I. **Announcements** To make Lab 5 educational, fun & safe for all, please read pp 5-1 thru 5-6 in LM twice before Thursday! Remaining exams & notebooks returned > lecture. Key posted in glass box in Huestis near 120 HUE. Estimate grade? Q?

II. **Blood Chemistry Connections** LS ch 11 p 303, ch 17 pp 525-36 Erythroblastosis fetalis, diabetes, insulin, glucagon

III. **Endocrinology Overview** LS ch 17, DC Module 13, SI Fox+
   A. Vignette: Cushing's syndrome LS fig 17-20 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 see-saw!) 2. Thyroid 3. Adrenals
Students who succeed are usually those who:

1. **Attend** class regularly
2. **Ask** questions
3. **Come** to office hours & problem-solving sessions
4. **Study** outside class both alone & in study groups
5. **Seek** to understand methods & overarching principles/concepts rather than specific answers
6. **Teach** or tutor others &
7. **Discuss** concepts informally with fellow students.

Q? What do I need on the final, if I want to get…?

A? You can actually calculate given assumptions…

e.g., 62 for Exam I & desire ≥ B- (assume ≥ 80)

Assume 100% for lecture (20% of grade) + lab attendance & participation (20% of grade!)

Solution:

Hope for?  Exam I  Lecture  Lab

\[
X = \left[ 80 - \left(0.3 \times 62 \right) + (0.2 \times 100) + (0.2 \times 100) \right] / 0.3
\]

\[
X = \left[ 80 - \left(18.6 + 20 + 20 \right) \right] / 0.3
\]

\[
X = [21.4] / 0.3 = 71.3
\]

Need this on Exam II for B- for course!

…Fortunately, the lab buffers the grade!
Erythroblastosis Fetalis?

e.g., Rh- mom
Rh+ baby

1994 Diabetes Prevalence in the US by State

Source: Centers for Disease Control, Division of Diabetes Translation, [http://www.cdc.gov/diabetes/statistics](http://www.cdc.gov/diabetes/statistics), S&W 2014 fig 4-15 p139A.
Source: Centers for Disease Control, Division of Diabetes Translation, [http://www.cdc.gov/diabetes/statistics](http://www.cdc.gov/diabetes/statistics), S&W 2014 fig 4-15 p139B.
Diabetic & Normal Response to Glucose Load

Blood glucose level (mg/100 ml) vs. Hours

Guyton & Hall 2000
Glucose: Sugar in Blood

- Normal: 70-99 mg/dL
- Pre-Diabetes: 100-125 mg/dL
- Diabetes: ≥ 126 mg/dL
**Proinsulin with C-Connecting Peptide**

**Fig. 10-4.** Amino acid sequence of a mammalian proinsulin molecule. Note how the insulin molecule can be formed by cleaving this polypeptide chain at two locations to liberate the C peptide.
NB: Diabetics have problems either here or here.
Times of Need!

Blood

Glucose

A cells

Glucagon

Insulin

B cells

Cellular uptake of glucose

Glycogenolysis

Mobilize!!

