PreMed.PK

COORDINATION &CONTROL

High Yield Notes

NOTES

NOTES COORDINATION AND CONTROL

COORDINATION IN PLANTS

- The plant responds to a variety of stimuli like animals some of their parts having special tissues which produce special chemicals for control mechanism and also function as coordination chemicals.
- These chemical messages are called hormones.
- The plant hormones are also called phytohormones or growth regulators.

Mechanism of Control and Coordination In Plants:

1.The plant hormones control and coordinate the plant responses in two ways.

- By shaving movement and regulating various metabolic functions.
- By controlling and initiating growth at various regions of plants.

- The first phytohormone was discovered by Fret Went in1926 while studying the phenomenon of phototropism in oat coleoptiles. He used the name Auxin (to increase) for this hormone.

Biological Clock and Circadian Rhythms:

- Living organisms when they repent their biological or behavioral activities at regular intervals, this behavior is called biological rhythms or biorhythms.
- The rhythmic movement of plants is not only controlled by light intensity and temperature changes but due to an independent time measuring system called biological clock.
- When biorhythms occur with a frequency of about 24hrs then they are called circadian rhythms e.g. a bean plant will continue its sleep movement even if kept in constant light or darkness.

NOTES

Photoperiodism:

- The response of plants to relative length of the day and night is called photoperiodism.

Responses to Environmental Stresses:

- Changes in environmental conditions are the big threats for living organisms especially for plants. These factors which change the normal condition of light, CO_2, nutrients, temperature, etc. cause severe stresses on plants. The common environmental stresses for plants are.

1. Water Shortage:

In dry conditions, the guard cells of the leaf become flaccid to close the stomata. In this way the transpiration is stopped. The dry condition also stimulates increased synthesis and release of abscisic acid. This hormone helps in keeping the stomata close. These plants produce a deeper root system.

2.Oxygen Deficiency:

Those plants which grow in wet habitats or marches, they develop aerial roots to absorb oxygen.

3. Salt Stress:

The plants, especially halophytes, have salt glands in their leaves where desalination occurs.
Those plants which grow in saline soil are called halophyte.

4. Heat Stress:

In plants there are two methods to tolerate heat stress
Transpiration has a cooling effect on the plant body. By this method the effect of heat is reduced. About 40°C plant cell start synthesizing relatively large quantities of special proteins called heat shock proteins

5. Cold Stress:

Plants respond to cold stress by altering the lipid composition of membranes. In freezing conditions, changes in solute composition of cells also occur by producing different polymers of fructose (fructans) which allow the cytosol to super cool without ice formation.

6. Responses to Herbivory:

Plants overcome excessive herbivory by developing forms and production of distasteful or toxic compounds.

NOTES

Plant Hormones (Phytohormones):

Introduction:

- Phytohormones are synthesized by plants in minute concentration and exert their effect by alteringing gene expression or inhibiting enzymes or changing properties of membranes.

Types of Phytohormones:

There are 5 types listed below.

1.Auxin:

Discovery:

The first auxin was discovered by Fret Went in 1926.

Chemical Nature:

- Indole Acetic Acid (IAA)
- Indole butyric Acid (IBA)
- Naphthalene acetic acid (NAA)

Site of Synthesis:

It is synthesized at the apices of stem and root, young leaves and young embryo.

Role of Auxin:

Cell division and cell elongation. It stimulates cell division and cell enlargement and brings about an increase in the length of the plant.

Initiation of Roots:

Auxin also initiates development of adventitious roots when applied at the cut base of stem.

Abscission:

In nature leaves and fruits when auxin production diminishes, a layer of these walled cells is formed at the base of petiole and stalk of fruits. This layer is called the abscission layer and causes fall of leaves and fruit with slight jerk.

Growth of Fruits:

Auxin produced in young embryo promotes the growth of fruit.

Parthenocarpy:

Use of Auxin helps in producing parthenocarpy or seedless fruits.

Apical Dominance:

Besides growth promoting function, auxin also has inhibitory effect on growth. Growth of apical bud inhibits growth of lateral buds beneath the stem. This phenomenon is termed as apical dominance, removal of apical buds initiates growth of lateral buds with more leaves and axillary bud.

Weedicide:

Auxins are selective weed killer.. 2-4 dichlorophenoxyacetic acid (2-4-D) is used to kill weeds in lawns and cereal crops.

NOTES

2.Giberillins:

Discovery:

T. Yabuta and T. Hayashi discovered a fungus called Gibberella fujikuroi. This fungus causes foolish seedling disease in rice. In this disease the infected rice seedlings elongate and ultimately fall over without producing gains.

Chemical Nature:

The chemical nature of Gibberellins is Gibberellic acid. 70 types of gibberellins have been discovered. Role of Gibberellin: Cell division and cell elongation. Also promotes cell division and cell elongation.

Control of dwarfism:

Gibberellins can control genetic and physiological dwarfism in plants.

Seed Germination:

They promote the synthesis of alpha-amylase enzyme is dormant seed due to the production of this enzymes start to germinate.

Parthenocarpy:

These hormones help in the formation of seedless fruits which are called parthenocarpic fruits. Increase of crop yield: The crop yield of sugar cane can be increased by the application of gibberellin about 50 tons / acre.

Formation of flower and growth of pollen tube:

They stimulate flowering and the growth of pollen tubes during fertilization.

3.Cytokinins:

Discovery:

Miller discovered coconut milk.

Chemical nature:

Chemically there are two types.
Kinetin: It is synthetic cytokinin.
Zeatin: It is found in maize grain.

Role of Cytokinin:

Cell Division(they initiate rapid cell division only in the presence of auxin).

Delay in senescence:

They also cause delayed senescence.

Breaking of seed dormancy:

They break seed dormancy and promote fruit development in some species.
.

NOTES

4.Abscisic acid

In contrast to growth promoting hormones, abscisic acid is a growth inhibitor produced by plants during adverse environmental conditions such as drought conditions.

Role of abscisic acid:

It increases dormancy in buds and seeds. It causes stomata to close. It turns leaf primordia into scales.

5.Ethene

It is a gas which also acts as a growth inhibitor.

Role of ethene:

It triggers ripening of fruits. It contributes in leaf abscission and also breaks dormancy of seeds and buds. It also initiates flowering in plants e.g. pineapple.

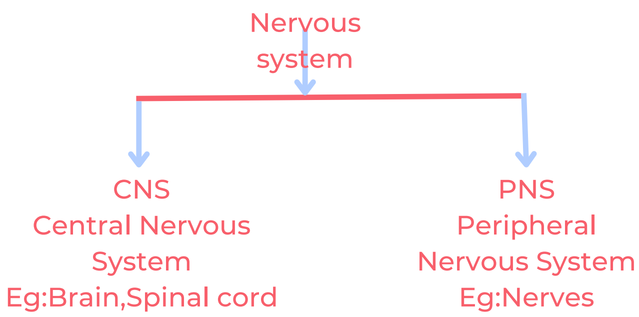
Hormones	Germination	Growth to maturity	Flowering	Fruit Development	Abcission	Seed Dormancy
Gibberellins	✓	✓	✓	✓	✗	✗
Auxins	✗	✓	✓	✓	✗	✗
Cytokinins	✗	✓	✓	✓	✗	✗
Ethylene	✗	✗	✓	✓	✓	✗
Abscisic acid	✗	✗	✗	✗	✓	✓

NOTES

COORDINATION IN ANIMALS

Steps Involved in Nervous Coordination:

Nervous coordination is brought about by means of the nervous system. In this method communication takes place by electrochemical message called nerve impulse.



Coordination:

- This type of coordination involves specialized cells or neurons linked together directly or indirectly via the central nervous system to form a network that connects the cell or organs which receives stimuli and those which carry out actions or responses.
- The neurons have the capacity to generate and conduct impulses which travel across the synapse.
- Three basic components of nervous system are:

Receptors:

- Neurons receive information about any change in external or internal environment of the body through sensory cells on organs called receptors for e.g. skin.

Neurons

Effectors:

- The organs tissues or cells of the body which translate the message of central nervous system into an action are called effectors. E.g. muscles.

NOTES

Sensory Receptors and Their Working:

- A cell or a neuron or a receptor organ which can detect changes in the external and internal environment of the animal is called a receptor.
- It acts as a transducer because it converts one form of energy into to another form. Receptors are classified based on stimuli as shown below:

Types	Locations	Functions	Subtypes
Photoreceptors	Retina of eye	Detect light stimuli	Rod cells Cone cells
Mechanoreceptors	Skin, Blood vessels	Changes in pressure,position or acceleration	Meissner's corpuscles Pacinian corpuscles Baroreceptors
Thermoreceptors	Mostly found in the skin Hypothalamus	Detect temperature stimuli.	Cold Warm
Chemoreceptors	Nasal epthelium Tongue Hypothalamus	Detection of ions or molecules Smell Taste Blood pressure	Osmoreceptors Olfactory receptors Gustation receptors
Nociceptors	Skin Joints Internal organs	Detect pain	

Working of Sensory Skin Receptors:

- At least 5 different sensations are perceived by the skin, i.e., touch, pressure, heat, cold and pressure.
- There are at least 5 different types of sensory endings concerned with these sensations:

Receptor	Locations	Structure	Sensation
Free Nerve Endings	At the base of hair	Free nerve endings	Touch
Meissner's corpuscles	In papillae which extend into ridges of fingertips.	Specialized cellular encapsulated corpuscles.Spiral and twisted endings, each ending terminates into a knob	Touch
Pacinian Corpuscles	Deep in the body	Encapsulated neuron endings. Mostly located in the limbs.	Deep pressure stimuli, vibration sensations

NOTES

Distribution of Receptors in the Skin

- Receptors are not evenly distributed throughout the skin rather are located at the sites of specific function.
- Their relative abundance also varies e.g.

1. Pain receptors 27X > Cold receptors
2. Cold receptors 10X < Heat receptors

Neurons:

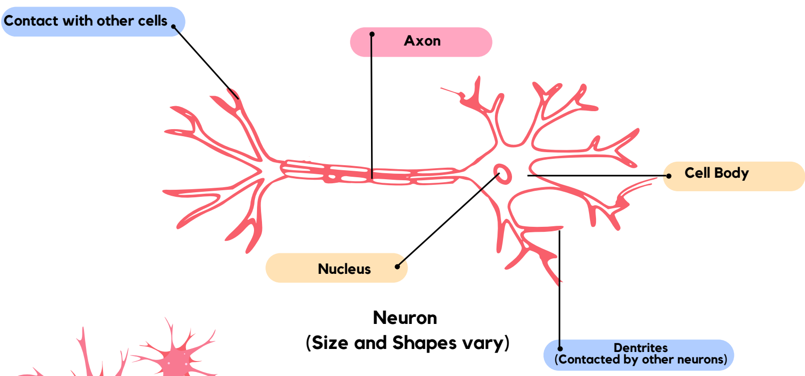
Introduction:

- A neuron is a special kind of animal cell, which can generate and conduct electric current
- Neuroglial (Glial Cells): Neurons in CNS are associated with other typ es of cells called neuroglia.

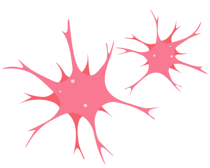
Function of Neuroglia:

1. Separation of neurons from one another.
2. They also perform the phagocytic function.
3. They synthesize myelin.

- Neurons once matured do not divide further. However, they exhibit little regenerative capabilities only if the neural cell body is intact.



