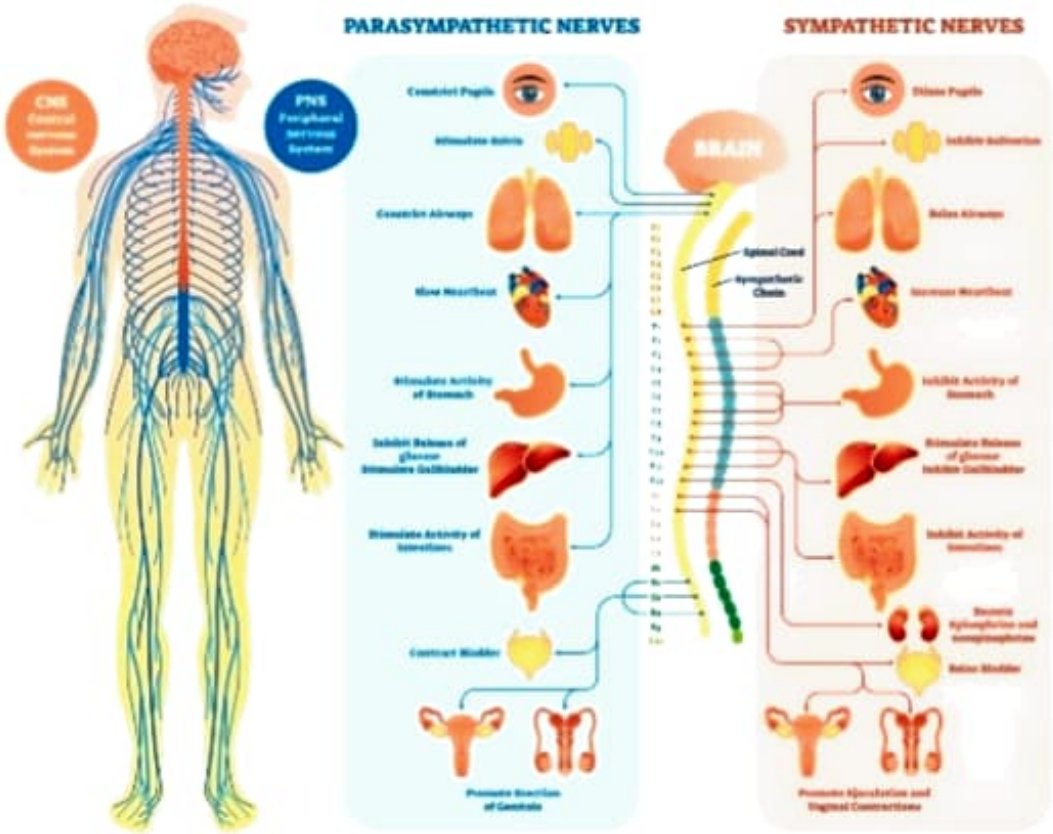
krishnagar Academy

BIOLOGY-

HUMAN NERVOUS SYSTEM



Class -10

REFLEX ACTIONS

Reflex *is a quick, involuntary, unpremeditated, unlearned, built-in response to a stimulus.*

Some examples of reflex actions in human body are as follows:

- Instantaneous withdrawal of hand on touching a hot surface—**muscular movement**.
- Knee jerk if the knee is hit lightly just below the knee cap—**muscular movement**.
- Sudden withdrawal of hand if a finger is accidentally pricked—**muscular movement**.
- Salivation on smell or taste of food—**glandular secretions**.
- Sudden contraction of diaphragm and internal intercostal muscles causing a violent expiration to blow irritant material out—**muscular movement**.
- Peristaltic movement of food in the alimentary canal—**muscular movement**.

All these reflex actions mediate along a typical pathway known as **reflex arc** which is the *shortest route for mediating a response to a stimulus.*

Reflex actions allow the body to make automatic adjustments due to external environment changes, control the internal environment of the body and also help in homeostasis.

Basic Components of the Reflex Arc

Stimulus

It is a detectable change in the internal or external environment such as change in temperature (external), blood pressure (internal), etc., which initiates a response in the body.

Receptor

The environmental change is detected by the receptors, *i.e.*, distal end of dendrites. These respond to the stimulus and initiate a nerve impulse.

