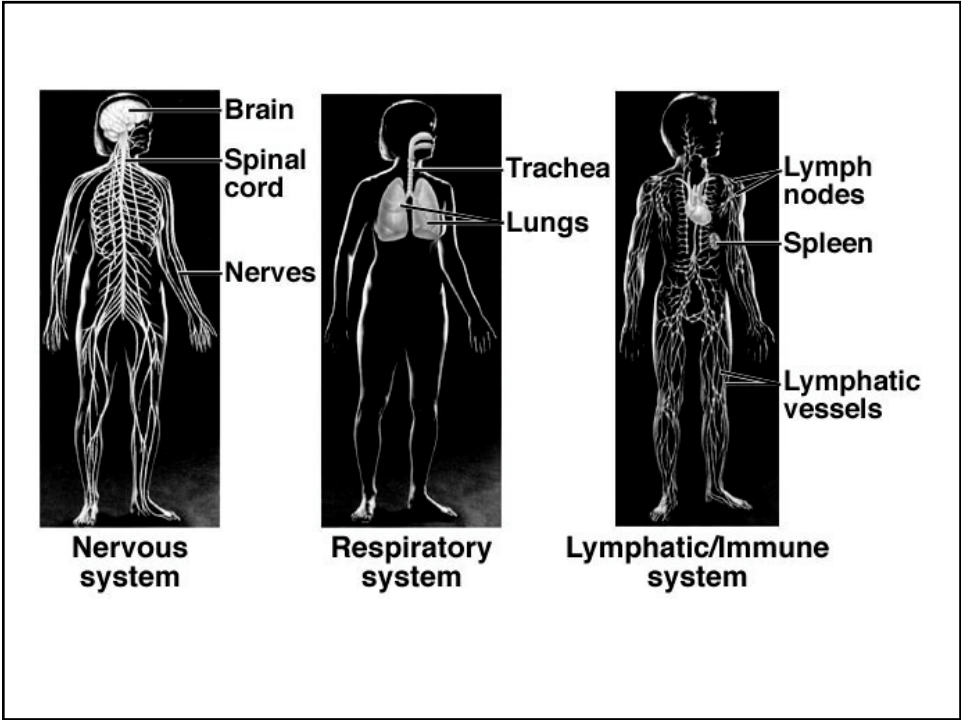
Thymus

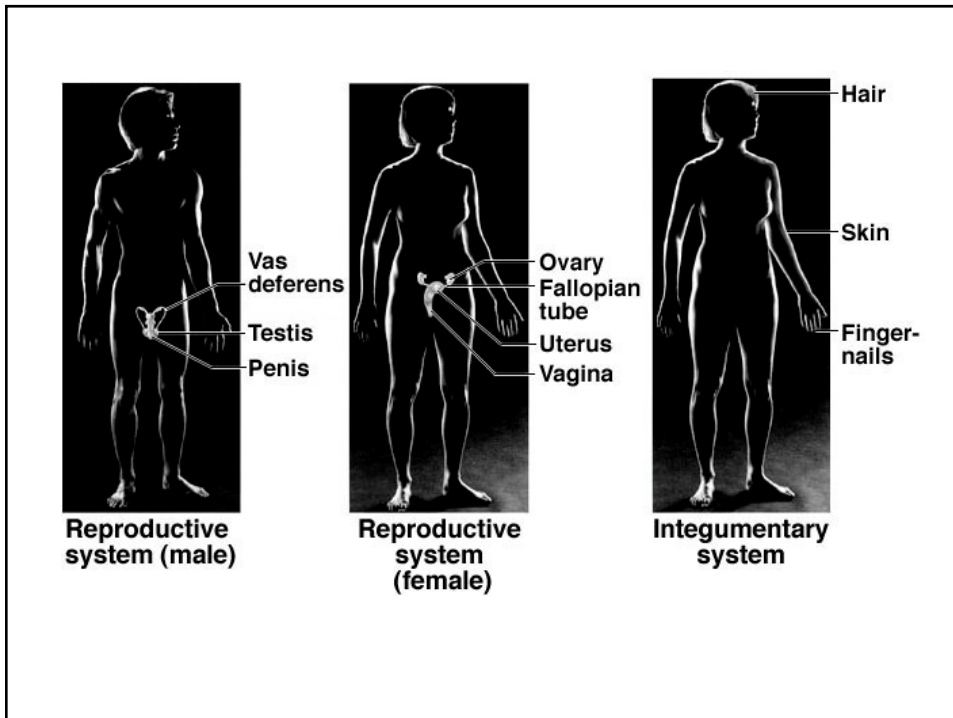
Adrenal gland

Pancreas

Ovary (female)

Testis (male)





