



SSC – CPO

Central Police Organization

STAFF SELECTION COMMISSION (SSC)

Volume - 4

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Science



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# 3 Chapter

## Biology

### The Cell

- **Simplest and most basic unit** of life.
- **Discovered:** Robert Hooke (1665)
- All living things made up of cells- **structural, functional, and biological unit of life.**
- Has the **ability to duplicate itself** on its own.
- aka "**building blocks of life.**"

### Cell Structure and its components

#### Cell Organelles

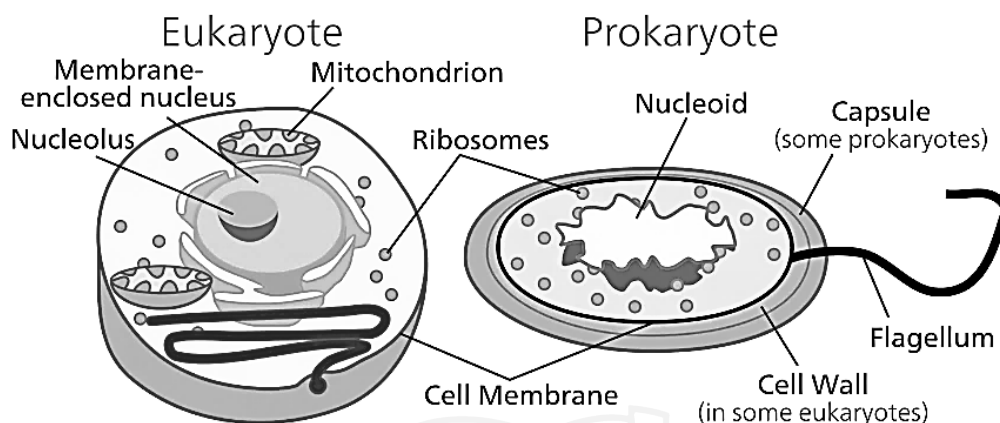
- Present within a cell & **perform certain specific functions to carry out life's processes.**

Plasma / Cell Membrane	<ul style="list-style-type: none"> <li>• <b>Outermost covering</b> of the cell</li> <li>• <b>Separates contents of cell</b> from its <b>external environment.</b></li> <li>• <b>A selectively permeable membrane</b> as it allows entry and exit of some materials in and out of the cell.</li> </ul>
Cell Wall	<ul style="list-style-type: none"> <li>• <b>ONLY</b> in <b>plants</b></li> <li>• <b>Outside</b> the <b>plasma membrane.</b></li> <li>• Mainly <b>composed of cellulose.</b> <ul style="list-style-type: none"> <li>○ <b>Cellulose:</b> A complex substance - provides structural strength to plants.</li> </ul> </li> </ul>
Cytoplasm	<ul style="list-style-type: none"> <li>• <b>Jelly-like substance</b> present between <b>cell membrane &amp; nucleus.</b></li> <li>• <b>Fluid content inside plasma membrane.</b></li> <li>• <b>Contains</b> many specialised <b>cell organelles</b> (mitochondria, golgi bodies, ribosomes, etc)</li> </ul>
Nucleus	<ul style="list-style-type: none"> <li>• <b>Contains chromosomes</b> that contain <b>information</b> for <b>inheritance</b> of features from parents to next generation in form of DNA</li> <li>• Plays a <b>central role</b> in <b>cellular reproduction.</b></li> <li>• <b>Nuclear membrane-</b> a <b>double-layered</b> covering on nucleus. <ul style="list-style-type: none"> <li>○ <b>Allows transfer</b> of <b>material</b> from <b>inside</b> nucleus <b>to its outside</b>, i.e., to cytoplasm.</li> </ul> </li> </ul>
Nucleolus	<ul style="list-style-type: none"> <li>• <b>Ribosome synthesis site</b> regulating <b>cellular activity</b> and <b>reproduction.</b></li> </ul>
Gene	<ul style="list-style-type: none"> <li>• <b>Unit of inheritance</b> in living organisms.</li> </ul>
Protoplasm	<ul style="list-style-type: none"> <li>• <b>Entire content of a living cell</b> [cytoplasm + nucleus].</li> <li>• aka <b>living substance of the cell.</b></li> </ul>
Chromosomes	<ul style="list-style-type: none"> <li>• <b>Rod-shaped structures</b></li> <li>• Visible <b>only when the cell is about to divide.</b></li> <li>• Contain <b>information for inheritance of features</b> from parents to next generation in the form of DNA (deoxyribo nucleic acid)</li> <li>• <b>Composed of DNA and Protein.</b></li> </ul>
DNA molecules	<ul style="list-style-type: none"> <li>• Contains <b>information necessary for constructing and organising cells.</b></li> <li>• Functional segments of DNA - <b>genes.</b></li> </ul>