Afferent Pathway

The nerve impulse is relayed to the integrating centre, the spinal cord, through the sensory nerves which constitute afferent pathway.

Integrating Centre

The interneurons in the spinal cord generate an outgoing motor impulse which reflects the effect of the afferent input.

Efferent Pathway

The output of the integrating centre is sent to the last component of the reflex arc through the motor or efferent neurons. This is like a command directing the last component to alter its activity.

Effector

The last component of the reflex arc, effector, may be a gland or a muscle. The stimulus received alters the activity of the effector, which constitutes the overall response of the system.

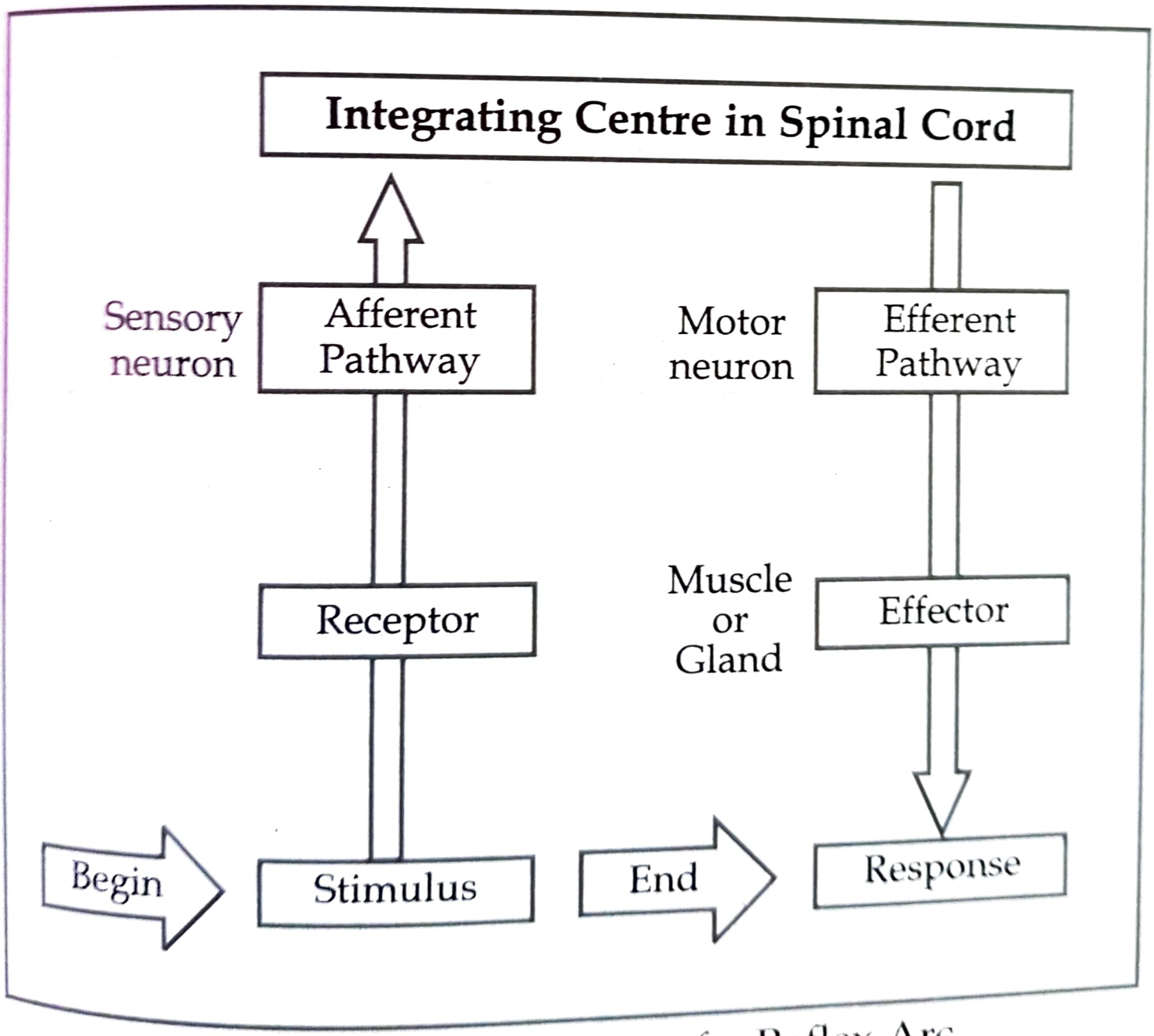


Fig. 10.13: Components of a Reflex Arc

Table 10.1: Differences between Reflex Actions and Voluntary Actions

S. No.	*Reflex Actions*	*Voluntary Actions*
1.	Involuntary in nature and are very quick.	Voluntary actions may be quick or slow.
2.	Initiated by a stimulus (light, heat, touch, etc.) without our will and even without our primary thought.	Take place at our will and are decided after thinking.
3.	Originate in spinal cord and there is no involvement of brain.	Take place after the decision taken by the brain.
4.	Come to know of the actions after the action is over.	Action known to us beforehand.
5.	Involve muscles and glands.	Involve only voluntary muscles.
	Examples: **Flexion reflex**—Drawing hand away from sharp needle or hot plate; **Peristaltic reflex**—contraction of gut muscles to push the food in alimentary canal, etc.	*Examples:* Pick up a book to read, driving, exercising, combing hair, wearing shoes, etc.

