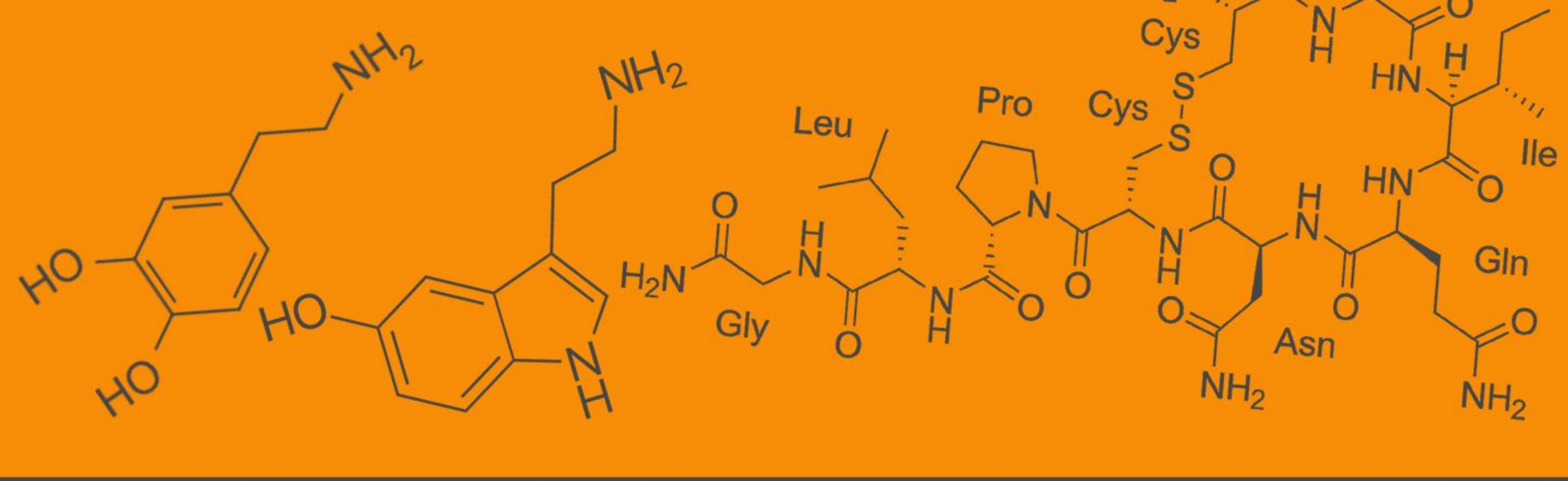


MEDICINE438's CNS PHYSIOLOGY

Lecture III: THE AUTONOMIC NERVOUS SYSTEM

EDITING FILE GSLIDES

IMPORTANT | MALE SLIDES | EXTRA | FEMALE SLIDES | LECTURER'S NOTES

1 THE AUTONOMIC NERVOUS SYSTEM

Lecture Three

OBJECTIVES

- **The anatomy of somatic and autonomic nervous system.**
- **Sympathetic and parasympathetic nerves.**
- **Pre and postganglionic neurons.**
- **Functions of sympathetic and parasympathetic nerves in head & neck, chest, abdomen and pelvis.**
- **Neurotransmitters release at pre and postganglionic sympathetic and parasympathetic nerves endings.**
- **Various responses due to stimulation of the sympathetic and the parasympathetic nervous system.**

BOX 3-1: GANONG'S & GUYTON AND HALL

- The human nervous system can generally be divided into a central nervous system and a peripheral nervous system, the peripheral nervous system can further be divided into a somatic nervous system and an autonomic nervous system. The autonomic nervous system is composed of motor neurons and is divided into sympathetic nervous system '*thoracolumbar*', and parasympathetic '*craniosacral*'.
- Myelin is protein-lipid complex that wraps itself around nerve fibers, it is an insulating substance produced by schwann cells around preganglionic fibers of the PNS cells. Myelin increases the speed of conduction of impulses, and conserves energy since only the spaces between the myelin sheaths, the nodes of Ranvier, need to be depolarized, thus conserving the energy of membrane potentials.
- The cell bodies of all preganglionic neurons exist in the CNS, and the fibers of those bodies, the axons, extends toward the PNS. Whereas the cell bodies of all postganglionic neurons exists in the PNS, these cell bodies act as ganglia.
- A ganglion is a collection of cell bodies outside of CNS composed of postganglionic cell bodies, it is essentially a site of communication, synapses, between the fibers of preganglionic neurons and the cell bodies of postganglionic neurons. Postganglionic neurons can then receive the information for any required function and extend their fibers towards an effector organ to perform its function.
- The ganglia of the sympathetic system lie in the sympathetic chain on each side of the spinal column mostly, whilst the ganglia of parasympathetic nervous system lie near effector organs. Therefore the preganglionic fibers of the parasympathetic nervous system are longer than that of the sympathetic system. The opposite is true for postganglionic fibers.
- The postganglionic neurons in the ganglia receive signals from preganglionic fibers when ACh is released from the presynaptic terminal of preganglionic fibers and binds to nicotinic receptors present on postsynaptic terminal of postganglionic fibers, ACh allows an influx of sodium inside the postganglionic neurons, thereby exciting it to transmit a signal.

Basic anatomical difference between the motor pathways of the voluntary somatic nervous system (to skeletal muscles) and those of the autonomic nervous system:

1. SOMATIC DIVISION OF PNS:

- **Cell bodies of motor neurons reside in CNS** (brain or spinal cord).
- Their axons (sheathed in spinal nerves) extend all the way to their skeletal muscles.
- Somatic signaling is faster than autonomic signaling because it is heavily myelinated.
- Controls organs under voluntary control (mainly skeletal muscles)

2. AUTONOMIC DIVISION OF PNS

- Chains of two motor neurons.
- 1st neuron: preganglionic neuron (in brain or spinal cord).
- 2nd neuron: ganglionic neuron **(cell body in ganglion outside the CNS).**
- Autonomic signaling is slower than somatic signaling because it is lightly or unmyelinated.
- Not under voluntary control.
- It regulates individual organ, visceral functions and homeostasis, known as the visceral or automatic system.
- Effectors includes **cardiac, smooth muscles** and **glands.**
- Helps to adapt the changes in environment. Adjusts or modifies functions in response to stress such as **blood pressure**, **body temperature**, **sweating** etc.

2 THE AUTONOMIC NERVOUS SYSTEM

Lecture Three

- The ANS is predominantly an **efferent** system transmitting impulses from the Central Nervous System (CNS) to peripheral organ systems.
- Autonomic nervous system is the subdivision of the peripheral nervous system that regulates body activities that are generally not under conscious control.

Subdivisions of the Autonomic nervous system:
A. Sympathetic B. Parasympathetic

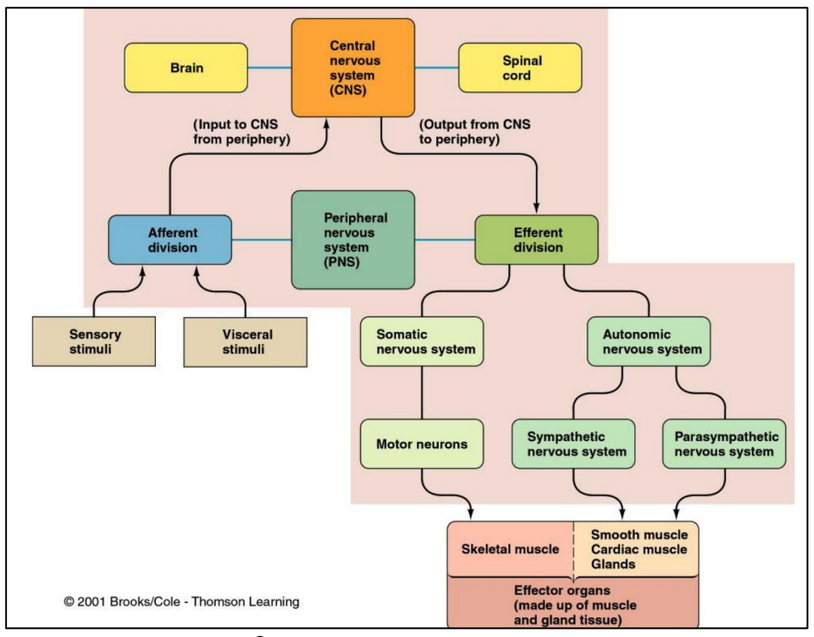


Figure 3-1

VISCERAL MOTOR INNERVATES NON-SKELETAL (NON-SOMATIC) MUSCLES:

1. Cardiac muscle
2. Smooth muscle (walls of viscera and blood vessels)
3. Internal organs
4. Skin

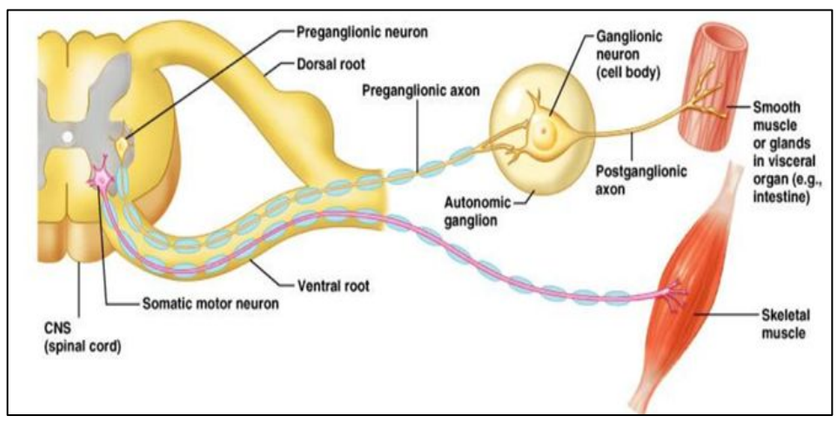


Figure 3-2

ACTIVATION AND OPERATION OF THE ANS

THE ANS IS ACTIVATED BY: Centers located in the spinal cord, brain stem, hypothalamus and also cerebral cortex especially the limbic cortex can transmit signals to the lower centers, influence autonomic control.

THE ANS OPERATES BY **visceral reflexes.** Subconscious sensory signals from a visceral organ enter the autonomic ganglia, brain stem or hypothalamus and then return subconscious reflex responses directly back to the visceral organ to control its activities.

CAUSES OF DEMYELINATION

- Inflammatory processes.
- Viral demyelination[1]
- Metabolic derangements.
- Hypoxic–ischemic demyelination.
- Focal compression.
- Multiple sclerosis[2]
- Acute encephalomyelitis

PRESENT ONLY IN MALE SLIDES

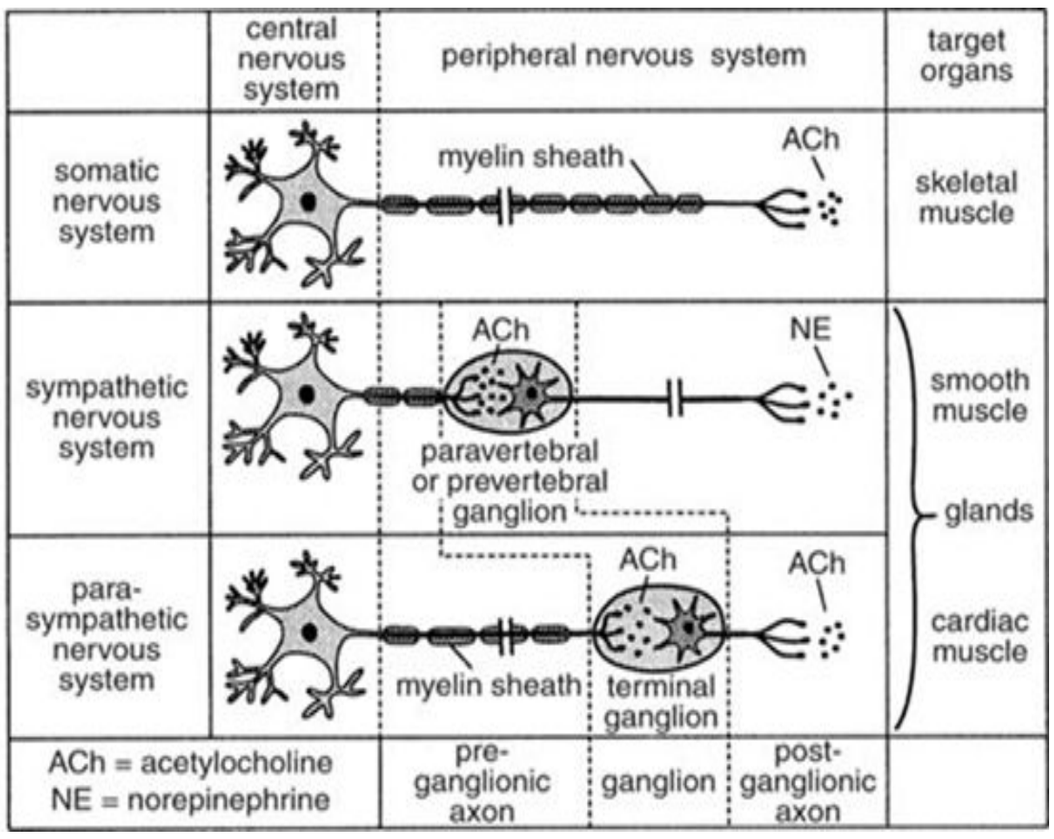


Table 3-1 Illustrating differences in sympathetic and parasympathetic divisions.

Characteristics	Sympathetic Division	Parasympathetic Division	Somatic Nervous System*
Origin of preganglionic neurons	Spinal cord segments T1–L3 (thoracolumbar)	Nuclei of CN III, VII, IX, and X; spinal cord segments S2–S4 (craniosacral)	—
Location of autonomic ganglia	Paravertebral and prevertebral	In or near effector organs	—
Length of preganglionic axons	Short	Long	—
Length of postganglionic axons	Long	Short	—
Effector organs	Smooth muscle; cardiac muscle; glands	Smooth muscle; cardiac muscle; glands	Skeletal muscle
Neurotransmitter and receptor type in ganglion	ACh/nicotinic receptor	ACh/nicotinic receptor	—
Neurotransmitter in effector organs	Norepinephrine (except sweat glands)	ACh	ACh
Receptor types in effector organs	α_1, α_2, β_1, β_2	Muscarinic	Nicotinic

ACh, Acetylcholine; CN, cranial nerve.

Table 3-2 Shows the organization of the autonomic nervous system.

FOOTNOTES

1. One theory for the mechanism of viral demyelination is by molecular mimicry, in which immune cells recognize peptides of foreign antigens that are similar to peptides present in self-antigen. Causing cross-reactivity and an autoimmune response.
2. An autoimmune disease in which the immune system attacks myelin sheaths. It is associated with EBV infection. More specifically it affects fasciculus cuneatus of cervical spines.

Axon of 1st (*preganglionic*) neuron leaves CNS to synapse with the 2nd (*postganglionic/ganglionic*) neuron, axon of 2nd (*postganglionic/ganglionic*) neuron extends to the organ it serves.

LOCATIONS OF AUTONOMIC GANGLIA

1. SYMPATHETIC GANGLIA

A. Trunk (chain) ganglia near vertebral bodies.
B. Prevertebral ganglia near large blood vessel in the gut: celiac, superior mesenteric & inferior mesenteric.

