

The Nervous System

PART 4 - The Autonomic Nervous System

1

The ANS

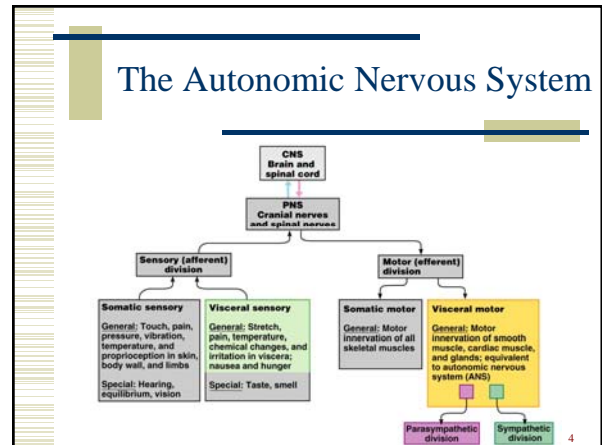
- ◆ The ANS – a system of **motor neurons**
- ◆ *Innervates*
 - Smooth muscle
 - Cardiac muscle
 - Glands

2

The ANS and Visceral Sensory Neurons

- Regulates *visceral functions* such as:
 - Heart rate
 - Blood pressure
 - Digestion
 - Urination
- The ANS is the
 - **General visceral motor** division of the PNS

3



Comparison of Autonomic and Somatic Motor Systems

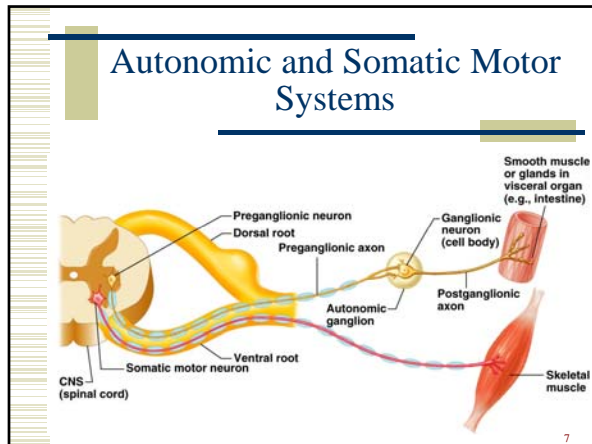
- ◆ **Somatic motor system**
 - One motor neuron extends from the CNS to skeletal muscle
 - Axons are well myelinated, conduct rapid impulses

5

Comparison of Autonomic and Somatic Motor Systems

- ◆ **Autonomic nervous system**
 - Chain of *two* motor neurons
 - **Preganglionic neuron** – cell body in CNS
 - **Postganglionic neuron** – cell body in autonomic ganglion
 - Conduction is *slower* than somatic nervous system due to
 - Thinly myelinated or unmyelinated axons
 - Motor neuron synapses in a ganglion

6



Divisions of the Autonomic Nervous System

- ◆ **Sympathetic and parasympathetic divisions**
 - Chains of *two motor neurons*
 - Innervate mostly the same structures
 - *Cause opposite effects*

Divisions of the Autonomic Nervous System

- ◆ **Sympathetic** – “fight, flight, or fright”
 - Activated during EXTREME situations
 - Exercise
 - Excitement
 - Emergencies
- ◆ **Parasympathetic** – “rest and digest”
 - Concerned with conserving energy

Anatomical Differences in Sympathetic and Parasympathetic Divisions

- ◆ Issue from different regions of the CNS
 - **Sympathetic** – also called the **thoracolumbar division**
 - **Parasympathetic** – also called the **craniosacral division**

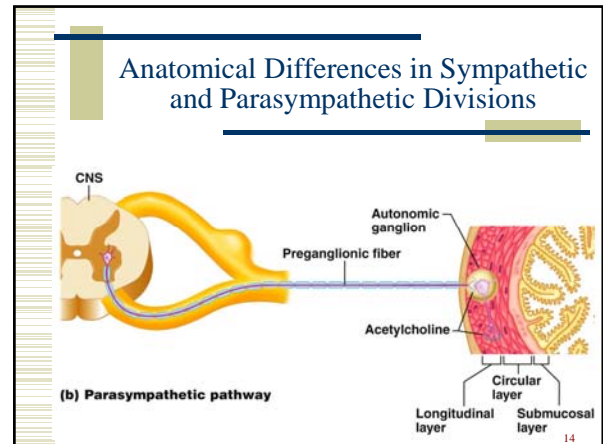
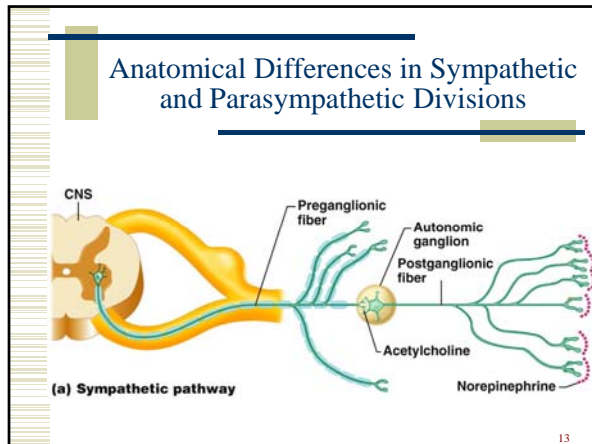
Labels in diagram: Brain stem, Cranial Sympathetic ganglia, Cervical, Thoracic, Lumbar, Sacral, Eye, Skin, Salivary glands, Heart, Lungs, Stomach, Pancreas, Liver and gall-bladder, Adrenal gland, Bladder, Genitals.