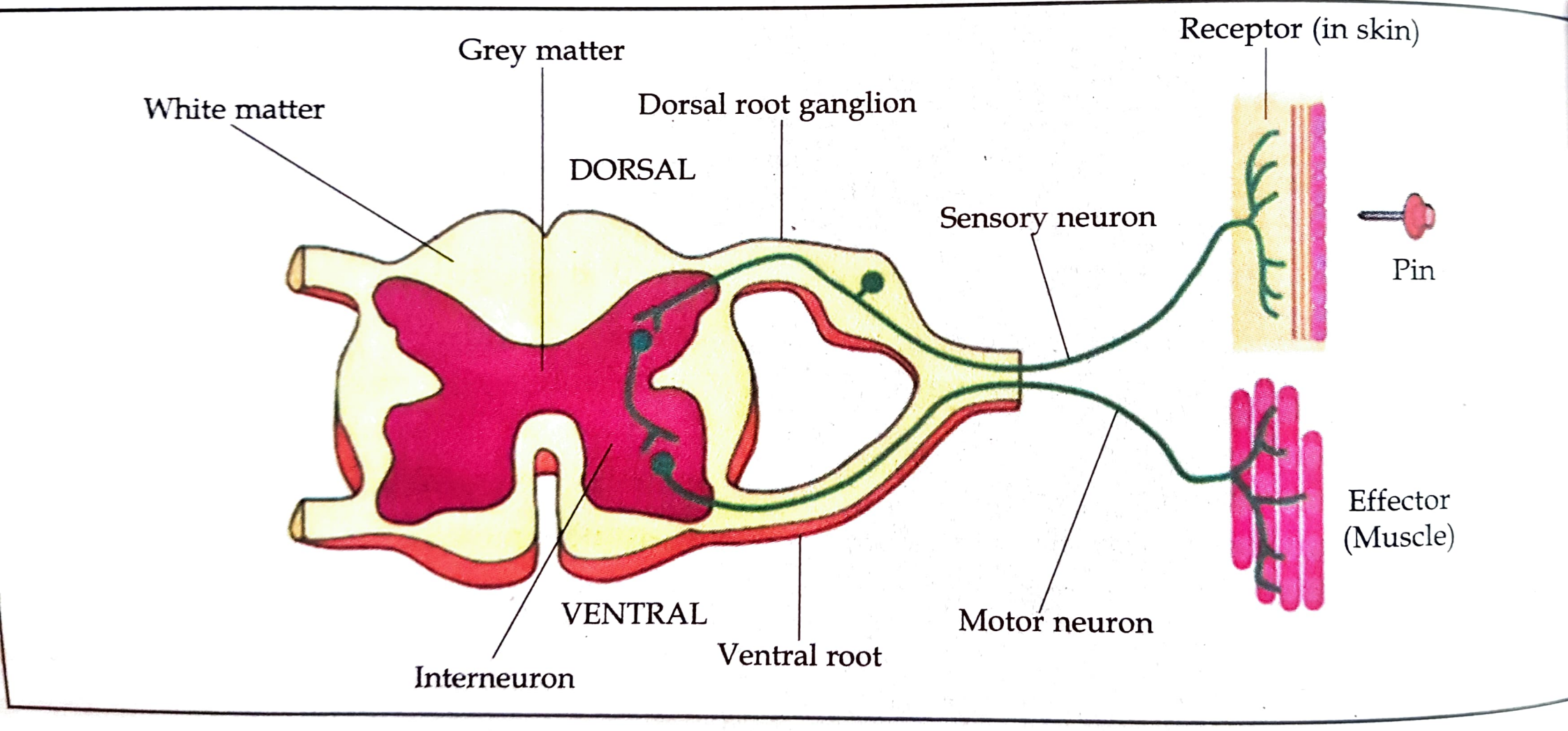


Fig. 10.12: A reflex arc

Types of Reflexes

The reflexes in the human body are of two types: **Natural Reflexes** and **Acquired Reflexes**.

Natural (Unconditioned) Reflexes

These are **inborn** and **inherited** reflexes which do not require any learning, experience or practice. A few examples are given below:

- **Pulling away one's hand** from a hot object.
- **Shutting of the eyes** as an object rapidly approaches the face or when a strong beam of light is flashed in the front.
- **Swallowing and propulsion of food** through the alimentary canal by peristaltic movements.
- **Blinking** of eyes.
- **Sneezing** when an irritant enters the nasal cavity.

- **Coughing** if, during eating, food enters the wind pipe instead of food pipe.

Acquired (Conditioned) Reflexes

These responses appear to be autonomous, but these develop only after learning, experience and practice. Some examples are:

- An experienced driver performs many complicated acts while **driving**. For the driver, these actions are automatic and stereotyped, but they occur only after making a great deal of conscious effort to learn them.
- **Standing** up in a classroom as soon as a teacher enters.
- **Playing** a casio, guitar, piano, etc.
- **Combing** your hair in a regular pattern.

Pavlov's Experiment

In 1890, a Russian biologist, **Ivan Pavlov**, carried out some experiments on dogs demonstrating **stimulus and response**. He noticed that a dog begins to salivate whenever he gets his food. He knew that the salivation at the sight of food was a **natural reflex action**. Therefore, he decided to investigate if the dog could be made to associate with other food stimuli.

In a typical experiment, a bell was rung just before the meat was given to the dog. The dog responded to the sound of the bell but did not show any salivation.

