

Central Nervous System
Dr Abdelrahim Alqudah

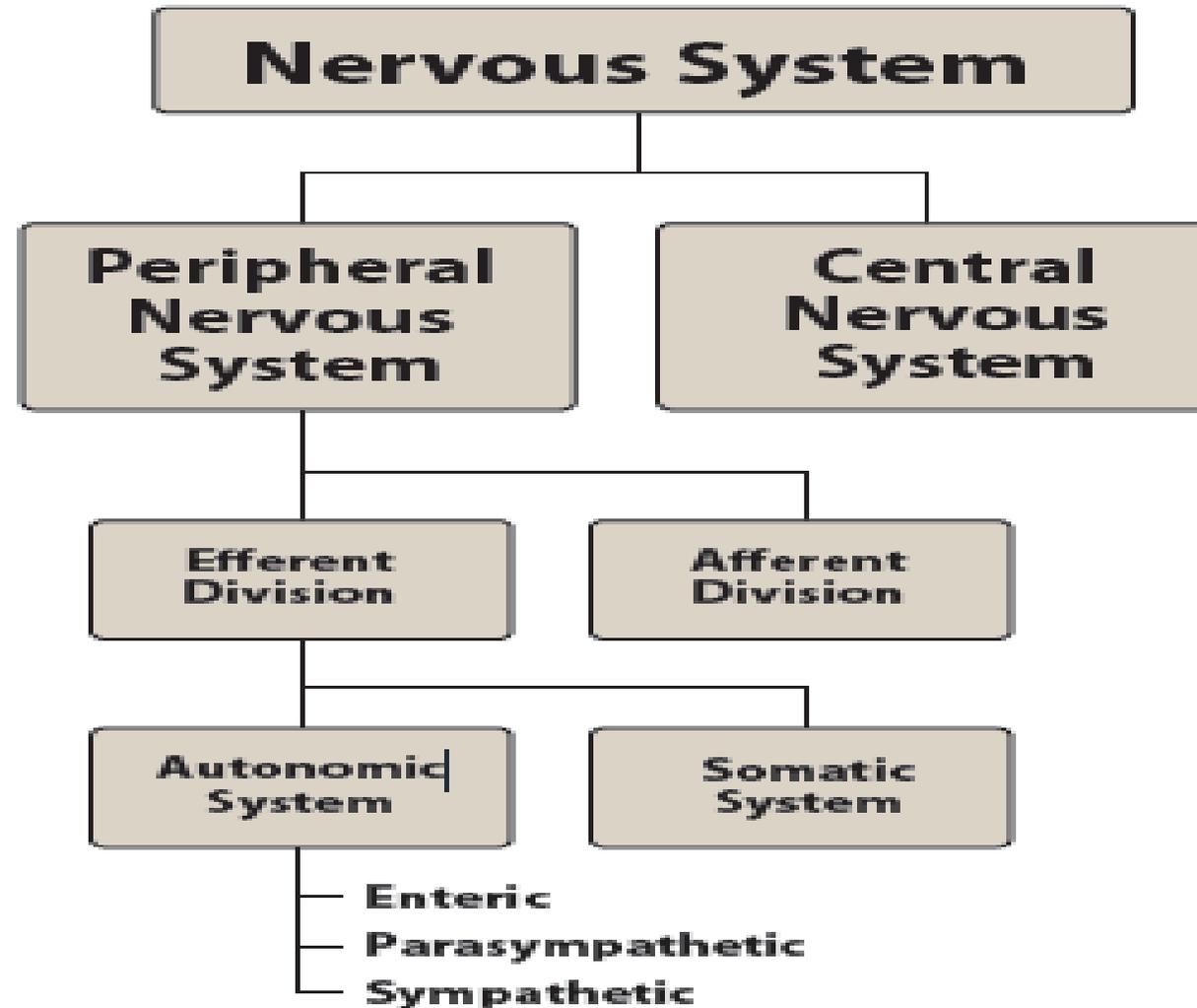


Figure 3.1
Organization of the nervous system.

General Functions of the Autonomic Nervous System.

