Lecture 11

I. **Announcements** Presentations Group I next Tuesday. Q? Outline comments complete. All drafts to Bella, Abbie & Mae.

II. **Endocrinology Connections** Thyroid + Adrenals G&H ch 77, 78

III. **Med Physiol News** Sex Allergy? Mom’s eggs execute dad’s mitochondria? Science News

IV. **Reproductive Physiology Primer** G&H ch 82, 81 + L Sherwood…

A. Female reproductive system fig 82-1, 82-2
B. Ovarian hormones + FB: estrogen, progesterone pp 1042-7
C. Follicle growth & ovulation mechanism fig 82-5, 82-3
D. Plasma gonadotropin & ovarian hormone [ ] in female sexual cycle fig 82-4
E. Female sexual cycle, menstruation fig 82-4, 82-9
F. Estrogen [ ] throughout lifespan, menopause fig 82-12
G. Birth control techniques L Sherwood + G&H
H. Male reproductive system fig 81-1 A & B
I. Sperm & development fig 81-2, 81-7, 81-3, 81-4, 81-5
J. Feedback regulation in males fig 81-10
K. Plasma testosterone [ ] throughout lifespan fig 81-9
Inadequate Iodine Promotes Goiter!

Hypothalamus
(Thyrotropin-releasing hormone)

Anterior pituitary

Inhibits

Cells

Increased metabolism

Thyroid-stimulating hormone

Thyroid

Hypertrophy

Increased secretion

Thyroxine

TSH ≡ Thyrotropin

Iodine present?

T_3 + T_4

Iodine

TRH

G&H 2011 fig 76-7
G&H 2016 fig 77-7
Near absence of thyroid-hormone function + myxedema
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.
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 \rightarrow \text{Hypothalamus} \rightarrow \text{Anterior Pituitary} \rightarrow \text{Adrenal Cortices} \rightarrow \text{Cortisol} \rightarrow \text{Glucose, Amino Acids, Fatty Acids}

\text{CRH} = \text{ACTH-RH}

\text{Corticotropin} = \text{ACTH}

\text{Metabolic Fuels Building Blocks Relieve Stress}

\text{Diurnal Rhythm}

\text{SOURCE: Modified after D Chiras 2003}
Adrenal Cortex Zones

- Zona glomerulosa
  - aldosterone
- Zona fasciculata
- Zona reticularis
- Medulla
  - (catecholamines)
- Cortex

Magnified section

Epinephrine 80% + Norepinephrine 20%

Fight/Flight Alarm Reaction

G&H 2016 fig 78-1
G&H 2011 fig 77-1
Questions + Discussion
Sex allergy: No laughing matter

The phrase "Not tonight, dear" may be a deadly serious matter for women who suffer from an allergy to their husband's seminal fluid, the liquid that carries sperm. In rare cases, such an allergic response can cause death.

The first case of an allergy to human seminal fluid was documented in 1958. Since then, the disorder has been diagnosed in a small number of cases. However, allergists believe the disorder is not readily recognized by gynecologists.

Some women with this condition report a dramatic, whole-body reaction to seminal fluid. Their symptoms include wheezing, vomiting, diarrhea, unconsciousness, or complete circulatory collapse. Other women experience a localized reaction, such as vaginal burning or swelling.

Researcher Jonathan A. Bernstein of the University of Cincinnati College of Medicine and his colleagues decided to study the prevalence of the disorder. They administered a questionnaire to 1,073 women who had reported symptoms consistent with the allergy.

Bernstein's team found that 12 percent of the women they studied met the diagnostic criteria for an allergy to seminal fluid. This result indicates that the disorder is much more common than previously suspected. The team reports its findings in the January ANNALS OF ALLERGY, ASTHMA, & IMMUNOLOGY.

Allergists can treat the condition, the researchers point out. Regular injections of purified seminal proteins can prevent the relationship-stopping symptoms, says Bernstein. — K.F.
Mom’s eggs execute Dad’s mitochondria

In “Hamlet,” Rosencrantz and Guildenstern deliver a letter to the rulers of England that carries the ill-fated duo’s own death sentence. Perhaps Shakespeare knew a bit about reproductive biology.

