

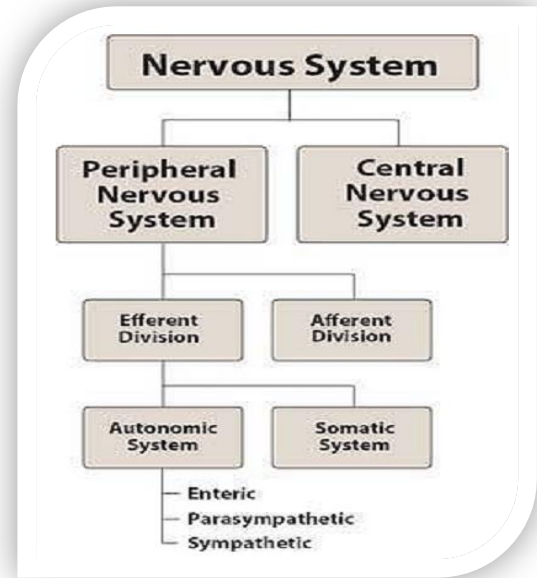
The Autonomic Nervous System

The nervous system is divided into "central" and "peripheral" nervous system.

The peripheral nervous system is divided physiologically into afferent (sensory) and efferent (motor-effector) nervous system.

The motor nervous system can be further divided into "somatic" nervous system & "autonomic" nervous system.

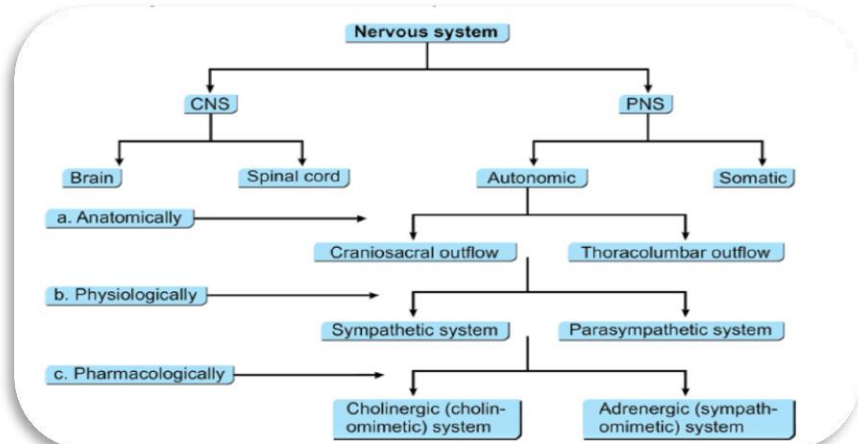
The autonomic nervous system consists of three main anatomical divisions: sympathetic, parasympathetic and enteric nervous systems. Enteric nervous system (known as the brain of the gut).



Division	Origin of Fibers	Length of Fibers	Location of Ganglia
Sympathetic	Thoracolumbar region of the spinal cord	Short preganglionic and long postganglionic	Close to the spinal cord
Parasympathetic	Brain and sacral spinal cord	Long preganglionic and short postganglionic	In the visceral effector organs

- Autonomic**
- Smooth and cardiac muscle and glands
 - Unconscious regulation
 - Target tissues stimulated or inhibited
 - Two synapses
 - Acetylcholine by preganglionic neurons and ACh or norepinephrine by postganglionic neurons
 - Receptor molecules: varies with synapse and neurotransmitter

- Somatic**
- Skeletal muscle
 - Conscious and unconscious movement
 - Skeletal muscle contracts
 - One synapse
 - Acetylcholine
 - Receptor molecules: nicotinic



Neurotransmitters

- Acetylcholine (ACh) and norepinephrine (NE) are the two major neurotransmitters of the ANS
- ACh is released by all preganglionic axons and all parasympathetic postganglionic axons
- Cholinergic fibers – ACh-releasing fibers
- Adrenergic fibers – sympathetic postganglionic axons that release NE (except for sweat glands)
- Neurotransmitter effects can be excitatory or inhibitory depending upon the receptor type.

How do drugs influence the ANS?

