



# Physiology Midterm Revision

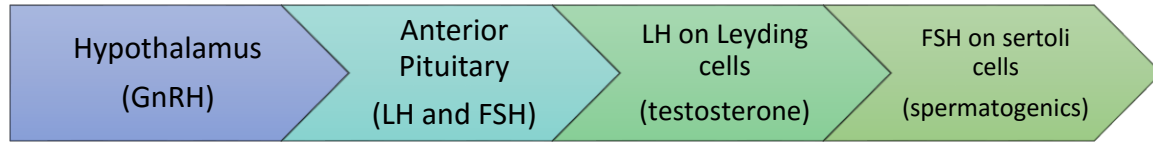
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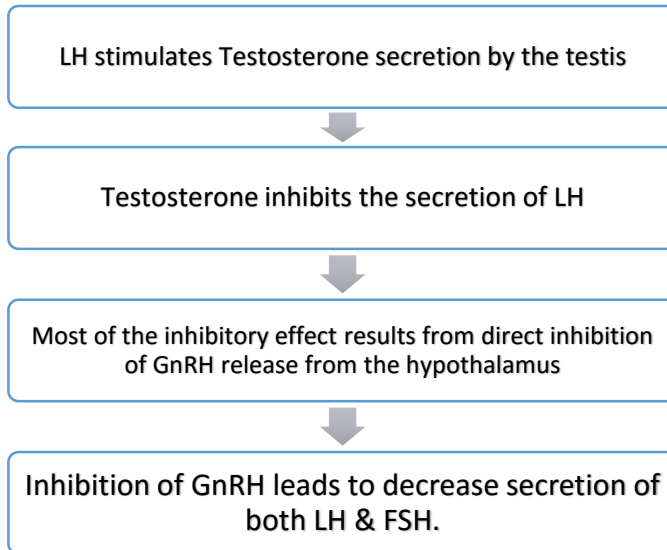
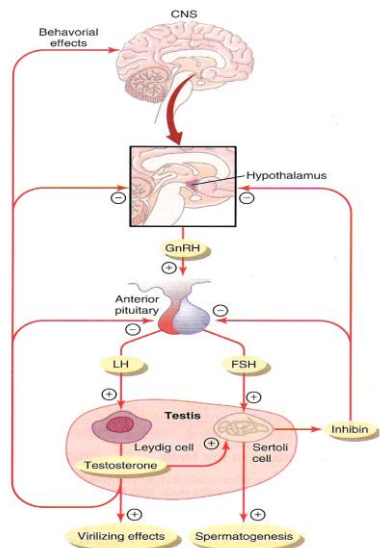
# 1-HPG axis

## Control of male sexual functions by hypothalamic & anterior pituitary hormones:



- GnRH a peptide secreted by the arcuate nuclei of hypothalamus
- Mature Leydig cells are found in child's testis few weeks after birth & then disappear until puberty when it appears again

## Negative Feedback Control of Testosterone:



## Regulation of spermatogenesis mainly by FSH and testosterone

- FSH binds with specific FSH receptors attached to the Sertoli cells in the seminiferous tubules → which causes these cells to grow & secrete spermatogenic substances
- Testosterone & Dihydrotestosterone diffuse into the seminiferous tubules from the Leydig cells and bind to ABP which enhances spermatogenesis

## Negative feedback control of seminiferous tubule



FSH: When the seminiferous tubules fail to produce sperm

- This is due to the secretion of **inhibin** hormone from the Sertoli cells which strongly inhibits the AP\* - FSH
- Inhibin has a slight inhibitory effect on the hypothalamus to inhibit GnRH secretion.



FSH: When spermatogenesis proceeds rapidly

## Hormonal Feedback (in female)

### Hormone inhibin:

from the corpus luteum secreted by the granulosa cells inhibits the secretion of FSH & to a lesser extent LH.

### Negative feedback effects of estrogen and progesterone:

Estrogen in small amounts has a strong effect to inhibit the production of LH & FSH and this inhibitory effect of estrogen is increased when progesterone is available. This inhibitory effect is more on the anterior pituitary directly & to a lesser extent on the hypothalamus to inhibit the secretion of GnRH.

