BI 121 Lecture 11

I. Lab 5 Review: Safety & Techniques Q?

II. Introduction to Endocrinology LS ch 17, DC Module 13, SI Fox+
   A. Endocrine vignette: Cushing's syndrome LS fig17-20 p 521-2
   B. Endocrine system DC p 103 fig 13-1, LS fig 17-1, tab 17-1
   C. What’s an endocrine? + classes ~ LS pp 495 - 6
   D. Hypothalamus (Master) – Pituitary (subcontroller)
      DC pp 104-6 + LS pp 499-506
   E. Posterior pituitary + hormones DC p 108, LS fig 17-4 p 502
   F. Anterior pituitary + hormones DC pp 105-7, LS pp 502-6
   H. Peripheral endocrine organs DC pp 109-13, LS pp 513-36
      1. Pancreas (insulin, glucagon, diabetes) 2. Thyroid 3. Adrenals

III. Nervous System & Excitable Cell Connections LS ch 5, 4, 7
   A. How is the nervous system organized? fig 5-1 p 108
   B. Neurons? What kind? fig 5-2 p 109
   C. Brain structure & function fig 5-7, 5-8 pp 116 - 7
   D. Protect your head with a helmet! Bicycle head injury statistics, NHTSA & BHSI
   E. Autonomic nervous system overview LS pp 178 – 85

Fun lab today! Data for a lifetime! Thanks for being prepared!
No food, drink or gum in lab today! Thanks sincerely!

…Healthy, tasty & fresh, but not in lab!!
WASH & DRY

ALCOHOL

PREPARATION
SAMPLE+TESTS

1. OBTAIN μSAMPLE

2. BLOOD GLUCOSE

3. BLOOD TYPING
Glucose: Sugar in Blood

Normal: 70-99
Pre-Diabetes: 100-125
Diabetes: ≥ 126 mg/dL
BLOOD TYPING

1. ADD ANTISERA

2. MIX W/TOOTHPICKS

3. READ & RECORD!!
CLEAN-UP!

1. FOLD DIAPER

2. BLOOD PRODUCTS

3. REWASH!!
Blood Chem Lab Q?
Cushing’s Syndrome = Hypersecretion of Cortisol: Hypothalamic (CRH), Pituitary (ACTH), or Adrenal (Cortisol)
ANP = Atrial Natriuretic Polypeptide
Hormone/Endocrine Classifications

**Exogenous**

**Endogenous**

![Image of pigs eating cucumbers](image1)

![Image of cow wearing a hat](image2)

![Diagram of hormone classification](image3)

![Diagram of hormone classification](image4)
Hypothalamus & Pituitary: Intimate Relationship
Hypothalamus
< 1% of Brain Mass
Hormone Master Controller
+100s of Functions!

Good Things Come in Small Packages!

Kreiger & Hughes 1980
Nervous Connection!!

Neurosecretory neurons

Hypothalamic-posterior pituitary stalk

Anterior pituitary

Hypothalamus

Posterior pituitary

Systemic arterial inflow

Systemic venous outflow

= Vasopressin

= Oxytocin

LS 2007
Hypothalamus-Anterior Pituitary Vascular Connection!

- Neurosecretory neuron
- Systemic arterial inflow
- Hypothalamic-hypophyseal portal system
- Anterior pituitary
- Posterior pituitary

- Hypophysiotropic hormones
- Anterior pituitary hormone

LS 2007
Pituitary Nourishing or Growth Hormones

RH + or RIH -

Hypothalamus

Neurosecretory neuron

Systemic arterial inflow

Hypothalamic-hypophyseal portal system

Pituitary Nourishing or Growth Hormones

Systemic venous outflow

- = Hypophysiotropic hormones
- = Anterior pituitary hormone

Hypophysis = Pituitary

LS 2007
Capillary-Venule-Capillary Intimate Circulation

Krieger & Hughes 1980
Paraventricular nucleus
Supraoptic nucleus
Median eminence
Portal system
Infundibulum
Hypothalamus
Anterior pituitary
Posterior pituitary

