9.01 Introduction to Neuroscience
Fall 2007

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CHEMICAL CONTROL OF THE BRAIN:
Patterns of communication in the nervous system:

(1) Point-to-point systems → neuron synapses on a few neurons
   - structure that uses point-to-point: dorsal thalamus to neocortex

(2) Hormones released by the hypothalamus

Overview:
   - Secretory hypothalamus regulates homeostasis (maintenance of the body’s internal environment including temperature, blood volume, pressure, O2 conc., etc)
   - By secreting chemical directly in the bloodstream, the secretory hypothalamus can influence functions throughout brain and body

Pathway:
   - Periventricular zone of hypothalamus has neurosecretory cells that send axons to the pituitary gland
   - Magnocellular neurosecretory cells extend into the posterior pituitary

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- Parvocellular neurosecretory cells extend into the anterior pituitary
  *the anterior pituitary is an actual gland; while the posterior pituitary is part of the brain

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(3) Networks of neurons of ANS activate tissues in the body

Overview:
- Periventricular zone of hypothalamus also controls the Autonomic Nervous System (ANS)
- Actions of ANS are usually carried out without conscious control, and are typically multiple, widespread and relatively slow (in comparison to somatic motor system).

Pathways:
- Sympathetic vs. Parasympathetic divisions

<table>
<thead>
<tr>
<th>General effect</th>
<th>Sympathetic</th>
<th>Parasympathetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fight, flight, fear, sex</td>
<td>Increases heart rate</td>
<td>Rest, digestion</td>
</tr>
<tr>
<td>Decreases digestion</td>
<td></td>
<td>Decreases heart rate</td>
</tr>
<tr>
<td>Increases digestion</td>
<td></td>
<td>Increases digestion</td>
</tr>
<tr>
<td>Point of origin</td>
<td>Middle of spinal cord (thoracic / lumbar)</td>
<td>Brain stem, sacral spinal cord</td>
</tr>
<tr>
<td>Ganglion location</td>
<td>Closer to cord</td>
<td>Closer to target organ</td>
</tr>
<tr>
<td>Neurotransmitter</td>
<td>Preganglionic: Acetylcholine</td>
<td>Preganglionic: Acetylcholine</td>
</tr>
<tr>
<td></td>
<td>Postganglionic: Norepinephrine (except adrenal medulla, where it’s both Norepinephrine and Epinephrine)</td>
<td>Postganglionic: Acetylcholine</td>
</tr>
</tbody>
</table>

- Also Enteric Division
  Controls physiological process of transport and digestion of food. Neural system found in lining of esophagus.
(4) Diffuse modulatory systems have divergent axonal projections
- Core system of small set of neurons (most from brain stem) influence many other neurons
  (axons may contact with more than 100,000 pathways)
- Not classical synapse, synapse releases neurotransmitter into extracellular fluid can diffuse to
  many neurons

ALZHEIMER’S DISEASE:
Important points from lecture:

Pathological features of AD:
(1) Brain atrophy
(2) Amyloid plaques
  APP → Aβ → Plaques → can affect hippocampus, glutamate receptors; etc. (studies suggest)

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- important genetics of AD: missense mutation in APP and the presenilins; also ApoE4
- transgenic mice over expressing APP $\rightarrow$ increased Aβ
  *found transgenic mice accumulated Aβ*56
  experiment: gave purified Aβ*56 to young rats and saw memory impairment
  IMPORTANT: know how to design experiments for exam!

(3) Neurofibrillary Tangles (NFT)

Tau $\rightarrow$ P-Tau (phosphorylated Tau) $\rightarrow$ Tangles

- Tau usually bound to microtubules. When phosphorylated by kinases (CDK5, etc.) unbinds and aggregates.
- Staining NFT by silver stain, dyes, antibodies, etc.
- Example experiment: neurodegeneration found in an inducible mutant Tau transgenic mouse
- Tangles also found in other diseases

EATING AND MOTIVATION

Important points in lecture:

Hormones involved in eating: leptin, ghrelin (talked about in lecture), insulin (in text)

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Other things to know:
- **Ob gene** codes for leptin.
- **Electrical self-stimulation:** when the rat presses the lever, it receives a brief electrical current to an electrode in its brain
  → repeated self-stimulation when stimulating electrode was placed in areas of the medial forebrain bundle
  → stimulation may not be causing pleasure, but motivation to repeatedly press the lever
- **Dopamine** plays a role in motivation and addiction

**PRACTICE EXAM QUESTIONS:**

**Review Questions for Ch. 15**

1. SSRI's, a class of drugs used to treat depression, have which of the following effects on the brain:
   a) They destroy the enzymes that degrades serotonin in the synaptic cleft.
   b) The block the reuptake of serotonin in the presynaptic neuron.
   c) They prevent axoplasmic transport from delivering serotonin to the axon terminal.
   d) They increase the production of serotonin in the presynaptic neuron.

2. Which of the following is TRUE regarding the stress response:
   a) Stress triggers the release of ACTH from the Hypothalamus.
   b) CRH is released from the Anterior Pituitary.
   c) Physiologic changes occur supporting the fight or flight response
d) All of the above

3. All of the following structures play a role in the release of cortisol into the blood stream **EXCEPT**
   a) parvocellular cells of the hypothalamus
   b) magnocellular cells of the hypothalamus
   c) anterior pituitary
   d) hippocampus
   e) adrenal cortex

4. All of the following are characteristics of the diffuse modulatory systems in the brain **EXCEPT**
   a) they tend to activate ionotropic receptors
   b) axons are widely divergent
   c) a small set of neurons form the core center for each system
   d) most core centers are located in the brainstem

5. Which statement accurately describes some important differences between the parasympathetic and sympathetic components of the autonomic nervous system?
   a) the parasympathetic system uses norepinephrine as its postganglionic neurotransmitter whereas the sympathetic system uses acetylcholine.
   b) the parasympathetic ganglia are located closer to the target organ than to the central nervous system, whereas the sympathetic ganglia are located closer to the central nervous system than to the target organ.
   c) the sympathetic nervous system is more active during non-REM sleep whereas the parasympathetic system is more active during REM sleep.
   d) the sympathetic system can sympathize with us in our times of need, whereas the parasympathetic system is just too selfish to even care.

6. Many hallucinogens share a common structure with
   a) dopamine
   b) norepinephrine
   c) serotonin
   d) acetylcholine

**Answers for Review Questions**
1. B
2. C
3. B
4. A
5. B
6. C

Could not find questions on Alzheimer's and Chapter 16.