Chapter-11

Nervous system

- Classification of nervous system
- Anatomy and physiology of cerebrum, cerebellum, mid brain
- Function of hypothalamus, medulla oblongata and basal ganglia
- Spinal cord-structure and reflexes
- Names and functions of cranial nerves.
- Anatomy and physiology of sympathetic and parasympathetic nervous system (ANS)

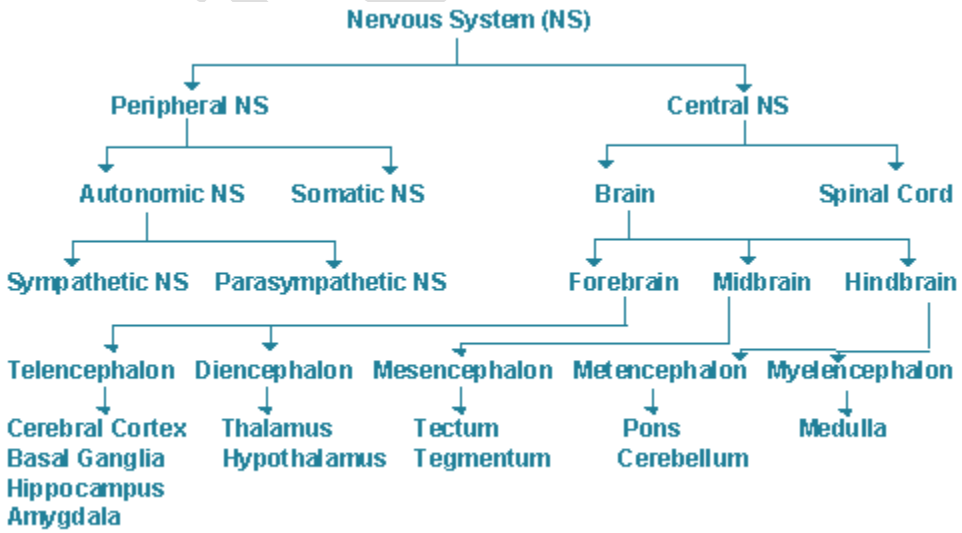
Nervous system

The Nervous system is the too much advanced network of specialised cells called the neurones.

- With the millions of neurones, nervous system co-ordinate the body function and transmit signals between the different body part.
- A signals nerve is a collection of various neurons.

Classification -

In human's nervous system is broadly classified into central nervous system and peripheral nervous system.



Central nervous system -

The Central nervous system consists of the brain (in the cranial cavity) and the spinal cord (in the vertebral column)

Inside the embryo the neural tube develops which arises because of unequal growth rate. These expansion take the form of forebrain, midbrain and hindbrain.

1. Forebrain

a. Cerebral hemispheres
b. Basal ganglia
c. Hypothalamus
d. Thalamus

2. Midbrain

a. Tectum
b. Tegmentum
c. Cerebral peduclous

3. Hind brain

a. Cerebellum
b. Pons
c. Medulla

Peripheral nervous system -

PNS includes nerves extending between the CNS and other parts of the body . It namely acts to control the voluntary functions of body.

- **Sensory neurons** - They carry information from the sensory tissues to the CNS in the firm of stimuli .
- **Motor neurons** - They carry back information from CNS today the effector organ.

PNS further divided in two types -

A. Somatic nervous system -this system controls skeleton muscles and the external sensory organs.
B. Autonomic nervous system -This system controls involuntary action of the body by controlling tyr involuntary muscles like smooth muscles and cardiac muscles . This further includes the sympathetic nervous system andar parasympathetic nervous system .

