Chapter 6: Control and Coordination

Introduction

- All living organisms respond to changes in their environment.
- The responses need coordination between different organs and systems.
- Multicellular organisms have complex systems for control and coordination.

$\hfill\square$ I. Control and Coordination in Animals

A. The Nervous System

♦ Basic Structure

- Made of **neurons** (nerve cells).
- Neurons transmit information via electrical impulses.

◆ Parts of a Neuron

- 1. **Dendrites** receive signals.
- 2. Cell body (cyton) processes signals.
- 3. Axon carries impulse away.
- 4. Axon terminals pass signal to next cell via synapse.

♦ Types of Neurons

- Sensory Neurons carry information from sense organs to brain/spinal cord.
- Motor Neurons carry commands from brain/spinal cord to muscles/glands.
- **Relay Neurons** connect sensory and motor neurons (in spinal cord and brain).

◆ Transmission of Nerve Impulse

- Electrical impulse travels along axon \rightarrow reaches axon terminal.
- **Synapse**: the gap between two neurons.
- Neurotransmitters cross the synapse to pass signal.

B. Human Nervous System

Divisions

- 1. Central Nervous System (CNS)
 - Brain and Spinal Cord
- 2. Peripheral Nervous System (PNS)

• Nerves that connect CNS to rest of the body.

Human Nervous System

The **nervous system** in humans is a complex network that controls and coordinates all activities of the body — from simple reflexes to thinking and emotions.

♦ Main Parts of the Nervous System:

1. Central Nervous System (CNS)

- It is the **main control center** of the body.
- Comprises:
 - o **Brain**
 - \circ Spinal Cord

♦ A. Brain

- Protected by the **skull** and cushioned by **cerebrospinal fluid**.
- Divided into three main parts:

Part	Function	
Cerebrum	Largest part, controls voluntary actions, intelligence, memory, language, emotions.	
Cerebellum	Controls balance and coordination of muscle movements.	
Medulla Oblongata	Controls involuntary activities like breathing, heartbeat, and digestion.	
Hypothalamus	Regulates body temperature, hunger, thirst, and emotions.	

♦ B. Spinal Cord

- A long, thick bundle of nerves running through the vertebral column.
- Connects the brain to the rest of the body.
- Controls reflex actions and passes messages between the brain and body.

2. Peripheral Nervous System (PNS)

- Made up of nerves that connect the CNS to body parts (muscles, glands, organs).
- Includes:

- Cranial nerves (from brain)
- **Spinal nerves** (from spinal cord)
- ♦ Divisions:
 - Somatic Nervous System: Controls voluntary activities (e.g., moving your hand).
 - Autonomic Nervous System: Controls involuntary activities (e.g., heartbeat, digestion).

3. Autonomic Nervous System (ANS)

- A part of the PNS that works **automatically**, without our conscious effort.
- Divided into:
 - **Sympathetic Nervous System** "Fight or Flight" response (prepares the body for emergencies).
 - **Parasympathetic Nervous System** "Rest and Digest" (brings body back to normal after stress).

Solution Flow of Information

 $Stimulus \rightarrow Receptor \rightarrow Sensory \ Neuron \rightarrow Spinal \ Cord/Brain \rightarrow Motor \ Neuron \rightarrow Effector \ (Muscle/Gland)$

C Reflex Action (Quick Response)

- An automatic, fast reaction to a stimulus without brain involvement.
- Example: Pulling hand away from a hot object.

★ Functions of the Nervous System

- 1. Controls all voluntary and involuntary activities.
- 2. Maintains coordination between body parts.
- 3. Helps in thinking, learning, emotions, and memory.
- 4. Works with the **endocrine system** for internal balance (homeostasis).

How the Human Nervous System Works (Step-by-Step)

The nervous system **collects information**, **processes it**, and **sends instructions** to the body. It works like a messaging system using **electrical impulses** and **chemical signals**.

