

pharmacology of Autonomic Nervous System:- Introduction to the Nervous System:-

The nervous system is divided into two anatomical divisions:

1-The central nervous system (CNS):- which is composed of the brain and spinal cord.

2-The peripheral nervous system:- which includes neuron located outside the brain and spinal cord that is, any nerves that enter or leave the CNS .

The peripheral nervous system is subdivided into:-

1-Efferent division:-

The neurons of which carry signals away from the brain and spinal cord to the peripheral tissues.

2-A afferent division:-

The neurons of which bring information from the periphery to the CNS.

Afferent neurons provide sensory input to modulate the function of the efferent division through reflex action .

The Efferent portion of the peripheral nervous system is further divided into two major functional subdivisions.

1-The somatic and 2- the autonomic systems .

The somatic efferent neurons are involved in the voluntary control of functions such as contraction of the skeletal muscles essential for locomotion.

The autonomic system regulates the everyday requirements of vital bodily functions without the conscious participation of the mind .

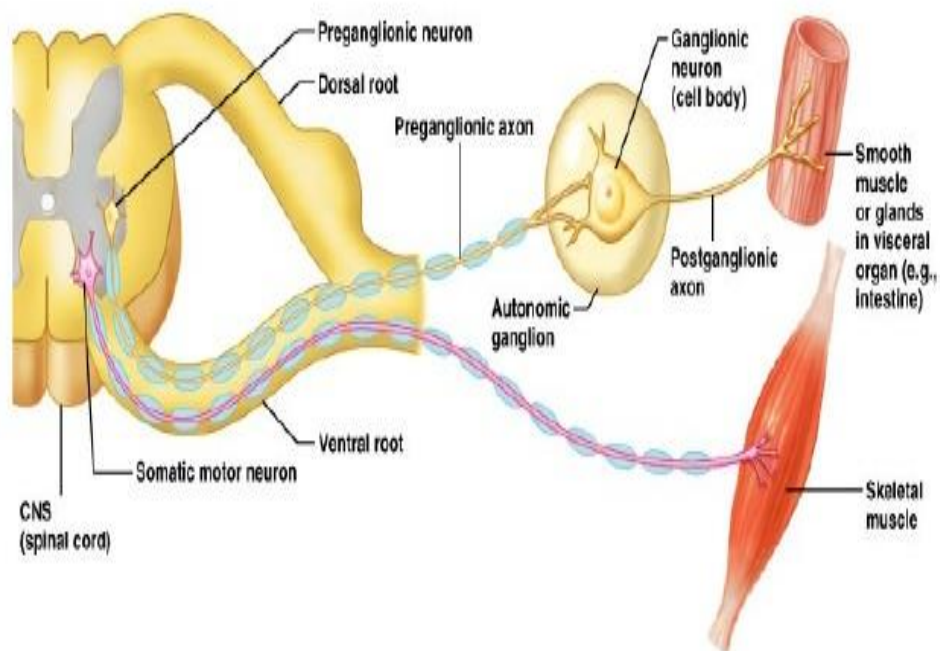
It is composed of Efferent neurons that innervate smooth muscle of the viscera, cardiac muscle, vasculature, and the exocrine glands, thereby controlling digestion, cardiac output, blood flow, and glandular secretion .