TSH
Prolactin
ACTH
Growth hormone
Gonadotropins
FSH
LH

Thyroid
Adrenal cortex
Ovary
Testis

Bone
Muscle
Adipose tissue

SI Fox 2008
cf: LS 2012 fig 17-5
Discussion
&/or
Break?
fig 17-10
Progression & Development of Acromegaly

Age 13

Age 21

Age 35

LS 2012 fig 17-11
Growth Hormone = Somatotrophic Hormone
Body Builder’s Dream?
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
Increase GH naturally with exercise & sleep!!

ng/ml = nanograms per milliliter
Endocrine Pancreas: Insulin (I) & Glucagon (G)
See-Saw Hormones in Regulating Blood Glucose

Hormones (insulin, glucagon)
Blood
Endocrine portion of pancreas (Islets of Langerhans)

Duct cells secrete aqueous NaHCO₃ solution
Acinar cells secrete digestive enzymes
Exocrine portion of pancreas (Acinar and duct cells)

The glandular portions of the pancreas are grossly exaggerated.
Times of Plenty!!

NB: Diabetics have problems either here or here.

Fox 1987
Times of Need!

Blood

Glucose

Glucagon

Insulin

Cellular uptake of glucose

Glycogenolysis

Fox 1987

Mobilize!!
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.
**Figure 77-1**

Secretion of adrenocortical hormones by the different zones of the adrenal cortex.

- **Zona glomerulosa** secretes aldosterone
- **Zona fasciculata**
- **Zona reticularis**

**Epinephrine** 80%

**Norepinephrine** 20%

Guyton & Hall 2000
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

Visceral stimuli

Eff erent division

Motor neurons

Somatic nervous system

Sympathetic nervous system

Parasympathetic nervous system

Autonomic nervous system

Stimuli in digestive tract

Enteric nervous system

Digestive organs only

Skeletal muscles

Smooth muscle
Cardiac muscle
Exocrine glands
Some endocrine glands

Effector organs
(made up of muscle and gland tissue)
~99% of all neurons in humans!
CNS ~100 billion interneurons!!
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)

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

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

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

LS 2006, cf: LS 2012 fig 5-8a
~540,000 bicyclists/yr visit emergency rooms
67,000 head injuries, 1 in 8 brain injuries
716 cyclists died in 2008 \(\equiv 2\%\) of all traffic fatalities
\(\frac{1}{2}\) of deaths children < 15 yr
53,000 cyclists have died since 1932
that's more than the population of
Springfield, OR 52,864
Bend, OR 52,029
Corvallis, OR 49,322

Bicycle crashes & injuries are under reported, since majority not serious enough for ER visits.
Helmets may prevent 45-88\% of brain injuries!
~$81 million/yr = direct injury costs from not using helmets!
The "typical" bicyclist killed on our roads is a sober male over 16 not wearing a helmet riding on a major road between intersections in an urban area on a summer evening when hit by a car. Please wear a helmet – it can make the difference between life and death.
Discussion &/or Break?
Why overlap or dual innervation?

Fine-tune control & safety!

cf: LS 2012 fig 7-3
PARASYMPATHETIC = RESTING, DIGESTIVE, HOUSEKEEPING FUNCTIONS
FIGHT/FLIGHT/ALARM REACTION!!
Homeostasis is a dynamic balance between the autonomic branches.

- **Rest-and-digest:** Parasympathetic activity dominates.
- **Fight-or-flight:** Sympathetic activity dominates.
Craniosacral parasym pathetic nerves

Thoracolumbar sympathetic nerves

Spinal cord

Brain

Adrenal medulla

Blood

Collateral ganglion

Terminal ganglion

Sympathetic ganglion chain

Effector organs

Cardiac muscle

Smooth muscle

Most exocrine glands and some endocrine glands

= Sympathetic system

= Parasympathetic system

= Preganglionic fiber

= Postganglionic fiber

ACh = Acetylcholine

NE = Norepinephrine

E = Epinephrine

= Cell body

= Cell body

= Axon

LS 2006
Why adrenal activation & response important?
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!

or

…choose this!!
Table 7-1 Effects of Autonomic Nervous System on Various Organs

<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>