Scientists have now found that during a sperm’s creation, its mitochondria—energy-producing units that power all cells—acquire molecular tags that mark them for destruction once the sperm fertilizes an egg. This death sentence, a protein called ubiquitin, may explain why mammals inherit the DNA within mitochondria only from their mothers, a biological curiosity geneticists have used to trace human evolution (SN: 2/6/99, p. 88). The finding may also have implications for species mitochondrial inheritance. Sperm mitochondria sometimes avoid destruction when two different species of mice mate, and Schatten’s team has shown this also holds true in cattle. It’s hard to understand how an egg distinguishes between paternal mitochondria of closely related species, says Schon.

When paternal mitochondria escape destruction in normal mating, the resulting embryo may suffer. Schatten notes that a colleague has found sperm mitochondria in some defective embryos from infertility clinics.

The success of cloning may depend on an egg’s ability to destroy foreign mitochondria. In the technique used to create

May Day! May Day! We’re doomed!!
Female Reproductive System
1FFECTIVE FEMALE HORMONES

1. Hypothalamus

2. Anterior Pituitary
   Gonadotropes/Basophilic Cells
   - GnRH

3. Target Organs – Ovaries
   - FSH/Follicle Stimulating Hormone
   - LH/Luteinizing Hormone

   Ovary – Follicles (~8-14)
   - E/Estrogen (17-β Estradiol)

   Ovary – Corpus Luteum
   - PRG/Progesterone

Ah Ha! Stain purple!
What Do **Estrogen** & **Progesterone** Do?

**Estrogen** – *E*

Growth & Development of:

1. **Ovaries**, fallopian tubes, uterus, vagina, external genitalia
2. **Breasts** stroma, ductile systems, adipocytes
3. **Skeleton** → osteoblastic activity

**Progesterone** – *PRG*

Promotes Progestation!

1. **Uterus**: endometrium 
   *Secretory Δ during last ½ of monthly cycle*
2. **Breasts**: 
   ↑ lobules & alveoli
3. **Uterus**: smooth muscle 
   ↓ excitability & motility
4. **Hypothalamus**: 
   ↑ body temp ≈ 0.5 °F
Uterus, Ovary & Uterine/Fallopian Tube

- Perimetrium
- Isthmus of uterine tube
- Ovarian ligament
- Ovarian stroma
- Ampullae of uterine tube
- Mucosal folds of uterine tube
- Fimbriae
- Uterine cavity
- Endometrium
- Myometrium
- Uterosacral ligament
- Cervical canal
- Vagina
- Vaginal rugae
- Isthmus of uterus
- Cervix
- Ovarian follicles
- Corpus luteum
- Broad ligament of uterus

G&H 2016 fig 82-2
G&H 2011 fig 81-2
Stigma
≡ Sheath or case
≡ Sac or cavity
≡ Grain or seed

Ovary 1.5-3.0 cm
Ovum ~100 μ

G&H 2016 fig 82-5
G&H 2011 fig 81-4
Primary Oocytes

Follicle undergoing atresia

Ovary cross section

Graffian Follicle with developing ovum/egg

Ovum

H Howard 1984
Proposed Ovulation Mechanism

Luteinizing hormone

Follicular steroid hormones (progesterone)

Proteolytic enzymes (collagenase)  Follicular hyperemia and prostaglandin secretion

Weakened follicle wall  Plasma transudation into follicle

Degeneration of stigma  Follicle swelling

Follicle rupture

Evagination of ovum
Estrogen Production: Theca & Granulosa Cell Interaction

Theca cell
- LH
- Cholesterol
- cAMP
- Pregnenolone
- Progesterone
- Androgens

Granulosa cell
- LH
- Cholesterol
- Pregnenolone
- Progesterone
- Androgens
- ATP
- Aromatase
- Estrogens

Capillaries/Extracellular fluid

G&H 2016 fig 82-8
G&H 2011 fig 81-7
Figure 81-8 Phases of endometrial growth and menstruation during each monthly female sexual cycle.
Home-pregnancy test + "morning" sickness?