- ❖ Autonomic nervous system regulates the activities of structures that are not under voluntary control and that function below the level of consciousness.
- ❖ Thus, respiration, circulation, digestion, body temperature, metabolism, sweating, and the secretions of certain endocrine glands are regulated, in part or entirely, by the autonomic nervous system.
- ❖ Thus, the autonomic nervous system is the primary regulator of the constancy of the internal environment of the organism

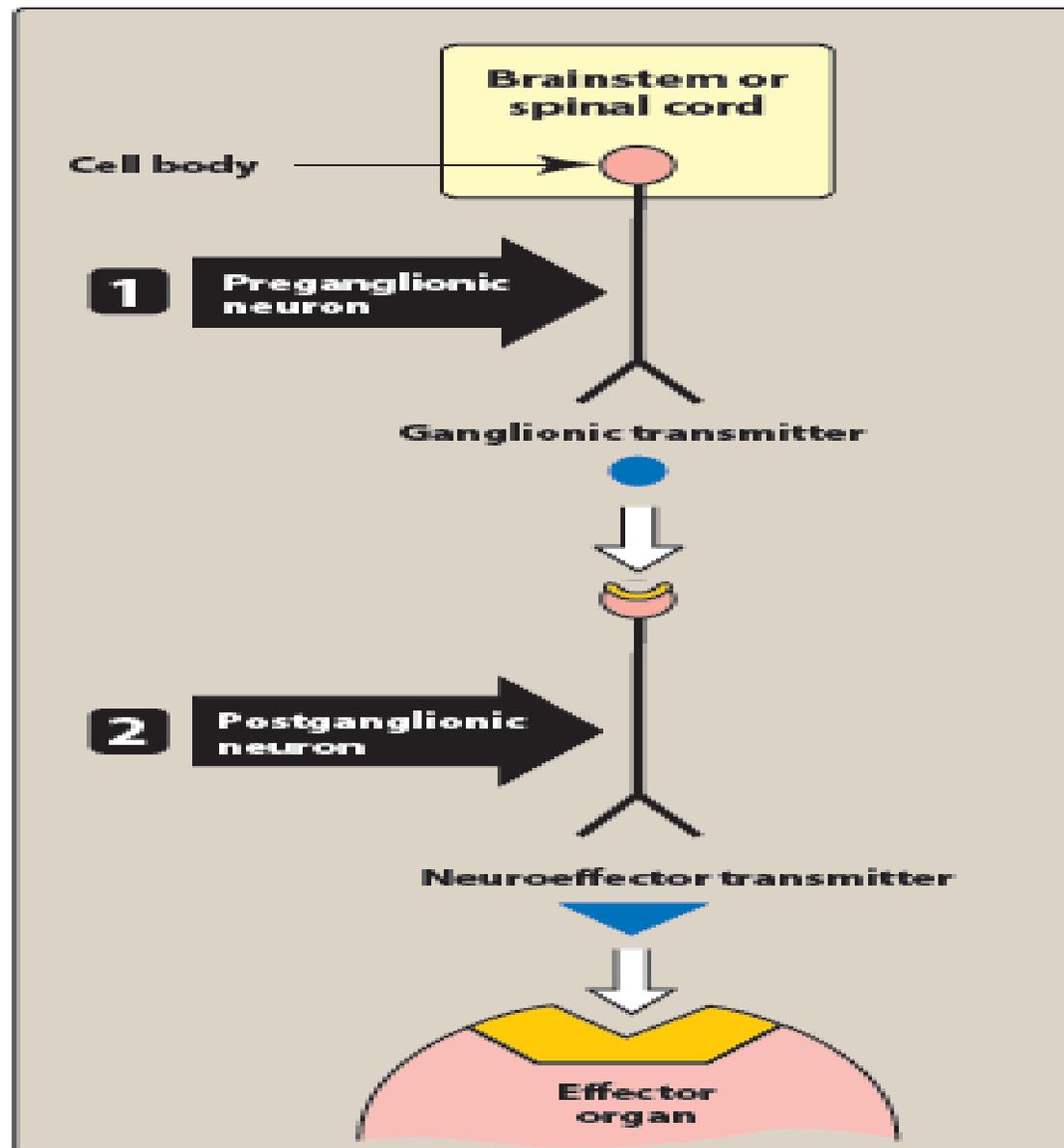


Figure 3.2
Efferent neurons of the
autonomic nervous system.

- ❖ The sympathetic system is associated with adrenal medulla
- ❖ Sympatho-adrenal functions becomes evident under circumstances of stress.

