

CALICUT UNIVERSITY

FOURTH

SEMESTER

FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

equipping with excellence

**BIOLOGICAL BASIS OF BEHAVIOUR
FYUGP PSYCHOLOGY-MAJOR**

PREPARED BY

ASIFA T

DEPARTMENT OF PSYCHOLOGY

CPA COLLEGE OF GLOBAL STUDIES

CPA COLLEGE OF GLOBAL STUDIES, PUTHANATHANI



Programme	B. Sc. Psychology				
Course Title	Biological Basis of Behaviour				
Type of Course	Major with Practicum				
Semester	IV				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This course provides the foundational level understanding on different biological processes and their relationship with behaviour. The course deals with the structure and functions of different systems which regulates behaviour and introduces various research methods for studying the brains and behaviour.				

COLLEGE OF GLOBAL STUDIES

DETAILED SYLLABI

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	The Nervous System		15	25
	1	Neurons, Cell body, dendrites, axons, Blood brain barrier, Cerebrospinal fluid	2	
	2	Structure and Functions of Nervous system : Central Nervous System (CNS) -Brain and Cerebral hemisphere- (CNS) Forebrain, Midbrain, Hindbrain, Ventricles and cerebral cortex	2	
	3	The spinal cord-structure and functions.	2	
	4	Peripheral Nervous System (PNS) (spinal nerve and cranial nerve)-Somatic and Autonomic nervous system	2	
	5	Neuronal Communication: Neuronal Signalling : Action potentials and synaptic transmission	2	
	6	Neurotransmitters : Major neurotransmitters – acetylcholine, monoamine, amino acids, peptides, lipids, nucleosides, soluble gases and their roles	2	
	7	Neurotransmitter imbalances and their implication-drug addictions	1	
	8	Brain plasticity, Factors affecting brain plasticity	1	
	9	Neurogenesis, brain mapping, synaptic pruning,	1	

	5	and synaptic transmission		
	6	Neurotransmitters : Major neurotransmitters – acetylcholine, monoamine, amino acids, peptides, lipids, nucleosides, soluble gases and their roles	2	
	7	Neurotransmitter imbalances and their implication-drug addictions	1	
	8	Brain plasticity, Factors affecting brain plasticity	1	
	9	Neurogenesis, brain mapping, synaptic pruning,	1	
II	Brain and Behaviour		12	15
	10	Brain structure that regulates sleep. Brain activity related with stages of sleep and dreaming.	6	
	11	Biological mechanism related to learning	2	
	12	Biological mechanisms related with memory	2	
	13	Neuronal basis of emotional regulation	2	
III	Hormonal and Genetic Influences on Behaviour		10	15
	14	Major Endocrine Glands and Their Hormones	4	

III	Hormonal and Genetic Influences on Behaviour		10	15
	14	Major Endocrine Glands and Their Hormones	4	

64

	15	The pituitary gland, thyroid gland, adrenal glands, pancreas, gonads, and their hormones Mechanism of action and different hormonal systems	2	
	16	Genetics and Behaviour	4	
	17	Sex linked and sex-limited genes Gene mutations and genetic disorders Heredity and environment ,Evolution of behaviour	2	

IV	Methods and strategies of research		8	15
	18	Experimental Ablation	1	
	19	Lesion study, Stereotaxic surgery, Histological method tracing neural connections,	2	
	20	Recording and stimulation neural activity - study brain by stimulating activity of specific brain region	2	
	21	Micro electrodes, macro electrodes, magnetoencephalography, CT, PET,MRI, fMRI	1	
	22	Twin study, Adoption study, Split brain studies	2	

	Practicum	30	
v	<p>Students are expected to present a report of any two of the following Activities:</p> <p><i>Field Trips:</i> Organize field trips to real-world applications of neuroscience and the latest research in the field.(eg: Scanning centers)</p> <p><i>Brain Model Making:</i> students can use materials like clay, paper mache, or craft supplies to create models of different brain structures. They can label the structures and present them to the class, explaining their functions.</p> <p><i>Artistic Expression of Brain Function:</i> They can create visual representations of neurons, brain regions, or neurotransmitter systems, incorporating their knowledge into creative artworks through artistic medium of drawing or painting</p> <p><i>Role-Playing Activities:</i> Assign students roles such as neurons, neurotransmitters, or brain regions, and conduct a role-playing activity to simulate neuronal communication. This will help students understand concepts like action potentials and synaptic transmission in a fun and interactive way.</p> <p><i>Case Studies:</i> students write a report on real-life case studies of</p>	30	

MODULE -1
THE NERVOUS SYSTEM

UNIT -1

Neurons

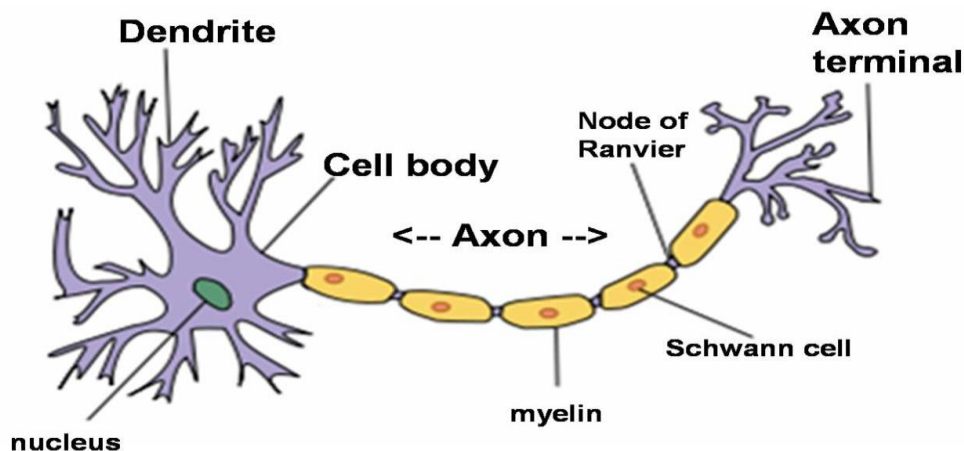
- Neurons are the **basic functional units of the nervous system.**
- They receive, process, and transmit information through **electrical and chemical signals.**
- Highly specialized, cannot be replaced easily.
- Communicate using **nerve impulses (action potentials).**
- Form networks that allow thinking, perception, movement, memory, and emotions.

Types of Neurons

1. **Sensory neurons** – Carry messages from body to brain/spinal cord.
2. **Motor neurons** – Carry commands from brain/spinal cord to muscles/glands.
3. **Interneurons** – Connect neurons within the brain and spinal cord; involved in reflexes and higher functions.

Basic Properties

- **Excitability** – Ability to generate signals.
- **Conductivity** – Ability to pass signals along the neuron and to the next cell.
- **Secretion** – Release neurotransmitters to communicate with the next neuron.



Cell Body (Soma)

The **cell body** is the central part of the neuron.

Functions

- Contains the **nucleus**, which stores genetic material.
- Has organelles needed for cell energy and growth.
- Integrates signals received from dendrites.
- Helps maintain and repair the neuron.

Important Components

- **Nucleus** – Controls cell activity.
- **Mitochondria** – Provide energy.
- **Nissl bodies** – Make proteins for neuron function.

Dendrites

Dendrites are **branch-like extensions** of the neuron.

Functions

- Receive incoming signals from other neurons.
- Carry these signals **toward the cell body**.
- Increase the neuron's surface area for communication.

Characteristics

- Usually short and highly branched.
- Have receptors for neurotransmitters.
- Play a role in **learning and memory** (dendritic growth increases with learning).

Axons

The axon is a **long, thin fibre** that carries signals **away from the cell body**.

Functions

- Transmits **action potentials** to other neurons, muscles, or glands.

Key Components

- **Axon hillock** – The "trigger zone" where action potentials begin.
- **Myelin sheath** – Fatty covering that increases signal speed.
- **Nodes of Ranvier** – Gaps in myelin that allow fast conduction (saltatory conduction).
- **Axon terminals** – Endpoints that release neurotransmitters.
- Damage to axons can cause paralysis or loss of sensation.

Blood–Brain Barrier (BBB)

BBB is a **protective barrier** between the brain's blood supply and its tissues.

Structure

- Formed by **tight junctions** between capillary cells.
- Supported by **astrocytes** (a type of glial cell).

Functions

- Protects brain from toxins, bacteria, and harmful chemicals.
- Allows essential substances like oxygen, glucose, and amino acids.
- Maintains stable environment for brain functioning.

Clinical Importance

- Many medicines **cannot cross** the BBB.
- Breakdown of BBB occurs in infections, trauma, stroke, and some diseases (e.g., multiple sclerosis).

Cerebrospinal Fluid (CSF)

CSF is a **clear, watery fluid** that surrounds the brain and spinal cord.

Produced by the **choroid plexus** in the ventricles of the brain.

Functions

1. **Protection** – Acts as a shock absorber.
2. **Buoyancy** – Makes the brain “float,” reducing pressure.
3. **Nutrient transport** – Delivers nutrients and removes waste.
4. **Chemical stability** – Maintains ideal chemical environment.

Circulation Pathway

Ventricles → Central canal → Subarachnoid space → Absorbed into venous system

Disorders

- **Hydrocephalus** – Excess CSF leading to pressure on the brain.
- **Meningitis** – Infection detectable through CSF analysis.

