Lecture 5: The Menstrual Cycle

- The Ovary
- The Menstrual Cycle
  - Follicular phase
  - Luteal phase
- Menstrual cycle and mate choice
- Cycle related psychological changes
- Cycle related physiological changes

Function of the Ovary

- Target Organ: Generates mature germ cells in response to hormonal control signals
- Endocrine Gland: Sends signals of its own to uterus, the hypothalamus and pituitary.

Ovary with Follicles

Each immature egg is called a primary oocyte and is contained in a follicle.
The Follicular Phase

H-P-O Axis
Hypothalamus-Pituitary-Ovarian Axis

(1) LH and FSH low at start of cycle

(2) Low FSH stimulates Hypothalamus to release GnRH which signals anterior pituitary

Low FSH

HYPOTHALAMUS

GnRH
(Gonadotropin Releasing Hormone)

ANTERIOR PITUITARY
H-P-O Axis

(3) Anterior Pituitary releases more FSH and LH.

HYPOTHALAMUS

GnRH

ANTERIOR PITUITARY

FSH (Follicle Stimulating Hormone)  LH (Luteinizing Hormone)

(4) FSH stimulates follicle to produce estrogen (estradiol)

Follicular Development

Development of Graffian Follicle

Follicular Development

Development of Graffian Follicle

Graafian Follicle

- Theca Cells - Cells on outside. LH stimulates theca cells to make testosterone. Some Estrogen made de novo.

- Granulosa Cells - Smaller cells on inside of follicle. Convert testosterone into estradiol under influence of FSH.

(5) Cells differentiate in the follicle, forming the Graffian Follicle

(6) Increasing amounts of Estrogen are produced by Graffian Follicles, one becomes “Dominant Follicle”
(7) Increase in estrogen sends a “Negative Feedback” signal to the Hypothalamus and Anterior Pituitary to stop producing GnRH FSH.

(8) At some point increasing estrogen switches to positive feedback.

(9) Hypothalamus secretes more GnRH - particularly LhRH at this point.
(10) When a threshold amount of LhRH is reached, the anterior pituitary release a massive dose of LH.

(11) This massive surge in LH causes the follicle to rupture and ovulation to occur.

Ovulation

Fallopian Tube & Corpus Luteum
The Luteal Phase

(12) Empty follicle is now called the Corpus Luteum.

(13) Corpus Luteum produces Estrogen and Progesterone.

(14) Estrogen and Progesterone cause changes in reproductive organs.

(15) LH and Progesterone are also involved in negative feedback loops.
What is Estrogen Doing?

• Stimulates growth of cells in the lining of the uterus, the cervix and the vagina
• Causes breast to increase progesterone receptor density
• Initiates proliferative phase in uterus

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What about Progesterone?

• Builds up the lining of the uterus for fertilization
• Increased concentration in breast in luteal phase
What about Progesterone?

- Builds up the lining of the uterus for fertilization
- Increased concentration in breast in luteal phase
- Initiates secretory phase in uterus

Inside the Uterus

**Proliferative Phase**

- Estrogen initiates a “proliferative phase” when glands of uterine lining thicken and grow and blood supply proliferates

Inside the Uterus

**Secretory Phase**

- Progesterone causes the uterus to enter a “secretory phase” when it secretes embryo-nourishing substances
Secretory Phase of Uterus

- The endometrium is now heavily vascularized
- There is active secretion of nutrient-rich medium for embryonic growth
- Embryo can only implant in a secretory lining

Changes in Cervical Mucous

- Normally forms a maze of tangled fibers
- Under influence of estrogen, fibers line up permitting sperm to get through

Changes in Cervix

- Closes soon after ovulation

Changes in Vagina

- Vagina becomes drier with increasing progesterone

Changes in the Breasts

- Estrogen causes breast cells to start to divide
Changes in the Breasts

- Estrogen causes breast cells to start to divide
- Estrogen increases progesterone receptors = increased progesterone levels
- Increased receptivity to progesterone
- Increased tenderness
- Increased nipple sensitivity

What Triggers Menstruation?

- No fertilization
- Corpus Luteum regresses after about 12 days
- Progesterone production drops off sharply
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- No fertilization
- Corpus Luteum regresses after about 12 days
- Progesterone products drop off sharply
- Endometrium sloughs off

The Menstrual Cycle and differences in ...

- Mate Choice
- Mood (including PMS)
- Cognition
- Sensation and Perception

The Menstrual Cycle & Mate Choice

- Women preferred males with more feminized faces.
  BUT...
Preference for Feminized Faces

Relationships

The Menstrual Cycle & Male Scent Attractiveness

Women preferred scent of more symmetrical men at midcycle

No difference when at low fertility risk

The Menstrual Cycle & Male Scent Attractiveness

What's happening here?

- Androstenol levels?
- Type of bacteria?
- Fatty acids?
- HLA Gene type?

Jealousy and Menstrual Phase

- Krug et al. (1996) found that women had stronger physiological responses to imagining loss of investment from their romantic partner when they were in the ovulatory phase of the menstrual cycle

Mood and PMS

- Many, many studies. Most show that mood is highest midcycle, lowest perimenstrually.