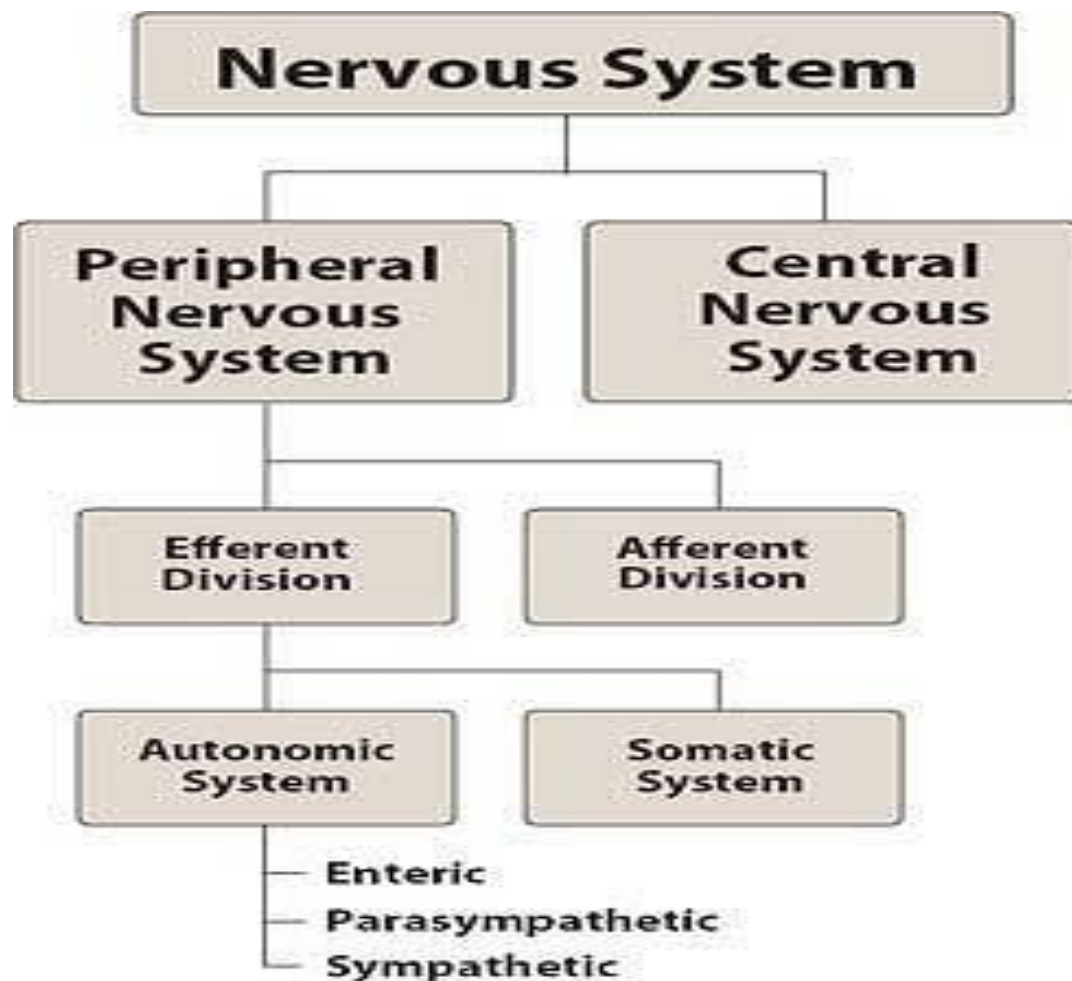
The autonomic nervous system carries nerve impulses from the CNS to the effector organs by way of two types of efferent neurons.

1-The first nerve cell is called a preganglionic neuron ,and its cell body is located within the CNS Preganglionic neurons emerge from

the brainstem or spinal cord and make a synaptic connection in ganglia (an aggregation of nerve cell bodies located in the peripheral nervous system).

These ganglia function as relay stations between a preganglionic neuron. and a second nerve cell, the postganglionic neuron.





Functional divisions within the nervous system:-

The efferent autonomic nervous system is divided into the :-

sympathetic and the parasympathetic nervous systems, as well as the enteric nervous system.

1-Sympathetic neurons :-

The preganglionic neurons of the sympathetic system come from thoracic and lumbar regions of the spinal cord, and they synapse in two cord-like chains of ganglia that run in parallel on each side of the spinal cord.

The preganglionic neurons are short in comparison to postganglionic ones.

The adrenal medulla, like the sympathetic ganglia, receives preganglionic fibers from the sympathetic system.

Lacking axons, the adrenal medulla, in response to stimulation by the ganglionic neurotransmitter the hormone epinephrine, also known as

adrenaline, and lesser amounts of norepinephrine into the blood.

2-Parasympathetic neurons: The parasympathetic preganglionic fibers arise from the cranium (from cranial nerves III, VII, IX, and X) and from the sacral region of the spinal cord and synapse in ganglia near or on the effector organs.

cranial nerves III:-which responsible for pupils constrict .

cranial nerves VII :- which responsible for tear, nasal, mucous and saliva secretion .

cranial nerves IX which responsible for Parotid salivary gland secretion .

cranial nerves X (Vagus nerve). which responsible for Visceral organs of thorax and abdomen.

Stimulate digestive glands

Increase motility of smooth muscle of digestive tract .

Decreases heart rate .