Fox 1987
### Table 4–8

#### Type 1 and Type 2 Diabetes Compared

<table>
<thead>
<tr>
<th></th>
<th>Type 1</th>
<th>Type 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of cases</td>
<td>5–10%</td>
<td>90–95%</td>
</tr>
<tr>
<td>Age of onset</td>
<td>&lt;30 years</td>
<td>&gt;40 years&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Associated characteristics</td>
<td>Autoimmune diseases, viral infections, inherited factors</td>
<td>Obesity, aging, inherited factors</td>
</tr>
<tr>
<td>Primary problems</td>
<td>Destruction of pancreatic beta cells; insulin deficiency</td>
<td>Insulin resistance, insulin deficiency (relative to needs)</td>
</tr>
<tr>
<td>Insulin secretion</td>
<td>Little or none</td>
<td>Varies; may be normal, increased, or decreased</td>
</tr>
<tr>
<td>Requires insulin</td>
<td>Always</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Older names</td>
<td>Juvenile-onset diabetes, Insulin-dependent diabetes mellitus (IDDM)</td>
<td>Adult-onset diabetes, Noninsulin-dependent diabetes mellitus (NIDDM)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Although type 2 diabetes typically occurs after age 40, it can occur at any age, and diagnosis in children has increased in recent years.
<p>| Table 4–9 |</p>
<table>
<thead>
<tr>
<th>Warning Signs of Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>These signs appear reliably in type 1 diabetes and, often, in the later stages of type 2 diabetes.</td>
</tr>
<tr>
<td>- Excessive urination and thirst</td>
</tr>
<tr>
<td>- Glucose in the urine</td>
</tr>
<tr>
<td>- Weight loss with nausea, easy tiring, weakness, or irritability</td>
</tr>
<tr>
<td>- Cravings for food, especially for sweets</td>
</tr>
<tr>
<td>- Frequent infections of the skin, gums, vagina, or urinary tract</td>
</tr>
<tr>
<td>- Vision disturbances; blurred vision</td>
</tr>
<tr>
<td>- Pain in the legs, feet, or fingers</td>
</tr>
<tr>
<td>- Slow healing of cuts and bruises</td>
</tr>
<tr>
<td>- Itching</td>
</tr>
<tr>
<td>- Drowsiness</td>
</tr>
<tr>
<td>- Abnormally high glucose in the blood</td>
</tr>
</tbody>
</table>
Diabetics must constantly juggle diet, exercise & medication to control blood glucose!
Like others, diabetics benefit from whole grains, vegetables, fruits, legumes & non-/low-fat milk products!
Exercise is a must based on its insulin-like effect!
Cushing’s Syndrome = Hypersecretion of Cortisol: Hypothalamic (CRH), Pituitary (ACTH), or Adrenal (Cortisol)
ANP = Atrial Natriuretic Polypeptide
Hormone/Endocrine Classifications

Exogenous

Endogenous

- Amino Acid or Polypeptide Hormone
- IntraCellular Receptor
- Protein Phosphorylation
- Nucleus
- Steroid Hormone
- Specific Receptor
- Hormonal Receptor Complex
- Protein Synthesis
- Altered Functional Response
- DNA
- mRNA
Hypothalamus & Pituitary: Intimate Relationship

- Hypothalamus
- Bone
- Anterior lobe of pituitary
- Posterior lobe of pituitary
- Anterior pituitary
- Posterior pituitary
- Optic chiasm
- Connecting stalk

LS 2012 fig 17-3
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
- Posterior pituitary

Systemic arterial inflow

Systemic venous outflow

• = Vasopressin
• = Oxytocin
Hypothalamus-Anterior Pituitary Vascular Connection!

Vascular Connection!!

- = Hypophysiotropic hormones
- = Anterior pituitary hormone

LS 2007
Pituitary Nourishing or Growth Hormones

Releasing or Release-Inhibiting Hormones

Hypothalamus

Systemic arterial inflow

Neurosecretory neuron

Hypothalamic-hypophyseal portal system

Systemic venous outflow

• • = Hypophysiotropic hormones
• = Anterior pituitary hormone

LS 2007
Capillary-Venule-Capillary Intimate Circulation

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

Mammary gland

Prolactin
TSH
Thyroid

ACTH
Adrenal cortex

Growth hormone
Gonadotropins

Bone
Muscle
Adipose tissue

FSH
Ovary
LH
Testis
fig 17-10
Progression & Development of Acromegaly

<table>
<thead>
<tr>
<th>Age 13</th>
<th>Age 21</th>
<th>Age 35</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Age 13" /></td>
<td><img src="image2" alt="Age 21" /></td>
<td><img src="image3" alt="Age 35" /></td>
</tr>
</tbody>
</table>

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!!

![Graph showing the increase in growth hormone (GH) levels during strenuous exercise and sleep.](image)

**Growth hormone (ng/ml plasma)**

**Time of day**

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

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

Endocrine portion of pancreas (Islets of Langerhans)

The glandular portions of the pancreas are grossly exaggerated.

LS 2007
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%

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

Guyton & Hall 2000