

PNS MODULE

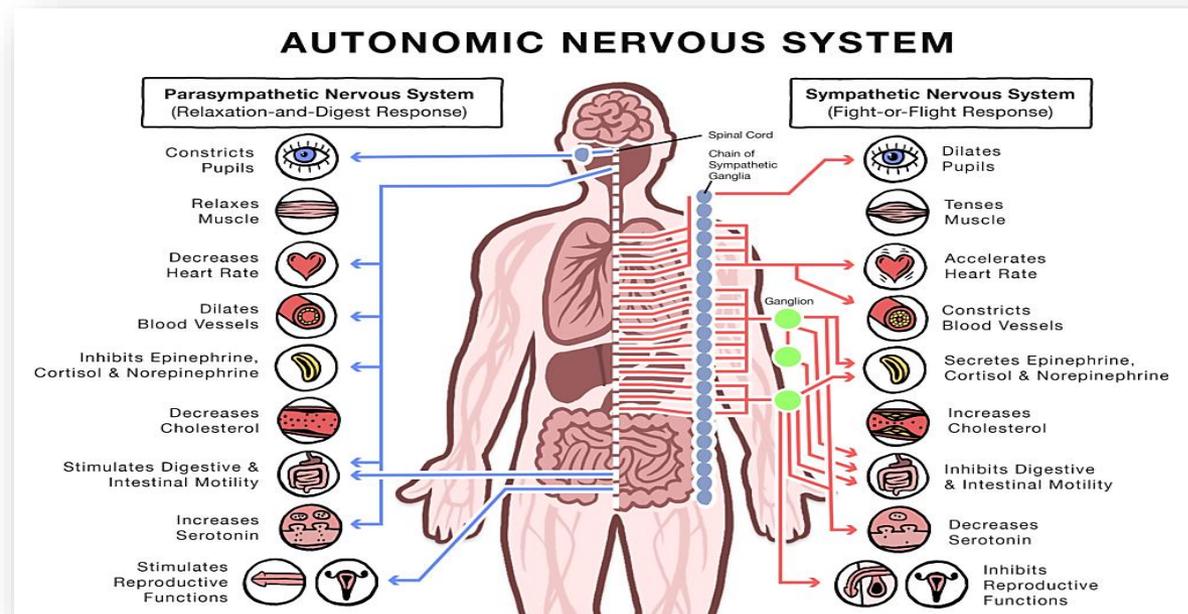
PHYSIOLOGY LECTURE (5)

(Function of Autonomic Nervous System II)

By

Dr. Fatma Farrag Ali

Associate Prof. of Medical Physiology
Faculty of Medicine-Mutah University
2025-2026



PARASYMPATHETIC DIVISION OF THE ANS

- ✓ **The parasympathetic nervous system is called the craniosacral division of the ANS** because of the location of its preganglionic neurons within several cranial nerve nuclei (III, VII, IX, and X) and the sacral spinal cord (S2-4).
- ✓ **PNS mediates “vegetative” responses, such as digestion. The parasympathetic system is activated, a person is in a rest-or-digest state**
- ✓ **It is anabolic**, helps to digest, absorb, metabolize food, produce and store energy as ATP store. So, it is sometimes called **anabolic nervous system**.
- ✓ **It produces V.D. and increases secretions.**
- ✓ **Acts on individual organs separately and not as a whole like the Sympathetic.**
- ✓ **Generalized parasympathetic activity is fatal.**

