UNIT – I
NERVOUS SYSTEM

Presented By

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Nervous system

- Nervous system is the master controlling and communicating system of the body. Every thought, action, and emotion reflects its activity.
- Its signaling device, or means of communicating with body cells, is electrical impulses, which are rapid and specific and cause almost immediate responses.
- As we know, the functions of the organs or the organ system in our body must be coordinated to maintain homeostasis.

- Coordination: the process through which two or more organs interact and complement the functions of one another.

- For e.g.: when we do physical exercise, the energy demand is increased for maintaining an increased muscular activity . The supply of oxygen is also increased and in turn the rate of respiration, heart beat and blood flow increases.

- When the physical exercise is stopped, the activities of nerves, lungs, heart and kidney gradually return to their normal conditions.

- Hence the functions of all these organs are coordinated while performing physical exercise.
- Nervous system and the endocrine system jointly coordinate and integrate all the activities of the organs.
- Nervous system detects and responds to changes inside and outside the body.
- Endocrine system provides chemical integration through hormones.

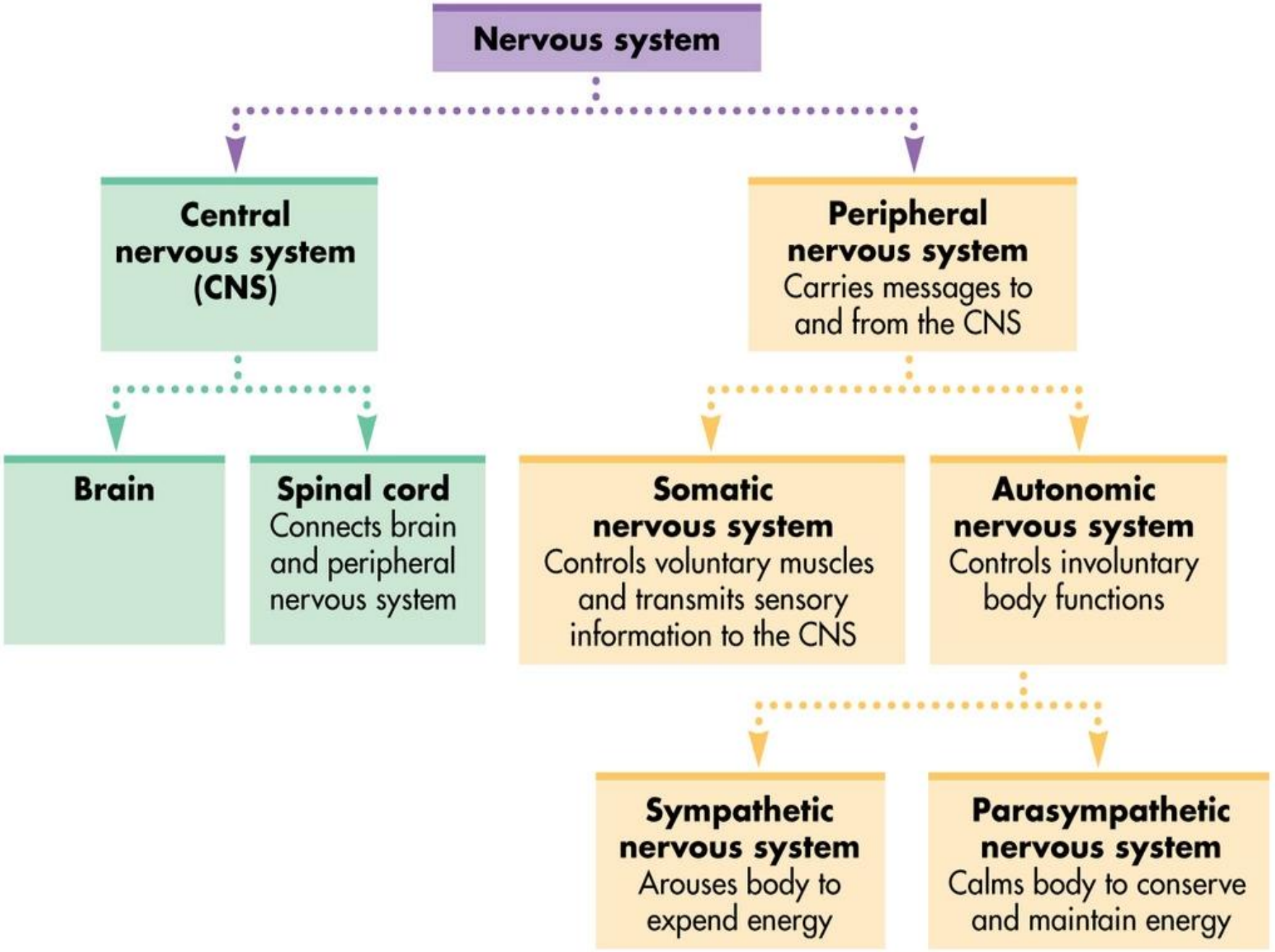
Organization of Nervous System

- The nervous system does not work alone to regulate and maintain body homeostasis. the endocrine system is a second important regulating system.
- Organization of the Nervous System We only have one nervous system, but, because of its complexity, it is difficult to consider all of its parts at the same time.
- So, to simplify its study, we divide it in terms of its structures (structural classification) or in terms of its activities (functional classification).
- Which includes all of the nervous system organs, has two subdivisions- the central nervous system and the peripheral nervous system.