Neuron
(Size and Shapes vary)



Neuroglia
(Supporting cell)

NOTES

Structure of Neuron:

A neuron is composed of the following parts.

1. Soma or cell body:

- It is the chief nutritional part of the cell and synthesizes materials necessary for growth and maintenance of neurons.
- The soma contains a single large nucleus with prominent nucleolus, and other cellular organelles, like E.R, ribosomes, Golgi apparatus, mitochondria embedded in the cytoplasm.
- In addition to typical cell organelles it contains Nissl substance which consist of ribosomes which are a group of ribosomes associated with RER and golgi apparatus.
- If it is intact, the neuron can generate its atonal and dendrital components.

2. Dendrites:

- These are the process that carry impulses towards the cells of the body.
- These are usually short, thin, often highly branched cytoplasmic extensions devoid of Schwan's cells and thus non myelinated.
- Atoms of other neurons form synapses with the dendrites. They give a spiny look to the neurons.
- From soma, arise a number of thread-like processes, the dendrites which receive stimuli and convey them to soma.

3. Axon:

- The processes carrying impulses/action potentials away from the cell body.
- An axon is a comparatively long and thick fiber which has a constant diameter and can vary in size from a few millimeters to a meter length.
- It may be branched or unbranched. It terminates by branching to form small extensions with enlarged ends(knob-like) called presynaptic terminals or axon terminals.
- Cellular organelles like mitochondria, microtubules and neurofibrils, R.E.R and Golgi apparatus are present throughout the axoplasm of the neuron.
- Most of the axons are surrounded by protective sheaths called myelin sheath, which is important for neuronal nutrition, protection and proper propagation of impulses.

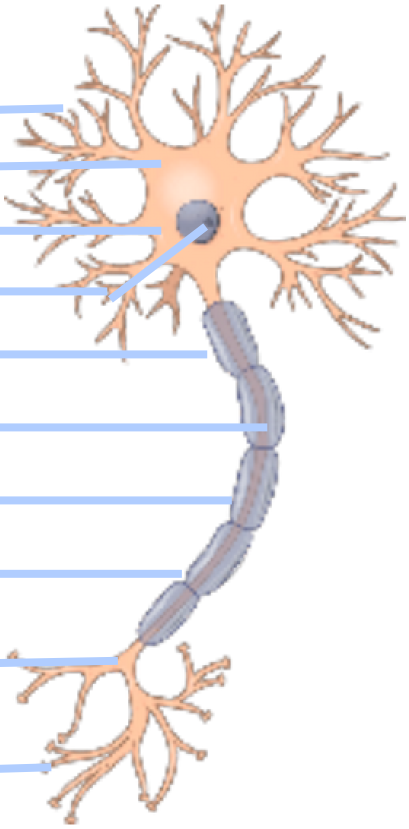
4.Myelin Sheath:

- Schwan's cells are neuroglial cells in the peripheral nervous system. Usually axons are covered by these cells which are strop-like cells that wrap around axon fibers.
- These cells are also covered by a fatty substance called myelin sheath that acts as an insulator. This is why axons are called myelinated fibers. A non myelinated part of the axon between two schwann cells is called the node of ranvier.

NOTES

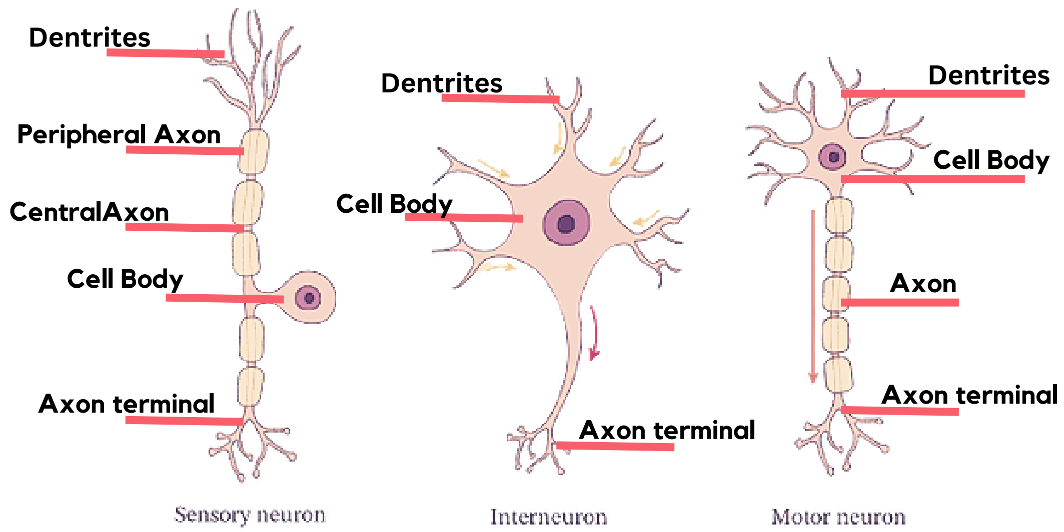
Mnemonic:
Daisy Nanny Can Now Speak Assamesse Marathi Nepali And Sindhi

- D= Dentrites
- N= Nissl's Granules
- C= Cell body
- N= Nucleus
- S= Schwaan cell
- A= Axon
- M= Myelin sheath
- N= Node of Ranvier
- A= Axon terminal
- S= Synaptic knob



Types of Neurons:

- All neurons vary somewhat in size, shape and characteristics depending on the function and role of the neuron. Based upon function there are three types of neurons.



NOTES

Types	Sensory neurons	Interneurons	Motor neurons
Cell body	Inside CNS, At the side with no dendrites	Inside CNS	Outside CNS, at the terminal with dendrites
Dendrites	Long, outside CNS, synapse with receptors. The dendrite endings of some sensory neurons also act as receptors. Usually have a single long dendrite called dendron which is structurally and functionally similar to axon.	Short, inside CNS, synapse with other neurons	Short, inside CNS, synapse with effectors
Axons	Short, inside CNS, synapse with interneurons and other neurons in CNS	Short, inside CNS, synapse with other neurons	Comparatively thin and non-myelinated. Long, outside CNS, end in effectors.
Functions	Transmit impulses from receptors to CNS	Connect sensory and motor neurons to form nerve circuit	Transmit impulses from CNS to effectors

NERVE IMPULSE:

Introduction:

Nerve Impulse is a wave of electrochemical changes which travels along the length of neurons involving movement of ions across the membrane and chemical reactions.

Generation and Transmission of Nerve Impulse:

- Here, the word 'electrochemical' refers to the electrical potential (capacity to do electrical work) that exists on the neuron membrane.
- In case of neuron, the electrical potential is termed as membrane potential which is exhibited in two different forms i.e., resting membrane potential and active membrane potential.

(i) Resting Membrane Potential:

- Potential difference across the membrane when the neuron is not being stimulated/ non-conducting is called resting membrane potential, and this is characterized by a more positive outside surface of the neuron membrane than inner surface.
- Neurons in this state are in polarized form.
- This means that there is an equal distribution of ions on the two sides of the nerve cell membrane. It's value for a typical is -70mV. RMP is established by the following factors:

NOTES

Distribution and Active Movement of Na and K:

- The concentration of K+ is 30x greater in the fluid inside the cell than outside and the concentration of Na is nearly 10X greater in the fluid outside the cell than inside.
- These ions are continuously moved against their concentration gradient through Na-K pumps by the expenditure of energy.
- For every 2K+ that are actively transported inward, 3Na+ are pumped out. So, inside becomes more negative than outside of the membrane.

(ii) Active Membrane Potential:

- AMP is characterized by more inside of the neuron than outside. This happens when positive charges tend to move inside of the neuron on receiving a particular stimulus.
- This electrochemical change appears on a short region of neuron for a brief period of time followed by recovery of the polarized state.
- Its value is +50mV.

Initiation of Nerve impulse:

- A stimulus capable of producing action potential in neurons is called threshold stimulus if it is not capable of exciting neurons then it is called sub-threshold stimulus.
- It results in a remarkable localized change in the resting membrane potential. It disappears for a brief instant and is replaced by active potential.

Mnemonic:
Here's an easy way to remember Na-k pump:

- N → Na+ (3)
- O → Outside
- K → K+ (2)
- I → Inside
- A → Use of ATP (1)

Negative Organic Ions:

- There are many organic compounds in the neuron cytoplasm that also have negative charge i.e. some amino acids, many proteins and RNA.
- Presence of these ions in the neuron cytoplasm makes the inside of the neuron more negative than outside.

Leakage of K+:

- The cell membrane is virtually impermeable to all ions except K+. Since the membrane is slightly permeable to K+, some of it leaves outside the cell
- Active membrane potential/Action Potential

NOTES

Influx of Na+:

- The passage of nerve impulse is associated with increased Na+ permeability moving inwards upsetting the potential momentarily, making the inside more positive than outside.
- This increased permeability is due to the opening of sodium gates. When these games open, when Na+ rushes onto the neuron by diffusion. Some K+ moves out.
- Since they are more Na+ entering than leaving, the electrical potential of the membrane changes from -70mV to zero and then reaches to +50mV. This reversal of the polarity across the two sides of the membrane is called depolarization.
- This electropositive inside and electronegative outside lasts for about 1 millisecond; the Na+ gates are not closed.

Repolarization of Neuron:

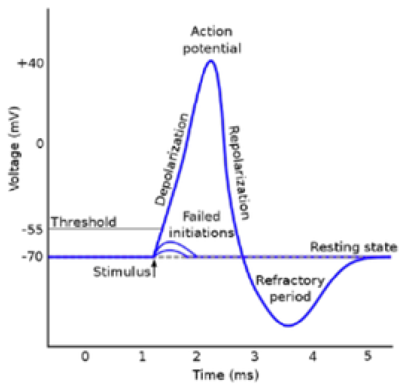
- It is the restoration of the resting membrane potential after the wave of depolarization has passed.
- It results from closure of Na+ gates and opening of K+ gates, therefore K+ diffuses out of the cell. Since K+ is positively charged, this makes the inside of the cell more negative and starts the process of repolarization.

Hyperpolarization:

- A slight overshoot into a more negative potential than the original RMP is called hyperpolarization.
- It is due to a slight delay in closing of K+ gates compared with Na+ gates. As K+ continue to enter the axon, their positive charge restores the normal potential.
- The Na-K pump continues to work during this time, so it gradually begins to restore the original RMP.

Refractory period:

- After an action potential, nerve fiber undergoes a period of recovery in which it regains its original ionic distribution and polarity and prepares itself for the next stimulation. This period of recovery is called refractory period.
- Na+/K+ pump restores the original ionic gradient and thus the resting potential.
- The whole process of depolarization and repolarization takes about 2-3 milliseconds. The process of nerve impulse conduction is shown in the following diagram.



NOTES

Velocities of Nerve Impulse :

- Velocities of nerve impulse in axolemma and synaptic cleft are variable. In humans, non-myelinated nerve fibers, nerve impulses travel at 1-3 m/sec while myelinated fibers conduct at speeds of up to 120 m/s. So, the velocity of the nerve impulse is faster in myelinated neurons due to saltatory conduction which is rapid transmission of nerve impulse along an axon, resulting from the AMP jumping from one node of Ranvier to another, skipping the myelinated regions of the membrane.
- It is up to 50X faster than conduction through the fastest non-myelinated axon because they don't have to travel throughout every single space before moving to the next.
- Another reason that myelinated fibres conduct faster impulse is that myelin sheath acts as an insulating sheath and prevents loss of energy, so myelinated neuron fibres require less energy.
- Thick neuron fibres conduct faster impulses than thin fibres because resistance to the electrical flow is inversely proportional to the cross sectional area. So, with the increase in thickness of neuron fibres, there is decrease in resistance of fibre to nerve impulse.