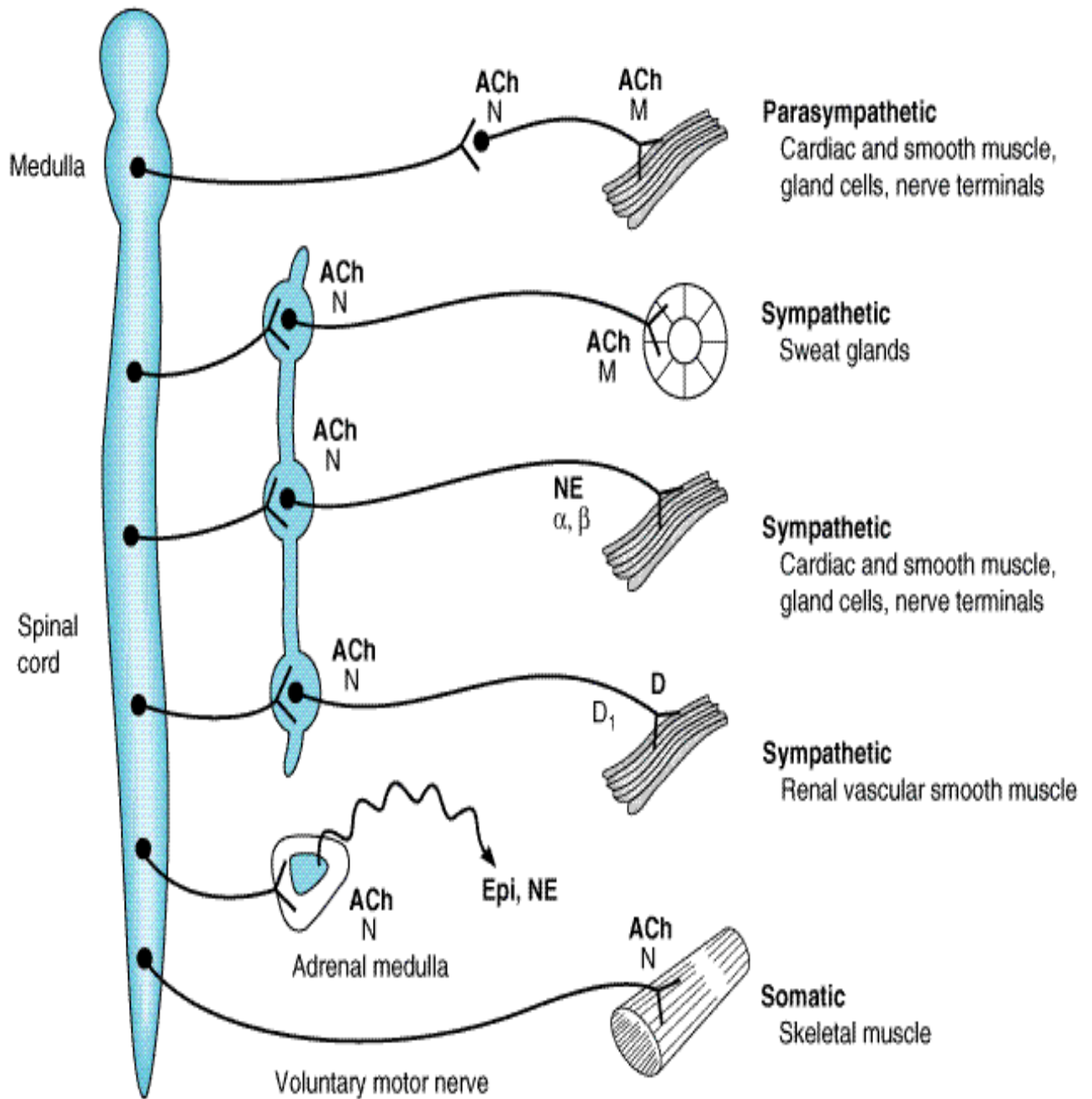
Causes bronchial constriction .

-Sacral outflow (S2-4) from pelvic splanchnic nerve supply of large intestine and supply all the pelvic genitourinary organs

3-Enteric neurons: The enteric nervous system is the third division of the autonomic nervous system.

It is a collection of nerve fibers that innervate the gastrointestinal tract, pancreas, and gallbladder, and it constitutes the (brain of the gut).

This system functions independently of the CNS and controls the motility, exocrine and endocrine secretions, and micro circulation of GIT. It is modulated by both sympathetic and parasympathetic nervous system.