- The nervous system of all animals is composed of highly specialised cells called neurons which can detect, receive and transmit different kinds of stimuli.

- Central nervous system (CNS). The CNS consists of the brain and spinal cord, which occupy the dorsal body cavity and act as the integrating and command centers of the nervous system

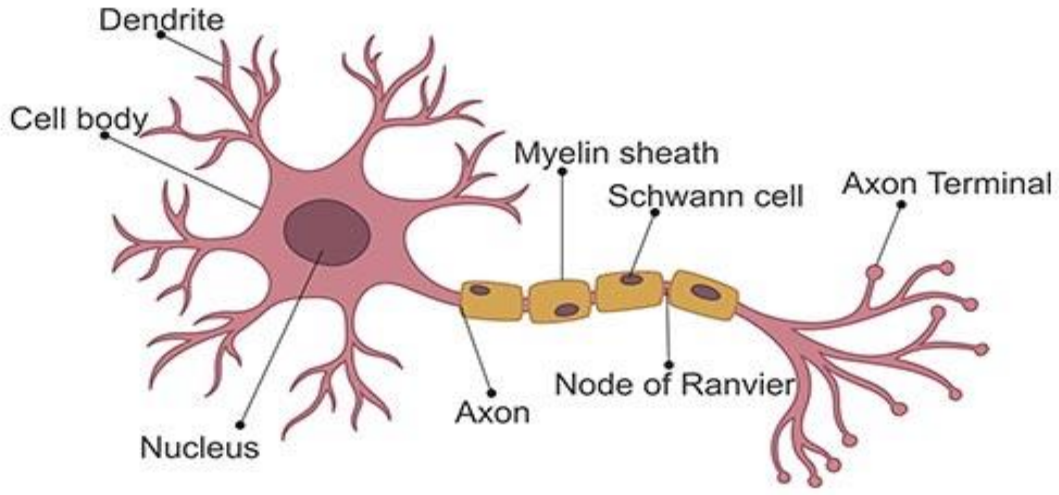
- Peripheral nervous system (PNS). The PNS, the part of the nervous system outside the CNS, consists mainly of the nerves that extend from the brain and spinal cord.


Nervous system
Central nervous system (CNS)
Peripheral nervous system
Carries messages to and from the CNS
Brain
Spinal cord
Connects brain and peripheral nervous system
Somatic nervous system
Controls voluntary muscles and transmits sensory information to the CNS
Autonomic nervous system
Controls involuntary body functions
Sympathetic nervous system
Arouses body to expend energy
Parasympathetic nervous system
Calms body to conserve and maintain energy

Neuron

- Neuron is the structural and functional unit of nervous system.
- It is commonly known as nerve cell.

- It is a microscopic structure consist of three major parts:
- Cell body
- Dendrites
- Axon



- Bundles of axons bound together to form nerves.
- Neurons cannot divide, and for their survival they need a continuous supply of oxygen and glucose.

CELL BODY

- Cell bodies: these bodies are located at the periphery of the brain and in the Centre of spinal cord
- Contains cytoplasm, cell organelles
- Groups of cell bodies are called nuclei in CNS
- Groups of cell bodies are called ganglia in PNS
- Cell body forms the grey matter of nervous system

Axon

- The axon is a long fibre extending from the cell body.
- The membrane of the axon is called axolemma and it encloses the cytoplasm.
- These axons carry impulses away from the cell body .
- Myelinated neurons: the large axons when surrounded by a myelin sheath
- This consists of a series of Schwann cells arranged along the length of the axon
- Each Schwann cell membrane is wrapped around the axon in concentric layers
- Myelin the fatty substance present between the layers of Schwann cell plasma membrane.

Dendrites

- These are short fibres which branch repeatedly and project out of the cell body.
- In motor neurons dendrites form part of synapses
- In sensory neurons they form the sensory receptors that respond to specific stimuli.

Classification of Neuron

Functional classification

- Sensory neuron: They convey information from autonomic sensory receptors, located primarily in the visceral organs such as stomach and lungs to the CNS.
- Motor neurons: Neurons carrying impulses from the CNS to the viscera and/or muscles and glands are motor, or efferent, neurons.
- Interneurons: The third category of neurons is known as the interneurons, or association neurons; they connect the motor and sensory neurons in neural pathways.

Structural classification

Structural classification is based on the number of processes extending from the cell body.

1) Multipolar neuron: If there are several processes, the neuron is a multipolar neuron; because all motor and association neurons are multipolar, this is the most common structural type.

2) Bipolar neurons: Neurons with two processes, an axon and a dendrite are called bipolar neurons, these are rare in adults, found only in some special sense organs, where they act in sensory processing as receptor cells.

3) Unipolar neurons: Unipolar neurons have a single process emerging from the cell's body, however, it is very short and divides almost immediately into proximal (central).