2. PARASYMPATHETIC GANGLIA

A. Terminal ganglia
B. In the wall of organ

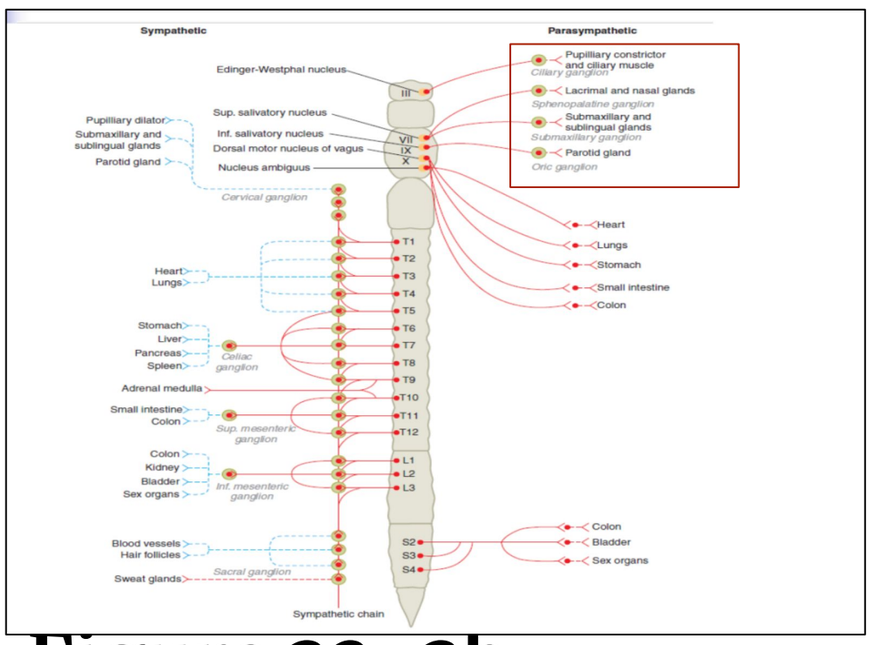


Figure 32-3b

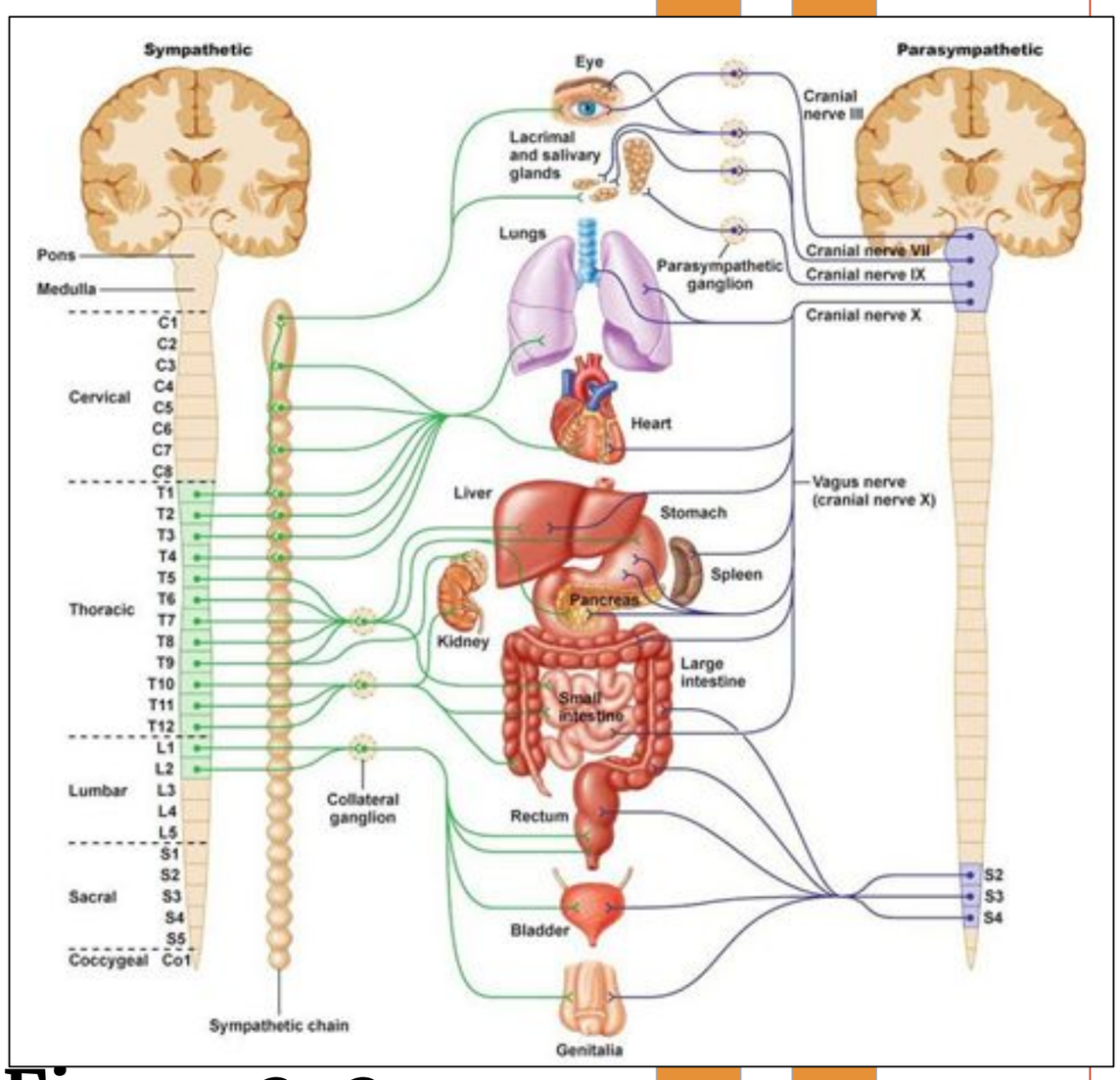


Figure 3-3a

INNERVATION OF VISCERAL TARGETS

Sympathetic

- Short, lightly myelinated preganglionic neurons.
- Long, unmyelinated postganglionic neurons.
- The sympathetic axons are Highly branched.
- Ganglia close to spinal cord

Parasympathetic

- Preganglionic neurons: long, & myelinated.
- Postganglionic neurons: short & unmyelinated
- The parasympathetic axons contain few branches.
- Ganglia close to or on target organs

Sympathetic and parasympathetic systems consist of myelinated preganglionic fibers which make synaptic connections with unmyelinated postganglionic fibers and then innervate the effector organ. These synapses usually occur in clusters are called ganglia.

Table 3-3

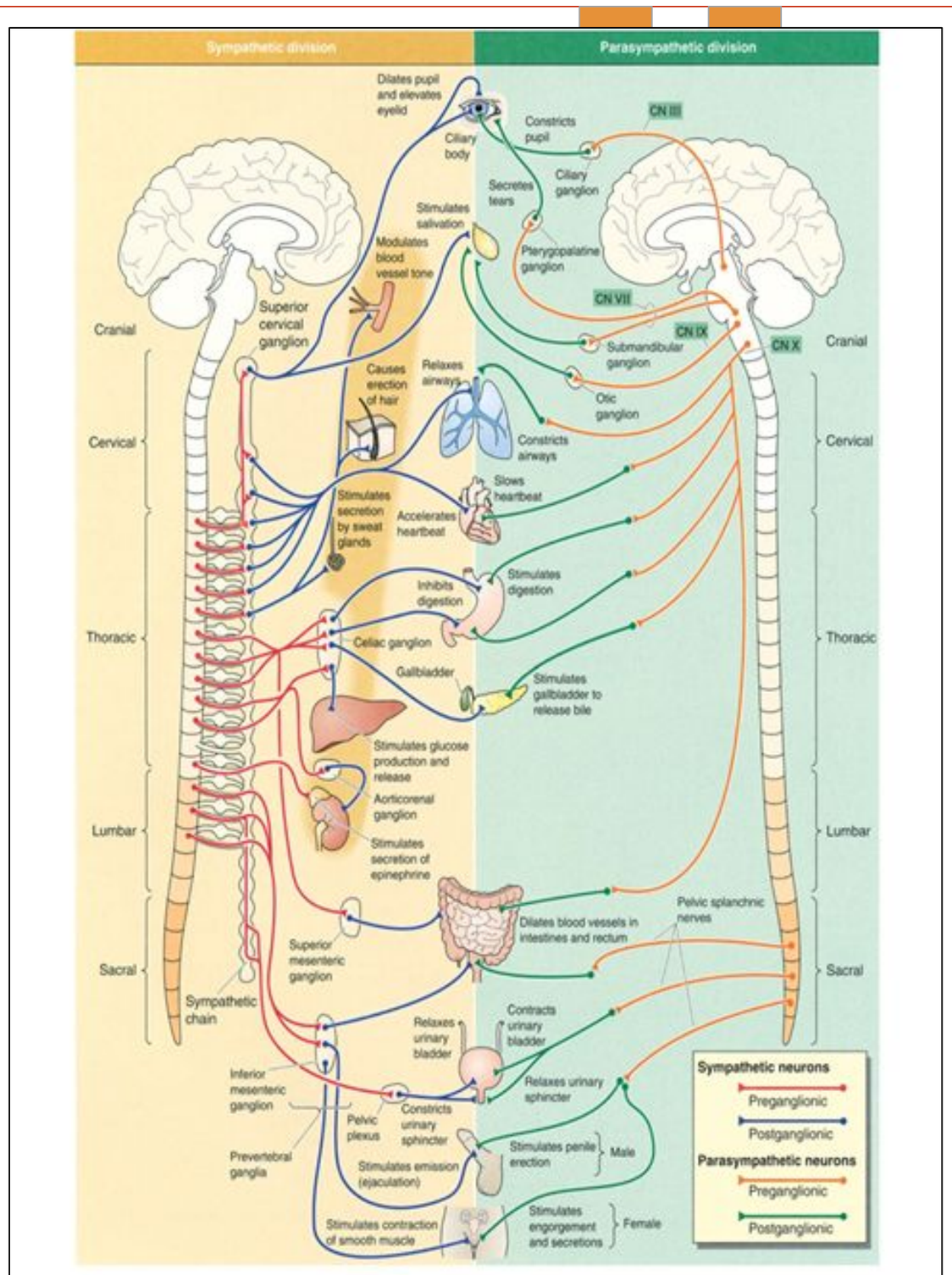
ORIGIN OF THE ANS

1. SYMPATHETIC - ORIGIN

- Thoracolumbar **lateral horns of the spinal segment T1 – L2.**
- Nerve fibers originate between T1 & L2.