UNIT 2

Structure and Functions of the Nervous System

Two Main Parts

1. **Central Nervous System (CNS)** – Brain + Spinal cord
2. **Peripheral Nervous System (PNS)** – All nerves outside CNS

Main Functions

- **Receive information** from the body and environment
- **Process and interpret** information
- **Send commands** to muscles and glands
- Regulate **thoughts, emotions, memory, movement, sensation, and homeostasis**

Central Nervous System (CNS)

Components

- **Brain** – Control centre
- **Spinal cord** – Pathway for signals between brain and body

Functions

- Controls thinking, sensation, movement

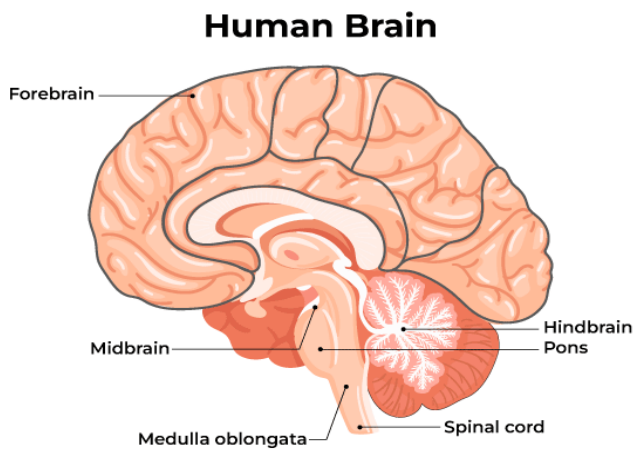
- Coordinates reflexes
- Stores memory, emotions, and learning
- Maintains vital functions (breathing, heartbeat, temperature)

Brain and Cerebral Hemispheres

Brain

Human Brain along with the spinal cord forms Central Nervous System. It is the site of information processing and control. Brain is protected inside the skull, suspended in cerebrospinal fluid, and isolated from the bloodstream by the blood–brain barrier. The adult human brain weighs on average about 1.2–1.4 kg. The human brain is primarily composed of neurons, glial cells, neural stem cells, and blood vessels.

Within the skull, the brain is covered by cranial meninges. Meninges are divided into three layers, the outer layer called the dura mater, very thin middle layer called arachnoid and an inner layer called **pia mater**. It consists of cerebrum, the brainstem and the cerebellum.



Cerebral Hemispheres

- Divided into **Right hemisphere** and **Left hemisphere**
- Connected by the **corpus callosum**
- **Left hemisphere** – Language, logic, analysis, math
- **Right hemisphere** – Creativity, spatial ability, emotions, art

Forebrain

Main Parts

1. **Cerebrum** (largest part)
2. **Thalamus**
3. **Hypothalamus**
4. **Limbic system** (amygdala, hippocampus)

Functions

- Thinking, planning, problem-solving
- Emotions and memory
- Sensory relay (thalamus)
- Regulation of hunger, thirst, temperature, hormones (hypothalamus)

Midbrain

Location

- Between forebrain and hindbrain

Main Functions

- Controls eye movements
- Coordinates hearing and motor responses
- Contains dopamine-producing centres (movement control)

Hindbrain

Parts

1. **Cerebellum** – Balance, posture, fine movements
2. **Pons** – Sleep, breathing, connects brain parts
3. **Medulla oblongata** – Heartbeat, breathing, blood pressure, reflexes

Functions

- Maintains survival functions
- Helps in movement coordination
- Controls automatic responses (cough, sneeze, swallowing)

Ventricles

- Four **fluid-filled cavities** inside the brain
- Filled with **cerebrospinal fluid (CSF)**
- **Right Lateral Ventricle**
- **Left Lateral Ventricle**

- **Third Ventricle**
- **Fourth Ventricle**
- Protect and cushion the brain

- Maintain pressure
- Circulate CSF for nutrient transport and waste removal

Cerebral Cortex

Definition

- The **outermost layer** of the cerebrum
- Grey matter (cell bodies)

Functions

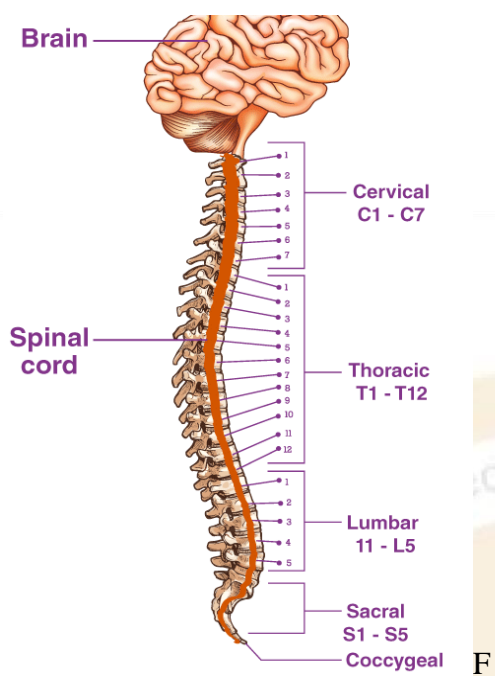
- Higher mental processes
- Sensory perception
- Motor control
- Language, memory, reasoning, decision-making

Four Lobes

1. **Frontal lobe** – Planning, speech, movement, personality
2. **Parietal lobe** – Touch, spatial awareness
3. **Temporal lobe** – Hearing, memory, understanding language
4. **Occipital lobe** – Vision

UNIT-3

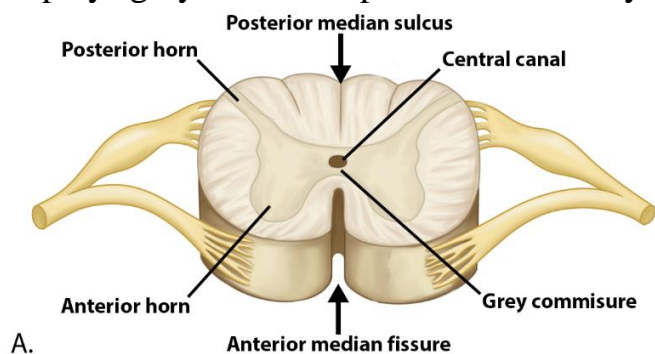
THE SPINAL CORD



The spinal cord is a part of the central nervous system. It is a long pipe-like structure arising from the medulla oblongata, part of the brain consisting of a collection of nerve fibres, running through the vertebral column of the backbone. It is segmented with a pair of roots (dorsal and ventral roots) consisting of nerve fibres joining to form the spinal nerves.

Structure of Spinal Cord

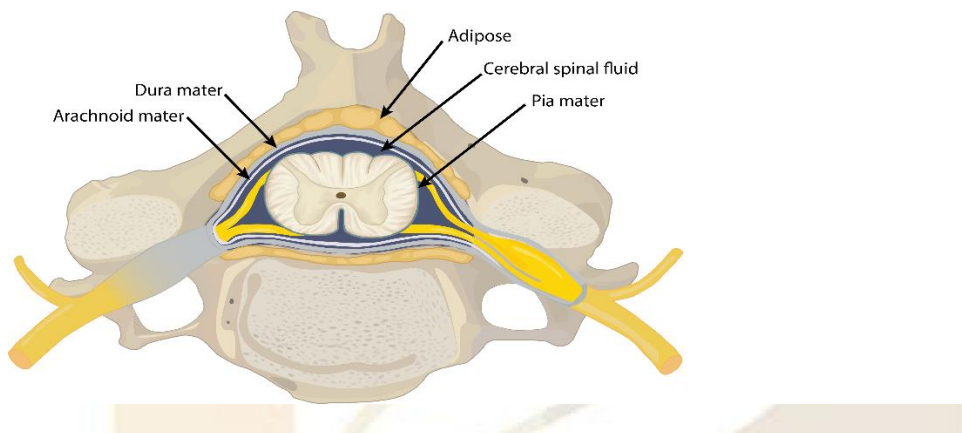
The Spinal cord runs through a hollow case from the skull enclosed within the vertebral column. Spinal nerves arise from different regions of the vertebral column and are named accordingly, the regions are – Neck, chest, pelvic and abdominal. Cross-section of spinal cord displays grey matter shaped like a butterfly surrounded by a white matter.



Grey matter consists of the central canal at the centre and is filled with a fluid called CSF (Cerebrospinal fluid). It consists of horns (four projections) and forms the core mainly containing neurons and cells of the CNS. There are two dorsal and two ventral horns.

The white matter consists of a collection of axons permitting communication between different layers of CNS. A tract is a collection of axons and carries specialized information. Ascending tracts and descending tracts send and transmit signals from the brain respectively to various nerve cells across the body. Spinal nerves act as mediators, communicating information to and from the rest of the body and the spinal cord. We have 31 pairs of spinal nerves.

Three layers of meninges surround the spinal cord and spinal nerve roots.



- Dura mater
- Arachnoid mater
- Pia mater

Dura mater consists of two layers- periosteal and meningeal. Epidural space is present between the two layers.

Subarachnoid space lies between the [arachnoid mater](#) and pia mater. It is filled with cerebrospinal fluid.

FUNCTIONS OF SPINAL CORD

Important functions of Spinal Cord are mentioned below:

- Forms a connecting link between the brain and the PNS
- Provides structural support and builds a body posture
- Facilitates flexible movements
- Myelin present in the white matter acts as an electrical insulation

- Communicates messages from the brain to different parts of the body
- Coordinates reflexes
- Receives sensory information from receptors and approaches towards the brain for processing.