## Tissues

### Epithelial Tissue

Covers Every Surface of the Body

Epidermis derived from ectoderm, comprises outer layer of skin

Digestive tract lined with endoderm derived epithelium

Body cavities lined with mesoderm derived epithelium

Functions of epithelial tissues

Provide selective barrier - facilitate or impede passage of materials into underlying tissues

Protect underlying tissue from dehydration and damage

Secrete materials via glands

Characteristics of epithelial layers

Cells bound tightly together, one or a few cells thick

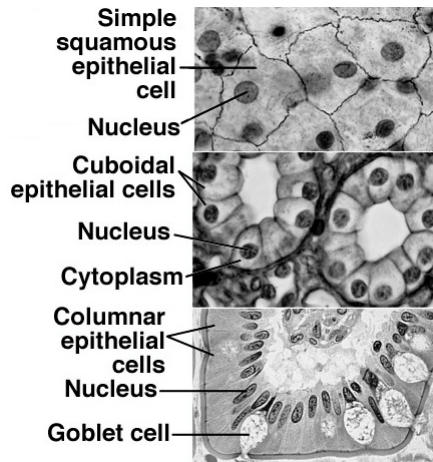
Possess few blood vessels, transport materials via diffusion

Readily regenerated

Two general classes

**Simple** epithelium - one cell layer thick

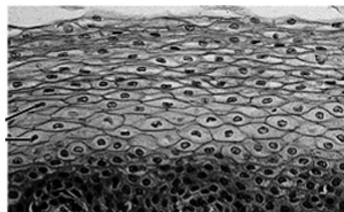
**Stratified** epithelium - more than one cell layer thick



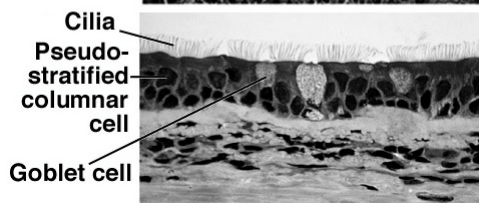
Simple squamous - flat cells with irregular shape - lining of lungs and capillaries

Simple cuboidal: Equal height and width - lining of glands and kidney tubules

Columnar: Height greater than width - lining of digestive and respiratory tracts



Stratified Squamous - skin and lining of mouth



Pseudostratified Columnar - lining of respiratory tract and glands

Glands - derived from invaginated epithelia, produce substances

Exocrine glands - Connected to epithelium by a duct

Product channeled to outside or to body cavity

Endocrine glands - No connection with epithelium, ductless

Secretions called hormones - enter blood at capillaries

## Connective Tissue

Derived from embryonic mesoderm

All connective tissue has widely-spaced cells imbedded in a non-cellular matrix

### Two categories

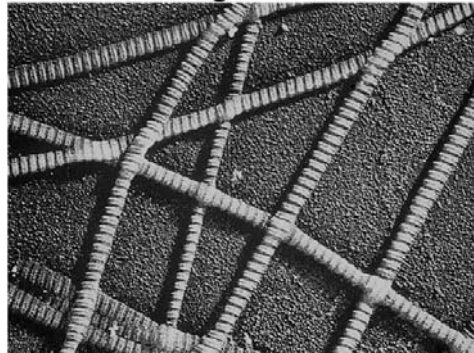
Connective tissue proper: Loose and dense

Special connective tissue: Cartilage, bone, blood

### Loose Connective Tissue

Strengthened by collagen, elastin and/or reticulin fibers  
Fibroblasts secrete collagen and fibrous proteins

### Collagen Fibers



### Cell of loose connective tissue

Mast cells produce histamine and heparin

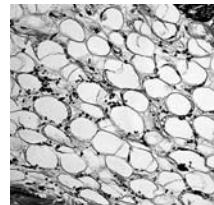
Phagocytic macrophages defend against invading organisms

May contain adipose (fat) cells

Each fat cell stores a droplet of triglycerides

Found under skin, between organs

provides support, insulation, food storage



### Dense Connective Tissue

Contains tightly packed collagen fibers - arranged in a regular or irregular pattern - has few cells

Provides strong and flexible connections and coverings

Regular collagen fibers are lined up in parallel

Tendons bind muscle to bone

Ligaments bind bone to bone



Irregular collagen fibers - nonparallel orientation

Tough coverings of organs - kidneys and adrenal glands

Perimysium covers muscles, perineurium covers nerves,  
periosteum covers bones

### Specialized Connective Tissue

#### Cartilage

Has special ground substance made from a glycoprotein

Collagen fibers laid down along lines of stress

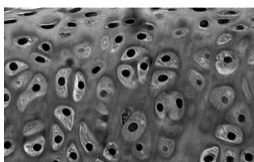
Firm, flexible tissue that is tough and doesn't stretch