The short journey across the synapse takes about a millisecond, longer than a nerve impulse takes to travel the same distance. This time is therefore called synaptic delay.

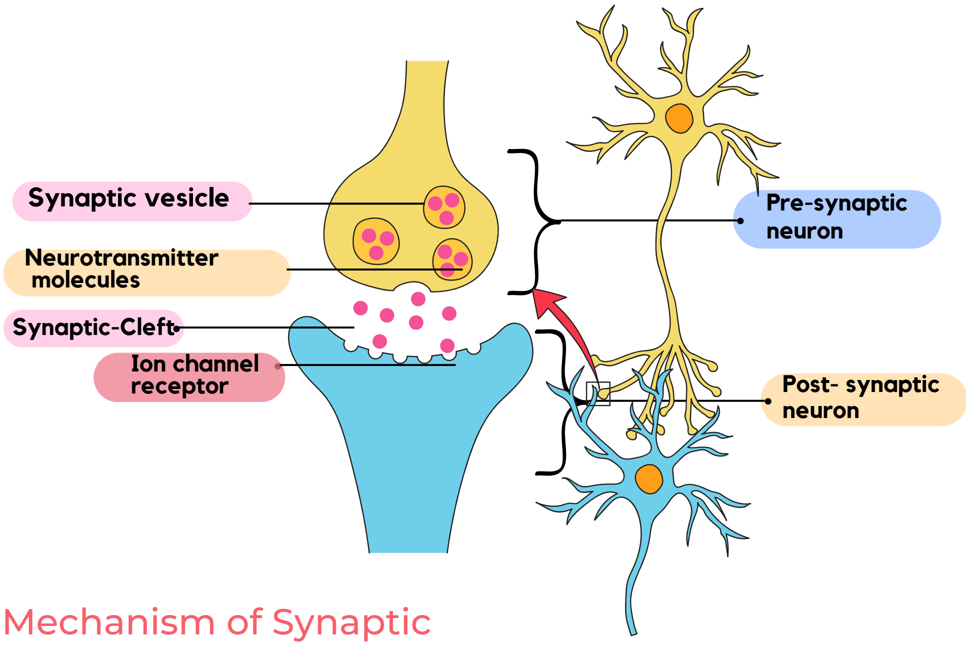
Introduction:

The junction between the axon terminal of one neuron and the dendrite of another neuron, where information from one neuron is transmitted or relayed to another neuron is called synapse.

Structure of Synapse:

- The neurons are not in direct contact at a synapse. There is a gap called a synaptic cleft.
- A single neuron may form synapses with many incoming fibers of different neurons.
- A neuron which carries an impulse towards a synapse is called pre-synaptic neuron while the one which receives the impulse after it crosses the synapse is called post-synaptic neuron.
- A single nerve does not necessarily get across the synapse. It may take two or three impulses arriving in rapid succession or perhaps simultaneously from two or more fibers to start an impulse in the next neuron.

NOTES



Mechanism of Synaptic Transmission:

- Synaptic transmission takes place in the form of a message which is transmitted across the synapse in the form of chemical messengers called neurotransmitters.
- The axons usually have several rounded synaptic knobs which contain numerous membranous sacs, called synaptic vesicles.
- The main steps involved in synaptic transmission is shown in the following diagram;
- Binding of neurotransmitters to the post-synaptic neuron allows Na+ to diffuse across the post-synaptic membrane. As a result, post-synaptic depolarizes and an action potential is generated. Since the depolarization brings the membrane potential towards threshold level, it is called excitatory post-synaptic potential(EPSP).
- At other synapses, different neurotransmitters bind to channels that are selectively permeable for only K+1 or Cl -1. When these channels open, the postsynaptic membrane hyperpolarizes, and this condition is called inhibitory post-synaptic potential(IPSP).

Classification of Neurotransmitters:

- Neurotransmitters are chemicals which are released at the axon ending of the neurons at synapse and are classified as excitatory and inhibitory neurotransmitters.

Excitatory Neurotransmitters:

- These neurotransmitters cause increased membrane permeability of Na+ and trigger nerve impulse.
- E.g. Acetylcholine(AcH) of PNS
- Amines of CNS
- These include epinephrine, norepinephrine, serotonin and dopamine, all of which affect sleep, mood, attention and learning.

NOTES

Mnemonic:
Heres a mnemonic that may help you remember the neurotransmitters:
S → Serotonin
E → Epinephrine
N → Norepinephrine
D → Dopamine

Inhibitory Neurotransmitter:

- These neurotransmitters cause decreased membrane permeability to Na+ thus causing the threshold stimulus to be raised.
- Gamma amino butyric Acid (GABA) and glycine are the examples of inhibitory neurotransmitters.

Types of Synapses:

There are 2 types of synapses:

1.Electrical Synapses:

- In electrical impulse which are specialized for rapid signal transmission the cells are separated by a gap, synaptic cleft, of only 0.2 nm so that zn action potential arriving at the presynaptic side of cleft, can sufficiently depolarize the pisr synaptic membrane to trigger its action potential directly.

Turning it OFF:

- A synaptic neurotransmitter is turned off by:
- Diffusion
- Enzymatic inactivation
- Reuptake into cells by transporters. Once the neurotransmitters have acted on the postsynaptic membrane they are immediately broken down by enzymes like acetylcholine by acetylcholinesterase and adrenaline by monoamine oxidase.
- Endorphins are peptides that function as both neurotransmitter and hormone, and decrease perception of pain.

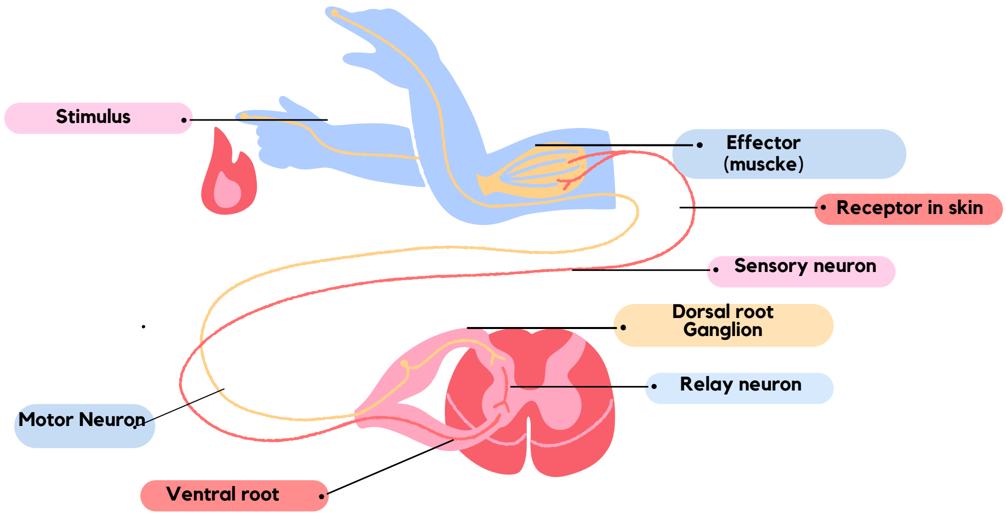
2.Chemical Synapses:

- The majority of synapses are chemical synapses where a synaptic cleft cleft has a gap of more than 20 nm.
- Through these synapses, information of impulse from one neuron is transmitted to another by means of chemical messengers, the neurotransmitters.

NOTES

Reflex Action and Reflex Arc:

- Reflex Action is an immediate, automatic and involuntary response to external and internal environmental changes/ injurious stimuli.



Mechanism of Reflex Action:

- Reflex arc is the pathway of the passage of impulse during a reflex Action action as shown below.
- Receptors → Sensory Neuron → Intermediate neurons →Motor neurons →Effectors →Brings about a desired action
- In this case, since only one synapse is involved so such reflex is called monosynaptic.

Types of Reflexes :

1.Monosynaptic:

- Can never have voluntary control.
- E.g. knee jerk, elbow jerk

Stimulus->Receptor->Sensory
Synapse
Response<-Efector<-Motor<--

2. Polysynaptic:

- Initially voluntary, later voluntary control
- E.g. blinking of an eye, withdrawal of hand from hot object

Stimulus->Receptor->Sensory
Synapse
Response<-Efector<-Motor<--
inter Synapse

NOTES

Classification of Reflex:

There are several ways to classify the reflexes of the body. Following are the classification of reflexes.

Classification based on	Types	Subtypes/ Working	Examples
Inborn or acquired	Unconditional reflexes Conditional reflexes	Do not require Learning Requires previous learning	Suckling reflex after birth Secretion of saliva after smelling specific food
Structural involvement	Cerebral Midbrain Spinal cord	Centre is located in the areas of the brain	Maintain balance and equilibrium Reflex eye movement Withdrawal reflex
Physiological / functional	Protector/Flexor/Antigravity/Extensor	Protective reflexes protect from harmful stimuli Antigravity reflexes protect body against gravity	Flexion of elbow to withdraw hands away from harmful stimuli Postural correction and maintenance
Number of Synapses	Monosynaptic Polysynaptic	Only one synapse in reflex arc	Osmoreceptors Olfactory receptors Gustation receptors
Somatic or Autonomic	Somatic nervous system is involved Autonomic nervous system is involved	Flexion/Extension through skeletal muscles	Participation of skeletal muscles Swallowing, coughing etc

Importance of Reflex Actions:

- It helps animals to save themselves from danger e.g. when a person steps on a sharp object this message is immediately conveyed by the pain receptors to the spinal cord which results in contraction of the muscles of the leg and immediate withdrawal of the hands.

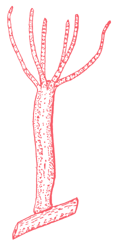
NOTES

EVOLUTION OF NERVOUS SYSTEM

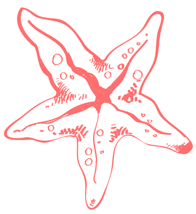
Types of Nervous System:

Diffused nervous system:

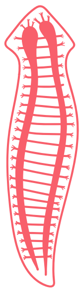
- This is found in cnidarians and echinoderms.
- In hydra and other cnidarians because of the radial symmetry, there are no anterior and posterior ends.
- The nervous system consists of a network which is woven through the tissue of the body.
- The flow of information through the network is in diffused form.



Cnidarian Hydra



Sea star



Planaria

Centralized nervous system:

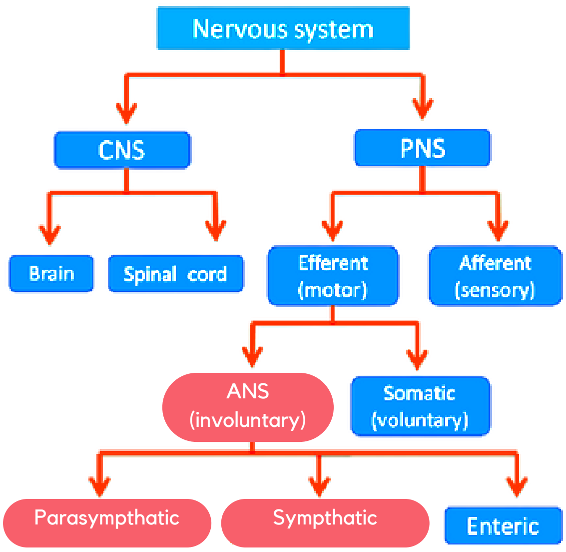
- It is the characteristic of bilaterally symmetrical animals which have definite anterior and posterior ends.
- For example, planaria is a simple animal which has the simplest form of centralized nervous system.
- It consists of an anterior part from which is connected with the sensory organ from the brain of planaria to cord like nerves running longitudinally through the body.

