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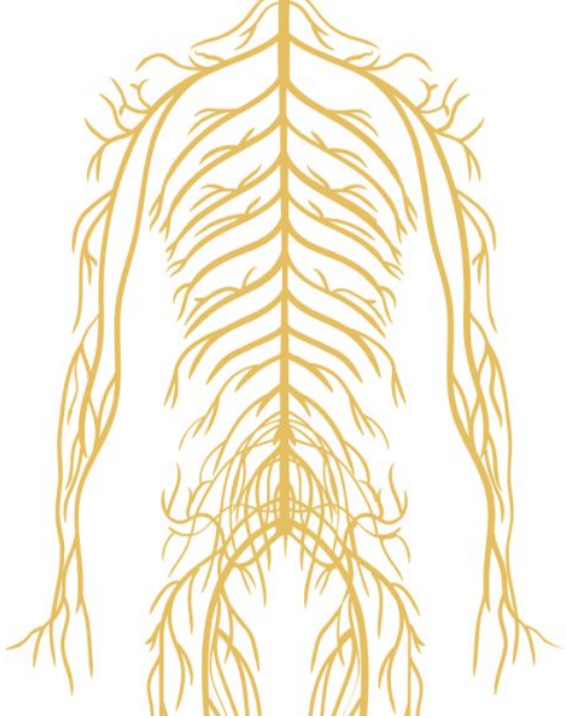

Sympathetic & parasympathetic nervous system

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Editing File

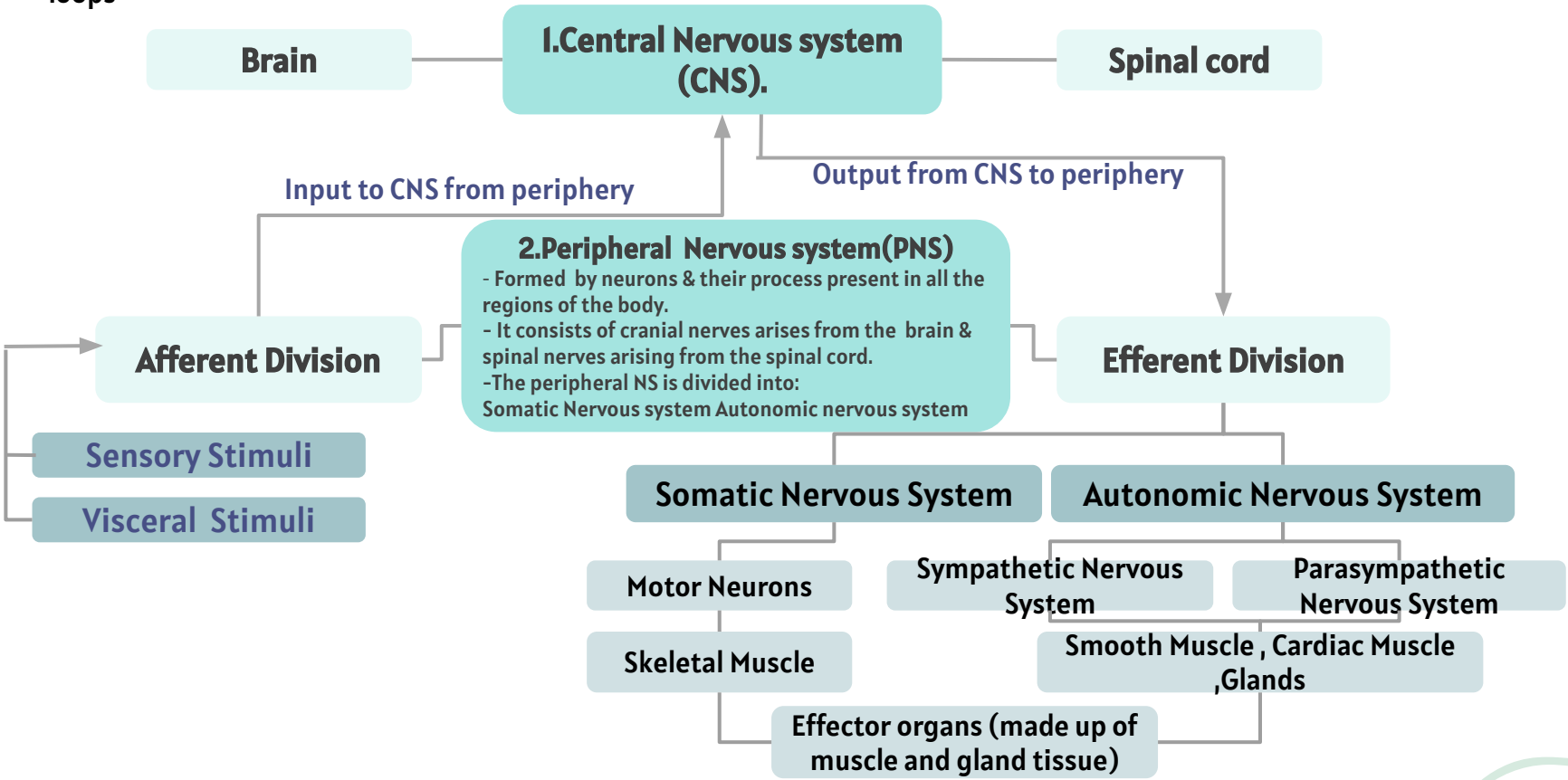
Objectives:

- Appreciate the anatomy of sympathetic & parasympathetic nervous system.
- Explain physiological functions of sympathetic & parasympathetic nerves in head & neck , chest, abdomen and pelvis.
- Describe neurotransmitters that can release at pre & post ganglionic of Autonomic NS.
- Describe Autonomic NS Receptors.
- Discuss autonomic disorders.
- Nervous System, introduction and classification
- The somatic and autonomic nervous system
- Various responses due to stimulation of the sympathetic / parasympathetic nervous system

Nervous system

Female slides

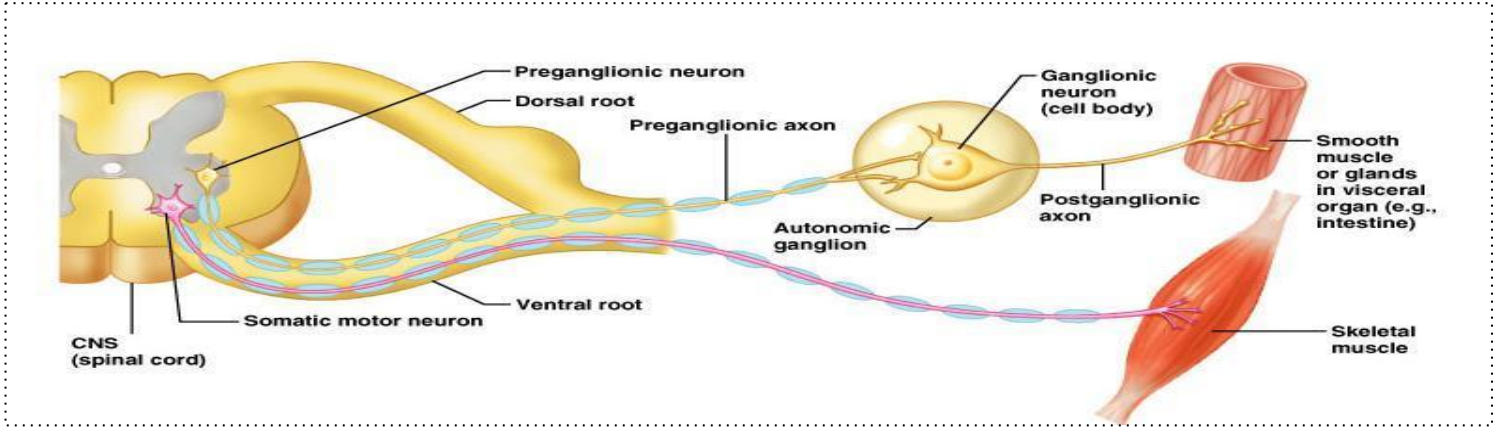
The nervous system monitors and controls almost every organ / system through a series of positive and negative feedback loops



Functional anatomy of the ANS

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

ANS is comprised of the sympathetic nervous system, parasympathetic nervous system, and the enteric nervous system. The major functions of the ANS is to maintain homeostasis despite some factors exerted by the external and internal environments.



Efferent Division of The peripheral NS is divided into:

Somatic Division	System	Autonomic System
Cell bodies of **motor neurons** reside in CNS (brain or spinal cord).	No. Of Neuron	chains of **two motor neurons**: - Ist = **preganglionic neuron** (in brain or cord). - 2nd = **postganglionic neuron** (cell body in ganglion outside CNS in an autonomic ganglion).
- Their axons (sheathed in spinal nerves) extend all the way to their skeletal muscles. - **One motor neuron** extends from the CNS to skeletal muscle. - Axons are **well myelinated**. - Conduct impulses **rapidly**. Cause of demyelination • Inflammatory processes • Viral demyelination • Metabolic derangements • Hypoxic–ischemic demyelination • Focal compression. • Multiple sclerosis • Acute encephalomyelitis	Axons	-preganglionic neuron axon is myelinated type fiber that extends to autonomic ganglion, post ganglionic neuron axon is unmyelinated type fiber that terminates in a visceral effector. - Axon of Ist (preganglionic) neuron leaves CNS to synapse with the 2nd (ganglionic) neuron/ autonomic ganglion. - **Axon of 2nd (ganglionic) neuron** extends to the organ it serves. Conduction is **slower** because lightly (thin) or **unmyelinated** axons. The ANS is predominantly an efferent system transmitting impulses from the Central Nervous System (CNS) to peripheral organ systems. Its effects include: • Control of heart rate and force of contraction • Constriction and dilatation of blood vessels • Contraction and relaxation of smooth muscle • Visual accommodation • Secretions from exocrine and endocrine glands.