Neuroglia

- Support, protect, connect and remove debris from the nervous system

Types of neuroglial cells

1) Astrocytes 2) Oligodendroglia 3)Microglia

Classification of Nerve Fibre

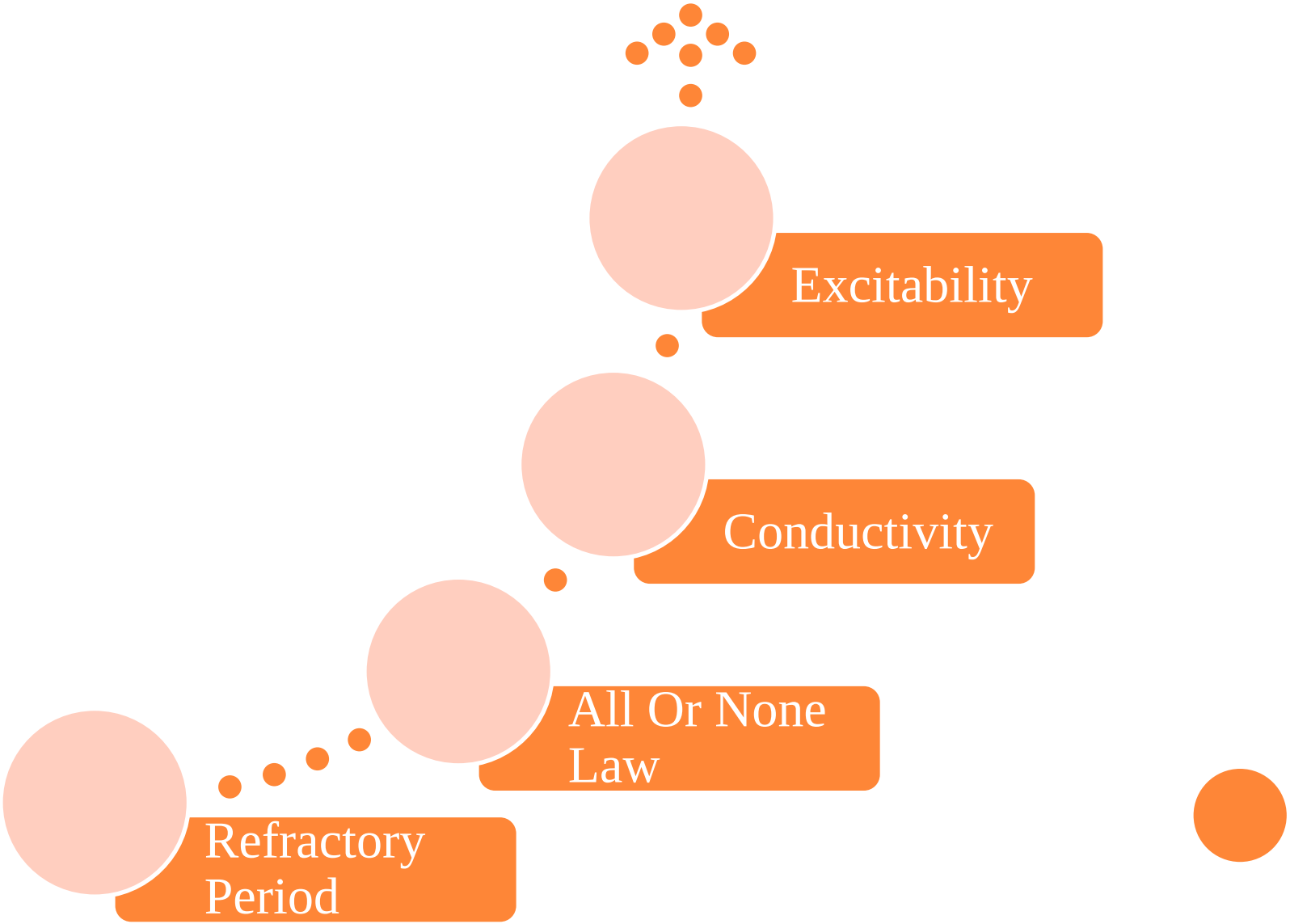
1. Depending upon Structure
   - Myelinated Nerve Fibres
   - Un Myelinated Nerve Fibres

2. Depending upon distribution
   - Somatic- supply skeletal muscles
   - Visceral / autonomic nerve fiber

3. Depending upon origin
   - Cranial nerves
   - Spinal nerves

4. Depending upon function
   - Motor nerve fibers
   - Sensory nerve fibers

Properties of nerve fibre



EXCITABILITY

- It's the ability of a cell to produce action potential in response to a stimulus.
- Stimulus - A change in environment which brings about a change in potential across a membrane in an excitable tissue.

TYPES OF STIMULI

- Electrical
- Chemical
- Thermal
- Mechanical

Conductivity

- Ability to conduct an impulse is called Conductivity.
- Two Types
- Orthodromic conduction
- Antidromic conduction

All or None Law

- A single nerve fiber obeys “all or none law”
- When stimulus of sub-threshold intensity is applied to the axon, then no action potential is produced (NONE RESPONSE)
- A response in the spike of action potential is observed when the stimulus if of threshold intensity
- There occurs no increase in the magnitude of action potential when the strength of stimulus is more than the threshold level (ALL RESPONSE)

REFRACTORY PERIOD

- The period of time during which an excitable cell cannot generate another action potential is called the refractory period.

