# Nervous System

# Objectives:

- By the end of this lecture, student should understand Structural Classification of the Nervous System

# Nervous System

- Master controller and communicating system in the body

- It signals the body through **electrical impulses** that communicate with the body cells.

- Its signaling and responding abilities are highly specific and rapid.
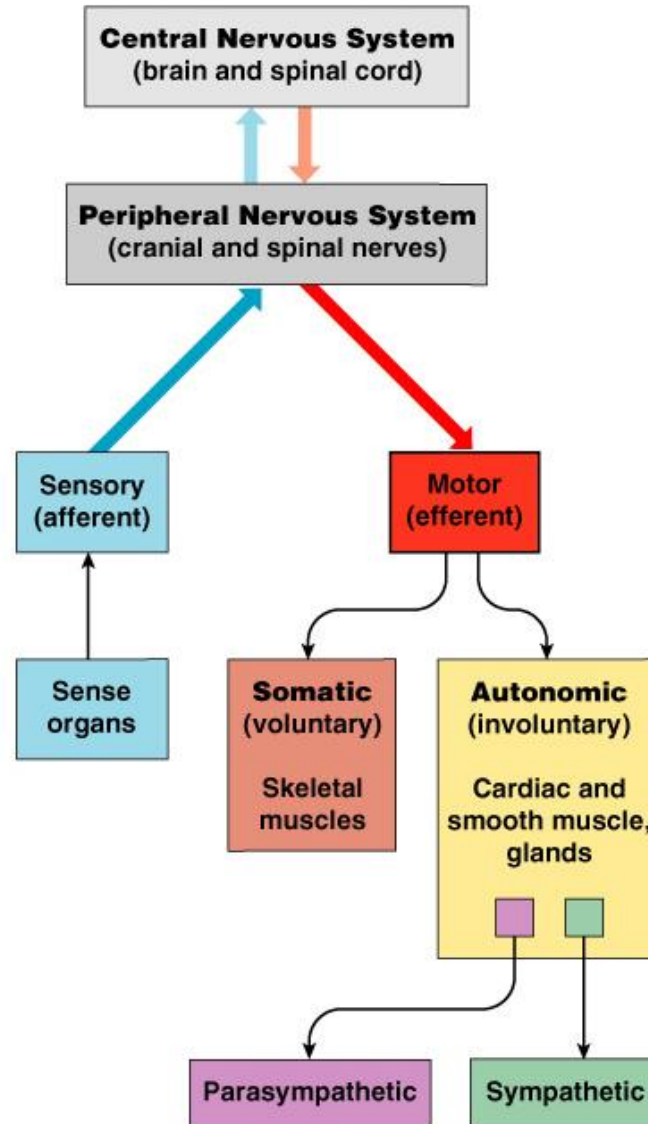
# Structural Classification of the Nervous System

❖ Central nervous system (CNS)
- Brain
- Spinal cord

❖ Peripheral nervous system (PNS)
- Nerve outside the brain and spinal cord

# Organization of the Nervous

# Nervous Tissue

- Comprise of 2 types of cells:
  - Neuroglia = supporting cells
    - The insulators, adhesive, protectors and nourishers
  - Neurons = nerve cells that transmit impulses

# Nervous Tissue: Support Cells (Neuroglia)

- **Astrocytes**
  - Abundant, star-shaped cells
  - Brace neurons
  - Form barrier between capillaries and neurons
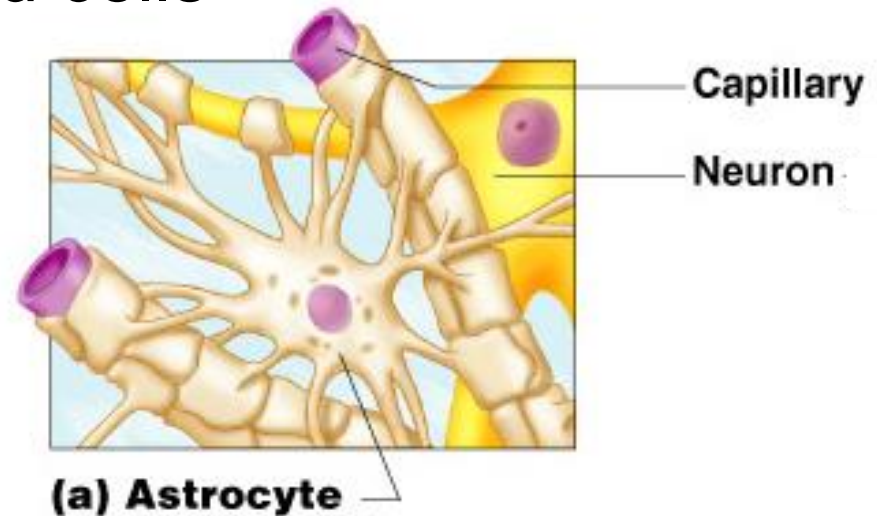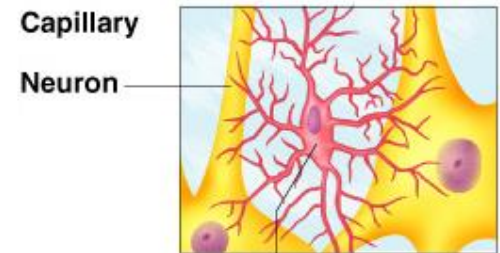  - Control the chemical environment of the brain
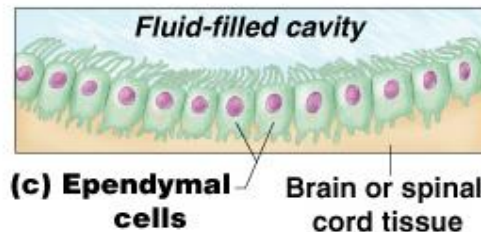
Capillary

