



# **Female reproductive system**

**By**

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# Structure of female reproductive system

## I. Primary sex organ (ovary) *endocrine Exo.*

- 1) Production of ova (Oogenesis). *Exo.*
- 2) Production of steroid hormones (**Estrogen & Progesterone**). *Endo.*

## II. Secondary sex organs

(Fallopian tubes & Uterus & Cervix & Vagina & External genital organs).

- *[at birth → million follicle at 2 sides.] during embryonic life*  
Ovaries in young female at menarche contain 400,000 follicles. ↑
- *menopause ↓ ↓ Puberty ↓ ↓*  
During reproductive period, only 500 follicles will complete their maturation to release ova and the others become atretic.



# Sex (Menstrual) cycle in female

## Definition:

➤ It is a monthly rhythmic changes in the **rate of secretion** of female sex hormones with corresponding changes in 1<sup>ry</sup> & 2<sup>ry</sup> sex organs. تغيير

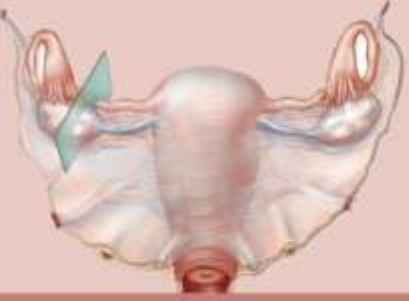
**Due to:** cyclic changes in hypothalamic Gn-RH & pituitary gonadotropins. [Continuous ← male]

\* **Aim:** is periodic preparation for fertilization & pregnancy.

**Length:** 28 days for each cycle. [لحسن في اختلاف من انثى الى انثى]

The sex (menstrual) cycle consists of:

1. Ovarian cycle
2. Uterine cycle
3. Vaginal cycle
4. Cyclic changes in cervix
5. Cyclic changes in breast



# Ovarian cycle

3 Phases

- Ovarian cycle is composed of 3 phases

<b>1) Follicular phase</b> ← بتتخير من نشأ الى انشأ	14 days	<ul style="list-style-type: none"> <li>Under control of <u>FSH</u>.</li> <li>Secretion of large amount of <b>estrogen</b>.</li> </ul>
<b>2) Ovulation phase</b>	Mid-cyclic ← يوم 14	<ul style="list-style-type: none"> <li>Caused by LH &amp; FSH <u>surge</u>.          ← at critical level at certain moment.</li> </ul>
<b>3) Luteal phase</b> ← نأية ما بتخير	14 days	<ul style="list-style-type: none"> <li>Under control of <u>LH</u>.</li> <li>Secretion of large amount of <b>progesterone</b>.</li> </ul>





## I. Follicular phase:

### ▲ At the start of each cycle:

- (6 – 12) <sup>by both ovaries</sup> **primordial follicles** <sup>by FSH</sup> enlarge to form **primary (pre-antral) follicles**.
- Under the effect of **FSH** which is released from anterior pituitary gland due to low level of estrogen.

### ▲ Composition of primary (pre-antral) follicle:

فيها 3 اجزاء

✦ **Primary oocyte** is increased in size.

✦ **Follicular cells** proliferate to form **granulosa cells** around the oocyte.

- **Ovarian stromal cells** proliferate to form **theca cells** around the follicle.

### ▲ Two cells mechanism for steroid production:

estrogen progesterone

2 cells

1) **Theca cells** synthesize **androgen** under the effect of **LH**.

2) **Granulosa cells** **convert androgen to estrogen** under the effect of **FSH**.

### ▲ Antral follicle:

[After one week (at the 7th day of the cycle):]

a) **Largest follicle (first in phase)** in one ovary enlarges & highly developed & secrete more estrogen.