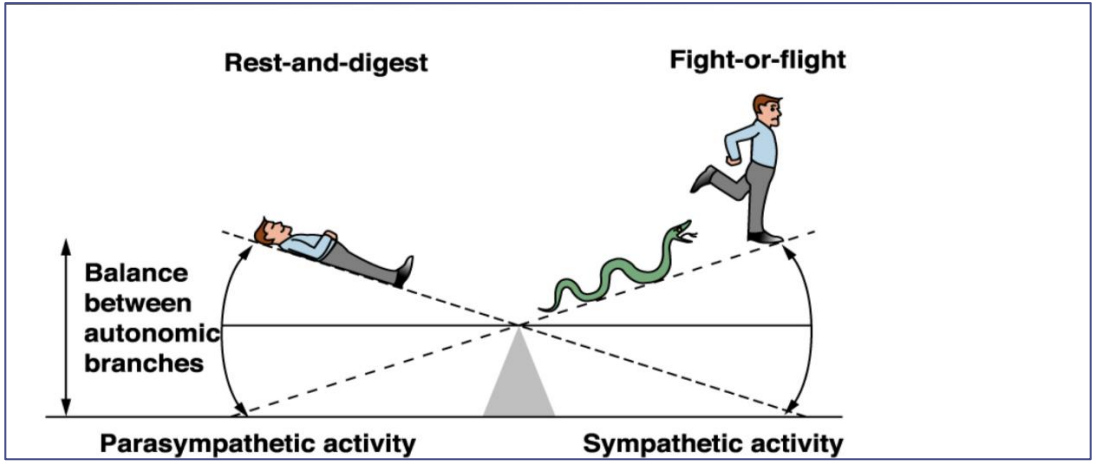
Efferent Division of The peripheral NS is divided into:

Somatic Division	System	Autonomic System
Controls organs under voluntary control (mainly skeletal muscles)	Innervation	ANS is the subdivision of the peripheral nervous system that **regulates body activities** that are generally **not under conscious control**. - **Visceral motor innervates** non-skeletal (non-somatic) muscles. - Composed of a special group of neurons serving: ❖ Cardiac muscle (the heart). ❖ Smooth muscle (walls of viscera and blood vessels). ❖ Internal organs. ❖ Skin. 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, sweating body temperature, sweating etc. It fully response in 3-5 seconds.

Organization of the Autonomic Nervous System

Characteristics	Sympathetic	Parasympathetic	Somatic Nervous System
Origin of Pre-ganglionic neurons (nerves employed)	Spinal cord segments (**Thoracolumbar**) lateral horn of the spinal segments TI-L2 (some people from TI-L3)	Nuclei of **Cranio-sacral** Nerve (III, VII, IX and X)and(S2,S3,S4)	-
Location of Autonomic Ganglia	Alongside vertebral column	On or near an effector organs	-
preganglionic Axons	Short/most divergence, lightly myelinated	Long/less divergence,myelinated	-
Postganglionic Axons	Long/start from sympathetic chain, unmyelinated	Short/in terminal (near organ)or intramural (in organ ganglia	-
Effector organs	Smooth muscle, cardiac muscle and the glands		Skeletal Muscle
Neurotransmitter and receptor type in Ganglion			-
Neurotransmitter in effector organs	Norepinephrine (expect sweat glands)	ACh	ACh
Receptor types in effector organs(target)	αI, α2, βI, β2, β3, D (Adrenergic)	Muscarinic/Nicotinic	Nicotinic
General function	Fight or flight	Conservation of body energy Rest and digest	

The Autonomic Nervous System ANS



1. Multiple system atrophy (MSA) is a neurodegenerative disorder associated with autonomic failure due to loss of preganglionic autonomic neurons in the spinal cord and brainstem.

2. **MSA** is defined as "a sporadic, progressive disorder characterized by autonomic dysfunction, parkinsonism, and cerebellar ataxia in any combination." Shy–Drager syndrome is a subtype of MSA in which autonomic failure dominates

3. The pathologic hallmark of MSA is cytoplasmic & nuclear inclusions in oligodendrocytes and neurons in central motor and autonomic areas.

4. In the absence of an autonomic nervous system, it is difficult to regulate body temperature, fluid and electrolyte balance, and blood pressure. In addition to these autonomic abnormalities, MSA presents with cerebellar, basal ganglia, inferior olivary nucleus, and pyramidal tract deficits.

The Autonomic Nervous System ANS

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

Sympathetic (fight or flight)		Parasympathetic (rest and digest)
1- Trunk (chain) ganglia near vertebral bodies. (Alongside vertebral column) - Ganglia close to spinal cord. 2- Prevertebral ganglia near large blood vessel in gut: ❖ celiac. ❖ superior mesenteric. ❖ inferior mesenteric. 	Location of ganglia	1- Terminal ganglia. 2- In the wall of organ. (Ganglia close to or on target organs(the effector)). 
- Short, lightly myelinated preganglionic neurons -Long, unmyelinated postganglionic neurons fibers which make synaptic connections with postganglionic fibers. These synapses usually occur in clusters called ganglia. - highly branched Axons.	Innervation of Visceral Targets	- Long, myelinated preganglionic neurons. -short postganglionic neurons. fibers which make synaptic connections with postganglionic fibers. These synapses usually occur in clusters called ganglia. - few branches.

The Autonomic Nervous System ANS

continued....