- ✓ Mimic or block the effects of the two primary neurotransmitters, Acetylcholine and Norepinephrine/Epinephrine
- ✓ Drugs that mimic neurotransmitters are referred to as “receptor agonists”
 - These drugs activate receptors
- ✓ Drugs that block neurotransmitters are referred to as “receptor antagonists”
 - These drugs block the endogenous neurotransmitters from activating receptors

Classification of drugs affecting the ANS

➤ Parasympathetic nervous system

Mimic acetylcholine

Cholinergic = muscarinic agonists = parasympathomimetic

Block acetylcholine

Anticholinergic = muscarinic antagonist = parasympatholytic

➤ Sympathetic nervous system

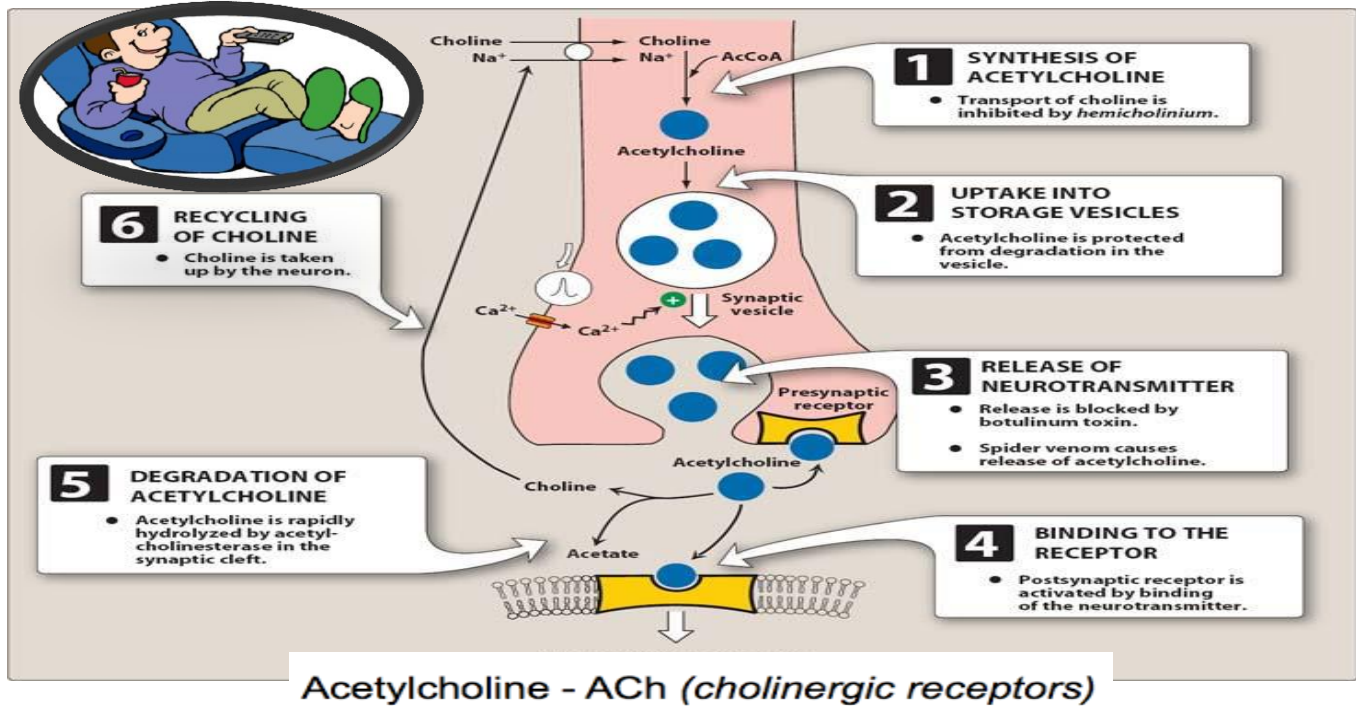
Mimic norepinephrine

Adrenergic = adrenergic agonist = sympathomimetic

Block norepinephrine

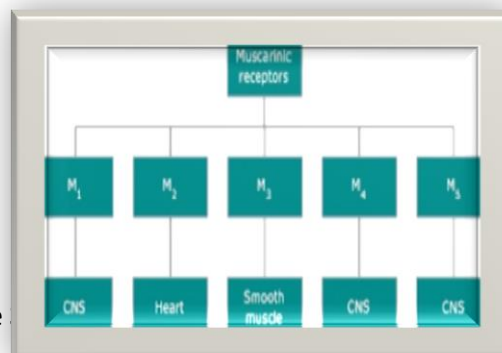
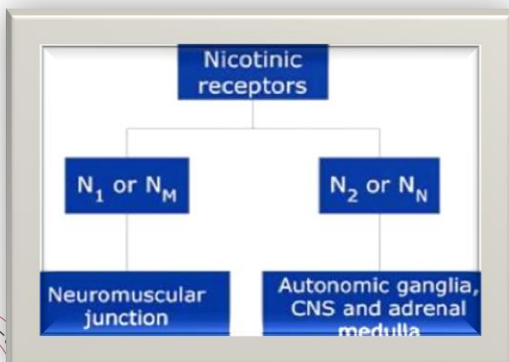
Antiadrenergic = adrenergic antagonist = sympatholytic

Cholinergic System



ACh

Nicotinic (N) Muscarinic (M)