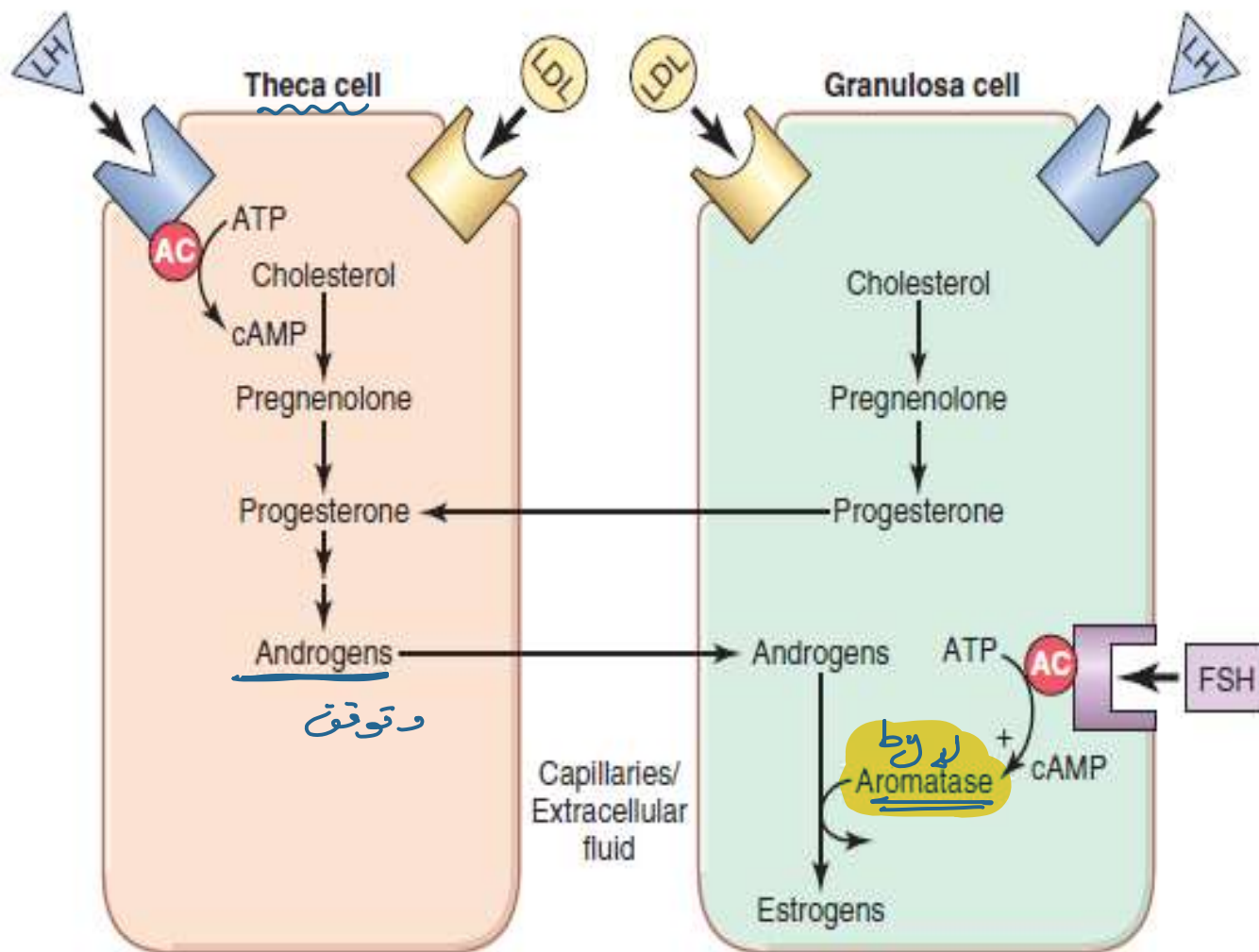
اول وحده دخلت وبلست تكبر

It is called **antral follicle or dominant follicle**.

It contains a large cavity filled with fluid called the antrum.

b) **Other follicles (competing follicles)** regress & degenerate.

↑ FSH receptors  
+  
↑ sensitivity to FSH-



Interaction of follicular theca and granulosa cells for production of estrogens. The theca cells, under the control of luteinizing hormone (LH), produce androgens that diffuse into the granulosa cells.

In mature follicles, follicle-stimulating hormone (FSH) acts on granulosa cells to stimulate aromatase activity, which converts the androgens to estrogens.





# Mechanism of uni ovulation

[The dominant follicle secretes large amount of estrogen.]