UNIT -4

PERIPHERAL NERVOUS SYSTEM (PNS)

The body's nervous system is divided into two parts: the central nervous system and the peripheral nervous system.

- **The central nervous system (CNS)** includes the brain and spinal cord
- **The peripheral nervous system (PNS)** includes all the nerves that branch out from the brain and spinal cord and extend to other body parts, including muscles and organs.

The nerves of the PNS extend from the central nervous system to the outermost areas of the body. The peripheral system allows the brain and spinal cord to receive and send information to other areas of the body, which allows us to react to stimuli in our environment.

The four primary functions of the PNS are to:

- Control autonomic body functions
- Control motor movements
- Digestion
- Relay sensory information to the central nervous system

Examples of processes controlled by the peripheral nervous system include dilating or constricting the pupils in response to light, stimulating digestion, activating the sweat response, controlling blood flow, and regulating heart rate.

Nerves in the Peripheral Nervous System

The PNS is composed of nerves that are responsible for carrying signals between the central nervous system and the parts of the body that lie outside the CNS. This includes information from the senses, organs, and muscles.

The axons of these nerve cells are bundled together and can be found throughout the body. Information is received by the dendrites of these cells, the information travels down the axon to the cell body. The message can then be communicated to other cells.

Spinal Nerves

Spinal nerves are responsible for transmitting information from the muscles, organs, and glands to the spinal cord. There are 31 spinal nerves that branch out to different areas of the body from the spinal cord.

Cranial Nerves

The cranial nerves are responsible for the receptors found in the head and neck area. Instead of connecting with the spinal cord, these nerves travel directly to the brain. There are 12 pairs of cranial nerves that transmit motor and sensory information from areas including the face, mouth, eyes, nose, and ears.

The Somatic Nervous System

The somatic system is the part of the peripheral nervous system responsible for carrying sensory and motor information to and from the central nervous system.

The somatic nervous system derives its name from the Greek word *soma*, which means "body."

The somatic system is responsible for transmitting sensory information as well as for controlling voluntary movement. To accomplish this, the somatic system contains two major types of neurons:

- **Motor neurons:** Also called efferent neurons, motor neurons carry information from the brain and spinal cord to muscle fibres throughout the body. These motor neurons allow us to take physical action in response to environmental stimuli.
- **Sensory neurons:** Also called afferent neurons, sensory neurons carry information from the nerves to the central nervous system. The sensory neurons allow us to take in sensory information and send it to the brain and spinal cord.

The Autonomic Nervous System

The autonomic nervous system (ANS) is the part of the peripheral nervous system that's responsible for regulating involuntary body functions, such as blood flow, heartbeat, digestion, and breathing.

The ANS controls aspects of the body that are usually not under voluntary control.

This system allows these functions to take place without needing to consciously think about them happening. It functions automatically, behind the scene, to regulate vital body functions such as your heart rate, respiration, and digestion. It allows your body to run smoothly without conscious effort.

The autonomic system is further divided into two branches:

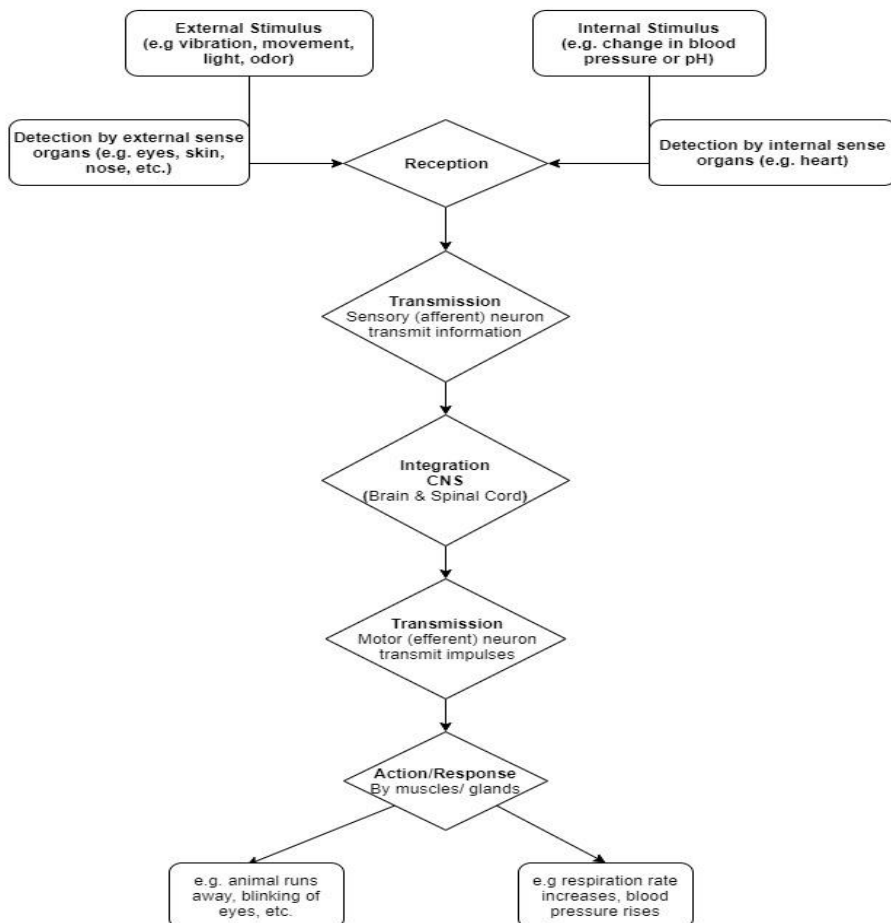
Sympathetic system: By regulating the flight-or-fight response, the sympathetic system prepares the body to expend energy to respond to environmental threats.

When action is needed, the sympathetic system triggers a response by accelerating heart rate, increasing breathing rate, boosting blood flow to muscles, activating sweat secretion, and dilating the pupils.

Parasympathetic system: This helps maintain normal body functions and conserve physical resources. Once a threat has passed, this system will slow the heart rate, slow breathing, reduce blood flow to muscles, and constrict the pupils. The parasympathetic nervous system allows the body to return to a normal resting state, which is why it is sometimes known as the rest-and-digest system.

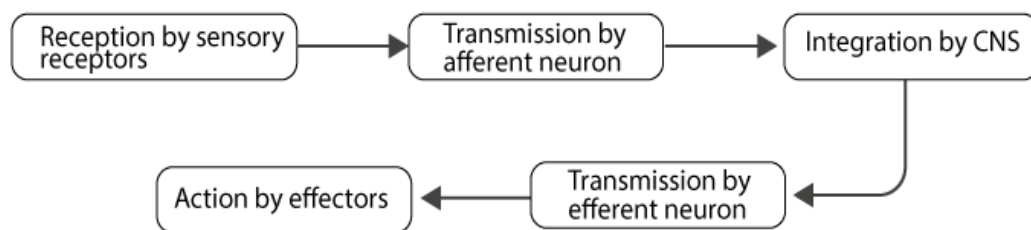
UNIT 5

Neural Communication An animal receives thousands of stimuli simultaneously. The survival depends on identifying and responding to these stimuli effectively. In most of the animals, neural communication involves four processes. Whether a stimulus originates externally or internally, information must be **received, transmitted to the CNS, integrated and transmitted to muscle or glands to carry out some action, the actual response.**



1. **Reception:** Reception is the process of detecting a stimulus by neurons or sensory receptors present in sensory organs like skin, eyes, ear, etc.
2. **Transmission:** Transmission is the process of sending signals to and fro from a neuron to another neuron or from neuron to muscles or glands
3. **Integration:** Integration involves sorting and interpreting incoming sensory information and determining the appropriate response
4. **Action or response:** The actual response to the stimulus by muscles or gland

In summary, information flows through the nervous system in the following sequence:

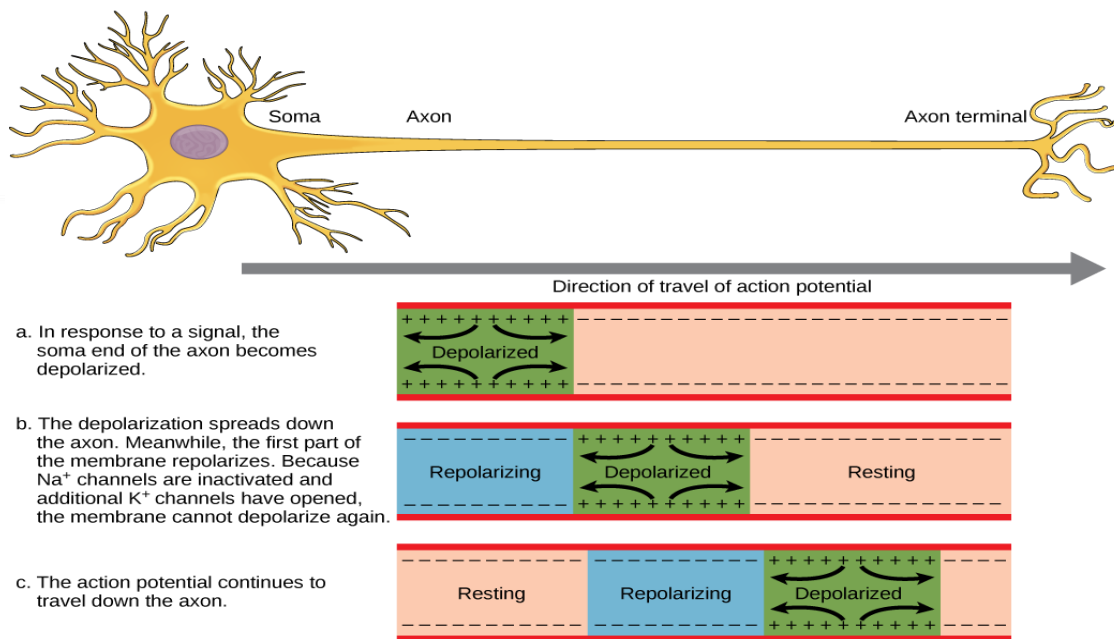


Neuronal signalling

To support the general function of the nervous system, neurons have evolved unique capabilities for *intracellular signalling* (communication within the cell) and *intercellular signalling* (communication between cells).