Brain

Brain is very complex organ forming the center of nervous system . The average weight office the brain in an adult man is about 1600 gm , while in adults female is 1450 gm

Part of brain:

The adult brain is composed of the following 4 major parts

A. Cerebrum

B. Cerebellum

C. Diencephalon

D. Brain Stem

a. Medulla oblongata
b. Pons
c. Midbrain

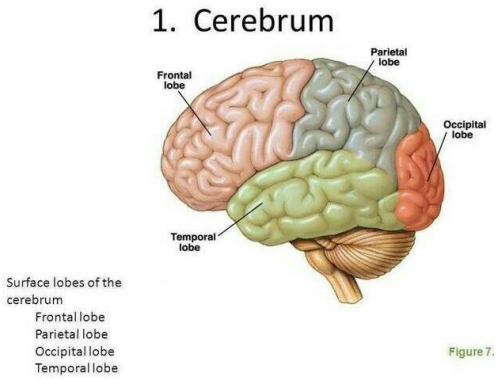
Anatomy and physiology of cerebrum, cerebellum and midbrain - Cerebrum

- Cerebrum form the major portion of the brain . it is divided into two hemispheres known as a cerebral hemispheres , which are positioned over the brain stem .
- The outer rim of cerebrum made up of grey matter and us known as cerebral cortex , and the white matter lying beneath the cerebral cortex is known as cerebral medulla .
- The left and right cerebral hemisphere are separated from each other by a prominent longitudinal fissure.

The fissure or sulcus further subdivided each of two hemispheres into four lobs -

A. Frontal lobs
B. Temporal lobs
C. Parietal lobs
D. Occipital lobs

Diagram of cerebrum



Function

A. Frontal lobs-

- Controls voluntary activities if opposite half of the body.
- Control the spoken speech .
- Control emotional , concentration ,attention and judgement.

B. Parietal lobs-

- Perception of exteroceptive (touch , pain and temperature)

C. Occipital lobs-

- Reception and perception of isolated visual impression of color , size , form , motion .

D. Temporal lobs

- Reception and perception of isolates auditory impression of loudness , quality and pitch .

Cerebellum

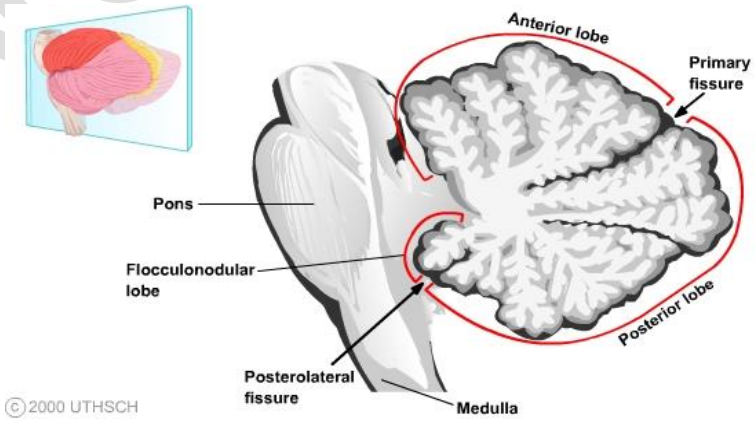
- Cerebellum appears as a distict structure forming lower part of the brain beneath the cerebral hemispheres.
- The cerebellum is separated from the cerebrum by the transverse tissue.

Structure

Cerebellum is butterfly shaped and is located inferiorly to the posterior portion of the cerebrum and posteriorly to pons and medulla oblongata.

The subdivision of cerebellum are shown in figure

Labelled diagram of cerebellum:



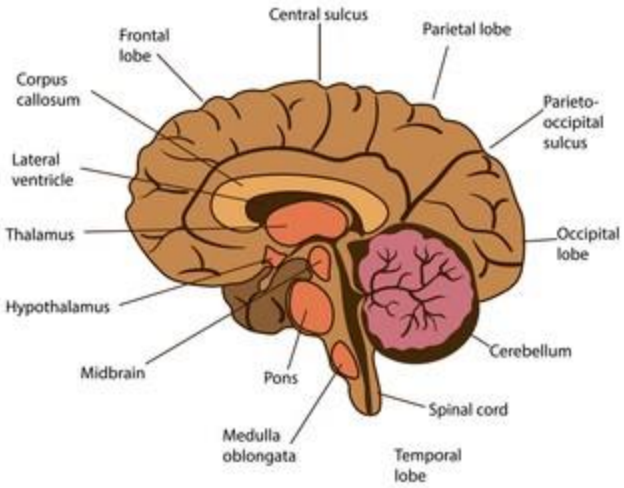
Functions:

1. Body posture and equilibrium is maintained by the cerebellum. The muscles, joints, eyes, and the ears bring in the sensory input for these functions.
2. In order to maintain the balance and equilibrium of the body, the cerebellum acts to influence impulses leading to the skeletal muscle contraction. It is responsible for controlling and coordinating the movements of several groups of muscles, resulting in smooth, even, and clear-cut action.
3. The coordination of voluntary muscular movement is carried out by the cerebellum. Activities of the cerebellum cannot be controlled voluntarily,

Midbrain

- The midbrain (or mesencephalon) comprises of tracts and nuclei .it divided into tactum and peduncle it give way to the cerebral aqueduct .
- Cerebral peduncles make up the anterior part of the midbrain .they exist in pairs and contain large ascending and descending tracts. The tract comprises of axon of motor neurons .
- The tectum makes up the posterior part of the midbrain . it consist of 4 round shaped elevation . the two elevation positioned superioly are called superior colliculi . the other two elevation positioned inferiorly are called inferior colliculi.

Diagram of midbrain



Functions

Midbrain performs the following functions:

1. Significant functions like eye movement and other functions of the visual and auditory systems are controlled by the midbrain.

2. Body movements are controlled by the red nucleus and the substantia nigra (parts of the midbrain).
3. Since neurons producing dopamine are located in the substantia nigra, degeneration of these neurons results in Parkinson's disease.

Functions of hypothalamus , medulla oblongata and basal ganglia

Hypothalamus -

- The hypothalamus is a structure deep within your brain. It's the main link between your endocrine system and your nervous system. Your hypothalamus keeps your body balanced in a stable state called homeostasis.

Functions

1. Your hypothalamus receives chemical messages from nerve cells in your brain and from nerve cells in your body (your peripheral nervous system), which is also responding to signals outside your body.
2. Your hypothalamus's main function is to react to these messages to keep your body in a stable state or internal balance. Just like you may have a "smart control" system to seamlessly manage all functions in your home, your hypothalamus is your body's "smart control" coordinating center. Your hypothalamus helps manage your:
    - Body temperature.
    - Blood pressure.
    - Hunger and thirst.
    - Sense of fullness when eating.
    - Mood.
    - Sex drive.
    - Sleep.
3. Your hypothalamus performs many of its "body balancing" jobs either by directly influencing the autonomic nervous system or by managing hormones. Your autonomic nervous system (bodily functions that work automatically) control several important functions, such as your heart rate and breathing (respiration).
4. your hypothalamys makes some hormones itself that are stored elsewhere (in your posterior pituitary).

Sends signals (hormones) to your pituitary gland, which either releases hormones that directly affect a part of your body or sends another signal (hormone) to a different gland in your body that then releases its hormone

Medulla oblongata

Medulla oblongata is the bottom-most part of your brain. Its location means it's where your brain and spinal cord connect, making it a key conduit for nerve signals to and from your body. It also helps control vital processes like your heartbeat, breathing and blood pressure.

Functions

Your medulla oblongata (med-oo-la ob-long-ah-ta), often just called the medulla, is a key part of your nervous system.

It's key not only because of its location but also because of what it controls.

Some of its jobs include:

- Manages heart, circulation and breathing. Your medulla is where your cardiovascular and respiratory systems link together into a united system that controls your heart rate, breathing, blood pressure and more.
- Manages other automatic processes. These are things that your body often does without you having to think about them. Some examples include coughing, sneezing, swallowing, vomiting and maintaining your balance.
- Nerve connections. The vast majority of major nerves converge at your spine, carrying signals to and from your brain. That means those signals must pass through your medulla. Four of your 12 cranial nerves (which connect areas of your throat and tongue directly to your brain) pass through your medulla.
- Crossover point. your medulla is the location of a region called "the pyramids," where most of the movement-related nerves in your body crisscross. That crossover is why one side of your brain almost always controls parts on the opposite side of your body.

Basal ganglia

The basal ganglia are a group of brain structures linked together, handling complex processes that affect your entire body. While best known for their role in controlling your body's ability to move, experts now know they also play a role in several other functions, such as learning, emotional processing and more.