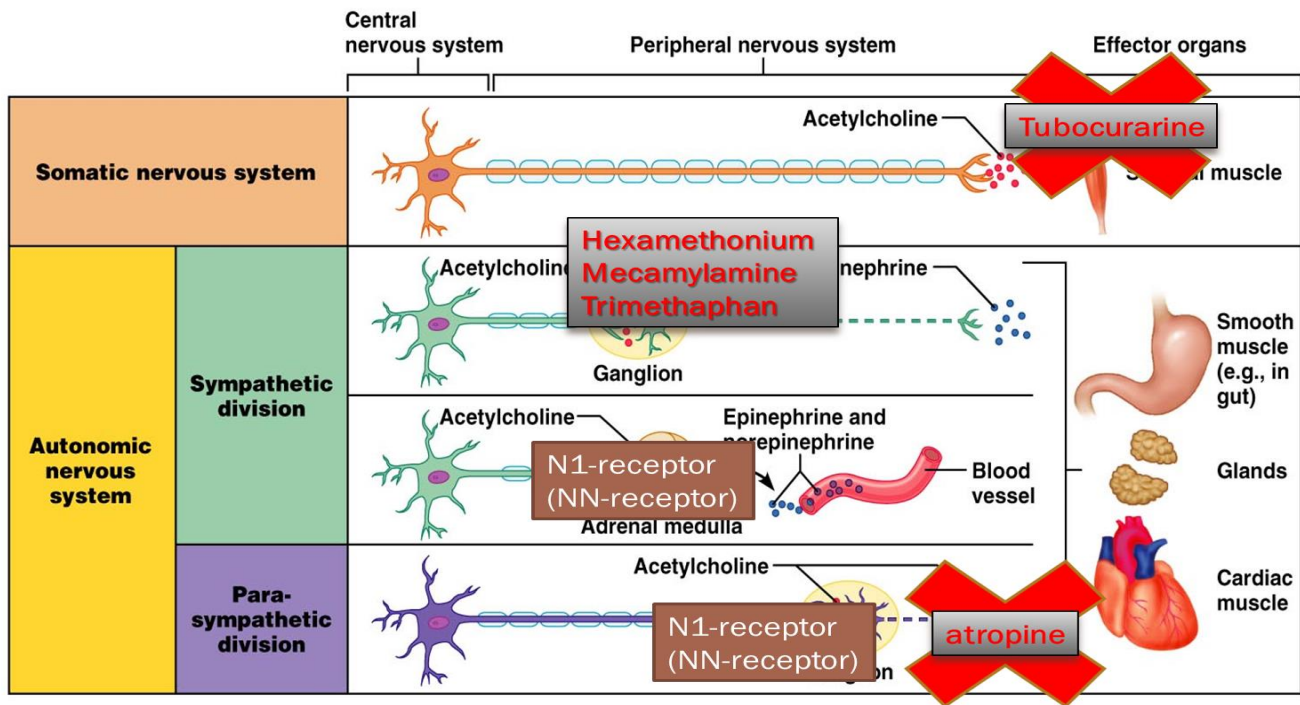
Nicotinic Receptors

- ❖ Nicotinic receptors are found on:
 - Motor end plates (somatic targets)
 - All ganglionic neurons of both sympathetic and parasympathetic divisions
 - The hormone-producing cells of the adrenal medulla
- ❖ The effect of ACh binding to nicotinic receptors is *always stimulatory*