Neuron

(a) Astrocyte

**Figure 7.3a**

# Nervous Tissue: Support Cells

- **Microglia**
  - Spider-like phagocytes
  - Dispose of debris
- **Ependymal cells**
  - Line cavities of the brain and spinal cord
  - Circulate cerebrospinal fluid

Capillary

Neuron

(b) Microglial cell

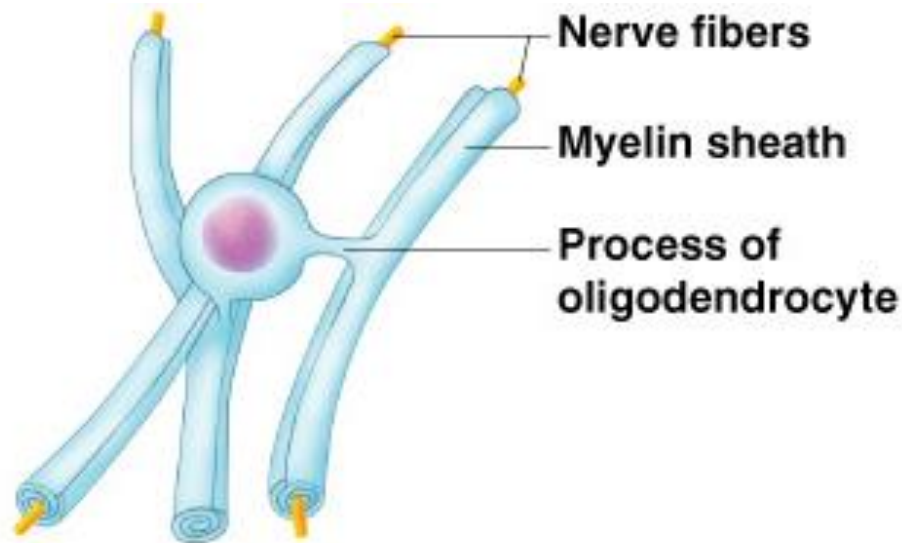Fluid-filled cavity

(c) Ependymal cells

Brain or spinal cord tissue

**Figure 7.3b–c**

# Nervous Tissue: Support Cells

- **Oligodendrocytes**
  - Produce myelin sheath around nerve fibers in the central nervous system

Nerve fibers

Myelin sheath

Process of oligodendrocyte

(d) Oligodendrocyte

Figure 7.3d

# Nervous Tissue: Support Cells

- **Satellite cells**
  - Protect neuron cell bodies

- **Schwann cells**
  - Form myelin sheath in the peripheral nervous system

Schwann cells (forming myelin sheath)

Cell body of neuron

Satellite cells

Nerve fiber (shown in longitudinal section)
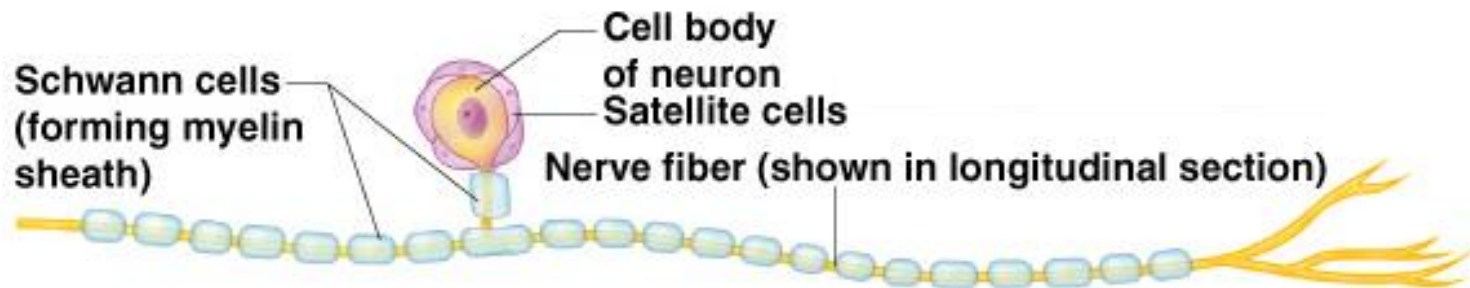
**(e) Sensory neuron with Schwann cells and satellite cells**