Sympathetic (fight or flight)		Parasympathetic (rest and digest)
Long unmyelinated postganglionic neurons/ fibers innervate the effector organ.	Post-ganglionic neuron	Short, Unmyelinated postganglionic neurons/ fibers innervate the effector organ.
Thoracolumbar (Originate in the thoracic & lumbar regions) lateral horns of the spinal segments TI-L2. \ (TI-TI2; LI-L2,3) -Nerve fibers originate between TI & L2.	Origin	**Craniosacral** cell bodies of the motor nuclei of the (originate from) : cranial nerves III, VII, IX and X in the brain stem. [S2- S3- S4] sacral segments of the spinal cord. (Nerve fibers emerge from brain & sacrum 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 organs.
fight or flight ("E" division). ❖ Exercise. ❖ Excitement. ❖ Emergency. ❖ Embarrassment.	Functaion	Rest and digest ("D" division). Conservation of body energy ❖ Digestion. ❖ Defecation. ❖ Diuresis.

The Autonomic Nervous System

1

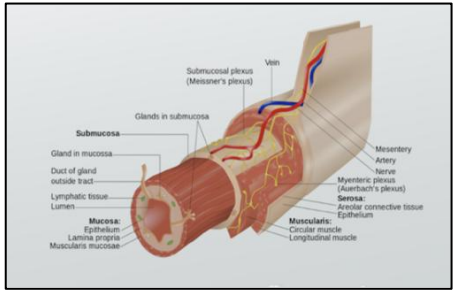
THE ANS IS ACTIVATED BY:

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..

2

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.



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.

Sympathetic Nervous System Function

- Sympathetic system enables body to prepared for fear, flight or fight (Frequently referred to as the fear, fight or flight response)
- Dominance by the sympathetic system is caused by physical or emotional stress "E situations".
- It has a stimulatory effect on organs and physiological systems, responsible for rapid sensory activity (pupils in the eye) and movement (skeletal muscle).

1. Diversion of blood flow via vasoconstriction away from the GIT and skin and splanchnic vessels to vessels supplying skeletal muscle. Blood flow to skeletal muscles, lungs is not only maintained, but enhanced (by as much as 1200%), in case of skeletal muscles.
2. Sympathetic responses include an increase in heart rate, blood pressure and cardiac output. It increases heart rate and the contractility of cardiac cells (myocytes), thereby providing a mechanism for the enhanced blood flow to skeletal muscles and cardiac muscle.
3. Increased pupil size, bronchiolar dilation, contraction of sphincters and metabolic changes such as the mobilisation of fat and glycogen. Blood glucose level increase.
4. Bronchioles dilate, which allows for greater alveolar oxygen exchange. Airways dilate & respiratory rate increases.
5. Sympathetic nerves dilate the pupil and relax the lens, allowing more light to enter the eye.

Parasympathetic Nervous System Function

The parasympathetic nervous system has rest & digest activity

Normally **dominate** over sympathetic impulses.

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.

SLUDD type responses: salivation, lacrimation, urination, digestion and defecation.
3 "Decreases": decreased HR, diameter of airways and diameter of pupil.

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, and facilitates digestion and absorption of nutrients, and consequently the excretion of waste products

The chemical transmitter at both pre and postganglionic synapse in the parasympathetic system is Acetylcholine (Ach)

Physiological Function Of The Autonomic Nervous System

Structure	Sympathetic stimulation	Parasympathetic stimulation
Iris (eye muscle)	Pupil dilation (allow more light to come to enhance the vision)	Pupil constriction
Salivary Glands	Saliva production decreased	Saliva Production Increased
Oral/Nasal Mucosa	Mucus production decreased	Mucus production increased
Heart	Heart rate and force increased	Heart rate and force decreased
Lungs	Bronchial muscle relaxed (to accomodate more oxygen)	Bronchial muscle Contracted
Stomach	Peristalsis reduced	Gastric juice secreted motility increased
Small intestine	Motility reduced	Digestion increased
Large intestine	Motility reduced	Secretions and motility increased
Liver	Increased conversion of glycogen to glucose	-
Kidney	Decreased urine secretion	Increased urine secretion
Adrenal medulla	Norepinephrine and epinephrine secreted	-
Bladder	Wall relaxed Sphincter closed	Wall contracted Sphincter relaxed

ANS Neurotransmitters

Classified as either cholinergic or adrenergic neurons based upon the neurotransmitter released.

1 Acetylcholine (Ach)

- **The ACh acts on two types of receptors, the muscarinic and nicotinic receptors.**

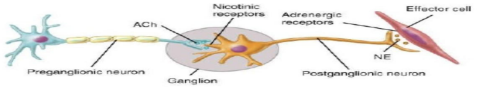
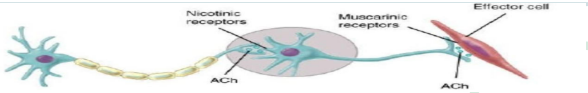
- **Nicotinic receptors** are found in the autonomic ganglia at the synapses between the preganglionic and postganglionic neurons of both the sympathetic and parasympathetic systems.
- **Muscarinic receptors** are found on all effector cells that are stimulated by the postganglionic cholinergic neurons of either the parasympathetic or the sympathetic system.
- **Muscarine activates** only muscarinic receptors whereas **nicotine activates** only nicotinic receptors; acetylcholine activates both of them.