1) Absolute refractory period-

- It is the period during an action potential, during which a second stimulus can't produce a second response.
- Period of action potential from firing level until repolarization is almost 1/3rd complete (spike potential)

2) Relative refractory period-

- It is the period during an action potential, during which a stimulus of higher intensity can produce a second response
- It extends from the end of absolute refractory period to the start of after depolarization phase of action potential

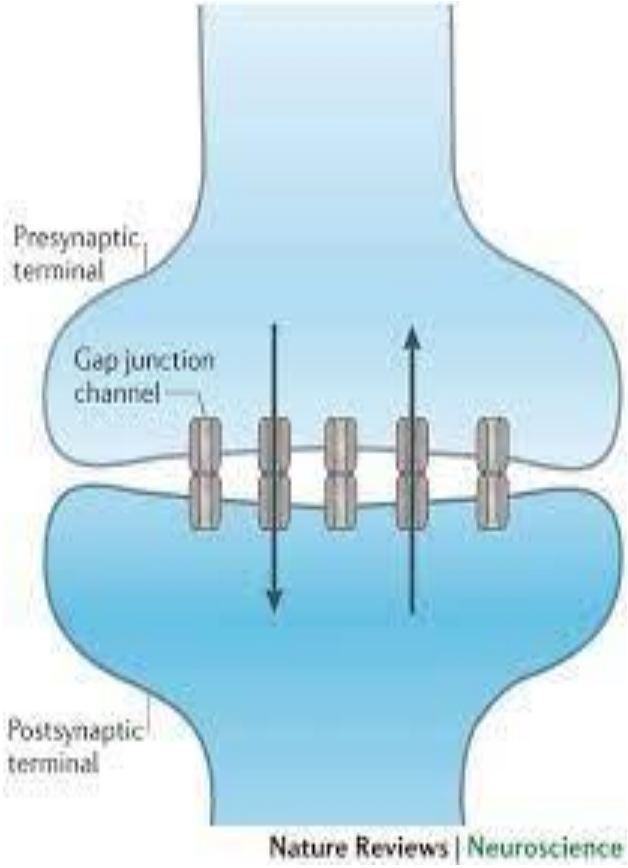
Action Potential

- Is the entire series of charges which contribute towards the changes in membrane potential.
- Occurs in response to a threshold stimulus
- Either occurs completely/it does not occur at all(all/none principle)

Two main phases

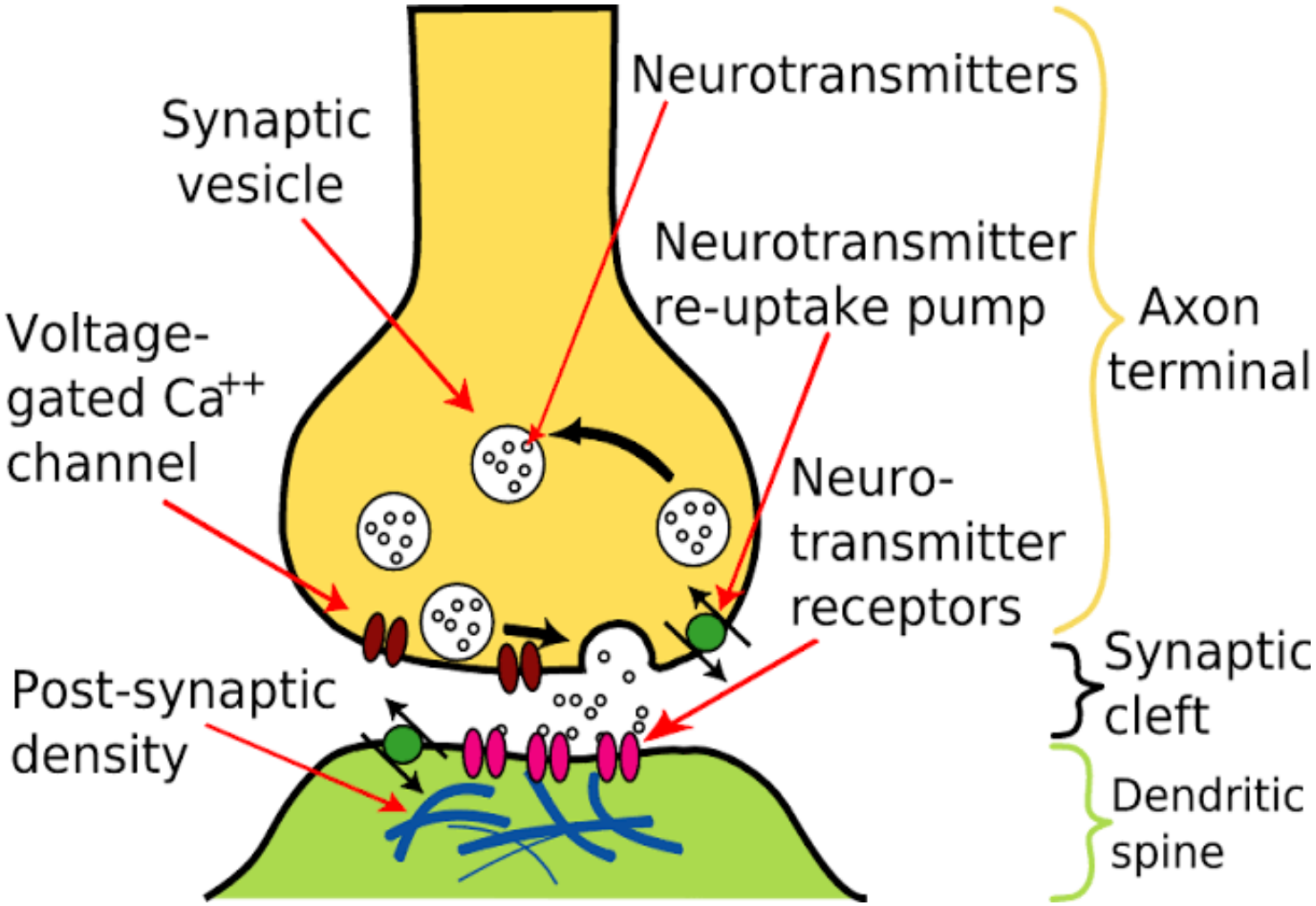
1. Depolarising phase: -ve memberane potential becomes less –ve reaches zero & then becomes +ve
2. Repolarising phase: the memberane potential is restored to the resting state of -70mV