**Figure 7.3e**

# Nervous Tissue: Neurons

- **Neurons = nerve cells**
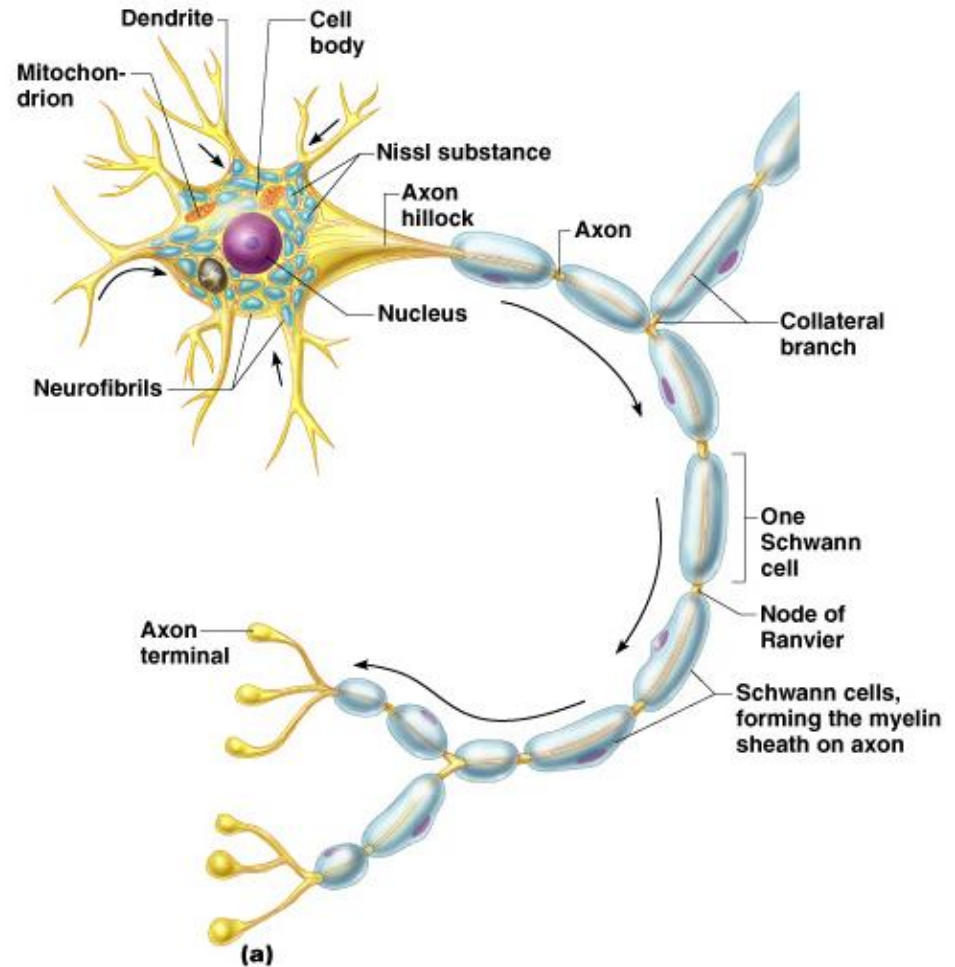  - Cells specialized to transmit messages
  - Major regions of neurons
    - Cell body – nucleus and metabolic center of the cell
    - Processes – fibers that extend from the cell body

# Neuron Anatomy

- **Cell body**
  - Nissl substance – specialized rough endoplasmic reticulum
  - Neurofibrils – intermediate cytoskeleton that maintains cell shape

# Neuron Anatomy

- **Extensions outside the cell body**

  – Dendrites – conduct impulses toward the cell body

  – Axons – conduct impulses away from the cell body
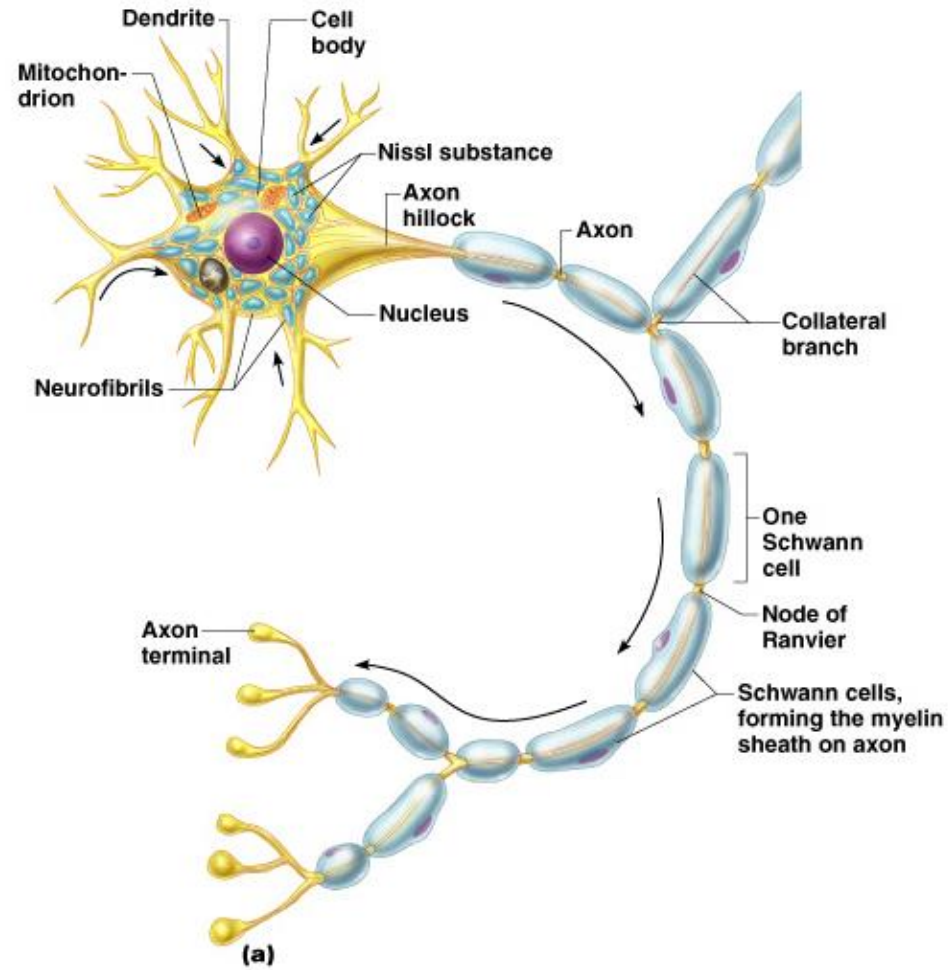


