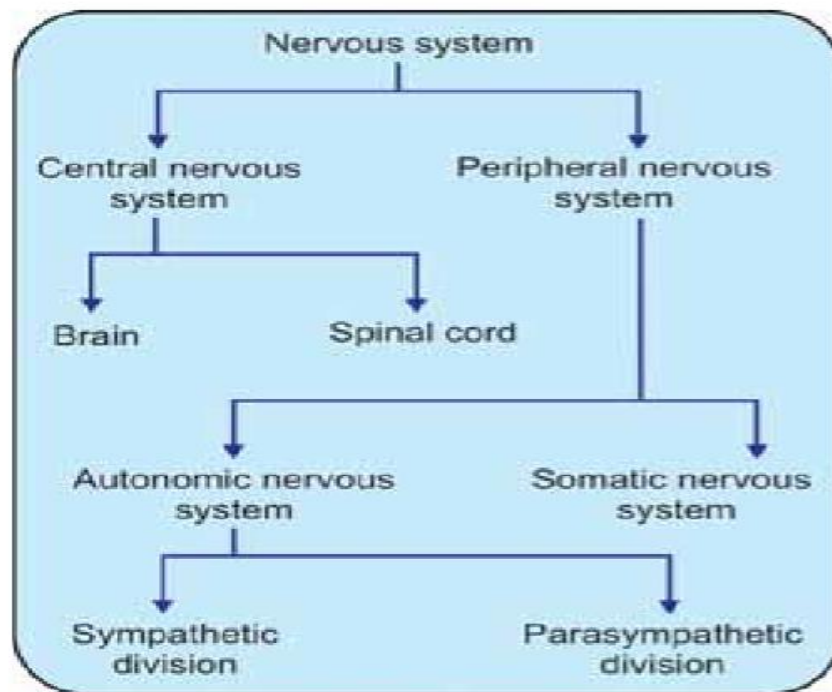


NERVOUS SYSTEM

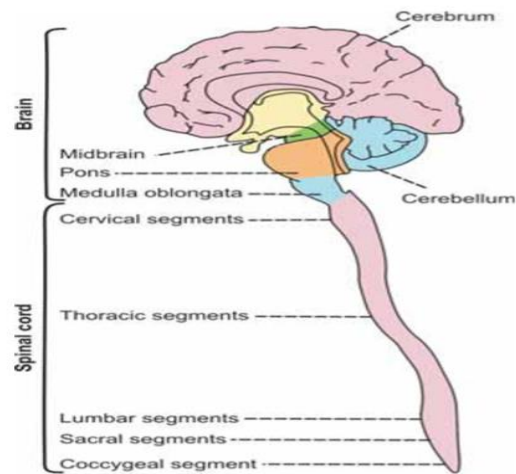
DIVISIONS OF NERVOUS SYSTEM

Nervous system controls all the activities of the body. It is quicker than the other control system in the body namely, the endocrine system. Primarily, the nervous system is divided into two parts.

