The Autonomic Nervous System

Dr. Ali Ebneshahidi
Autonomic Nervous System (ANS)

1. Cranial and spinal nerves that function independently, autonomously, and continuously, without conscious effort.
2. Controls smooth and cardiac muscles, and glands.
3. Regulated largely by reflexes where stimuli are detected by sensory neurons, after processing by the brain or spinal cord, motor neurons produce activities at the effector organ.

- 2. subdivided into sympathetic ("in agreement") and parasympathetic ("disagreement ") nerves; where in general sympathetic nerves stimulate the effector organ (except certain digestive organs) and parasympathetic nerves inhibit the effector organ (except certain digestive organs).
Central nervous system (CNS)
- Brain and spinal cord
- Integrative and control centers

Peripheral nervous system (PNS)
- Cranial nerves and spinal nerves
- Communication lines between the CNS and the rest of the body

Sensory (afferent) division
- Somatic and visceral sensory nerve fibers
- Conducts impulses from receptors to the CNS

Motor (efferent) division
- Motor nerve fibers
- Conducts impulses from the CNS to effectors (muscles and glands)

Somatic nervous system
- Somatic motor (voluntary)
- Conducts impulses from the CNS to skeletal muscles

Autonomic nervous system (ANS)
- Visceral motor (involuntary)
- Conducts impulses from the CNS to cardiac muscle, smooth muscle, and glands

Sympathetic division
- Mobilizes body systems during activity

Parasympathetic division
- Conserves energy
- Promotes housekeeping functions during rest

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Parasympathetic

- Eye
- Salivary glands
- Heart
- Lungs
- Stomach
- Pancreas
- Liver and gall-bladder
- Bladder
- Genitals

Brain stem
Cranial
Sacral

1. Fibers originate in the brain stem (cranial fibers) or sacral spinal cord.
2a. Preganglionic fibers are long.
2b. Postganglionic fibers are short.
3. Ganglia are within or near visceral effector organs.

Sympathetic

- Eye
- Skin
- Salivary glands
- Lungs
- Heart
- Stomach
- Pancreas
- Liver and gall-bladder
- Adrenal gland
- Bladder
- Genitals

T₁
L₁

1. Fibers originate in the thoracic and lumbar spinal cord.
2a. Preganglionic fibers are short.
2b. Postganglionic fibers are long.
3. Ganglia are close to spinal cord.
Sympathetic Division

- most sympathetic nerves secrete norepinephrine and as a result are referred to as adrenergic fibers.
- location of ganglia is within few cm of CNS, along the vertebral column.
- sympathetic fibers originate from the thoracolumbar region of the spinal cord (mostly thoracic) [T1- L2].
- short preganglionic fibers.
- Long postganglionic fibers.
• Preganglionic sympathetic neurons in the gray matter of the spinal cord produce the lat. horns.

• after leaving the cord via ventral root the preganglionic sympathetic fibers pass through a white ramus communicans and enter paravertebral chain ganglion forming part of the sympathetic trunk (chain).
• All sympathetic preganglionic fibers release **Acetylcholine**. Most postganglionic fibers release **Norepinephrine**.

• Postganglionic fibers run from the ganglion to the organs that they supply.

<table>
<thead>
<tr>
<th>Cell bodies in central nervous system</th>
<th>Peripheral nervous system</th>
<th>Neurotransmitter at effector</th>
<th>Effector organs</th>
<th>Effect</th>
</tr>
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<tbody>
<tr>
<td>SOMATIC NERVOUS SYSTEM</td>
<td>Single neuron from CNS to effector organs</td>
<td>ACh</td>
<td>Skeletal muscle</td>
<td>+ Stimulatory</td>
</tr>
<tr>
<td></td>
<td>Heavily myelinated axon</td>
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<th>Two-neuron chain from CNS to effector organs</th>
<th>NE</th>
<th>Effector organs</th>
<th>+ – Stimulatory or inhibitory, depending on neurotransmitter and receptors on effector organs</th>
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<td>Lightly myelinated preganglionic axons</td>
<td>ACh, Norepinephrine</td>
<td>Measured postganglionic axon</td>
<td>Adrenal medulla, Blood vessel</td>
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<td>Ganglion</td>
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Acetylcholine (ACh)  Norepinephrine (NE)

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Parasympathetic Division

- preganglionic fibers of parasympathetic nerves arise from the CNS (brain stem) and sacral region of spinal cord ($S_2$- $S_4$).
- ganglia are close to visceral organs served.
- long preganglionic fibers.
- short postganglionic fibers.
- All fibers release Ach. (cholinergic fibers).
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Acetylcholine (ACh)  Norepinephrine (NE)
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Cranial Nerves with Parasympathetic Outflow

1. Oculomotor nerve III
2. facial nerve VII
3. Glossopharyngeal nerve IX
4. Vagus nerve X

- when vagus nerve pass through the thorax, it send branches to following plexuses:
  a. Cardiac - supply the heart.
  b. Pulmonary - supply the lungs and bronchi.
  c. Esophageal - supply the esophagus.

- when the main trunk of vagus nerve reaches the esophagus, it forms the Vagal Trunk.
Effects of Autonomic Stimulation

**Skin:** Apocrine gland
- S) sympathetic: ↑ secretion
- P) parasympathetic: No Action

Eccrine gland

**Special senses:**

**Iris of eye**
- S) sympathetic: dilation
- P) parasympathetic: constriction

**Tear gland:**
- S) inhibitory
- P: greatly ↑ secretion

**Endocrine system:**

**Adrenal cortex & Adrenal medulla**
- S: ↑ secretion
- P: No Action
Digestive system:
Gall bladder
• S: relaxation
• P: contraction
Intestine
• S: ↓ peristaltic Action
• P: ↑ peristaltic Action
Pancreas
• S: ↓ secretion
• P: ↑ secretion
Respiratory system
• S: dilate bronchioles
• P: constrict bronchioles
Heart muscle
• S: ↑ rate of heartbeat
• P: ↓ rate of heartbeat
Blood vessels suppling skin and other blood vessels

- S: constriction
- P: no action

Muscles of bladder

- S: relaxation
- P: contraction

Urinary sphincter

- S: contraction
- P: relaxation

Penis

- S: causes erection
- P: causes ejaculation

Vagina

- S: causes erection of clitoris
- P: causes contraction of vagina