<b>Vacuoles</b>	<ul style="list-style-type: none"> <li>● <b>Empty structure in cytoplasm</b></li> <li>● Act as storage sacs for solid or liquid contents.</li> <li>● <b>Common in plant cells.</b></li> <li>● <b>Smaller in animal cells.</b></li> <li>● <b>Substances stored-</b> amino acids, sugars, various organic acids and some proteins.</li> </ul>
<b>Endoplasmic Reticulum</b>	<ul style="list-style-type: none"> <li>● A large network of membrane-bound tubes and sheets.</li> <li>● <b>2 types :</b> <ol style="list-style-type: none"> <li>1. <b>Rough endoplasmic reticulum [RER]</b> <ul style="list-style-type: none"> <li>○ <b>Has ribosomes</b> attached to its surface.</li> <li>○ <b>Ribosomes</b> - sites of <b>protein manufacture.</b></li> </ul> </li> <li>2. <b>Smooth endoplasmic reticulum</b> <ul style="list-style-type: none"> <li>○ Helps in the <b>manufacture of fat molecules</b>, or lipids, important for cell function.</li> <li>○ Some of these proteins and lipids <b>help in building the cell membrane k/a membrane biogenesis.</b></li> </ul> </li> </ol> </li> <li>● Serve as <b>channels for transport of materials</b> between various regions of cytoplasm or between the cytoplasm and the nucleus.</li> <li>● Also functions as a <b>cytoplasmic framework</b> providing a <b>surface for some biochemical activities of cells.</b></li> </ul>
<b>Golgi Apparatus/ Complex</b>	<ul style="list-style-type: none"> <li>● A <b>system of membrane-bound vesicles</b> arranged <b>parallel</b> to each other in <b>stacks</b> called <b>cisterns.</b></li> <li>● <b>Packages and dispatches material synthesised near ER to various targets</b> inside and outside the cell.</li> <li>● <b>Stores, modifies and packages products</b> in vesicles.</li> <li>● Involved in the <b>formation of lysosomes.</b> <ul style="list-style-type: none"> <li>○ <b>Membrane-bound sacs</b> filled with digestive enzymes.</li> <li>○ Kind of <b>waste disposal system</b> of the cell.</li> <li>○ <b>Help to keep the cell clean by digesting any foreign material</b> as well as <b>worn-out cell organelles.</b></li> </ul> </li> </ul>
<b>Mitochondria</b>	<ul style="list-style-type: none"> <li>● Aka <b>powerhouse of the cell.</b></li> <li>● <b>Energy required</b> for various chemical activities <b>is released</b> by mitochondria in the form of <b>ATP</b> (Adenosine Triphosphate) molecules.</li> <li>● <b>2 membranes:</b> <ul style="list-style-type: none"> <li>○ <b>Outer membrane-</b> porous</li> <li>○ <b>Inner membrane - deeply folded.</b> <ul style="list-style-type: none"> <li>■ <b>Folds create a large surface area for ATP-generating chemical reactions.</b></li> </ul> </li> </ul> </li> </ul>
<b>ATP</b>	<ul style="list-style-type: none"> <li>● aka <b>energy currency of the cell.</b></li> <li>● <b>Body uses energy</b> stored in <b>ATP</b> for <b>making new chemical compounds</b> and for mechanical work.</li> </ul>
<b>Ribosomes</b>	<ul style="list-style-type: none"> <li>● <b>Site of protein synthesis.</b></li> <li>● <b>Polyribosomes or Polysomes:</b> Several <b>ribosomes may attach to a single mRNA and form a chain.</b></li> <li>● <b>Prokaryotes-</b> ribosomes are associated with the <b>plasma membrane of the cell.</b></li> </ul>
<b>Cilia and Flagella</b>	<ul style="list-style-type: none"> <li>● <b>Hair-like outgrowths of the cell membrane.</b></li> <li>● <b>Cilia</b> - small structures which work like oars, causing the <b>movement of either the cell or the surrounding fluid.</b></li> <li>● <b>Flagella</b> - comparatively <b>longer</b> and responsible for cell movement.</li> </ul>

	<ul style="list-style-type: none"> <li>Prokaryotic bacteria have flagella but structurally different from eukaryotic flagella.</li> </ul>
<b>Centrosome and Centrioles</b>	<ul style="list-style-type: none"> <li>Centrosome- an organelle usually containing 2 cylindrical structures called centrioles.</li> <li>Surrounded by amorphous pericentriolar materials.</li> <li>Both the centrioles in a centrosome lie perpendicular to each other</li> </ul>