2. PARASYMPATHETIC - ORIGIN

- Craniosacral cell bodies of the motor nuclei of the **cranial nerves III, VII, IX and X** in the brain stem.
- **Second, third and fourth [S2-S4] sacral segments** of the spinal cord.
- Nerve fibers emerge from brain & sacrum forming craniosacral outflow
- The **cranial nerves III, VII and IX** affect the pupil and salivary gland secretion.
- **Vagus nerve (X)** carries fibres to the heart, lungs, stomach, upper intestine and ureter.
- **The sacral fibres** form pelvic plexuses which innervate the distal colon, rectum, bladder and reproductive organ.



Organization of sympathetic (left) and parasympathetic (right) nervous systems. Preganglionic sympathetic and parasympathetic neurons are shown in red and orange, respectively; postganglionic sympathetic and parasympathetic neurons in blue and green, respectively. (Reproduced with permission from Boron WF, Boulpaep EL: *Medical Physiology.* Elsevier, 2005.)

Figure 3–3

AUTONOMIC NERVOUS SYSTEM: DIVISIONS AND RESPONSES

SYMPATHETIC:

- "Fight or Flight"
- "Alarm Reaction"
- **"E" division** (exercise, excitement, emergency, and embarrassment.)
- Regulated by neurons in the Posterior part of the hypothalamus.

PARASYMPATHETIC:

- "Rest and digest"
- **"SLUDD"** responses: **S**alivation, **L**acrimation, **U**rination, **D**igestion & **D**efecation.
- **"D" division** (digestion, defecation, and diuresis)
- **Paradoxical fear:** when there is no escape route or no way to win causes massive activation of parasympathetic division
- Loss of control over urination and defecation.
- Regulated by neurons in the Anterior part of the hypothalamus.

Functions of the Sympathetic Nervous System

FEAR, FIGHT, FLIGHT

- The sympathetic nervous system enables the body to be prepared for the **Fear-Flight-Fight** situations.
- Dominance by the sympathetic system is caused by physical or emotional stress **"E situations": Emergency, Exercise, Embarrassment, Excitement.**
- Sympathetic responses also contribute to Increase in heart rate , blood pressure , and cardiac output.
- It diverts blood flow away from the GIT "splanchnic vessels "and skin via **vasoconstriction**.
- It has a stimulatory effect on organs and physiological systems, responsible for rapid sensory activity (pupils in the eye) and movement (skeletal muscle).
- Blood flow to skeletal muscles, lungs is not only maintained, but enhanced (by as much as 1200%), in case of skeletal muscles.
- Increase pupil size, bronchial dilatation, and contraction of sphincters and metabolic changes **such as the mobilisation of fat and glycogen.**

IMPORTANT ACTIONS

- Bronchioles dilate → increased alveolar oxygen exchange.
- Increases heart rate and contractility of skeletal muscles (Myocytes) → will increase blood flow to skeletal muscles.
- Dilation of the pupil and relaxation of lens → Allow MORE light to enter through the eye.

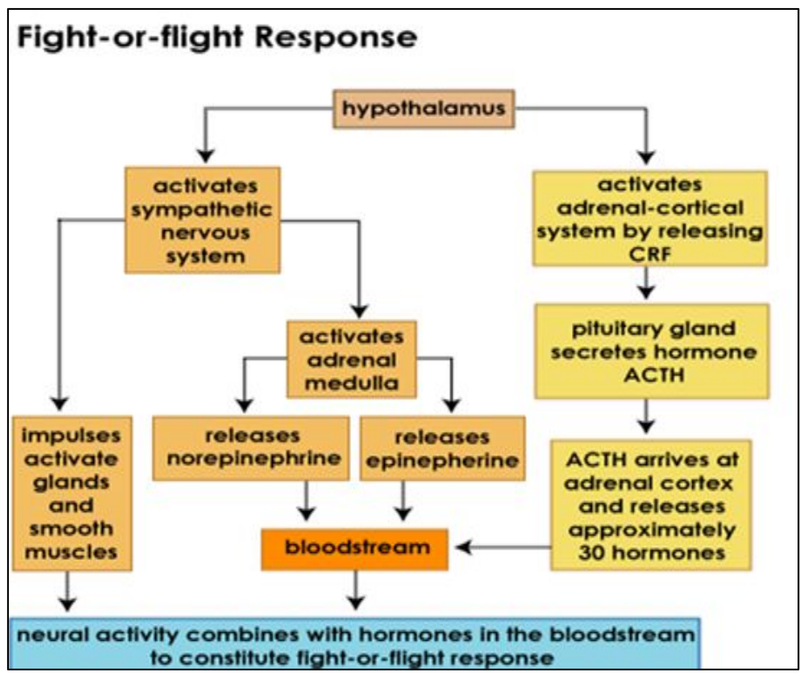
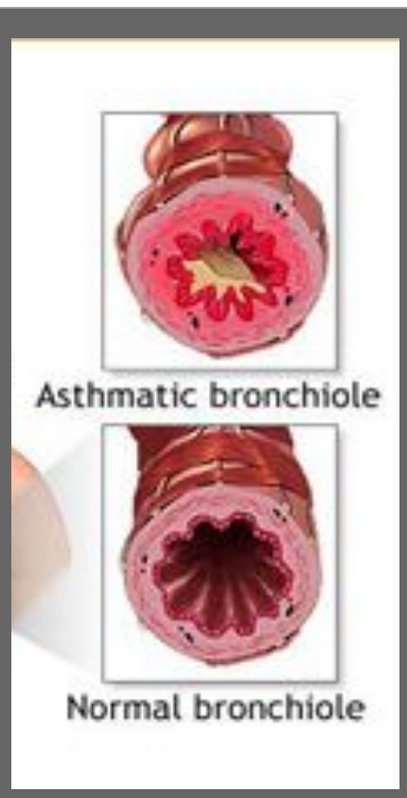


Figure 3-5[1]

BOX 3-2: CLINICAL RELEVANCE

- Bronchial asthma is respiratory inflammatory disease in which the body, particularly the airways are in constant alarm for allergens. T-Helper 2 cells, which recognize extracellular antigens, recognize allergens through dendritic cells, and in response recruit B lymphocytes which in turn activate mast cells by the release of IgE which binds on mast cells, mast cells are then equipped with membrane-bound IgE and are said to be sensitized, further antigen binding to those IgEs causes mast cells to release allergic mediators that cause bronchoconstriction, increased mucus secretion, resulting in a chronic, reversibly obstructed airways, and constricted, hypertrophied smooth muscle cells.
- Beta-2 agonists, such as salbutamol (short-acting), formoterol and salmoterol (long-acting) cause bronchodilation by relaxation of bronchial smooth muscles, as well as by a mast cell stabilizing effect.



FOOTNOTES

1. CRF is a releasing hormone found mainly in the paraventricular nucleus of the mammalian **hypothalamus** that regulates the release of corticotropin (ACTH) from the pituitary gland. ACTH is a tropic hormone, meaning that it is released by the hypothalamus to target other glands to release their hormones, in this case, the adrenal cortex, which release hormones like aldosterone, angiotensin I, cortisol and adrenaline.