1. Central nervous system
2. Peripheral nervous system.



Organization of nervous system



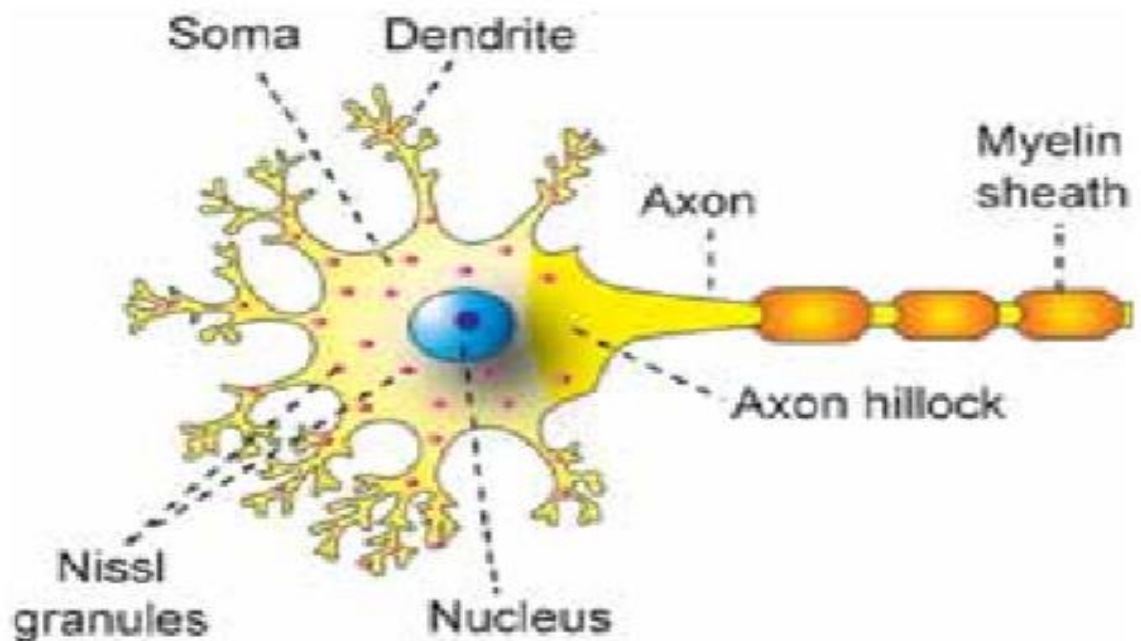
The parts of central nervous system

Neuron: is defined as the structural and functional unit of the nervous system. It is otherwise called nerve cell. Neuron is like any other cell in the body having nucleus and all the organelles in the cytoplasm. However, it is different from other cells by two ways:

1. Neuron has branches or processes called axon and dendrites
2. Neuron does not have centrosome; so it cannot undergo division

STRUCTURE OF NEURON Each neuron is made up of three parts:

1. Nerve cell body
2. Dendrite
3. Axon



- The dendrite and axon together form the processes of neuron. In general, the dendrites are short processes and the axons are long processes. The dendrites and axons are usually called nerve fibers.
- Nerve Cell Body: The nerve cell body is also known as soma or perikaryon. It is irregular in shape and, it is constituted by a mass of cytoplasm called neuroplasm which is covered by a cell membrane. The cytoplasm contains a large nucleus, Nissl bodies, neurofibrils, mitochondria and Golgi apparatus. Nissl bodies and neurofibrils are found only in nerve cell and not in other cells.
- Nucleus: Each neuron has one nucleus which is centrally placed in the nerve cell body. The nucleus has one or two prominent nucleoli. The nucleus does not contain centrosome. So, the nerve cell cannot multiply like the other cells. Nissl bodies Nissl bodies or Nissl granules are small basophilic granules found in cytoplasm of neurons and are named after the discoverer. These bodies are present in the soma except in axon hillock. Nissl bodies are called tigroid substances since these bodies are responsible for the tigroid or spotted appearance of soma after suitable stain-ing. The Nissl granules flow into the dendrites from soma, but not into axon. So, the dendrites are distinguished from axons by the presence of Nissl granules under microscope.

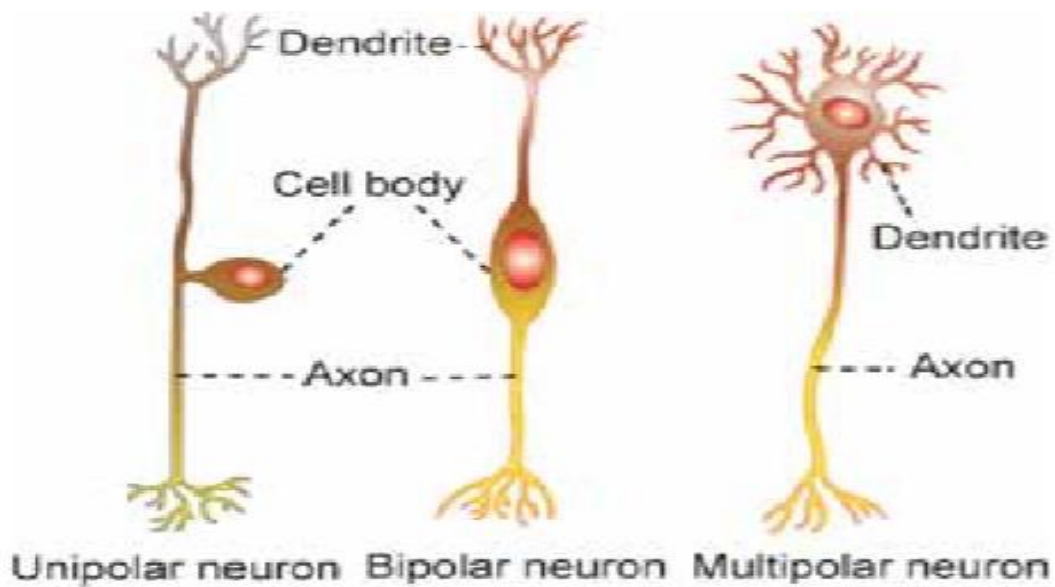
- Neurofibrils: Neurofibrils are thread like structures present in the form of network in the soma and the nerve processes. Presence of neurofibrils is another characteristic feature of the neurons.
- Mitochondria: The mitochondria are present in the soma and in axon. As other cells, the mitochondria form the powerhouse of the nerve cell, where ATP is produced.
- Golgi apparatus: Golgi apparatus of the nerve cell body is similar to that of other cells. It is concerned with processing and packaging of proteins into granule.
- Dendrite: The dendrite is the branched process of the neuron and it is branched repeatedly. The dendrite may be present or absent. If present, it may be one or many in number. The dendrite has Nissl granules and neurofibrils. Dendrite is conductive in nature. It transmits impulses towards the nerve cell body.
- Axon: The axon is longer than dendrite. Each neuron has only one axon. The axon arises from axon hillock of the nerve cell body. The axon extends for a long distance away from the nerve cell body. The length of the longest axon is about one meter.