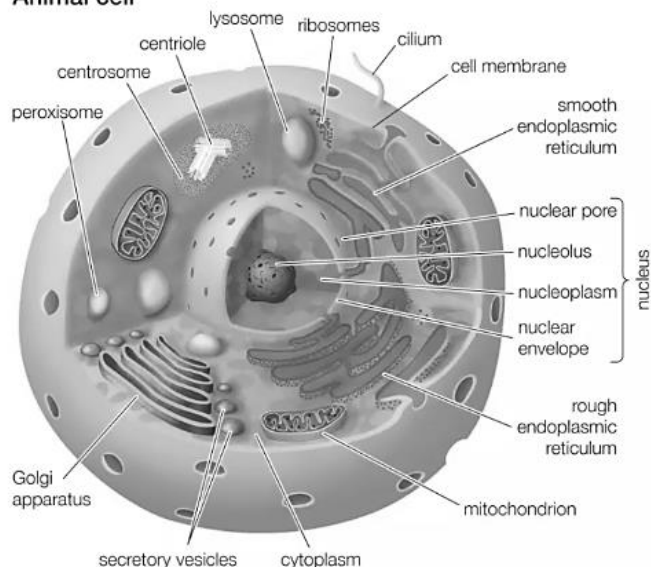
## Types of Cells



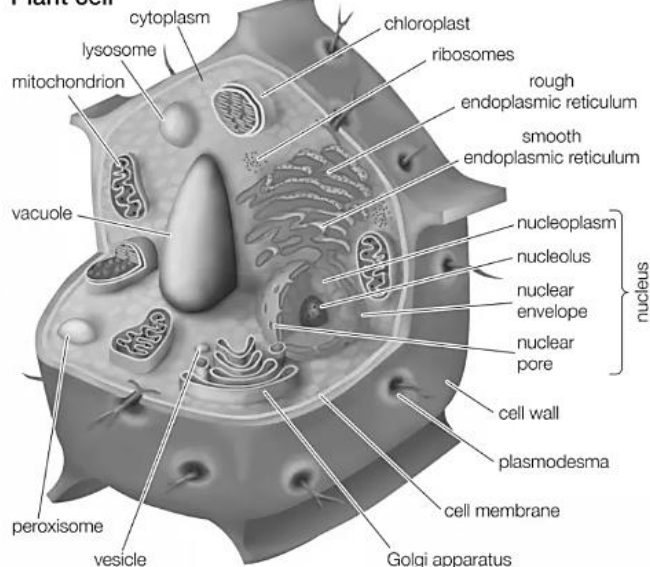
Prokaryotic Cell	Eukaryotic Cell
<ul style="list-style-type: none"> <li>Primitive/undeveloped nucleus.</li> </ul>	<ul style="list-style-type: none"> <li>Has true or developed nucleus</li> </ul>
<ul style="list-style-type: none"> <li>Size - 0.2 - 2.0 micrometers</li> </ul>	<ul style="list-style-type: none"> <li>Size- 10- 100 micrometers.</li> </ul>
<ul style="list-style-type: none"> <li>Simpler in structure</li> </ul>	<ul style="list-style-type: none"> <li>More complex</li> </ul>
<ul style="list-style-type: none"> <li>Organelles not membrane-bound</li> </ul>	<ul style="list-style-type: none"> <li>Organelles membrane bound &amp; specific in function.</li> </ul>
<ul style="list-style-type: none"> <li>DNA arranged in circular shape</li> </ul>	<ul style="list-style-type: none"> <li>DNA linear in shape</li> </ul>
<ul style="list-style-type: none"> <li>Cytoplasm present, but lacks in most cell organelles.</li> </ul>	<ul style="list-style-type: none"> <li>Consists of both cytoplasm and organelles</li> </ul>
<ul style="list-style-type: none"> <li>Cell wall present.</li> <li>Made of mucopeptide or peptidoglycan</li> </ul>	<ul style="list-style-type: none"> <li>Usually, absence of cell wall here.</li> <li>Made of cellulose</li> </ul>
<ul style="list-style-type: none"> <li>Cell division - binary fission, transduction, conjugation, and transformation</li> </ul>	<ul style="list-style-type: none"> <li>Cell division - mitosis</li> </ul>
<ul style="list-style-type: none"> <li>Mitochondria absent</li> </ul>	<ul style="list-style-type: none"> <li>Mitochondria present.</li> </ul>
<ul style="list-style-type: none"> <li>Endoplasmic reticulum not present.</li> </ul>	<ul style="list-style-type: none"> <li>Endoplasmic reticulum present.</li> </ul>
<ul style="list-style-type: none"> <li>Ribosome present</li> </ul>	<ul style="list-style-type: none"> <li>Ribosome present</li> </ul>
<ul style="list-style-type: none"> <li>Plasmids commonly found. <ul style="list-style-type: none"> <li>A small, circular, double-stranded DNA molecule distinct from a cell's chromosomal DNA.</li> <li>Naturally exist in bacterial cells.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Plasmids very rarely found</li> </ul>
<ul style="list-style-type: none"> <li>Only asexual reproduction.</li> </ul>	<ul style="list-style-type: none"> <li>Both sexual and asexual reproduction.</li> </ul>
<ul style="list-style-type: none"> <li>Have a single origin of replication</li> </ul>	<ul style="list-style-type: none"> <li>Have multiple origins of replication</li> </ul>
<ul style="list-style-type: none"> <li>Only 1 chromosome.</li> </ul>	<ul style="list-style-type: none"> <li>Many chromosomes present</li> </ul>
<ul style="list-style-type: none"> <li>Eg. Bacteria and Archaea.</li> </ul>	<ul style="list-style-type: none"> <li>Eg. Plant and animal cells.</li> </ul>