Electrical Synapse : Gap Junction



- Present in nervous system between glial cells and certain neurons in regions such as the cerebellum, spinal cord, thalamus, hippocampus, olfactoray bulb, retina, and striatum
- Information can be bidirectional and results in no synaptic delay in communication and synchronized

Chemical Synapse



Neurotransmitter Receptor

- The response(s) elicited by a neurotransmitter is determined by receptor to which it binds
- Two general families:

✓ Ionotropic receptors (ligand gated ion channels)

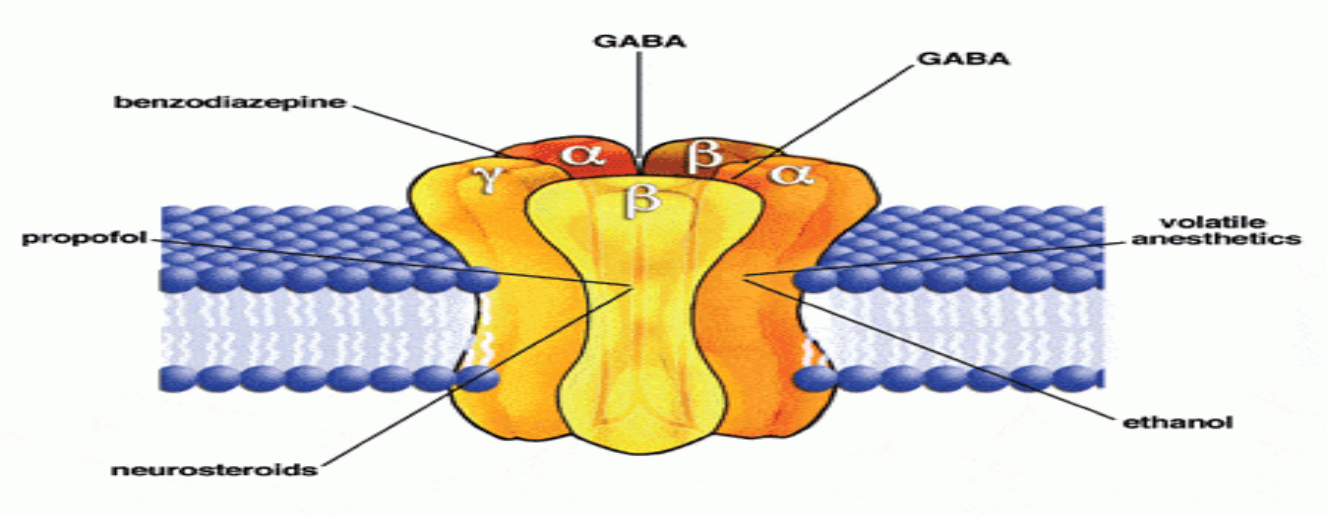
- Directly linked to ion channels
- Activation results in post synaptic events that are rapid in onset

✓ Metabotropic receptors (G-protein coupled receptors)