- Spermatogenesis takes place in the seminiferous tubules at age of 13 & decrease in old age.
- Leydig cells (secrete testosterone) → within the interstices between the seminiferous tubules, non-existent in childhood, numerous in the newborn male infants, active at puberty & throughout adult life.
- Testosterone causes hypertrophy of the laryngeal mucosa, enlargement of the larynx (adult masculine voice)
- Testosterone inhibits the secretion of LH by negative feedback regulation

- Sperms in the epididymis are inactive (by inhibitory factors) → then it will be activated in female genital tract (by uterine & fallopian fluids), for the processes of fertilization. These activation changes are called **capacitation** of the spermatozoa (require 1 to 10 hours).
- Erection is caused by parasympathetic

- The testis form up to 120 million sperms a day.
- At fetal life testosterone production starts from **genital ridges**

- Ejaculated semen → from VD (10%), prostate gland (30%), seminal vesicles (60%), PH=7.5
- Alkaline prostatic fluid → help to neutralize the mild acidity of other portions of the semen & gives the semen a milky appearance.

- Ejaculated Sperm count below 20 million leads to infertility.
- Non-motile or entirely non-motile which causes infertility

- The height of an adult eunuch is slightly greater than normal because of slow union of the **epiphyses**.
- Cancer of the prostate gland caused by stimulation of **cancerous cells** by testosterone
- **Froehlich's syndrome**: results in obesity with eunuchism.
- The seminal vesicles → secrete mucoid material, & large quantities of prostaglandins & fibrinogen.

- Mature sperm are **motile** & capable of fertilizing the ovum, activity enhanced in alkaline and depressed in acidic, the life of ejaculated sperm in the female genital tract is only 1 to 2 days
- LH → secreted by the AP gland, stimulates the Leydig cells to secrete testosterone.
- FSH → stimulates the sertoli cells, stimulate the conversion of spermatids to sperm. Majority of sperms are stored in the vas deferens (maintaining their fertility for at least a month).

## Lecture 2: Male Androgens and Secondary Sexual Characteristic

- Ejaculation caused by sympathetic
- Testosterone is the most **abundant** form while dihydrotestosterone is most **active**.
- Testosterone converted into dihydrotestosterone (by enzyme 5 α reductase) in the target cells.
- Testosterone converted to estrogen in the liver.
- Testosterone have anabolic effect on proteins and muscle of the body
- Testosterone increases red blood cells

- Testosterone increases bone matrix and causes Ca<sup>2+</sup> retention, increase the reabsorption of Na<sup>+</sup> in the distal tubules of the kidney

- Cryptorchidism: failure of the testes to descend in the scrotum which normally occur during fetal life

- The acrosome cover the anterior 2/3 of the head of the sperm
- Eunuchism: male loses his testis before puberty.

- Epididymis → sperm maturation and storage.
- Estrogen Formed from testosterone by sertoli cells under FSH control

- Testosterone decreases the growth of hair on the top of the head

- Testosterone → increases the secretion of the **sebaceous** glands → causing acne
- Y chromosome controls whether an embryo will develop testes or ovaries

- During fetal life the testis are stimulated by **placenta chorionic gonadotropin** to produce testosterone throughout fetal life & the 10 weeks after birth

