I. **Announcements** Thanks for your help with blood lab! Great job! No lab this week. Study for Exam II, Dec 7, Friday, 8 am!

II. **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 2013 & 2014

III. **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!
Nervous System

CNS

PNS

input

output

https://www.youtube.com/watch?v=uU_4uA6-zcE&vl=ko
~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

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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 $\equiv$ 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

α, β, γ, δ

C = Small unmyelinated, < 0.25 m/sec

IV
What is myelin?
Why is it important?

Lipid insulative coat
↑ $\vec{v}$, 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
M. Supplementary motor area
(on inner surface—not visible; programming of complex movements)

M. Premotor cortex (coordination of complex movements)

M. Primary motor cortex (voluntary movement)

Central sulcus

S. Primary sensory cortex (sensation)

A. Prefrontal association cortex
(planning for voluntary activity; decision making; personality traits)

M. Broca’s area
(speech formation)

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)

A. Wernicke’s area
(speech understanding)

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

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)
300 million axons enable R & L hemisphere cross-talk!!
MRI 061307
Lumbar spine
Lateral view

Disc herniation
Discs bulging
Disc herniation
~ 500,000 bicyclists/yr visit emergency rooms

As of 2014, the population estimate of
State of Wyoming  584,153
  Albany OR  51,980
  Corvallis OR  54,953
  Springfield OR  60,263

~ 26,000 traumatic brain injuries

743 of ~900 cyclist deaths, 2013  \(\equiv\)  ~ 2% of all traffic fatalities
13% of deaths children \(\leq\) 14 yr, 87% \(\sigma\)
11% involved wrong-way riding!

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

Helmets may reduce head & brain injury risk by 85%!

\(~\$2.3\) billion/yr = indirect injury costs from not using helmets!

Helmets Cheap, Brains Expensive!!
Use Your Head, Get a Helmet!!

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

Helmets Cheap, Brains Expensive!!
Use Your Head, Get a Helmet!!

http://www.bhsi.org/stats.htm
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.
Hey, I’m alive because I wore a helmet!!
Stories, Discussion, Questions or Comments!
Homeostasis is a dynamic balance between the autonomic branches.

- **Rest-and-digest:** Parasympathetic activity dominates.
- **Fight-or-flight:** Sympathetic activity dominates.
PARASYMPATHETIC = RESTING, DIGESTIVE, HOUSEKEEPING FUNCTIONS
FIGHT/FLIGHT/ALARM REACTION!!

BI 121 + other exams!
Why overlap or dual innervation?

Fine-tune control & safety!

cf: LS 2012 fig 7-3

Autonomic Nervous System
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!

Problem?

Like hammering the gas pedal & brake at the same time!!
Autonomic Nervous System Innervation
In Sympathetic Fight-or-Flight why is it important to activate the adrenals?
80% Epinephrine/Adrenaline (E)
20% Norepinephrine (NE)

Hormonal Adrenaline Surge Reinforces Nervous Outflow & Accesses Tissues Not Directly Innervated!!

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

or

or

...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>