- Estrogen from dominant follicle will cause the following:

FSH ↑  
estrogen ↑

**1) Negative feedback on competing follicles:**

- ↑ Estrogen ⇒ ↓ FSH secretion from anterior pituitary.

- (↓) FSH ⇒ (↓) growth of competing follicles ⇒ atretic follicles.

**2) Positive feedback on dominant follicle:** *more growth*

- ↑ Estrogen (in the follicle) ⇒ (↑) number & sensitivity of FSH receptors on granulosa cells of dominant follicle ⇒ ↑ response of granulosa cells to FSH in dominant follicle ⇒ ↑ estrogen secretion from dominant follicle ⇒ more growth of the dominant follicle.

[Also, the dominant follicle secretes **inhibitory peptides** that cause degeneration of the competing follicles.]

عشرات تخلص من الـ follicles  
الى خلية .



## Just before ovulation:

✦ The follicle becomes **mature graafian follicle** (reach 1 – 2 cm in diameter).

*Haploid number*

- The oocyte complete the **meiosis** reduction division to produce **secondary oocyte** and **first polar body**.

- The secondary oocyte is **arrested in the metaphase** until fertilization.

*بليست انقسام  
دوقفه*

- In Antral follicle, the spaces unite and give one large space,

- oocyte is located in a mass of granulosa cells (cumulus oophorus) that project into antrum,

- The first layer of granulosa cells that surround the oocyte and in close contact with zona pellucida, becomes elongated and is called **corona radiata**.

☐ In presence of **FSH and increased estrogens** outer layers of granulosa cells of large antral follicle synthesize LH receptors.

*حطه على حالي*

Σ Just before ovulation, these cells begin to synthesize **progesterone** instead of converting androgens to estrogens.

*بدل ما تصنع estrogen صارت تحول الى progesterone*





## II. Ovulation

★ **Timing:** ovulation occurs at the 14th day of the cycle. (mid-cyclic). ]

★ **Cause of ovulation:** gonadotropin surge. (LH & FSH surge).

## III. Luteal phase

★ **Formation of corpus luteum:**

- After ovulation, the ruptured follicle becomes filled with blood forming corpus hemorrhagicum, then clotted blood is removed by phagocytosis. ]

- Then, it is converted to corpus luteum **under the effect of LH.** *due to LH receptors*

- Both granulosa & theca cells are converted to **lutein cells.**

✓ Lutein cells are rich in lipids. So, corpus luteum is **yellow** in color. ]