Functions -

The basal ganglia are best known for how they help your brain control your body's movements. However, ongoing research continues to uncover other ways that the basal ganglia interact with other parts of your brain. Though experts continue to uncover more about the inner workings of the basal ganglia, there's much about them that remains unknown.

Movement

- The basal ganglia are a key part of the network of brain cells and nerves that control your body's voluntary movements.
- They can approve or reject movement signals that your brain sends, filtering out unnecessary or incorrect signals.
- This lets you control certain muscles without also using other muscles that are nearby.
- If the basal ganglia approve a signal, it continues to the motor pathways, the nerves that eventually carry the signal down your spinal cord and nerves to their destination muscle. If they don't approve the signal, they redirect it into an area where other brain cells dampen those signals until they stop.
- The parts of your brain that process information from your senses, namely sight, sound, smell, taste and touch, also send that information to your basal ganglia.
- That sensory information helps the basal ganglia refine your movements further.

Decision-making

Another job of the basal ganglia is processing how you evaluate goals and risks. It also processes signals that affect your emotions and your motivation. That means it also plays a role in learning and forming habits, planning and carrying out tasks, and more.

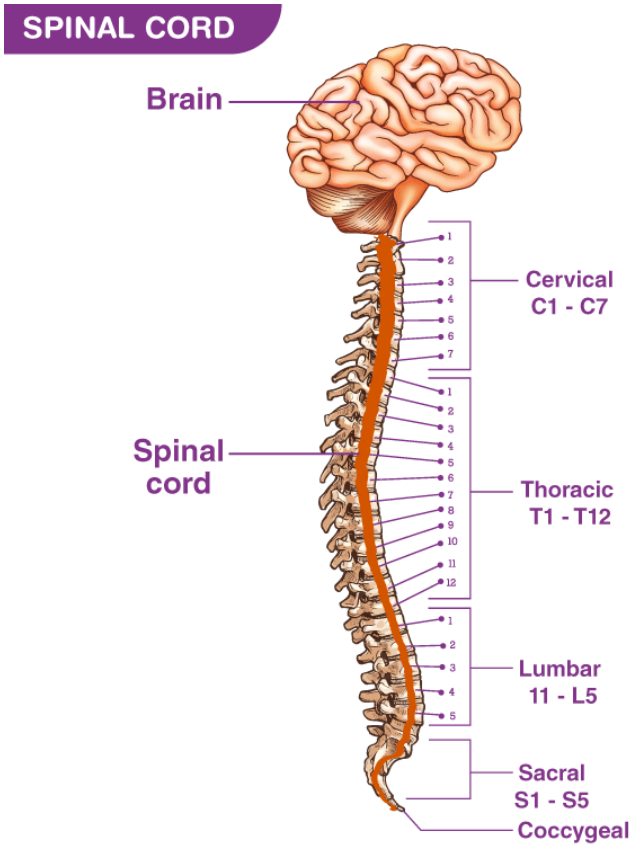
Spinal cord structure and reflexes

- Spinal cord is the elongated part of the CNS extending from the lower end. It is cylindrical in shape and includes the upper two-thirds of the vertebral canal. It ranges from the level of the upper border of the atlas to either the upper border or the lower border of vertebra, Spinal cord forms the pathway for sensory input to the brain and motor output from the brain.
- The spinal cord and spinal nerve contain neural circuits responsible for rapid reaction towards environmental stimuli.

External structure

- On viewing the spinal cord externally, two visible enlargements i.e. the cervical enlargement (superior) and lumbar enlargement (inferior) are seen. From the cervical enlargement, arises the nerves to and from the upper limb; and from the lumbar enlargement, arises the nerves to and from the lower limbs.