Examples :

- ✓ Body temperature
- ✓ concentration of glucose in blood
- ✓ vascular responses
- ✓ instinctive reactions to the external environment

- The sympathetic system normally is continuously active; the degree of activity varies from moment to moment and from organ to organ.
- Examples on SNS actions include :
 - Increase Heart Rate
 - Increase Blood pressure
 - Increase Breathing Rate
 - Blood flow is shifted from the skin to the skeletal muscles;
blood

-bronchioles and pupils dilate

-organism is better prepared for "fight or flight."

➤ Many of these effects result primarily from or are reinforced by the actions of epinephrine secreted by the adrenal medulla

The parasympathetic system

- concerned primarily with conservation of energy and maintenance of organ function during periods of minimal activity.
- The parasympathetic system slows the heart rate, lowers the blood pressure, stimulates gastrointestinal movements and secretions, aids absorption of nutrients, protects the retina from excessive light, and empties the urinary bladder and rectum.
- Many parasympathetic responses are rapid .

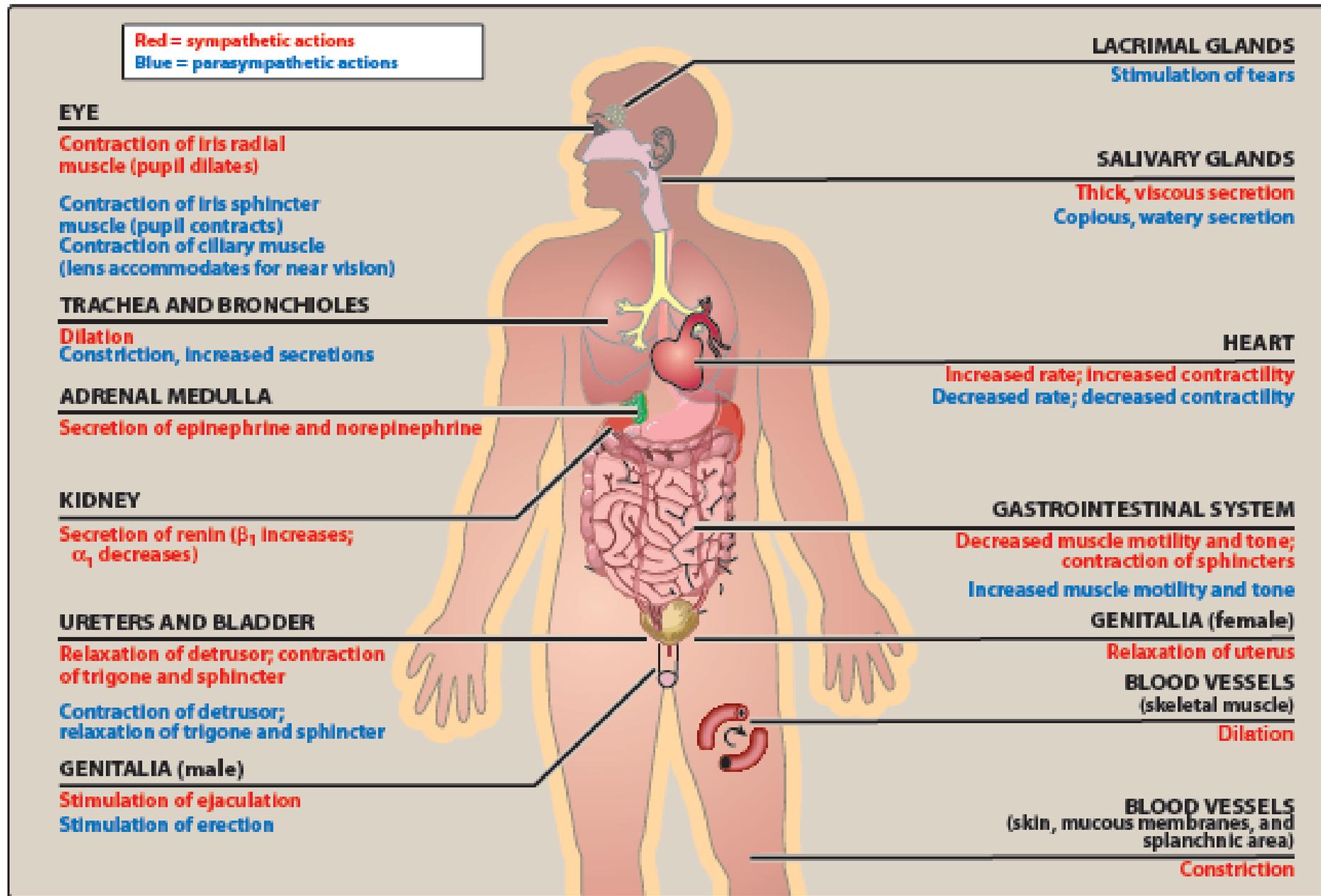
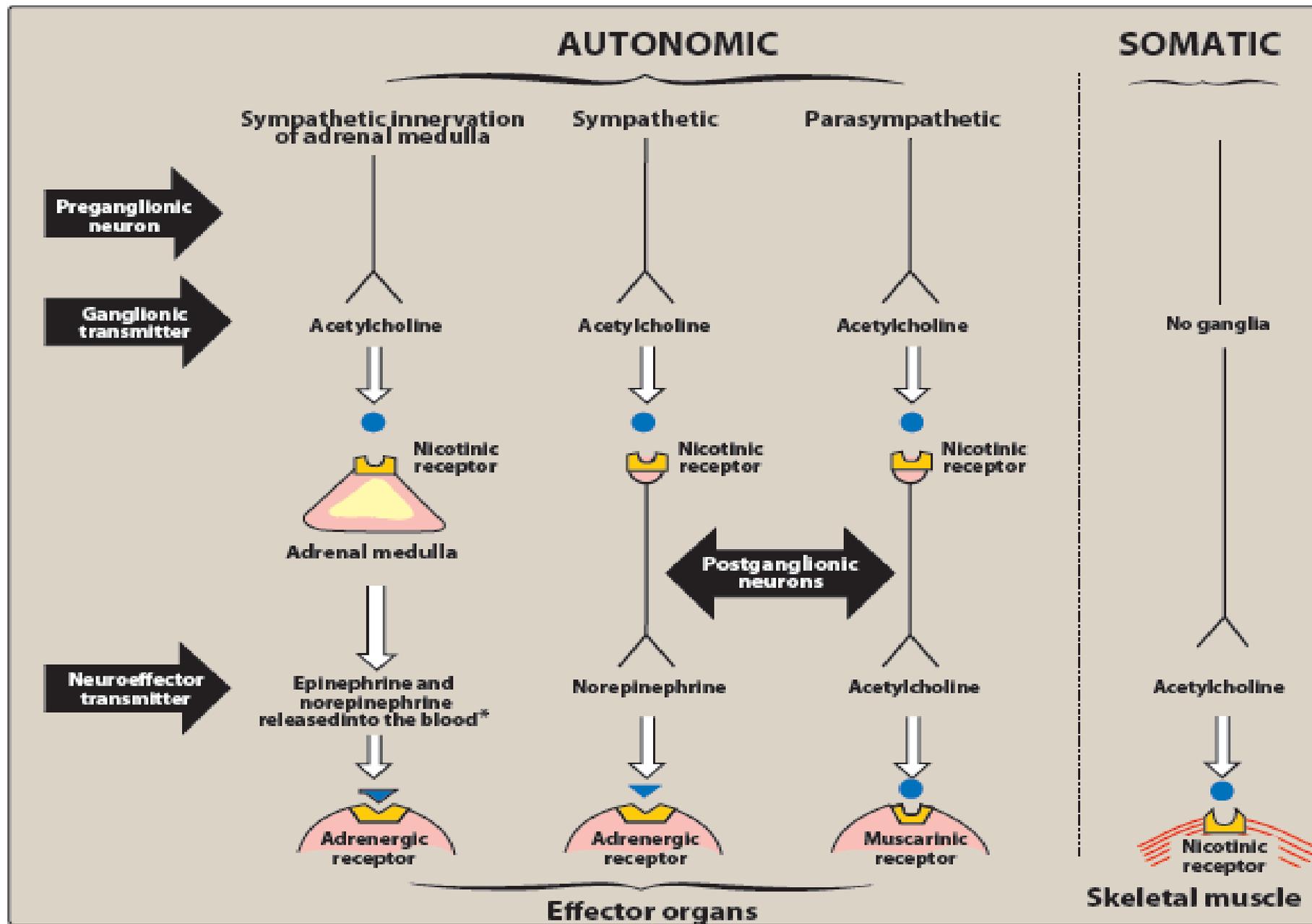


Figure 3.3

Actions of sympathetic and parasympathetic nervous systems on effector organs.

