Two Parts of the Nervous System

- Central Nervous System (CNS)
  - Brain and Spinal Cord

- Peripheral Nervous System (PNS)
  - Nervous tissue outside brain and spine
  - Sense organs

Peripheral Nervous System

- **Somatic nervous system** – part of PNS that controls voluntary functions
  - Movement, controls skeletal muscles

- **Autonomic nervous system** – part of PNS that control involuntary functions
  - Controls cardiac and smooth muscles, and glands

Outline

I. Central Nervous System vs Peripheral Nervous System

II. Peripheral Nervous System
   A. Autonomic Nervous Systems
   B. Somatic Nervous Systems

III. Autonomic Nervous System
   A. Parasympathetic Nervous Systems
   B. Sympathetic Nervous Systems

IV. Reflex Actions

V. Central Nervous System
   A. Protection of CNS
   B. Spinal Cord
   C. Brain

Figure 8.1 The nervous system
Autonomic Nervous System

- Autonomic Nervous System is divided into two systems:
  - **Parasympathetic division** – “rest and digest”
  - **Sympathetic division** – stimulatory stress responses (flight or fight responses)

Parasympathetic – rest and digest

- Constricts eye pupils
- Stimulate salivation
- Slows heart rate
- Constricts breathing
- Dilates blood vessels
- Stimulates digestion
- Constricts bladder
- Stimulates sex organs

Sympathetic – fight or flight

- dilates eye pupils
- Inhibits salivation
- Accelerates heart rate
- Facilitates breathing
- Stimulates secretion of epinephrine and norepinephrine
- Stimulates release of free glucose
- Inhibits digestion
- Relaxes bladder
- Inhibits sex organs

Reflex Actions

- Sometime we need a really quick response – reacting to a hot stove. We may not have time to send the message up to the brain to process the information.

- The spinal cord can process the information and send a response back to the motor nerves
Reflex Arc

- The pathway consisting of a sensory receptor, a sensory neuron, interneurons, a motor neuron and an effector (muscle)

Central Nervous System

- Brain
- Spinal cord

Protection of the CNS

- The CNS is protected by:
  1. Bone (skull and vertebral column)
  2. Meninges
  3. Cerebrospinal fluid
  4. Blood-Brain barrier

Meninges

- There are three layers of the meninges:
  1. Dura mater – outer layer
  2. Arachnoid mater – middle layer
  3. Pia mater – inner layer

Meningitis

- Meningitis - Inflammation of the meninges
- It is caused by many forms of bacteria and viruses
- It can lead to encephalitis, an inflammation of the brain.
Function of Cerebrospinal Fluid

- Functions
  1. Shock absorption
  2. Support the weight of the brain
  3. Nourishment and waste removal

Blood-brain barrier

- Permits certain substances to enter the brain, while inhibiting others from entering
- It inhibits many drugs that are not lipid soluble from reaching brain tissue

Protection of the CNS

The bones of the skull and vertebral column act as a rigid protective case for the brain and spinal cord.

Cerebrospinal fluid cushions the brain and spinal cord.

The meninges are three membranes that protect the brain and spinal cord.

Spinal Cord

- Spinal cord extends from the base of the brain down the back – transmits messages between the brain and the rest of the body
- There is cerebrospinal fluid in a central canal

If you look at a cross section of the spinal cord you will see “white matter” and “grey matter”

- The white matter is myelinated axons
- Grey matter is mainly cell bodies and non-myelinated axons
The Brain

- Cerebrum
  - Cerebral cortex
  - Hippocampus
  - Amygdala
  - Hypothalamus
  - Thalamus
  - Cerebellum
- Brain stem – midbrain, pons, medulla oblongata
  - (Pineal gland and Pituitary gland is in the brain but it is part of the endocrine system)

The Brain

- The Brain is the control center
- The cerebral cortex of the cerebrum is the thinking, conscious part of the brain

Cerebrum

- Contains sensory areas for skin senses, vision, hearing, olfaction
- Motor areas for voluntary movement
- Association areas for interpreting sensations, language, decision making, self-awareness, creativity, and storage of memories

The Brain

- Corpus callosum: Allows left and right cerebral hemispheres to communicate with one another

Spinal Cord

- White matter
- Gray matter
- Dorsal root
- Dorsal-root ganglion
- Ventral root
- Pair of spinal nerves

(a) View from front of body

Figure 8.11a

Figure 8.3 (2 of 2)
Cerebrum

- Contains:
  - Cerebral cortex
  - Hippocampus
  - Amygdala

Cerebrum

- Functions as the sensory area for touch, vision, hearing, and olfaction as well as association areas for interpreting sensations, language, thinking, decision making, self-awareness, creativity, and storing memories.