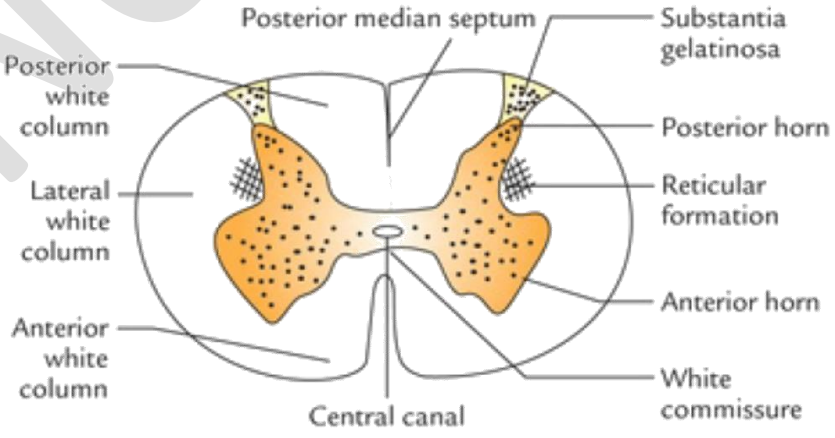
Diagram of external structure



Internal structure

Internally, the spinal cord is made up of grey and white matter . The grey matter is arranged in the shape of H or a butterfly and is surrounded by the white matter. The grey matter is made up of dendrites, neuronal cell bodies, non-myelinated axons, and neuroglia; and the white matter consists of bundles of myelinated axons of neurons.

Diagram of internal structure



Function

Sensory and motor tracts are contained within the white matter of the spinal cord.

1) The sensory tracts conduct nerve impulses towards the brain and the motor tracts conduct motor nerve impulses from the brain to the effector organs.
2) The grey matter of the spinal cord forms the spot for integration (summing) of Excitatory and Inhibitory Postsynaptic Potentials (EPSPs and IPSPs, respectively).
3) CNS is connected to the sensory receptors, muscles, and glands all over the body via the spinal nerves and their branches.
4) 4) All reflex activities are mediated through spinal cord.

Reflex action

- An action produced instantaneously and automatically without intentions, in response to a mechanical stimulus (produced by stimulation of specific receptors) is termed as a reflex activity.

Given below are some examples of reflex actions:

- When pricked with needle, the hand is a spontaneously withdrawn.
- When a strong light is flashed, the eyes close spontaneously.
- When a decapitated frog is touched with an acid or a live electric wire, it spontaneously withdraws its legs.
- Beating of the heart, peristalsis, secretions from glands, and other visceral functions.
- Coughing, sneezing, yawning, blinking of eyes, etc.

Names and function of cranial nerves

Cranial nerve:

There are twelve pairs of nerves attached to the brain these may be sensory , motor and mixed .

TABLE A2 ■ The Cranial Nerves and Their Primary Functions

Cranial nerve	Name	Sensory and/or motor	Major function	Location of cells whose axons form the nerve
I	Olfactory nerve	Sensory	Sense of smell	Nasal epithelium
II	Optic nerve	Sensory	Vision	Retina
III	Oculomotor nerve	Motor	Eye movements; pupillary constriction and accommodation; muscle of upper eyelid	Oculomotor nucleus in midbrain; Edinger-Westphal nucleus in midbrain
IV	Trochlear nerve	Motor	Eye movements (intorsion, downward gaze)	Trochlear nucleus in midbrain
V	Trigeminal nerve	Sensory and motor	Somatic sensation from face, mouth, cornea; muscles of mastication	Trigeminal motor nucleus in pons; trigeminal sensory ganglion (the gasserian ganglion)
VI	Abducens nerve	Motor	Eye movements (abduction or lateral movements)	Abducens nucleus in pons
VII	Facial nerve	Sensory and motor	Controls the muscles of facial expression; taste from anterior tongue; lacrimal and salivary glands	Facial motor nucleus in pons; superior salivatory nuclei in pons; geniculate ganglion
VIII	Vestibulocochlear (auditory) nerve	Sensory	Hearing; sense of balance	Spiral ganglion; vestibular (Scarpa's) ganglion
IX	Glossopharyngeal nerve	Sensory and motor	Sensation from posterior tongue and pharynx; taste from posterior tongue; carotid baroreceptors and chemoreceptors; salivary gland	Nucleus ambiguus in medulla; inferior salivatory nucleus in pons; glossopharyngeal ganglia
X	Vagus nerve	Sensory and motor	Autonomic functions of gut; cardiac inhibition; sensation from larynx and pharynx; muscles of vocal cords; swallowing	Dorsal motor nucleus of vagus; nucleus ambiguus; vagal nerve ganglion
XI	Spinal accessory nerve	Motor	Shoulder and neck muscles	Spinal accessory nucleus in superior cervical cord
XII	Hypoglossal nerve	Motor	Movements of tongue	Hypoglossal nucleus in medulla