NOTES

CENTRAL NERVOUS SYSTEM

Introduction:

- The human nervous system consists of the central nervous system and peripheral nervous system.
- The CNS is a coordinating center and it lies in the midline of the body whereas the PNS transmits information from receptors to CNS and transmits orders and commands from CNS to effectors.
- An outline of division of the nervous system is shown in the following diagram.



Mnemonic:
☆Here's an acronym that may help you remember names of meninges:
P → Pia mater
A → Arachnoid layer
D → Dura mater

Architecture of Brain and Spinal Cord and their Functions:

Components of CNS:

- Central nervous system consists of the brain and spinal cord and both are hollow.
- The spinal cord has a central canal and the brain has many cavities/ventricles filled by CSF which is also present between meninges.

Protection of CNS

Meninges:

- The brain and spinal cord are covered with three protective membranes called meninges. The three meninges are:
- Dura mater(next to the cranium)- thickest outer layer
- Arachnid layer(middle membrane)- middle, thin membrane
- Pia mater(next to the nervous tissue)- inner, thin membrane

NOTES

Cranium and Vertebral column:

Brain is enclosed within the cranium while the spinal cord is enclosed within the vertebral column.

Cerebrospinal Fluid (CSF):

The space between the arachnoid and pia mater contains a fluid, the CSF, which helps to cushion the brain from shock. The space is called subarachnoid space.

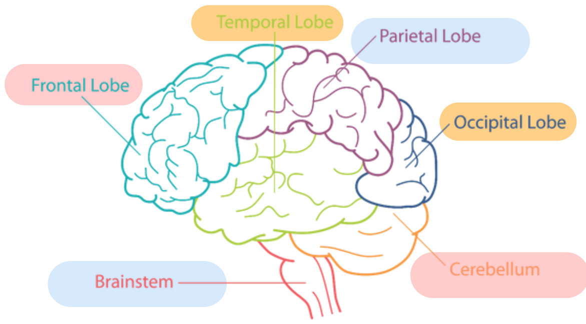
Mnemonic:

This simple mnemonic will help to remember the parts of the brain. Check it out!

Brain

Forebrain	Midbrain	Hindbrain
HTC mobile	CC to mail	PMC subject
1. Hypothalamus	1. Cerebral Aqueduct	1. Pons
2. Thalamus	2. Corpora Quadregemenia	2. Medulla
3. Cerebrum		3. Cerebellum

Brain:



Introduction:

- Protected by skull.
- Connected to the spinal cord.
- Made up of nerves and supportive tissues.
- The human brain is the most wonderful and mysterious creation of nature. It coordinates the actions so that they happened in the right sequence at the right time and place.
- It is a hollow structure and it has cavities called ventricles. There are four ventricles in the brain.
- It has 3 main parts:
-

Forebrain:

- Divided further into 2 divisions
- Telencephalon: Contains cerebrum which can be further divided into 4 lobes
- Frontal
- Parietal
- Temporal
- Occipital

Diencephalon:

Consists of

- Thalamus and
- Limbic system: It has following parts:
- Hypothalamus
- Amygdala
- Hippocampus
- Midbrain
- Hindbrain

Brain Stem:

- Consists of midbrain, medulla obligation and pons.

Mnemonic:

Here's an acronym to help you remember the 4 lobes of the brain:

FTOP:

- **Freud**
- **Tore his**
- **Pants**
- **OFF**

NOTES

Parts	Sub-parts	Features	Functions
Forebrain	Cerebrum	Has many folds Largest portion of the brain.	
		Divided into 2 hemispheres, Left cerebral hemispheres Right cerebral hemispheres connected together by a band of axons called corpus callosum.	The right hemisphere controls.the left side of the body. The left hemisphere controls the right side of the body.
		Each hemisphere contains 4 lobes:	Each lobe has different functions.
		Frontal (front) lobe	Controls movement, speech, behavior, memory, emotions and intellectual functioning such as thought processe, reasoning, problem solving, decision making and planning.

Parts	Sub-parts	Features	Functions
		Parietal(top) lobe	Controls sensations, such as touch, pressure, pain and temperature. It also controls spatial orientation (understanding of size, shape and direction).
		Temporal (side) lobe	Controls hearing, memory and emotions. The left temporal also controls speech.
		Occipital (back) lobe	Controls vision.
		Each functional area consists of 3 subareas i.e., sensory area, association area and motor area.	

NOTES

Parts	Sub-parts	Features	Functions
	Thalamus	Situated below the cerebrum	
	Limbic System	Complex set of structures that lies on both sides of the thalamus Divided into 3 further parts.	The right hemisphere controls.the left side of the body. The left hemisphere controls the right side of the body.
	1.Hypothalamus	Located on the ventral side of the thalamus is the hypothalamus.	Regulates homeostasis and pituitary gland.
	2.Amygdala	Two almond shaped masses of neurons on either side of the thalamus	Produces sensation of pleasure, punishment and sexual response.

Parts	Sub-parts	Features	Functions
	Hippocampus	Consists of two horns that curve back from amygdala	Involved in long term memory.
Midbrain		Reduced in human.	Receives and integrates sensory information like vision, odor from spinal cord and relays them to fore brain.
Hindbrain	Pons	Small and lies above the medulla oblongata	Regulates activities like muscular coordination, facial expression, breathing and sleeping.
	Cerebellum	Second largest portion of the brain.	Controls breathing, heart-beat, blood pressure, coughing, sneezing, vomiting, etc.

NOTES

Parts	Sub-parts	Features	Functions
		It consists of a central lobe and 2 lateral lobes. Best developed in birds which engage them in complex activity of flight.	Controls breathing, heart-beat, blood pressure, coughing, sneezing, vomiting, etc. Controls breathing, heart-beat, blood pressure, coughing, sneezing, vomiting, etc.

NOTES

Spinal Cord:

- The spinal cord is the most important structure between the body and the brain.
- The spinal cord extends from the foramen magnum (a hole in the bottom of skull) where it is continuous with the medulla to the level of the first or second lumbar vertebrae.
- It is a vital link between the brain and the body, and from the body to the brain.

Structure:

- A transverse section of the adult spinal cord shows white matter in the periphery, gray matter inside, and a tiny central canal filled with CSF at its center.

Grey Matter:

- Grey matter is shaped like the letter 'H' or a 'butterfly'.
- As in the other part of the nervous system, the grey matter consists of neuron cell bodies and non-myelinated parts of the fibres.
- Several pairs of spinal nerves originate from the ventral horn of grey matter. Similarly, several pairs of spinal nerves join the spinal cord through the dorsal horn of gray matter.
- The Dorsal root of spinal nerves also contain ganglia present just beside the spinal cord.
- The white matter is made up of bundles of myelinated fibres.

White Matter:

- White matter shows deep grooves from both sides i.e., from dorsal side to the central canal and from ventral side to the central canal.

Spine:

- The bony sections that protect the spinal cord.
- Consists of vertebrae and disc- a layer of cartilage between each vertebrae that cushions and protects the vertebrae and spinal cord.
- Divided into 5 different regions: the cervical, thoracic, lumbar and sacral regions.
- The different cord regions can be visually distinguished from one another. Two enlargements of the spinal cord can be visualized: The cervical enlargement, which extends between C3 to T1; and the lumbar enlargements which extends between L1 to S2.
- The cord is segmentally organized. There are 31 segments, defined by 31 pairs of nerves exiting from the cord. These nerves are divided into 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal nerve.

- Dorsal and ventral roots enter and leave the vertebral column respectively through intervertebral foramen at the vertebral segments corresponding to the spinal segment.

NOTES

Name	Location	NO. of pairs of spinal nerves originating
Cervical	From base of Skull to lower part of neck	8
Thoraic	From Shoulder to mid back	12
Lumber	From mid back to hips	5
Sacrum	At the base of spine- fused vertebrae	5
Coccyx	Tail bone at the end of spine- fused vertebrae	1

NOTES

PERIPHERAL NERVOUS SYSTEM

Peripheral Nervous System:

- PNS comprises sensory and motor neurons. These neurons are distributed throughout the body in the form of ganglia and nerves.
- The collection of neuron cell bodies is called ganglia. It often interconnects with other ganglia to form a complex system of ganglia known as plexus.
- The bundle of axon fibers(dendrites or axons) covered by the connective tissue are called nerves and can be classified on the basis of function and origin.

Spinal Nerves:

- Relay messages between the body and the brain
- These nerve messages control body functions like movement, bladder, bowel control and breathing.
- Each vertebrae has a pair of spinal nerves that receive the sensory impulses and send motor impulses.

Mnemonic:
Here's a mnemonic that may help you remember spinal nerves:

Breakfast at 8 ->Cervical 8
Lunch at 12->Thoracic 12
Dinner at 5 ->Lumber,Sacral(5)

NOTES

Cranial and Spinal Nerves:

- The PNS consists of nerves that branch out from the CNS and connect it to other body parts. The peripheral nervous system includes:

Cranial Nerves:

- Arise from the brain
- Have 12 pairs of nerves. Functionally three pairs are sensory(I, II, VIII), four pairs(III, IV, VI, XI, XII are motor and 5 are mixed nerves(V, VII,XI,X).
- Largely concerned with the head, neck and facial regions of the body.

Spinal Nerves:

- Arise from the spinal cord
- Have 31 pairs of spinal nerves. They are all mixed nerves and they provide two way communication between the spinal cord and parts of legs, arms, neck and trunk.
- Each spinal nerve emerges from the spinal cord by two short branches or roots which lie within the vertebral column.

- Dorsal Root: Contains fibers of sensory neurons which conduct impulses towards the spinal cord.

- Ventral Root: Contains fibers of motor neurons which conduct impulses away from the spinal cord. The two roots join just before a spinal nerve leaves the vertebral column. Each spinal nerve serves the particular region of the body where it is located.

Somatic and Autonomic System:

- The PNS can be divided into somatic and autonomic nervous systems.

Somatic Nervous System:

- Consists of cranial and spinal nerve fibers that connect the CNS to the skin and skeletal muscles.
- Nerves are related to skeletal muscles(voluntary activity).

Autonomic Nervous System:

- Deals with smooth muscles(involuntary activity).
- Includes fibers that connect the CNS to the visceral organs such as heart, stomach, intestines and various glands.
- It is connected with unconscious activities.
- It is divided into sympathetic and parasympathetic systems. Both of these systems function automatically and usually unconsciously in an involuntary manner.

NOTES

Features	Sympathetic	Para-sympathetic
Origin	Middle portion of spinal cord/Thoracic region	Bottom portion of spinal cord + cranial nerves (vagus nerves)/lumbar region
Length of preganglionic fibres	Short	Long
Length of preganglionic fibres	Long	Short
Functions	Works in emergency, fear and fight situations	Promotes relaxed state
Actions	• Accelerates heartbeat • Dilates pupil • Inhibits digestion of food • Raises in blood pressure	• Retards heartbeat • Causes onstriction of pupils • Promotes digestion of food • Lowers of blood pressure

Mnemonic:

☆This trick will help you differentiate between the 2 nervous systems:

The letter "S" in sympathetic response is related to stress while

The letter "p" in parasympathetic response is related to peace

Effects of Drugs on Coordination:

- A drug is a chemical substance that provokes a specific physiological response in the body. They act as stimulants, depressants and hypnotic.