Schematic diagram comparing some anatomic and neurotransmitter features of autonomic and somatic motor nerves . Parasympathetic ganglia are not shown because most are in or near the wall of the organ innervated. Note that some sympathetic postganglionic fibers release acetylcholine or dopamine rather than norepinephrine. (ACh, acetylcholine; D, dopamine Epi, epinephrine; NE, norepinephrine; N, nicotinic recep).

PARASYMPATHETIC

SYSTEM

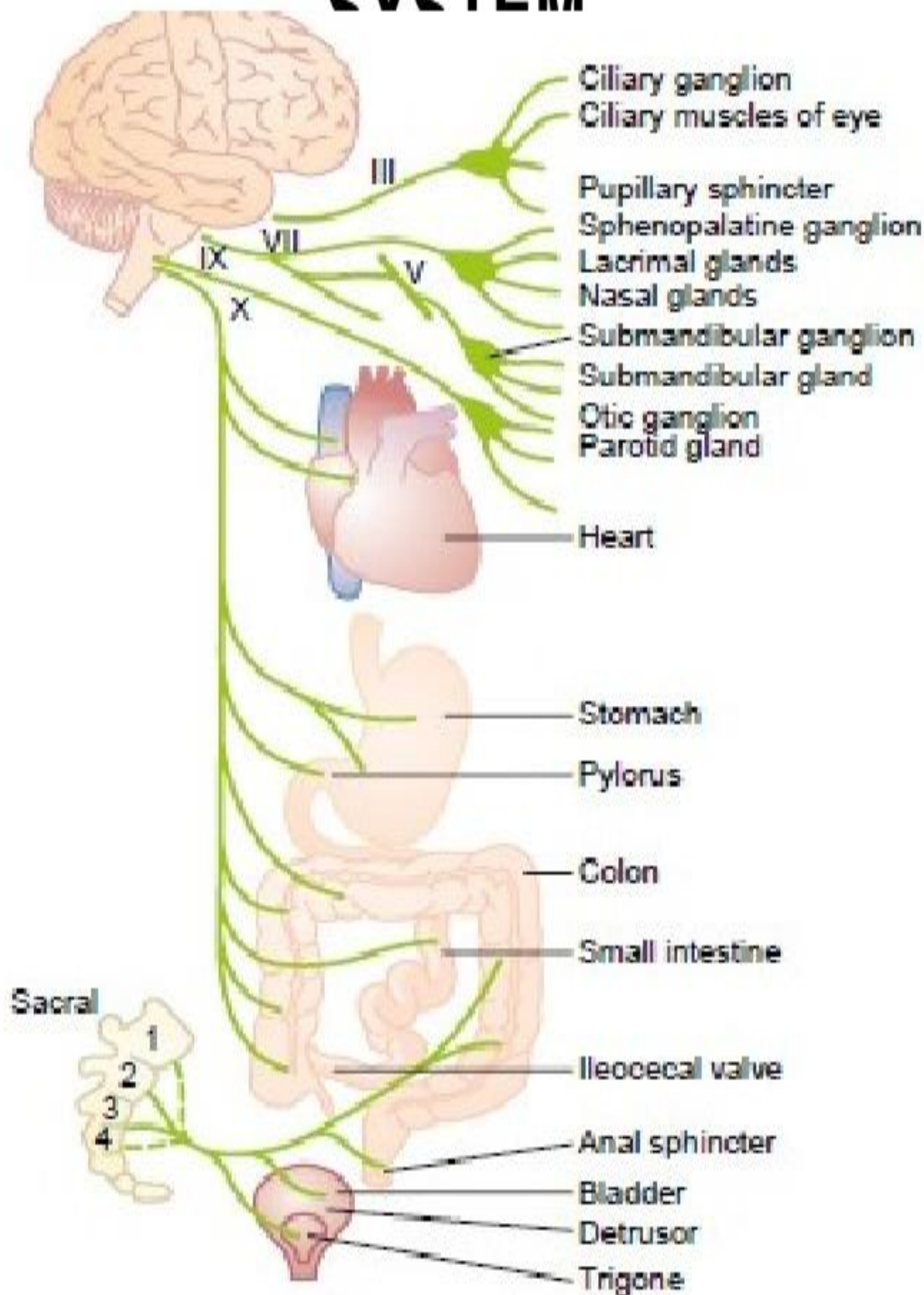


Figure 80.9

Functions of the parasympathetic nervous system:-

The parasympathetic division maintains essential bodily functions, such as digestive processes and elimination of wastes, and is required for life.