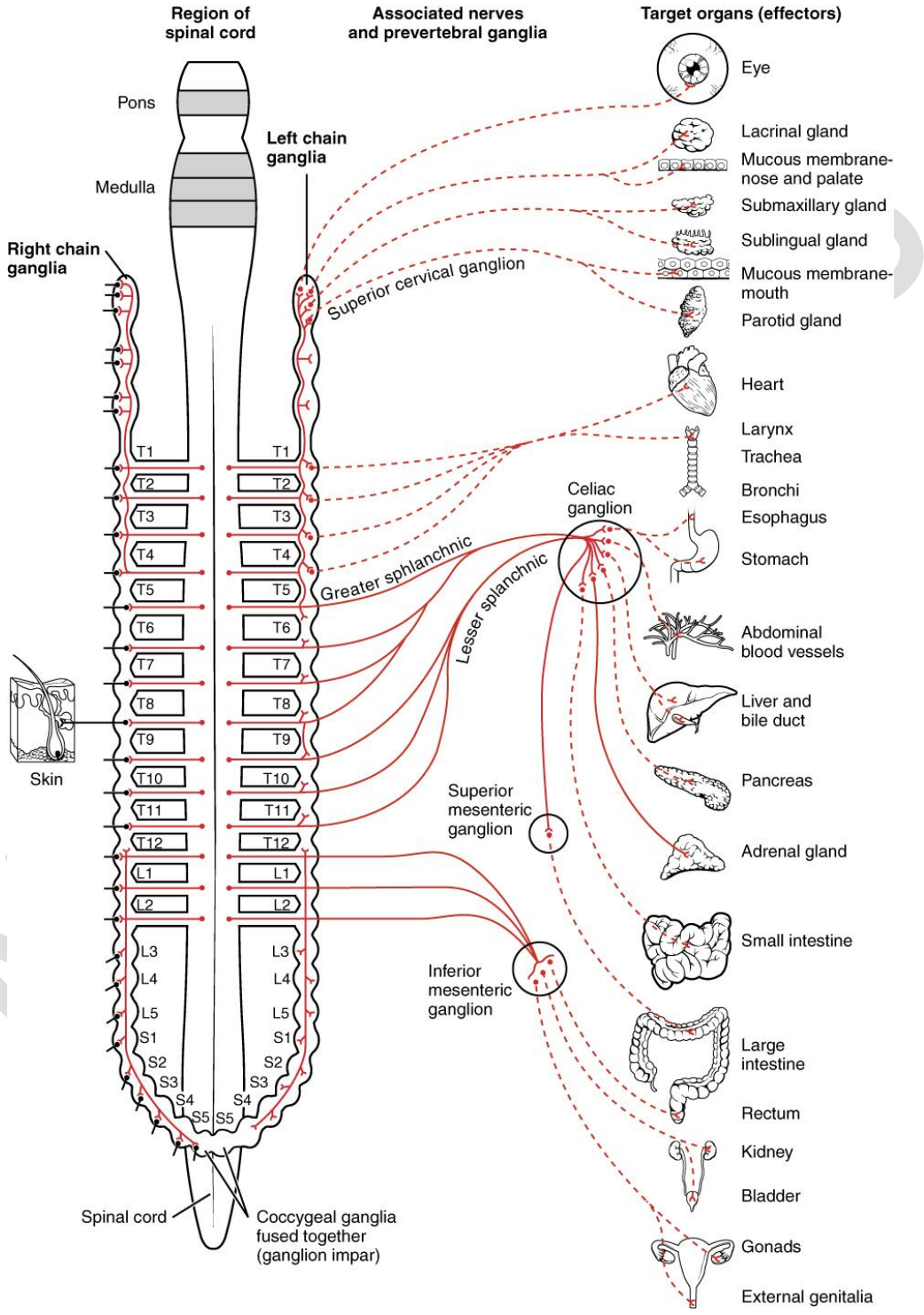
Anatomy and physiology of sympathetic and parasympathetic nervous system (ANS)

The sympathetic nervous system is one of the two branches of the autonomic nervous system. It is responsible for the body's "fight or flight" response, which prepares the body for action in response to stress or danger.