CLASSIFICATION OF NEURON

- I. Depending upon number of poles
- II. Depending upon function
- III. Depending upon length of the axon.

Depending upon Number of Poles Based on the number of poles from which the nerve fibers arise, neurons are divided into three types:

1. Unipolar neurons that have only one pole from which, both the axon and dendrite arise.
2. Bipolar neurons which have two poles. Axon arises from one pole and dendrites arise from the other pole.
3. Multipolar neurons which have many poles. One of the poles gives rise to the axon and, all the other poles give rise to dendrites.



Depending upon Function On the basis of function, the nerve cells are classified into two types:

1. Motor neurons or efferent neurons which carry the motor impulses from central nervous system to the peripheral effector organs like muscles, glands, blood vessels, etc.
2. Sensory neurons or afferent neurons which carry the sensory impulses from periphery to the central nervous system.

Depending upon Length of Axon

- Depending upon the length of axon, neurons are divided into two types:
 1. Golgi type I neurons that have long axons. The cell body of these neurons is in central nervous system and their axons reach the remote peripheral organs
 2. Golgi type II neurons that have short axons. These neurons are present in cerebral cortex and spinal cord.

- Action potential or nerve impulse The action potential in a nerve fiber is similar to that in a muscle, except for some minor differences.. The resting membrane potential in the nerve fiber is -70 mV. The firing level is at -55 mV. Depolarization ends at $+35$ mV. Usually, the action potential starts in the initial segment of nerve fiber.
- Conductivity is the ability of nerve fibers to transmit the impulse from the area of stimulation to the other areas. The action potential is transmitted through the nerve fiber as nerve impulse. Normally in the body, the action potential is transmitted through the nerve fiber in only one direction.
- Neuroglia or the glia (glia = glue) is the supporting cell of the nervous system. The neuroglial cells are non-excitabile and do not transmit nerve impulse (action potential). So, these cells are also called non-neural cells or glial cells. Receptors are the sensory (afferent) nerve endings that terminate in the periphery as bare unmyelinated nerve endings or in the form of specialized capsulated structures. When stimulated, receptors produce a series of impulses which are transmitted through the afferent nerves. Actually receptors function like a transducer. Transducer is a device, which converts one form of energy into another. So, the receptors are often defined as the biological transducers which convert various forms of energy (stimuli) in the environment into action potentials in nerve fiber.

CLASSIFICATION OF NERVE FIBERS

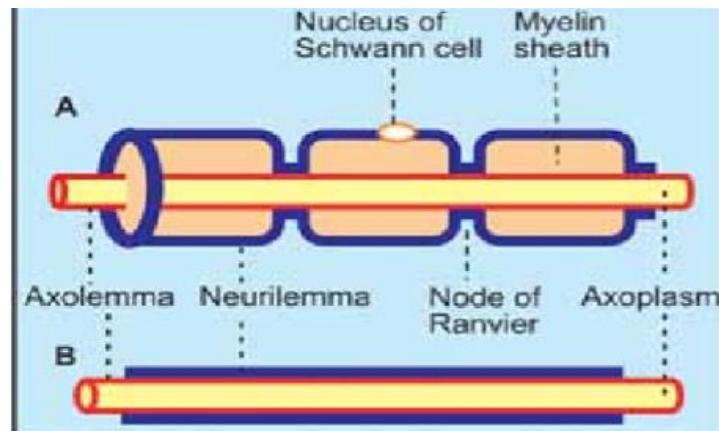
The nerve fibers are classified by different methods. The basis of classification differs in each method. Nerve fibers are classified by six methods:

1. Depending upon structure
2. Depending upon distribution
3. Depending upon origin
4. Depending upon function
5. Depending upon secretion of neurotransmitter
6. Depending upon diameter and conduction of impulse (Erlanger-Gasser classification).