## Plant and Animal Cells

**Animal cell**



**Plant cell**



	Animal Cell	Plant Cell
<b>Nucleus</b>	Present	Present
<b>Cilia</b>	Present	Very rare
<b>Shape</b>	Round (irregular shape)	Rectangular (fixed shape)
<b>Chloroplast</b>	NO chloroplasts	Chloroplasts present
<b>Cytoplasm</b>	Present	Present
<b>Endoplasmic Reticulum</b>	Present	Present
<b>Ribosomes</b>	Present	Present
<b>Mitochondria</b>	Present	Present
<b>Vacuole</b>	One or more small vacuoles (much smaller than plant cells).	One large central vacuole taking up 90% of cell volume.

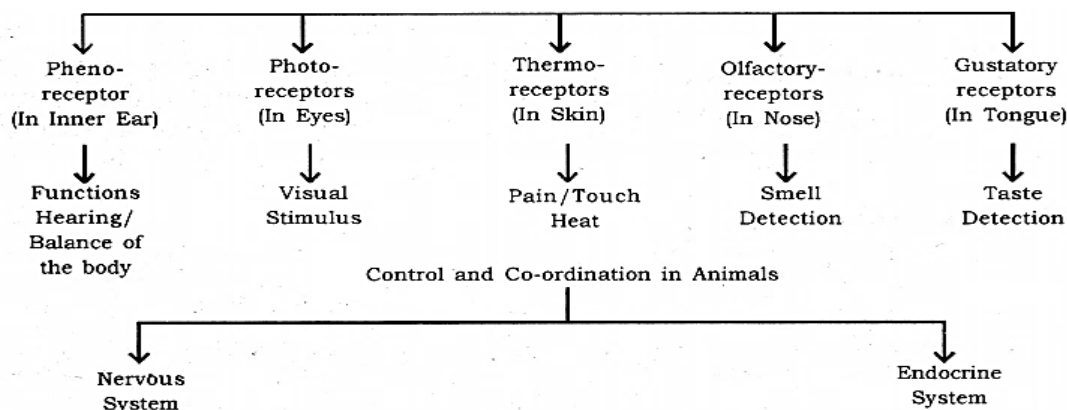
## Control and Coordination

### In animals

Nervous system and hormonal system are responsible for control and coordination.

Receptors:

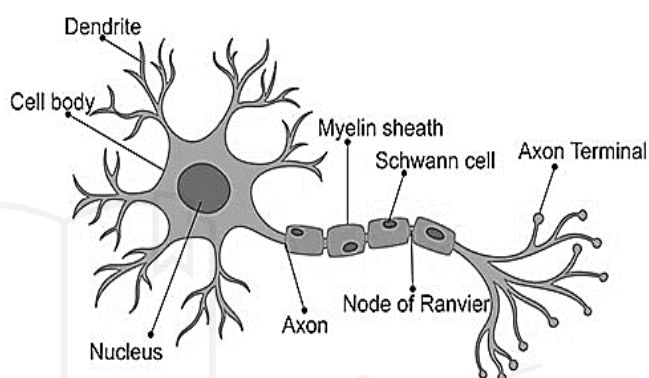
- Specialized tips of nerve fibres that collect information to be conducted by nerves.
- In the sense organs of the animals.



- **Types:**
- 1. **Nervous System**
- A **highly complex regulatory system** in animals.
- **Coordinates actions & transmits sensory information and signals** to/from the different parts of body.
- **Neuron - structural and functional unit** of entire system.
- **Functions:**
  - **Receives information** from the **environment**.
  - Receive the information from the **various body parts**.
  - **Act accordingly** through muscles and glands.
- **Movement- ability** of an organism **to move** a **particular body part**.
- **Locomotion - ability** of an organism **to move** its **whole body** from one place to another.