To achieve long distance, rapid communication, neurons have evolved special abilities for sending electrical signals (action potentials) along axons. This mechanism, called conduction, is how the cell body of a neuron communicates with its own terminals via the axon. Communication between neurons is achieved at synapses by the process of neurotransmission.

Conduction Of A Nerve Impulse



In the resting state, when a neuron is not conducting an impulse, the neuron membrane is in the polarised state.

at the resting state, potassium ion (K^+) concentration inside the axon in axoplasm is more compared to outside the cell and sodium ion (Na^+) concentration is more outside

Propagation of Nerve Impulse and Repolarisation

An action potential is self-propagating.

An action potential is an **all-or-none response** and no variation exists in the strength of a single impulse. The intensity of sensation depends on the number of neurons stimulated and on their frequency of discharge.

Action potential or nerve impulse is an electrical signal that travels rapidly down the axon into the synaptic terminals.

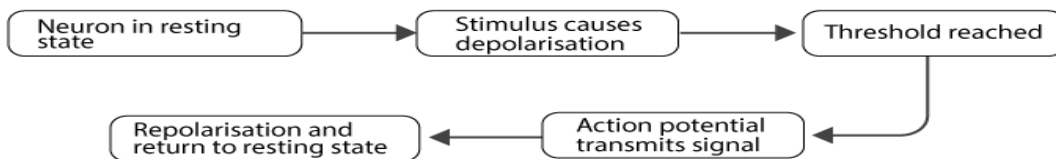
At site B, ahead of where the action potential is generated (site A), the membrane is polarised, i.e. negatively charged inside and positively charged outside so the current flows from A to B at the inner surface and from B to A on the outer surface. This results in the reversal of polarity and the action potential or nerve impulse is generated at site B. The conduction of impulse throughout the length of the axon is the result of a repeated sequence of these steps.

Depolarisation is very rapid so the conduction of nerve impulse along the entire length of axon occurs in a fraction of second.

After a certain period (milliseconds) membrane again becomes impermeable to Na^+ as Na^+ channels close. Voltage activated K^+ channels open resulting in diffusion of K^+ outside the membrane and the resting potential is restored. This is called **repolarisation**.

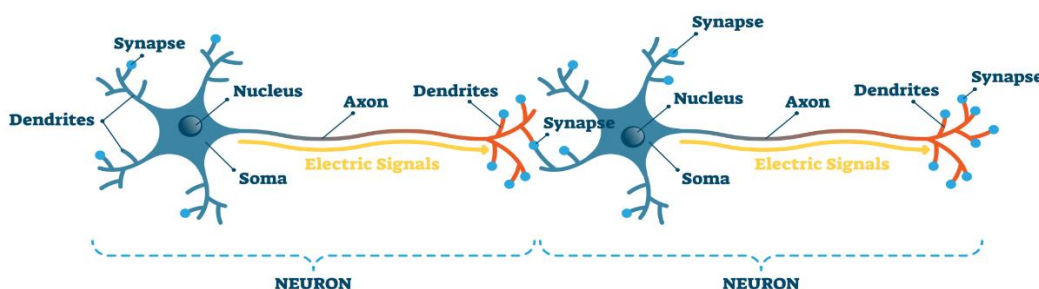
A wave of depolarisation moves down the membrane of axon and the normal polarised state is quickly re-established behind, i.e. known as **repolarisation**. The membrane resting potential is restored and the membrane once more becomes responsive to further stimulation. Most neurons can transmit several hundred impulses per second.

In summary, conduction of impulse along the axon proceeds as follows:



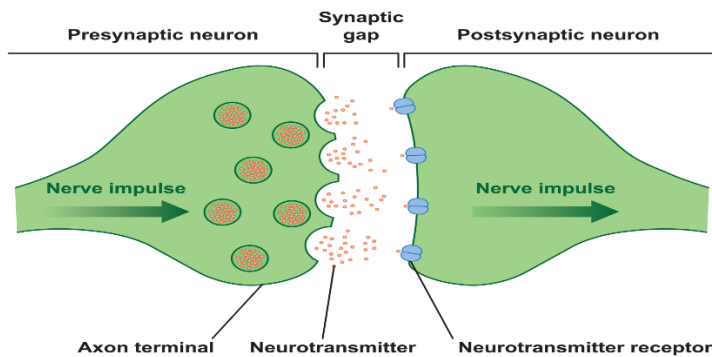
SYNAPTIC TRANSMISSION

- Synaptic transmission is the process by which a nerve impulse passes across the synaptic cleft from one neuron to another.
- It is a method neurons use to communicate, enabling the transmission of information both within a neuron (via electrical signals) and between neurons (via chemical signals).
- Neurons do not make direct contact with each other. Instead, there is a very small gap between them called a synapse.



- Information is transmitted across this gap from a transmitting neuron, known as the presynaptic neuron, to a receiving neuron, called the postsynaptic neuron.

Synaptic Transmission



Synaptic transmission is the process by which nerve cells (neurons) communicate with each other. It involves sending chemical signals across a tiny gap between neurons called the synapse

UNIT 6

NEUROTRANSMITTERS

- Neurotransmitters are your body's chemical messengers. They carry messages from one nerve cell across a space to the next nerve, muscle or gland cell
- They enable the brain to provide a variety of functions, through the process of chemical synaptic transmission. These endogenous chemicals are integral in shaping everyday life and functions.
- Neurotransmitters are located in a part of the neuron called the axon terminal. They're stored within thin-walled sacs called synaptic vesicles. Each vesicle can contain thousands of neurotransmitter molecules.

MAJOR NEUROTRANSMITTERS

1. Amino acids neurotransmitters

These neurotransmitters are involved in most functions of your nervous system.

- **Glutamate.** This is the most common excitatory neurotransmitter of your nervous system. It's the most abundant neurotransmitter in your brain. It plays a key role in cognitive functions like thinking, learning and memory. Imbalances in glutamate levels are associated with [Alzheimer's disease](#), [dementia](#), [Parkinson's disease](#) and [seizures](#).
- **Gamma-aminobutyric acid (GABA).** GABA is the most common inhibitory neurotransmitter of your nervous system, particularly in your brain. It regulates brain activity to prevent problems in the areas of [anxiety](#), irritability, concentration, sleep, seizures and [depression](#).
- **Glycine.** Glycine is the most common inhibitory neurotransmitter in your spinal cord. Glycine is involved in controlling hearing processing, pain transmission and metabolism.

2. Monoamines neurotransmitters

These neurotransmitters play a lot of different roles in your nervous system and especially in your brain. Monoamines neurotransmitters regulate consciousness, cognition, attention and emotion.

- **Serotonin.** Serotonin is an inhibitory neurotransmitter. Serotonin helps regulate mood, sleep patterns, sexuality, anxiety, appetite and pain. Diseases associated with serotonin imbalance include [seasonal affective disorder](#), [anxiety](#), [depression](#), [fibromyalgia](#) and chronic pain. Medications that regulate serotonin and treat these disorders include selective serotonin reuptake inhibitors (SSRIs) and serotonin-norepinephrine reuptake inhibitors (SNRIs).
- **Histamine.** Histamine regulates body functions including wakefulness, feeding behaviour and motivation. Histamine plays a role in [asthma](#), bronchospasm, mucosal edema and [multiple sclerosis](#).
- **Dopamine.** Dopamine plays a role in your body's reward system, which includes feeling pleasure, achieving heightened arousal and learning. Dopamine also helps with focus, concentration, memory, sleep, mood and motivation. Diseases associated with dysfunctions of the dopamine system include Parkinson's disease, [schizophrenia](#), [bipolar disease](#), [restless legs syndrome](#) and [attention deficit hyperactivity disorder](#) (ADHD).
- **Epinephrine.** Epinephrine (also called adrenaline) and norepinephrine are responsible for your body's so-called "fight-or-flight response" to fear and stress. These neurotransmitters stimulate your body's response by increasing your heart rate, breathing, blood pressure, blood sugar and blood flow to your muscles, as well as heighten attention and focus to allow you to act or react to different stressors. Too much epinephrine can lead to [high blood pressure](#), [diabetes](#), heart disease and other health problems. As a drug, epinephrine is used to treat anaphylaxis, [asthma](#) attacks, cardiac arrest and severe infections.
- **Norepinephrine.** Norepinephrine (also called noradrenaline) increases blood pressure and heart rate. It's most widely known for its effects on alertness, arousal, decision-making, attention and focus. Many medications (stimulants and depression medications) aim to increase norepinephrine levels to improve focus or concentration to treat ADHD or to modulate norepinephrine to improve depression symptoms.

3. Peptide neurotransmitters

Peptides are polymers or chains of amino acids.

- **Endorphins.** Endorphins are your body's natural pain reliever. They play a role in our perception of pain. Release of endorphins reduces pain, as well as causes "feel good" feelings. Low levels of endorphins may play a role in [fibromyalgia](#) and some types of headaches.

