I. **Announcements** Thanks! Q from last t?

II. **Endocrine Connections** DC pp 109-13, LS pp 513-36
   A. GH glucose mismatch. B. Peripheral endocrine organs
   1. Thyroid  2. Adrenals  C. Stress response?

III. **Introduction to the Nervous System** LS ch 5, DC Module 9
   A. How 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*, 2013 & 2014

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!
GH/STH Effects: Insulin Resistance/Type II Diabetes?

↑ Amino Acid uptake & Protein synthesis

↑ Lipolysis & Fatty Acid mobilization

↓ Glucose uptake
   (skeletal muscle & adipocytes)

↑ Glucose production
   (liver glycogenolysis)

↑ Insulin secretion

Mismatch!!
Thyroid →
metabolism
highly vascularized

**Adrenals/Suprarenals**

**Adrenal gland**

- **Cortisol**
- **Adrenal cortex**
- **Adrenal medulla**

**Adrenalin Hormones**

**Kidney**

**Stress hormones!**

**FIGURE 13-12 Adrenal Gland** The adrenal glands sit atop the kidney and consist of an outer zone of cells, the adrenal cortex, which produces a variety of steroid hormones, and an inner zone, the adrenal medulla. The adrenal medulla produces adrenalin and noradrenalin.
Epinephrine 80%
Norepinephrine 20%
Adrenals/Suprarenals

- Adrenal medulla
- Adrenal cortex

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

Connective tissue capsule
Zona glomerulosa
Zona fasciculata
Zona reticularis

Medulla
Cortex
Stress Also Promotes Cortisol Secretion!

Cushing’s Syndrome
Excess Nutrients!

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)
Questions + Discussion
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!
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 \(120 \text{ m/sec}\),

\[\alpha, \beta, \gamma, \delta\]

C = Small unmyelinated, \(<0.25 \text{ m/sec}\),

IV

---

[Image of Roary the Racing Car and a camel]
What is myelin? Why is it important?

Lipid insulative coat

$\uparrow$ $\vec{v}$, 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

Cell body
Myelin sheath
Node of Ranvier
Nerve impulse
Axon

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

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)

A. Limbic association cortex
(mostly on inner and bottom
surface of temporal lobe;
motivation and emotion; memory)
300 million axons enable R & L hemisphere cross-talk!!
MRI 061307
Lumbar spine
Lateral view

Disc herniation
Discs bulging
Disc herniation
Helmets Cheap, Brains Expensive!!
Use Your Head, Get a Helmet!!
http://www.bhsi.org/stats.htm

~ 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 ≡ ~ 2% of all traffic fatalities
13% of deaths children ≤ 14 yr, 87% σ
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!
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 Neurotransmitters & Receptors

**Cholinergic**
Nicotinic
Muscarinic

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

G&H 2011 p 731-3
**Parasympathetic**

Ach = Acetylcholine

- = Nicotinic Receptor

\[ \alpha \] = \( \alpha_1 \), \( \alpha_2 \)

\[ \beta \] = \( \beta_1 \), \( \beta_2 \)

**Sympathetic**

NE = Norepinephrine
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!!

Output to blood

Adrenals = Paired organs above kidneys
## Table 7-1 | Effects of Autonomic Nervous System on Various Organs

<table>
<thead>
<tr>
<th>Organ</th>
<th>Effect of Sympathetic Stimulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart</td>
<td>Increases heart rate and increases force of contraction of the whole heart</td>
</tr>
<tr>
<td>Blood Vessels</td>
<td>Constricts</td>
</tr>
<tr>
<td>Lungs</td>
<td>Dilates the bronchioles (airways)</td>
</tr>
<tr>
<td>Digestive Tract</td>
<td>Decreases motility (movement)</td>
</tr>
<tr>
<td></td>
<td>Contracts sphincters (to prevent forward movement of tract contents)</td>
</tr>
<tr>
<td></td>
<td>Inhibits digestive secretions</td>
</tr>
<tr>
<td>Urinary Bladder</td>
<td>Relaxes</td>
</tr>
<tr>
<td>Eye</td>
<td>Dilates the pupil</td>
</tr>
<tr>
<td></td>
<td>Adjusts the eye for far vision</td>
</tr>
<tr>
<td>Liver (glycogen stores)</td>
<td>Glycogenolysis (glucose is released)</td>
</tr>
<tr>
<td>Adipose Cells (fat stores)</td>
<td>Lipolysis (fatty acids are released)</td>
</tr>
<tr>
<td>Exocrine Glands</td>
<td></td>
</tr>
<tr>
<td>Exocrine pancreas</td>
<td>Inhibits pancreatic exocrine secretion</td>
</tr>
<tr>
<td>Sweat glands</td>
<td>Stimulates secretion by sweat glands important in cooling the body</td>
</tr>
<tr>
<td>Salivary glands</td>
<td>Stimulates a small volume of thick saliva rich in mucus</td>
</tr>
<tr>
<td>Endocrine Glands</td>
<td></td>
</tr>
<tr>
<td>Adrenal medulla</td>
<td>Stimulates epinephrine and norepinephrine secretion</td>
</tr>
<tr>
<td>Endocrine pancreas</td>
<td>Inhibits insulin secretion</td>
</tr>
<tr>
<td>Genitals</td>
<td>Controls ejaculation (males) and orgasm contractions (both sexes)</td>
</tr>
<tr>
<td>Brain Activity</td>
<td>Increases alertness</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fight-or-Flight Stories!

or

or

...choose this!!