## Neuron

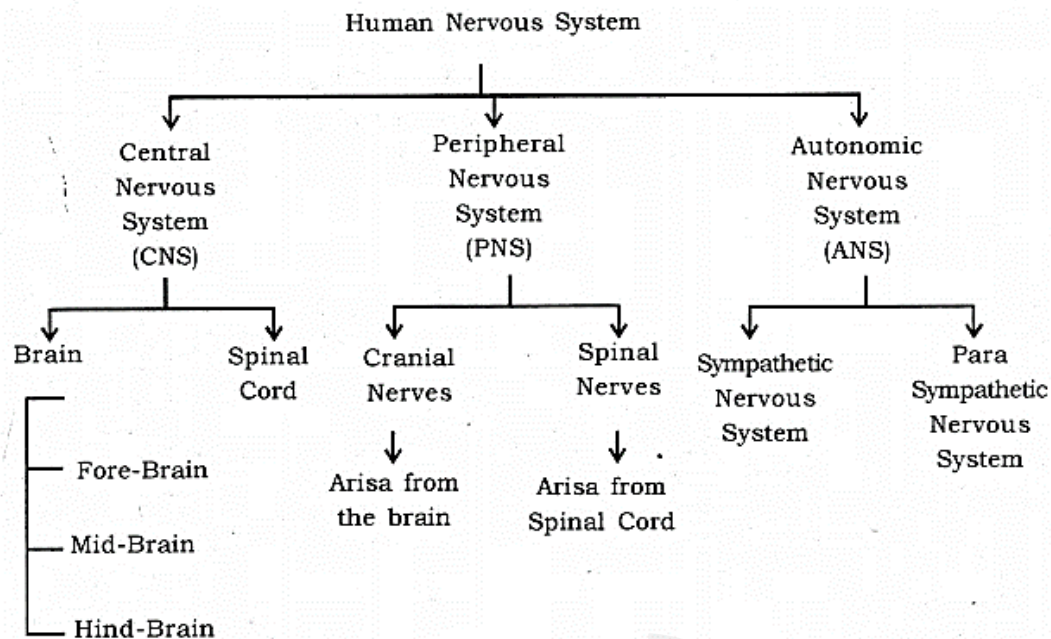
- **Structural and functional unit of the nervous system**
- **Coordinates and controls the complex actions** in animals.
- **Specialized cells** responsible for **transmission of nerve impulses**.
- **3 parts-**
  1. **Axon-**
    - **Tail of the neuron**.
    - **Ends in fine hair-like structures** k/a **axon terminals** which rely on nerve impulses
    - **Axons - myelinated or unmyelinated**.
    - **Impulse transmission** is faster in **myelinated neurons**.
  2. **Cyton/soma/cell body-**
    - **Star-shaped** having various **hair-like structures** k/a **dendrites** which **receive the nerve impulses**
  3. **Myelin Sheath-**
    - An **insulating sheath** on **axon**.
    - **Insulates axon against nerve impulse** from its **surroundings**.
    - **Dendrites receive the impulse** from other neurons.
    - **Cyton or Soma cells process the impulse- transmitted** to the **Axon**. Gets transmitted either to other neurons or to muscles for taking necessary action.



- **Types :**
  1. **Sensory neurons-** Receive the signals from a sense organ
  2. **Motor neurons-** Send the signals to a gland or muscle
  3. **Relay or association neuron-** Relay signals between a motor neuron and sensory neuron.
- **Synapse**
  - A **microscopic gap** between **two adjacent neurons**.
  - A **point contact between terminal branches** of **axon** of one neuron and with the dendrite of another neuron.
  - **Convert electric signals** into **chemicals** that can cross over gap between axon and dendrite.
  - **Chemical message** is **passed to next neuron** and **converted back** to the **electrical signal** for **interpretation**.
- **Neuromuscular Junction:**
  - **Point where a muscle fibre comes in contact with a motor neuron** carrying nerve impulse from the control nervous system.



## Human nervous system



### 1. Central Nervous System:

- **Brain + spinal cord.**
- **Brain controls** all the **functions** in the human body.
- **Spinal cord** works as **relay channel** for **signals between brain** and **peripheral nervous system**.

## Human Brain

- A **highly complex organ** mainly **composed** of **nervous tissue**.
- **Tissues highly folded** to **accommodate** a **large surface area** in **less space**.
- **Covered by a 3-layered system** of **membranes k/a meninges**.
- **Cerebrospinal fluid** filled **between meninges** **cushions** the **brain** against **mechanical shocks**.

### • 3 parts:

#### 1. Fore-brain:

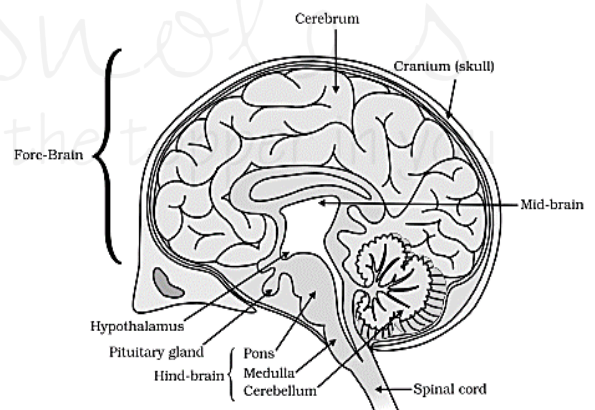
- **Composed** of the **cerebrum**.
- **Cerebrum- Largest part** in human brains.
- Divided into **2 hemispheres** k/a **cerebral hemispheres**.
- **Functions:**
  - **Controls voluntary** motor actions.
  - **Site of sensory perceptions**, like tactile and auditory perceptions.
  - **Site of learning** and **memory**.

#### 2. Mid-brain:

- **Composed** of the **hypothalamus**.
- **Hypothalamus-** lies at the **base** of the **cerebrum**.
- **Controls sleep** and **wake cycle** (circadian rhythm) of the body.
- **Controls** the urges for **eating** and **drinking**.