Figure 7.4a

# Structural Classification of Neurons

- Multipolar neurons – many extensions from the cell body
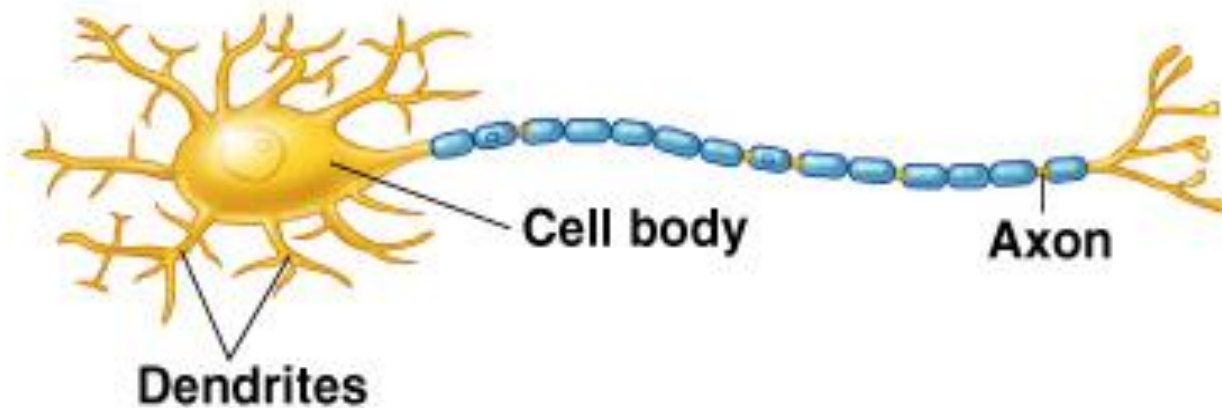


(a) Multipolar neuron

Figure 7.8a

# Structural Classification of Neurons

- Bipolar neurons – one axon and one dendrite



(b) Bipolar neuron

Figure 7.8b

# Structural Classification of Neurons

- Unipolar neurons – have a short single process leaving the cell body



(c) Unipolar neuron

Figure 7.8c
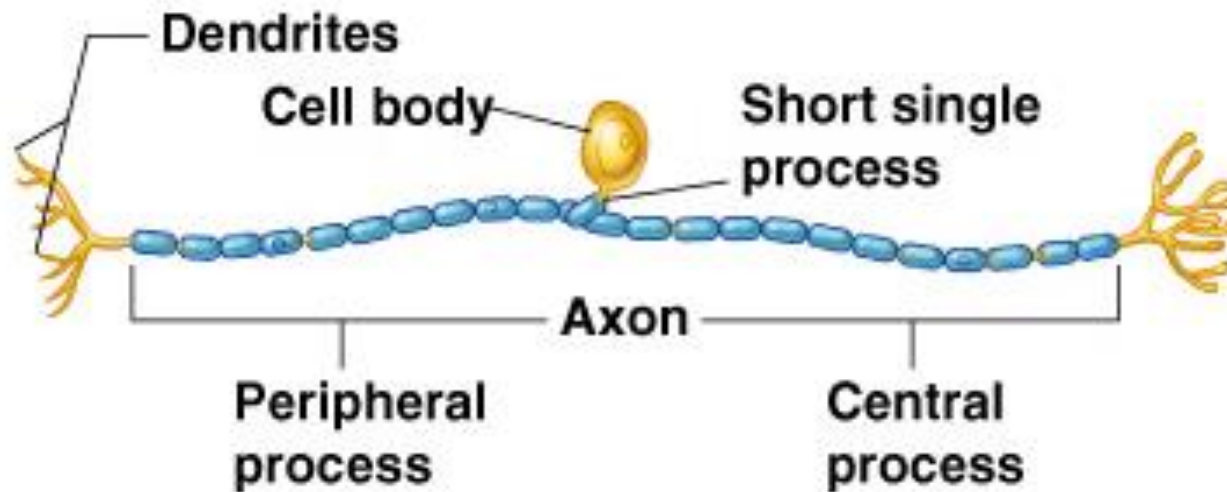
# Regions of the Brain

- Cerebral hemispheres
- Diencephalon
- Brain stem
- Cerebellum



(b) Adult brain

Cerebral hemisphere
Diencephalon
Cerebellum
Brain stem
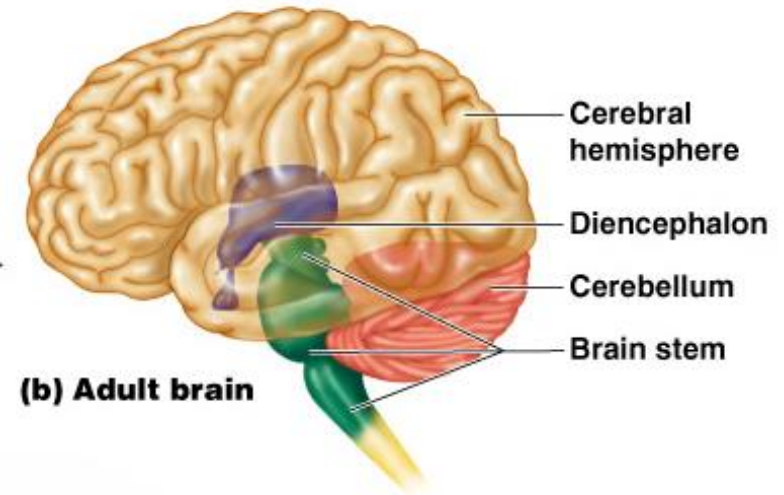
**Figure 7.12b**