The experiment was repeated several times. Thereafter, Pavlov noticed that the dog began to salivate as soon as the bell was rung even if the food was not given. Thus, the normal inborn reflex of salivating in the presence of food can be converted to a conditioned reflex by associating two stimuli.

Table 10.3: Differences between the Unconditioned Reflexes and Conditioned Reflexes

S. No.	*Unconditioned Reflexes*	*Conditioned Reflexes*
1.	Inborn and inherited reflexes.	Acquired by learning and experience.
2.	Specific characteristics of all members of a given species.	Differ in individuals based on learning and experience.
3.	Evoked in response to the stimulus.	Brought about by conditions different from the direct stimulus.

PERIPHERAL NERVOUS SYSTEM

The peripheral nervous system (PNS) consists of the nerve fibres that transmit signals between the central nervous system (brain and spinal cord) and the receptors and effectors in all parts of the body. It is divided into **somatic nervous system** and **autonomic nervous system**.

Somatic or Voluntary Nervous System

Somatic nervous system consists of the nerve fibres that arise from the central nervous system and supply to the skeletal muscles for voluntary actions. These nerve fibres are without any synapses in between and lead to the contraction of the skeletal muscles. It consists of 42 pairs of nerves which are divided into two types:

Cranial Nerves (Cerebral Nerves)

Cranial nerves arise from the brain. There are 12 pairs of cranial nerves. These include:

- Sensory nerves, *e.g.*, olfactory nerve (for nose), auditory nerve (for ears) and optic nerve (for retina of the eyes).
- Motor nerves, *e.g.*, the nerves which innervate the muscles of the eyeball.
- Mixed nerves, *e.g.*, the nerves supplying the face, jaws, etc.

Spinal Nerves

Spinal nerves (31 pairs) arise from the spinal cord. These are classified into five subgroups based on the area of spinal cord from where they arise. All of these are mixed nerves.

