Chapter 15: Chemical Control of the Brain and Behavior

Today's focus: Autonomic Nervous system -- Sympathetic and Parasympathetic divisions

The Autonomic Nervous System
- Divisions of autonomic nervous system (ANS)
  - Sympathetic division (fight or flight)
    - Increased heart rate and blood pressure
    - Depressed digestive function
    - Mobilized glucose reserves
  - Parasympathetic division (rest and digest)
    - Slower heart rate, fall in pressure
    - Increased digestive functions
    - Stop sweating

The Autonomic Nervous System
- ANS Circuits versus Somatic Motor System
  - ANS
    - Actions multiple, widespread, slow
    - Widely coordinated and graded control
    - Commands all tissues and organs except skeletal muscle
    - Outside CNS
    - Disynaptic efferent pathways
The Autonomic Nervous System

ANS Circuits versus Somatic Motor System (Cont’d)

- Somatic
  - Rapid and accurate
  - Only peripheral targets
  - Commands only skeletal muscle
  - Within CNS
  - Monosynaptic pathway

Table 8-1

<table>
<thead>
<tr>
<th>Target tissue</th>
<th>Sympathetic division</th>
<th>Parasympathetic division</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lacrimal (tear) glands</td>
<td>No effect</td>
<td>Stimulates production of tears</td>
</tr>
<tr>
<td>Salivary glands</td>
<td>Stimulates production of a small amount of saliva (dry mouth)</td>
<td>Stimulates production of large amount of dilute saliva</td>
</tr>
<tr>
<td>Adrenal medulla</td>
<td>Stimulates secretion</td>
<td>No effect</td>
</tr>
<tr>
<td>Eye</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radial muscles of iris</td>
<td>Papillary dilation</td>
<td>No effect</td>
</tr>
<tr>
<td>Iris sphincter muscles</td>
<td>No effect</td>
<td>Papillary constriction</td>
</tr>
<tr>
<td>Ciliary muscle (controls thickness of lens)</td>
<td>Relaxation (focuses on distant objects)</td>
<td>Contraction (focuses on close objects)</td>
</tr>
<tr>
<td>Heart</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pacemaker cells</td>
<td>Increases rate of heartbeat</td>
<td>Decreases rate of heartbeat</td>
</tr>
<tr>
<td>Ventricular contractile fibers</td>
<td>Increases force of contraction</td>
<td>Little or no effect</td>
</tr>
</tbody>
</table>

Table 8-1

<table>
<thead>
<tr>
<th>Target tissue</th>
<th>Sympathetic division</th>
<th>Parasympathetic division</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lungs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smooth muscle in walls of bronchi</td>
<td>Dilates bronchi</td>
<td>Constricts bronchi</td>
</tr>
<tr>
<td>Mucous glands</td>
<td>No effect</td>
<td>Stimulates secretion of mucus</td>
</tr>
<tr>
<td>Gastrointestinal tract</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphincter muscles</td>
<td>Contraction</td>
<td>Relaxation</td>
</tr>
<tr>
<td>Smooth muscle in walls of tract</td>
<td>Reduces tone and motility</td>
<td>Increases tone and motility</td>
</tr>
<tr>
<td>Exocrine glands</td>
<td>Inhibits secretion</td>
<td>Stimulates secretion</td>
</tr>
<tr>
<td>Gallbladder</td>
<td>Inhibits contraction</td>
<td>Stimulates contraction</td>
</tr>
<tr>
<td>Liver</td>
<td>Increases glycogenolysis and therefore blood sugar</td>
<td>No effect</td>
</tr>
<tr>
<td>Other tissues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary bladder</td>
<td>No effect</td>
<td>Stimulates muscle contraction</td>
</tr>
<tr>
<td>Arteries</td>
<td>Vasoconstriction in vessels supplying skin and gut</td>
<td>No effect</td>
</tr>
<tr>
<td></td>
<td>Vasodilatation in some vessels supplying skeletal muscle</td>
<td></td>
</tr>
</tbody>
</table>
Sympathetic and Parasympathetic Divisions