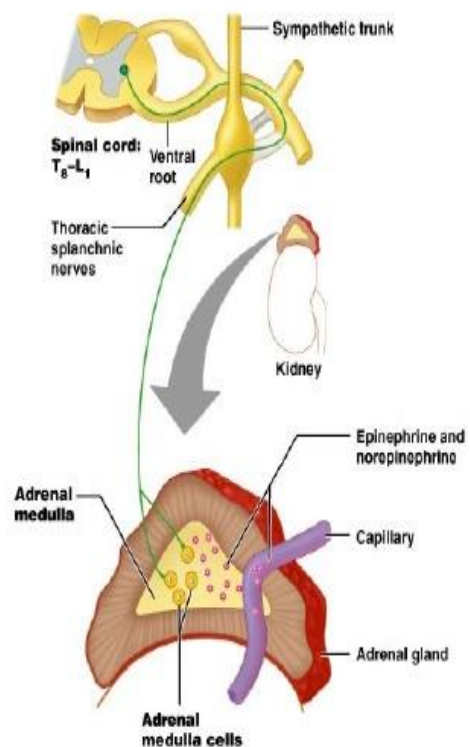
It usually acts to oppose or balance the actions of the sympathetic division and is generally dominant over the sympathetic system in (rest and digest situations).

The parasympathetic system is not a functional entity as such and it never discharges as a complete system. If it did, it would produce massive, undesirable, and unpleasant symptoms

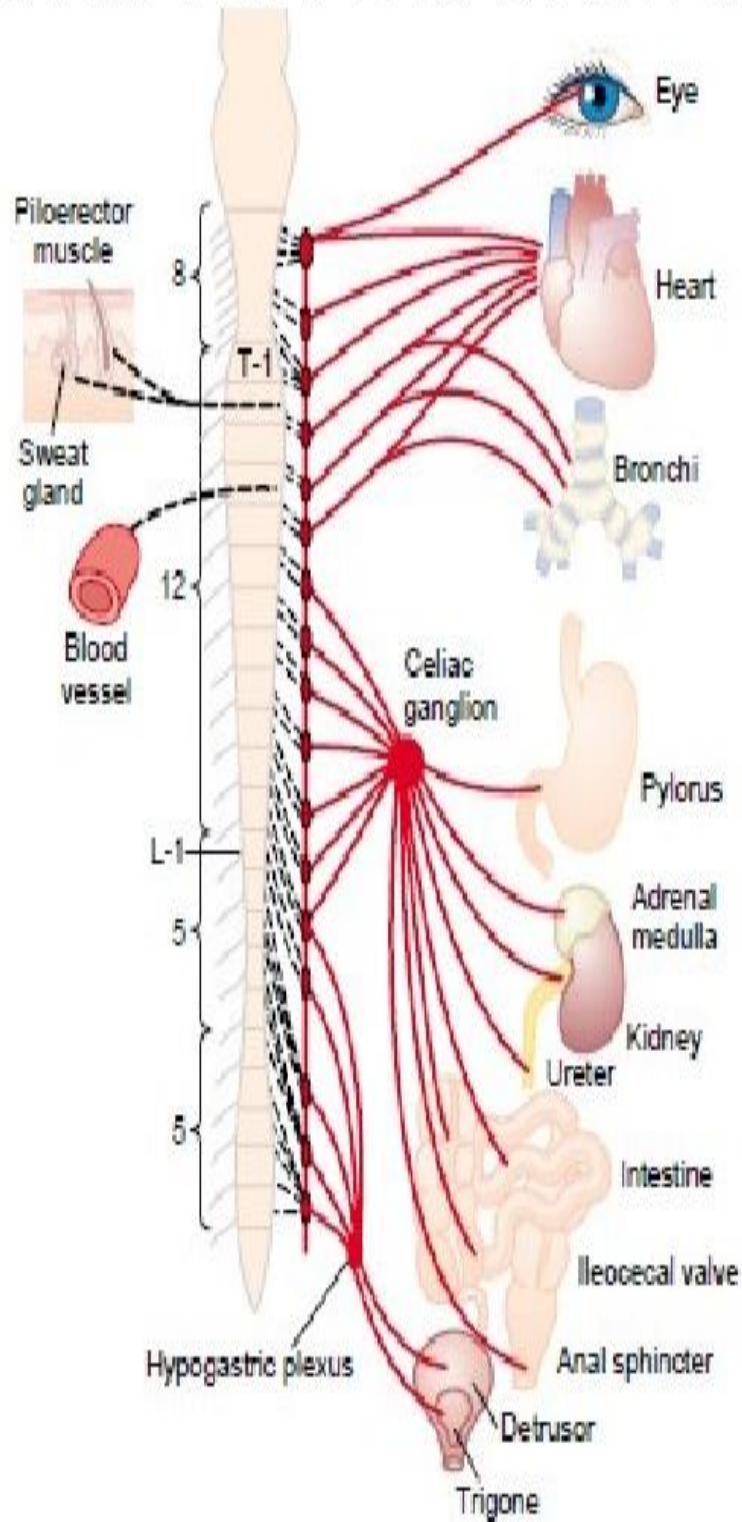
Instead, discrete parasympathetic fibers are activated separately, and the system functions to affect specific organs, such as the stomach or eye.