Anatomical Differences in Sympathetic and Parasympathetic Divisions

- ◆ Length of postganglionic fibers
 - **Sympathetic** – *long* postganglionic fibers
 - **Parasympathetic** – *short* postganglionic fibers
- ◆ Branching of axons
 - **Sympathetic axons** – highly branched
 - Influences *many organs*
 - **Parasympathetic axons** – few branches
 - *Localized effect*

Anatomical Differences in Sympathetic and Parasympathetic Divisions

- ◆ Neurotransmitter released by postganglionic axons
 - **Sympathetic** –
 - most release **norepinephrine**
 - **Parasympathetic** –
 - release **acetylcholine**



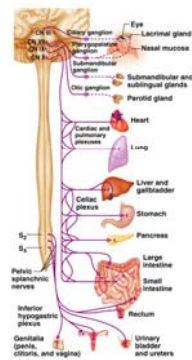
- ### The Parasympathetic Division
- ♦ **Cranial outflow**
 - Comes from the brain
 - *Innervates*
 - Organs of the head, neck, thorax, and abdomen
 - ♦ **Sacral outflow**
 - Innervation supplies
 - Remaining abdominal and pelvic organs
- 15

- ### Cranial Outflow (Parasympathetic)
- ♦ **Preganglionic fibers** run via
 - Oculomotor nerve (CN III)
 - Facial nerve (CN VII)
 - Glossopharyngeal nerve (CN IX)
 - Vagus nerve (CN X)
- 16

- ### Sacral Outflow
- ♦ Emerges from S_2-S_4
 - ♦ Innervates organs of the **pelvis and lower abdomen**
 - ♦ Axons run in ventral roots to **ventral rami**
- 17

- ### The Parasympathetic Division
- ♦ Cell bodies of preganglionic motor neurons located in parts of certain cranial nerves or in sacral part of the spinal cord
 - ♦ Preganglionic axons synapse in terminal ganglia which are located close to or on the organ being innervated
 - ♦ Postganglionic axons travel from the terminal ganglia to the target organ
- 18

The Parasympathetic Division



19

The Sympathetic Division

- ◆ Basic organization
 - Issues from T₁–L₂
 - Preganglionic fibers form the **lateral gray horn**
 - Supplies visceral organs and structures of superficial body regions
 - Contains *more ganglia* than the parasympathetic division

20

Sympathetic Trunk Ganglia

- ◆ Long chains of axons on *both sides* of the vertebral column.
- ◆ Linked by short nerves into **sympathetic trunks**

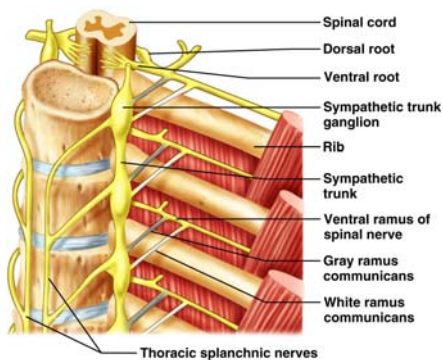
21

Sympathetic Trunk Ganglia

- ◆ Joined to **ventral rami** by white and gray **rami communicans**
 - White rami – runs from spinal nerve to the sympathetic trunk
 - Gray rami – sympathetic trunk TO spinal nerve

22

Sympathetic Trunk Ganglia

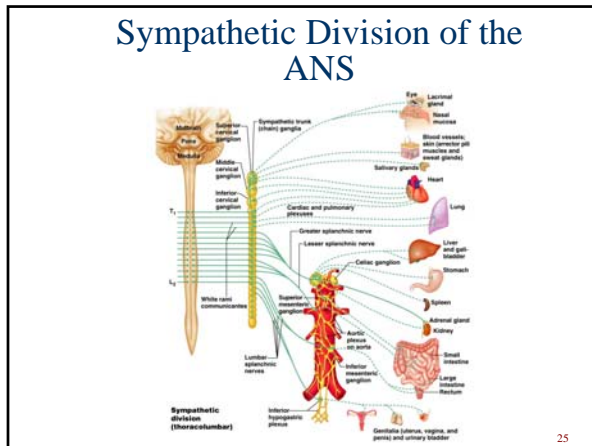


23

Prevertebral Ganglia

- ◆ Unpaired, *not segmentally arranged*
- ◆ Occur *only in abdomen and pelvis*
- ◆ Lie anterior to the vertebral column
- ◆ Main ganglia
 - Celiac, superior mesenteric, inferior mesenteric, and inferior hypogastric ganglia