Makes up skeleton of jawless fishes, cartilaginous fishes, and parts of skeleton in all other vertebrates

Cells are chondrocytes - have no direct blood supply

Receive oxygen and nutrients by diffusion from vessels in surrounding tissues

Cartilage matrix is not calcified like bone - remains soft



Found at joints, between vertebrae, nose, ears

reduces friction, and absorbs shock

difficult to repair

## Bone

Matrix is collagen fibers hardened with calcium phosphate

Cells are Osteocytes

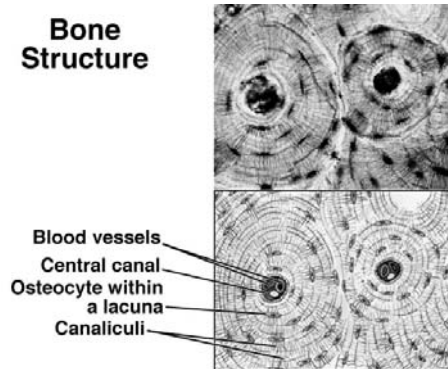
Bone has blood supply through canals, osteocytes have extensions to blood supply in canaliculi (small canals)

Many bones in fetus first modeled in cartilage

Cartilage hardened by calcification, cells die, replaced by bone with living osteocytes

Easily repaired

### Bone Structure



## Blood

Contains fluid matrix - plasma

Cells -

Erythrocytes (red cells) have hemoglobin which carries oxygen

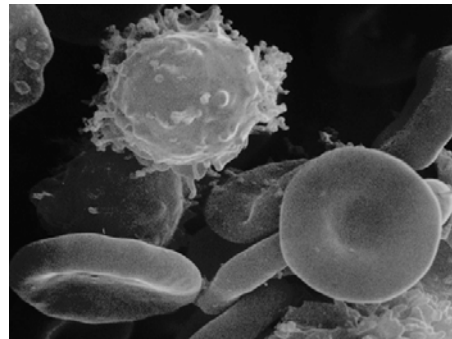
Leukocytes (white cells) lack hemoglobin

Neutrophils, eosinophils, basophils can be stained

Lymphocytes and monocytes have immune functions

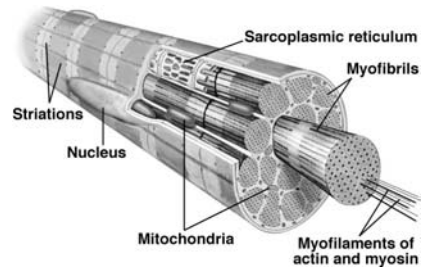
Thrombocytes (platelets) are fragments of a type of bone marrow cell - function in clotting

Blood plasma contains nutrients, metabolic wastes, regulatory molecules, inorganic salts, proteins like fibrinogen and albumin



## Muscle Tissue

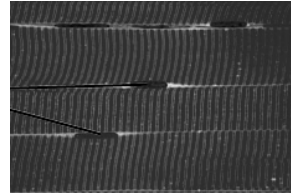
Muscle cells (fibers) have large numbers of actin and myosin filaments, specialized for contraction



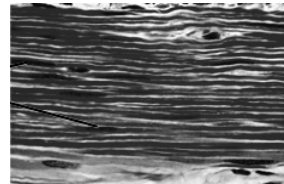
Three types of vertebrate muscle:

Smooth, Skeletal and Cardiac

Skeletal and Cardiac are “striated” muscles have lines running across muscle fibers due to arrangement of actin and myosin



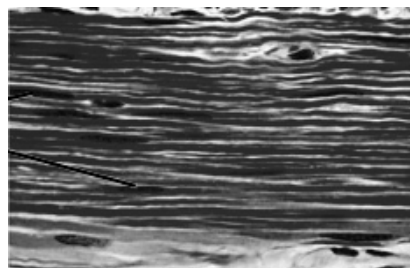
Smooth muscle has more irregular arrangement



Smooth muscle is found throughout animal kingdom

Cells are long and spindle-shaped, each with one nucleus

Cells organized into sheets



Two types of contraction occur in smooth muscle:

All muscles contract as a unit when stimulated by nerve

seen in muscles lining blood vessels, and muscles of iris

Individual cells contract spontaneously (without stimulation)