2 Norepinephrine

Guyton: The norepinephrine acts on two classes of receptors,
- Alpha (α).
- Beta (β)

alpha receptors divided into α1 and α2 which are linked to different G proteins beta receptors divided into β1, β2, and β3, because certain chemicals affect certain β receptors

The Neurotransmitters & Receptors Of Autonomic

	Sympathatic	Parasympathatic
Neurotransmitters	-Cholinergic = (release acetylcholine by pre-ganglionic axons). -Postganglionic neurons: release norepinephrine at target ie. organs Adrenergic.	Pre & Postganglionic neurons release acetylcholine = Cholinergic
Preganglionic Axons	All preganglionic release Acetylcholine (Ach)	
Postganglionic Axons	All sympathetic postganglionic release Noradrenaline except sweat glands & blood vessels to skeletal muscles (explained in the next slide)	All parasympathetic postganglionic release Acetylcholine (Ach)
Receptors	The Sympathetic NS Acts on two types of receptors : α and β. What do the receptors do? - Activation of α receptors leads to smooth muscle contraction. (Like blood vessels) - Activation of β2 receptors leads to smooth muscle relaxation. (Like the lungs) - Activation of βI receptors leads to smooth muscle contraction (especially in heart).	The ACh acts on two types of receptors, the muscarinic and nicotinic cholinergic receptors. 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 to stimulate the muscarinic receptors of the target organ
Picture		

The Neurotransmitters & Receptors of Autonomic

All sympathetic postganglionic release Noradrenaline except sweat glands & blood vessels to skeletal muscles, why ?

- Skeletal muscle has one motor neuron extends from the CNS to skeletal muscle. the cholinergic receptors Are located in skeletal muscle at the neuromuscular junction.

- Blood vessel: the adrenal medulla work as ganglia, which has a cholinergic receptors that activated by Acetylcholine, activates postsynaptic cholinergic receptors (on adrenal glands) triggers the secretion of medullary hormones (epinephrine and norepinephrine) in the blood vessels.

- Sweat glands: its ganglion release Acetylcholine. **Guyton:** The sweat glands secrete large quantities of sweat when the sympathetic nerves are stimulated, but no effect is caused by stimulating the parasympathetic nerves. However, the sympathetic fibers to most sweat glands are cholinergic (except for a few adrenergic fibers to the palms and soles), in contrast to almost all other sympathetic fibers, which are adrenergic.
Furthermore, the sweat glands are stimulated primarily by centers in the hypothalamus that are usually considered to be parasympathetic centers. Therefore, sweating could be called a parasympathetic function, even though it is controlled by nerve fibers that anatomically are distributed through the sympathetic nervous system.
Guyton: These glands can also be stimulated to some extent by epinephrine or norepinephrine circulating in the blood, even though the glands themselves do not have adrenergic innervation.

- **The chemical transmitter at both pre and postganglionic synapses in parasympathetic system is acetylcholine (Ach)**

The Autonomic Nervous System

	Sympathetic (adrenergic with exceptions)	Parasympathetic (muscarinic)
Circulatory System		
Cardiac Output	Increases	M2: decreases
SA node: heart rate (chronotropic)	βI,β2: increases	M2: decreases
Cardiac muscle: Contractility(inotropic)	βI,β2 increases	M2: decreases (atria only)
Conduction at AV node	βI: increases	M2: decreases
vascular smooth muscle	M3: contracts; α = contracts; β2 = relaxes	-
platelets	α2: aggregates	-
Mast cells - histamine	β2: inhibits	-
Respiratory system		
Smooth muscles or bronchioles	β2: relaxes (major contribution); αI:contracts (minor contribution)	M3: contracts
Nervous system		
Pupil of eye	αI: relaxes	M3: contracts
ciliary muscle	β2: relaxes	M3: contracts

The Autonomic Nervous System
continued....

	Sympathetic (adrenergic with exceptions)	Parasympathetic (muscarinic)
Endocrine system		
Pancreas (islets)	α2: decreases secretion	-
Adrenal medulla	N: secretes epinephrine	-
Digestive system		
Salivary Glands: secretions	β: stimulates viscous, amylase secretions; α = stimulates potassium cation	stimulates watery secretions
Lacrimal Glands (tears)	decreases	M3: increases
Kidney (renin)	secretes	-
parietal cells	-	MI: secretion
liver	αI, β2: glycogenolysis, gluconeogenesis	-
GI tract motility	decreases	MI,M3: increases
Smooth muscles of GI tract	α,β2: relaxes	M3: contracts
Sphincters of GI tract	αI: contracts	M3: relaxes

The Autonomic Nervous System
continued....

	Sympathetic (adrenergic with exceptions)	Parasympathetic (muscarinic)
Urinary system		
Bladder wall	β2: relaxes	contracts
ureter	αI: contracts	relaxes
Sphincter	αI: contracts, β2 relaxes	relaxes
Sweat gland secretion	M: stimulates (major contribution) αI: stimulates (minor contribution)	-
Arrector pili	αI: stimulates	-

The Stress Reaction

Female slides

- **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.**

Causes of autonomic disorders

- Autonomic disorders may result from disorders that damage autonomic nerves or parts of the brain that help control body processes, or they may occur on their own, without a clear cause.
- Common causes of autonomic disorders are:
  - Diabetes (the most common cause)
  - Peripheral nerve disorders
  - Aging
  - Parkinson disease