The anatomy of the sympathetic nervous system includes:

1. Sympathetic ganglia: These are clusters of nerve cells located outside of the central nervous system. They are connected to the spinal cord via nerve fibers called preganglionic fibers.
2. Preganglionic fibers: These are the nerve fibers that connect the spinal cord to the sympathetic ganglia. They originate in the spinal cord and travel to the ganglia, where they synapse with postganglionic fibers.
3. Postganglionic fibers: These are the nerve fibers that connect the sympathetic ganglia to their target organs. They leave the ganglia and travel to various organs, including the heart, lungs, liver, and kidneys.

4. Adrenal medulla: This is a specialized gland located above the kidneys that is connected to the sympathetic nervous system. When activated, it releases hormones called adrenaline and noradrenaline into the bloodstream, which prepare the body for action.



The physiological effects of the Sympathetic Nervous System (SNS) activation include:

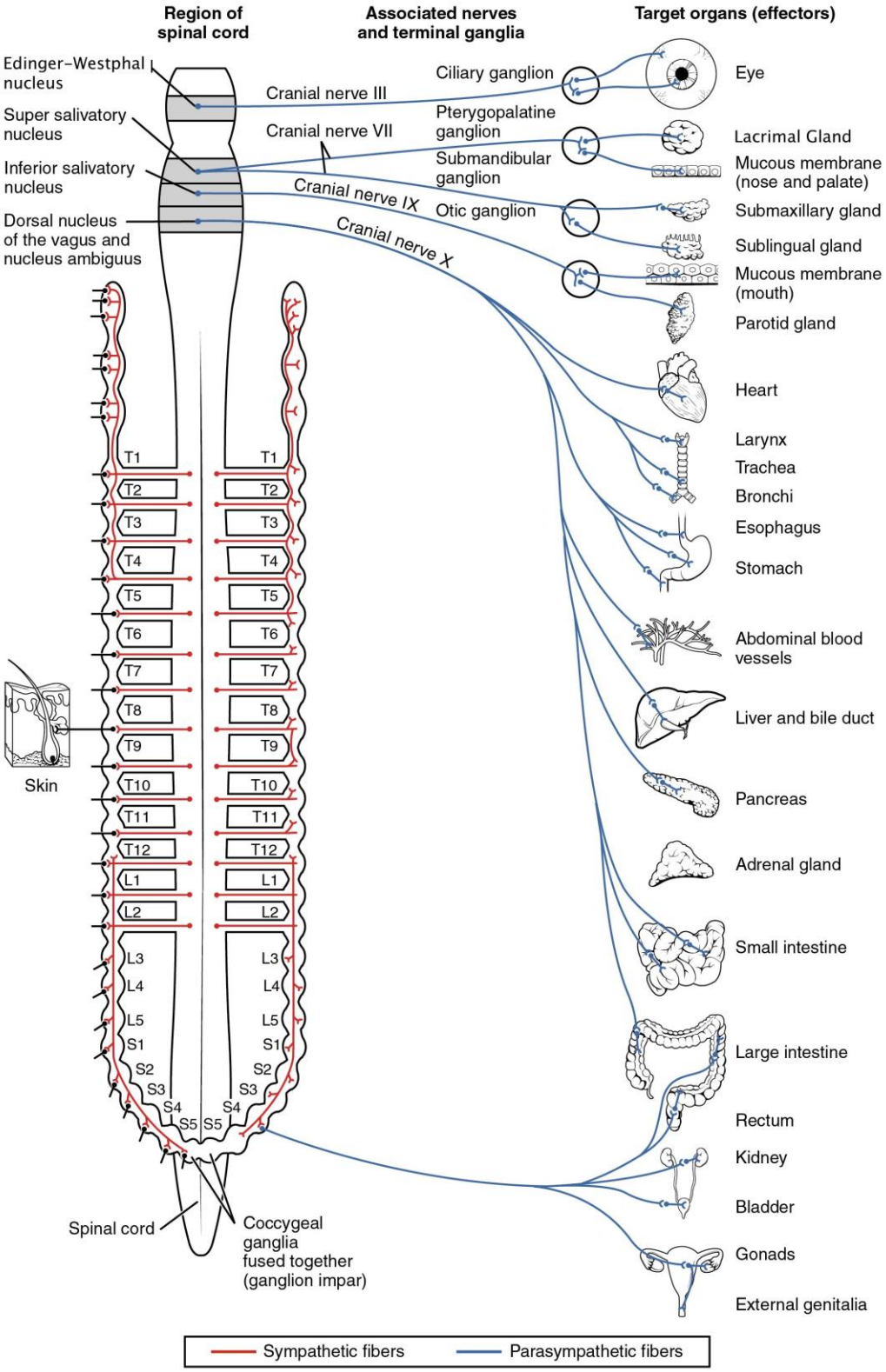
1. Increased heart rate: The SNS increases heart rate and force of contraction, leading to increased cardiac output and blood pressure.
2. Dilation of airways: The SNS dilates the airways in the lungs, allowing more oxygen to enter the bloodstream.
3. Constriction of blood vessels: The SNS constricts blood vessels in some parts of the body, such as the skin and digestive system, and dilates blood vessels in others, such as the muscles, to increase blood flow and oxygen delivery.
4. Increased blood sugar: The SNS stimulates the liver to release glucose into the bloodstream, increasing blood sugar levels for energy.
5. Increased sweating: The SNS stimulates sweat glands to produce more sweat, which helps to regulate body temperature during physical activity.
6. Increased pupil dilation: The SNS dilates the pupils, allowing more light to enter the eyes and improving visual acuity.
7. Decreased digestive activity: The SNS inhibits digestive activity, including the secretion of digestive enzymes and the contraction of the stomach and intestines, in order to redirect blood flow to the muscles and brain.