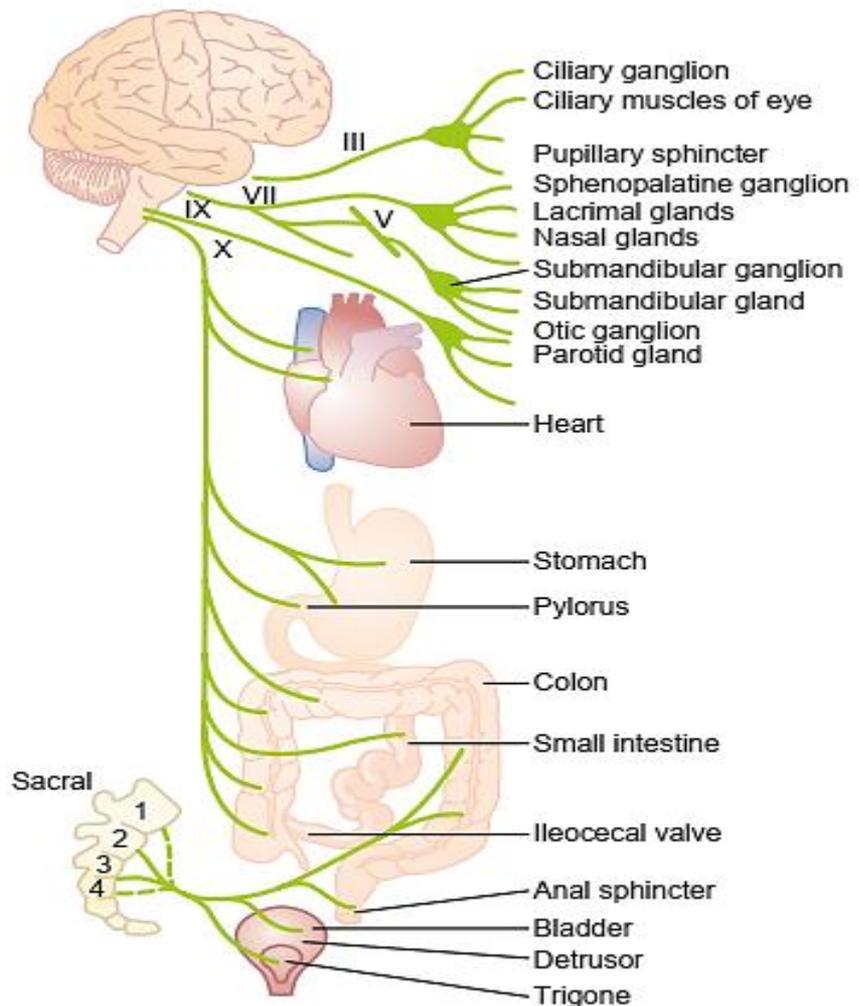


Figure 60-3

Parasympathetic nervous system.

Distribution & Functions of Parasympathetic Nervous System

I- Cranial Parasympathetic Outflow:

It is present in cranial nerves (III, VII, IX and X).

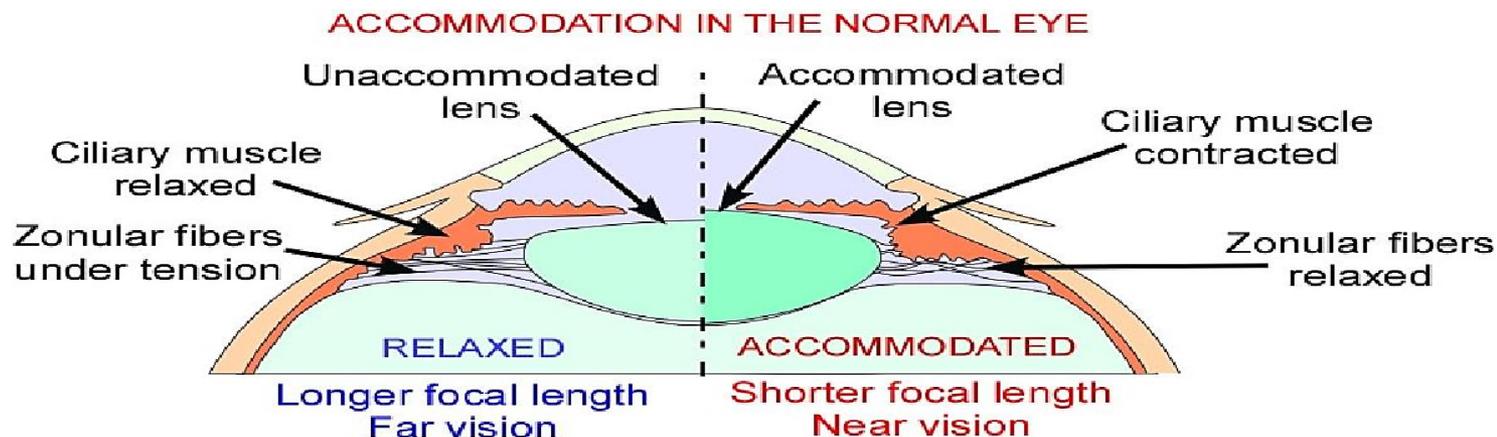
1- The Oculomotor (3rd Cranial, III) Nerve:

The cell bodies in the Edinger-Westphal nucleus of the oculomotor nerve project to the ciliary ganglion to innervate the sphincter (constrictor) muscle of the iris and the ciliary muscle.