★ **Functions of corpus luteum:**

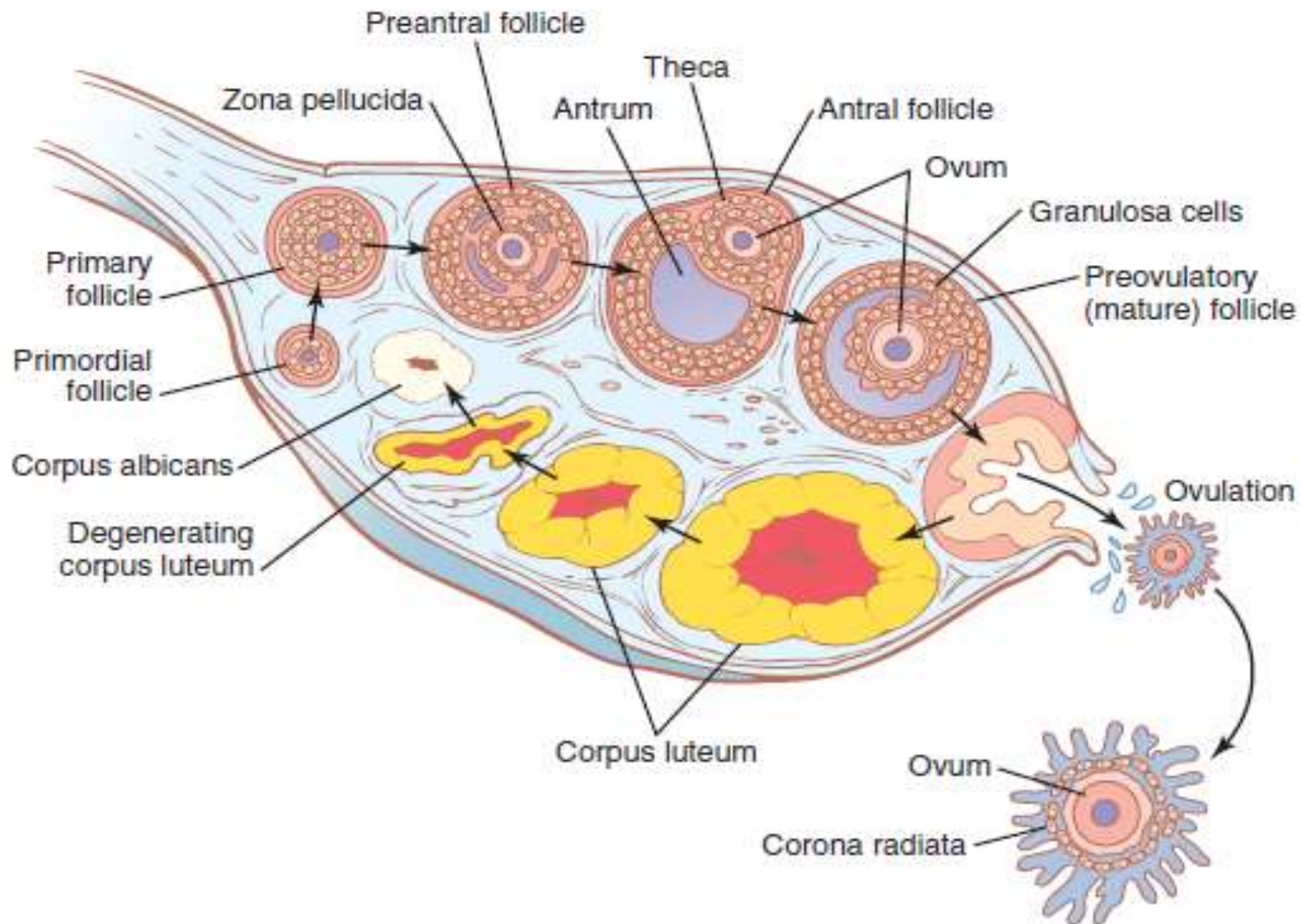
- It is a **temporary endocrinal** organ. Secretes progesterone & estrogen. ]

- So, after ovulation by **8 days**, there is **progesterone** peak with second peak of **estrogen.** (first estrogen peak is mid-cyclic).

*على اليوم 22 من اول عاوية*

*just before ovulation 2*

*الاعتمادية من اول مرة -*



**Stages of follicular growth in the ovary, also showing formation of the corpus luteum**



## ★ Fate of corpus luteum

### A. If no fertilization & no implantation:

- ↓ LH (due to high level of progesterone & estrogen) ⇒  
degeneration of corpus luteum (luteolysis) ⇒ [drop of progesterone & estrogen level 9 days after ovulation.] 23-24 day.

مقابله الهرمون  
الرجعي  
destructive

After 14 days of ovulation, it becomes corpus albicans.

Corpus albicans is removed by macrophages leaving fibrous scar.

كل شيء

### - Drop of progesterone & estrogen level lead to:

a) Shedding of endometrium in uterus (menstruation). menses

b) Stimulation of FSH secretion to start another cycle.

### B. If fertilization occurs:

Gn-RH

- Corpus luteum is maintained by human chorionic gonadotropin (hCGn) for 6 months and called corpus luteum of pregnancy, Which secretes progesterone for stabilization of pregnancy.

له دوره هرمون الحمل لذلك



عك البيج 14

# Ovulation



## Definition

It is the process of **rupture** of **mature** graafian follicle and **expulsion of ovum** into the peritoneal cavity to be picked up by the fimbriated end of the fallopian tube.

2ry oocyte



**Timing:** Ovulation occurs at the 14th day of the cycle. [mid-cyclic].

لداول ريجولر cycle



## Mechanism of ovulation

### 1. Before ovulation

- Premature oocyte **maturation & luteinization** are prevented by:

1) **Oocyte Maturation Inhibitor (OMI):**

- It is formed by the granulosa cells.
- It prevents meiosis of the oocyte until the pre-ovulatory LH surge removes this inhibition.