4. Acetylcholine

This excitatory neurotransmitter does a number of functions in your central nervous system (CNS [brain and spinal cord]) and in your peripheral nervous system (nerves that branch from the CNS).

Acetylcholine is released by most neurons in your autonomic nervous system regulating heart rate, blood pressure and gut motility.

Acetylcholine plays a role in muscle contractions, memory, motivation, sexual desire, sleep and learning. Imbalances in acetylcholine levels are linked with health issues, including Alzheimer's disease, seizures and muscle spasms.

5. Gaseous neurotransmitters

- Nitric oxide (NO) acts as a retrograde messenger at some synapses
- It transmits information from postsynaptic to the presynaptic neuron, i.e. the opposite direction
- Carbon monoxide (CO) is shown to function as a neuromodulator

6. Neuropeptides

These are chemical messengers made up of small chains of [amino acids](#) that are synthesized and released by [neurons](#).

UNIT 7

NEUROTRANSMITTER IMBALANCES

A neurotransmitter imbalance is when there is too much or too little of a brain chemical messenger, affecting mood, sleep, and cognition. This can be caused by issues with production, reuptake, or receptor function, and is linked to many mental health disorders like depression, anxiety, and schizophrenia, as well as neurological conditions like Alzheimer's. _

	HIGH	LOW
Cortisol	Fatigue Inflammation and Allergies Anxiety Poor Sleep Insulin Resistance Immune Suppression	Fatigue Inflammation and Allergies
Dopamine	Developmental Problems Schizophrenia Psychosis Possible increased testosterone production	Lack of Motivation Focus Memory Addictions and Cravings Low Libido/ decreased testosterone Poor motor control/ Tremors
Noradrenaline	Stress and Anxiety Hyperactivity Increased Blood Pressure Pain	Lack of Focus/Energy/Motivation Depression with Apathy
Adrenaline	Insomnia Anxiety Stress Blood Sugar Imbalance Insulin Resistance Allergic reactions	Poor Methylation Lack of Focus Lack of Energy Poor Blood Sugar Control
Glutamate	Neurotoxicity Anxiety Stress Decreased Mood Sleep disturbances	Fatigue Low Brain Function Poor Memory
Serotonin	Headache, mental confusion Sweating, shivering Hypertension, tachycardia Nausea, vomiting Muscle twitching, tremor	Depression/Low Mood Hot Flashes Sleep Difficulties/Anxiety Carbohydrate Cravings Constipation
GABA	Anxiety Tingling of extremities Shortness of breath Numb feeling around the Mouth Throbbing heart	Anxiety Hyperactivity PMS Sleep issues Mood disorders/Anxiety Depression

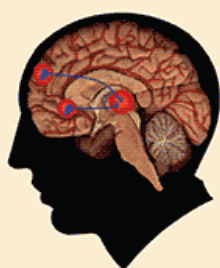
NEUROTRANSMITTER IMBALANCE-DRUG ADDICTION

Pleasure or euphoria—the high from drugs—is still poorly understood, but probably involves surges of chemical signalling compounds including the body’s natural opioids (endorphins) and other neurotransmitters in parts of the basal ganglia (the reward circuit). When some drugs are taken, they can cause surges of these neurotransmitters much greater than the smaller bursts naturally produced in association with healthy rewards like eating, hearing or playing music, creative pursuits, or social interaction.

It was once thought that surges of the neurotransmitter *dopamine* produced by drugs directly caused the euphoria, but scientists now think dopamine has more to do with getting us to repeat pleasurable activities (reinforcement) than with producing pleasure directly.

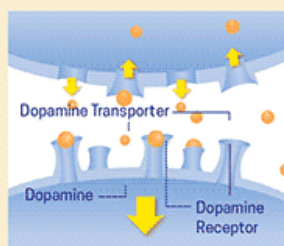
Some drugs target the brain’s pleasure center

Brain reward (dopamine pathways)

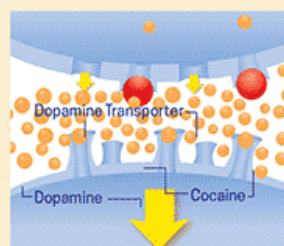


These brain circuits are important for natural rewards such as food, music, and sex.

How drugs can increase dopamine



While eating food



While using cocaine

Typically, dopamine increases in response to natural rewards such as food. When cocaine is taken, dopamine increases are exaggerated, and communication is denied.

For the brain, the difference between normal rewards and drug rewards can be likened to the difference between someone whispering into your ear and someone shouting into a microphone. Just as we turn down the volume on a radio that is too loud, the brain of someone who misuses drugs adjusts by producing fewer neurotransmitters in the reward circuit, or by reducing the number of receptors that can receive signals. As a result, the person's ability to experience pleasure from naturally rewarding (i.e., reinforcing) activities is also reduced.

This is why a person who misuses drugs eventually feels flat, without motivation, lifeless,

and/or depressed, and is unable to enjoy things that were previously pleasurable. Now, the person needs to keep taking drugs to experience even a normal level of reward—which only makes the problem worse, like a vicious cycle. Also, the person will often need to take larger amounts of the drug to produce the familiar high—an effect known as *tolerance*.

UNIT 8

Neuroplasticity OR Brain plasticity

Neuroplasticity is the brain's ability to change and adapt due to experience. It is an umbrella term referring to the brain's ability to change, reorganize, or grow neural networks. This can involve functional changes due to brain damage or structural changes due to learning.

Neuroplasticity allows nerve cells to change or adjust.

Factors That Influence brain plasticity

- **Experience:** Learning environments that offer plenty of opportunities for focused attention, novelty, and challenge have been shown to stimulate positive changes in the brain. This is particularly important during childhood and adolescence, but enriching your environment can continue to provide brain rewards well into adulthood.
- **Sleep:** Sleep plays a role in dendritic growth in the brain, which can encourage greater brain plasticity. Sleep also affects physical and mental health. Some researchers suggest that this is partly due to genetics and partly due to the makeup of the grey matter in the brain.
- **Exercise:** Regular physical activity may prevent neuron loss and encourage the development of new neurons in the hippocampus, a part of the brain involved in memory and other functions. Exercise impacts brain-derived neurotrophic factor (BDNF, a protein that impacts nerve growth), functional connectivity, and the basal ganglia—the part of the brain responsible for motor control and learning.
- **Injury:** The brain can sometimes rewire itself following an injury. However, some damage is permanent. Brain plasticity can be problematic when it allows detrimental changes caused by substance use, disease, or trauma (including brain injury or traumatic experiences that result in post-traumatic stress disorder or PTSD). For example, lead poisoning can negatively impact brain plasticity.

- **Medical conditions:** Some medical conditions can limit or hinder brain plasticity. Among them are a variety of paediatric neurological disorders such as epilepsy, cerebral palsy, tuberous sclerosis, and Fragile X syndrome.

UNIT 9

Neurogenesis

Neurogenesis is the process by which new neurons are formed in the brain. Neurogenesis is crucial when an embryo is developing, but also continues in certain brain regions after birth and throughout our lifespan.

This process is crucial for learning, memory, and emotional regulation, and it can be stimulated by factors like exercise, learning new things, and social interaction. Conversely, stress, poor diet, and aging can negatively impact neurogenesis.

Key aspects of neurogenesis

- **Formation of new neurons:** Neurogenesis is the creation of new nerve cells (neurons) from neural stem cells.
- **Occurs throughout life:** While the majority of neuron formation happens during development, the brain continues to generate new neurons into adulthood.
- **Specific brain regions:** In adults, neurogenesis occurs primarily in the hippocampus (specifically the sub granular zone) and the sub ventricular zone (SVZ).

Factors that promote neurogenesis:

- **Exercise:** Regular aerobic activity can increase the rate of neurogenesis.
- **Learning:** Engaging in new learning experiences can stimulate the brain to create new neurons.
- **Social interaction:** Socializing can positively influence neurogenesis.
- **Diet:** Diets rich in [polyphenols](#) and [polyunsaturated fatty acids](#) may promote neurogenesis.

Factors that inhibit neurogenesis:

- **Stress and sleep deprivation:** These can decrease the rate of new neuron formation.
- **Aging:** The process naturally declines over time.

- **Certain diets:** High-fat and high-sugar diets can negatively affect neurogenesis.

Brain mapping

According to the definition established in 2013 by Society for Brain Mapping and Therapeutics (SBMT), brain mapping is specifically defined, in summary, as the study of the anatomy and function of the brain and spinal cord through the use of imaging, immunohistochemistry, molecular & optogenetics, stem cell and cellular biology, engineering, neurophysiology and nanotechnology.

Synaptic pruning

Synaptic pruning is a natural process that occurs in the brain between early childhood and adulthood. During synaptic pruning, the brain eliminates extra synapses. Synapses are brain structures that allows the neurons to transmit an electrical or chemical signal to another neuron.