Neurotransmitters

- **Neurotransmitters** are endogenous chemicals which transmit signals from a neuron to a target cell across a synapse.
- Neurotransmitters are packaged into synaptic vesicles, and are released into the synaptic clefts, where they bind to receptors in the membrane on the postsynaptic side of the synapse.
- Neurotransmitters are synthesized from plentiful and simple precursors, such as amino acids



Neurotransmitters

- Excitatory : Glutamate
- Inhibitory : GABA

Examples :

- [Glutamate](#) is used at the great majority of fast excitatory synapses in the brain and spinal cord..
- [GABA](#) is used at the great majority of fast inhibitory synapses in virtually every part of the brain. Many sedative/tranquilizing drugs act by enhancing the effects of GABA.
- [Glycine](#) is the inhibitory transmitter in the spinal cord.

- [Acetylcholine](#) is distinguished as the transmitter at the neuromuscular junction NMJ connecting motor nerves to muscles. Acetylcholine also operates in many regions of the brain, but using different types of receptors.
- [Dopamine](#) has a number of important functions in the brain, dysfunction of the dopamine system is also implicated in Parkinson Disease PD and Schizophrenia.

- Serotonin

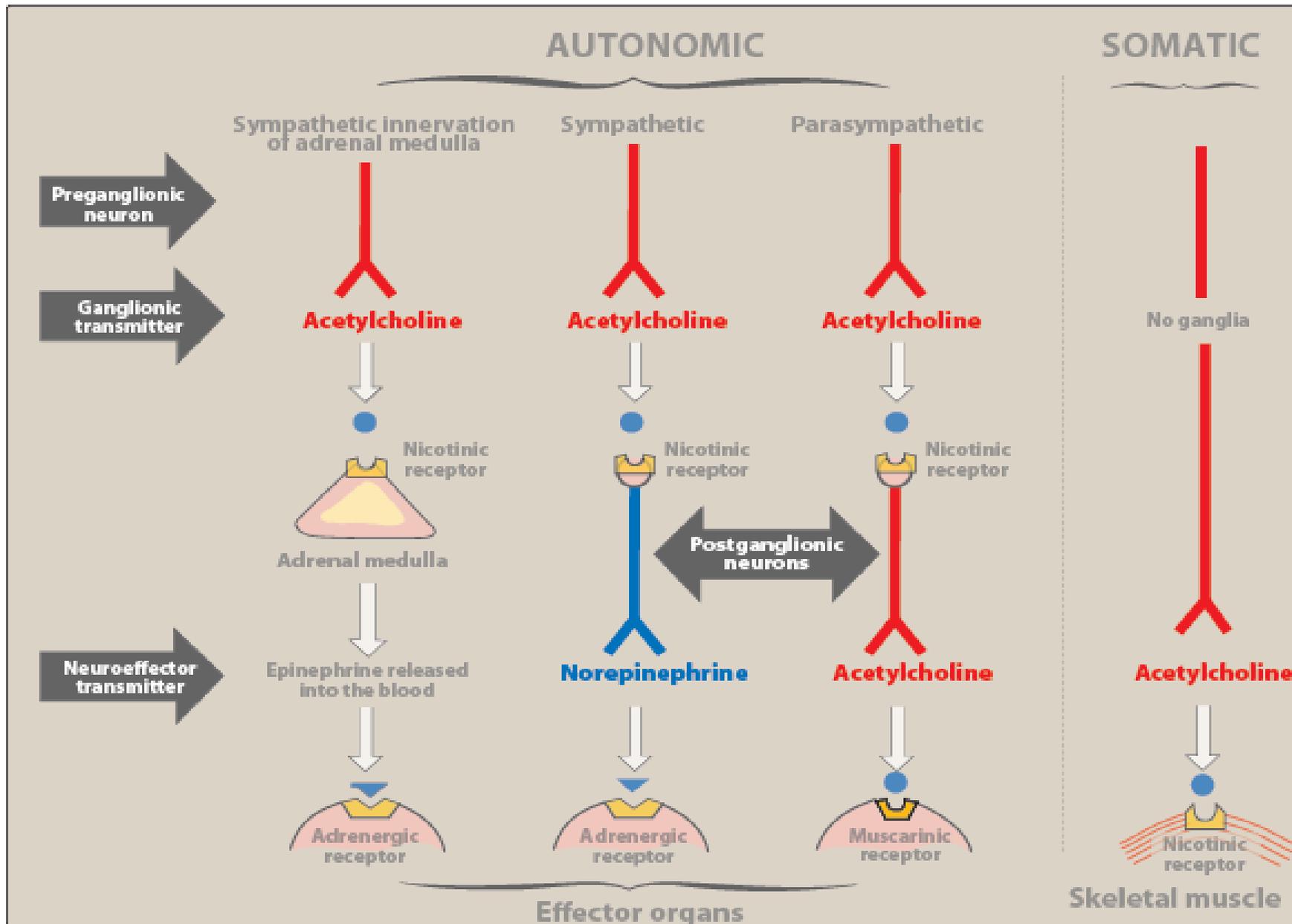
Most is produced by and found in the intestine (approximately 90%), and the remainder in CNS.