The 12 pairs of Cranial Nerves

Mnemonic:
On Old Olympus' Towering Top
A Finn And German Viewed Some Hoes

Table 1. Cranial Nerves Summary

http://www.meddean.luc.edu/lumen/MedEd/grossanatomy/h_n/cn/cn1/table1.htm
The Enteric Division
- Location: Lining of esophagus, stomach, intestines, pancreas, and gallbladder
- Composition: Two complicated networks - myenteric (Auerbach’s) plexus and submucous (Meissner’s) plexus
- Function: Control physiological processes involved in transport, digestion of food
- Inputs: From brain via axons of the sympathetic and parasympathetic divisions

The Autonomic Nervous System
- Central Control of the ANS
  - Connections for autonomic control
    - Periventricular zone connections to brain stem and spinal cord nuclei
    - Nucleus of solitary tract
  - Function of solitary nucleus
    - Integrates sensory information from internal organs and coordinates output

Neurotransmitters and the Pharmacology of Autonomic Function
- ANS: Better understanding of drug mechanisms influencing synaptic transmission (vs. CNS)
- Preganglionic Neurotransmitters
  - Primary transmitter: ACh
  - ACh: Binds to nAChR, evokes fast EPSP
  - Ganglionic ACh: Activates mAChR, slow EPSPs and IPSPs
  - Preganglionic terminals: Small EPSPs

Postganglionic Neurotransmitters
- Parasympathetic: Release ACh
  - Local effect
  - Sympathetic: Release NE
  - Far-reaching effects
- Parasympathomimetic: Mimic or promote muscarinic actions of ACh or inhibit actions of NE
- Sympathomimetic: Mimic or promote NE actions or inhibit muscarinic actions of ACh
Table 8-2: Pharmacology of neurotransmission in the autonomic nervous system

<table>
<thead>
<tr>
<th></th>
<th>Transmitter of preganglionic neuron</th>
<th>Receptors on preganglionic neuron</th>
<th>Transmitter of postganglionic neuron</th>
<th>Receptors on postganglionic neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sympathetic division</td>
<td>Acetylcholine (ACh)</td>
<td>Nicotinic ACh receptors</td>
<td>Norepinephrine</td>
<td>a- or b-Adrenergic receptors</td>
</tr>
<tr>
<td>Parasympathetic division</td>
<td>Acetylcholine</td>
<td>Nicotinic ACh receptors</td>
<td>Acetylcholine</td>
<td>Muscarinic ACh receptors</td>
</tr>
</tbody>
</table>

http://en.wikipedia.org/wiki/Adrenergic_receptor

http://www.youtube.com/watch?v=5ePYet3Fbts&feature=related

Why Zebras don’t get Ulcers

http://www.youtube.com/watch?v=hrQVz25eQ5s

Robert Sapolsky – uniqueness of humans
Robert Sapolsky's Reduce Stress Summary

1. **Perspective.** You probably have enough food to eat, and you probably won’t get eaten by a lion on the way home.

2. Take time to groom someone.

3. **Don't get gored!** (It can cause sepsis).

Fight-or-Flight Response

General Adaptation Syndrome (GAS)

- **Alarm & mobilization stage**
  - Become aware of stressor

- **Resistance stage**
  - Preparation to fight the stressor

- **Exhaustion stage**
  - Negative consequences of stress appear

**Mnemonic:**
The word “cushingoid” is a useful way to consider the complications and symptoms of Cushing’s:
- Cataracts
- Ulcers
- Skin: striae, thinning, bruising
- Hypertension
- Hyperglycemia
- Infections
- Necrosis, avascular necrosis of the femoral head
- Glycosuria
- Osteoporosis
- Obesity
- Immunosuppression
- Diabetes