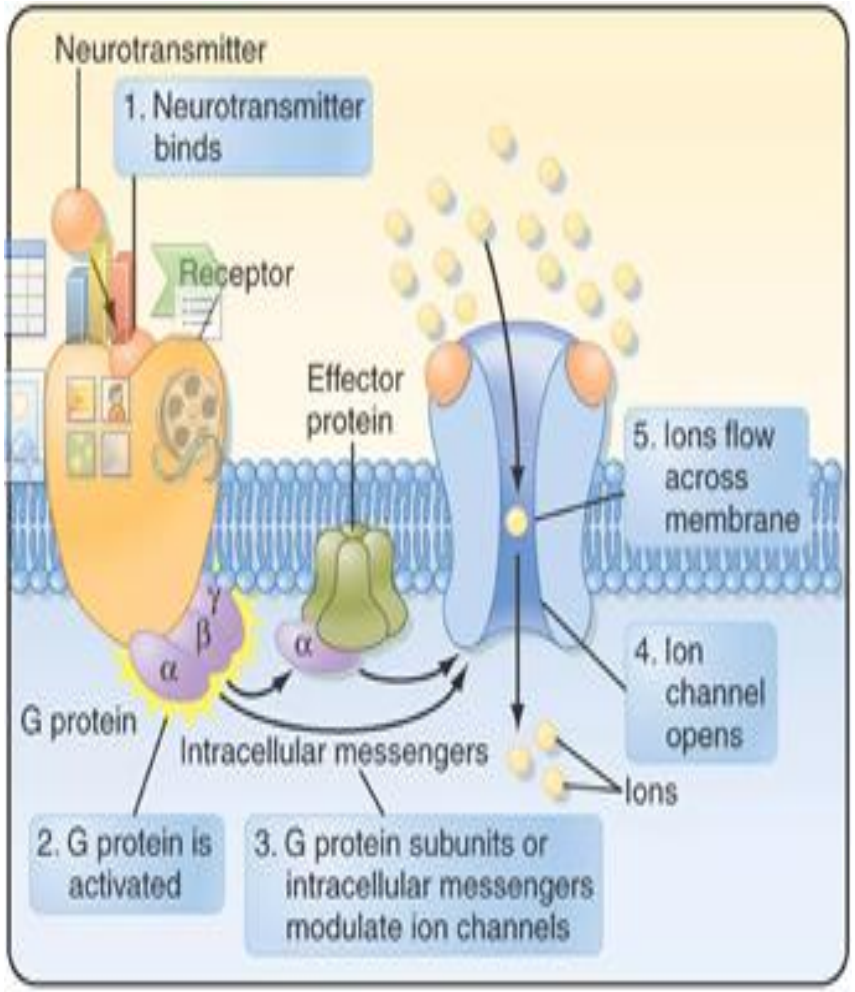
- Activation results in modification of enzyme or membrane proteins
- Post synaptic events have slower onset and longer

Ionotropic Receptors

- Two functional domains
- Extracellular site binds neurotransmitters
- Membrane-spanning domain forms ion channel
- Examples:
- Ionotropic glutamate receptors
- Ionotropic GABA receptors



Metabotropic receptors



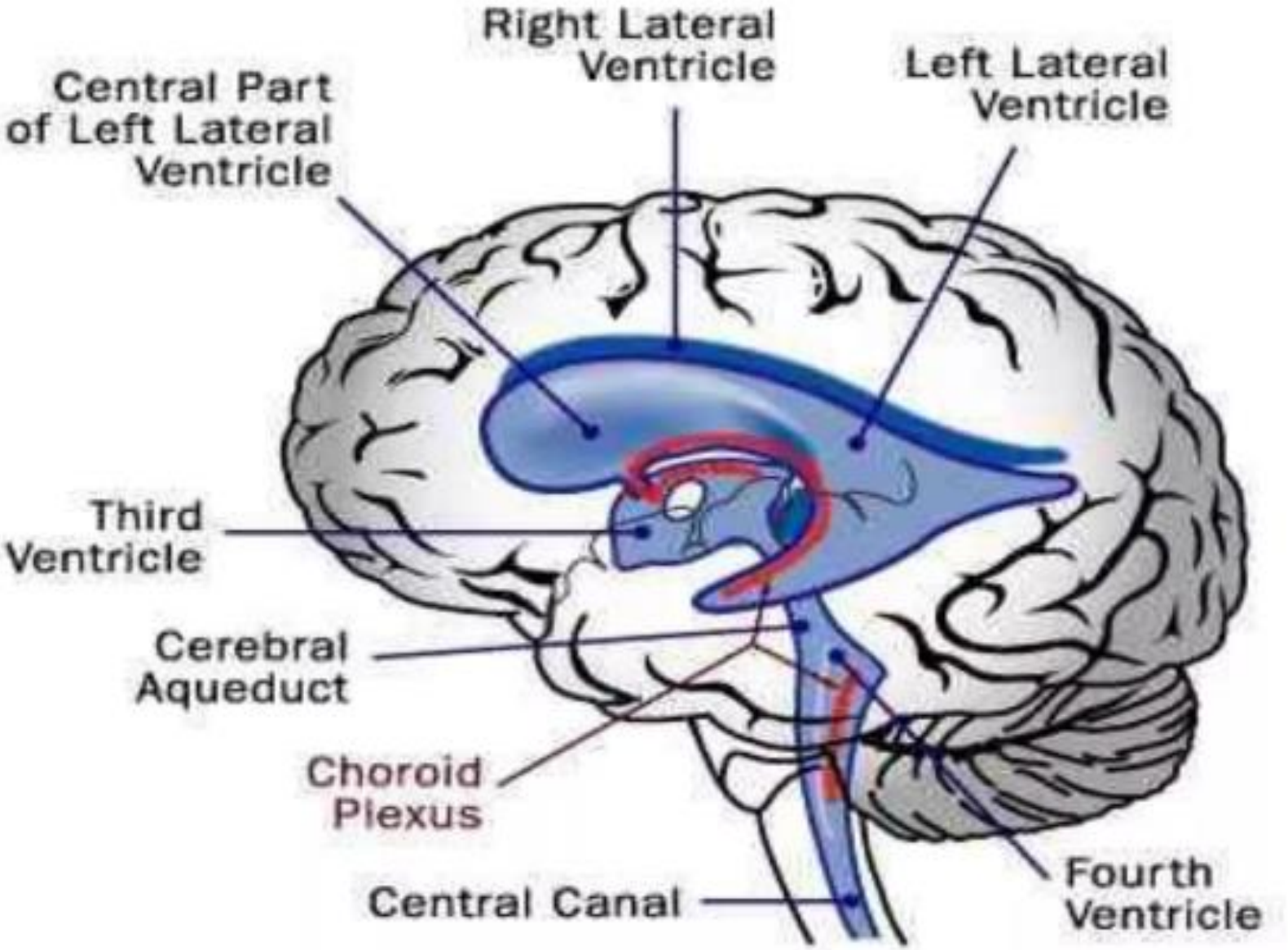
- ✓ Two functional domains:
- Extracellular domain binds neurotransmitters
- Intracellular domain binds to G-proteins
- G proteins couples neurotransmitter binding to modulation of intracellular or membrane proteins
- Examples:
- Metabotropic glutamate receptors
- Muscarinic acetylcholine (Ach) receptors
- Adrenergic receptors