Adrenal gland is exception

- Synapse in gland
- Can cause body-wide release of epinephrine and norepinephrine



SYMPATHETIC SYSTEM



Although continually active to some degree (for example, in maintaining the tone of vascular beds), the sympathetic division has the property of adjusting in response to stressful situations, such as trauma, fear, hypoglycemia, cold, or exercise.

Effects of stimulation of the sympathetic division:

The effect of sympathetic output is to:-

1-Increase heart rate and blood pressure.

2-Mobilize energy stores of the body, and to increase blood flow to skeletal muscles and the heart while diverting flow from the Skin and internal organs.

3-Sympathetic stimulation results in dilation of the pupils and the bronchioles .

4-It also affects gastrointestinal motility and the function of the bladder and sexual organs.

-Fight or flight response: The changes experienced by the body during emergencies have been referred to as the (fight or flight) response .

These reactions are triggered both by direct sympathetic activation of the effector organs and by stimulation of the adrenal medulla to release epinephrine and lesser amounts of norepinephrine.

These hormones enter the bloodstream and promote responses in effector organs that contain adrenergic receptors .

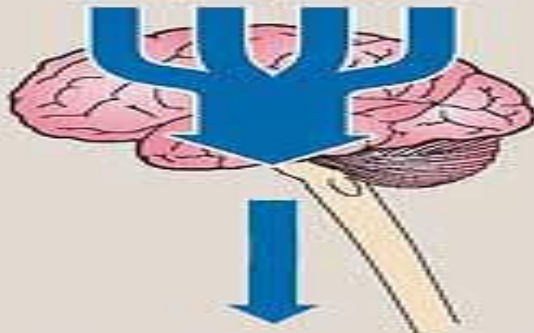
The sympathetic nervous system tends to function as a unit, and it often discharges as a complete system (for example, during severe exercise or in reactions to fear.

**"Fight or flight"
stimuli**



Sympathetic output
(diffuse because postganglionic
neurons may innervate
more than one organ)