هو مسبك مانير OMI

### 2) **Luteinization Inhibitor (LI):**

- It is formed by the granulosa cells.

It inhibits luteinization until the pre-ovulatory LH surge removes this inhibition.



## II. Gonadotropin surge

FSH / LH mainly

➤ **Definition:** it is mid-cyclic increase in gonadotropins level in blood.

➤ *Cause of gonadotropin surge*

- When estrogen level in the blood reaches a high critical level and maintained for a critical time (it induce sudden increase in LH (LH surge) + FSH)

على حثا

➤ *Aim of gonadotropin surge*

1) Final **maturation** of the oocyte.

by OMI

By removal of the inhibitory effect of **Oocyte Maturation Inhibitor**

2) Physical **release** of the oocyte from the mature graafian follicle.

By removal of the inhibitory effect of **Luteinization Inhibitor**

by LI



# Functions of LH surge

- For maturation*
1. **Complete the meiosis:** by removal of inhibitory effect of **OMI**
  2. **Luteinization of granulosa cells:** by removal of inhibitory effect of **LI**  
*granulosa ← LH عتاش*
  3. **↑ Progesterone synthesis** Progesterone leads to:
    - a) Hyperemia of follicle  $\Rightarrow$  Plasma transudation  $\Rightarrow$  swelling of the follicle.
    - b)  $\uparrow$  Distensibility of follicular wall to accommodate rapid increase in follicular fluid without marked change in the intra-follicular Pressure.  
*large volume*
  4. **↑ Proteolytic enzymes activity (collagenase)**  
This leads to digestion of collagen in the follicular wall.





## 5. ↑ **Plasminogen activator**

This leads to conversion of plasminogen to plasmin (active proteolytic enzyme)  $\Rightarrow$  lysis of the follicular wall connective tissue.

## 6. ↑ **Prostaglandin synthesis (PGE & PGF)**

- a) PG act to free lysosomal enzymes within the follicular fluid  $\Rightarrow$  digest the follicular wall.
- b) PG contract the ovarian smooth muscles  $\Rightarrow$  help the expulsion of ovum into the peritoneal cavity.



## Functions of FSH surge:

↳ main function

1. Increase number of **LH receptor** on the **granulosa cells** for luteinization and normal corpus luteum formation.
2. Stimulation of **granulosa cells** to produce **plasminogen activator**.

## Indications (signs) of ovulation

- Ovulation occurs at the 14th day of the cycle. (mid-cyclic).  
i.e. 14 days from the start of menstruation (if the cycle is regular).