- Other, less common causes include the following:
  - Autonomic neuropathies
  - Multiple system atrophy
  - Pure autonomic failure
  - Spinal cord disorders
  - Certain drugs
  - Disorders of the neuromuscular junction (where nerves
  - connect with muscles), such as botulism and Lambert-Eaton syndrome
  - Certain viral infections, including COVID-19 ————————>
  - Injury to nerves in the neck, including that due to surgery

Diagnosis of Autonomic Disorders

• A doctor's evaluation
• Tests to determine how blood pressure changes during certain maneuvers
• Electrocardiography
• Sweat testing

- Autonomic dysfunction that occurs with COVID-19 is still being studied. It can cause orthostatic intolerance and, less commonly, an autonomic neuropathy. Orthostatic intolerance describes dysfunction of the autonomic nervous system that occurs when a person stands up. Symptoms include light-headedness, blurred vision, head pressure, palpitations, tremulousness, nausea, and difficulty breathing. Even loss of consciousness can occur.

Symptoms of autonomic disorders

-In men, difficulty initiating and maintaining an erection (**erectile dysfunction**) can be an early symptom of an autonomic disorder.

-Autonomic disorders commonly cause dizziness or light-headedness due to an excessive decrease in blood pressure when a person stands (**orthostatic hypotension**).

-People may sweat less or not at all and thus become intolerant of heat. The eyes and mouth may be dry.

-After eating, a person with an autonomic disorder may feel prematurely full or even vomit because the stomach empties very slowly (called gastroparesis). Some people pass urine involuntarily (**urinary incontinence**), often because the bladder is overactive. Other people have difficulty emptying the bladder (**urine retention**) because the bladder is underactive.

- **Constipation** may occur, or control of bowel movements may be lost.

-The pupils may not dilate and narrow (constrict) as light changes.

Diagnosis of autonomic disorders

-During the physical examination, doctors can check for signs of autonomic disorders, such as orthostatic hypotension. For example, they measure blood pressure and heart rate while a person is lying down or sitting and after the person stands to check how blood pressure changes when position is changed. When a person stands up, gravity makes it harder for blood from the legs to get back to the heart. Thus, blood pressure decreases. To compensate, the heart pumps harder, and the heart rate increases. However, the changes in heart rate and blood pressure are slight and brief. If the changes are larger or last longer, the person may have orthostatic hypotension.

-Blood pressure is also measured continuously while the person does a Valsalva maneuver (forcefully trying to exhale without letting air escape through the nose or mouth—similar to straining during a bowel movement). Electrocardiography is done to determine whether the heart rate changes as it normally does during deep breathing and the Valsalva maneuver.

-A tilt table test may be done to check how blood pressure and heart rate change when position is changed. In this test, blood pressure is measured before and after the person, who is lying flat on a pivoting table, is tilted into an upright position.

- The tilt table test and the Valsalva maneuver, done together, can help doctors determine whether a decrease in blood pressure is due to an autonomic nervous system disorder.

-Doctors examine the pupils for abnormal responses or lack of response to changes in light.

- Sweat testing is also done. For one sweat test, the sweat glands are stimulated by electrodes that are filled with acetylcholine and placed on the legs and forearm. Then, the volume of sweat is measured to determine whether sweat production is normal. A slight burning sensation may be felt during the test.

-In the thermoregulatory sweat test, a dye is applied to the skin, and a person is placed in a closed, heated compartment to stimulate sweating. Sweat causes the dye to change color. Doctors can then evaluate the pattern of sweat loss, which may help them determine the cause of the autonomic nervous system disorder.

-Other tests, including blood tests, may be done to check for disorders that can cause the autonomic disorder.

Treatment of autonomic disorders

• Treatment of the cause if identified
• Symptom relief
- Disorders that may be contributing to the autonomic are treated. .If no other disorders are present or if such disorders cannot be treated, the focus is on relieving symptoms.
- Simple measures and sometimes drugs can help relieve some symptoms of autonomic disorders:

Orthostatic hypotension: People are advised to elevate the head of the bed by about 4 inches (10 centimeters) and to stand up slowly. Wearing a compression or support garment, such as an abdominal binder or compression stockings, may help. Consuming more salt and water helps maintain the volume of blood in the bloodstream and thus blood pressure. Sometimes drugs are used. Fludrocortisone helps maintain blood volume and thus blood pressure. Midodrine helps maintain blood pressure by causing arteries to narrow (constrict). These drugs are taken by mouth.

Decreased or absent sweating: If sweating is reduced or absent, avoiding warm environments is useful.

Urinary retention: If urinary retention occurs because the bladder cannot contract normally, people can be taught to insert a catheter (a thin rubber tube) through the urethra and into the bladder themselves. The catheter allows the retained urine in the
• bladder to drain out, thus providing relief. People insert the catheter several times a day and remove it after the bladder is empty. Bethanechol can be used to increase bladder tone and thus help the bladder empty.

Constipation: A high-fiber diet and stool softeners are recommended. If constipation persists, enemas may be necessary.

Erectile dysfunction: Usually, treatment consists of drugs such as sildenafil, tadalafil, or vardenafil taken by mouth. Constriction devices (bands and rings placed at the base of the penis) and/or vacuum devices are sometimes used.