- Action of Nicotine: It is extracted from tobacco and it directly stimulates the sensory organs.

NOTES

DISORDERS OF THE NERVOUS SYSTEM

Nervous Disorders:

- It affects the postsynaptic membrane in CNS and PNS.
- It mimics the action of Ach on nicotinic receptors.
- It increases heart beat rate, blood pressure and digestive tract mobility.
- It may induce vomiting and diarrhea as well as water retention relation by kidneys.

Nervous Disorders:

- Following are some of the common diseases of the nervous system in humans:

NOTES

Feature	Parkinson Disease	Epilepsy	Alzheimer's Disease
Definition	Nervous Disorder characterized by involuntary tremors, diminished motor power and rigidity	Convulsive disorder of nerves characterized by abrupt transient symptoms of motor, sensory and psychological psychic or autonomic nature, frequently associated with changes in consciousness.	Controls sensations, such as touch, pressure, pain and temperature. It also controls spatial orientation (understanding of size, shape and direction).
Onset	Late age disease (50's or 60's) & progressive	Before 30 years of age Organic disease after 30 years	Late age disease & progressive
Cause	Cell death in brain area that produces dopamine that maybe due to head trauma	No known cause. Emotional disturbance, alcohol etc. are aggravating factors	Genetic predisposition. High levels of Aluminum Organic disease after 30 years
Treatment	L-dopa, use of GDNF	EEG for diagnosis, Anticonvulsant drugs for therapy	Non-curable

NOTES

ENDOCRINE SYSTEM AND ITS HORMONES

Introduction:

- The cellular functions needed to be continuously regulated. The nerve fibers do not innervate all the cells of the body; so a special kind of coordination system is thus required.
- The hormonal system is concerned with control of the different metabolic functions of the body, such as the rate of chemical reactions, transport of substances through plasmalemma, growth and secretions. This coordination is called chemical coordination.

Hormone - The Chemical Messengers:

- Endocrine glands are ductless glands and secrete chemical messengers called hormones. (N in endocrine → No and d in endocrine → ductless)
- Hormones are organic compounds of varying structural complexity.
- They are poured directly in blood and transported to the respective target cells/tissues.
- They do not initiate new biochemical reactions but produce their effects by regulating enzymatic and other chemical reactions already present.
- They may either stimulate or inhibit a function.
- Hormones may also control some long term changes such as rate of growth, rate of metabolic activity and sexual maturity.

NOTES

Mechanism of Hormonal Action:

- Hormone does not act on the target cell directly. It combines with a receptor to form a hormone-receptor complex. This complex executes the action through one of the following mechanisms:
- By altering permeability of cell membrane
- By activating intracellular enzyme
- By acting on genes

Chemical Nature of Hormones:

- Chemically hormones may be of following types:

Category	Hormones	Glands
Protein	Insulin, Glucagon	Islets of langerhans
Polypeptides	ADH, Oxytocin	Produced in hypothalamus and secreted from posterior pituitary
Amino acid derivatives	T3, T4(Thyroxin)	Thyroid
Catecholamine	Adrenaline, Nor-adrenaline	Adrenal medulla
Steroid	Estrogen, Testosterone, Cortisone	Gonads, Adrenal cortex

Transportation of Hormones:

- Hormones are transported through the blood cells. They travel with the blood stream either in the free form or attached with the transport proteins.
- Water soluble hormones travel in the free form as blood consists of 90% plasma.
- Fat soluble hormones are transported through the transport proteins produced by the liver called albumin and globulin.

NOTES

Mode of Hormone Action:

- Proteins and peptides cannot pass through cells' plasma membranes because they are water soluble. These hormones bind with their receptor on the plasma membrane of the target cell, starting a series of events in the cell which generates 2nd messenger e.g. cAMP. The second messenger then triggers various changes in the cell.
- Steroid and thyroid hormones can pass through plasma membranes because they are lipid soluble. Receptors for these hormones are located in the cytoplasm or nucleus.
- Hormone binds with their receptors to form hormone-receptor complex which then binds with the promoter region of a particular gene, thus modifying the cellular activities by altering gene expression.

Regulation if Hormone Secretion

- The regulation of hormones is carried through different mechanisms.
- Humoral– hormones are released in response to changing levels of ions or nutrients in the blood
- Neural– stimulation of hormone release is received by nerve impulses
- Hormonal– stimulation of hormone release is received from other hormones. In many cases, the level of hormone in the blood turns production off and on through feedback mechanism
- If high levels of hormones stimulate the output of even more hormones – positive feedback.
- If the production of some hormone or substance stops the production of another hormone – negative feedback.

Functions of Hormones:

- Overall metabolism
- Maintenance of homeostasis
- Growth
- Reproduction
- Behavior

NOTES

Endocrine System of Man and Hypothalamus :

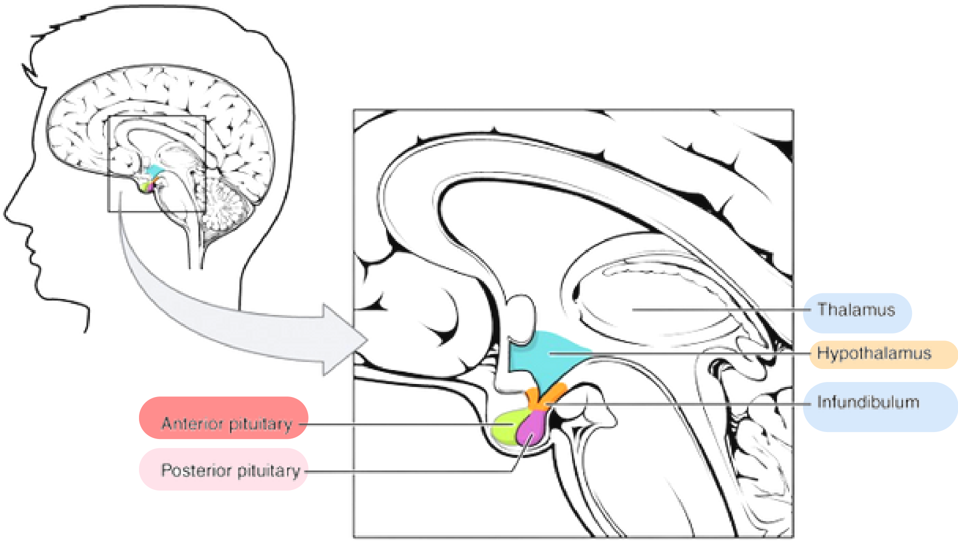
- Glands and the tissues which produce and release some products called secretions.
- Endocrine system is the type of glandular system, consisting of some 20 ductless glands lying in different parts of the body.
- These are the organs that are specialized for the secretions. Glandular cells are secretary or neurosecretory cells that are abundant in the golgi complex.
- Hormones released from neurosecretory cells are called as neuro secretions e.g. ADH
- There are mainly two types of glands in the body, exocrine and endocrine glands which can be distinguished in the following table:

Features	Exocrine Glands	Endocrine Glands
Another name	Ducted glands	Islets of langerhans
Secretions	Enzymes, mucus etc	Hormones
Trans-portation	Through ducts	Through blood
Examples	Sweat glands, Salivary glands	Adrenal glands, Pituitary glands

Hypothalamus:

- It is a part of the forebrain. It acts as a master control center of the endocrine system. It is here that many of the sensory stimuli of the nervous system are converted into hormonal responses.
- Its endocrine signals directly control the pituitary gland. It contains a special group of neurosecretory cells. These cells conduct impulses and have developed secretary capacity to a high level. The hormones produced by the hypothalamus are either releasing factors or inhibiting factors.

NOTES



Gland/ Hormone	Effect
Releasing hormone	Stimulate hormone production in anterior pituitary
Inhibiting hormone	Prevent hormone production in anterior pituitary

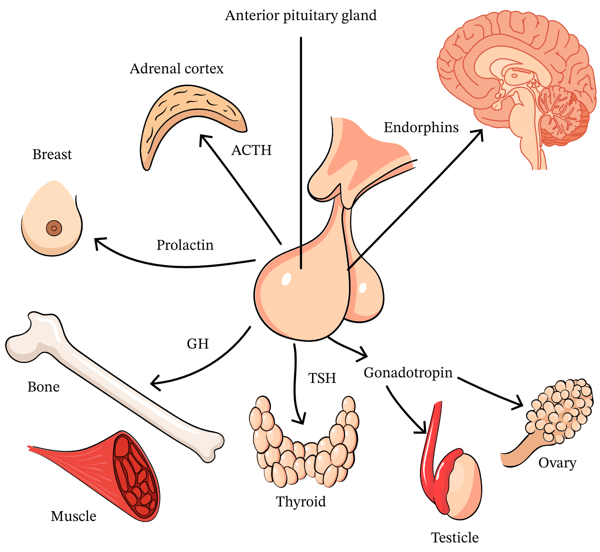
The releasing and inhibiting hormones of hypothalamus and their functions are given in the following table:

Sr. No.	Hormone from Hypothalamus	Other name	Anterior Pituitary Gland
1	Growth hormone releasing factor (GHRF)		Secretion of GH
	Growth hormone inhibiting factor	Somatostatin	Inhibition of GH
	Hormone from Hypothalamus	Prolactin releasing hormone	Secretion of TSH
	Adrenocorticotrophin releasing factor (CRF)		
	Prolactin inhibiting factor (PIF)	Dopamine	Inhibits secretion of prolactin
	Gonadotropin releasing factor (GnRH)		Secretion of FSH and LH/ICSH

NOTES

- These are produced into the cell bodies and packed into granules and are transported down to the axon by cytoplasmic streaming. The axon ending of neurosecretory cells synapses with blood capillaries and releases their hormone into blood when stimulated.
- The integration of hypothalamus through its hormones with other endocrine glands is shown in the following diagram.
- It is believed that oxytocin and ADH are produced in the hypothalamus and travel down the nerves to the posterior lobe of the pituitary to be stored in nerve endings. They are released from the posterior pituitary after receiving nerve impulses from the hypothalamus.

Hormone	Other name	Functions
Oxytocin		For uterine contraction Lactation (Let down reflex or milk ejection reflex)
Vasopressin	Antidiuretic hormone	Produces concentrated urine by conserving water. It increases reabsorption of water in the distal convoluted tubule and collecting duct of nephrons.