علامات انحصار  
ovulation

## Methods used to determine time of ovulation:

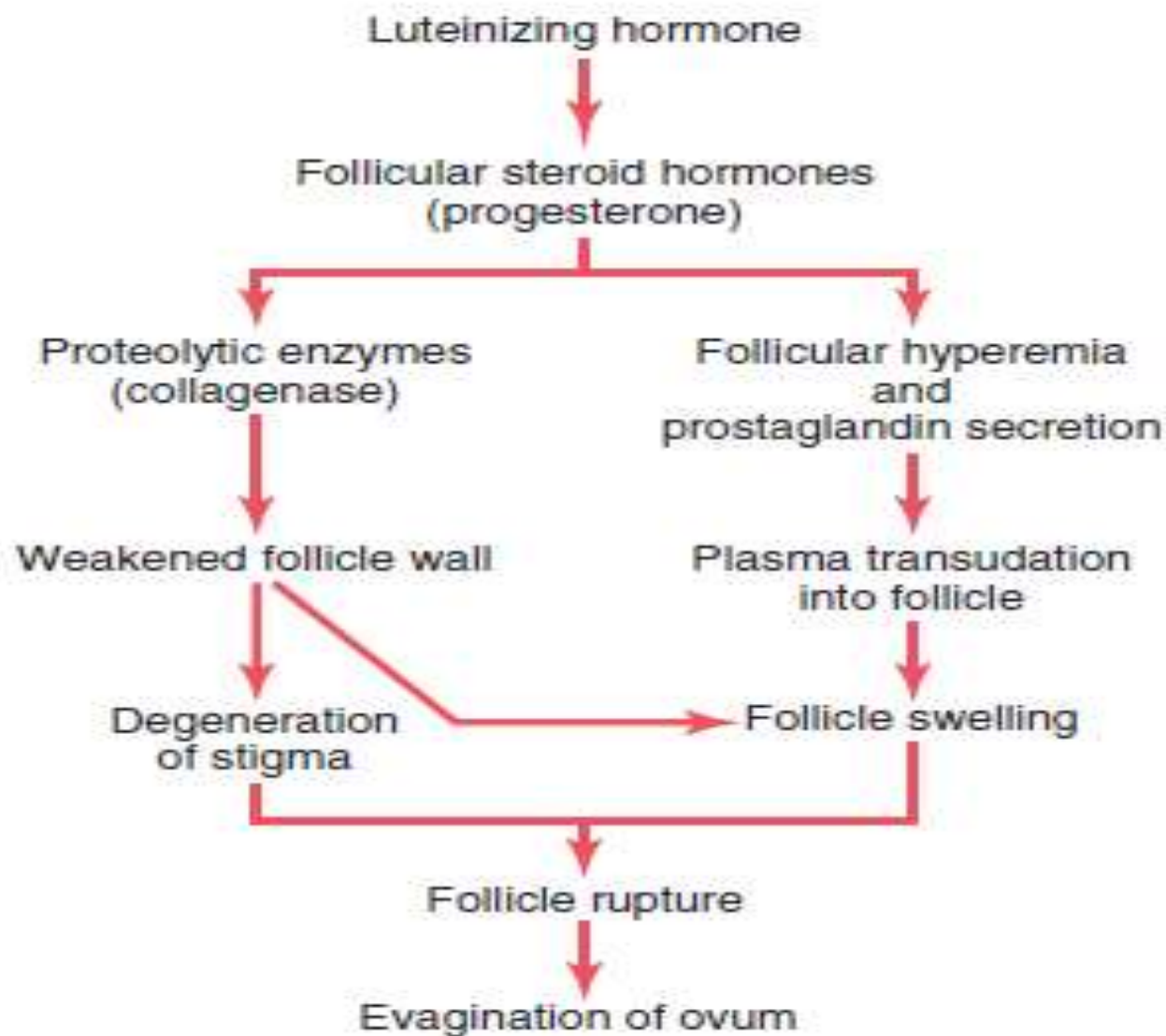
- Ovulation and **corpus luteum** formation is indicated by the presence of signs of **progesterone** release.

↳ mainly

1. **LH surge**: ↑ plasma LH 9 – 11 hours before ovulation.
2. **Urine**: ↑ presence of **pregnandiol** (metabolic end product of progesterone).
3. **Temperature**: ↑ body temperature by 0.5 °C at the time of ovulation, that persists until menstruation occurs. [must be morning temperature].
4. **Ovary**: lower abdominal pain at the time of ovulation.
5. **Ultrasound imaging**: to see the mature graafian follicle.

كل شهر على سبعة مرة كل مرة ١٢. ١٢

قبل اي هورونات  
تأثيره



**The postulated mechanism of ovulation**



# Failure of ovulation (non-ovulatory cycles)

ال non-ovulatory

- Non-ovulatory cycles are present normally in the first 1 - 2 years after the onset of puberty and before the menopause.  
↑ Painless
- Bleeding is due to withdrawal of estrogen due to <sup>atresia</sup> atrophy of graafian follicle. <sup>مقل</sup>
- \* Some women are infertile due to non-ovulatory cycles.
- non-ovulatory cycles occur also in women treated with contraceptive pills.



# Uterine cycle

➤ **Definition:** - Cyclic changes of the endometrium under the effect of ovarian hormones.

➤ **Aim:** [Preparation of endometrium to receive zygote] (implantation). - If no implantation, the prepared endometrium is destroyed as menstruation.

[So, menstruation is the crying of uterus for lack of a baby].

➤ **Phases:**

1. **Proliferative phase** 5-14 day

2. **Secretory phase** (Luteal phase)

3. **Menstrual phase (Destructive phase)** 1-5 day

1-3 → Follicular Phase in ovary.