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.**

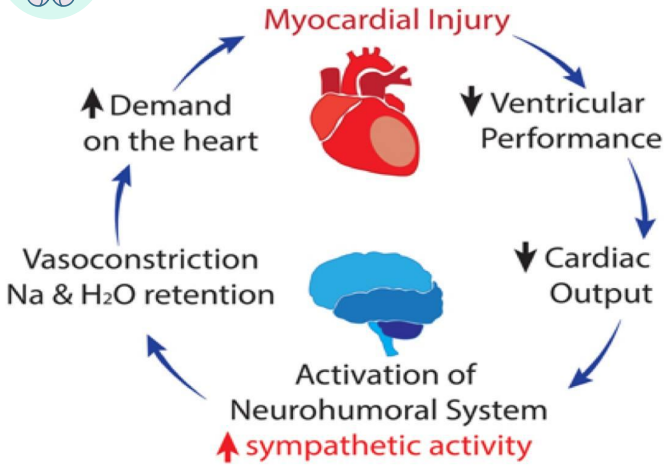
Response To Stress

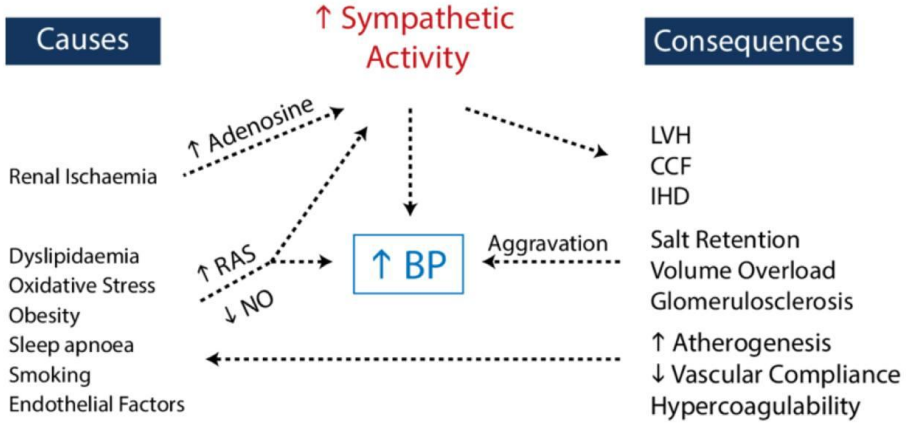
Psychological	Behavioral	Psychosomatic
- Short fuse - irritability - depression - frustration - emotional irritability - insecurity - mental illness - anxiety	- Drug use/abuse - alcohol use/abuse - smoking -strained relationships - eating problems - suicide attempts - violence - impulsive - irrational behavior	- Ulcers - High blood - Pressure - Insomnia - Indigestion - Headaches -Other cardiovascular -body infections -Irregular Pulse rate

Autonomic Brain Centers And Pathophysiology of COVID-19

- In summary, the potential role of autonomic brain control in the management of some physiopathological aspects observed in COVID- 19 patients has been discussed notably in relation to appetite loss and nausea/vomiting signs.

The Autonomic Nervous System





Non-Invasive Test

❖ **Tests for cardiac vagal function:**

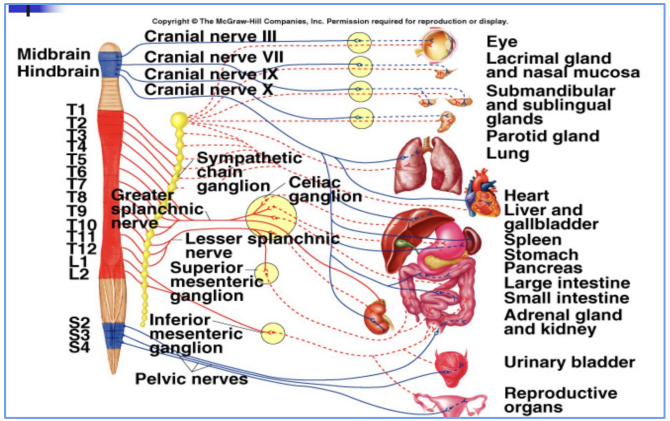
- respiratory sinus arrhythmia.
- valsalva ratio (phase IV/II).
- Bradycardia during phenylephrine challenge.
- Absence of tachycardia with atropine.