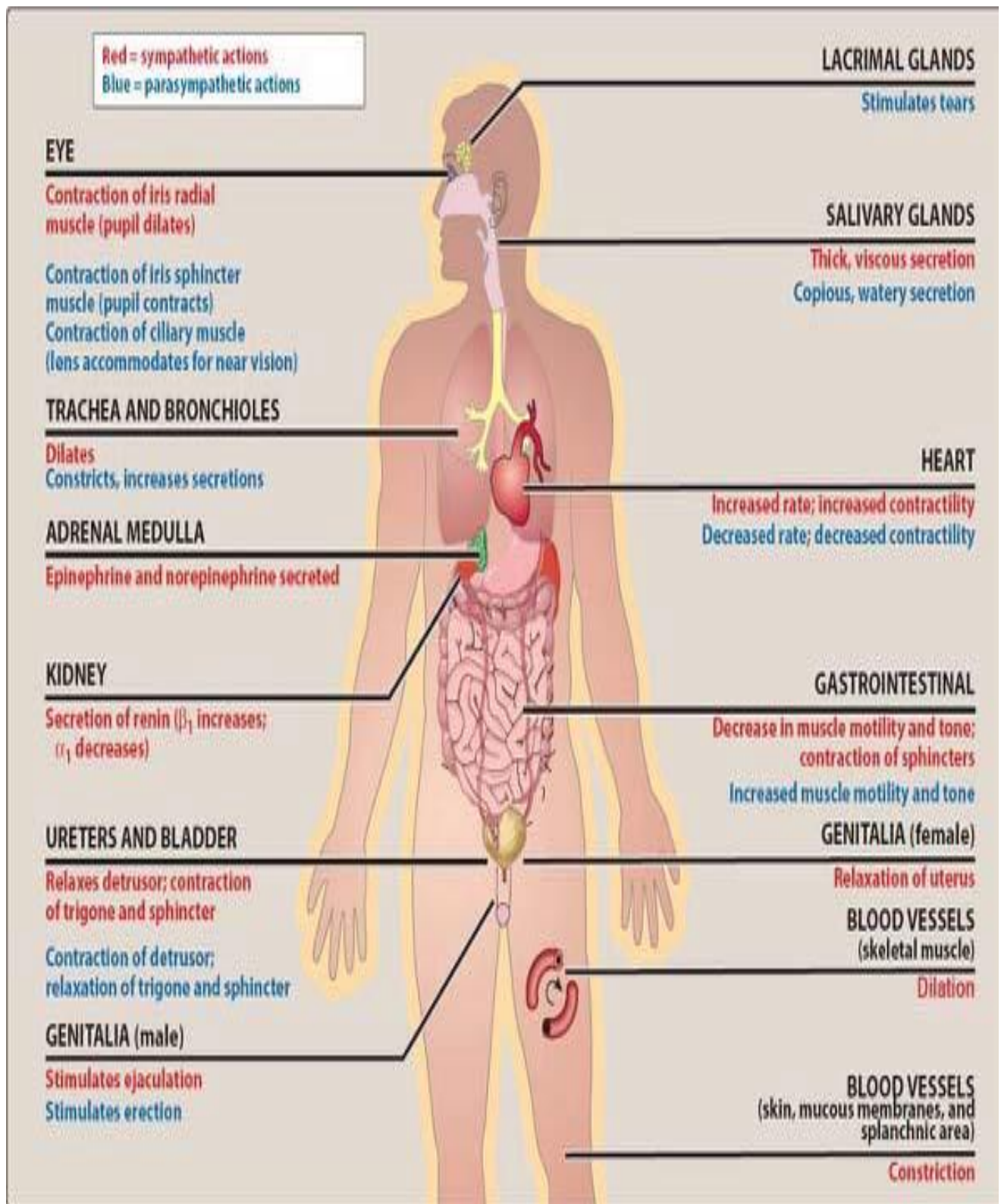
**"Rest and digest"
stimuli**



Parasympathetic output
(discrete because postganglionic
neurons are not branched, but
are directed so a specific organ)

**Sympathetic and para-
sympathetic actions
often oppose each other**





Action of sympathetic and parasympathetic nervous systems on effector organs.

Somatic nervous system:-

The somatic nervous system is under voluntary control, whereas the autonomic is an involuntary system.

Chemical Signaling Between Cells:-

Neurotransmission in the autonomic nervous system is an example of the more general process of chemical signaling between cells .

In addition to neurotransmission, other types of chemical signaling are the release of local mediators and the secretion of hormones .

Most cells in the body secrete chemicals that act locally that is, on cells in their immediate environment. These chemical signals are rapidly destroyed or removed; therefore, they do not enter the blood and are not distributed throughout the body.

Specialized endocrine cells secrete hormones into the bloodstream, where they travel throughout the body exerting effects on broadly distributed target cells in the body.

Neurotransmitters:-

Communication between nerve cells and between nerve cells and effector organs occurs through the release of specific chemical signals, called neurotransmitters, from the nerve terminals.

This release is triggered by the arrival of the action potential at the nerve ending, leading to depolarization .Uptake of Ca^{2+} initiates fusion of the synaptic vesicles with the presynaptic membrane and release of their contents. The neurotransmitters rapidly diffuse across the synaptic cleft or space (synapse)between neurons and combine with specific receptors on the postsynaptic target cell.

