BI 121 Lecture 12

I. **Announcements**  Thanks for your help with blood lab! Great job! No lab this week. Study for Exam II, Dec 8, Mon!

II. **Endocrine Connections**  Thyroid + Adrenals/Suprarenals
   LS pp 513-25 fig 17-18, 17-19; DC p 109-113 +…

III. **Introduction to the Nervous System**  LS ch 5, DC Module 9
   A. How is the nervous system organized? LS fig 5-1 DC p 67
   C. What’s myelin? How does it help? DC fig 9-3, LS pp 83-5
   D. Brain structure & function DC fig 9-6 thru 9-10 pp 71-5 +…
   E. Protect your head with a helmet! Bicycle head injury statistics, NHTSA & BHSI from 2011, the most recent yr

IV. **Autonomic Nervous System**  LS ch 7 pp 178-85+…
   A. Sympathetic vs Parasympathetic branches LS fig 7-3
   B. Neurotransmitters & receptors LS fig 7-1 & 7-2, tab 7-2
   C. Actions LS tab 7-1
   D. Fight-or-flight stories!

Thanks to you, Holly, Sarah, & Christina!

For your effort & your 💦!!
Thyroid cartilage of larynx
Cricoid cartilage of larynx
Thyroid gland
Trachea
(a) Gordon
Adrenals/Suprarenals

- Adrenal medulla
  - Mineralocorticoids (aldosterone)
  - Glucocorticoids (cortisol) and sex hormones (dehydroepiandrosterone)
  - Catecholamines (epinephrine and norepinephrine)

- Adrenal cortex

- Connective tissue capsule
  - Zona glomerulosa
  - Zona fasciculata
  - Zona reticularis

Medulla

Cortex
Stress Promotes Cortisol Secretion

- Stress activates the hypothalamus, which releases corticotropin-releasing hormone (CRH).
- CRH stimulates the anterior pituitary to release adrenocorticotropic hormone (ACTH).
- ACTH triggers the adrenal cortex to release cortisol.

Metabolic fuels and building blocks available to help resist stress:

- ↑ Blood glucose (by stimulating gluconeogenesis and inhibiting glucose uptake)
- ↑ Blood amino acids (by stimulating protein degradation)
- ↑ Blood fatty acids (by stimulating lipolysis)
Epinephrine 80%
Norepinephrine 20%
Central nervous system (CNS)

Input to CNS from periphery

Brain and spinal cord

Output from CNS to periphery

Peripheral nervous system (PNS)

Afferent division
- Sensory stimuli
- Visceral stimuli

Efferent division
- Somatic nervous system
- Motor neurons
  - Skeletal muscles
- Sympathetic nervous system
  - Smooth muscle
    - Cardiac muscle
    - Exocrine glands
    - Some endocrine glands
- Parasympathetic nervous system
  - Enteric nervous system
    - Digestive organs only

Stimuli in digestive tract

Effector organs
~99% of all neurons in humans! CNS ~100 billion interneurons!!
~ 90% of Cells w/in CNS are not neurons but glial cells = neuroglia or nerve glue!
Neuron 1

Input
Dendrites ≡ Antennae

Controller
Soma ≡ NCB

Output
Axon

Neuron 2

Neuron 3

H. Howard 1980
A single nerve cell may have as many as 200,000 inputs!
Nerve cell with multiple axons grown by adding a mitogen/neurogen ≡ nerve growth factor!
Sensory nerves especially, come in all shapes & sizes!

Figure 46–1

Several types of somatic sensory nerve endings.
Nerve Extremes: Far ends of the Continuum

A = Large to medium myelinated, up to 120 m/sec

C = Small unmyelinated, < 0.25 m/sec

α, β, γ, δ
What is myelin? Why is it important?

Lipid insulative coat

↑ υ, conserves ions & ATP
A large myelinated "survival" nerve can conduct impulses the length of football field in < 1 second!
Saltatory/Leaping Conduction! Crucial Sensory & Motor Nerves

L. saltare to hop or leap! Fr. salt, sautier, sauté, leap, high air, vault

DC 2003
HEARING

SEEING

SPEAKING

THINKING

LS 2012 fig 5-8b
Motor

M. Supplementary motor area (on inner surface—not visible; programming of complex movements)

M. Premotor cortex (coordination of complex movements)

S. Primary auditory cortex surrounded by higher-order auditory cortex (hearing)

A. Limbic association cortex (mostly on inner and bottom surface of temporal lobe; motivation and emotion; memory)

Sensory

M. Primary motor cortex (voluntary movement)

S. Primary sensory cortex (sensation)

A. Posterior parietal cortex (integration of somatosensory and visual input; important for complex movements)

A. Wernicke’s area (speech understanding)

A. Parietal-temporal-occipital association cortex (integration of all sensory input; important in language)

S. Primary visual cortex surrounded by higher-order visual cortex (sight)

Key

M. Motor cortex
A. Association cortex
S. Sensory cortex

LS 2006, cf: LS 2012 fig 5-8a
Two somatosensory cortical areas, somatosensory areas I and II.
Section Human Brain (from above)

- Left hemisphere
- Right hemisphere
- Frontal lobe
- Central sulcus
- Parietal lobe
- Occipital lobe
- Primary motor cortex
- Somatosensory cortex

Front
Back (a)
Top

LS 2006; cf: LS 2012 fig 5-9
Sensory Homunculus

L Brain

R Sensation

LS 2006; cf: LS 2012 fig 5-9
DC 2003; cf: LS 2012 fig 5-6
300 million axons enable R & L hemisphere cross-talk!!
MRI 061307
Lumbar spine
Lateral view

Disc herniation
Discs bulging
Disc herniation

Oregon Imaging
MRI 061307
Lumbar spine
Axial view
9.4 x 8.1 mm Protrusion
Oregon Imaging
Helmets Cheap, Brains Expensive!!
Use Your Head, Get a Helmet!!

http://www.bhsd.org/stats.htm

~540,000 bicyclists/yr visit emergency rooms
67,000 head injuries, 1 in 8 brain injuries
677 cyclists died in 2011 ≡ 2% of all traffic fatalities
9% of deaths children ≤ 14 yr, 69% ♂
> 54,000 cyclists have died since 1932

As of 2012, the population of
  Albany, OR  51,322
  Corvallis, OR  54,998
  Springfield, OR  59,869

Bicycle crashes & injuries are under reported,
since majority not serious enough for ER visits.

