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

II. **Endocrine Connections**  Peripheral Endocrine Organs…

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!

Thanks to you, Katie, Kelsey, Steph, Janelle & Patrick! For your effort & your 🎉!!
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 Promotes Cortisol Secretion

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%

F I G U R E 77-1
Secretion of adrenocortical hormones by the different zones of the adrenal cortex.

Guyton & Hall 2000
Questions + Discussion
Nervous System

CNS

PNS

input

output
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

Afferent division

Visceral stimuli

Efferent division

Somatic nervous system

Motor neurons

Skeletal muscles

Sympathetic nervous system

Smooth muscle

Cardiac muscle

Exocrine glands

Parasympathetic nervous system

Some endocrine glands

Entric nervous system

Stimuli in digestive tract

Digestive organs only
~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!
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

\[\vec{v}, \text{conserves ions & ATP}\]
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
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)

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

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

M. Broca’s area (speech formation)

A. Wernicke’s area (speech understanding)

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)

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
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.bhsio.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% o
  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!
Autonomic Nervous System

Why overlap or dual innervation?

Fine-tune control & safety!

cf: LS 2012 fig 7-3

LS 1995
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.

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D Silverthorn 2010
Autonomic Neurotransmitters & Receptors

**Cholinergic**
- Nicotinic
- Muscarinic

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

G&H 2011 p 731-3
Ach = Acetylcholine

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)

Adrenals = Paired organs above kidneys

Output to blood
Fight-or-Flight Stories!

…choose this!!

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>Liver (glycogen stores)</td>
<td>Glycogenolysis (glucose is released)</td>
<td>Adjusts the eye for near vision</td>
</tr>
<tr>
<td>Adipose Cells (fat stores)</td>
<td>Lipolysis (fatty acids are released)</td>
<td></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>