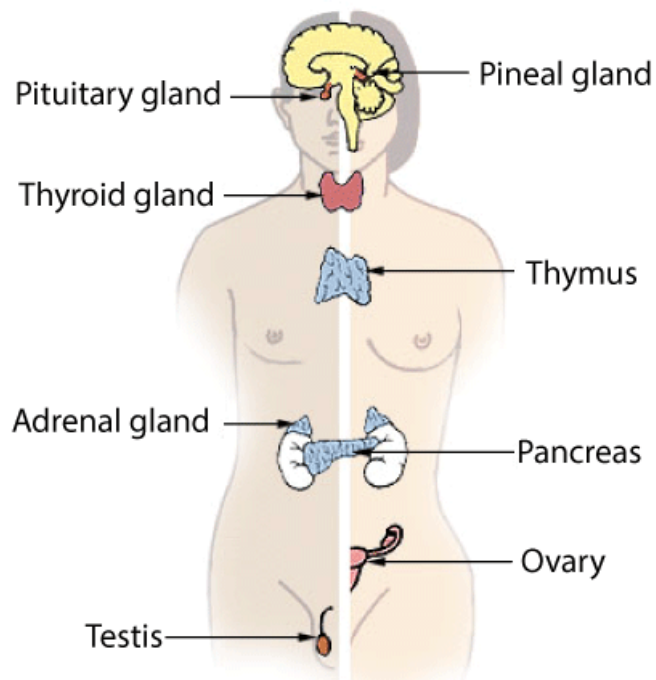
MODULE -3

HORMONAL AND GENETIC INFLUENCES ON BEHAVIOUR

UNIT-1 MAJOR ENDOCRINE GLANDS AND THEIR HORMONES

Animals including humans have a complex living system. In the case of animals, they have the nervous system and endocrine system for control and coordination. The Endocrine System is responsible for chemical coordination. Numerous involuntary physiological activities are under the control of the endocrine system. It consists of glands which release hormones. Endocrine glands are also called ductless glands. Hormones play a vital role in various activities in the body including growth and development. They also support the nervous system.

Endocrine glands in animals are the hypothalamus, the pituitary gland, the pineal gland, the thyroid, the parathyroid, the thymus, the pancreas, the adrenal gland and the gonads.



Different endocrine glands along with the hormone they release are given below:

Hypothalamus

This gland is a part of the brain that consists of neurosecretory cells. They connect both the nervous and the endocrine system. The hypothalamus secretes various releasing hormones like gonadotropin-releasing hormones and **growth hormone**-releasing hormones. These hormones act on the pituitary gland to stimulate other glands.

Hypothalamus is a minute region, almost the size of an almond, present at the centre of the human brain, near the pituitary gland.

It consists of three main regions:

- The anterior region.
- The middle region.
- The posterior region.

It plays a vital role in the production of hormones. Maintaining the hypothalamus health is very important. Its improper functioning causes several disorders.

Hormones Secreted by Hypothalamus

The anterior region of the hypothalamus is responsible for hormone secretion. The nuclei present in this region lead the process. The important hormones secreted by hypothalamus are:

1. **Corticotropin-Releasing Hormone:** This hormone is responsible for the regulation of metabolic and immune response.
2. **Thyrotropin Releasing Hormone:** It triggers the pituitary gland to release a thyroid-stimulating hormone which plays a major role in the functioning of organs of the body such as heart, muscles, etc.
3. **Gonadotropin-Releasing Hormone:** It stimulates the pituitary gland to release several reproductive hormones.
4. **Oxytocin:** It is involved in several processes such as lactation, childbirth, regulating sleep cycles, maintaining body temperature.
5. **Somatostatin:** This hormone is also known as Growth Hormone Inhibiting Hormone. It regulates the endocrine system and affects the neurotransmission and cell proliferation by interacting with G-protein coupled receptors.

The middle region of hypothalamus stimulates the release of Growth Hormone Releasing Hormone. This hormone plays a major role in the growth and development of the body.

Pituitary Gland

The pituitary gland is the master gland. It is a pea-sized gland that is located at the bottom of the brain. It controls and regulates other glands in the body. Hormones released by this gland are growth hormone, thyroid-stimulating hormone, LH, FSH etc.

The Pituitary gland, also known as the hypophysis, is a pea-sized endocrine gland situated at the base of our brain. It is often referred to as the 'Master Gland' because it produces some of the important hormones in the body. It is situated in a bony structure called the Pituitary fossa, just below the hypothalamus, close to the optic nerve. The pituitary gland is divided into three parts, also called lobes:

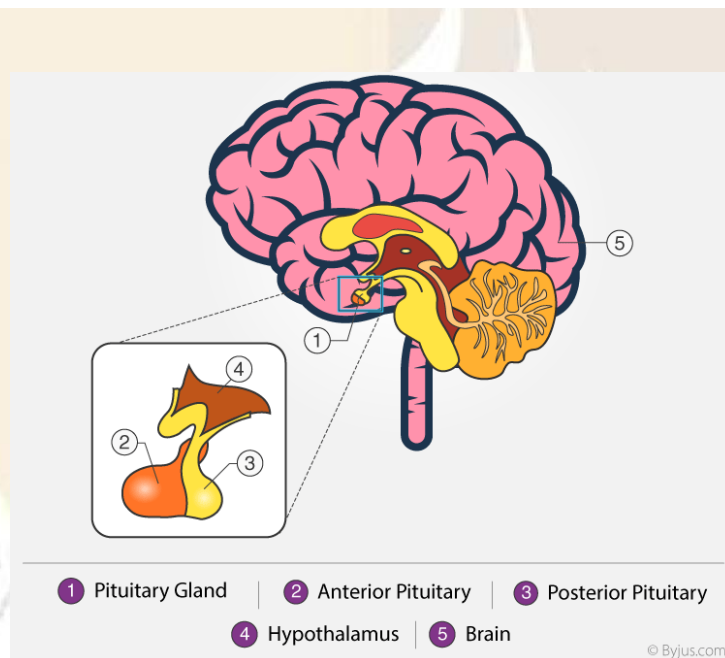
- Anterior pituitary
- Intermediate pituitary (Absent in adult human beings)
- Posterior pituitary

Anterior Pituitary Hormones

The anterior pituitary is responsible for the synthesis and secretion of several key hormones in the body. These hormones include:

- **Human Growth Hormone (HGH):** Responsible for the growth and repair of all cells in the body.

- **Thyroid Stimulating Hormone (TSH):** Influences the thyroid gland for the release of thyroxine, its own hormone. TSH is also called Thyrotropin.
- **Adrenocorticotrophic Hormone (ACTH):** Influences the adrenal gland to release of Cortisol or the “stress hormone”. ACTH is also known as corticotropin.
- **Luteinising Hormone (LH) and Follicle-Stimulating Hormone (FSH):** Collectively known as Gonadotropins, LH and FSH control the sexual and reproductive characteristics in males and females.
- **Prolactin (PRL):** Produces milk in the breast. Though it is present at all times, the secretion is increased during and just after pregnancy.
- **Melanocyte-Stimulating Hormone (MSH):** Involved in the stimulation of the production of melanin by skin and hair.



Posterior Pituitary Hormones

The posterior pituitary is responsible for the storage and secretion of two very important hormones:

Antidiuretic Hormone (ADH): Controls the water balance of the body by affecting reabsorption of water by the kidneys

Oxytocin: Controls certain aspects of pregnancy and childbirth such as uterine contraction and production of milk.

Pineal Gland

This gland is also located in the brain. It releases the hormone called melatonin which regulates the wake-up and sleep clock and helps in **immunity** etc.

It is a pinecone-shaped small gland located in the middle of the human brain in between the two hemispheres in an area called epithalamus. It was once known as “the third eye”. It is the major site for melatonin secretion, which regulates the body’s internal clock (Circadian rhythm).

This gland is rich in calcium levels. The calcium acts as a radiopaque to locate the middle of the brain in X-ray images. It was also one of the last glands to be discovered.

Hormones Secreted by Pineal Gland– Melatonin

The pineal gland synthesises melatonin and serotonin, hence they are also called as the Pineal Gland Hormone. The pineal gland also produces neurosteroids.

Serotonin is the precursor of melatonin. Serotonin is acetylated and methylated to yield melatonin within the pineal gland. The light exposure to the eyes affects the synthesis and secretion of melatonin.

Two melatonin receptors have been found in mammals- Mel1A and Mel1B. These are G-protein coupled cell surface receptors.

Melatonin affects circadian rhythm.

Our circadian rhythm is a 24-hour biological cycle, characterised by the sleep-wake patterns. The daylight and darkness regulate our circadian rhythms. The secretion of melatonin is stopped on exposure to light which in turn controls the circadian rhythm. The secretion of melatonin is high during dark and low during daylight. This influences our reaction to photoperiod.

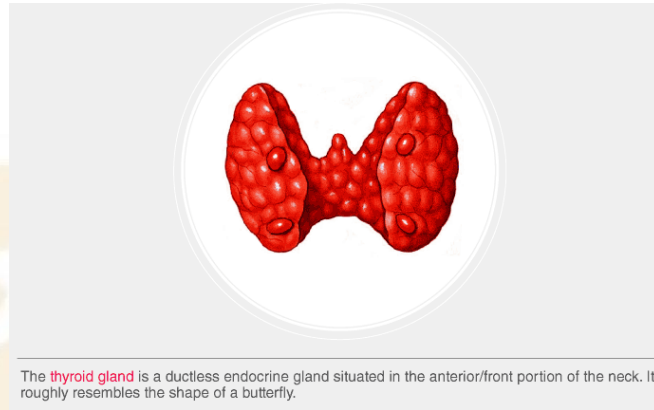
The secretion of gonadotropins from the anterior **Pituitary gland** is blocked by melatonin thereby affecting reproduction. These hormones aid in the development of ovaries and testes.

Thyroid gland

This is a butterfly-shaped paired gland located in the neck region. It releases the hormones triiodothyronine (T3) and thyroxine (T4). These hormones regulate body metabolism. Iodine is vital for thyroxine synthesis. Its deficiency leads to a disease called goitre.