#### 3. Hind-brain:

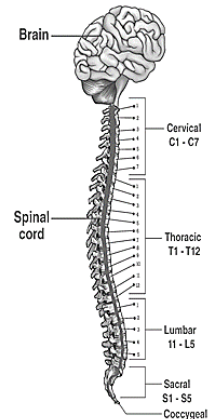
- **Composed** of **cerebellum**, **pons**, **medulla**, **oblongata**.
- **Cerebellum-** lies **below cerebrum** and at back of whole structure.
  - **Coordinates** the **motor functions**.
  - Eg. riding a bicycle, ensures perfect coordination between pedalling and steering control.
  - **Controls posture** and **balance**.
  - **Controls** the **precision** of **voluntary action**.



- **Medulla: Forms brain stem**, along with the pons.
  - **Lies at the base of brain** and **continues** into **spinal cord**.
  - **Controls** various **involuntary functions**, like hear beat respiration, etc.
  - **Controls involuntary actions**.
  - **Eg:** Blood pressure, salivation, vomiting.
- **Pons:**
  - **Relays impulses** between **lower cerebellum** and **spinal cord**
  - **Regulates respiration**.

## Spinal cord:

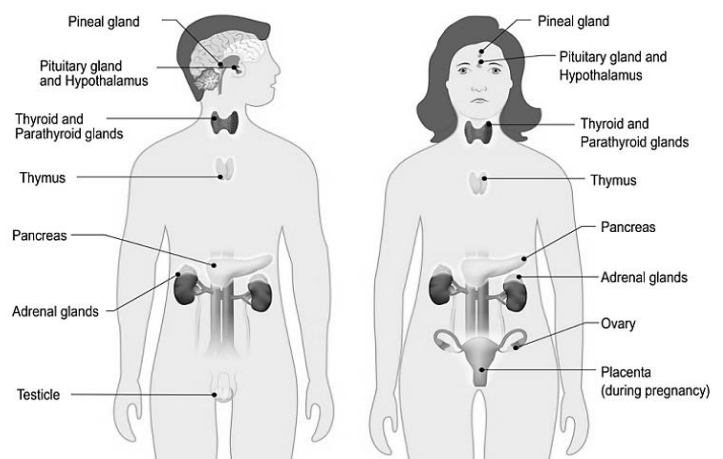
2. **Controls reflex actions** and conducts messages between different parts of body and brain.
3. **Reflex Action:**
4. **Sudden** and **involuntary response** to **stimuli**.
5. **Helps organisms** to **quickly adapt** to an **adverse circumstance** that could cause bodily harm or even death.
6. **Eg.** Pulling our hands away immediately after touching a hot or cold object.
7. **Reflex Arc:**
8. **Path** through which nerves signals, **involved** in a **reflex action**, travel.  
**Receptor → Sensory neuron → Relay neuron → Motor neuron → Effector** (muscle)
9. **Peripheral Nervous System:**
  - **Cranial nerves + spinal nerves.**
  - **12 pairs** of **cranial nerves** coming out of brain and go to the organs in the head region.
  - **31 pairs** of **spinal nerves** coming out of spinal cord and go to the organs which are below the head region.
10. **Autonomous Nervous System:**
  - **Composed** of a **chain of nerve ganglion** which **runs along spinal cord**.
  - **Controls** all the **involuntary actions** in the **human body**.
    - **2 parts :**
      - A. **Sympathetic Nervous System:**
        - **Increases activity** of an **organ** as required.
        - **Eg.** during running, there is an increased demand for oxygen by the body - fulfilled by an increased breathing rate and increased heart rate.
      - B. **Parasympathetic Nervous System:**
        - **Decreases the activity** of an organ and thus has a calming effect.
        - **Eg.** during sleep, breathing rate slows down and so does the heart rate.
        - Helps in the **conservation of energy**.



## 2. Endocrine System

- **Made up of interconnected glands** that create **hormones**.
- Almost **every cell, organ, and function** in **our body** is **influenced by the endocrine system**.
- **Aids** - regulation of mood, growth and development, tissue function, metabolism, and sexual and reproductive functions.
- Also k/a **ductless system** as the endocrine glands **secrete** their **hormones** directly into **bloodstream**.

