BI 121 Lecture 12

I. **Announcements**  Thanks for your help with blood lab! No lab this week. Study for Exam II, Dec 13, Friday 8 am!

II. **Endocrine Connections**  Adrenals  DC pp 112-13, LS pp 517-25

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 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!
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

LS 2012 fig 17-18
Stress Also Promotes Cortisol Secretion!

Cushing’s Syndrome Excess Nutrients!

↑ Blood glucose (by stimulating gluconeogenesis and inhibiting glucose uptake)
↑ Blood amino acids (by stimulating protein degradation)
↑ Blood fatty acids (by stimulating lipolysis)

Stress

Diurnal rhythm

Hypothalamus

Corticotropin-releasing hormone (CRH)

Anterior pituitary

Adrenocorticotropic hormone (ACTH)

Adrenal cortex

Cortisol

Metabolic fuels and building blocks available to help resist stress
Questions + Discussion
Nervous System

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

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

\( \alpha, \beta, \gamma, \delta \)

C = Small unmyelinated, 0.25 m/sec

IV
What is myelin? Why is it important?

Lipid insulative coat

↑ $\nu$, 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
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)

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

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

A. Posterior parietal cortex (integration of somato-sensory 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)

Key

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

LS 2006, cf: LS 2012 fig 5-8a
300 million axons enable R & L hemisphere cross-talk!!
Disc herniation

Discs bulging

MRI 061307
Lumbar spine
Lateral view

Oregon Imaging
~ 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!

Autonomic Nervous System

cf: LS 2012 fig 7-3

LS 1995
**Autonomic Neurotransmitters & Receptors**

**Cholinergic**
- Nicotinic
- Muscarinic

**Adrenergic**
- $\alpha = \text{Alpha}$
- $\beta = \text{Beta}$

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G&H 2011 p 731-3
Parasympathetic

Ach = Acetylcholine

= Nicotinic Receptor

= Muscarinic Receptor

Sympathetic

NE = Norepinephrine

= α Receptor (α₁, α₂)

= β Receptor (β₁, β₂)
Nicotine activates **both** Sympathetic & Parasympathetic post-ganglionic neurons!

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?
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
<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>
Fight-or-Flight Stories!

or

or

...choose this!!