Anatomy and physiology of Parasympathetic Nervous System (PSNS**):**

The parasympathetic nervous system (PSNS) is one of the two branches of the autonomic nervous system (ANS), the other being the sympathetic nervous system (SNS). It is responsible for promoting rest, digestion, and relaxation in the body. The PSNS is involved in the maintenance of internal homeostasis, by regulating organ function, blood pressure, and heart rate.

Anatomy of the PSNS:

- The PSNS originates from the cranial and sacral regions of the spinal cord. The cranial outflow arises from the brainstem and includes the oculomotor, facial, glossopharyngeal, and vagus nerves. The sacral outflow arises from the sacral spinal cord segments S2 to S4. These fibers are carried by the pelvic nerves to the pelvic organs.
- The PSNS fibers run in two sets of nerves: cranial and sacral. The cranial nerves include the oculomotor nerve, facial nerve, glossopharyngeal nerve, and vagus nerve. The sacral nerves include the pelvic splanchnic nerves.



Physiology of the PSNS:

- The PSNS functions to conserve and restore energy in the body. It promotes rest and relaxation by slowing down heart rate, reducing blood pressure, and stimulating digestion.
- The PSNS uses the neurotransmitter acetylcholine (ACh) to communicate with its target organs. ACh is released by the PSNS fibers and binds to specific receptors on the target cells, causing various physiological effects.

Functions of the PSNS include:

1. Decreasing heart rate: The PSNS slows down the heart rate by reducing the firing rate of the sinoatrial node, which is the heart's natural pacemaker.
2. Constricting the pupils: The PSNS constricts the pupils by stimulating the circular muscles of the iris.
3. Stimulating digestion: The PSNS stimulates digestion by increasing the secretion of digestive enzymes and increasing the motility of the gastrointestinal tract.
4. Promoting urination: The PSNS promotes urination by relaxing the smooth muscle of the bladder and increasing the tone of the detrusor muscle.
5. Stimulating glandular secretion: The PSNS stimulates glandular secretion in various organs, such as the salivary glands, the lacrimal glands, and the pancreas.