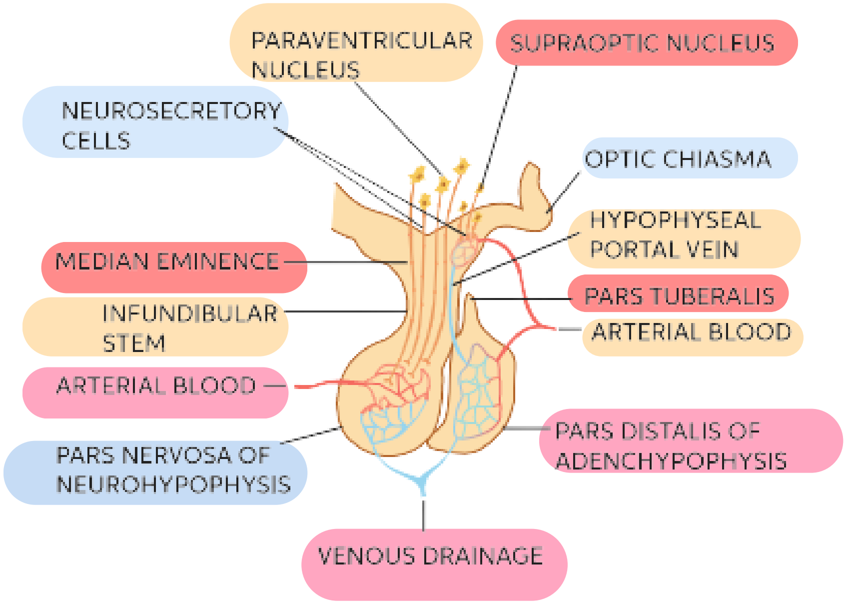
NOTES

Pituitary Gland:

- Located just below the hypothalamus
- An avoid structure of about 0.5mg in the adult and is connected to brain through a short stalk, the infundibulum
- Has 3 lobes viz, anterior, median and posterior

Anterior lobe/Hypophyses:

- Master gland because in addition to producing primary hormones it produces tropic hormones which control the secretion of hormones in many other endocrine glands.



Anatomical relation B/w Hypothalamus and pituitary gland

Mnemonic:

☆Here's a mnemonic that may help you remember hormones secreted by anterior pituitary gland:

- F → FSH
- L → LH
- A → ACTH
- T → TSH
- P → Prolactin
- I → Ignore
- G → GH

NOTES

- The table below shows the first 4 hormones which are tropic hormones i.e. they regulate the production of other hormones.

Feature	STH	TSH	ACTH	GnRH
Stimulus for secretion	Hypothalamus → SRF →Anterior pituitary →STH →Growth	Thyroxine in Blood → Hypothalamus → TRF → Anterior Pituitary → TSH → Thyroid Gland →Thyroxine	Steroid in Blood → Hypothalamus → CRF → Anterior Pituitary → ACTH → Adrenal Cortex → Corticosteroid	Hypothalamus→ Anterior Pituitary →LH/ FSH →Gonads →Sex Hormones (Estrogen & Progesterone in females/ Testosterone in males)
Function	Growth hormone SRF is secreted from the hypothalamus throughout life. When growth has mostly ceased after adolescence, the hormone continues to promote protein synthesis throughout the body.	Release of thyrotrophin releasing factor from the hypothalamus is controlled by the levels of thyroxine in the blood. In the presence of low levels of thyroxine, there is increasing production of TSH and vice versa. It is secreted throughout life but particularly reaches high levels during the periods of rapid growth and development.	Release of corticotrophin releasing factor from the hypothalamus is controlled by steroid levels in the blood and by direct nervous stimulation of the hypothalamus as a result of stress e.g. cold, heat, pain, fright, infections.	These are follicle stimulating hormone (FSH), luteinizing hormone (LH, also called ICSH in male) and prolactin (sometimes inappropriately called luteotropic hormone, LTH). FSH and LH/ICSH share a common hypothalamic releasing factor. Prolactin is continuously produced from the pituitary and is inhibited by prolactin inhibiting factor (PIH) from the hypothalamus. Prolactin is continuously produced from the pituitary and is inhibited

NOTES

Feature	STH	TSH	ACTH	GnRH
				by prolactin inhibiting factor (PIH) from the hypothalamus. Prolactin stimulates milk production and acts with LH. FSH in females stimulates follicle development and secretion of estrogen from the ovaries; in males it stimulates development of the germinal epithelium of testes and sperm production.

Feature	STH	TSH	ACTH	GnRH
Function				LH works with FSH to stimulate estrogen secretion and rupture of mature follicles to release egg or ovum. It also causes the lutenization of mature follicles and acts synergistically with prolactin to maintain corpus luteum (and hence the progesterone it secretes). ICSH in the male stimulates the interstitial cells of the testes to secrete testosterone.

NOTES

Feature	STH	TSH	ACTH	GnRH
Over secretion	Causes gigantism in childhood in which the bones are still capable of growth and a person's height increases abnormally. Over secretion of GH at adulthood causes acromegaly in which bones are no longer capable of increasing in length but grow in thickness Acromegaly is characterized by enlargement of hands, feet, skull and jaw bones.		Disturbance of normal adrenal function	

Feature	STH	TSH	ACTH	GnRH
Under secretion	Causes dwarfism with lack of thyroid and adrenal hormones.		Disturbance of normal adrenal functions	

NOTES

- FSH and LH are Gonadotropin hormones
- The table below includes tropic hormones and their features.

Features	FSH	LH
Target site	Ovaries/testes (tubules)	Ovaries/testes(leydig cells)
Function	Stimulates the growth of graffian follicles.	Stimulates ovulation.

Median lobe:

- Secretes MSH
- Inhibition of secretion is controlled by hypothalamus.
- External light governs its secretion
- More secretion in pregnancy stimulates melanocytes in skin to produce brown pigment, melanin, which darkens the skin
- Excess MSH is secreted in Addison's disease which causes darkening of skin.

Posterior lobe/ Adenohypophyses:

- Not glandular itself. It does not synthesize any hormone.
- Largely made up of axons of neurosecretory cells of hypothalamus which secrete ADH and oxytocin.

Features	Vasopressin/ADH	Oxytocin
Chemical nature	Polypeptide	Polypeptide
Stimulus for secretion	Low blood pressure, decreased blood volume, dehydration	Childbirth (low level of progesterone) , Suckling
Target site	Distal convoluted tubules and collecting ducts of nephrons	Smooth muscles of uterus and mammary glands
Functions	Increases reabsorption of water from kidneys leading to a concentrated urine. Increases blood pressure.	Stretching of the uterus and the cervix, Milk ejection reflex (letdown reflex).In males it helps to eject semen during copulation.
Over secretion	May lead to kidney problem	Rupturing of uterine wall
Under secretion	Diabetes insipidus. It's symptoms include:Polyuria(increased urination)Thirst low ADH secretion	Inhibits normal labor process

NOTES

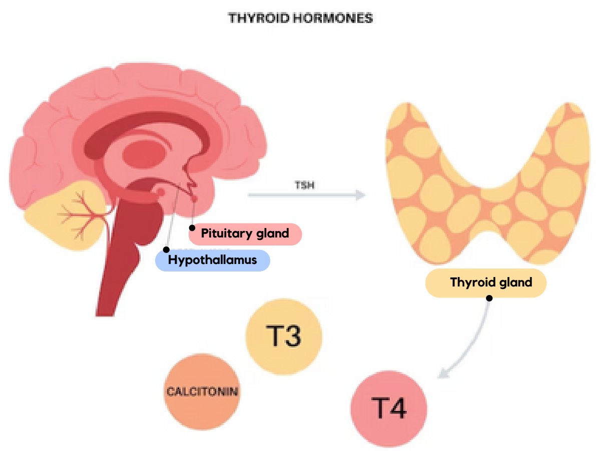
Thyroid and Parathyroid Glands:

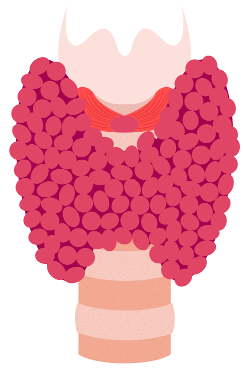
Introduction to Thyroid Gland:

- Located below the larynx(voice box).
- Composed of 2 lobes which are located on either side of the trachea.

Hormones:

- T4 (Triiodothyronine) - 80%
- T3 (Triiodothyronine)-20%
- Calcitonin- antagonistic to parathormone





Pituitary gland

Features	T3 and T4
Control	Negative physiological control by anterior pituitary via TSH
Chemical nature	Iodine containing compounds
Target site	muscles, brain, heart and digestive system
Functions	• Both act essentially in the same way. • They act on basal metabolic rate by stimulating the breakdown of.glucose and release of heat and generation of ATP. • Enhance synthesis of cholesterol in the liver. Act in conjunction with somatotropin in bringing about growth.
	• Promote development of the nervous system in fetus and infants. • They act on muscles for their development and functioning. • Promote growth and maturation of the skeleton. • Promote normal GIT motility.
Over secretion (Hyperthyroidism)	• Excess thyroxine produces a condition called Grave's disease which is characterized by exophthalmic goiter and increase in metabolic rate. This can lead to Cardiac failure if prolonged.

NOTES

Features	T3 and T4
	• It is caused by production of abnormal protein which continuously stimulates thyroid to excessive secretion.
Under secretion (Hypothyroidism)	• In adults full blown hypothyroid syndrome is called myxedema which is characterized by low metabolic rate, feeling chilled puffy eyes, thick and dry skin with hair loss from the scalp and eyebrows, edema, tongue swelling, constipation and enlarged thyroid gland .i.e. goiter. All body and mental processes are retarded. • If congenitally deficient the lack of thyroxine causes cretinism which. Is characterized by mental retardation with poor physical growth and disproportionate body size. Bone maturation and puberty are severely delayed and infertility is common.

Introduction to Parathyroid Gland:

- In humans there are 4 parathyroid glands.
- They are small, light colored masses that stick out from the posterior surface of the thyroid gland.
- The parathormone is the single most important hormone produced by the parathyroid gland.

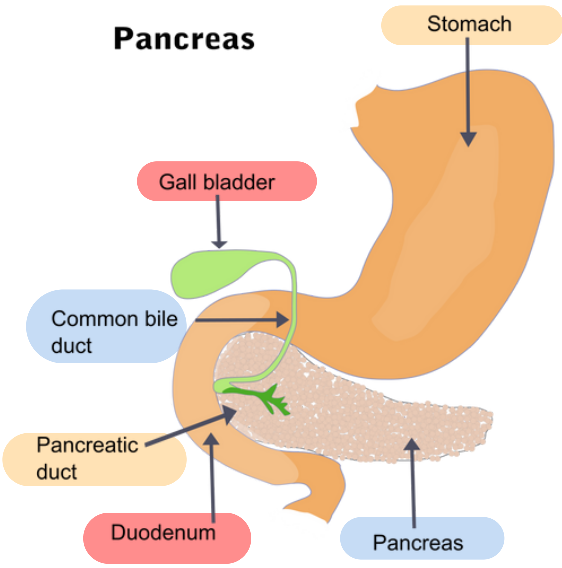
Features	Calcitonin	Para-thormone
Target sites	Small intestine, kidney tubules and bone cells	Small intestine, kidney tubules and bone cells
Stimulus for secretion	Excessive Ca^{2+} in blood	Low blood Ca^{2+} levels
Functions	Control extracellular levels of calcium by inhibiting Ca^{2+} absorption by the intestines. Decrease reabsorption of Ca^{2+} from the kidney tubules allowing its excretion in urine.	Control the calcium balance of the blood by stimulating osteoclasts to reabsorb bone mineral and liberating calcium into blood, stimulates absorption of calcium in the intestine and and also its reabsorption in the kidney tubules.
Over secretion	Symptoms include brittle bones and disorders related with nervous system and muscular systems.	Usually results from a parathyroid gland tumor. Soft bones leasing to fracture simultaneously. Hyperglycemia which depresses nervous system, causes weakness of nervous system and leads to kidney stone.
Under secretion	Ca^{2+} are deposited in bones. High blood Ca^{2+} level causes disturbance in the functioning of muscles and may lead to kidney stones	Hypoglycemia increases excitability of neurons, muscular tetany. If untreated, it can be fatal.