Cerebrum – Cerebral cortex

- **Cerebral cortex** - The thin outer layer of the cerebrum is where most of the higher thinking and processing takes place.
  - Contains sensory areas
  - Prefrontal region of the cerebral cortex is responsible for decision making
  - Folding increases surface area

Cerebrum – Corpus callosum

- Beneath the cortex is white matter
  - **Corpus callosum** – band of white matter that connects the two cerebral hemispheres

Cerebrum – cerebral cortex

<table>
<thead>
<tr>
<th>Longitudinal fissure</th>
<th>Left hemisphere</th>
<th>Right hemisphere</th>
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Cerebrum

- The corpus callosum is a band of white matter that allows communication between the cerebral hemispheres.
- Gray matter consists of interneurons, cell bodies, and unmyelinated axons that integrate information.
- White matter consists of myelinated axons that allow communication over long distances.
Cerebrum

- **Hippocampus** – important in long term memory
- **Amygdala** – important in remembering fear and responding to it.

Memory

- **Thalamus** – Processes sensory information (except smell) and relays it to other areas of brain

Hypothalamus

- **Functions of hypothalamus:**
  1. maintains homeostasis: Controls heart rate, blood pressure, breathing rate, body temperature
  2. regulates drives including hunger,
  3. controls the pituitary gland

The Brain

- **Thalamus**
  - Processes all sensory information (except smell)
  - Relays information to appropriate higher brain centers
- **Hypothalamus**
  - Controls heart rate, blood pressure, breathing rate, body temperature, body weight
  - Temperature regulator
  - Conserves water (secondary source of drinking water)
  - Controls body rhythms
  - Serves as “master biological clock”
### Cerebellum

- **Cerebellum** – maintains balance and coordination, refines motor skills, new motor skills (playing piano)

### Brain Stem

- Contains:
  - Medulla oblongata
  - Midbrain
  - Pons

### Brain Stem – Medulla oblongata

- **Medulla oblongata** – controls many vital involuntary functions including breathing, heartbeat and blood pressure

### Brain Stem - Pons

- Function of the pons:
  - Assists the medulla oblongata to control involuntary breathing
  - Relays messages between the spinal cord and the cerebellum with the cerebrum, thalamus, and hypothalamus
Brain Stem - Midbrain

- **Functions of Midbrain**
  - Important in voluntary muscle control
  - Relay station for auditory and visual information
  - Relays information between the cerebellum or spinal cord and the cerebrum
  - Controls eye movement

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The Brain

- Medulla oblongata
  - Contains autonomic centers for heart rate and digestive activities
  - Relays sensory information to thalamus
- Pons
  - A bridge between higher and lower brain centers
- Midbrain
  - Relays information between the cerebellum or spinal cord and the cerebrum
  - Integrates sensory input
  - Controls eye movement

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Glands

- Pituitary gland and pineal glands are part of the brain but will be covered in the endocrine system

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Important Concepts

- Read Chapter 9
- What are the somatic nervous system and autonomic nervous system, what do they control?
- What are reflex actions?
- What are the Parasympathetic division and the Sympathetic division – what specifically do they control (increase heart rate, etc)

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Important Concepts

- What protects the CNS
- What are the three layers of the meninges, be able to describe them and their location (which is the inner, middle or outer layer.
- What is meningitis, what is the cause, what is encephalitis
- What are the functions of cerebrospinal fluid
- What is the function of the blood-brain barriers, what does it allow to pass?
### Important Concepts
- Major regions of the brain and their functions: Cerebrum (including the cerebral cortex, hippocampus, and amygdala), Hypothalamus, Thalamus, Cerebellum, Brain stem (including the midbrain, pons, and medulla oblongata).
- What parts of the brain are in the cerebrum and in the brain stem?
- What is the corpus callosum and what is its function?

### Definitions
- Long term memory, somatic nervous system, autonomic nervous system, voluntary, involuntary, reflex arc, constrict, dilate, inhibits, accelerates, facilitates, stimulates, relaxes, white matter, grey matter, prefrontal region,