Muscarinic Receptors

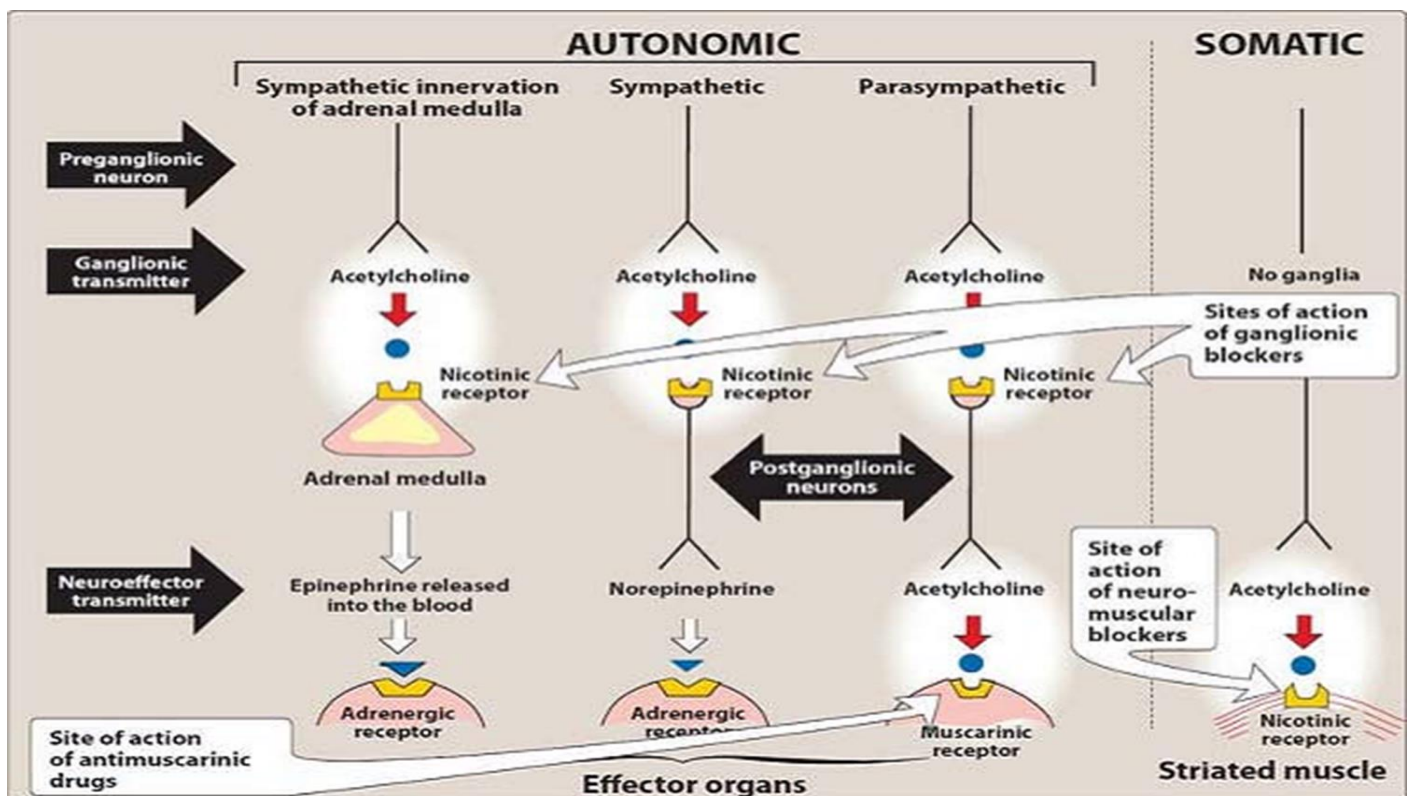
- ❖ Muscarinic receptors occur on all effector cells stimulated by postganglionic cholinergic fibers
- ❖ The effect of ACh binding:
 - Can be either inhibitory or excitatory
 - Depends on the receptor type of the target organ