NOTES

Pancreas:

Introduction:

- Pancreas is composed of 2 types of tissues e.g.exocrine tissue which produces and secretes digestive tissue and endocrine tissue which produce hormones.
- The endocrine tissues are distributed in the form of patches which are called Islets of Langerhans.



Hormones:

- The islets contain a large number of B-cells associated with insulin production.
- The smaller number of a-cells secrete glucagon.

Features	Glucagon	Insulin
Control	Under control of pituitary tropic hormones, STH and ACTH, and also responds directly to the level of blood glucose..	
Stimulus for secretion	liver, the skeletal muscle and adipose tissue	liver, the skeletal muscle and adipose tissue
Stimulus for secretion	Decrease in blood glucose level whose set point is about 90mg/100 ml blood.	Increase in blood glucose level whose set point is about 90mg/100 ml blood.
Metabolic functions	Essentially antagonistic to insulin. Causes increase in blood glucose level Sympathetic nervous system also stimulates its secretion while high blood glucose level, insulin and somatostatin suppress its secretion.	Depresses blood glucose levels in a variety of ways: Increase the rate of glucose uptake by skeletal muscles and fat cells. Increase use of glucose in cellular respiration Increase glycogen synthesis (glycogenesis) Promote conversion of glucose into proteins and lipids

NOTES

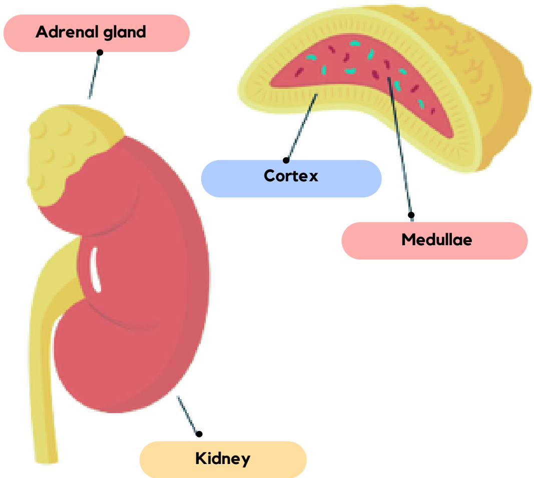
Features	Glucagon	Insulin
Control	It plays its role mainly by: Promoting breakdown of glycogen to glucose in liver and muscles. Increasing the rate of breakdown of fats.	Inhibit the hydrolysis of glycogen (glycogenolysis) in the liver and muscles. Inhibits gluconeogenesis.
Over secretion	Glucagon abnormalities seem to be rare endocrine systems. Tumor of B-cells will cause excess Glucagon secretion and consequently high blood glucose levels. This in turn damages the cells.	Utilization of sugar is too great and its level falls in the blood (hypoglycemia) which upsets nerve and muscle functioning.
Under secretion	Causes hypoglycemia due to which inadequate glucose is supplied to the brain, leading to impairment of function.	Failure to produce insulin leads to diabetes mellitus.Symptoms include: High level of blood sugar in urine. A disturbance in body's osmotic equilibrium. Derangement of the nervous system.Toxic metabolites from fat(which need 'glucose energy' for their oxidation) also accumulate and are only lost from the kidney with valuable metal cations. The body becomes dehydrated.

NOTES

Adrenal Glands:

Introduction:

- A pair of adrenal glands is present, one top of each kidney. These are called as glands of emergency or supra-renal glands.
- Each adrenal gland is composed of an inner portion called adrenal medulla and outer portion is called adrenal cortex.
- Adrenal medulla produces following hormones:
- Adrenaline/Epinephrine
- Nor-adrenaline/Norepinephrine



Features	Adrenaline & Nor-adrenaline
Control	Secreted in stress situations. Influenced by the sympathetic nervous system.
Target sites	Heart, skeletal muscles, iris in the eye, hairs in the skin, lungs and liver.
Stimulus for secretion	Stress situations
Functions	Epinephrine increases heartbeat, blood glucose, breathing rate and metabolic rate. The primary function of non-epinephrine is to sustain blood pressure. Promote metabolic activity and bronchodilation. Essentially adrenaline dilates blood vessels in certain parts of the body such as skeletal muscles and increases the heart's output.

	Adrenaline & Nor-adrenaline
	Nor-adrenaline constricts blood vessels but again only in certain areas such as the gut. Effects of 2 hormones are synergistic in raising blood pressure. Adrenaline and nor-adrenaline promote the release of glucose from liver glycogen and reinforce the effects of the sympathetic system.
Over secretion	Over secretion of catecholamine may cause hypertension and aggressive behavior during routine life.
Under secretion	Causes failure to combat an emergency situation. For example, in rats whose adrenal medulla has been removed surgically, the ability to withstand any stress situation such as cold is markedly diminished.

NOTES

- Adrenal medulla produces the following hormones:

1. Cortisol - glucocorticoid
2. Corticosterone - both glucocorticoid and mineralocorticoid
3. Aldosterone - principal mineralocorticoid
4. Androgens

Feature	Cortisol	Corticosterone	Aldosterone	Androgens
Control	Secreted under the influence of ACTH from adrenal cortex.			
Target site	Liver, muscle, adipose tissue, and pancreas	Liver, adipose tissue, brain and lung,	Kidney tubules	Testis (males),
Functions	Increases blood sugar level by increasing synthesis of glucose from non carbohydrate substances (protein) and antagonizing the action of insulin. Reduces inflammation (anti-inflammatory)	Increases blood glucose levels and regulates mineral ion balance.	Relwased during hypotension. Increases the reabsorption of Na+ and Cl- ions by the kidney, maintaining fluid volume and blood pressure.	Similar to male sex hormone testosterone. Produced in both the sexes. Responsible for secondary sexual characteristics.

Feature	STH	TSH	ACTH	GnRH
Over secretion	The hyper secretion of cortisol results in Cushing syndromes which is characterized by obesity, muscles wasting, hyper tension, diabetes.	The reverse of this is found in Cushing's disease where too much cortical hormone is produced. Symptoms are an excessive protein breakdown resulting in muscular and bone weakness. The high blood sugar disturbs the metabolism as in diabetes.	Disturbance of normal adrenal functions	Androgens cause development of the male secondary sex characteristics. Very small amounts of androgens are secreted in both male and female by adrenal glands. A tumor on the inner part of the adrenal cortex in a female can cause excess androgens to be produced and thus the development of certain male characteristics. Such cases are very rare.

NOTES

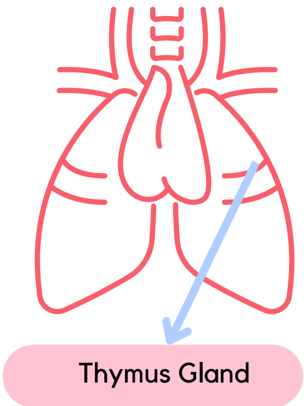
Feature	Cortisol	Corticosterone	Aldosterone	Androgens
Under secretion	The hypo secretion of this hormone causes Addison's disease which is characterized by weakness weight loss, low blood sugar and reduced blood pressure.	The destruction of the adrenal cortex, such as occurs in Addison's disease, will lead to general metabolic disturbance, in particular weakness of muscle action and loss of salts. Stress situations, such as cold, which would normally be overcome, lead to collapse and death.		
Funct-ions				

NOTES

Thymus Gland :

Introduction:

- This gland is situated in the upper part of the chest and consists of two lobes that join in front of the trachea.
- It secretes several hormones including thymosin that stimulates the development and
- differentiation of lymphocytes.



Pineal Gland:

Introduction:

- It is a tiny cone shaped body within the brain.
- It secretes melatonin at night.
- It produces biorhythms.

NOTES

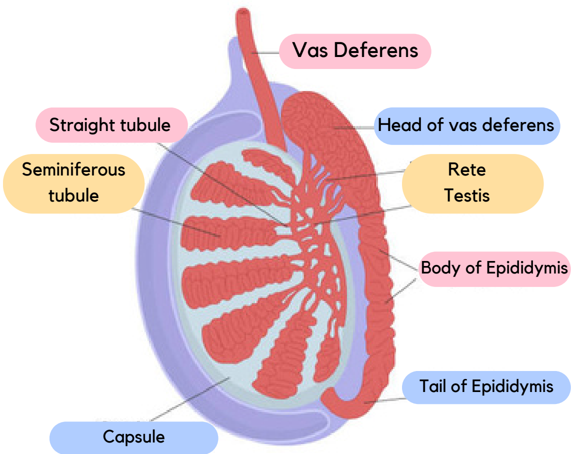
Gonads:

Testes:

- Consists of many coiled seminiferous tubules where the spermatozoa develop
- Between the tubules, regions of interstitial cells produce gonadal hormones known bas testosterone and B-hydroxytestosterone
- After the puberty the supply of LH/ICSH and therefore remains constant.

Functions:

- In the fetus, it initiates the development of sex organs.
- At puberty, it brings about development of the male secondary sexual characteristics and his his body tends more towards the form of the immune system

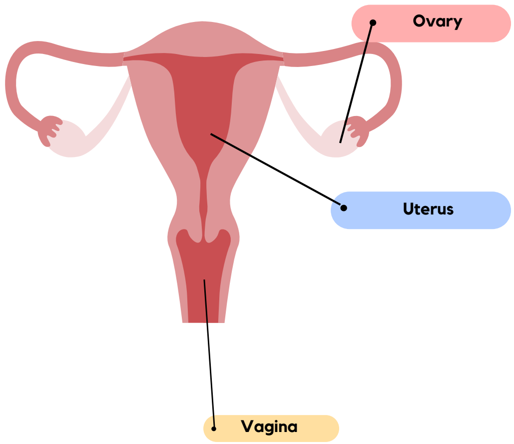


Introduction:

- Special type of endocrine glands which beside hormone secretions ald produce gametes
- Reproductive organs such as testes and ovaries release hormones responsible for secondary sexual characteristics

Ovarian hormones:

- Ovaries are involved in production and secretion of female sex hormones mainly estrogen and progesterone.



NOTES

Features	Estrogen	Progesterone
Production & Control	Secreted by graafian follicles whose development has been initiated by FSH from the pituitary gland. In many species it is produced by interstitial cells.	Produced by corpus luteum in response to LH during normal menstrual cycle but is produced and released from placenta during pregnancy.
Target sites	Uterus	Uterus
Stimulus for secretion	FSH	LH
Functions	Brings about the development of secondary sexual characteristics in females. Cause the thickening of the uterine wall. At a point during estrogen or menstrual cycle exercises a positive feedback which results in a sharp rise in LH output by the pituitary. They also aid in healing and repair of uterine wall after menstruation. Under the influence of estrogen some of the cells of the uterine wall become glandular and start secreting proteins secretions which are taken up by the embryo during its early stages of development.	It inhibits further FSH secretion from the pituitary, thus preventing any more follicles from ripening. It also affects the uterus, causing further thickening and vascularization of its wall and other areas of the body, preparing it for maintaining the state of pregnancy. It suppresses ovulation that is why it is a major constituent of birth control pills.

Abnormalities	Its over secretion leads to the development of fibroids in the uterus and polycystic ovaries. Deficiency of the sex hormones, for one reason or another, leads in the young of failure to mature sexually and sterility in the adult.	Under secretion of progesterone during the menstrual cycle decreases the chances of pregnancy and may cause early menstruation. Under secretion during pregnancy may lead to miscarriage.