Functions of the Parasympathetic Nervous System

REST AND DIGEST

- In physiological terms, the parasympathetic system is concerned with conservation and restoration of energy, as it causes *a reduction in heart rate and blood pressure*, diameter of airways and diameter of pupil and facilitates digestion and absorption of nutrients, and consequently the excretion of waste products.
- The chemical transmitter at both pre and postganglionic synapses in the parasympathetic system is **Acetylcholine (Ach).**

Sympathetic and Parasympathetic Systems Comparison

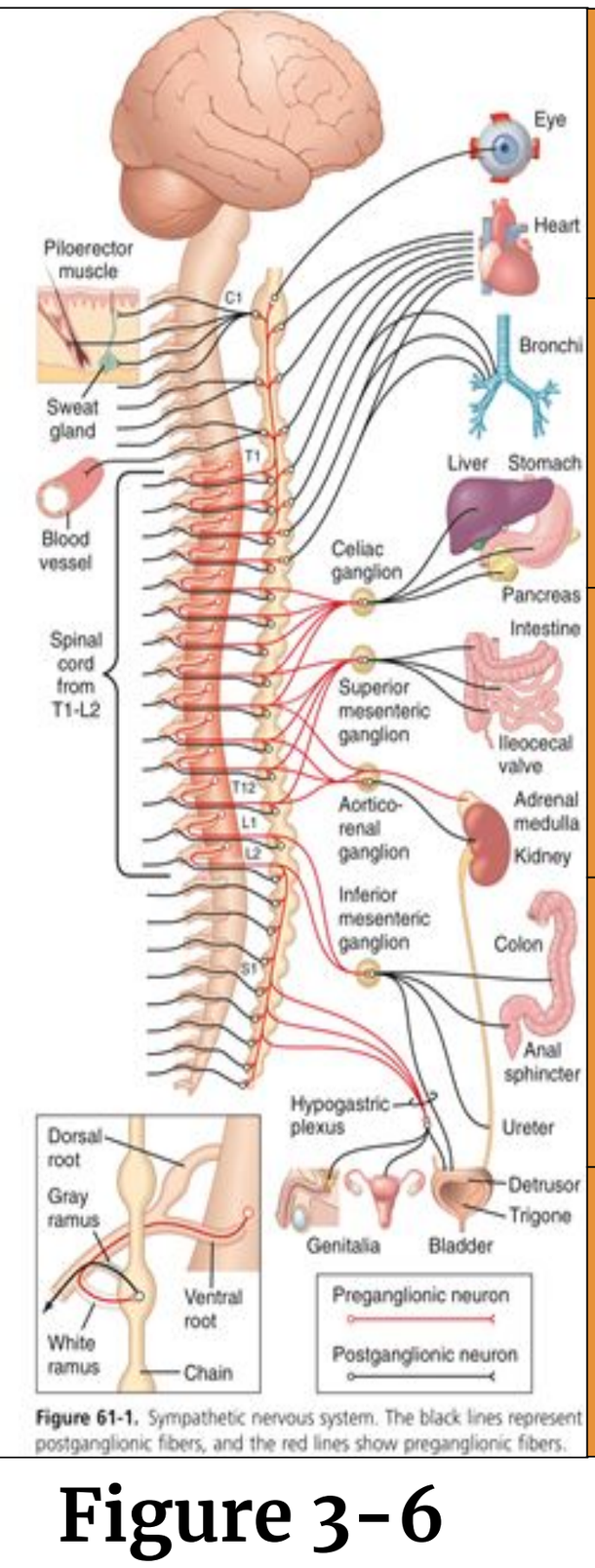


Figure 61-1. Sympathetic nervous system. The black lines represent postganglionic fibers, and the red lines show preganglionic fibers.

SUBDIVISIONS	Sympathetic	Parasympathetic
NERVES EMPLOYED	Thoracolumbar	Craniosacral
LOCATIONS OF GANGLIA	Alongside vertebral column	On or near an effect organ
CHEMICAL MESSENGERS	Norepinephrine	Acetylcholine
GENERAL FUNCTIONS	Fight or flight	Conservation of body energy

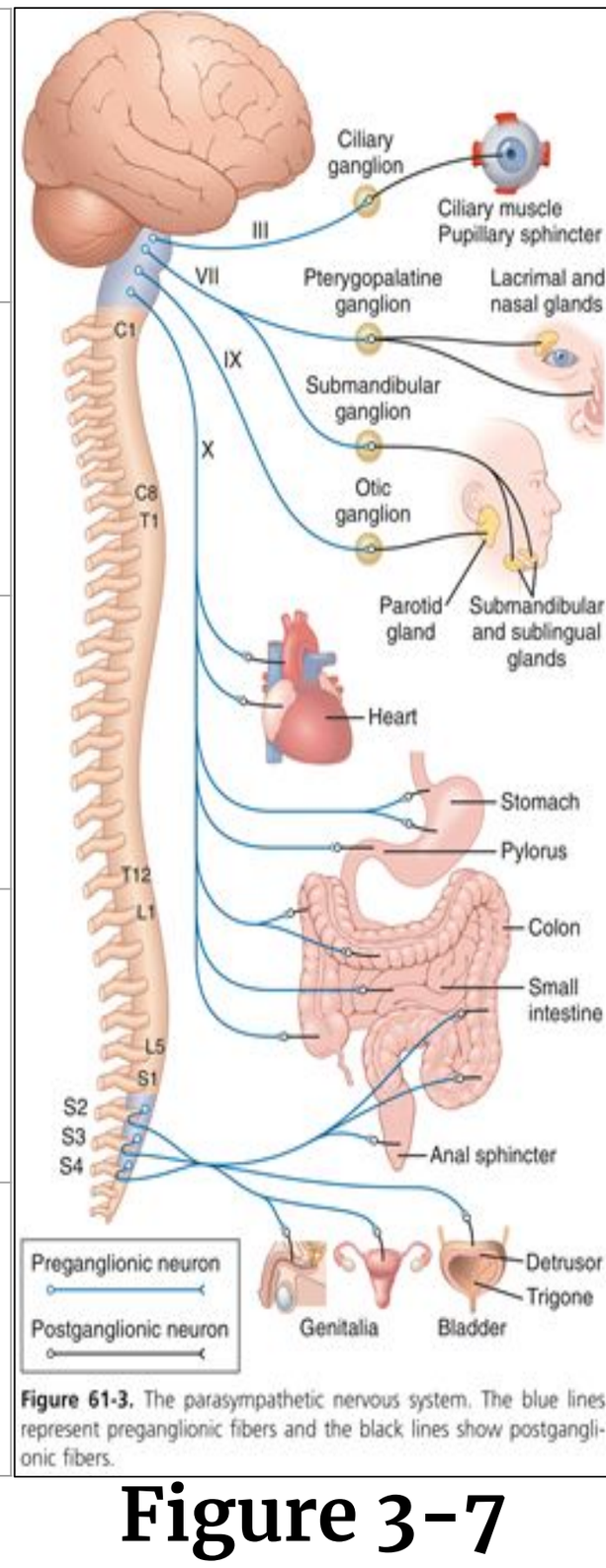


Figure 61-3. The parasympathetic nervous system. The blue lines represent preganglionic fibers and the black lines show postganglionic fibers.

Figure 3-6 **Table 3-4** **Figure 3-7**

BOX 3-3: CLINICAL RELEVANCE

- Antimuscarinic drugs have variety of uses that antagonize parasympathetic stimulation, most notably atropine which can be used in cases like sinus bradycardia to increase the heart rate. Tropicamide for fundus examination by dilating the pupil, and hyoscine for irritable bowel syndrome, an idiopathic disease of the large intestines that causes intestinal spasms and an inflammatory GIT.
- Muscarinic agonists can be used to treat glaucoma, like carbachol, methacholine, and pilocarpine, which have an advantage over ACh by being slowly or not destroyed by Acetylcholinesterase.