It functions to regulate **appetite**, sleep, memory and learning, temperature, **mood**, behaviour, muscle contraction, and function of the Cardiovascular System.

It is speculated to have a role in depression, as some depressed patients are seen to have lower concentrations of metabolites of serotonin in their cerebrospinal fluid and brain tissue.

Substance P is responsible for transmission of pain from certain sensory neurons to the central nervous system.

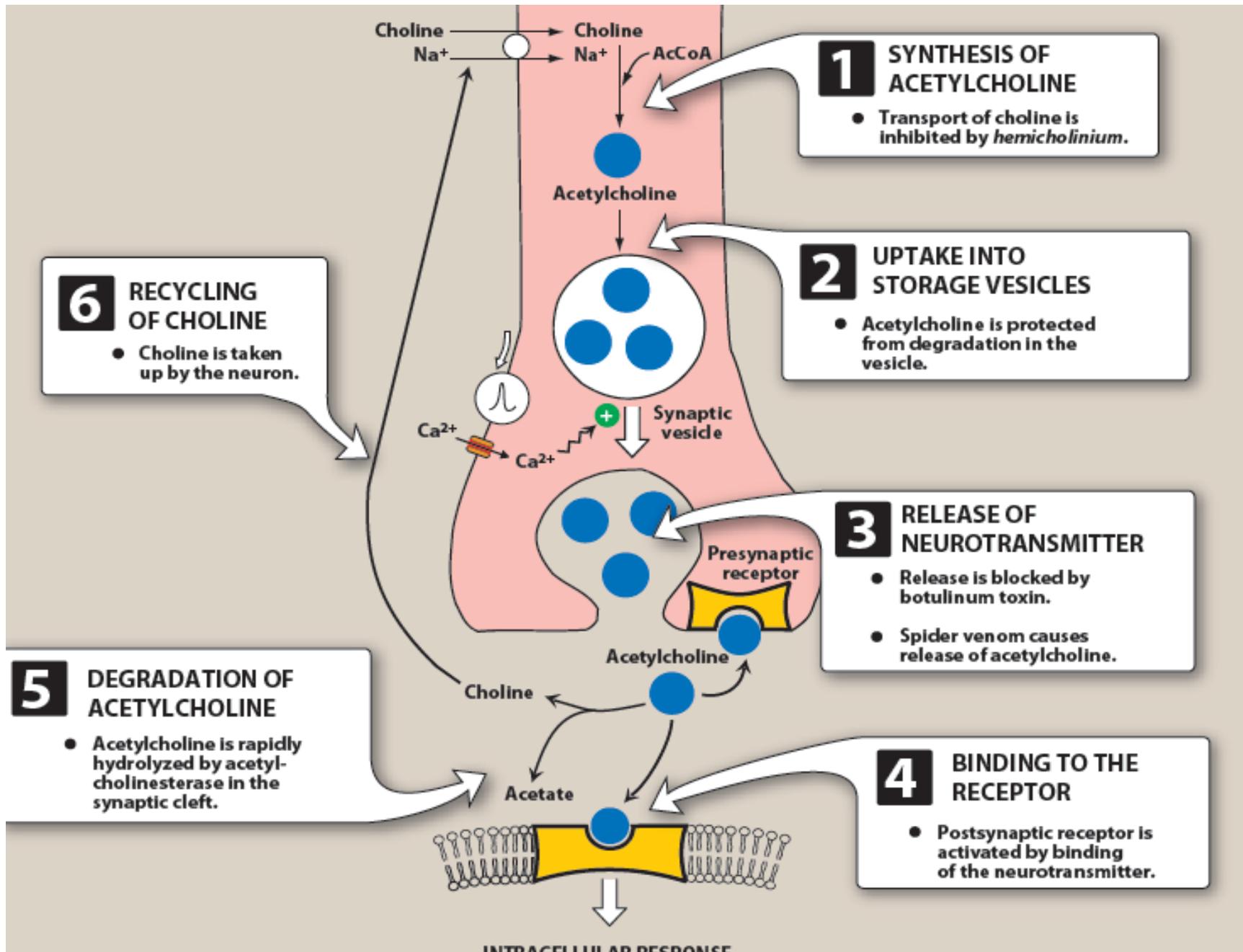
Norepinephrine: the major neurotransmitter for sympathetic activity(adrenergic transmission), which is mainly secreted by adrenal medulla