NOTES

Other Endocrine Tissues/Cells:

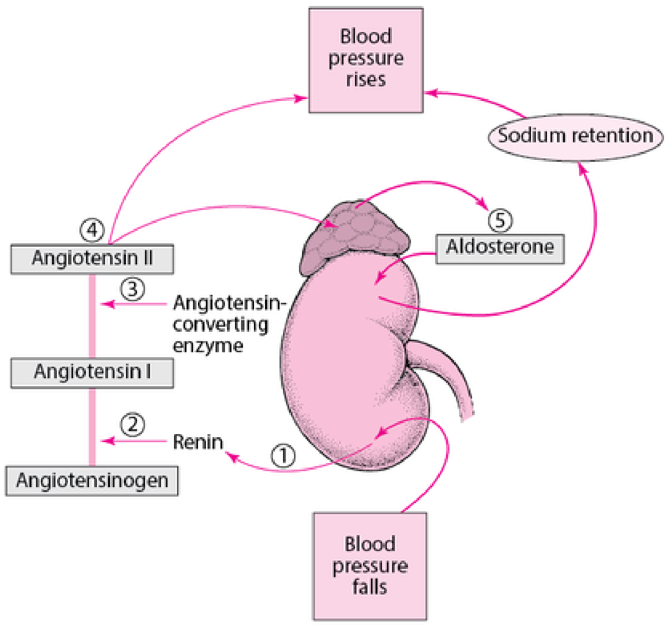
- Hormones are also produced by the organs or cells whose function is not primarily an endocrine one.
- Each nerve cell produces hormone. The table below includes hormones and their respective features.

Hormone	Target organ	Functions
Gastrin	Small intestine	Stimulates the secretion of HCl and pepsinogen
Secretin	Small intestine	Stimulates the pancreas to secrete pancreatic juice with a high concentration of bicarbonate.
Cholecystokinin	Small intestine	Stimulates secretion of bile juice
Prostaglandins	Placenta	Group of localized hormones which provide protection during infections.
Endorphins	Placenta	Bind to receptors, blocking sensations of pain.
Human chronic Gonadotropin (HCG)	Placenta	Stimulates the corpus luteum to produce progesterone to thicken the uterine lining during pregnancy to support a growing embryo.
Erythropoietin	Kidney	Sends signals to the bone marrow to increase RBC production.
Renin(converted to angiotensin II in kidneys)	Juxta-glomerular cells of kidney	Released during hypotension. Indirectly signals adrenal cortex to secrete aldosterone.
Calcitriol	Kidney	Absorbs calcium from small intestine

NOTES

Maintenance of Low Blood Pressure (Hypotension):

- Renin is an enzyme secreted into the blood from specialized cells that encircle the arterioles at the entrance to the glomeruli of the kidneys (the renal capillary networks that are the filtration units of the kidney).
- The renin-secreting cells, which compose the juxtaglomerular apparatus, are sensitive to changes in blood flow and blood pressure.
- The primary stimulus for increased renin secretion is decreased blood flow to the kidneys, which may be caused by loss of sodium and water (as a result of diarrhea, persistent vomiting, or excessive perspiration) or by narrowing of a renal artery.
- Renin catalyzes the conversion of a plasma protein called angiotensinogen into a decapeptide (consisting of 10 amino acids)nin-angiotensin system
- An enzyme in the serum called angiotensin-converting enzyme (ACE) then converts angiotensin I into an octapeptide (consisting of eight amino acids) called angiotensin II.
- Angiotensin II acts via receptors in the adrenal glands to stimulate the secretion of aldosterone, which stimulates salt and water reabsorption by the kidneys, and the constriction of small arteries (arterioles), which causes an increase in blood pressure.
- Angiotensin II further constricts blood vessels through its inhibitory actions on the reuptake into nerve terminals of the hormone norepinephrine.
- ACE inhibitors, which block the formation of angiotensin II, are used in treating high blood pressure (hypertension), which is produced by excessive constriction of the small arteries.
- Drugs that block the binding of angiotensin II to its receptor can also be used.



NOTES

FEEDBACK MECHANISM

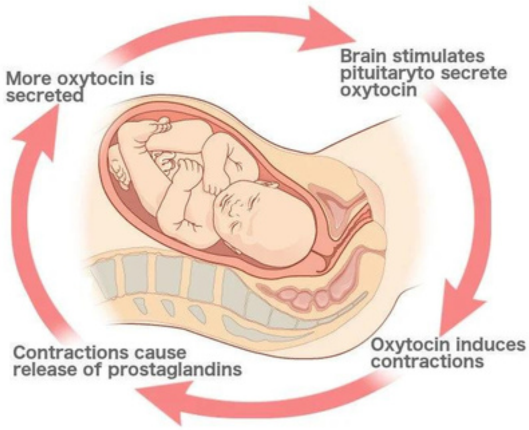
Hormonal Feedback Mechanism:

Introduction:

- A type of interaction in which a controlling mechanism is itself controlled by the products of a reaction it is controlling.
- After receiving the signal a change occurs to correct the deviation bby depressing it with positive feedback.

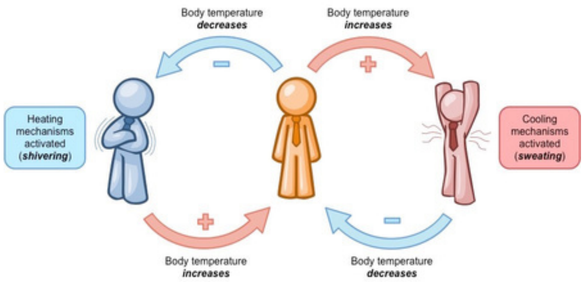
Positive Feedback Mechanism:

- End product speeds up its reaction
- These responses are not homeostatic and are rare in healthy individuals
- E.g. childbirth



Negative Feedback Mechanism:

- End product results in a reversal of the direction of change and tends to maintain homeostasis.
- An endocrine system is either sensitive to change the concentration of a substance it regulates or to the concentration of the product from the process it controls.
- E.g., regulation of blood glucose in the blood by pancreatic endocrine glands



NOTES

NATURE AND TYPES OF BEHAVIOUR

Introduction:

- The response of an animal in relation to its internal or external environment is called animal behavior.
- The scientific study of the nature of behaviors is known as ethology.

Types of Behaviors:

- There are two basic types of behaviors.
- Innate (instinctive) behavior
- Learned behaviors

Innate Behaviors:

- Innate behavior is automatic, pre-programmed, genetically determined, stereo type activities which do not include any learning.

Types of Innate Behavior:

1. Kinases:

- In this kind the rate movement is related to the intensity of the stimulus rather than its direction.
- Example: wood lice move quickly in dry conditions but slow do Example: a moth flies towards the light in the photo-taxis.

2. Taxes:

- This behavior is related to the direction of stimulus.
- Example: a moth flies towards the light in the photo-taxis.

3. Reflexes:

- These are stereo-typed, short-lived, rapid responses mediated by the nervous system.
- Example: knee jerk, blinking of eye.

4. Fixed Action Pattern: (FAP)

- This kind of innate behavior is triggered or released by an external sensory stimulus known as sign stimulus or releaser.
- Example: Male three spine stick-back fish which attack other males that enter his territory. It was found that the releaser of the attack is the red belly.

Learned Behavior:

- It refers to a more or less permanent change in the behavior which occurs as a result of experience.
- Types of Learned Behavior:

1. Habituation:

- It is the simplest type of learned behavior in which an animal stops responding to a repeated stimulus which is neither beneficial nor harmful.
- Example: Birds feeding along a road side.

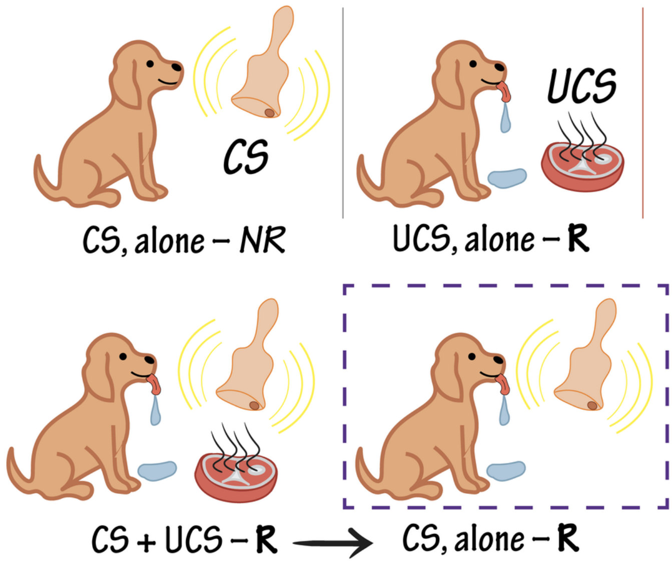
2. Imprinting:

- The term imprinting was coined by Konard Lorenz in 1930. It occurs during the very early stage in the life of birds and mammals and the animals are primed to learn specific information which is then incorporated into an innate behavior.
- Example: Ducklings follow the first large noisy moving object they see after hatching.

3. Classic Conditioning:

- It is associated with the reward of punishment. Ivan Pavlov, a Russian physiologist in 1902 performed a classic experiment on digestion in dogs.
- Experiment: He first placed dried meat powder into the dog's mouth causing release of saliva. Thereafter, he rang a bell before presenting meat powder. The process was repeated several times. Later the dog started salivating at singing the bell rather than seeing the meat.

NOTES



4. Operant conditioning:

- In this kind of learning an animal learns to associate one of its behaviors to receive an award or punishment.
- An American psychologist developed a box called Skinner box for his experiment with hungry pigeons or mice
- Inside the layer there was a lever which operated a food supply.

5. Latent learning:

- This type of learning is not associated with particular stimulus and is not normally rewarded or punished e.g. if a rat is placed in a maze it was observed that using its natural ability. The rat very soon finds its way out.

6. Insight Learning:

- Solving a problem without trial and error learning is called insight learning. It is the most developed form of learning behavior.
- E.g. insight learning was performed in chimpanzees presented with a bunch of bananas too high to reach and a few boxes. Some chimpanzees piled up boxes to make a stand for themselves.

Innate behavior	Learning behavior
Comes natural or by default	Should be developed with experience.
Cannot be modified	Can be easily modified.
May or may not have the direct involvement of the brain	Has the direct involvement of brain.
No use of energy	Uses ATP as energy
More common in Animals having shirt life span.	More common in animals having long life span.
Economical as animals require no time to adapt them.	Not economical as animals require more time to adapt them.

NOTES

Biological Rhythms:

- Definition: Some organisms do some activities at regular intervals irrespective of the season or day length. This kind behavior is called time biology or biological rhythms. It indicates the existence of a biological clock within the organism.

Types of Biological Rhythms:

- Exogenous Rhythms: These rhythms are controlled by external changes such as 24-hour cycles of light and dark.
- Endogenous Rhythms: These rhythms are controlled by biochemical and physiological changes.

Examples of Rhythmical Behavior:

- Breeding Season: Many animals do not breed all the year round and there is specific time of their breeding.
- Biannual Migration: Salmons and eels migrate between sea water and fresh water more than once in their life cycle. A number of birds have migratory life cycles.

Daily Rhythm:

- Animals are active for only a part of the 24-hr cycle.
- Example:
- Some function at dawn (crepuscular)
- Some function in night (nocturnal)
- Some function in the day (diurnal)