The thyroid gland is a ductless endocrine gland situated in the anterior/front portion of the neck. It roughly resembles the shape of a butterfly. It is also one of the largest endocrine glands, weighing an average of 25 – 30 g. This gland has two lobes on either side of the trachea, with each lobe measuring 4 – 6 cm in length and 1.3 – 1.8 cm in width.

The primary function of the thyroid gland is to secrete two hormones, namely, Triiodothyronine (T3) hormone and the Thyroxine hormone (T4). Both T3 and T4 hormones play a very important role and affect almost every tissue in the body.



Thyroid Hormones

There are two thyroid hormones:

- T4: Thyroxin (Tetraiodothyronine)
- T3: Triiodothyronine

T4

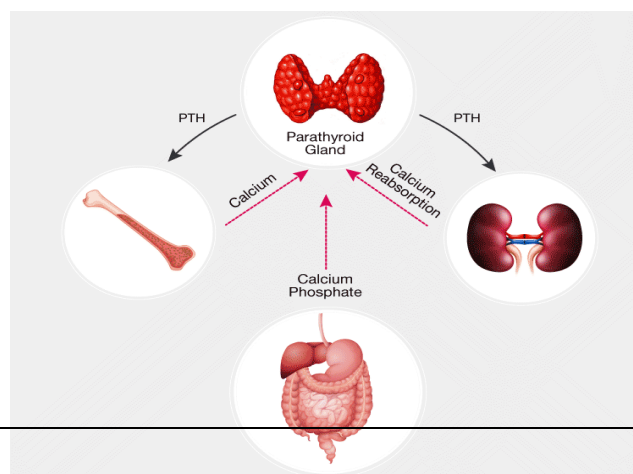
Thyroxine is a hormone secreted by the thyroid gland in the bloodstream. It then travels to the organs such as kidneys and liver where it gets converted into and gets converted into its active form triiodothyronine.

T3

It is a thyroid hormone that affects physiological processes such as growth, development, metabolism, etc.

Parathyroid Gland

This gland is located near the Thyroid gland in the neck region. The hormone released by this gland is called Parathyroid hormone, which regulates calcium and phosphorus level in bones.



Pancreas

The pancreas is an endocrine as well as an exocrine gland. That is why the Pancreas is also known as a mixed gland. The pancreas secretes hormones like glucagon and insulin; these two hormones balance the blood sugar level in the body. Other hormones secreted are somatostatin and pancreatic polypeptide.



The pancreas secretes digestive enzymes such as amylase, proteases and lipase into the duodenum. These enzymes help in digesting sugar, proteins and fat respectively. Islets of Langerhans are embedded in the pancreas that secretes hormones such as insulin and glucagon into the blood.

Pancreas Function

The pancreas performs the following functions:

Exocrine Function

The pancreas consists of exocrine glands that produce enzymes trypsin and chymotrypsin that are essential for digestion. These enzymes contain chymotrypsin and trypsin to digest proteins, amylase for the digestion of carbohydrates and lipase to break down fats. These pancreatic juices are liberated into the system of ducts and culminated in the pancreatic duct when the food enters the stomach.

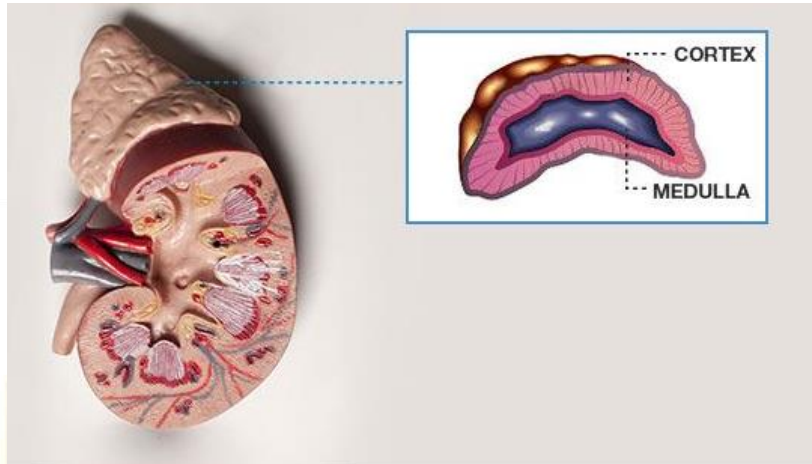
Endocrine Function

The endocrine part of the pancreas comprises Islets of Langerhans that release insulin and glucagon directly into the bloodstream. They help in regulating the blood sugar levels of the body.

Adrenal Glands

Adrenal glands have two regions known as the adrenal cortex and adrenal medulla.

The cortex region of the adrenal gland secretes the hormones cortisol, aldosterone, and androgens while the medulla region secretes the hormones adrenaline and noradrenaline. Adrenaline is the hormone responsible for the fight or flight response of the body in times of emergency.



Adrenal Gland Hormones

- **Epinephrine:** Also called adrenaline, this hormone rapidly responds to stress by increasing the heart rate and raising blood glucose levels in the blood.
- **Norepinephrine:** Also called noradrenaline, this hormone works with epinephrine in reacting to stress. Its primary function is to mobilize the body and brain for action.
- **Hydrocortisone:** It is commonly known as cortisol or a steroid hormone. It is involved in regulating body functions like the conversion of fats, and carbohydrates to energy and also plays a vital role in other metabolic processes.
- **Corticosterone:** This hormone works with hydrocortisone to control the immune response and prevents inflammatory reactions.

Gonads

Gonads are reproductive glands present in males and females. The male gonad is the pair of testes which secretes the hormone testosterone. This is responsible for the secondary sexual characteristics in males. The female gonad consists of a pair of ovaries. They secrete two hormones estrogen and progesterone. Both of these regulate secondary sexual characteristics in females.

Gonads are the female and male reproductive organs. Testes are the male gonads and ovaries in females. These reproductive organs are essential for sexual reproduction since they are responsible for the production of male and female gametes. Gonads are also responsible for producing sex hormones required for the development and growth of primary and secondary sexual characteristics.

Gonads: Sex Hormones

Being a component of [Endocrine system](#), both male and female gonads generate sex hormones. The sex hormones are steroid hormones and can pass through the cell membrane of their target cells. Gonadal hormones are regulated by hormones secreted by the pituitary gland in the brain. Hormones that are responsible for

stimulating the gonads to produce sex hormones are called gonadotropins. The gonadotropins called luteinizing hormone (LH) and follicle-stimulating hormone (FSH) are secreted by the pituitary.

Female Gonad Hormones

The major hormones of the ovaries are progesterone and estrogens.

Estrogens – It is a group of female sex hormones essential for reproduction and the development of the female reproductive system. Estrogens are responsible for maturation and growth of the vagina and uterus, widening of pelvis, breast and the uterus changes during the menstrual cycle, and increasing growth of hairs on the body.

Progesterone – These are the hormones whose function is to prepare the uterus for conception, regulating changes in the uterus during the [Menstrual cycle](#), ovulation aids, and stimulating gland development for the production of milk during pregnancy.

Male Gonad Hormones

Androgens are hormones that majorly influence the development of the male reproductive system.

Testosterone is responsible and essential for increased growth of bone and muscle, growth of body hair, developing broader shoulder, voice deepening and growth of the penis.

Androstenedione – These are the hormones that act as a precursor to estrogens and testosterone.

Inhibin – These hormones inhibit the release of FSH and thought to be involved in sperm cell regulation and development.

Hormone Action

A Hormone is a tiny chemical messenger, travelling along with the bloodstream. It exists to maintain internal balance or in other words, keeps the human body in a state of [homeostasis](#).

This is an extremely rudimentary definition of hormones, as in reality there are numerous hormones that perform an immense number of functions for various purposes.

Starting with receptors, they are specific for every hormone. Their sensitivity and responsiveness are dependent on both, the number of receptors and its affinity. Also, the site of the receptor might be:

- Present in or on the surface of the cell membrane. g. protein or peptide hormones and catecholamines.
- In the cytoplasm. E.g. steroid hormones; Or
- In the cell nucleus. E.g. thyroxine.

Furthermore, hormones can be divided into groups on the basis of their chemical nature:

- Peptide, polypeptide, protein hormones.
- Steroids
- Iodothyronines (thyroid hormone).
- Amino acid derivatives.

The [hormones](#) that interact with membrane-bound receptors generally don't enter target cells, rather generate second messengers that proceed to regulate cellular metabolism.

On the other hand, hormones which interact with intracellular receptors mostly regulate gene expression or chromosome function by the interaction of hormone receptor complex with the genome. The sum total of all the biochemical actions results in physiological and developmental effects.

Mechanism of Hormone Action

The mechanism of hormone action is grouped into two classes:

- Fixed membrane receptor mechanism
- Mobile receptor mechanism

Fixed Membrane Receptor Mechanism

This type of mechanism is shown by the water-soluble hormones that are amines or proteins in composition such as the growth hormone, oxytocin, ADH, etc.

These hormones can't pass through the lipid membrane. They have their target receptor on the cell membrane to which the hormone binds.

When the hormone binds on the specific target receptor, the enzyme adenylyl cyclase in the cell membrane is activated. This helps in the production of cyclic AMP (cAMP).

cAMP acts as the secondary messenger. It diffuses through the cell membrane and activates several enzymatic reactions to cause biochemical changes.

The target cell responds to these changes and cAMP is deactivated by the enzyme phosphodiesterase.

