

Revision Notes on Neural Control and Coordination

Parts of nervous system

(1) Nervous system is divided into three parts:

(i) Central nervous system (CNS):

(a) In all the vertebrates including man, CNS is dorsal, hollow and non-ganglionated while in invertebrates when present, it is ventral, solid and ganglionated.

(b) CNS is formed of two parts:

Brain – Upper and broader part lying in the head; and

Spinal cord – Lower, long and narrow part running from beginning of neck to trunk.

(ii) Peripheral nervous system (PNS):

(a) It is formed of long, thin, whitish threads called nerves which extend between CNS and body parts (muscles, glands and sense organs).

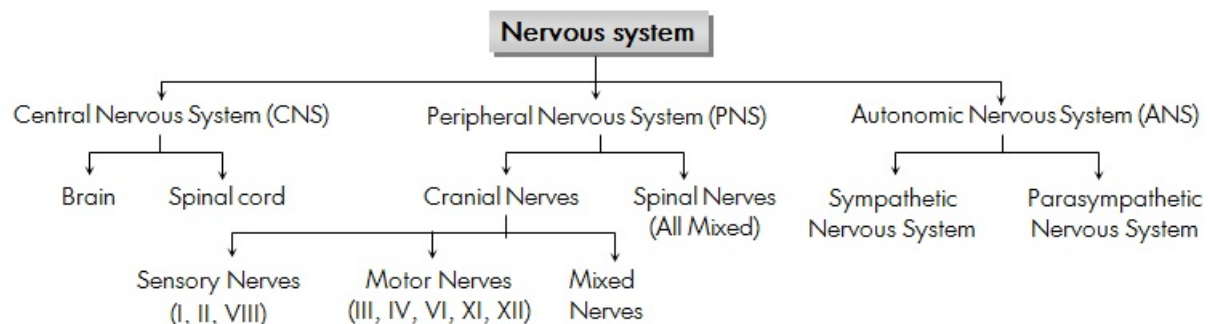
(b) It controls the voluntary functions of the body.

(c) It has cranial and spinal nerves.

(iii) Autonomic nervous system (ANS):

(a) It is formed of nerve fibres extending upto visceral organs and controls the involuntary functions of visceral organs of body like heart beat, peristalsis etc.

(b) It is again formed of two systems: sympathetic and para-sympathetic nervous system which has opposing functions.



Central nervous system:

(1) Central nervous system is made up of brain and spinal cord. CNS is covered by 3 meninges and its wall has two type of matter.

(2) Types of matter: CNS of vertebrates is formed of two types of matter –

(a) Grey matter: It is formed of cell-bodies and non-medullated nerve fibres.

(b) White matter: It is formed of only medullated nerve fibres which appear white due to presence of medullary sheath.

Brain (Encephalon):

It is soft, whitish, large sized and slightly flattened structure present inside cranial cavity of cranium of the skull. In man, it is about 1200-1400 gm in weight and has about 10,000 million neurons. Brain is made up of 3 parts

(1) Fore brain (Prosencephalon)

(i) Olfactory lobe – Rhinencephalon

(ii) Cerebrum – Telencephalon

(iii) Diencephalon – Diencephalon

(2) Mid brain (Mesencephalon)

(i) Optic lobes – Mesencephalon

(3) Hind brain (Rhombencephalon)

(i) Cerebellum – Metencephalon

(ii) Medulla oblongata – Myelencephalon

Important areas in the human brain

| Area | Location | Function |
|------------------|----------------|--|
| Premotor area | Frontal lobe | The highest centre for involuntary movements of muscles and ANS. |
| Motor area | Frontal lobe | Controls voluntary movements of the muscle |
| Broca's area | Frontal lobe | Motor speech area |
| Somesthetic area | Parietal lobe | Perception of general sensation like pain, touch and temperature |
| Auditory area | Temporal lobe | Hearing |
| Olfactory area | Temporal lobe | Sense of smell |
| Wernicke's area | Temporal lobe | Understanding speech written and spoken |
| Gustatory area | Parietal lobe | Sense of taste |
| Visual area | Occipital lobe | Sensation of light |

Differences between Cerebrum and Cerebellum

| Cerebrum | Cerebellum |
|---|---|
| (1) It is the largest part of the brain, forming four-fifths of its weight. | (1) It is the second largest part of the brain, forming one-eighth of its mass. |