Neurotransmitters

- Acetylcholine affects movement, learning, memory, Sleep.
- Dopamine (DA) Attention, Sleep, learning, regulation of movements and coordination, emotions, voluntary decision-making ability
- Nor - epihephrine (NE) Affects eating, Regulation of mood, locomotion, cardiovascular functioning, and sleep.
- Epinephrine Affects metabolism of glucose, energy release during exercise.

- Serotonin Affects mood, sleep, appetite, aggression Neurotransmitter
- Glutamate active in areas of the brain involved in learning good emotion GABA (Gamma-amino butyric Acid) Facilitates neural inhibition in the central nervous system (Too much action potential)
- Endorphins Provide relief from pain and feelings of pleasure and well- being

The Ventricular System of the Human Brain



Cerebrospinal fluid

- Plays an important role in cushioning and protecting the brain from major shocks. It also plays an important role in the homeostasis and metabolism of the central nervous system.

CSF flow

- CSF is produced from arterial blood by the choroid plexus of the lateral and fourth ventricles
- CSF flows through the inter ventricular foramina into the third ventricle.
- CSF flows down the cerebral aqueduct into fourth ventricle.
- CSF flows out two lateral apertures and one median aperture.
- CSF fills subarachnoid space and bathes external surface of brain and spinal cord.
- At the arachnoid villi (granulations), CSF is reabsorbed into the venous blood of dural venous sinuses.

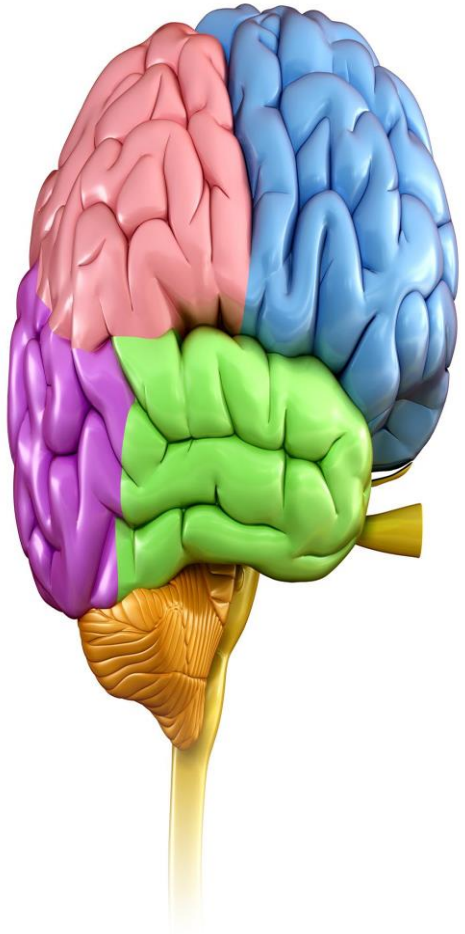
Physical characteristics and composition of the CSF	
Appearance	Clear and colourless
Volume	130 ml
Rate of production	0.5 ml/min
Pressure	60-150 mm of water
Composition	
protein	15-45 mg/100 ml
glucose	50-85 mg/ 100 ml
chloride	720-750 mg/100 ml
No. of cells	0-3 lymphocytes/cu mm

Brain

- Weighs about 3 pounds in adults
- 75% water
- 20% of oxygen
- Contains over 100 billion neurons
- Controls bodily functions and interactions with the outside world

Four Parts

- Cerebrum
- Diencephalons
- Brain stem
- Cerebellum



Brain stem

- Made up of the midbrain; Pons and the medulla oblongata.
- ✓ Midbrain : Involved with visual reflexes