Functions:

Postganglionic fibers (short ciliary nerves)

- Motor to the pupillary sphincter muscle → **constriction of the pupil (miosis).**
- Motor to **ciliary muscle** → contraction → relaxation of suspensory ligament → **↑ lens curvature and power** → **accommodation to near vision (= accommodation reflex).**



2- The Facial (7th Cranial, VII) Nerve:

Neurons in the superior salivary nucleus of the facial nerve project to the sphenopalatine ganglion to innervate the lacrimal and nasal glands and mucosa of soft palate and nasopharynx and to the submandibular ganglion to innervate the submandibular (also called submaxillary) and sublingual glands.

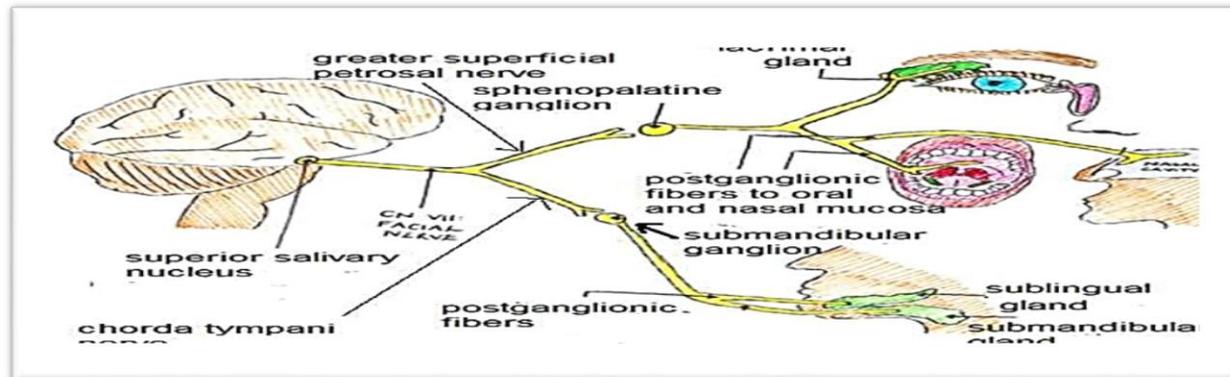
Postganglionic fibers supply:

- Submandibular and sublingual salivary glands.
- Anterior 2/3 of tongue.
- Lacrimal and nasal glands.

Functions:

-Vasodilation (V.D.)

-Secretion: It is true secretion i.e. watery, large in amount (profuse) and little in enzymes.



3- The Glossopharyngeal (9th Cranial, IX) Nerve

The cell bodies in the inferior salivary nucleus of the glossopharyngeal nerve project to the otic ganglion to innervate the parotid salivary gland.

The post ganglionic fibers supply:

- Parotid gland.
- Posterior 1/3 of the tongue.

Functions:

- Vasodilation (V.D.).
- Secretion: ↑profuse (true) watery salivary secretion (large volume).

4- The Vagus (10th Cranial, X) Nerve:

Vagal preganglionic fibers synapse on ganglia cells clustered within the walls of visceral organs (terminal ganglia) ; thus, these parasympathetic postganglionic fibers are very short.

- It constitutes 75 % of parasympathetic fibers in the body.
- Supply the thoracic and abdominal viscera.

Functions: Postganglionic fibers supply:

A-Thorax:

1-Heart:

- It acts on the atria only ↓ **all properties of cardiac muscle:**
- decrease heart rate and force of atrial muscles contraction (no supply to ventricles).
- ↓ cardiac metabolism and decrease oxygen consumption by the heart → ↓ metabolites → coronary V.C. → decrease of coronary blood flow.

N.B. parasympathetic stimulation produces V.D. all over the body except in coronary blood vessels (V.C.).