# Cerebral Hemispheres (Cerebrum)

- Paired (left and right) superior parts of the brain

- Include more than half of the brain mass

- The surface is made of ridges (gyri) and grooves (sulci)
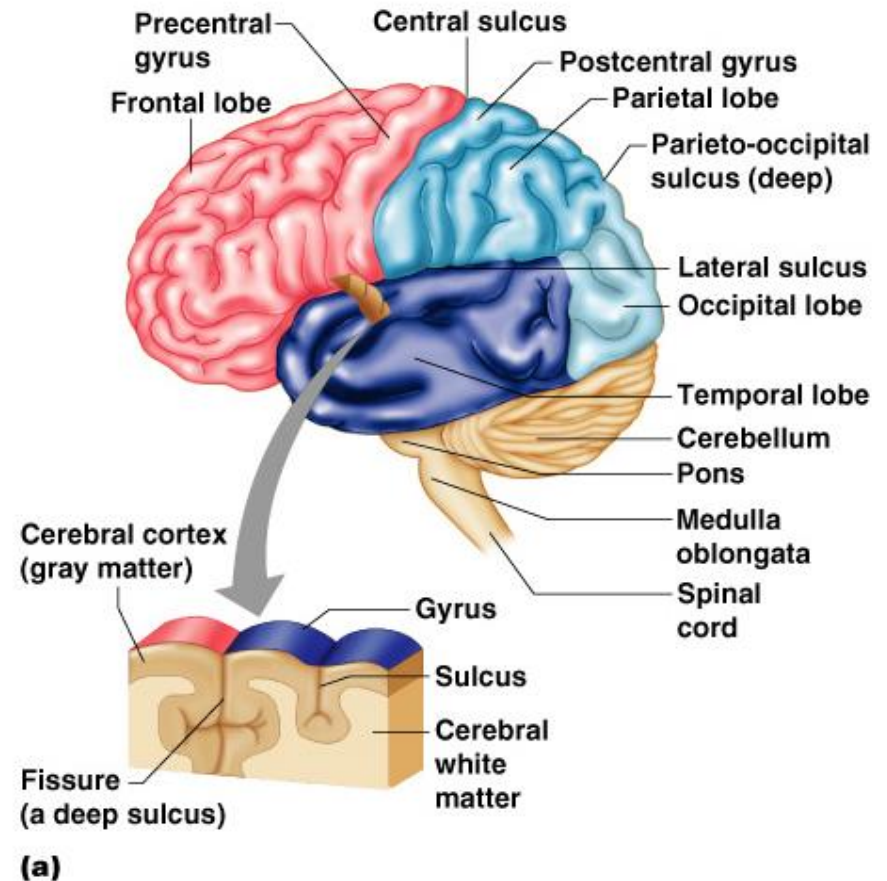


Figure 7.13a

# Lobes of the Cerebrum

- Fissures (deep grooves) divide the cerebrum into lobes

- Surface lobes of the cerebrum
  - Frontal lobe
  - Parietal lobe
  - Occipital lobe
  - Temporal lobe

# Lobes of the Cerebrum



Third ventricle

Intermediate mass of thalamus

Frontal lobe of cerebral hemisphere

Anterior commissure

Hypothalamus

Optic chiasma

Pituitary gland

Temporal lobe of cerebral hemisphere

Mammillary body

Pons

Medulla oblongata

Spinal cord

Parietal lobe of cerebral hemisphere

Corpus callosum

Choroid plexus of third ventricle

Occipital lobe of cerebral hemisphere

Thalamus (encloses third ventricle)

Pineal body (part of epithalamus)

Corpora quadrigemina

Cerebral aqueduct

Midbrain

Cerebral peduncle of midbrain

Fourth ventricle

Choroid plexus

Cerebellum

(a)

# Diencephalon

- Sits on top of the brain stem
- Enclosed by the cerebral heispheres
- Made of three parts
  - Thalamus
  - Hypothalamus
  - Epithalamus

