The Autonomic Nervous System

• Regulate activity of smooth muscle, cardiac muscle & certain glands

• Structures involved
  – general visceral sensory neurons
  – integration center within the brain
  – general visceral motor neurons
Autonomic versus Somatic NS

• Somatic nervous system
  – consciously perceived sensations
  – excitation of skeletal muscle
  – one motor neuron connects CNS to organ

• Autonomic nervous system
  – unconsciously perceived visceral sensations
  – involuntary inhibition or excitation of smooth muscle, cardiac muscle or glandular secretion
  – two motor neurons needed to connect CNS to organ
    • preganglionic and postganglionic neurons
Autonomic versus Somatic NS

- Notice that the ANS pathway is a 2 neuron pathway while the Somatic NS only contains one neuron.
Basic Anatomy of ANS

- **Preganglionic motor neuron**
  - cell body in brain or spinal cord
  - axon is myelinated fiber that extends to autonomic ganglion

- **Postganglionic motor neuron**
  - cell body lies outside the CNS in an autonomic ganglion
  - axon is unmyelinated fiber that terminates in a visceral effector
Divisions motor neurons in the ANS

- 2 major divisions
  - parasympathetic
  - sympathetic

- Dual innervation
  - one speeds up organ
  - one slows down organ
  - Sympathetic NS increases heart rate
  - Parasympathetic NS decreases heart rate
Sources of Dual Innervation

**Sympathetic (thoracolumbar) division**
- preganglionic cell bodies in thoracic and first 2 lumbar segments of spinal cord

**Parasympathetic (craniosacral) division**
- preganglionic cell bodies in nuclei of 4 cranial nerves and the sacral spinal cord
Locations of Autonomic Ganglia

- Ganglia contain soma of postganglionic neurons

- **Sympathetic Ganglia**
  - trunk (chain) ganglia near vertebral bodies
  - prevertebral ganglia near large blood vessel in gut
  - *Preganglionic sympathetic neurons are shorter than parasympathetic*

- **Parasympathetic Ganglia**
  - terminal ganglia in wall of organ
Circuitry of Sympathetic NS

• Divergence = each preganglionic cell synapses on many postganglionic cells
• Mass activation due to divergence
  – multiple target organs
  – fight or flight response explained
• Adrenal gland
  – modified cluster of postganglionic cell bodies that release epinephrine & norepinephrine into blood
Physiological Effects of the ANS

• Most body organs receive dual innervation
  – innervation by both sympathetic & parasympathetic

• Hypothalamus regulates balance (tone) between sympathetic and parasympathetic activity levels

• Some organs have only sympathetic innervation
  – sweat glands, adrenal medulla, arrector pili muscle & many blood vessels
Sympathetic Responses

- Dominance by the sympathetic system is caused by physical or emotional stress -- “E situations”
  - emergency, embarrassment, excitement, exercise
- Alarm reaction = flight or fight response
  - dilation of pupils
  - increase of heart rate, force of contraction & BP
  - decrease in blood flow to nonessential organs
  - increase in blood flow to skeletal & cardiac muscle
  - airways dilate & respiratory rate increases
  - blood glucose level increase
- Long lasting due to lingering of NE in synaptic gap and release of norepinephrine by the adrenal gland
Parasympathetic Responses

• Enhance “rest-and-digest” activities
• Mechanisms that help conserve and restore body energy during times of rest
• Normally dominate over sympathetic impulses
• SLUDD type responses = salivation, lacrimation, urination, digestion & defecation and 3 “decreases”---decreased HR, diameter of airways and diameter of pupil
• 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
Autonomic or Visceral Reflexes

- Autonomic reflexes occur over autonomic reflex arcs. Components of that reflex arc:
  - sensory receptor
  - sensory neuron
  - integrating center
  - pre & postganglionic motor neurons
  - visceral effectors

- Unconscious sensations and responses
  - changes in blood pressure, digestive functions etc
  - filling & emptying of bladder or defecation
Control of Autonomic NS

• Not aware of autonomic responses because control center is in lower regions of the brain

• Hypothalamus is major control center