# 3- Ovarian Cycle



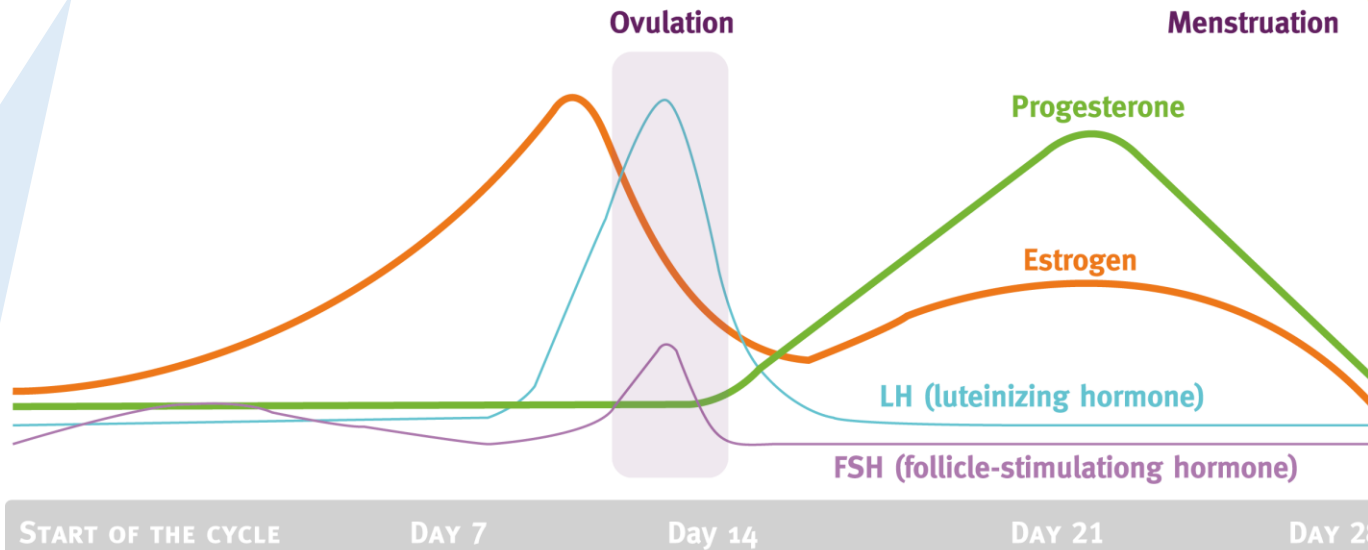
Ripening of follicles

Ovulation

Ripening of the corpus luteum

## Follicular Phase

## Luteal Phase



1. Increase in secretion of **FSH** & **LH** (FSH slightly more)
2. **Primordial follicles** turn into **primary follicles**: increase in size of the ovum & growth of additional layers of granulosa
3. Ovary interstitium collects → theca cells
4. Theca cells divide:  
**Theca interna** → secrete sex hormones  
**Theca externa** → highly vascular
5. Granulosa cells secrete follicular fluids containing high estrogen → **antral follicle** (by **FSH**)
6. Additional fluid → **vesicular follicle**\*

1. 2 days before ovulation **LH** secretion increases 6-16 folds & peaks 16hrs before ovulation, **FSH** increases to 2-3 folds → swelling of the follicle
2. LH turns granulosa & theca cells into **progesterone** secreting cells → ↓**estrogen**
3. Theca externa secrete proteolytic enzymes → weakening follicle wall & degeneration of stigma
4. Follicular hyperemia & prostaglandin secretion → follicle swelling

\*vesicular follicle growth is caused by:

1. ↑**estrogen** secreted into follicles → ↑**FSH** receptors → **+ve feedback**
2. **estrogen** + **FSH** → ↑**LH** receptors → ↑follicular secretions
3. ↑**estrogen** + ↑**LH** → proliferation of theca cells + ↑secretions

1. Luteinization process is inhibited before ovulation by: **luteinization inhibiting factor** in the follicular fluid
2. Conversion of granulosa & theca cells into lutein cells
3. Granulosa cells → secrete **progesterone** & **estrogen**
4. Theca cells → secrete androgens which get converted to female hormones by granulosa cells
5. corpus luteum grows to about 1.5cm at about 7-8 days after ovulation
6. 12 days after ovulation it turns into corpus albicans

In pregnancy: **chorionic gonadotropin** from the placenta prolongs corpus luteum's life

## 1- Proliferative phase (estrogen phase):

- At the beginning of each cycle, most of the endometrium desquamated by menstruation.
- After menstruation only thin layer of the endometrial stroma remains & deeper glands of endometrium
- estrogens secreted by the ovaries cause the stromal cells & epithelial cells proliferate rapidly.
- The endometrial surface re-epithelialized within 4-7 days after the beginning of menstruation.
- Before ovulation the endometrium thickness increase, due to increase numbers of stromal cells & progressive growth of the glands & new blood vessels.
- At the time of ovulation, the endometrium is 3-5 mm thick
- . The endometrial glands in cervical region secrete a thin, stringy mucus which help to guide sperm in the proper direction from the vagina into the uterus.