Helmets may reduce head & brain injury risk by 66-88%!
~$81 million/yr = direct injury costs from not using helmets!
The "typical" bicyclist killed on our roads is a sober male over 16 riding without a helmet. He's hit by a car on a major road between intersections in an urban area on a summer evening. Please wear a helmet – it can make the difference between life and death.
Stories, Discussion, Questions or Comments!
Why overlap or dual innervation?

**Fine-tune control & safety!**

cf: LS 2012 fig 7-3
PARASYMPATHETIC = RESTING, DIGESTIVE, HOUSEKEEPING FUNCTIONS
FIGHT/FLIGHT/ALARM REACTION!!

BI 121 + other exams!
Homeostasis is a **dynamic balance** between the autonomic branches.

- **Rest-and-digest:** Parasympathetic activity dominates.
- **Fight-or-flight:** Sympathetic activity dominates.
Autonomic Neurotransmitters & Receptors

Cholinergic
Nicotinic
Muscarinic

Adrenergic
\[ \alpha = \text{Alpha} \]
\[ \beta = \text{Beta} \]

G&H 2011 p 731-3
Parasympathetic

Ach = Acetylcholine  

Nicotinic Receptor  
Muscarinic Receptor

Sympathetic

NE = Norepinephrine  

α Receptor ($\alpha_1, \alpha_2$)  
β Receptor ($\beta_1, \beta_2$)
Nicotine activates both Sympathetic & Parasympathetic post-ganglionic neurons!

Like hammering the gas pedal & brake at the same time!!

Problem?
Autonomic Nervous System Innervation

LS 2012 fig 7-2
In Sympathetic Fight-or-Flight why is it important to activate the adrenals?
Hormonal Adrenaline Surge Reinforces Nervous Outflow & Accesses Tissues Not Directly Innervated!!

80% Epinephrine/Adrenaline (E)
20% Norepinephrine (NE)

Output to blood

Adrenals = Paired organs above kidneys
Fight-or-Flight Stories!

...choose this!!
<table>
<thead>
<tr>
<th>Organ</th>
<th>Effect of Sympathetic Stimulation</th>
<th>Effect of Parasympathetic Stimulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart</td>
<td>Increases heart rate and increases force of contraction of the whole heart</td>
<td>Decreases heart rate and decreases force of contraction of the atria only</td>
</tr>
<tr>
<td>Blood Vessels</td>
<td>Constricts</td>
<td>Dilates vessels supplying the penis and the clitoris only</td>
</tr>
<tr>
<td>Lungs</td>
<td>Dilates the bronchioles (airways)</td>
<td>Constricts the bronchioles</td>
</tr>
<tr>
<td>Digestive Tract</td>
<td>Decreases motility (movement)</td>
<td>Increases motility</td>
</tr>
<tr>
<td></td>
<td>Contracts sphincters (to prevent forward movement of tract contents)</td>
<td>Relaxes sphincters (to permit forward movement of tract contents)</td>
</tr>
<tr>
<td></td>
<td>Inhibits digestive secretions</td>
<td>Stimulates digestive secretions</td>
</tr>
<tr>
<td>Urinary Bladder</td>
<td>Relaxes</td>
<td>Contracts (emptying)</td>
</tr>
<tr>
<td>Eye</td>
<td>Dilates the pupil</td>
<td>Constricts the pupil</td>
</tr>
<tr>
<td></td>
<td>Adjusts the eye for far vision</td>
<td>Adjusts the eye for near vision</td>
</tr>
<tr>
<td>Liver (glycogen stores)</td>
<td>Glycogenolysis (glucose is released)</td>
<td>None</td>
</tr>
<tr>
<td>Adipose Cells (fat stores)</td>
<td>Lipolysis (fatty acids are released)</td>
<td>None</td>
</tr>
<tr>
<td>Exocrine Glands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exocrine pancreas</td>
<td>Inhibits pancreatic exocrine secretion</td>
<td>Stimulates pancreatic exocrine secretion (important for digestion)</td>
</tr>
<tr>
<td>Sweat glands</td>
<td>Stimulates secretion by sweat glands important in cooling the body</td>
<td>Stimulates secretion by specialized sweat glands in the armpits and genital area</td>
</tr>
<tr>
<td>Salivary glands</td>
<td>Stimulates a small volume of thick saliva rich in mucus</td>
<td>Stimulates a large volume of watery saliva rich in enzymes</td>
</tr>
<tr>
<td>Endocrine Glands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adrenal medulla</td>
<td>Stimulates epinephrine and norepinephrine secretion</td>
<td>None</td>
</tr>
<tr>
<td>Endocrine pancreas</td>
<td>Inhibits insulin secretion</td>
<td>Stimulates insulin secretion</td>
</tr>
<tr>
<td>Genitals</td>
<td>Controls ejaculation (males) and orgasm contractions (both sexes)</td>
<td>Controls erection (penis in males and clitoris in females)</td>
</tr>
<tr>
<td>Brain Activity</td>
<td>Increases alertness</td>
<td>None</td>
</tr>
</tbody>
</table>