1. Depending upon Structure

Based on the structure, the nerve fibers are classified into two types:

- i. Myelinated nerve fibers that are covered
- ii. Nonmyelinated nerve fibers which are not covered by myelin sheath.



A. Myelinated nerve fiber

B. Non-myelinated nerve fiber

Nonmyelinated nerve fiber The nerve fiber described above is the nonmyelinated nerve fiber which is not covered by myelin sheath.

Myelinated nerve fiber The nerve fibers which are insulated by myelin sheath are called myelinated nerve fibers

Functions of myelin sheath

1. **Faster conduction:** Myelin sheath is responsible for faster conduction of impulse through the nerve fibers. In the myelinated nerve fibers, the impulses jump from one node to another node by saltatory conduction.

2. Insulating capacity: Myelin sheath has a high insulating capacity. Because of this quality, the myelin sheath restricts the nerve impulse within the singleneurite fiber, and prevents the stimulation of neighboring nerve fibers.

2. Depending upon Distribution

Nerve fibers are classified into two types on the basis of the distribution:

- i. Somatic nerve fibers which supply the skeletal muscles of the body
- ii. Visceral or autonomic nerve fibers which supply internal organs of the body.

3. Depending upon Origin

On the basis of origin, the nerve fibers are divided into two types:

- i. Cranial nerves arising from brain
- ii. Spinal nerves arising from spinal cord.

4. Depending upon Function

Functionally, the nerve fibers are of two types:

- i. Sensory or afferent nerve fibers which carry sensory impulses from different parts of the body to the central nervous system
- ii. Motor or efferent nerve fibers which carry motor impulses from central nervous system to different parts of the body.

5. Depending upon Secretion of Neurotransmitter

Depending upon the neurotransmitter substance secreted, the nerve fibers are divided into two types:

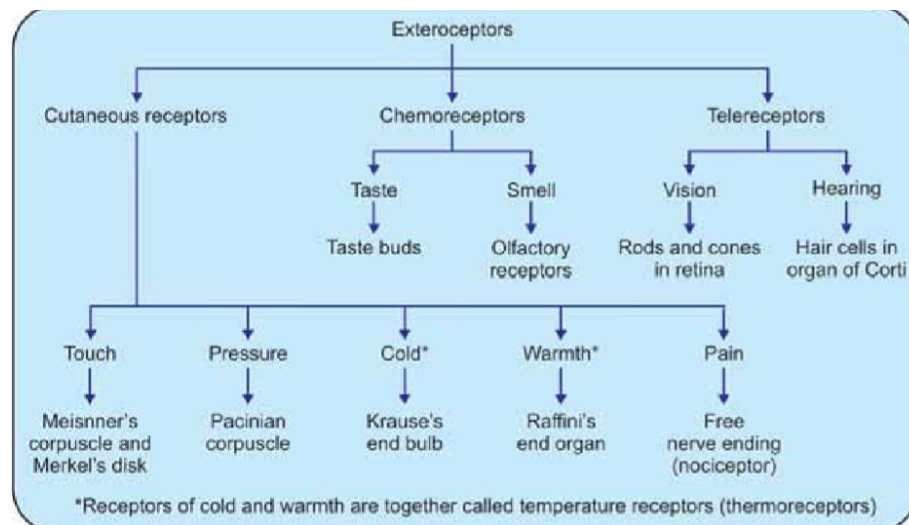
- i. Adrenergic nerve fibers that secrete noradrenaline
- ii. Cholinergic nerve fibers that secrete acetylcholine.

