Somatic Motor and Autonomic Nervous Systems

PNS

Afferent Division

<table>
<thead>
<tr>
<th>Efferent Division</th>
<th>Effectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Somatic Motor</td>
<td>skeletal muscles</td>
</tr>
<tr>
<td>Autonomic</td>
<td>cardiac muscle, smooth muscle, glands, adipose tissue</td>
</tr>
</tbody>
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sympathetic division
parasympathetic division

A. Somatic Motor Division
- *somatic motor neurons* activate skeletal muscles
- voluntary (mostly): control of movement, posture, breathing

1. Somatic Motor Pathway
- one motor neuron pathway from CNS to muscle:
  - motor neuron cell bodies located in ventral gray horn of spinal cord
  - axons travel through spinal nerves
  - axon terminals located at the neuromuscular junctions

2. Neuromuscular Junction

3 components:
1. axon terminal of motor neuron
2. synaptic cleft
3. motor end plate

- axon terminals secrete ACh into the synaptic cleft

**nicotinic cholinergic receptors** at the motor end plate

binding of ACh open cation channels → strong EPSP → exceeds threshold → muscle AP

B. Autonomic Division (ANS)
- involuntary control of autonomic effectors (visceral organs, blood vessels, etc.)
- activated by the hypothalamus, pons & medulla, and spinal cord (autonomic reflexes)

- two motor neuron pathway from CNS to effectors:
  - *preganglionic* fibers from CNS to *autonomic ganglia*
  - *postganglionic* fibers from autonomic ganglion to target organ

- 2 divisions:
  - **sympathetic** “fight or flight”
  - **parasympathetic** “rest and digest”

dual innervation of sympathetic and parasympathetic to target organs, usually antagonistic

both systems are active, but parasympathetic dominates during normal maintenance states; sympathetic system dominates during short-term stress, exercise, cold, drop in BP

1. ANS Organization
a. Sympathetic Division
- thoracolumbar outflow
- short preganglionic, long postganglionic fibers
- ganglia located in sympathetic chain and collateral ganglia
- postganglionic neurons secrete norepinephrine (NE) as the neurotransmitter at target cells
- **adrenal medulla** is functionally part of the sympathetic system

  stimulated directly by preganglionic sympathetic fibers

  secretes epinephrine (E) and norepinephrine (NE) as hormones

b. Parasympathetic Division
- craniosacral outflow
  - **vagus nerve** (cranial nerve X) is the major parasympathetic nerve to visceral organs
  - long preganglionic, short postganglionic fibers
  - postganglionic neurons secrete acetylcholine (ACh) as the neurotransmitter at target cells
  - terminal ganglia located in or near target organs
2. ANS Neurotransmitters and Receptors

**preganglionic fibers:** ACh → *nicotinic* cholinergic receptors
(sympathetic and parasympathetic)

**postganglionic fibers**
1. sympathetic: E, NE → *adrenergic* receptors
   a. **alpha-adrenergic receptors** ($\alpha_1$ → constriction of blood vessels)
      G-protein coupled receptors, activate phospholipase C second-messenger pathway
   b. **beta-adrenergic receptors** ($\beta_1$ → stimulates heart; $\beta_2$ → bronchodilation)
      G-protein coupled receptors, activate cAMP second-messenger pathway
2. parasympathetic: ACh → *muscarinic* cholinergic receptors
   G-protein coupled receptors, open or close K$^+$ channels (excitatory or inhibitory)

3. Summary of Sympathetic and Parasympathetic Effects

<table>
<thead>
<tr>
<th>Sympathetic</th>
<th>Parasympathetic</th>
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<tbody>
<tr>
<td>increases heart rate and contractility</td>
<td>decreases heart rate (no effect on contractility)</td>
</tr>
<tr>
<td>inhibits digestive tract motility and secretion</td>
<td>stimulates digestive tract motility and secretion</td>
</tr>
<tr>
<td>vasoconstriction in peripheral blood vessels</td>
<td>no effect on blood vessels</td>
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<tr>
<td>vasodilation in skeletal muscles</td>
<td></td>
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<tr>
<td>bronchiole dilation</td>
<td>bronchiole constriction</td>
</tr>
<tr>
<td>pupil dilation</td>
<td>pupil constriction</td>
</tr>
<tr>
<td>mobilization of energy reserves (glycogen and lipids)</td>
<td>no metabolic effects</td>
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