NERVOUS SYSTEM:
AUTONOMIC NERVOUS SYSTEM
In Anatomy Today
Functional Overview of the Nervous System

- **Central Nervous System** (brain and spinal cord)
  - Sensory information within afferent division
  - Motor commands within efferent division

- **Peripheral Nervous System**
  - Somatic nervous system
  - Autonomic nervous system
    - Parasympathetic division
    - Sympathetic division

- **Receptors**
  - Special sensory receptors (provide sensations of smell, taste, vision, balance, and hearing)
  - Visceral sensory receptors (monitor internal organs, including those of cardiovascular, respiratory, digestive, urinary, and reproductive systems)
  - Somatic sensory receptors (monitor skeletal muscles, joints, skin surface; provide position sense and touch, pressure, pain and temperature sensations)

- **Effectors**
  - Skeletal muscle
  - Smooth muscle
  - Cardiac muscle
  - Glands

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The Autonomic Nervous System

• “Involuntary”
• Function to modulate ongoing automatic activities
• Effectors (target tissues)
  – smooth muscle
  – cardiac muscle
  – glands
• Functional examples:
  – heart rate
  – ventilation
  – digestive tract activity
ANS is a Two Neuron System

- Preganglionic fibers
  - exit the CNS and terminate onto autonomic ganglia

- Postganglionic fibers
  - exit the autonomic ganglia and terminate onto the target
Components and Subdivisions of the ANS

- **Sympathetic division**
  - Fight or flight
  - Preganglionic fibers emerge from T1-L2
  - Postganglionic neurons emerge from sympathetic chain ganglia

- **Parasympathetic division**
  - Rest and repose
  - Preganglionic fibers emerge from pons, medulla, S2-S4
  - Postganglionic neurons within effector
Components and Subdivisions of the ANS

AUTONOMIC NERVOUS SYSTEM

THORACOLUMBAR DIVISION (sympathetic division of ANS)

CRANIOSACRAL DIVISION (parasympathetic division of ANS)

Cranial nerves (N III, N VII, N IX, and N X)

Thoracic nerves

Lumbar nerves (L1, L2 only)

Sacral nerves (S2, S3, S4 only)

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Organization of the Sympathetic Division

**SYMPATHETIC DIVISION OF ANS**

**PREGANGLIONIC NEURONS**
- Lateral gray horns of spinal segments $T_1 - L_2$

**GANGLIONIC NEURONS**
- Sympathetic chain ganglia (paired)
- Collateral ganglia (unpaired)
- Suprarenal medullae (paired)

**TARGET ORGANS**
- Visceral effectors in thoracic cavity, head, body wall, and limbs
- Visceral effectors in abdominopelvic cavity
- Organs and systems throughout body

**KEY**
- Preganglionic fibers
- Postganglionic fibers
- Hormones released into circulation

Through release of hormones into the circulation

Innervation by post-ganglionic fibers
Sympathetic Division

• Sympathetic chain
  – Location: either side of vertebral column
  – Innervate effectors in body wall, inside thoracic cavity
  – preganglionic fibers synapse on postganglionic fibers very close to the CNS and far away from effector organs

• Collateral ganglia
  – Location: between sympathetic chain and effector

• Adrenal medulla
  – Sympathetic preganglionic neurons enter adrenal medulla and stimulate postganglionic neurons
  – Cells respond and release adrenalin (80% epinephrine, 20% norepinephrine)
Anatomical Distribution of Sympathetic Postganglionic Fibers
Collateral Ganglia

- **Celiac ganglion**
  - Stomach, duodenum, liver, pancreas, spleen, gallbladder

- **Superior mesenteric ganglion**
  - Small intestines, beginning of large intestines

- **Inferior mesenteric ganglion**
  - Kidney, bladder, reproductive organs, large intestines
Adrenal Medulla

THE SUPRARENAL MEDULLAE

KEY
- Preganglionic neurons
- Ganglionic neurons

Preganglionic fibers
Endocrine cells (specialized ganglionic neurons)
Suprarenal medullae

Secretes neurotransmitters into general circulation
Organization of the Parasympathetic Division

**PARASYMPATHETIC DIVISION OF ANS**

**PREGANGLIONIC NEURONS**
- Nuclei in brain stem
  - N III
  - N VII
  - N IX
  - N X

**GANGLIONIC NEURONS**
- Ciliary ganglion
- Pterygopalatine and submandibular ganglia
- Otic ganglion
- Intramural ganglia

**TARGET ORGANS**
- Intrinsic eye muscles (pupil and lens shape)
- Nasal glands, tear glands, and salivary glands
- Parotid salivary gland
- Visceral organs of neck, thoracic cavity, and most of abdominal cavity
- Visceral organs in inferior portion of abdominopelvic cavity

**KEY**
- Preganglionic fibers
- Postganglionic fibers

Nuclei in spinal cord segments $S_2 - S_4$

Pelvic nerves
Parasympathetic Division

• Involves cranial nerves: III, VII, IX and X, S2-S4
• Innervates visceral organs
• Preganglionic fibers synapse on postganglionic fibers far away from the CNS and within effector organs
Anatomical Distribution of Parasympathetic Postganglionic Fibers
Dual Innervation
Levels of Autonomic Control

- CEREBRAL CORTEX
- LIMBIC SYSTEM AND THALAMUS
  - Emotions, sensory input
- HYPOTHALAMUS
  - Sympathetic and parasympathetic headquarters
- PONS
  - Higher levels of respiratory control
- MEDULLA OBLONGATA
  - Processing centers for complex visceral reflexes (sympathetic and parasympathetic)
- SPINAL CORD
  - T1 – L2
  - Neurons controlling sympathetic visceral reflexes
- SACRAL SPINAL CORD
  - S2 – S4
  - Neurons controlling parasympathetic visceral reflexes (e.g., defecation, urination)