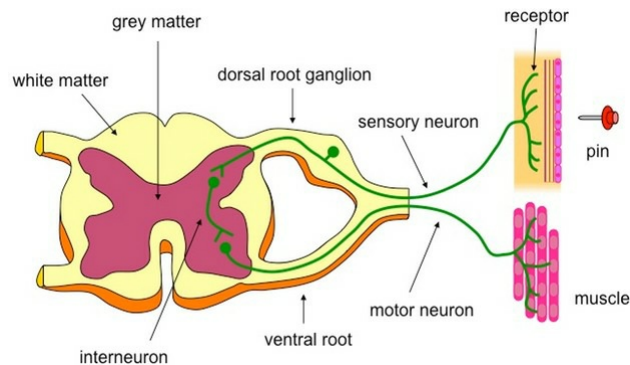
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|---|--|
| (2) It covers the rest of the brain. | (2) It covers the medulla oblongata only. |
| (3) It is a part of the forebrain. | (3) It is a part of the hindbrain. |
| (4) It consists of 2 cerebral hemispheres each comprising 4 lobes : frontal, occipital, parietal, temporal. | (4) It consists of two cerebellar hemispheres and a median vermis. |
| (5) It encloses 2 lateral ventricles. | (5) It is solid. |
| (6) White matter does not form arbor vitae. | (6) White matter form arbor vitae. |
| (7) It initiates voluntary movements, and is a seat of will, intelligence, memory <i>etc.</i> | (7) It maintains posture and equilibrium. |

Subdivisions, parts and associated structures of a vertebrate brain

| Divisions | Subdivisions | Parts | Cavity | Associated structures |
|---------------------------------------|-------------------|-----------------------|-------------------------------------|--|
| (I) Prosencephalon (Forebrain) | (1) Telencephalon | Rhinencephalon | I Ventricle (<i>Rhinocoel</i>) | Olfactory bulbs Olfactory tracts Olfactory lobes Palaeocortex on pallium |
| | | Cerebral hemispheres | II or Lateral Ventricles | Corpora striata or basal ganglia Corpus callosum Neocortex on pallium Paraphysis |
| | (2) Diencephalon | Epithalamus (roof) | | Habenulae Pineal apparatus Parapineal or parietal |
| | | Thalamus (sides) | | |
| | | Hypothalamus (floor) | | Hypothalamic nuclei Optic chiasma Median eminence Infundibular stalk Pituitary Saccus vasculosus Mamillary bodies Anterior choroid plexus |
| | | | | |
| (II) Mesencephalon (Midbrain) | – | Crura cerebri (floor) | <i>Iter or cerebral aqueduct</i> | Cerebral peduncles |
| (III) Rhombencephalon (Hind brain) | (1) Metencephalon | Cerebellum | | Trapezoid body Pons |
| | | | IV Ventricle | Restiform bodies |

| | | | | |
|--|--------------------|-------------------|----------|----------|
| | (2) Myelencephalon | Medulla oblongata | Metacoel | Pyramids |
|--|--------------------|-------------------|----------|----------|

Reflex action



(1) The reflex actions are involuntary actions because these are not under the conscious control of the brain.

(2) The spinal cord and brain stem are responsible for most of the reflex movements.

(3) A few examples of the reflex actions are withdrawal of hand or leg if pricked by a pin, secretion of saliva as soon as one thinks of delicious food or mere its sight causes salivation, if the body part is touched with acid or hot object it is automatically, without thinking and planning is withdrawn, cycling, motor driving etc.

(4) Component of reflex action: The whole of the reflex are includes six parts –

(a) Receptor organs: Receptors are windows of the body or guards of the body. These are situated on all, important organs, for example – eyes, nose, ear, tongue, integument etc. These perceive the stimuli from outside the body.

(b) Sensory neurons: These are also termed afferent neurons. These carry the stimuli from receptors to spinal cord. These neurons are situated in the ganglion on the dorsal side of spinal cord.

(c) Nerve centre: Spinal cord is termed as nerve centre. Synaptic connections are formed in it.

(d) Association neurons: These are also called intermediate neurons or interstitial neurons. These are found in spinal cord. They transfer the impulses from sensory neurons to motor neurons.