Muscarinic was introduced because of the mushroom poison muscarine

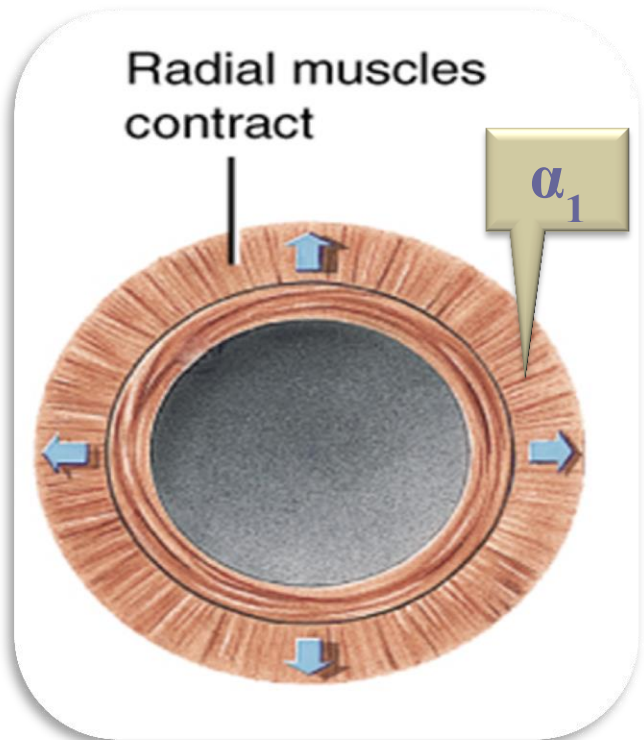
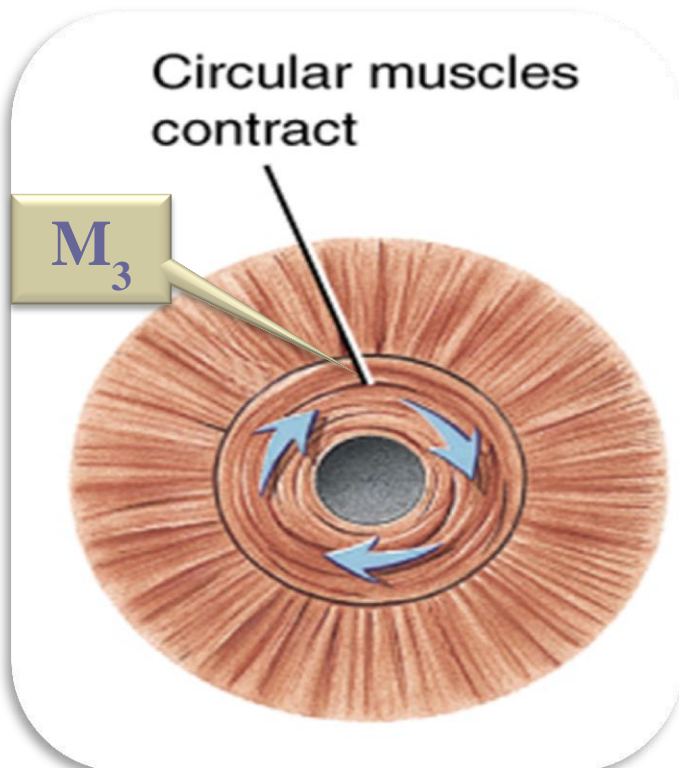
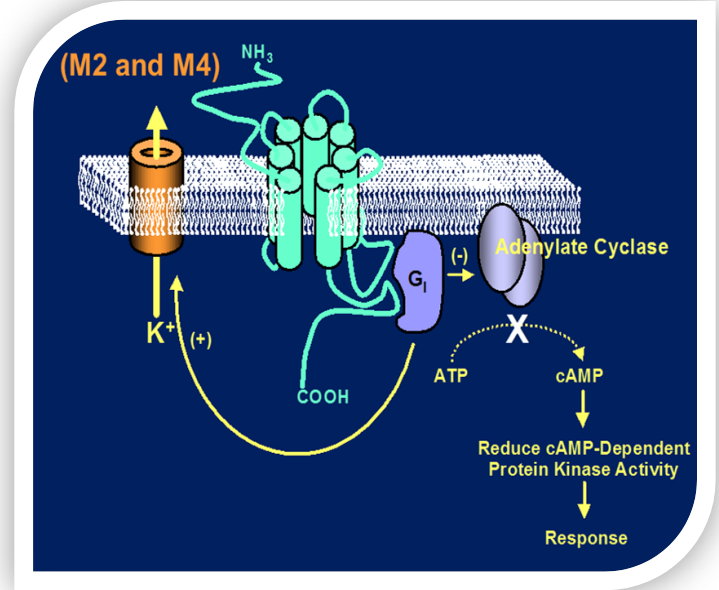
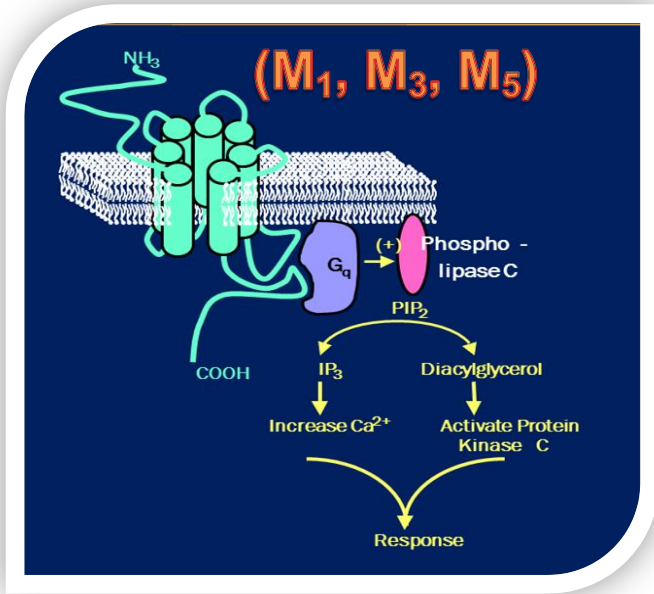