6. Depending upon Diameter and Conduction of Impulses

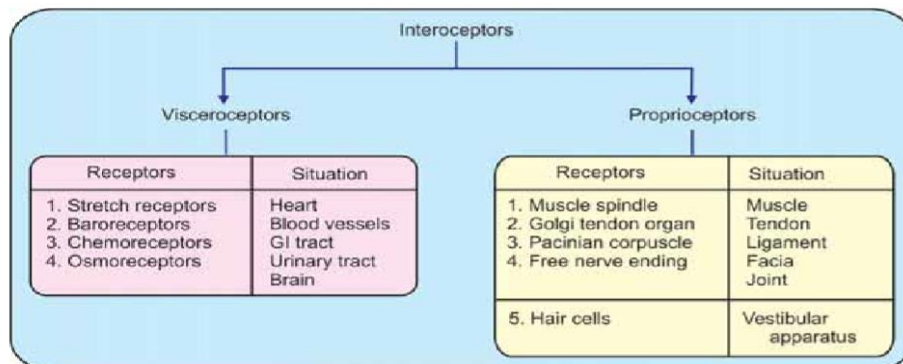
Erlanger and Gasser classified the nerve fibers into three major types on the basis of diameter

of the fibers and the rate of conduction of impulses

1. Type A nerve fibers
2. Type B nerve fibers
3. Type C nerve fibers.



Exteroceptors



Interoceptors

Synapse and Neurotransmitter

- Synapse is the junction between the two neurons. It is not the anatomical continuation. But, it is only a physiological continuity between two nerve cells.

CLASSIFICATION OF SYNAPSE

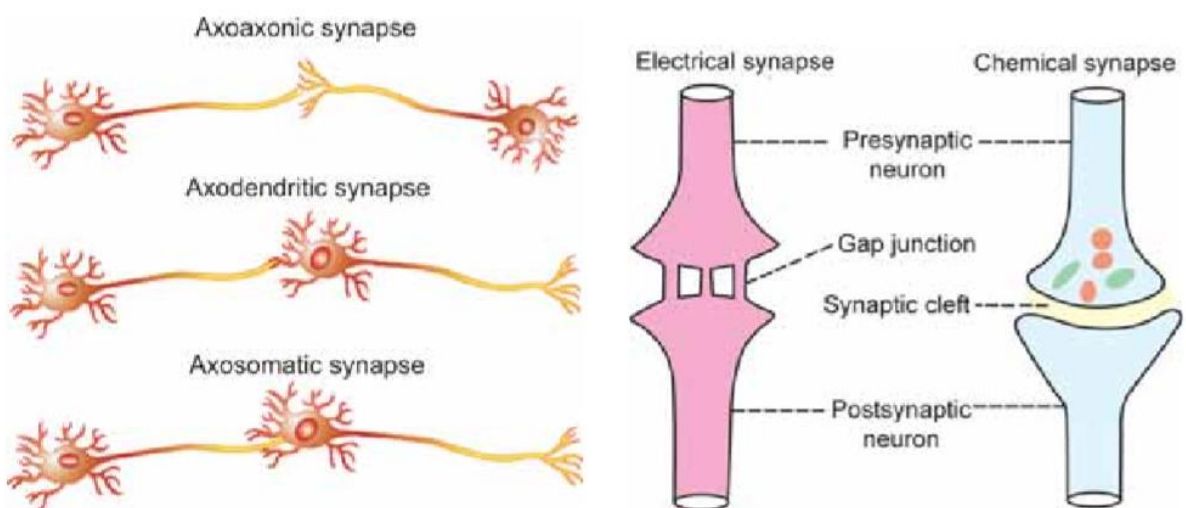
Synapse is classified by two methods, anatomical classification and functional classification.

- **ANATOMICAL CLASSIFICATION:** Synapse is formed by axon of one neuron ending on the cell body, dendrite or axon of the next neuron. Depending upon the ending of axon, the synapse is classified into three types

1-Axoaxonic synapse in which axon of one neuron terminates on axon of another neuron

2- Axodendritic synapse in which axon of one neuron terminates on dendrite of another neuron

3- Axosomatic synapse in which axon of one neuron ends on soma (cell body) of another neuron.



FUNCTIONAL CLASSIFICATION

Function classification depends upon of mode of impulse transmission. On this basis, synapse is classified into two types:

1. Electrical Synapse

Electrical synapse is the synapse in which the physiological continuity between the presynaptic and the postsynaptic neurons is provided by the gap junction between these two neurons.

There is direct exchange of ions between the two neurons though the gap junction. So, the action potential reaching the terminal portion of presynaptic neuron directly enters the postsynaptic neuron.

2. Chemical Synapse

Chemical synapse is the junction between a nerve fiber and a muscle fiber or between two nerve fibers, through which the signals are transmitted by the release of chemical transmitter. In the chemical synapse, there is no continuity between the presynaptic and postsynaptic neurons.