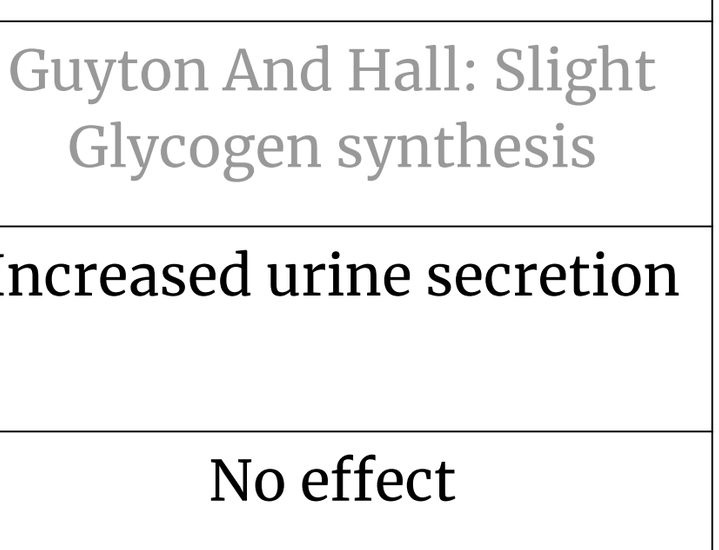
STRUCTURE	SYMPATHETIC STIMULATION	PARASYMPATHETIC STIMULATION
Iris (eye muscle)	Pupil dilation	Pupil constriction
Salivary Glands	Saliva production reduced	Saliva production increased
Oral/Nasal Mucosa	Mucus production reduced	Mucus production increased
Heart	Heart rate and force increased	Heart rate and force decreased
Lung	Bronchial muscle relaxed	Bronchial muscle contracted
Stomach	Peristalsis reduced	Gastric juice secreted; motility increased
Small Intestines	Motility reduced	Digestion increased
Large Intestines	Motility reduced “Constipation”	Motility increased
Liver	Increased conversion of glycogen to glucose	Guyton And Hall: Slight Glycogen synthesis
Kidney	Decreased urine secretion	Increased urine secretion
Adrenal medulla	Norepinephrine and epinephrine secreted	No effect
Bladder	Wall relaxed Sphincter closed	Wall contracted Sphincter relaxed

Table 3-5

Enteric Nervous System

Myenteric plexus: is located between longitudinal and circular layers of muscle; it is involved in control of digestive tract motility.

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.



PRESENT ONLY IN MALE SLIDES

ANS RECEPTORS: (1) Cholinergic, (2) adrenergic receptors.

NEUROTRANSMITTERS OF THE ANS	PREGANGLIONIC FIBERS	POSTGANGLIONIC FIBERS
SYMPATHETIC NERVOUS SYSTEM	**Cholinergic** Release acetylcholine.	**Adrenergic** Release norepinephrine. Exception: Sweat glands and blood vessels to skeletal muscles where they release ACh.
PARASYMPATHETIC NERVOUS SYSTEM	**Cholinergic** Release acetylcholine.	**Cholinergic** Release acetylcholine.

Table 3-6

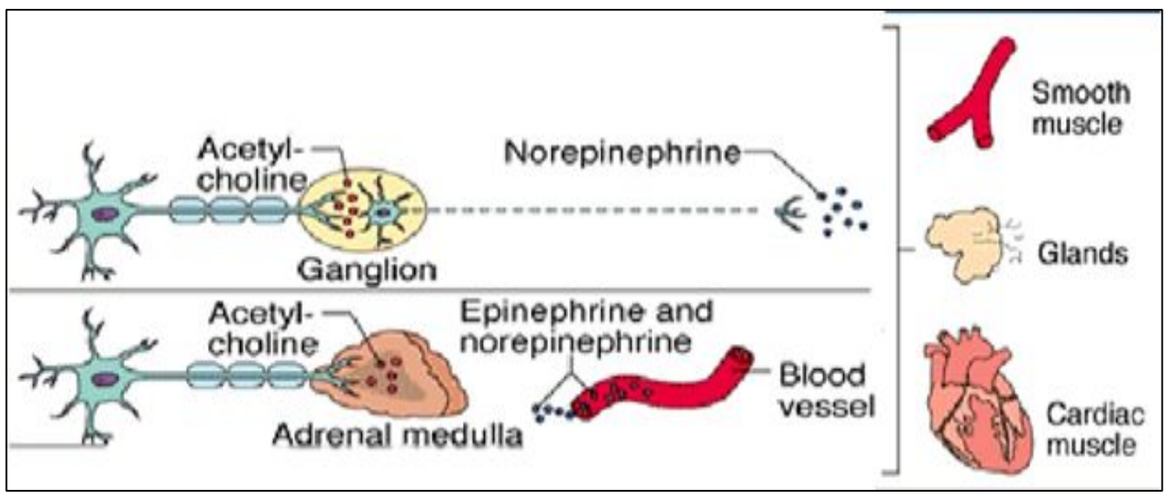


Figure 3-8 Depicting sympathetic nervous system neurotransmitters.

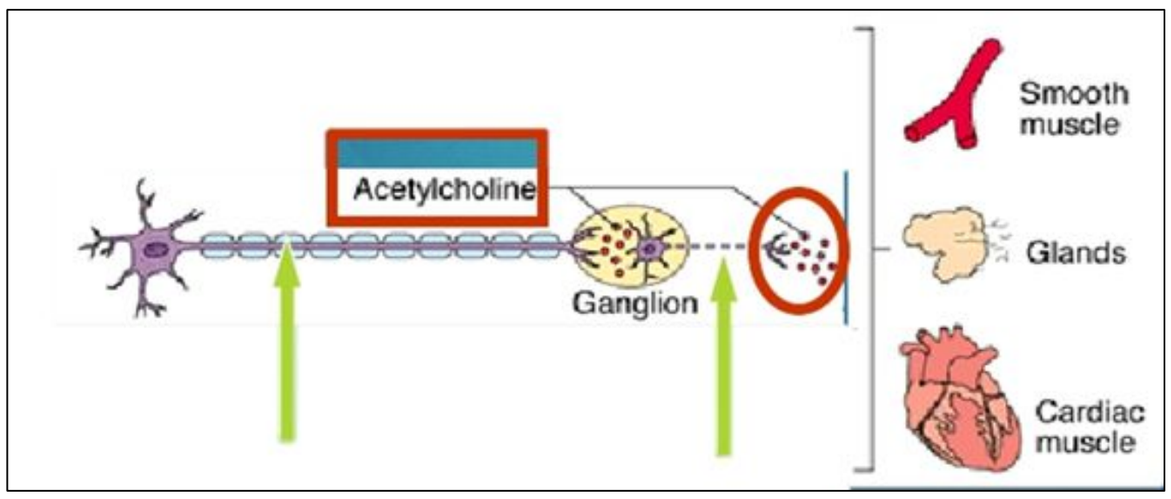


Figure 3-9 Depicting parasympathetic nervous system neurotransmitters.

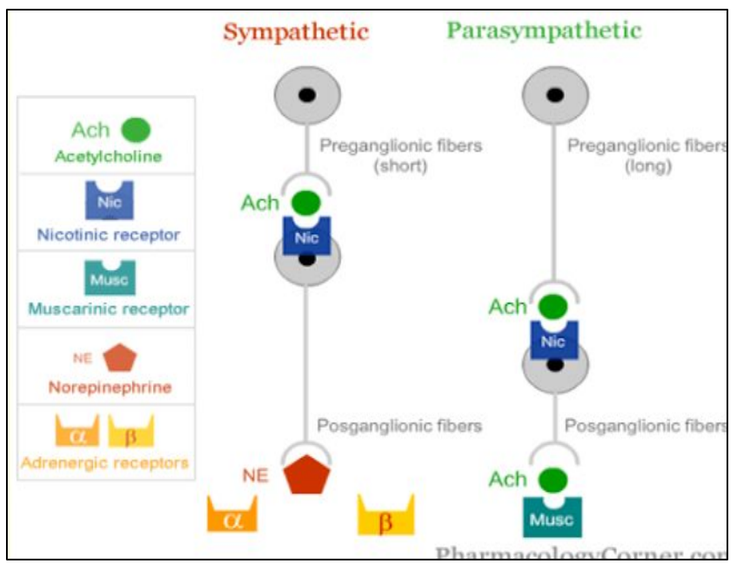


Figure 3-10 Comparing sympathetic and parasympathetic transmission.

CHEMICAL OR NEURAL NEUROTRANSMITTERS

- All preganglionic fibers release acetylcholine (Ach).
- All parasympathetic postganglionic release Ach.
- All sympathetic postganglionic release noradrenaline except sweat glands & blood vessels to skeletal muscles.

RECEPTORS

- **The parasympathetic nervous system** uses only **acetylcholine (ACh)** as its neurotransmitter.

The ACh acts on two types of receptors, the muscarinic and nicotinic receptors, whereas nicotine activates only nicotinic receptors, muscarine only activates muscarinic receptors.