2-Lungs:

- **Bronchoconstriction** → narrowing of air passages → ↓ air entry.
- **Increase mucous secretion.**
- **Pulmonary vasodilation.**

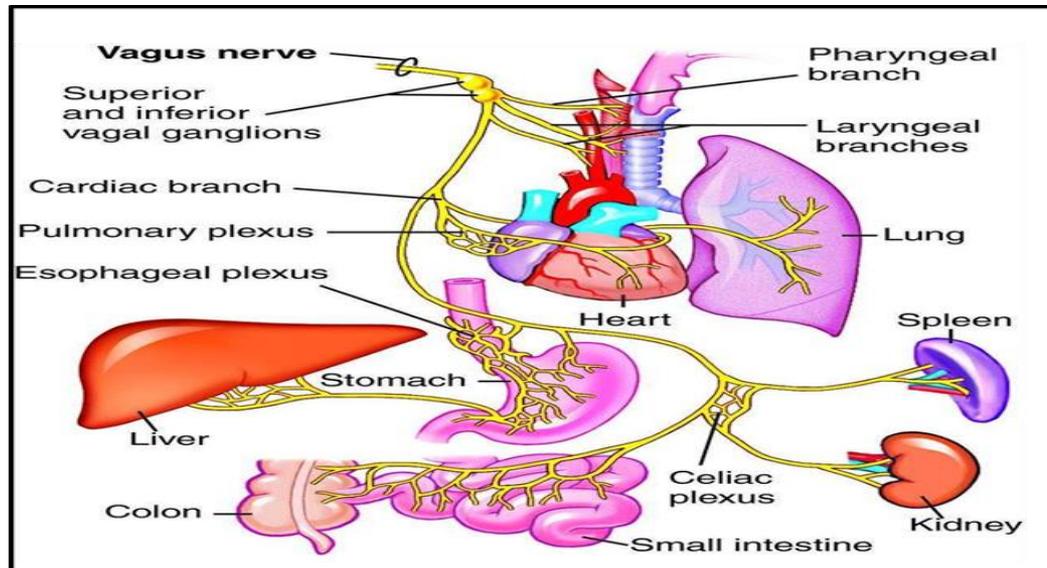
B - Abdomen:

- Gastrointestinal tract (GIT):

(esophagus, stomach, small intestine, and proximal half of large intestine).

- Motor to wall of esophagus, stomach, small intestine and proximal part of large intestine and relaxation of sphincters → **accelerates emptying of GIT.**
- **Vasodilator to GIT vessels** → ↑ all GIT secretions (Stomach, liver, pancreas and duodenum).
- **Gall bladder:**

Stimulates Gall bladder contraction and inhibits the sphincter of Oddi → gall bladder emptying (cholagogue) → ↑ bile flow.



II- Sacral Parasympathetic Outflow (= Pelvic Nerve; S2,3,4):

- Contraction of the wall of the rectum and anal canal and relaxation of the internal anal sphincter leading to **defecation**.
- Contraction of the wall of the urinary bladder and relaxation of the internal urethral sphincter leading to **micturition**.
- Secretory to the seminal vesicles and prostate.
- Vasodilation of the blood vessels of external genital organs leading to **erection** of penis (male) and clitoris (female).