Basis of birth control pills ≡ false luteal phase
<table>
<thead>
<tr>
<th>Location</th>
<th>Time of appearance (min after ejaculation)</th>
<th>Percent of ejaculated sperm*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilization site (upper third of oviduct)</td>
<td>30–60</td>
<td>0.001</td>
</tr>
<tr>
<td>Uterus</td>
<td>10–20</td>
<td>0.1</td>
</tr>
<tr>
<td>Cervical canal</td>
<td>1–3</td>
<td>3</td>
</tr>
<tr>
<td>Vagina</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

*Based on data from animals. Sperm and ovum enlarged.

**FIGURE 20-20**
Ovum and sperm transport to the site of fertilization

180 million sperm deposited
5.4 million sperm deposited
180,000 sperm deposited
1800 sperm deposited
1800 million sperm deposited

Ampulla of oviduct
Sperm surrounding ovum
Fimbria
Optimal site of fertilization
Oviduct
Ovary
Ovulated ovum
Cervical canal
Uterus
Vagina
Penis

LS1 2004, LS2 2012
FIGURE 20-23

Early stages of development from fertilization to implantation

Note that the fertilized ovum progressively divides and differentiates into a blastocyst as it moves from the site of fertilization in the upper oviduct to the site of implantation in the uterus.

Day 1
- Fertilization

Day 4-5
- Cleavage
- Blastocyst becomes amniotic sac

Day 5-7
- Trophoblast
- Inner cell mass
- Destined to become fetus
- Trophoblast accomplishes implantation and develops into fetal portions of placenta

Implantation
- Endometrium of uterus

Ovulation
- Ovary

Ovum (cross section)
- Spermatozoa

Structures not drawn to scale.

Actual size
~ 56 days

~ 30 mm
# Average Failure Rate of Various Contraceptive Techniques

<table>
<thead>
<tr>
<th>Contraceptive Method</th>
<th>Average Failure Rate (annual pregnancies/100 women)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>90</td>
</tr>
<tr>
<td>Natural (rhythm) methods</td>
<td>20–30</td>
</tr>
<tr>
<td>Coitus interruptus</td>
<td>23</td>
</tr>
<tr>
<td>Chemical contraceptives</td>
<td>20</td>
</tr>
<tr>
<td>Barrier methods</td>
<td>10–15, 20!</td>
</tr>
<tr>
<td>Oral contraceptives</td>
<td>2–2.5</td>
</tr>
<tr>
<td>Implanted contraceptives</td>
<td>1</td>
</tr>
<tr>
<td>Intrauterine device</td>
<td>4</td>
</tr>
</tbody>
</table>

Abstinence works best!
Important Facts

- 4 Million births in the US per yr
- 200 abortions per 1000 live births
- 638,169 legal abortions reported in 2015
- Sperm survive for 48 hr to 5 d in female reproductive tract
- Eggs start to disintegrate 12-24 hr > ovulation
- Ovulation varies & may be tough to predict...

http://www.cdc.gov/nchs/fastats/births.htm
https://www.cdc.gov/mmwr/volumes/67/ss/ss6713a1.htm
http://www.who.int/reproductivehealth/en/
https://kinseyinstitute.org/research/index.php
G&H 2016 fig 81

G&H 2011 fig 80

Seminiferous tubules

Efferent ductules

Body of epididymis

Rete testis

Head of epididymis

Testicular artery

Vasectomy

Tail of epididymis

G&H 2016 fig 81-1 B
G&H 2011 fig 80-1 B
Figure 80-4 Structure of the human spermatozoon.
Figure 80-5 Abnormal infertile sperm, compared with a normal sperm on the right.

G&H 2016 fig 81-5
G&H 2011 fig 80-5
Male Feedback Regulation

Behavioral effects

Hypothalamus

GnRH

Anterior pituitary

GnRH

LH

FSH

Testis

Leydig cell

Sertoli cell

Testosterone

Inhibin

Androgenic effects

Spermatogenesis