- **Muscarinic receptors** are found on all effector cells that are stimulated by the postganglionic cholinergic neurons of either the parasympathetic nervous system or the sympathetic system.
- **Nicotinic receptors** are found in the autonomic ganglia at the synapses between the preganglionic and postganglionic neurons of both the sympathetic and parasympathetic systems.

Most transmissions occur in two stages:

- When stimulated, the preganglionic nerve releases ACh at the ganglion, which acts on nicotinic receptors of the postganglionic nerve.
- The postganglionic nerve then releases ACh or NE to stimulate the muscarinic or adrenergic receptors of the target organ.

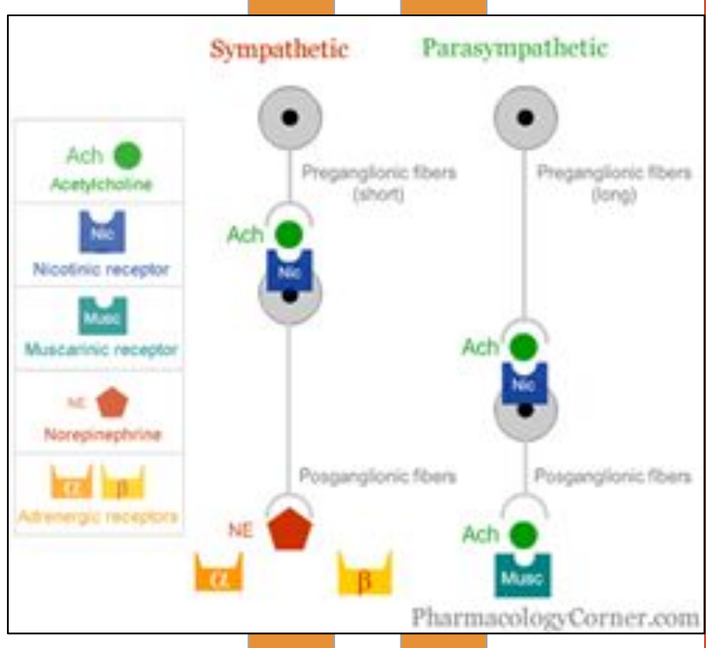


Figure 3-10

Sympathetic Nervous System Acts on Two Receptor Types

α-receptor[1]

Action: smooth muscle **contraction.**

β-receptor

β_1 action: smooth muscle contraction especially in heart.

β_2 action[2]: smooth muscle relaxation. .

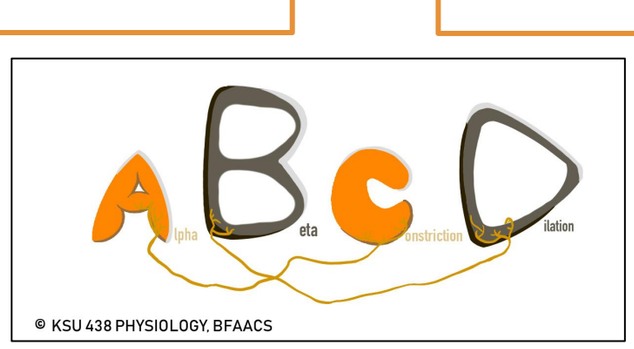


Table 3-7

FOOTNOTES

1. Generally alpha-1 receptors are what's referred to here. Alpha-2 receptors are mostly presynaptic, that is, they exist on the fiber of the neuron releasing the neurotransmitter and acts as a negative feedback system to prevent further release of norepinephrine when norepinephrine binds to it, inhibiting its own release.
2. Please note that this is the postsynaptic function, the presynaptic function of beta-2 receptors, meaning their functions when they are on the fiber releasing the neurotransmitter, is to increase the release of norepinephrine therefore acting as a positive feedback system.Beta-3 receptors exist on the surface of adipocyte and their stimulation causes increased adipolysis.

ANS: Neurotransmitters & Receptors

Adrenergic receptors: In General, NE or epinephrine binding to alpha-receptors are stimulatory while their binding to beta- receptors are inhibitory.

Both receptors have distinct subtypes (alpha 1 ,2 , beta 1, 2).

Nicotinic receptors: Are all excitatory, Their response is rapid (milliseconds).
Muscarinic receptors: Either excitatory or inhibitory , depending on the target organ.

α_1	Reflect the "flight or fight" RX. • Vasoconstriction of blood vessels (control of B.P.). • Inhibit motility in the gut by contracting sphincter muscles and relaxing non – sphincter tissue. • Mobilize energy by breaking down liver glycogen to glucose.
α_2	• Found in presynaptic membranes. • Provide feedback control of neurotransmitter secretion (inhibit Ca++ influx, decrease neurotransmitter release)(autoreceptor negative feedback).
β_1	• Well known for their effects in the heart • increase heart rate and force of contraction • Induce muscle relaxation in the gut.
β_2	• Induce bronchodilation. • Induce smooth muscle relaxation in the gut. • Induce conversion of glycogen to glucose. • Stimulate secretion of insulin from pancreas.
M	• Decrease heart activity. (M2) • Increase motility in G.I. tract. (M1, M3) • Depolarization of smooth muscle fibers, (M3) • Hyperpolarization of cardiac muscle fibers. (M2)

Table 3-8

PRESENT ONLY IN FEMALE SLIDES

α_1	α_2
STIMULATORY **Respiratory system:** - Bronchiolar smooth muscles: contraction (minor contribution) **Circulatory System:** - Vascular smooth muscles: contracts **Digestive System:** - Salivary glands: stimulates potassium cation - Liver: Gluconeogenesis, glycogenolysis. - GIT sphincter: contracts. **Urinary system:** - Ureter: contraction - Urinary sphincter: contraction **Others:** - Arrector pili muscle: contraction - Sweat glands: stimulates secretion (minor contribution) INHIBITORY **Nervous system:** - Pupil of the eye: relaxation	STIMULATORY **Circulatory system:** - Platelets: aggregation INHIBITORY **Endocrine System:** - Pancreas (islets): decreased secretion -
β_1	β_2
STIMULATORY **Circulatory System:** - SA node: increased heart rate (chronotropic) - Cardiac muscles: increased contractility (inotropic) - AV node: increased conduction (dromotropic)	STIMULATORY **Circulatory system:** - SA node: increased heart rate (chronotropic) - Cardiac muscles (increased contractility) **Digestive System:** - Liver: Gluconeogenesis, glycogenolysis. INHIBITORY **Circulatory system:** - Mast cell – histamine: inhibits **Respiratory system:** - Bronchiolar smooth muscles: relaxation (major contribution.) **Digestive System:** Smooth muscles of the GIT: relaxation **Nervous system:** - Ciliary muscle: relaxation **Urinary system:** - Bladder wall: relaxation - Urinary sphincter: relaxation
SYMPATHETIC	UNSPECIFIED RECEPTORS - ($\beta_?$) Stimulates viscous, amylase secretions; - Cardiac output increased (β_1, - Lacrimal glands (tears): decreased (α_1) - Kidney (renin): secretion (β_1) - GI tract motility: decreased (mostly β_2) - ($\alpha_?$)Smooth muscles of GIT: relaxes. NICOTINIC - Activation of nicotinic receptors on adrenal medulla: increased epinephrine secretion. MUSCARINIC - Increase sweat glands secretion (major contribution)

Table 3-9

PRESENT ONLY IN MALE SLIDES

M1	M2
STIMULATORY **Digestive system:** - GIT Motility: increases - Parietal cells: secretion	INHIBITORY **Circulatory system:** - Cardiac output: decreases - SA node: decreases heart rate (chronotropic) - Cardiac muscles: decreases contractility (atria only)(inotropic) - AV node: decreases conduction velocity (dromotropic)
M3	**PARASYMPATHETIC**
STIMULATORY **Circulatory system:** **Vascular smooth muscles: contracts.** **Respiratory system:** - Bronchiolar smooth muscles: contraction **Nervous system:** - Ciliary muscle: contraction - Pupil of the eye: contraction **Digestive system:** - Smooth muscles of GIT: contraction - GIT motility: increases. **Others:** - Lacrimal glands (tears): increases. INHIBITORY **Digestive system:** - GIT Sphincters: relaxation	UNSPECIFIED RECEPTORS - Salivary gland: stimulates watery secretions (mostly M_3) - Ureter: relaxes Urinary sphincter: relaxes

PRESENT ONLY IN MALE SLIDES

Table 3-10 Showing parasympathetic receptors and their respective actions.