- In normal menstruation, about 40 ml of blood + 35 ml of serous fluid are lost.
- The menstrual blood is normally non-clotting due to the presence of fibrinolysin.
- Within 4 to 7 days after menstruation, the loss of blood ceases & the endometrium become re-epithelialized.
- During menstruation, leukocytes are released with blood so the uterus is highly resistant to infection

## 2- Secretory phase (progestational phase):

- After ovulation, estrogen & progesterone are secreted by the corpus luteum.
- Progesterone causes marked swelling & secretory development of the endometrium.
- The glands increase in tortuosity, excess secretory substances accumulate in the glands.
- Stromal cells cytoplasm increases (Lipid & glycogen deposits )
- Blood supply to the endometrium increases and become more tortuous.
- 1 week after ovulation, endometrium thickness is 5-6 mm.
- The secretory changes prepare the endometrium (stored nutrients) for implantation.
- Uterine secretions called “uterine milk” provide nutrition for the diving ovum.

The trophoblastic cells on the surface of the implanted ovum begin to digest the endometrium & absorb endometrial stored substances

### Definition of menopause:

- The period during which the cycle stop & the female sex hormones diminish (Fall of estrogens.) The ovaries no longer secrete estrogen and progesterone.
- The reproductive cycle becomes irregular, Ovulation fails to occur & the cycle ceases. (decline in the number of primordial follicles)
- The ovaries no longer secrete estrogen and progesterone.
- The uterus and vagina atrophy.

### Physiological changes due to loss of estrogens

“hot flushes” - psychic sensations and dyspnea. – Irritability – Fatigue  
– Anxiety - various psychotic states - decreased strength and calcification of bones

## Lecture 4: Uterine Cycle

-During the postovulatory phase the corpus luteum secrete large quantities of both progesterone & estrogen & inhibin which all together cause negative feedback effect on AP & hypothalamus to inhibit both FSH & LH secretion.

- (lowest level 3-4 days before the onset of menstruation)

### Abnormalities of menstrual cycle

Amenorrhea: Is absence of menstrual period either

- Primary amenorrhea :menstrual bleeding has never occurred.
- Secondary amenorrhea : cessation of cycles in a woman with previously normal periods, causes:
- Pregnancy

Menorrhagia: profuse flow during regular periods.

Hypomenorrhea: Refer to scanty flow.

Dysmenorrhea: Painful menstruation (cramps due to accumulation of prostaglandins)

### Menstruation:

- If the ovum is not fertilized, 2 days before the end of the monthly cycle, the corpus luteum involutes & estrogens & progesterone decrease to low levels. decrease stimulation of the endometrium followed by involution of the endometrium
- 24 hrs before the menstruation, there is vasospasm of the tortuous blood vessels due to release (prostaglandins).

#### There is

1) Vasospasm 2) Decrease nutrients to the endometrium 3) Loss of hormonal stimulation,

- Gradual necrosis of the outer layer of the endometrium
- Within 48 hrs, all the superficial layers of the endometrium desquamated in the uterine cavity.
- - The mass of desquamated tissue & blood plus the contractile effects of prostaglandins initiate contractions which expel the uterine contents.

## Female

## Male

<b>P1</b>	Prepubertal (Before puberty)	Prepubertal, testicular volume < 2mls.
<b>P2</b>	Early development of subareolar breast bud +/- small amounts of pubic and axillary hair.	Enlargement of scrotum and penis, Scrotum slightly pigmented and Few pubic hairs.
<b>P3</b>	Increase in size of palpable breast tissue and areolae, increased pubic/axillary hair.	Lengthening of penis, Further growth of testes and scrotum and Pubic hair darker.
<b>P4</b>	Breast tissue and areolae protrude above breast level. Further increased pubic/axillary hair growth.	Penis increases in length and thickness, Increased pigmentation of scrotum and Increased pubic/axillary hair.
<b>P5</b>	Mature adult breast. Complete pubic/axillary hair growth.	Genitalia adult in size and shape and Completed pubic/axillary hair growth

### Important notes:

- Puberty usually completed within 3-4 years of onset (otherwise it will be considered as delayed puberty)
- **Thelarche**: development of breast
- **Puberarche**: development of axillary and pubic hair
- **Adrenarche**: onset of secretion of androgens, development of axillary and pubic, acne and body odour.
- **Gonadarche**: Maturation of gonadal function
- First signs are, breast enlargement/ testicular enlargement
- Leptin: has the same receptor in the hypothalamus that decreases the NPY (feeling of fullness) and increase GnRH "that causes early puberty in obese children"
- Precocious puberty: in girls before 8 and boys before 9.
- Delayed puberty: in girls after 13 or (primary amenorrhea after 16) and boys after 14