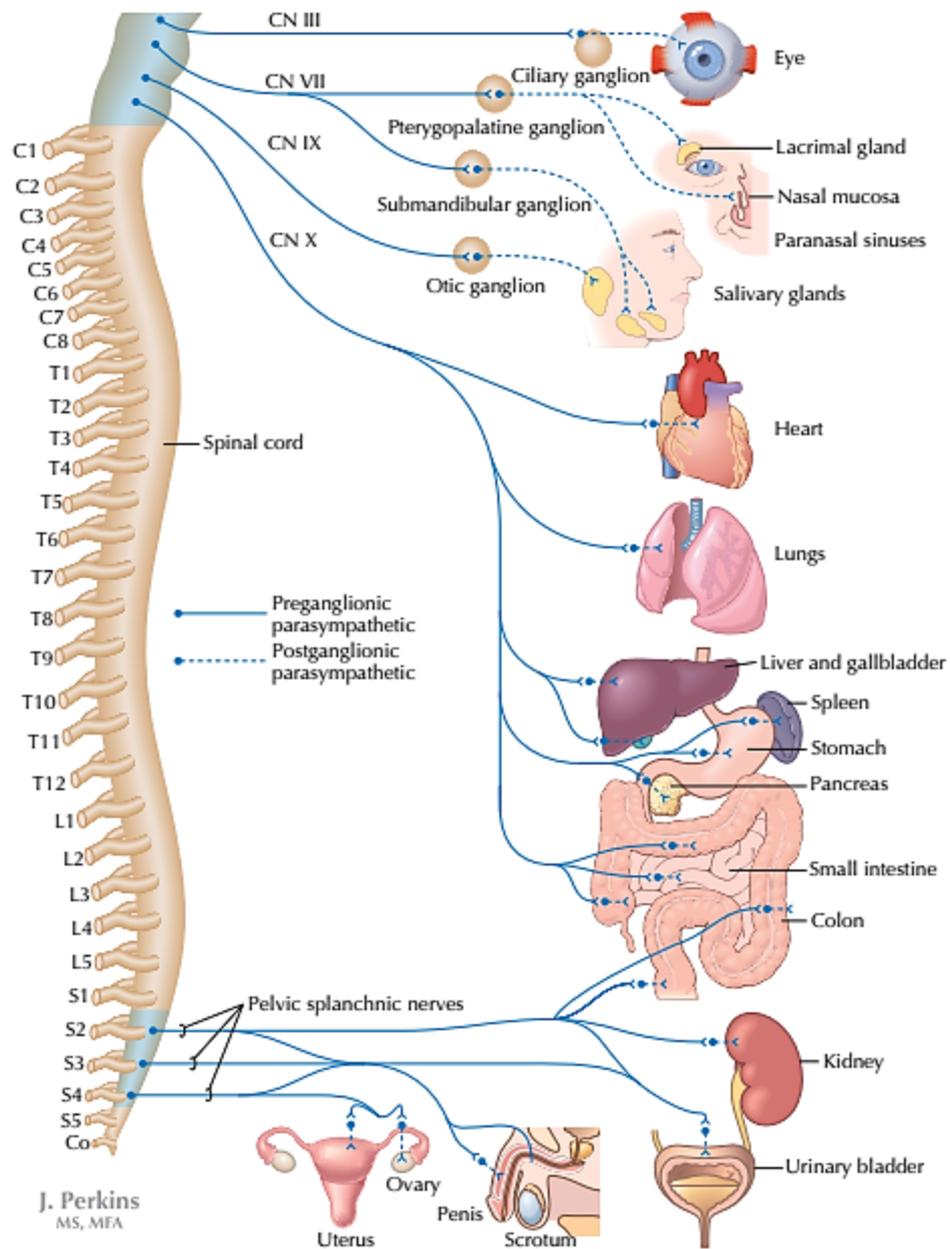


Figure 7.3 Autonomic Nervous System: Parasympathetic Division Preganglionic fibers of the PNS are associated with cranial nerves III, VII, IX, and X and also emerge from the sacral spinal cord at levels S2–S4. The PNS is involved in “vegetative” processes such as digestion as well as homeostatic functions. In general, the SNS and PNS work together in reciprocal fashion to regulate bodily function.

Comparison of Some Effects of Autonomic Nervous System Activity

Effector organ	Sympathetic nervous system effect	Parasympathetic nervous system effect
Eyes Iris muscle Ciliary muscle	Contracts radial muscle (widens pupil; mydriasis)	Contracts sphincter muscle (makes pupil smaller; miosis) Contraction (allows lens to become more convex for near vision)
Heart SA node Atria AV node Ventricles	Increases heart rate Increases contractility Increases conduction velocity Increases contractility	Decreases heart rate Decreases contractility Decreases conduction velocity Decreases contractility slightly (-)
Lungs Bronchial muscle	Relaxation (bronchodilation)	Contraction (bronchoconstriction)
Salivary glands	Stimulates secretion (thick viscous secretion), Stimulates enzyme secretion	Stimulates watery secretion (profuse watery secretion)
Stomach Motility Sphincters Secretion	Decreases Contraction	Increases Relaxation Stimulation
Intestine Motility Sphincters Secretion	Decreases Contraction Inhibition	Increases Relaxation Stimulation

Comparison of Some Effects of Autonomic Nervous System Activity

Effector organ	Sympathetic nervous system effect	Parasympathetic nervous system effect
Gallbladder Liver	Relaxation Glycogenolysis	Contraction -
Pancreas Exocrine glands	Decreased secretion	Increased secretion
Adipose tissue	Increases fat breakdown (lipolysis)	-
Kidneys Urinary bladder Bladder wall Sphincter	Increases renin secretion Relaxation Contraction	- Contraction Relaxation
Reproductive tract (male)	Ejaculation	Erection
Skin Pilomotor muscles Sweat glands	Contraction Generalized abundant, dilute secretion	- -
Lacrimal glands	-	Secretion
Nasopharyngeal glands	-	Secretion