Cholinergic Transmission

Neurotransmission at cholinergic neurons

- 1) Synthesis
- 2) Storage,
- 3) Release
- 4) Binding of ACh to a receptor,
- 5) Degradation of the neurotransmitter in the synaptic cleft
- 6) Recycling of choline and acetate



Cholinergic Transmission

- Acetylcholine synthesis is catalyzed by Choline **Acetyltransferase enzyme**.
- Axonal terminals contain a large number of mitochondria, where acetyl CoA is synthesized.
- After its synthesis from choline, ACh is taken up by the storage vesicles principally at the nerve terminals
- The release of ACh and other neurotransmitters occurs by exocytosis , in which the vesicles move to the prejunctional synapse

Acetylcholinesterase (AChE)

- For ACh to serve as a neurotransmitter in the motor system and at other neuronal synapses, it must be removed or inactivated within the time limits
- AChE digests Acholine.

CHOLINERGIC RECEPTORS (CHOLINOCEPTORS)

- **Muscarinic receptors**
- **Nicotinic receptors**

Muscarinic Receptors

- M1, M2, M3, M4, and M5
- Only M1 M2 and M3 are considered functional
- M1 receptors are found on gastric parietal cells(increase Ca^{+2})
- M2 receptors on cardiac cells and smooth muscle (cGMP and increase K)
- M3 receptors on the bladder, exocrine glands, and smooth muscle.