✓ PONS

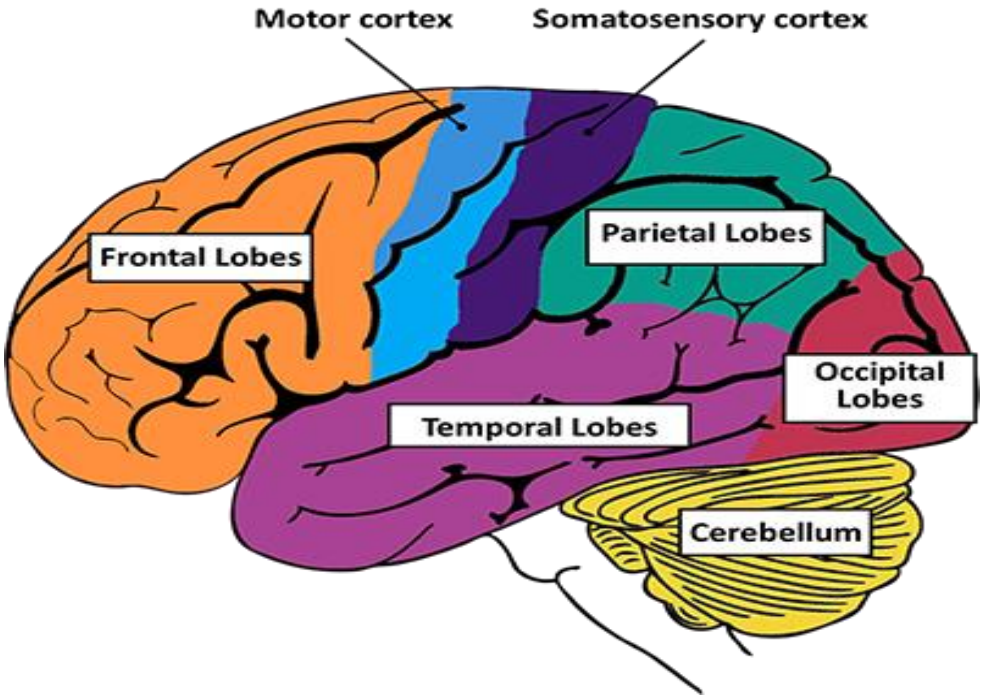
- Located between the midbrain and the medulla oblongata
- Controls certain respiratory functions

✓ MEDULLA OBLONGATA

- Contains centers that regulate heart and lung functioning, swallowing, coughing, vomiting and sneezing

Cerebellum

- Area that coordinates musculoskeletal movement to maintain posture, balance, and muscle tone.
- Inferior to the occipital lobes of the cerebrum.
- Posterior to the pons and medulla oblongata



Cerebrum

- Located above the cerebellum.
- Contains two hemispheres with an outer portion called the cerebral cortex.

- The two hemispheres are connected by a bridge of nerve fibers that relay information between the two hemispheres called the corpus callosum.

- The left and right lobes are each divided into four lobes or parts
- parietal lobe
- Frontal lobe
- Temporal lobe
- Occipital lobe

Diencephalon

- Diencephalon: The deep portion of the brain containing:
  - Thalamus
  - Hypothalamus
  - Epithalamus
  - Ventral thalamus

- ✓ Serves as relay center for sensations like:

- Heart rate
- Blood pressure
- Temperature control
- Behavioral responses
- Digestive functions
- Water and electrolyte balance

Spinal cord

- Extends from the medulla oblongata of the brain to the area around the first lumbar vertebra in the lower back.
- Nerves from the peripheral nervous system extend out from the spinal cord.
- Protected by: Vertebral column, Cerebrospinal fluid, Meninges

✓ Meninges are three layers of membranes that cover the brain and spinal cord.

Layers of the meninges

- Dura mater - Outer tough fibrous membrane.
- Arachnoid mater - Middle weblike membrane containing CSF.
- Pia mater - Innermost layer containing several blood vessels.

Cranial Nerves

- There are 12 pairs of cranial nerves originating from the nuclei in the inferior surface of the brain.
- Some are sensory, some are motor and some are mixed.
- Their names and numbers are as follows:

Types of Cranial Nerves

Cranial nerves		
Number	*Name*	*Function*
I	olfactory	smell
II	optic	Sight
III	oculomotor	moves eye, pupil
IV	trochlear	moves eye
V	trigeminal	face sensation
VI	abducens	moves eye
VII	facial	moves face, salivate
VIII	vestibulocochlear	hearing, balance
IX	glossopharyngeal	taste, swallow
X	vagus	heart rate, digestion
XI	accessory	moves head
XII	hypoglossal	moves tongue

Spinal nerves

- Peripheral nervous system consist of:
- 31 pairs of spinal nerves
- 12 pairs of cranial nerves
- There are 31 pairs of spinal nerves that leaves the vertebral canal (formed by 33 vertebrae) by passing through the intervertebral foramina.
- They are named and grouped according to the vertebrae with which they are associated:
- ✓ 8 cervical
- ✓ 12 thoracic
- ✓ 5 lumbar
- ✓ coccygeal


thank you