CHEMICAL TRANSMITTERS OF THE AUTONOMIC NERVOUS SYSTEM (ANS)

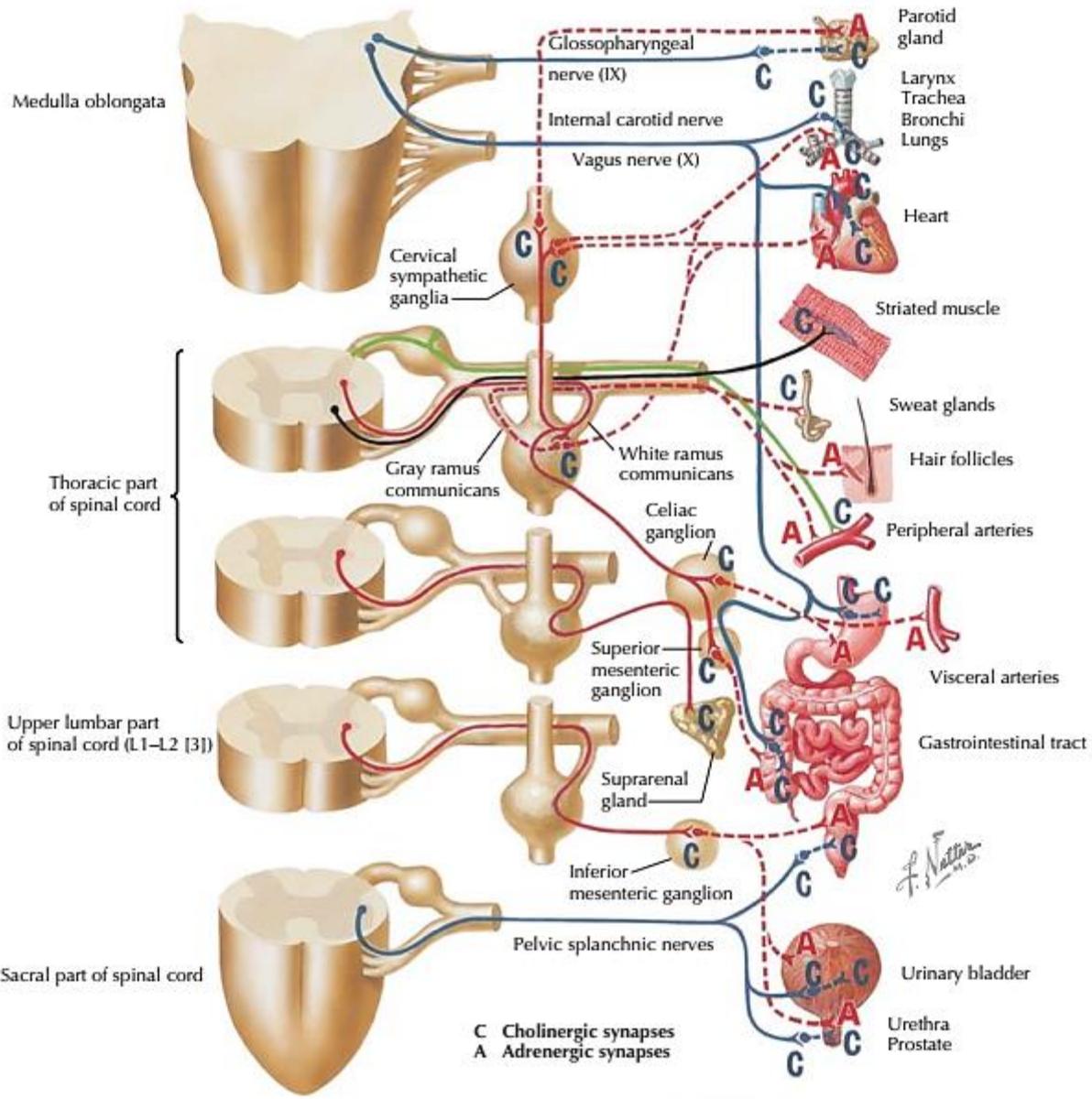
ACETYLCHOLINE & NOREPINEPHRINE

Acetylcholine and norepinephrine are the principal neurotransmitters synthesized and released by autonomic neurons.