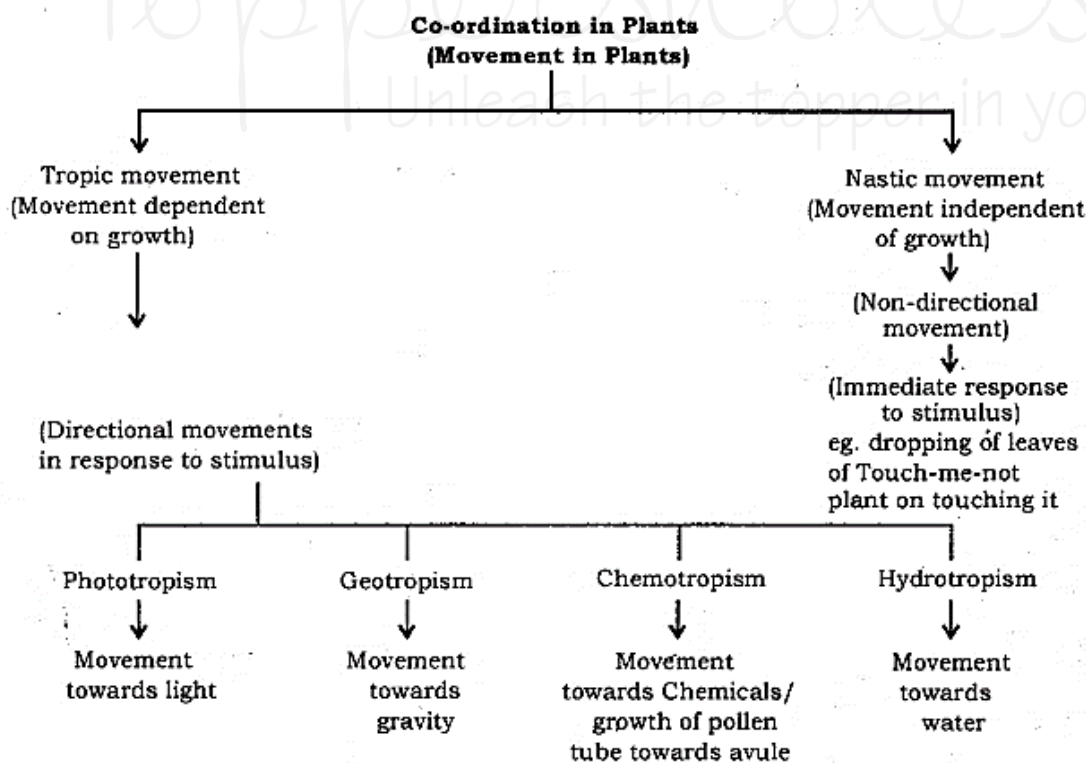
## ENDOCRINE SYSTEM



## Hormones released by endocrine glands

Endocrine Gland	Location	Hormones Produced	Functions
<b>Pituitary gland (aka master gland)</b>	Base of brain	<ul style="list-style-type: none"> <li>Growth hormone (GH).</li> <li>Thyroid stimulating hormone (TSH).</li> <li>Follicle stimulating hormone (FSH)</li> </ul>	<ul style="list-style-type: none"> <li><b>GH stimulates growth.</b></li> <li><b>TSH stimulates the functioning of thyroid gland.</b></li> <li><b>FSH stimulates follicles during ovulation.</b></li> </ul>
<b>Thyroid Gland</b>	Neck	<ul style="list-style-type: none"> <li>Thyroxine</li> </ul>	<ul style="list-style-type: none"> <li><b>Controls general metabolism and growth in the body.</b></li> </ul>
<b>Adrenal gland</b>	Above kidneys	<ul style="list-style-type: none"> <li>Adrenalin</li> </ul>	<ul style="list-style-type: none"> <li><b>Prepares the body for emergency situations and hence is also called 'Fight and flight' hormone.</b></li> </ul>
<b>Pancreas</b>	Near stomach	<ul style="list-style-type: none"> <li>Insulin</li> </ul>	<ul style="list-style-type: none"> <li><b>Controls blood sugar level</b></li> </ul>
<b>Testis (male)</b>	In Scrotum	<ul style="list-style-type: none"> <li>Testosterone</li> </ul>	<ul style="list-style-type: none"> <li><b>Sperm production, development of secondary sexual characters during puberty.</b></li> </ul>
<b>Ovary (female)</b>	Near uterus	<ul style="list-style-type: none"> <li>Oestrogen</li> <li>Progesterone</li> </ul>	<ul style="list-style-type: none"> <li><b>Egg production, development of secondary sexual characters during puberty.</b></li> </ul>

## In Plants



- Plants do **not** have a nervous system.
- Use **chemical** means for control and co-ordination.
  - Responsible for various kinds of **movements in plants**.
- Types of movements:

### 1. Tropic Movement:

- Movements in a **particular direction** in relation to **stimulus**.
- **Occur** as a **result** of **growth** of a plant part in a particular direction.
- **4 types** of tropic movements.

#### A. Geotropic movement:

- **Growth in a plant part in response to the gravity.**
- **Eg. Roots** - positive geotropic movement.
- **Stems** - negative geotropic movement.

#### B. Phototropic Movement:

- **Growth in a plant part in response to light.**
- **Eg. Stems** - positive phototropic movement,
- **Roots** - negative phototropic movement.

#### C. Hydrotropic Movement:

- **Growth in a plant part in response to water.**
- **Eg. Roots** - positive hydrotropic movement.