Types of neurotransmitters

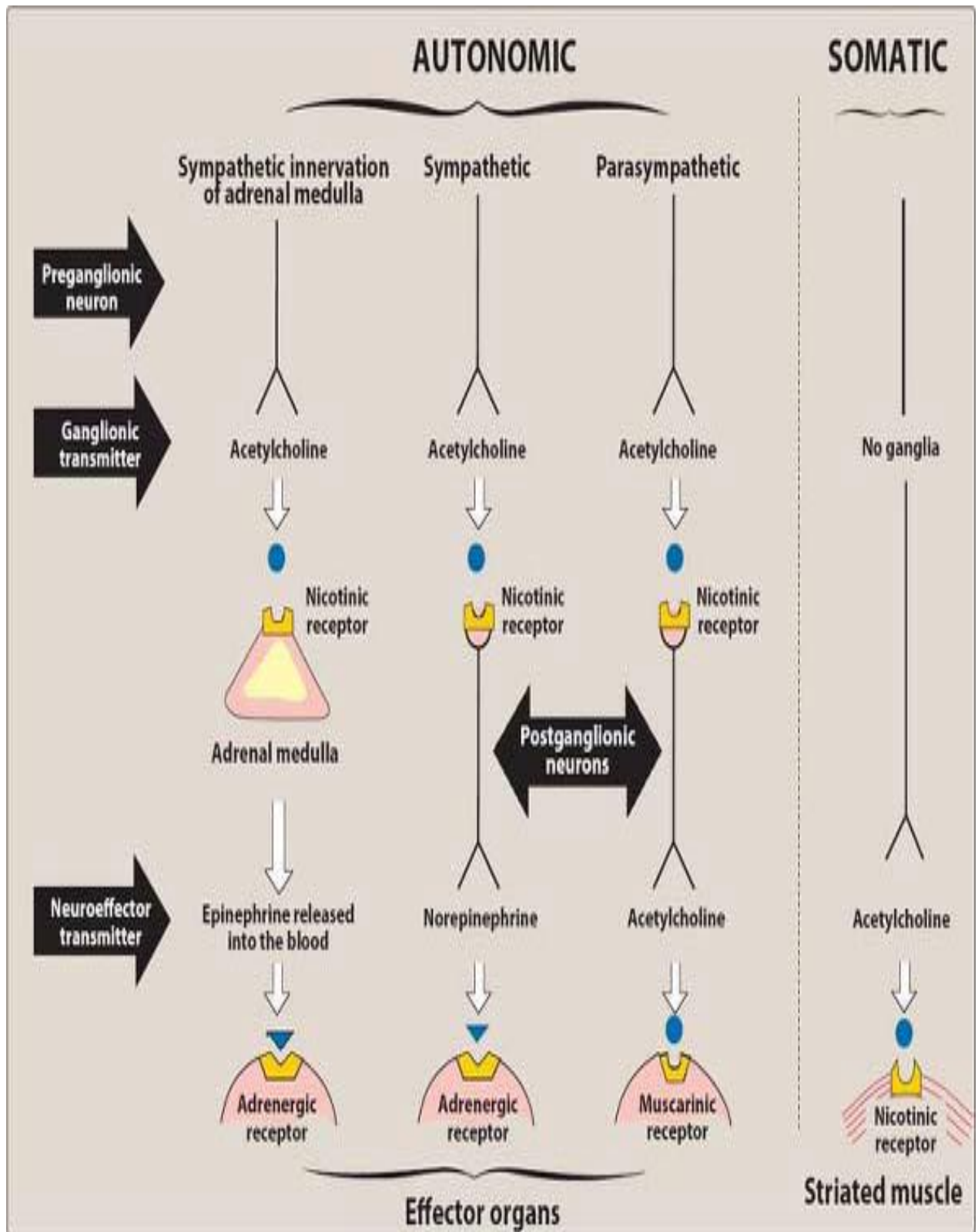
signal compounds norepinephrine and the closely related epinephrine, acetylcholine, dopamine, serotonin, histamine, and aminobutyric acid are most commonly involved in the actions of of therapeutically useful drugs.

Each of these chemical signals binds to a specific family of receptors Acetylcholine and norepinephrine are the primary chemical signals in the autonomic nervous system, whereas a wide variety of neurotransmitters function in the CNS.

Second Messenger Systems in Intracellular Response:-

The binding of chemical signals to receptors activates enzymatic processes within the cell membrane that ultimately result in a cellular response, such as the phosphorylation of intracellular proteins or changes in the conductivity of ion channels .

A neurotransmitter can be thought of as a signal and a receptor as a signal detector and transduce second –messenger molecules, produced in response to neurotransmitter binding to a receptor, translate the extracellular signal into a response that may be further propagated or amplified within the cell. Each component serves as a link in the communication between extracellular events and chemical changes within the cell.



Summary of the neurotransmitters released and the types of receptors found within the autonomic .