Causes slow, steady contraction of the tissue

seen in muscles in the walls of the gut

Nerves suppress contractions, do not cause it

## Skeletal Muscle

Attached to bones by tendons, contract and cause bones to move

Numerous parallel muscle cells act in concert

Stronger contractions result when more fibers contract

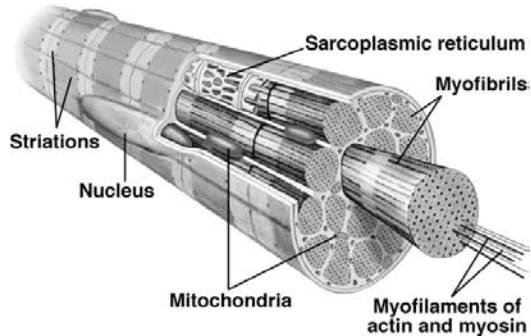
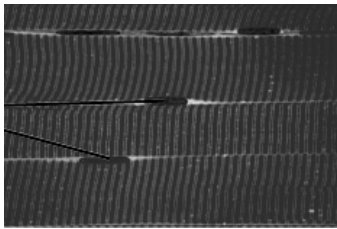
Number involved depends on stimulation by nerves

Contain highly ordered arrays of actin and myosin filaments  
organized in bundles called myofibrils

Fibers are long and are the result of fusion of cells

have multiple nuclei

Each fiber runs the length  
of the entire muscle



## Cardiac Muscle

Vertebrate hearts made of specially arranged striated muscle fibers

Composed of interconnected cells, each with its own nucleus

Interconnections appear as lines called intercalated disks

Lines are regions where cells are linked by gap junctions

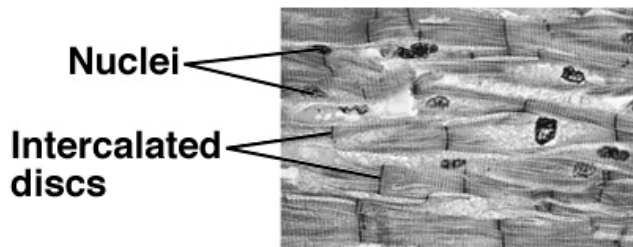
Interconnections allow heart to contract as single unit

Functioning contractile unit is called a myocardium

Certain muscle cells generate spontaneous electrical impulse

Impulses spread across gap junction from cell to cell

All cells in myocardium ultimately contract



## Nerve Tissue

Neurons are cells specialized for transmission of nerve impulses

has three parts: Cell body, dendrites, axon

Cell body contains the nucleus

Dendrites are highly branched protrusions from the cell body

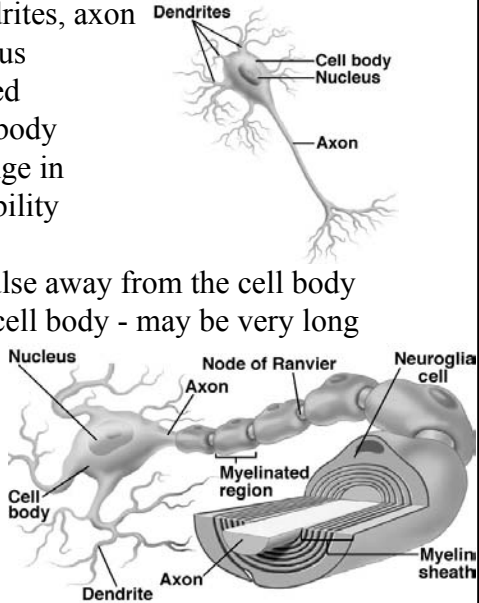
Receive stimulation, change in membrane ion permeability travels to cell body

Axon - transmits nerve impulse away from the cell body

Tubular extension of the cell body - may be very long

Axon may be covered with myelin sheath - "myelinated"

Nodes of Ranvier - regular gaps in myelin sheath



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Table 49.5 Nerve Tissue

	<p><b>SENSORY NEURONS</b></p> <p><i>Typical Location</i> Eyes; ears; surface of skin</p> <p><i>Function</i> Receive information about body's condition and external environment; send impulses from sensory receptors to CNS</p> <p><i>Characteristic Cell Types</i> Rods and cones; muscle stretch receptors</p>
	<p><b>MOTOR NEURONS</b></p> <p><i>Typical Location</i> Brain and spinal cord</p> <p><i>Function</i> Stimulate muscles and glands; conduct impulses out of CNS toward muscles and glands</p> <p><i>Characteristic Cell Types</i> Motor neurons</p>
	<p><b>ASSOCIATION NEURONS</b></p> <p><i>Typical Location</i> Brain and spinal cord</p> <p><i>Function</i> Integrate information; conduct impulses between neurons within CNS</p> <p><i>Characteristic Cell Types</i> Association neurons</p>

Nerves Are Bundles of Axon Fibers - many cells make a nerve

Central nervous system (CNS): Include brain and spinal cord

Peripheral nervous system (PNS): Include nerves and ganglia