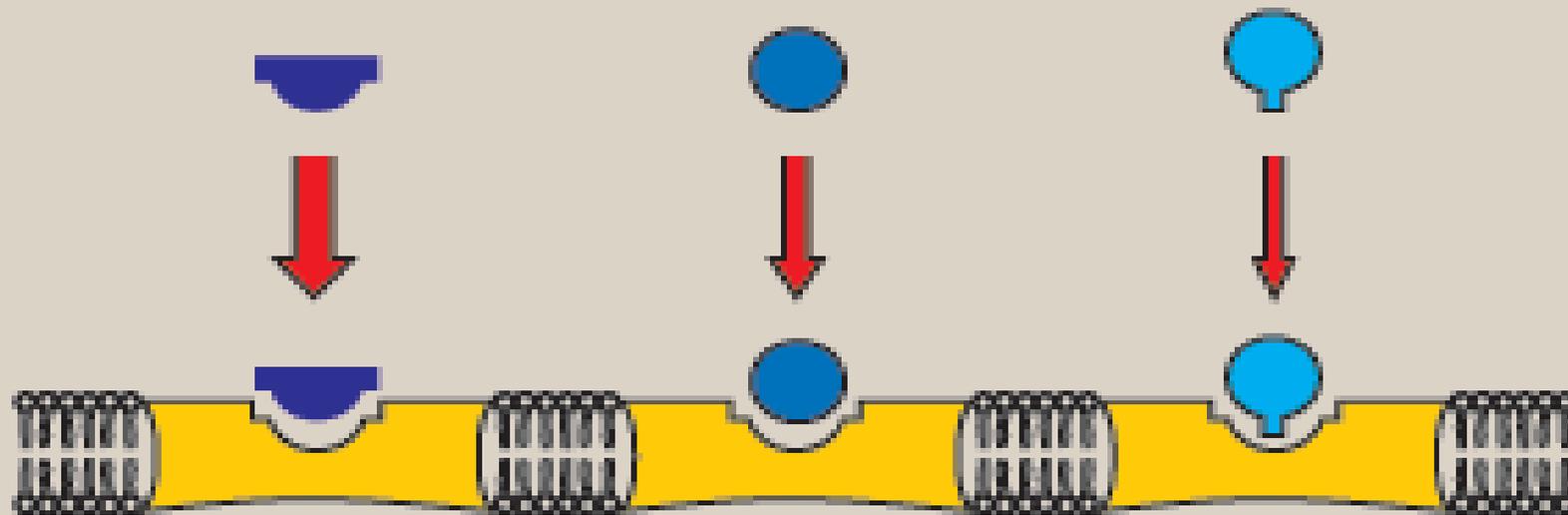
A

Muscarinic receptors

Muscarine

Acetylcholine

Nicotine



High
affinity

Low
affinity

Nicotinic Receptor

- The nicotinic receptor is composed of five subunits and it functions as a ligand-gated ion channel
- Binding of two ACh molecules elicits a conformational change that allows the entry of sodium ions, resulting in the depolarization of the effector cell

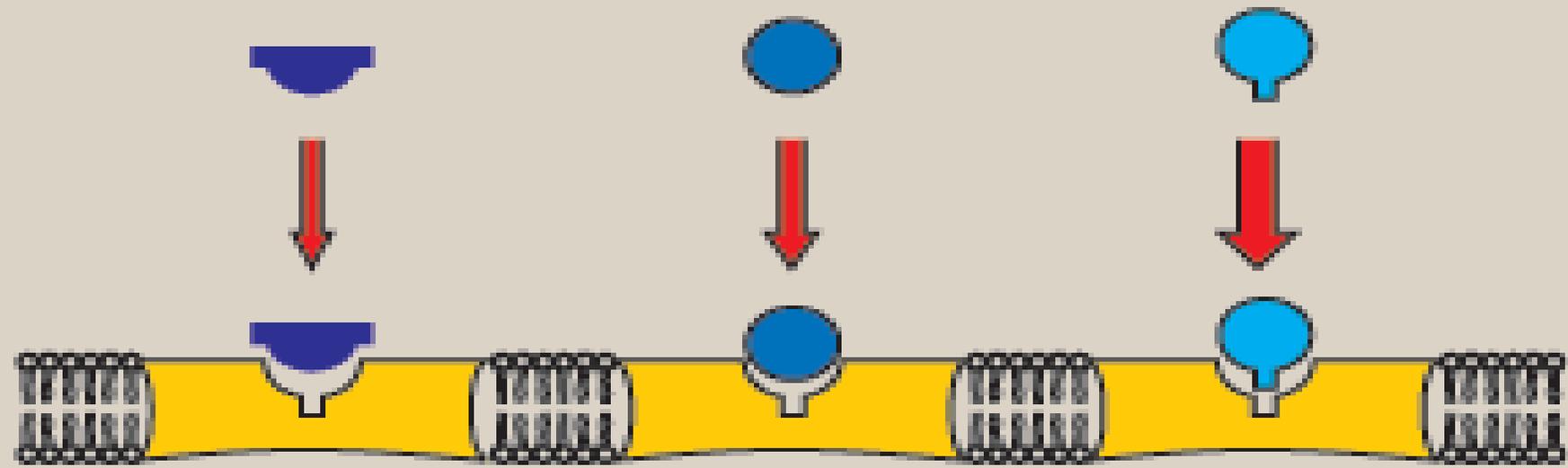
B

Nicotinic receptors

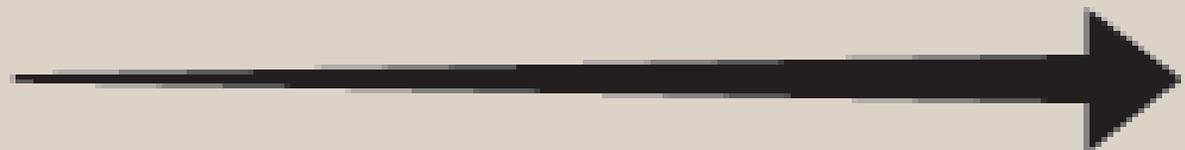
Muscarine

Acetylcholine

Nicotine



Low affinity



High affinity