# Diencephalon



**Third ventricle**

**Intermediate mass of thalamus**

**Frontal lobe of cerebral hemisphere**

**Anterior commissure**

**Hypothalamus**

**Optic chiasma**

**Pituitary gland**

**Temporal lobe of cerebral hemisphere**

**Mammillary body**

**Pons**

**Medulla oblongata**
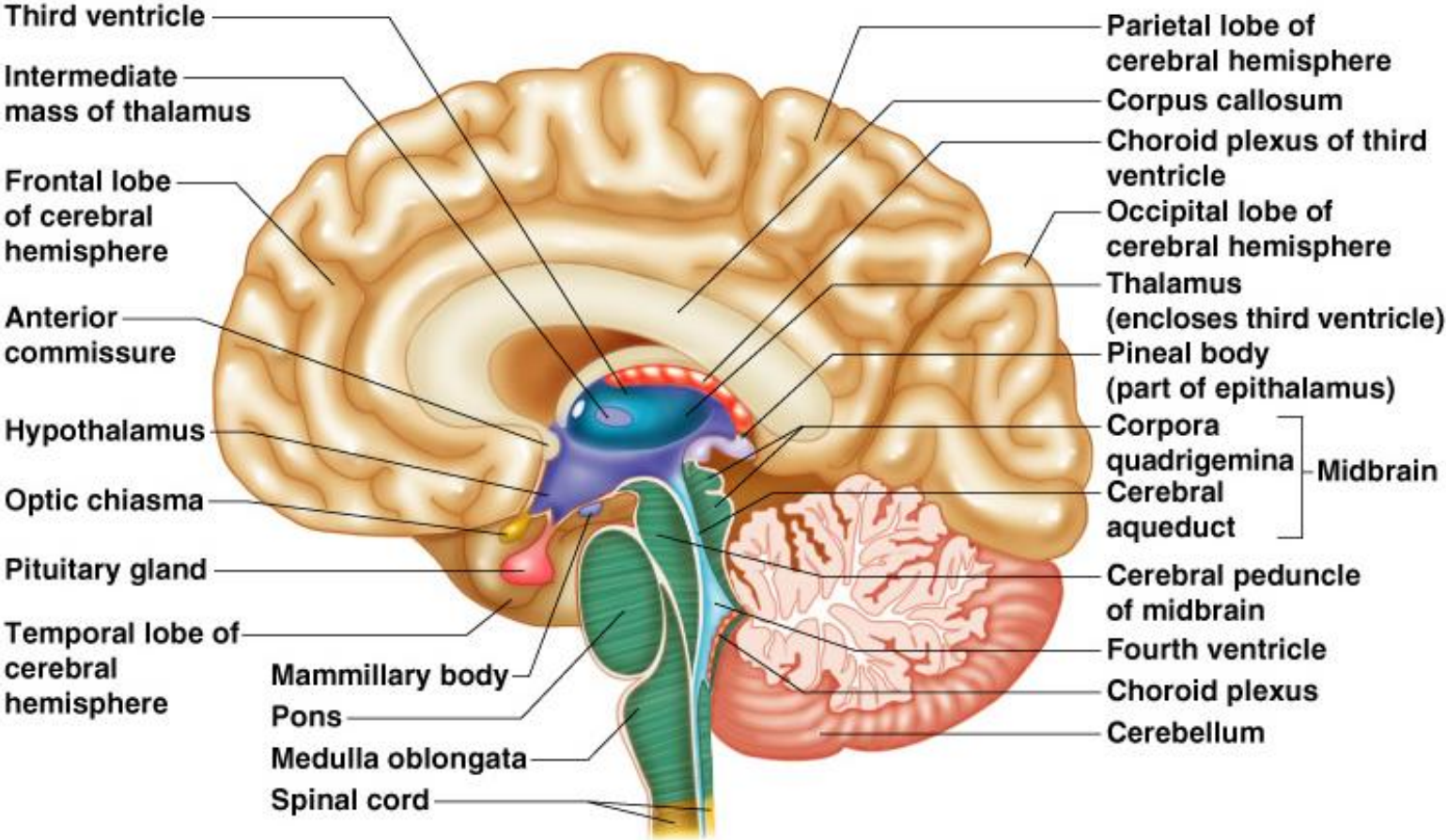
**Spinal cord**

**Parietal lobe of cerebral hemisphere**

**Corpus callosum**

**Choroid plexus of third ventricle**

**Occipital lobe of cerebral hemisphere**

**Thalamus (encloses third ventricle)**

**Pineal body (part of epithalamus)**

**Corpora quadrigemina** — **Midbrain**

**Cerebral aqueduct**

**Cerebral peduncle of midbrain**

**Fourth ventricle**

**Choroid plexus**

**Cerebellum**

(a)

# Thalamus

- Surrounds the third ventricle
- The relay station for sensory impulses
- Transfers impulses to the correct part of the cortex for localization and interpretation

# Hypothalamus

- Under the thalamus
- Important autonomic nervous system center
  - Helps regulate body temperature
  - Controls water balance
  - Regulates metabolism
- An important part of the limbic system (emotions)
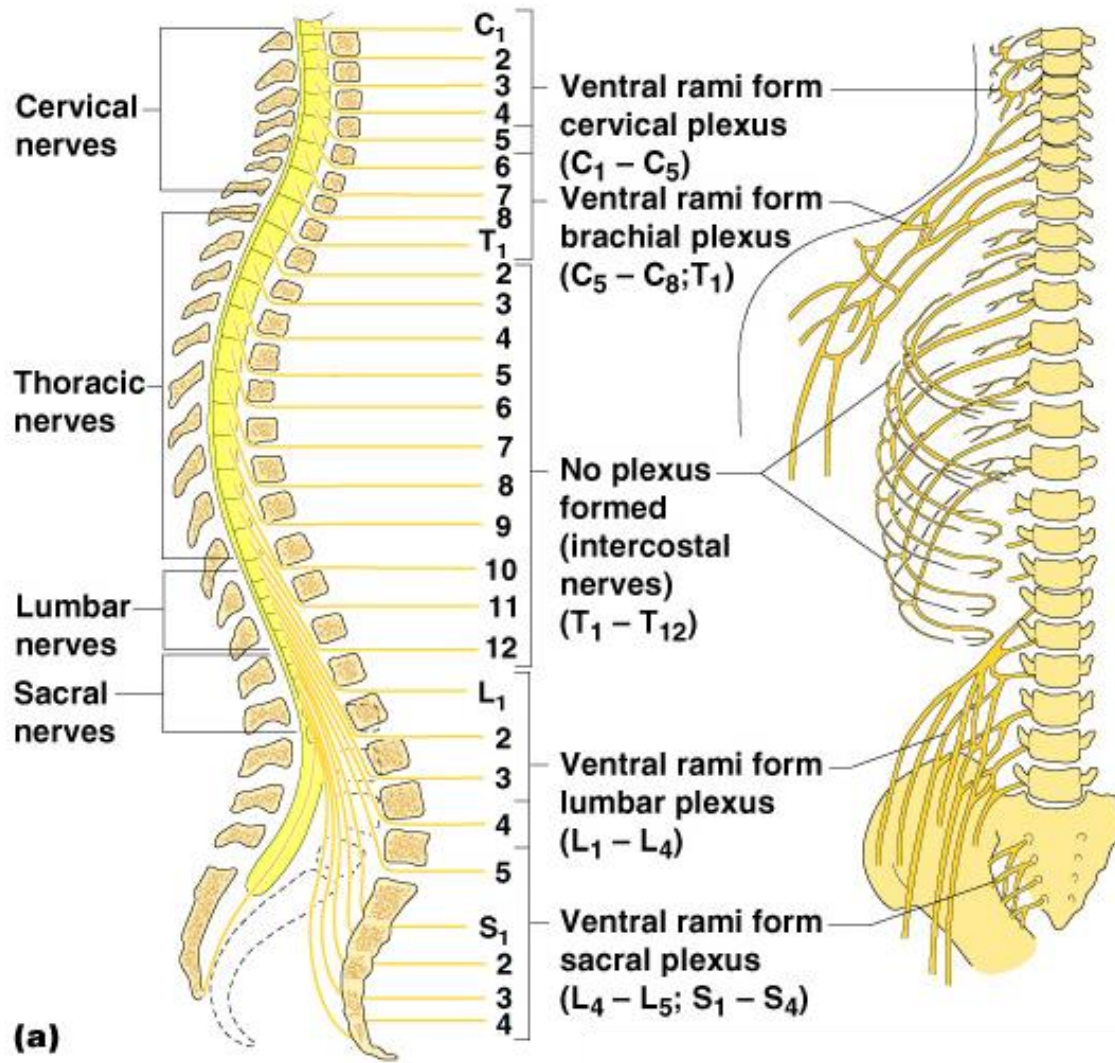- The pituitary gland is attached to the hypothalamus