The cholinergic autonomic neurons (ie, release acetylcholine) are:

- ✓ All preganglionic neurons (in autonomic ganglia).
- ✓ All parasympathetic postganglionic neurons.
- ✓ Sympathetic postganglionic neurons that innervate sweat glands, and
- ✓ Sympathetic postganglionic neurons that end on blood vessels in skeletal muscles and produce vasodilation when stimulated (sympathetic vasodilator nerves).
- ✓ The remaining sympathetic postganglionic neurons are noradrenergic (ie, release norepinephrine).

In addition to the classical autonomic neurotransmitters, there is a widespread network of postganglionic neurons recognized as non-adrenergic and non-cholinergic. These neurons use nitric oxide and other neurotransmitters to mediate some forms of blood vessel dilation and to regulate various gastrointestinal, respiratory, urinary, and reproductive functions.



Sympathetic fibers { Presynaptic ——— Postsynaptic - - - - } Parasympathetic fibers { Presynaptic ——— Postsynaptic - - - - } Somatic fibers Antidromic conduction ———

ADRENAL MEDULLA

- The adrenal medulla functions as part of the SNS. It is essentially a sympathetic ganglion in which the postganglionic cells have lost their axons and secrete both epinephrine and norepinephrine directly into the bloodstream.
- Preganglionic axons of the SNS extend to the adrenal gland, where they stimulate Chromaffin cells of the adrenal medulla that act as postganglionic cells of the SNS, releasing epinephrine 80% (and to some extent, norepinephrine 20%) directly into the blood stream.
- The circulating epinephrine and norepinephrine have almost the same effects on the different organs as the effects caused by direct sympathetic stimulation, except that the effects last 5 to 10 times as long because both of these hormones are removed from the blood slowly.

- The circulating norepinephrine causes constriction of essentially all the blood vessels of the body; it also causes increased activity of the heart, inhibition of the gastrointestinal tract, dilation of the pupils of the eyes, and so forth.
- Epinephrine causes almost the same effects as those caused by norepinephrine, but the effects differ in the following respects:
 - ✓ First, epinephrine, because of its greater effect in stimulating the beta receptors, has a greater effect on cardiac stimulation than does norepinephrine.
 - ✓ Second, epinephrine causes only weak constriction of the blood vessels in the muscles, in comparison with much stronger constriction caused by norepinephrine. Because the muscle vessels represent a major segment of the vessels of the body, this difference is of special importance because norepinephrine greatly increases the peripheral resistance and elevates arterial pressure, whereas epinephrine raises the arterial pressure to a lesser extent but increases the cardiac output more.
 - ✓ A third difference between the actions of epinephrine and norepinephrine relates to their effects on tissue metabolism. Epinephrine has 5 to 10 times as great a metabolic effect as norepinephrine.