The Stress Reaction

When stress occurs, the sympathetic nervous system is triggered. Norepinephrine is released by nerves, and epinephrine is secreted by the adrenal glands. By activating receptors in blood vessels and other structures, these substances ready the heart and working muscles for action. Acetylcholine is released in the parasympathetic nervous system, producing calming effects. The digestive tract is stimulated to digest a meal, the heart rate slows, and the pupils of the eyes become smaller. The neuroendocrine system also maintains the body's normal internal functioning.

PRESENT ONLY IN FEMALE SLIDES

Chronic Stress

When glucocorticoids or adrenaline are secreted in response to the prolonged psychological stress commonly encountered by humans, the results are not ideal. Normally, bodily systems gear up under stress and release hormones to improve memory, increase immune function, enhance muscular activity, and restore homeostasis. If you are not fighting or fleeing, but standing frustrated in a supermarket checkout line or sitting in a traffic jam, you are not engaging in muscular exercise. Yet these systems continue to be stimulated, and when they are stimulated chronically, there are different consequences: Memory is impaired, immune function is suppressed, and energy is stored as fat.

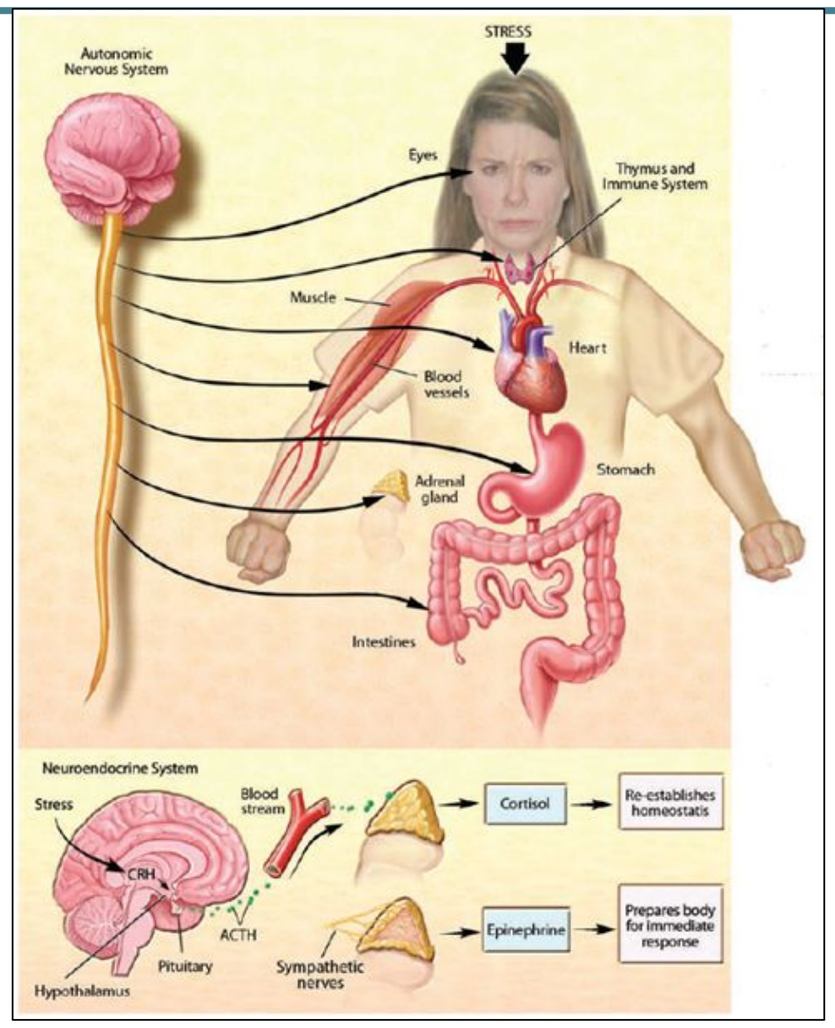


Figure 2-11

RESPONSE TO STRESS

PSYCHOLOGICAL

- Mental illness
- Anxiety

- Short Fuse
- Irritability

- Depression
- Frustration
- Emotional irritability
- Insecurity

BEHAVIORAL

- Drug use/abuse
- Alcohol use/abuse

- Smoking
- Strained relationships
- Eating problems
- Suicide attempts

- Violence/impulsive

- Irrational behavior

PSYCHOSOMATIC

- Ulcers
- High blood pressure
- Insomnia
- Indigestions
- Headaches
- Other cardiovascular body infections
- Irregular pulse rate

Table 3-11

QUIZ

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1. What is meant by paradoxical fear?

A) Excessive activation of the sympathetic system in response to a win situation
B) Excessive activation of parasympathetic system when there is no win or escape
C) Decreased activation of parasympathetic system
D) Contraction of sphincters in response to a painful stimulus

2. Which of the following statements is correct:

A) Preganglionic fibers are highly myelinated
B) Postganglionic fibers are thinly myelinated
C) Preganglionic fibers of the sympathetic nervous system is shorter than that of the parasympathetic nervous system
D) None of the above is correct

3. What type of fiber and receptor stimulates adrenaline and noradrenaline secretion from adrenal medulla?

A) Preganglionic sympathetic fibers stimulating nicotinic receptors
B) Postganglionic sympathetic fibers stimulation beta-receptors
C) Postganglionic parasympathetic fibers stimulating muscarinic receptors
D) Preganglionic parasympathetic fibers stimulating nicotinic receptors

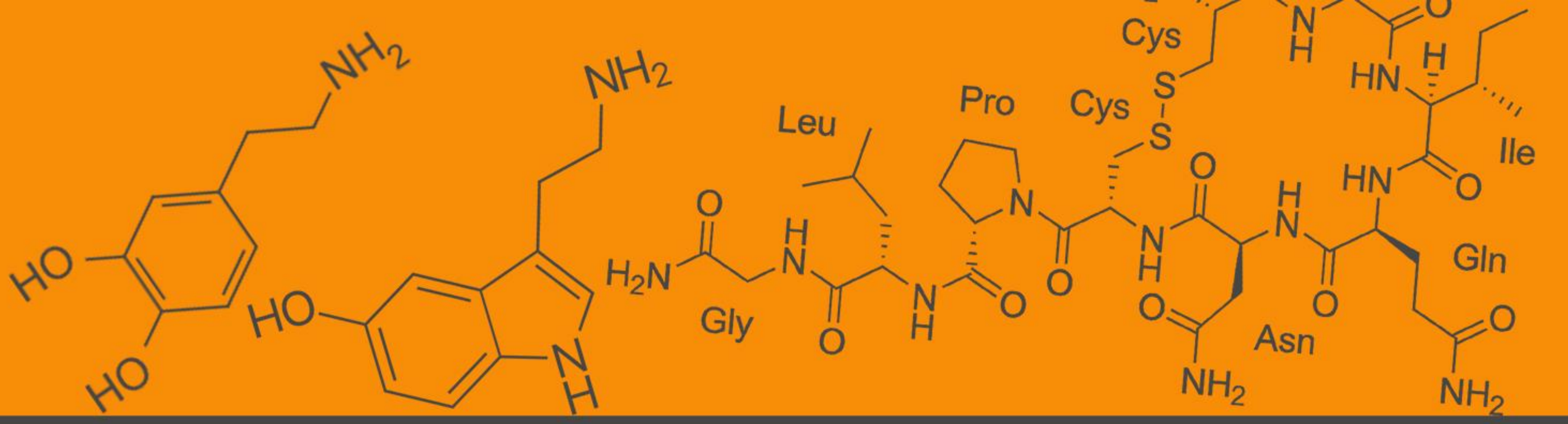
4. Nicotine excites which of the following receptors:

A) All cholinergic receptors
B) Only nicotinic receptors
C) Muscarinic and nicotinic receptors
D) All adrenergic receptors

5. Which of the following statement is correct about the ANS:

A) Autonomic reflexes are relayed through a polysynaptic pathway
B) Autonomic nervous system is a part of the somatic nervous system
C) Autonomic reflexes are also classified under stretch reflexes
D) None of the above

ANSWER KEY: B, C, A, B, A



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- Guyton and Hall Textbook of Medical Physiology
- Ganong's Review of Medical Physiology