# Epithalamus

- Forms the roof of the third ventricle
- Houses the pineal body (an endocrine gland)
- Includes the choroid plexus – forms cerebrospinal fluid

# Spinal Nerves

- There is a pair of spinal nerves at the level of each vertebrae for a total of 31 pairs
- Spinal nerves are formed by the combination of the ventral and dorsal roots of the spinal cord
- Spinal nerves are named for the region from which they arise

# Spinal Nerves



Cervical nerves

Thoracic nerves

Lumbar nerves

Sacral nerves

$C_1$
2
3
4
5
6
7
8
$T_1$
2
3
4
5
6
7
8
9
10
11
12
$L_1$
2
3
4
5
$S_1$
2
3
4

Ventral rami form cervical plexus ($C_1 - C_5$)

Ventral rami form brachial plexus ($C_5 - C_8$; $T_1$)

No plexus formed (intercostal nerves) ($T_1 - T_{12}$)

Ventral rami form lumbar plexus ($L_1 - L_4$)

Ventral rami form sacral plexus ($L_4 - L_5$; $S_1 - S_4$)

(a)

# Anatomy of Spinal Nerves

- Spinal nerves divide soon after leaving the spinal cord

  - Dorsal rami – serve the skin and muscles of the posterior trunk

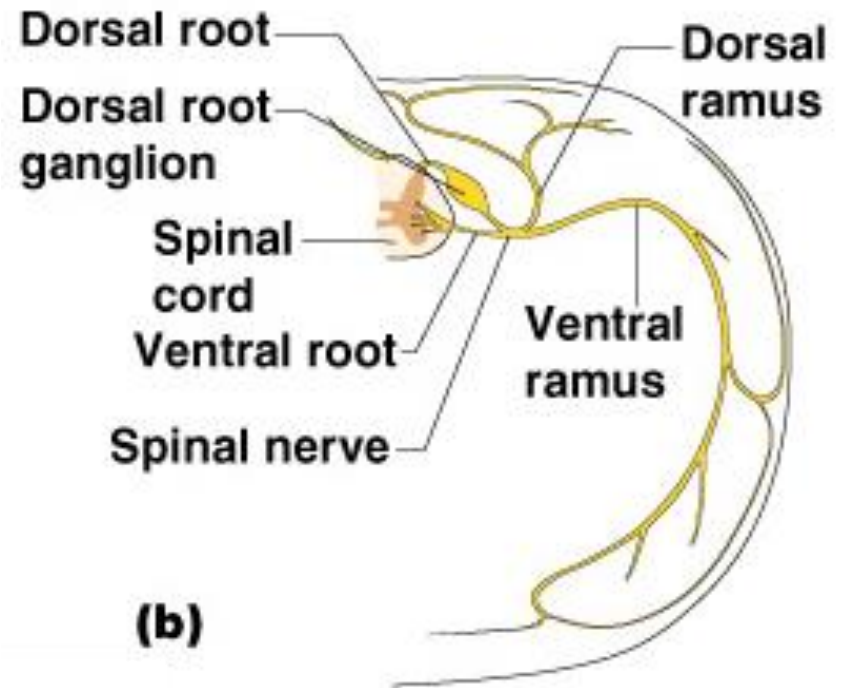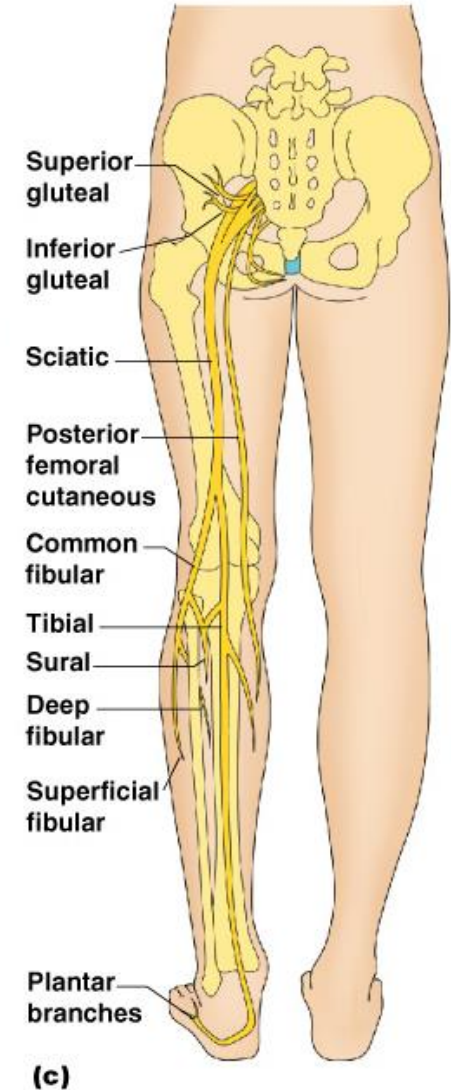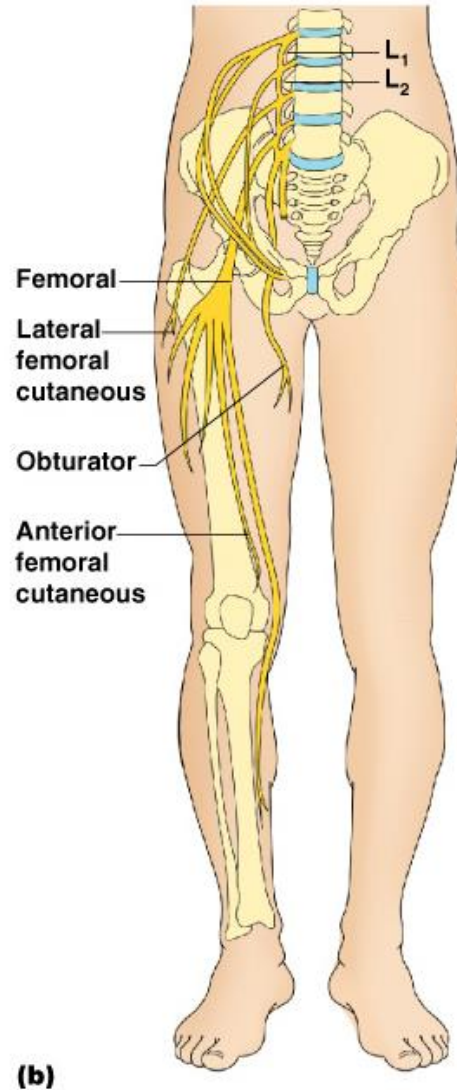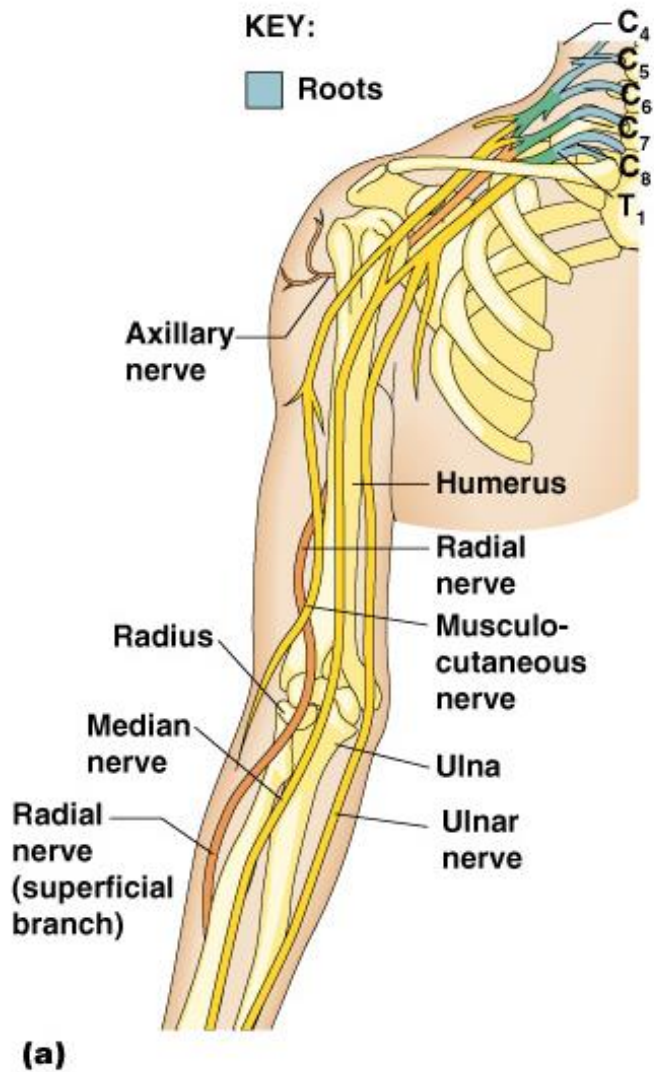  - Ventral rami – forms a complex of networks (plexus) for the anterior



Dorsal root

Dorsal root ganglion

Spinal cord

Ventral root

Spinal nerve

Dorsal ramus

Ventral ramus

(b)

**Figure 7.22b**

# Examples of Nerve Distribution



(a)

KEY:
Roots

C$_4$
C$_5$
C$_6$
C$_7$
C$_8$
T$_1$

Axillary nerve

Humerus

Radial nerve

Musculo-cutaneous nerve

Radius

Median nerve

Ulna

Ulnar nerve

Radial nerve (superficial branch)

(b)

L$_1$
L$_2$

Femoral

Lateral femoral cutaneous

Obturator

Anterior femoral cutaneous

(c)

Superior gluteal

Inferior gluteal

Sciatic

Posterior femoral cutaneous

Common fibular

Tibial

Sural

Deep fibular

Superficial fibular

Plantar branches

- THANKS