(e) Motor neurons: These are situated in the ventral horn of spinal cord. These carry the impulses to effector organs.

(f) Effector organs: These are the organs, which react and behave in response to various stimuli, for example – muscles and glands.

(5) Type of reflexes: The reflexes are of following types –

(a) Monosynaptic reflex

(b) Polysynaptic Spinal Reflex

(c) Polysynaptic Spinal/Brain Reflexes

(d) Unconditioned or Simple reflex

(e) Conditioned or Acquired reflex

Cranial nerves of mammal at a glance

| S.No. | Name | Nature | Origin | Distribution | Function |
|-------|-------------------|---------|--|--|--|
| (1) | Olfactory Nerves | Sensory | Olfactory lobe | Sensory epithelium of olfactory sacs | Receive stimuli from the sensory epithelium of olfactory sac and carry them to olfactory lobes |
| (2) | Optic nerves | Sensory | Optic lobes | Retina in Eyes | Stimulus of light is carried to optic lobes |
| (3) | Oculomotor nerves | Motor | Crura cerebri | Eye ball muscles, except superior oblique muscle | Carry the impulses from crura cerebri to the eye muscles |
| (4) | Trochlear nerves | Motor | From in between the optic lobes and cerebellum | Superior oblique muscle of eye ball | Carry the impulses from the brain to superior oblique muscles of the eye |
| (5) | Trigeminal nerves | Mixed | From the gasserian ganglia situated on the lateral side of medulla oblongata | — | — |
| (i) | Ophthalmic nerve | Sensory | „ | Skin of lips | |
| (ii) | Maxillary | Sensory | „ | Upper lip, skin of nose, lower eye lid. | Carry the stimuli from these organs to brain |
| (iii) | Mandibular nerve | Mixed | „ | Lower lip and skin of jaw | Carry the stimuli from these organs to brain |
| (6) | Abducens nerves | Motor | Medulla | Eye muscles | Carry the impulses from the brain (medulla) to eye muscles |
| (7) | Facial nerves | Mixed | Behind trigeminal nerve, from geniculate ganglion | — | — |
| (i) | Palatinus | Sensory | — | In the roof of mouth cavity | Carry the impulses from roof of mouth cavity |
| (ii) | Hyoman dibular | Motor | — | Muscles of low jaw, muscles of neck and pinna (external ear) | Carry the impulses from brain muscles of lower jaws, neck and pinna. |
| (iii) | Chordotympani | Mixed | — | In salivary glands and taste buds | Receives the stimuli from the taste buds and carry the stimulus to salivary gland. |
| (8) | Auditory nerves | Sensory | Medulla | — | — |
| (i) | Vestibular nerve | „ | „ | Utriculus, sacculus, semicircular canals and Cochlea. | Receives impulses from the internal ear and carry to brain. |
| (ii) | Cochlear nerve | „ | „ | Cochlea | — |
| | | | | Taste buds | Carry sound impulses to |

| | | | | | |
|-------|---------------------------|-------|--|--|--|
| (9) | Glossopharyngeal nerve | Mixed | „ | taste buds present in tongue and muscles of oesophagus | Carry sound impulses to brain, to muscles of oesophagus and carry the taste impulse of tongue to the brain |
| (10) | Vagus nerve | Mixed | After arising from medulla, 9 th and 10 th cranial nerves unite to form vagus nerve but become separate and divide into branches | — | — |
| (i) | Superior laryngeal nerve | Motor | — | Glottis | Carry the impulse to muscle of glottis |
| (ii) | Recurrent laryngeal nerve | Motor | — | Glottis | „ |
| (iii) | Cardiac nerve | Motor | — | Heart Muscles | From brain to heart muscles |
| (iv) | Pneumogastric | Motor | — | In the abdominal cavity, in stomach and lungs. | Carry impulse from these organs to brain and from brain to muscles of these organs. |
| (v) | Depressor nerve | Motor | — | Diaphragm | Carry the impulse to diaphragm |
| (11) | Spinal accessory | Motor | Medulla | Muscles of neck and shoulders | From brain to muscles of neck and shoulder |
| (12) | Hypoglossal nerve | Motor | „ | Muscles of tongue and neck | From brain to their muscles |