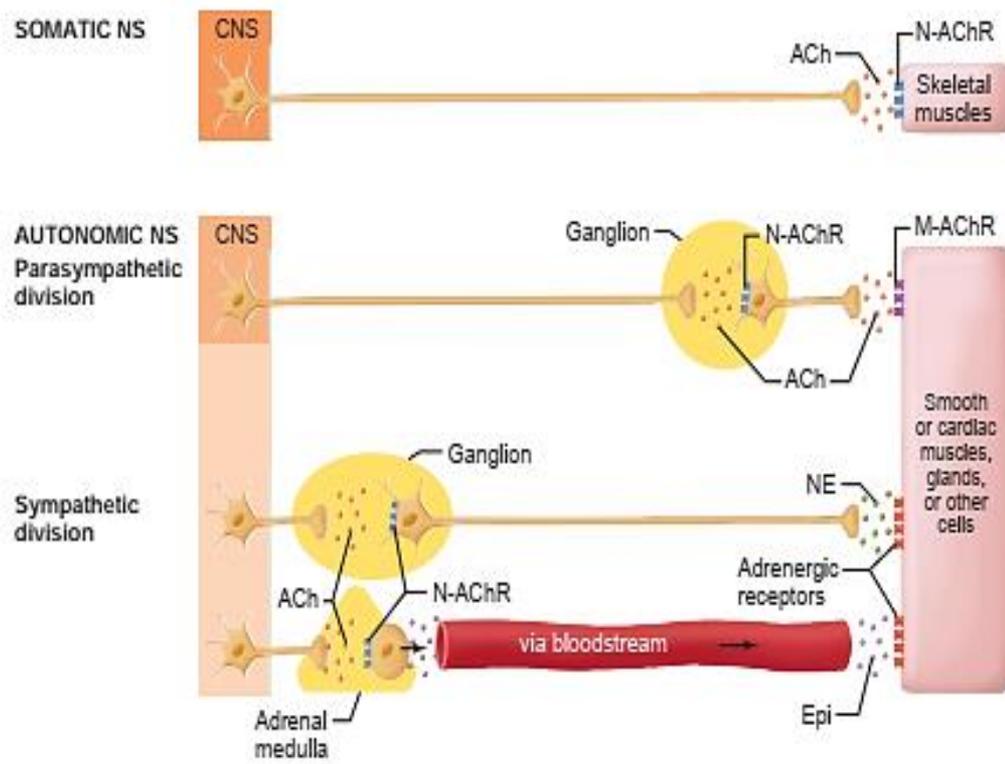


Figure 6.46 Transmitters used in the various components of the peripheral efferent nervous system. Notice that the first neuron exiting the CNS—whether in the somatic or the autonomic nervous system—releases acetylcholine. In a very few cases, postganglionic sympathetic neurons may release a transmitter other than norepinephrine. (ACh, acetylcholine; NE, norepinephrine; Epi, epinephrine; N-AChR, nicotinic acetylcholine receptor; M-AChR, muscarinic acetylcholine receptor)

PHYSIOLOGICAL INQUIRY

- How would the effects differ between a drug that blocks muscarinic acetylcholine receptors and one that blocks nicotinic acetylcholine receptors?

Answer can be found at end of chapter.

AUTONOMIC RECEPTORS

- ✓ Many of the drugs that stimulate or inhibit various components of the autonomic nervous system affect receptors for acetylcholine and norepinephrine.
- ✓ There are several types of receptors for each neurotransmitter.
- ✓ Acetylcholine receptors in the autonomic ganglia are nicotinic receptors. In contrast, the acetylcholine receptors on cellular targets of postganglionic autonomic neurons are muscarinic receptors.
- ✓ The cholinergic receptors on skeletal muscle fibers, innervated by the somatic motor neurons, not autonomic neurons, are nicotinic receptors.
- ✓ The overall effect of catecholamines released by adrenal medulla is slightly different due to the fact that some adrenergic receptor subtypes have a higher affinity for epinephrine, whereas others have a higher affinity for norepinephrine.

Locations of Receptors for Acetylcholine, Norepinephrine, and Epinephrine

I. Receptors for acetylcholine		II. Receptors for norepinephrine and epinephrine
A. Nicotinic receptors	B. Muscarinic receptors	A. On smooth muscle
1. On postganglionic neurons in the autonomic ganglia	1. On smooth muscle	B. On cardiac muscle
2. At neuromuscular junctions of skeletal muscle	2. On cardiac muscle	C. On gland cells
3. On some CNS neurons	3. On gland cells	D. On other tissue cells (e.g., adipose, renal tubules)
	4. On some CNS neurons	E. On some CNS neurons

ENTERIC NERVOUS SYSTEM

- The enteric nervous system or third division of the ANS is located within the wall of the digestive tract from the esophagus to the anus.
- It is composed of two well-organized neural plexuses. The myenteric plexus is located between longitudinal and circular layers of muscle and is involved in control of digestive tract motility. The submucosal plexus is located between the circular muscle and the luminal mucosa; it senses the environment of the lumen and regulates gastrointestinal blood flow and epithelial cell function.
- The enteric nervous system contains all the elements of a nervous system (sensory neurons, interneurons, and motor neurons) leading to it being referred to as a “mini-brain.”
- Sensory neurons innervate receptors in the mucosa that respond to mechanical, thermal, osmotic, and chemical stimuli. Motor neurons control motility, secretion, and absorption by acting on smooth muscle and secretory cells. Interneurons integrate information from sensory neurons and feedback to the enteric motor neurons.
- Parasympathetic and sympathetic nerves connect the CNS to the enteric nervous system or directly to the digestive tract.
- Although the enteric nervous system can function autonomously, normal digestive function often requires communication between the CNS and the enteric nervous system.

Thank
you

The image features the words "Thank you" written in a highly decorative, cursive script. The letters are a dark teal color with a white outline and a soft grey drop shadow, giving them a three-dimensional appearance. The text is centered and surrounded by a variety of colorful floral and leaf motifs. These include small pink and red flowers, orange and yellow leaves, and teal sprigs with small buds. The overall composition is balanced and visually appealing, set against a plain white background.