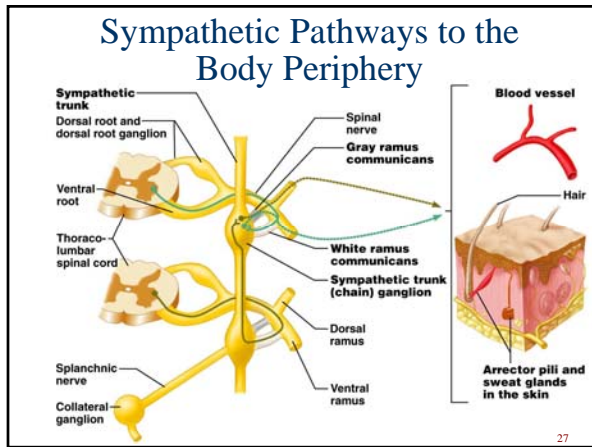
24



Sympathetic Pathways to the Body Periphery

- ◆ Innervate
 - Sweat glands
 - Peripheral blood vessels
 - *Arrector pili* muscles

26



Sympathetic Pathways to the Head

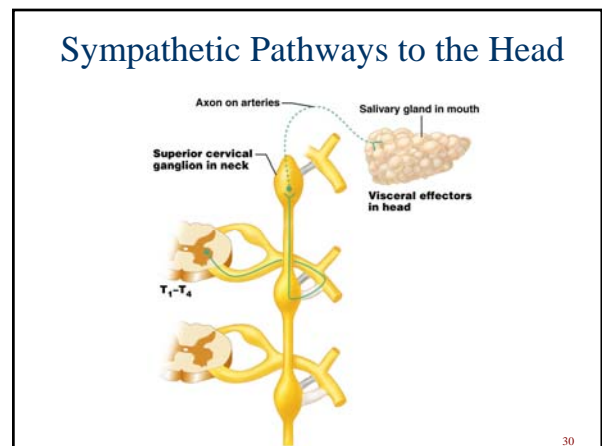
- ◆ Preganglionic fibers originate in spinal cord at T₁-T₄
- ◆ Fibers ascend in the **sympathetic trunk**
 - Synapse in superior cervical ganglion

28

Sympathetic Pathways to the Head

- ◆ Postganglionic fibers associate with large arteries
 - Carried by these structures to
 - Glands
 - Smooth muscle
 - Vessels throughout the head

29

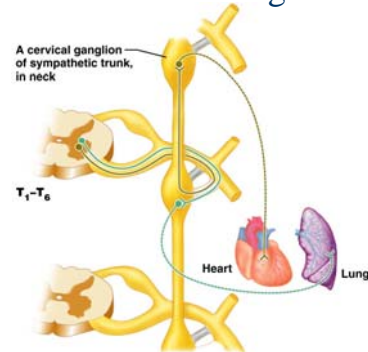


Sympathetic Pathways to Thoracic Organs

- ◆ Preganglionic fibers originate at spinal levels T₁-T₆
- ◆ Some fibers synapse in nearest sympathetic trunk ganglion
- ◆ **Postganglionic fibers** run directly to the organ supplied

31

Sympathetic Pathways to Thoracic Organs



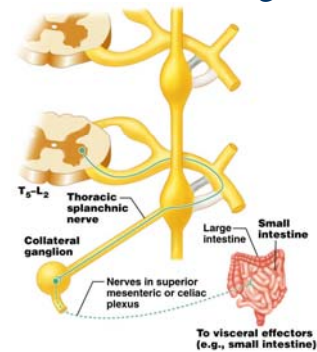
32

Sympathetic Pathways to Abdominal Organs

- ◆ Preganglionic fibers originate in spinal cord (T₅-L₂)
- ◆ Pass **through** adjacent sympathetic trunk ganglia
 - Then travel in **thoracic splanchnic nerves**
 - Synapse in **prevertebral ganglia** on the abdominal aorta
 - Celiac and superior mesenteric ganglia
 - **Inhibit activity** of muscles and glands in visceral organs

33

Sympathetic Pathways to the Abdominal Organs



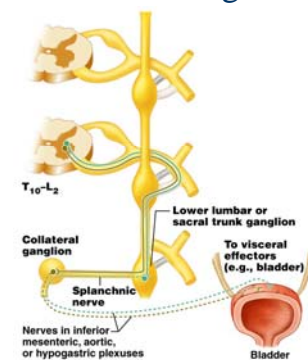
34

Sympathetic Pathways to the Pelvic Organs

- ◆ **Preganglionic fibers** originate in spinal cord (T₁₀-L₂)
- ◆ Some fibers *synapse in sympathetic trunk*
- ◆ *Other preganglionic fibers synapse in prevertebral ganglia*
- ◆ Postganglionic fibers proceed from plexuses to pelvic organs

35

Sympathetic Pathways to the Pelvic Organs



36