#### D. Thigmotropism Movement:

- **Growth in a plant part in response to touch.**
- **Eg. tendrils of climbers.**

### 2. Nastic Movement:

- **Do not depend** on **direction of stimulus**.
- **Eg**, when someone touches the leaves of touch-me-not plant, the leaves droop - independent of direction from which the leaves are touched.

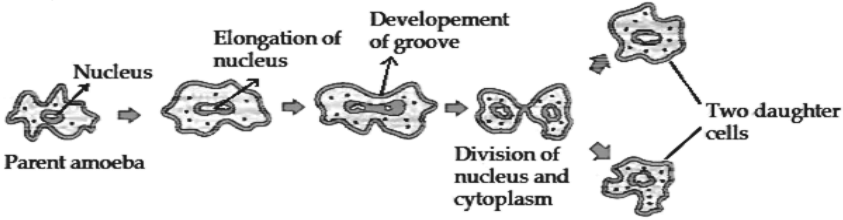
## Reproductive System

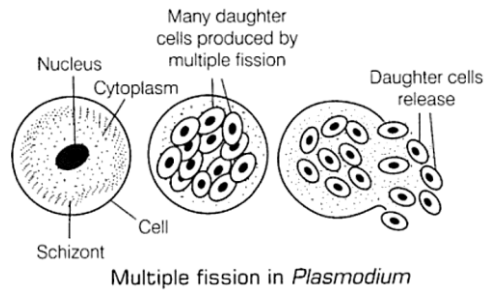
- A **biological process** by which an **organism produces an offspring** (biologically similar to the organism).
- Ensures the continuity of species, generation after generation.
- **Main feature of life on earth.**
- **2 types :**

#### 1. Asexual Reproduction

- Involves **only one parent**.
- **No formation** and fusion of **gametes**.
- **Young offsprings almost identical** to each other & parent.
- **Occurs** during **favourable environmental conditions** and when there is an abundance of food.
- **Faster** method of **reproduction**.

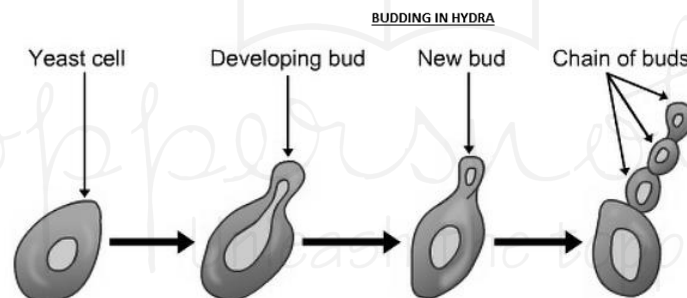
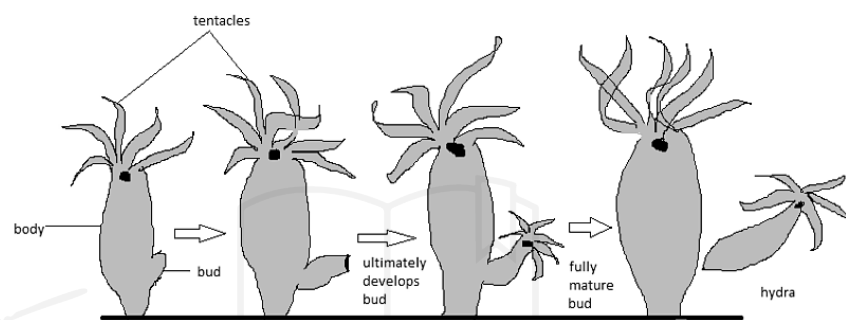
#### ● Types:

Binary Fission:	<ul style="list-style-type: none"><li>● In <b>bacteria, protozoa</b>.</li><li>● <b>Process:</b> <b>Withdrawing of pseudopodia (false cavity) → Nuclear division → cytoplasmic division → 2 daughter cells formed</b></li></ul>  <p style="text-align: center;"><b>Binary fission in Amoeba</b></p> <ul style="list-style-type: none"><li>● <b>Cytokinesis:</b> Division of cytoplasm.</li><li>● <b>Karyokinesis:</b> Division of Nucleus.</li></ul>
Multiple Fission	<ul style="list-style-type: none"><li>● A <b>single parent cell</b> is divided into many <b>daughter cells</b>.</li><li>● <b>Most common</b> form of <b>reproduction</b> in <b>protists</b> and in some <b>parasitic species</b>.</li></ul>



## Budding

- A **genetically identical new organism** grows attached to **body of parent** and **separates later** on.
- A **bud develops as an outgrowth** due to **repeated cell division** at one **specific site**.
- **Grows randomly.**
- **No specific order** or direction they follow.
- **Eg.** in hydra and yeast



## Regeneration

- **Ability of organisms to develop** their **lost parts**.
- **Some organisms** show have **high regenerative capacity**
- **Eg.** Planaria.
- **Carried out** by **specialized cells** which **redivide** to form a mass of cells from which different cells **undergo changes** to become different cell types and tissues.
- **Occur** in an **organized sequence** k/a **development**.

