

Autonomic Nervous System

Autonomic nervous system (ANS): system of neurons that innervates smooth and cardiac muscle and glands; involuntary division of the PNS.

I. Overview.

A. Comparison of ANS and somatic nervous system (SNS)

- general theme:

- both systems have motor fibers; however they differ in their effectors, efferent pathways, responses of the target organs to their neurotransmitters.

1. Effectors: SNS stimulates skeletal muscle; ANS stimulates cardiac and smooth muscle, and some glands.

2. Efferent pathways:

- SNS cell bodies of motor neurons are in the CNS, their axons extend in spinal nerves to skeletal muscles they serve
- in the ANS the motor unit is a two motor neuron chain; cell body of the first motor neuron, preganglionic neuron, in the CNS (brain or spinal cord); cell body of postganglionic neuron in ganglion outside CNS, postganglionic axon extends to the effector organ.
- preganglionic neuron is myelinated; postganglionic unmyelinated; pre- and postganglionic axons part of spinal or cranial nerves.
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3. Effects on target organs: all somatic motor neurons release ACh at the neuromuscular junction; all preganglionic autonomic motor neurons release ACh at axon terminals; postganglionic motor neurons release norepinephrine or ACh at synapse with effector organs.

B. Divisions of the ANS.

- sympathetic and parasympathetic.

- serve same visceral organs, cause essentially opposite effects - dual innervation.

- in comparing parasympathetic and sympathetic divisions pay attention to origin of preganglionic fibers, different lengths of pre- and postganglionic fibers, location of respective ganglia.

1. Parasympathetic division: "resting and digesting"; keeps energy use low while maintaining vital functions; preganglionic fibers originate in the brain and sacral spinal cord; long preganglionic fibers, short postganglionic fibers (ganglia are close to or on the effector organs innervated).

2. Sympathetic division: "fight or flight" takes over during stressful or emotional situations; preganglionic fibers originate in the thoracolumbar region of SC; short preganglionic fibers, and long post ganglionic fibers; ganglia are close to the spinal cord.

II. Parasympathetic division

- preganglionic axons extend from CNS nearly all the way to structure being innervated; they synapse with the postganglionic neurons very close to or within the target organ.

A. Cranial outflow.

- some cranial nerves have parasympathetic fibers.
- preganglionic fibers run in the oculomotor, facial, glossopharyngeal, and vagus nerves.
- cell bodies in motor nuclei in the brain stem.

B. Sacral outflow

- arises from neurons located in the lateral gray matter of sacral spinal cord segments.
- axons of those preganglionic neurons run in ventral roots of spinal cord to ventral rami, then branch to form pelvic splanchnic nerves.
- postganglionic fibers are found in the intramural ganglia of innervated organs (large intestines, bladder).

III. Sympathetic division.

- besides internal organs, innervates certain visceral structures in the skin (sweat glands, pili muscles).

A General

- all preganglionic fibers arise from cell bodies located in lateral horns of spinal cord segments.
- leave spinal cord via a ventral root, enters a paravertebral ganglion of sympathetic chain, three things can happen:

1. Synapses with a postganglionic neuron at that paravertebral ganglion.

2. Ascends or descends sympathetic chain to synapse with postganglionic neuron in another paravertebral ganglion.

3. Can pass through paravertebral ganglion without synapsing; synapses with postganglionic neurons in prevertebral ganglion associated with the aorta; postganglionic fibers travel to target organs.

IV. ANS physiology.

A. Neurotransmitters and their receptors.

- ACh and norepinephrine (NE) are major neurotransmitters released by ANS neurons.
- all preganglionic axons of the ANS release ACh -- effect on postganglionic neuron always excitatory
- parasympathetic system postganglionic axons release ACh.
- sympathetic postganglionic axons release norepinephrine (NE).
- remember that ACh and NE effects on effectors are not consistent with either excitation or inhibition; response depends on NT receptors present in the effectors.

B. NT receptors.

a. Cholinergic receptors --bind ACh.

- nicotinic: all postganglionic neuron receptive regions; hormone producing cells of adrenal medulla; also in MEP of skeletal muscle.
- muscarinic receptors: effector cells of postganglionic parasympathetic fibers.

b. Adrenergic receptors -- bind NE.

- two major classes are alpha (usually stimulatory), and beta (usually inhibitory); found in effector cells of postganglionic sympathetic fibers.

C. Effects of parasympathetic and sympathetic divisions on various organs -- see Table 14.4

- recall that visceral organs innervated by both the parasympathetic and sympathetic divisions of the ANS, dual innervation, usually antagonistic; however some structures exclusively innervated by one division or the other.

D. Localized versus diffuse effects of sympathetic and parasympathetic divisions.

- pattern of parasympathetic division innervation is very specific -- ganglia located in the walls of effector organs.
- pattern of sympathetic innervation is more diffuse, fibers going to many different effectors originate in the same ganglia, therefore, sympathetic effects are more diffuse and the parasympathetic effects are more specific.
- ACh: NT of all postganglionic parasympathetic neurons quickly destroyed, parasympathetic effects are short lived.
- NE: NT of most postganglionic sympathetic neurons, inactivated slowly; acts via second messengers; effects are more diffuse and long-lasting.