Mobile Receptor Mechanism

This type of mechanism is shown by lipid soluble hormones such as fatty acids and steroids that can easily pass through the plasma membrane.

They possess intracellular receptors. The hormones bind to the target receptor that activates the enzymatic activity of the cell to bring about biochemical changes.

Transcription of DNA is initiated by the hormone-receptor complex.

The mRNA is translated into protein. This protein causes biochemical changes inside the cell.

UNIT -3 GENETICS AND BEHAVIOUR

Behavioural genetics is the study of how genetic makeup (genotype) and environmental factors (nurture) combine to influence behaviour (phenotype) in humans and animals.

Genetics and behaviour is a field that examines how heredity (genes) and environment interact to influence behaviour, personality, intelligence, mental health, and psychological traits. Behaviour is not determined by genes alone; rather, it is the result of a complex interaction between genetic predispositions and environmental experiences.

Basic Concepts in Genetics

Gene

A gene is the basic unit of heredity made up of DNA. Genes carry instructions for the development and functioning of the body and brain.

Chromosomes

Chromosomes are thread-like structures found in the nucleus of cells. Humans have 23 pairs of chromosomes (22 pairs of autosomes and 1 pair of sex chromosomes).

DNA (Deoxyribonucleic Acid)

DNA is the chemical substance that carries genetic information. It has a double-helix structure.

Alleles

Alleles are alternative forms of a gene. For example, a gene for eye colour may have different alleles.

Genotype and Phenotype

- **Genotype:** The genetic makeup of an individual.
- **Phenotype:** The observable characteristics or behaviour resulting from the interaction of genotype and environment.

Role of Genetics in Behaviour

Genes influence:

- Brain structure and functioning
- Neurotransmitter activity
- Hormonal regulation
- Temperament and emotional responses

Nature vs Nurture Debate

Nature vs. nurture" is the ongoing debate about whether human traits, behaviours, and development are primarily shaped by **genetics and inherited biology (nature)** or by **environmental influences, upbringing, and experiences (nurture)**, with modern science recognising it's a complex interaction, not an either/or, where genes and environment constantly influence each other. Nature refers to our biological "pre-wiring," while nurture encompasses everything after conception, from parenting to culture.

Nature (Genetics)

- **Definition:** Your inherited DNA, biological makeup, and genetic predispositions.
- **Examples:** Eye colour, blood type, predisposition to certain diseases, or natural temperament

Nurture (Environment)

- **Definition:** All external influences, experiences, learning, and care after conception.
- **Examples:** Parenting styles, education, diet, social interactions, culture, and life events.

Heritability

Heritability is a statistical estimate that indicates how much variation in a trait within a population is due to genetic differences.

Examples of Traits with Genetic Influence

- Intelligence
- Personality traits
- Temperament
- Mental disorders

Methods of Studying Genetics and Behaviour

Twin Studies

- **Monozygotic (Identical) twins:** Share 100% of genes
- **Dizygotic (Fraternal) twins:** Share about 50% of genes

Higher similarity in identical twins suggests genetic influence.

Adoption Studies

Compare adopted children with biological and adoptive parents to separate genetic and environmental effects.

Family Studies

Examine similarities in behaviour among family members across generations.

Genetics and Aggression

- Genetic factors influence impulsivity and emotional regulation
- Neurotransmitters like serotonin are genetically regulated
- Environment plays a major role in shaping aggressive behaviour

Genetics and Addiction

- Genetic predisposition affects vulnerability to substance use
- Reward system in the brain is influenced by genes
- Environmental exposure is necessary for addiction to develop

Behaviour is influenced by both genes and environment

Genes provide predispositions, not destiny

Modern psychology supports an interactionist and epigenetic perspective

Understanding genetics helps in prevention, intervention, and mental health care

Epigenetics

Epigenetics refers to the study of heritable changes in gene expression that do not involve alterations in the DNA sequence itself. These changes determine whether certain genes are turned **on** or **off**.

Epigenetics and Behaviour

- Explains individual differences in behaviour
- Early experiences shape emotional regulation and stress response
- Helps understand learning, memory, and personality development

UNIT 4 SEX-LINKED AND SEX LIMITED GENES, GENE MUTATION AND GENETIC DISORDER, HEREDITY AND ENVIRONMENT, EVOLUTION OF BEHAVIOUR

SEX-LINKED AND SEX LIMITED GENES

Sex-linked genes are on sex chromosomes (X/Y) causing traits like colour blindness, while sex-limited genes are on autosomes but expressed only in one sex (e.g., milk production in females, beard growth in males), controlled by sex hormones, leading to different appearances between sexes despite same gene presence. The key difference is gene location and expression control: sex-linked traits show distinct patterns because of sex chromosome inheritance, whereas sex-limited traits are "turned off" in one sex by hormonal differences.



BIOLOGICAL BASIS OF BEHAVIOUR
MODULE 4 –METHODS & STRATEGIES OF RESEARCH

UNIT-1 EXPERIMENTAL ABLATION

Experimental ablation is a technique used in neuroscience to study the function of specific brain areas by intentionally damaging or removing them and observing the resulting behavioural or physiological changes.

This method allows researchers to infer the role of a specific brain region in a particular cognitive function, behaviour, or neurological process.

The ablation process can be performed through various means, including surgical removal, chemical lesioning, or the use of neurotoxins that selectively target certain types of neurons.

The choice of technique depends on the research objective and the nature of the brain region being studied. For example, a surgical ablation might involve removing a small portion of brain tissue using precise surgical tools, while a chemical ablation might involve injecting a neurotoxin that selectively destroys neurons in a targeted area.

Types of Ablation

1. **Surgical Ablation:** This involves the physical removal of a specific brain region. It requires a high level of precision to avoid damage to surrounding tissues. It is often used to study the effects of large brain regions and is more invasive compared to other methods.
2. **Chemical Ablation:** This method uses neurotoxins or other chemicals that selectively destroy specific types of neurons. An advantage of this technique is its ability to target specific neural populations, preserving the architecture of surrounding tissues.
3. **Electrical Ablation:** This involves using electrical current to destroy targeted brain tissue. It is highly controlled and can focus on very specific locations within the brain. However, it can sometimes damage surrounding areas if not applied carefully.
4. **Reversible Ablation:** Also known as temporary inactivation, this method involves cooling or applying drugs like tetrodotoxin to temporarily disable a brain area without causing permanent damage. This approach allows researchers to study the transient effects of ablation and compare them with pre- and post-ablation conditions.

Applications and Implications

- The experimental ablation method has been crucial in understanding the brain's functional organisation. For example, early studies by Pierre Flourens in the 19th century

using this method revealed that different brain areas have distinct functions, such as motor coordination, vision, and hearing.

- Modern applications include studying the effects of ablation in animal models to understand human neurological diseases, such as Parkinson's disease, Alzheimer's disease, and epilepsy. However, ethical considerations, especially regarding the welfare of animal subjects, remain a concern.
- While experimental ablation provides valuable insights into brain function, it is not without limitations. The main drawback is that it is invasive and often irreversible, making it unsuitable for human research.
- Additionally, ablation studies can sometimes yield ambiguous results due to the complex interconnectedness of brain regions. Researchers must carefully design experiments to isolate the effects of ablation and interpret findings accurately.

Conclusion

Experimental ablation remains a powerful technique in neuroscience research, providing valuable insights into the functional organisation of the brain. Despite its limitations and ethical concerns, it continues to be a foundational method for understanding the neural basis of behaviour and neurological disorders.

UNIT 2 – LESION STUDY, STEREOTAXIC SURGERY, HISTOLOGICAL METHOD TRACING NEURAL CONNECTIONS

Lesion study

A **lesion study** is a research method in neuroscience and biological psychology in which damage (lesion) to a specific part of the brain is studied to understand its function. By observing changes in behaviour, cognition, or emotions after brain damage, researchers identify the role of that brain area.

A **lesion** refers to any destruction or abnormal change in tissue due to:

- Injury
- Stroke
- Tumor
- Infection
- Surgical removal
- Experimental damage (mainly in animals)

Types of Lesion Studies

1. Natural Lesions (Accidental Damage)

Damage occurs naturally due to stroke, trauma, or disease.

Example: Phineas Gage

- Iron rod passed through his frontal lobe.
- After the accident, his personality changed.
- Helped scientists understand the role of the **frontal lobe in personality and decision-making**.

2. Experimental Lesions (Animal Studies)

Researchers intentionally damage specific brain areas in animals to study behavioural changes.

- Done under controlled laboratory conditions.
- Used in early brain research.
- Raises ethical concerns.

3. Temporary Lesions (Reversible)

Modern techniques temporarily disrupt brain activity without permanent damage.

Example:

- **TMS (Transcranial Magnetic Stimulation)** – temporarily deactivates parts of the brain.

Important Brain Areas Studied Using Lesion Method

Frontal Lobe

- Personality
- Decision making
- Impulse control

Occipital Lobe

Vision

Broca's Area

Speech production discovered through:

Paul Broca

- Patient “Tan” could understand language but could not speak properly.
- Led to discovery of **Broca’s area** in left frontal lobe.

Advantages of Lesion Studies

- Helps identify specific brain functions.
- Established foundation of neuropsychology.
- Provides real evidence of brain–behaviour relationship.

Limitations of Lesion Studies

- Ethical issues (especially in animals).
- Brain functions are interconnected (not always localized).
- Damage is often widespread, not precise.
- Difficult to generalize findings.