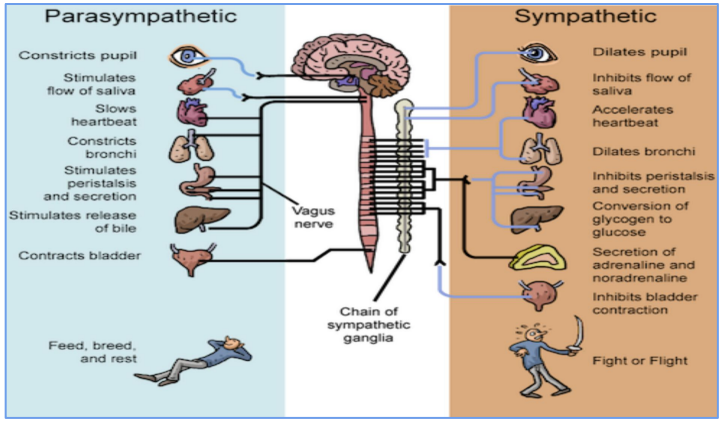
❖ **Tests for sympathetic function:**

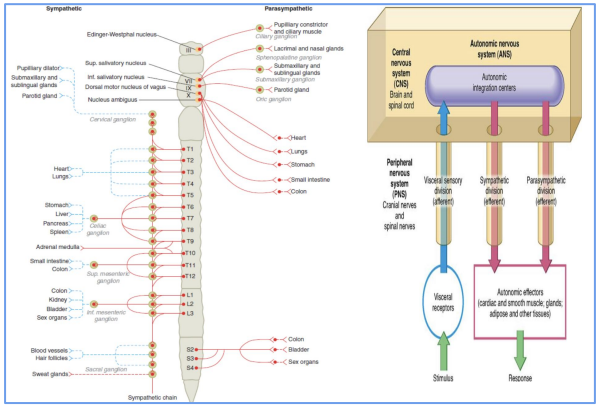
I) Cardiac:
- tachycardia during standing or head-up tilt.
- tachycardia during valsalva strain (phase II).

2) Peripheral:
- Blood pressure overshoot after valsalva release.
- BP increase when cold pressure test.
- Diastolic BP rise with isometric handgrip.
- Systolic and diastolic BP response to Upright position.

Pictures for better understanding..







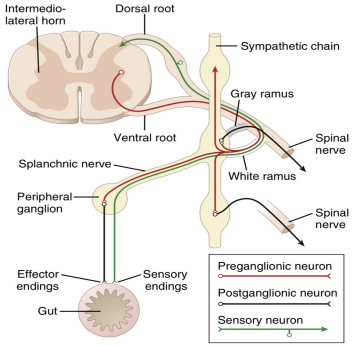


Figure 61-2. Nerve connections among the spinal cord, spinal nerves, sympathetic chain, and peripheral sympathetic nerves.

Table 61-1 Adrenergic Receptors and Function

Alpha Receptor	Beta Receptor
Vasoconstriction	Vasodilation (β_2)
Iris dilation	Cardioacceleration (β_1)
Intestinal relaxation	Increased myocardial strength (β_1)
Intestinal sphincter contraction	Intestinal relaxation (β_2) Uterus relaxation (β_2)
Pilomotor contraction	Bronchodilation (β_2)
Bladder sphincter contraction	Calorigenesis (β_2)
Inhibits neurotransmitter release (α_2)	Glycogenolysis (β_2) Lipolysis (β_1) Bladder wall relaxation (β_2) Thermogenesis (β_3)

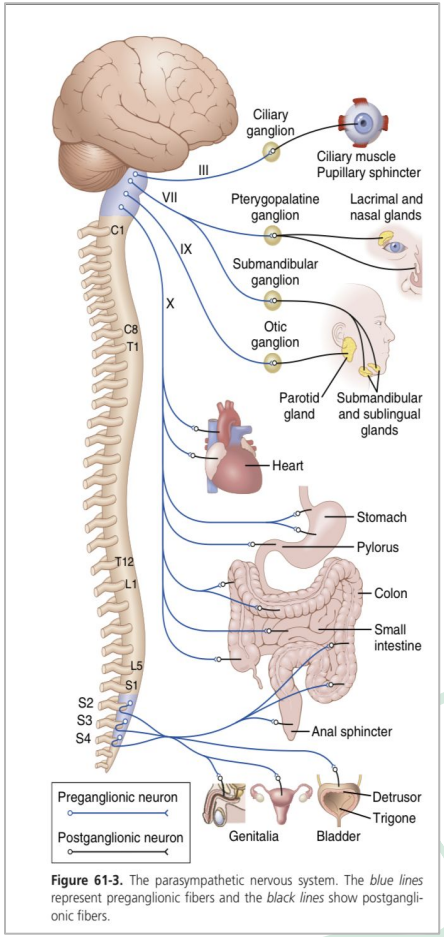


Figure 61-3. The parasympathetic nervous system. The *blue lines* represent preganglionic fibers and the *black lines* show postganglionic fibers.

TEST YOURSELF !

1- Which of the following neurotransmitters is found on both preganglionic & postganglionic neurons of the parasympathetic system?

A) Epinephrine
B) Norepinephrine
C) Dopamine
D) Acetylcholine

2- Which ONE of the following neurons is found in the lateral grey horn of the spinal cord?

A) Motor
B) Sensory
C) Sympathetic
D) Parasympathetic

3- Which one of the following receptors is found at the synapse between preganglionic and postganglionic sympathetic?

A) Adrenergic
B) Nicotinic
C) Serotonergic
D) Muscarinic

4- Which one of the following neurotransmitters is released at all the preganglionic autonomic neurons?

A) Dopamine
B) Epinephrine
C) Nicotine
D) Acetylcholine

Answers: D, C, B, D

SAQ

1- mentions two differences between autonomic and somatic nervous systems ?

1) somatic axons is myelinated
2) autonomic has two neurons (preganglionic and postganglionic)

2- mention the origin of sympathetic and parasympathetic nerve fibers?

Sympathetic: Thoracolumbar lateral horns of the spinal segment TI-L2.
Parasympathetic: Craniosacral. Cranial nerves III, VII, IX and X in the brain stem.
[S2-S4] sacral segments of the spinal cord.

3- mention the ANS neurotransmitters and what receptors do they act on

Acetylcholine and norepinephrine, they act on nicotinic and muscarinic receptors

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