- Cervical nerves—8 pairs
- Thoracic nerves—12 pairs
- Lumbar nerves—5 pairs
- Sacral nerves—5 pairs
- Coccygeal nerves—1 pair

Cranial nerves can be sensory, motor or mixed nerves with both motor and sensory fibres.

Spinal nerves are always mixed nerves. These are the mixture of sensory fibres entering through the dorsal root and motor fibres leaving through the ventral root of spinal cord.

Autonomic Nervous System

It is made up of the nerve fibres emerging from the CNS to all the tissues and internal organs (other than the skeletal muscles) for **involuntary action**, *e.g.*, bladder, gastrointestinal tract, heart, eyes, lungs, etc. The neurons are in contact with each other with the synapse in between.

The autonomic nervous system is further categorised into two parts:

Sympathetic Nervous System

It consists of nerve fibres which leave from the thoracic and lumbar regions of the spinal cord.

Parasympathetic Nervous System

It is made up of the cranial and sacral nerves of the peripheral nervous system.

The sympathetic and parasympathetic systems regulate the functioning of all the internal organs of the body. However, these two systems exert **opposite effects** on these organs. This control is **automatic and unconscious**.

The sympathetic nervous system is **stimulatory** in function and, thus, speeds up the action of different organs to face the emergency situations whereas the parasympathetic nervous system is **inhibitory** in function and slows down the functioning of organs bringing to normal level after emergency is over.

The two systems together regulate:

- The rate and force of heartbeats
- Digestive secretions
- Contraction of smooth muscles
- Size of pupil of the eye
- Blood supply to the viscera and skin.

