The Autonomic Nervous System
Chapter 16

Introduction
• Makes all routine adjustments in physiological systems.
• Consists of visceral motor (efferent) neurons
• Involves 2 neurons synapsing in an autonomic ganglion
  – Preganglionic (neuron #1)
  – Postganglionic (neuron #2)

Nerve Fibers of the ANS
• Preganglionic (neuron #1)
  – Always myelinated
  – Neurotransmitter
    • ACh
• Postganglionic (neuron #2)
  – Always nonmyelinated
  – Neurotransmitter
    • Ach
    • Norepinephrine

Subdivisions of the ANS
• Sympathetic division (thoracolumbar)
  – Cell bodies for neurons #1
    • thoracic and lumbar portions of the spinal cord.
    • T1 – L2
• Parasympathetic division (craniosacral)
  – Cell bodies
    • brain stem (cranial nerves)
    • sacral portion of the spinal cord.

Functions of the ANS
• Sympathetic division
  – Stimulates heart beat & tissue metabolism,
  increases alertness, prepares the body to deal with emergencies ("fight or flight" division)
• Parasympathetic division
  – Slows the heart rate, inhibits senses, prepares the body for rest and relaxation; ("rest and digest" division).

The Sympathetic Division
Organization of the SNS

- Neurons #1
  - Short
  - Usually synapse with neurons #2 (long) in ganglia
- Ganglia
  - Sympathetic chain
  - Collateral

Sympathetic Chain Ganglia

- A chain of ganglia that run alongside the spinal cord
- Extends on both sides of the vertebral column
- Carries preganglionic fibers and cell bodies of postganglionic neurons

Anatomy of the Sympathetic Chain

- Rami communicantes from spinal nerves connect to the chain
- Splanchnic nerves project from the chain

Routes of Preganglionic Axons

- Cell bodies of neurons #1
  - In lateral gray horns
- Axons of neurons #1 enter ventral root
- Axons pass to spinal nerve
- Axons leave spinal nerve via white and gray branches (rami communicantes)

Routes of Preganglionic Axons – Possibility #1

- Neuron #1 synapses with the ganglion at same level of spinal cord
  - Neuron #2 leaves at that level via the gray ramus communicans, rejoins the same level spinal nerve

- There are 4 possible routes that sympathetic neurons #1 may follow
Routes of Preganglionic Axons - Possibility #2

- Neuron #1 goes up or down the chain and synapses at some other level.
  - Neuron #2 leaves at that level via the gray ramus communicans, rejoins the spinal nerve at that level.

Routes of Preganglionic Axons - Possibility #3

- Neuron #1 does not synapse in the chain but exits by a splanchnic nerve and synapses in a collateral ganglion.
  - Neuron #2 travels from that ganglion to its destination.

Collateral Ganglia

- Location – anterior to the aorta in the abdominopelvic cavity
  - Celiac ganglion
    - Innervates upper abdominal viscera
  - Superior mesenteric ganglion
    - Innervates middle abdominal viscera
  - Inferior mesenteric ganglion
    - Innervates lower abdominal & pelvic organs

Routes of Preganglionic Axons – Possibility #4

- Neuron #1 does not synapse in a ganglion
  - Synapses with adrenal medulla
  - Only preganglionic neurons are in this pathway
  - Neuron #1 stimulates the medulla
  - The medulla releases norepinephrine and epinephrine (adrenaline) to blood

Adrenal Medulla

- Widespread
  - The sympathetic chain allows one preganglionic fiber to synapse with many postganglionic neurons
- Enhanced & prolonged by the adrenal medulla
Neurotransmitters

- Preganglionic fibers release acetylcholine (Ach) – Cholinergic
- Postganglionic fibers (most) release norepinephrine (NE) – Adrenergic
- Adrenal medulla releases norepinephrine and epinephrine (adrenaline)

Membrane Receptors & Sympathetic Function

- 2 types of receptors in synapses
  - The same neurotransmitter can have different effects
- Alpha receptors cause a rise in intracellular calcium
- Beta receptors cause changes in the metabolic activity of the target cells

Summary of Sympathetic Division

- Cell bodies are found in the thoracic and lumbar portions of the spinal cord
- Preganglionic fibers are short, connect to the sympathetic chain, and synapse with long postganglionic fibers
- Preganglionic fibers produce Ach, postganglionic fibers produce NE or Ach
- “Fight or flight” division

The Parasympathetic Division

Organization of the PNS

- Cell bodies are in the brain or in the gray matter of the spinal cord (sacral region)
- Neurons #1 exit the cranial region through cranial nerves 3, 7, 9, & 10
- Neurons #1 exit the spinal cord through the sacral spinal nerves

Organization of the PNS

- Neurons #1 are long and synapse with neurons #2 (short) in ganglia
- Ganglia are found on near the visceral effector
Effects of Parasympathetic Stimulation
• The cranial nerve fibers involved are motor-control smooth muscle & glands in the upper body

General Functions of the PNS
• Prepares the individual for rest and relaxation
• "Rest & digest" division
• Effects on various organs:
  – Decreases heart rate
  – Constricts bronchioles
  – Increases salivation
  – Increases motility of stomach
  – Increases motility of colon
  – Constricts pupils

Neurotransmitter
• Both preganglionic and postganglionic fibers release acetylcholine
  – Causes localized and short-term effects

Summary of the Parasympathetic Division
• Cell bodies are found in the brain and in the sacral region of the spinal cord
• Preganglionic fibers are long and synapse with short postganglionic fibers on or near the target viscera
• Both preganglionic and postganglionic fibers produce Ach
• "Rest & digest" division

Relationship Between the Sympathetic and Parasympathetic Divisions
• Most organs receive dual innervation
• Visceral organs are intrinsically excited
  – ANS either increase excitation or inhibit the activity
  – Eg. Heart rate