Key:

— = Preganglionic axons (sympathetic) - - - = Postganglionic axons (sympathetic) ⊖ = Myelination
 — = Preganglionic axons (parasympathetic) - - - = Postganglionic axons (parasympathetic)



Receptors and signal transduction in the ANS:
Muscarinic receptors



Target		Receptor	Response
Eye	Sphincter	M ₃	Contraction—miosis
	Ciliary muscle	M ₃	Contraction—accommodation for near vision
Heart	SA node	M ₂	↓ Heart rate (HR)—negative chronotropy
	AV node	M ₂	↓ Conduction velocity—negative dromotropy No effects on ventricles, Purkinje system
Lungs	Bronchioles	M ₃	Contraction—bronchospasm
	Glands	M ₃	Secretion
GI tract	Stomach	M ₃	↑ Motility—cramps
	Glands	M ₁	Secretion
	Intestine	M ₃	Contraction—diarrhea, involuntary defecation
Bladder		M ₃	Contraction (detrusor), relaxation (trigone/sphincter), voiding, urinary incontinence
Sphincters		M ₃	Relaxation, except lower esophageal, which contracts
Glands		M ₃	Secretion—sweat (thermoregulatory), salivation, and lacrimation
Blood vessels (endothelium)		M ₃	Dilation (via NO/endothelium-derived relaxing factor)—no innervation, no effects of indirect agonists