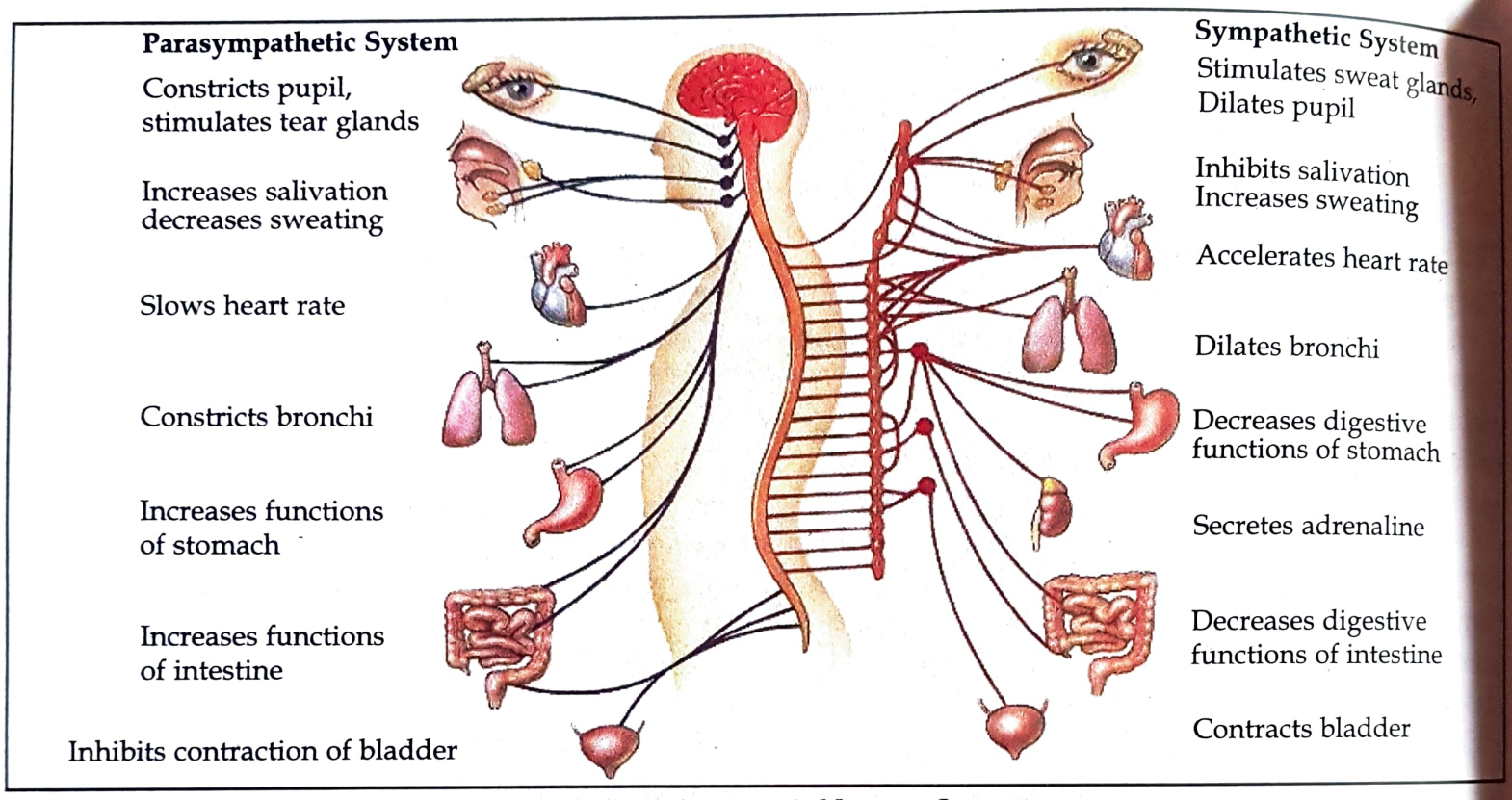


Fig. 10.15: Autonomic Nervous System

Table 10.5: Differences between the Functions of Sympathetic and Parasympathetic Nervous System

S. No.	*Organs/Functions*	*Sympathetic Nervous System Secretes Adrenaline and Noradrenaline**	*Parasympathetic Nervous System Secretes Acetylcholine***
1.	Heart	Increases rate of heartbeat	Decreases rate of heartbeat
2.	Trachea and bronchi	Dilates	Constricts
3.	Sweat glands	Stimulates sweat secretion	Inhibits secretion of sweat
4.	Tear glands	Inhibits secretion	Stimulates secretion
5.	Salivary glands	Inhibits salivary secretion	Stimulates secretion
6.	Alimentary canal	Decreases peristaltic movements and inhibits digestive enzyme secretions	Increases peristalsis and stimulates digestive enzyme secretions
7.	Eye	Dilates pupil	Constricts pupil
8.	Blood vessels	Constricts	Dilates
9.	Blood flow to skeletal muscles and brain	Increases	Decreases
10.	Urinary bladder	Relaxation of muscles (decreases urination)	Contraction of muscles (increases urination)

* Adrenaline and Noradrenaline are the two hormones produced by adrenal medulla. Their effects are similar to those of sympathetic nervous system.

** Acetylcholine is a neurotransmitter secreted by all the axon terminals except that of the sympathetic system.

Draw a cross-section of the spinal cord and label the following parts:

(*a*) The central part which is filled with the cerebrospinal fluid.

(*b*) The part from where the axons of efferent or motor neurons leave.

(*c*) The portion which has concentration of cell bodies of nerve fibres.

(*d*) The part which extends into spinal nerve.

State whether the following statements are *true* or *false*. If *false*, correct the statement.

(*a*) Reflex actions are quick and under the control of brain.

(*b*) The dorsal root ganglion of spinal cord contains cell bodies of sensory nerves.

(*c*) The outermost covering of spinal cord is called dura mater.

Which of the following pairs are matched incorrectly?

(*a*) Blinking—Conditioned reflex

(*b*) Salivation on seeing favourite food—Unconditioned reflex

(*c*) Saying hello when you meet friends—Acquired reflex

(*d*) Swallowing—Natural reflex

. State whether the following statements are *true* or *false*. If *false*, correct the statement.

(*a*) Autonomic nervous system controls the voluntary actions of the body.

(*b*) Olfactory nerve is a cranial nerve that arises from the brain.

(*c*) Somatic nervous system innervates skeletal muscles and digestive glands.

. Fill in the blanks by choosing the correct alternative given in brackets:

(*a*) Parasympathetic nervous system is _____ in function. (stimulatory/inhibitory)

(*b*) Adrenaline _____ the rate of heartbeat. (increases/decreases)

(*c*) Human body has _____ pairs of thoracic nerves. (10/12)