Sequence of events during synaptic transmission. Ach = Acetylcholine.
ECF = Extracellular fluid. EPSP = Excitatory postsynaptic potential

FUNCTIONS OF SYNAPSE

Function of the synapse is to transmit the impulses from one neuron to another. However, some synapses inhibit the impulses. Accordingly, synapse is divided into two types:

1. Excitatory synapses, which transmit the impulses — excitatory function
2. Inhibitory synapses, which inhibit the transmission of impulses — inhibitory function.

CLASSIFICATION OF NEUROTRANSMITTERS

Depending Upon Chemical Nature: Depending upon chemical nature, neurotransmitters are classified into three groups:

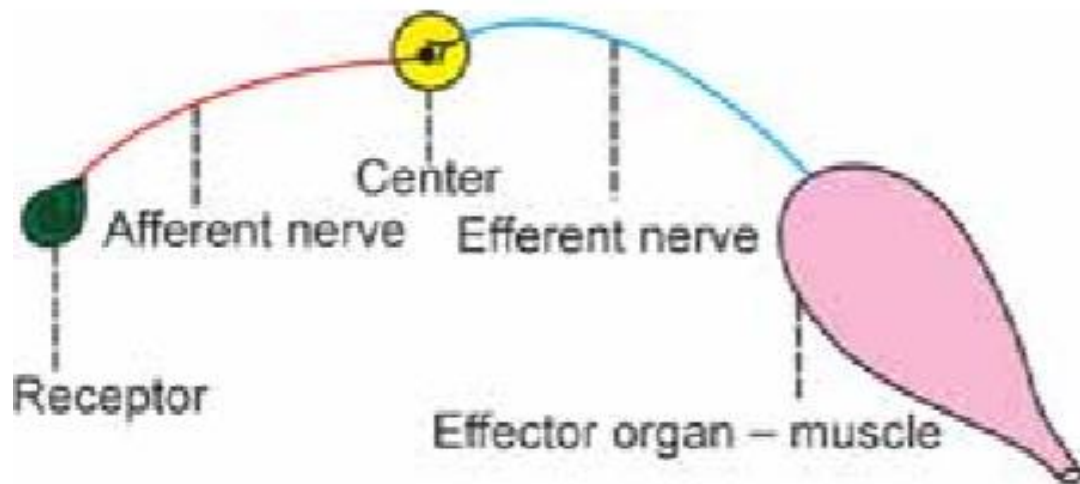
1. Amino acids
2. Amines
3. Others

Depending Upon Function: Depending upon function, neurotransmitters are classified into two types:

1. Excitatory neurotransmitters which are responsible for the conduction of impulse
2. Inhibitory neurotransmitters which inhibit the conduction of impulse.

Reflex Activity

is the response to a peripheral nervous stimulation that occurs without our consciousness. It is a type of protective mechanism and it protects the body from irreparable damages. For example, when the hand is placed on a hot object, it is withdrawn immediately. When a very bright light is thrown into the eyes, eyelids are closed and pupil is constricted to prevent the damage of retina by the entrance of excessive light into the eyes.



DIVISIONS OF ANS: Autonomic nervous system is divided into two divisions:

1. Sympathetic division
2. Parasympathetic division.

The differences between both the divisions of ANS are given in Table below. The autonomic nervous system (ANS) is primarily concerned with the regulation of visceral or vegetative functions of the body. So, it is also called vegetative or involuntary nervous system.

Actions of sympathetic and parasympathetic divisions of ANS

Effector organ		Sympathetic division	Parasympathetic division
1. Eye	Ciliary muscle	Relaxation	Contraction
	Pupil	Dilatation	Constriction
2. Lacrimal glands		Decrease in secretion	Increase in secretion
3. Salivary secretion		Decrease in secretion and vasoconstriction	Increase in secretion and vasodilatation
4. Gastrointestinal tract	Motility	Inhibition	Acceleration
	Secretion	Decrease	Increase
	Sphincters	Constriction	Relaxation
	Smooth muscles	Relaxation	Contraction
5. Gallbladder		Relaxation	Contraction
6. Urinary bladder	Detrusor muscle	Relaxation	Contraction
	Internal sphincter	Constriction	Relaxation
7. Sweat glands		Increase in secretion	-----
8. Heart rate and force		Increase	Decrease
9. Blood vessels		Constriction of all blood vessels except those in heart and skeletal muscle	Dilatation
10. Bronchioles		Dilatation	Constriction