Percentages of Women who Report PMS

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Menstrual Distress Questionnaire</th>
<th>Premenstrual Assessment Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast Pain</td>
<td>35%</td>
<td>84%</td>
</tr>
<tr>
<td>Weight Gain</td>
<td>34%</td>
<td>83%</td>
</tr>
<tr>
<td>Swelling</td>
<td>36%</td>
<td>77%</td>
</tr>
<tr>
<td>Backaches</td>
<td>24%</td>
<td>77%</td>
</tr>
<tr>
<td>Sadness</td>
<td>43%</td>
<td>76%</td>
</tr>
<tr>
<td>Anxiety</td>
<td>30%</td>
<td>70%</td>
</tr>
<tr>
<td>Skin Blemishes</td>
<td>34%</td>
<td>69%</td>
</tr>
<tr>
<td>Dizziness</td>
<td>5%</td>
<td>25%</td>
</tr>
</tbody>
</table>
**PMS and reproductive hormones**

- No physiological abnormalities have been consistently linked with steroid hormone concentrations in women with PMS
- Preventing luteal phase with mifepristone (progesterone antagonist) did not prevent symptoms (Schmidt et al., 1991)
- But completely shutting down the cycle with GnRH antagonist did (Brown et al., 1993)

**Do Western Women seem to experience PMS more because they have many more menstrual cycles?**

*Compare hunter-gathering societies to Modern Western:*

- Age of menarche (17 v. 12)
- Age of first pregnancy (18 v. 26)
- Number of pregnancies (6 v. 2)
- Amount of time spent in lactational amenorrhea (10 years v. 3 months)
- Number of menstrual cycles experienced by HG women? 10-20 (Dennis, 1992)
- Number of menstrual cycles experienced by Modern Western women not on hormonal contraceptives? 300

**Cognition**

- When asked on a questionnaire if they have menstruation related cognitive changes – 20% of women say “yes.”
- No differences in learning and memory across menstrual cycle in most of the dozens of studies.
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• When asked on a questionnaire if they have menstruation related cognitive changes – 20% of women say “yes.”
• No differences in learning and memory across menstrual cycle in most of the dozens of studies.
• Academic performance does not seem to be significantly affected by menstrual cycle phase.

Kimura et al. (1988)

• Women performed better with verbal skill (repeating tongue twisters) and muscular coordination (finger tapping) when estrogen was high (midluteal phase).

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• Women performed better with verbal skill (repeating tongue twisters) and muscular coordination (finger tapping) when estrogen was high (midluteal phase).
• Women performed better on a measure of spatial-perceptual skill (Rod and Frame test) during menstruation (early follicular).
• Postmenopausal women on estrogen replacement performed better at verbal and motor function than other post menopausal women not on Hormonal Replacement Therapy

Spatial Ability & Cycle Phase

Math Speed/Accuracy & Cycle Phase

![Spatial Ability & Cycle Phase Graph](image_url)

![Math Speed/Accuracy & Cycle Phase Graph](image_url)
Cycle related physiological changes

- Body temperature
- Food intake and carbohydrate metabolism
- Weight
- Alcohol metabolism
- Sensitivity
- Speech
- Clinical ailments

Body Temperature

- Basal body temperature (temp when someone wakes up) is low during follicular phase, dips at ovulation and then rises noticeably just after ovulation (~0.4 degrees) and then continues to rise for the rest of the cycle.

Temperature shift is used in research and natural family planning to detect ovulation.

Food Intake and Carbohydrate Metabolism

- Food intake (and basal metabolic rate) are consistently higher during luteal phase.

Increase in food intake is primarily due to increased carbohydrate consumption.
**Food Intake and Carbohydrate Metabolism**

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- Increase in food intake is primarily due to increased carbohydrate consumption.
- Women with PMS show a more significant increase in appetite and carbohydrate craving than women without PMS.

**Weight**

- Approximately one third of women report a change in body weight (1-5 pounds) with menstrual phase, usually premenstrually or perimenstrually depending on study.

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- When estrogens are given experimentally to both rats and humans, there are increases in sodium and chloride which cause fluid retention.
- Fluid retention and increased food consumption may together account for cycle related weight fluctuations.

**Alcohol Metabolism**

- In study where men and women were given the same amount of alcohol (not controlling for body weight), women got more intoxicated and had a higher blood alcohol level than men.

**Alcohol Metabolism**

- Unclear why more affected in late luteal phase.
Senses

• Almost all of the senses (visual, auditory, tactile, and especially olfactory) appear to be more acute during the follicular phase of the menstrual cycle.

• Conflicting studies about sensitivity to pain, but many show an increase sensitivity to pain at midcycle.

• Some researchers speculate that heightened sensitivity during mid-cycle may be useful for increasing the probability of coitus.

Clinical Ailments

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- Rheumatoid arthritis symptoms are lowest when ovarian steroids are low (early follicular phase).

Next Time...

- Menarche
- Puberty Rituals