™ Step-by-Step Process

◆ 1. Receiving the Stimulus

- A stimulus is any change in the environment (e.g., touching something hot).
- Sense organs like skin, eyes, nose, etc., have receptors that detect the stimulus.

(F Example: Your skin feels heat.)

◆ 2. Sensory Neuron Sends Message

• The **sensory neuron** carries the message from the receptor to the **spinal cord** or **brain**.

G Signal: "Hot object touched!"

♦ 3. Processing in Brain or Spinal Cord

- The central nervous system (CNS) processes the information.
- It **decides** what to do (e.g., move the hand away).

(F Decision made: "Pull hand back!"

◆ 4. Motor Neuron Sends Command

• A motor neuron carries the command from the brain/spinal cord to muscles or glands (effectors).

G Command: "Move hand!"

♦ 5. Muscles React

• Muscles act upon the signal and move your hand away from the hot object.

Example in Real Life:

- **Stimulus**: You touch a hot pan.
- **Receptors**: Skin senses the heat.
- Sensory neuron: Sends message to spinal cord.
- Spinal cord (via reflex arc): Immediately sends signal via motor neuron.
- Muscles: Contract and pull your hand back even before your brain feels the pain!

Summary:

Step	Action
1	Stimulus detected
2	Message sent via sensory neuron
3	Brain/spinal cord processes it
4	Motor neuron sends response
5	Effector (muscle) acts

C. The Brain

Part	Function	
Cerebrum	Largest part; controls voluntary actions, thinking, memory, emotions.	
Cerebellum	Coordinates muscle movements and balance.	
Medulla Oblongata	Controls involuntary actions like heartbeat, breathing.	
Hypothalamus	Regulates body temperature, hunger, thirst, emotions.	

 \rightarrow \Box The brain is protected by the **skull** and **cerebrospinal fluid**.

D. Reflex Action and Reflex Arc

- **Reflex Action**: Quick, automatic response to a stimulus (e.g., pulling hand away from hot object).
- **Reflex Arc**: Pathway followed by the nerve impulse during a reflex.

Pathway:

Stimulus \rightarrow Receptor \rightarrow Sensory Neuron \rightarrow Spinal Cord (Relay Neuron) \rightarrow Motor Neuron \rightarrow Effector (muscle)

□ **Example**: Touching a hot plate – hand pulls back instantly.

7 II. Control and Coordination in Plants

Unlike animals, **plants do not have a nervous system**. Instead, they use **chemical coordination**.

A. Types of Movements

- Tropic Movements (directional)
 - Movement in response to **external stimuli**.
 - Types:
 - **Phototropism** towards light (shoots).
 - Geotropism response to gravity (roots grow down).
 - **Hydrotropism** towards water.
 - **Thigmotropism** response to touch (tendrils).
 - **Chemotropism** response to chemicals (pollen tube grows toward ovule).
- ◆ Nastic Movements (non-directional)
 - Not dependent on direction of stimulus.
 - **Example**: Touch-me-not (Mimosa pudica) closes leaves when touched.

Hormone	Function	
Auxins	Promote cell elongation, phototropism.	
Gibberellins	Stimulate stem growth, seed germination.	
Cytokinins	Promote cell division.	
Abscisic Acid	Inhibits growth, promotes dormancy.	
Ethvlene	Ripening of fruits.	

B. Plant Hormones (Phytohormones)

III. Hormonal Coordination in Animals

A. Endocrine System

- Consists of **glands** that secrete **hormones** directly into the blood.
- Hormones act on target organs.

B. Important Human Endocrine Glands

Gland	Hormone	Function
Pituitary	Growth Hormone (GH), TSH, etc.	"Master gland", controls other glands.
Thyroid	Thyroxine	Controls metabolism.
Pancreas	Insulin, Glucagon	Controls blood sugar level.
Adrenal	Adrenaline	Prepares body for emergencies.
Testes	Testosterone	Male secondary sexual characteristics.
Ovaries	Estrogen, Progesterone	Female reproductive roles.