# 1. Proliferative phase

Correspond to follicular phase in ovary.

From 5th to 14th day of the cycle.

Under the effect of **estrogen**  
Secreted from the developing follicle.

## Changes:

- **Endometrium:** rapid increase in thickness from 1  $\Rightarrow$  4 mm.
- **Uterine glands:** increase in length rapidly but with no secretions.
- **Epithelial cells:** contain little glycogen.
- **Vascularity:** blood vessels become more spiral but not tightly coiled.



## 2. **Secretory phase** (مخابسة)

**Correspond to luteal phase in ovary.**

From 15th day to the beginning of next cycle.

Under the effect of **progesterone & estrogen**  
Secreted from corpus luteum.

### **Changes:**

- **Endometrium:** more increase in thickness from 4  $\Rightarrow$  8 mm.
- **Uterine glands:** become coiled with thick mucoid secretion rich in glycogen.
- **Epithelial cells:** rich in glycogen.
- **Vascularity:** blood vessels become tightly coiled.
- Connective tissue in lamina propria undergo decidual reaction.  
مستعداً لاي حمل
- At the end of this phase, the endometrium can be divided into 3 regions:
  - a) **Compact:** neck of the glands.
  - b) **Spongy:** dilated part of the glands.
  - c) **Basal:** blind ends of the glands.  $\rightarrow$  Regeneration of basal layer
- **Functional layer** = (compact & spongy) are supplied by spiral arteries.
- During menstruation the functional layer is lost while the basal remains.



### 3. Menstrual phase (Destructive phase)

- **Timing:** from the first to the 5th day of the cycle. *اول 5 ايام من اول follicular*
- **Cause:** due to degeneration of corpus luteum ⇒ removal of the hormonal support of the endometrium.
- **Mechanism:** *التي تسمى في corpus luteum*
- VC of spiral arteries ⇒ ischemia & necrosis of functional layer.
  - Then, VD of spiral arteries ⇒ rupture & hemorrhage.
  - Finally, the endometrium is shed in patches soaked with blood.
  - (The bleeding ends when the spiral arteries constrict again.) *V.C*
- \* **The menstrual bleeding** is not clotted due to fibrinolytic system. *20 ml*
- menorrhagia → excess production of blood + clotting.*



Other cycles.

### 3- Vaginal cycle

- In the follicular stage : under the effect of estrogens the vaginal epithelium becomes cornified (identified in the vaginal smear) and there is acidic secretion.
- In the luteal stage : under the effect of progesterone the vaginal epithelium proliferates.

### 4- Cyclic changes in cervix

- In the follicular stage : under the effect of estrogen there is thin , watery , alkaline mucous that help transport and survival of sperm and gives (positive fern pattern arborization).   
 ← مساعدة لا سperm فطرح  
 لواخذت صنية وخليتها تشبه فطرح
- In the luteal stage : under the effect of progesterone there is thick , cellular secretion that gives negative fern pattern arborization.   
 ما بعد سكر، رقيقة  
 Leukocytes

### 5- Cyclic changes in breast

- Ten days before menstruation, there is swelling, tenderness and pain the breast, probably due to distension of ducts , hyperemia and edema of the interstitial tissue of the breast , all these changes regress during menstruation .

by estrogen + progesterone  
 on luteal phase.  
 Pre-menstrual - menstruation syndrome



# Ovarian hormones

## 1. ESTROGENS

Steroid hormones .

- **Three types** of estrogens are secreted from the ovaries  
Estradiol (most potent) , Estrone , and Estriol .

مصادره Secreted from :

- 1- Ovary from **growing follicles** and **corpus luteum** .
  - 2- Non ovarian sources : **placenta** and **suprarenal cortex** .
- **Transported** in blood in free form and bound with globulins .
  - **Metabolism** : mainly in liver

افرازه مستمر  
معدل  
تختلف - **Estrogen secretion is continuous** , however , it **shows cyclic variation in the rate of secretion** i.e. estrogen has 2 peaks :

- (1) At time of ovulation or just before ovulation
- (2) Mid-luteal phase which is less than pre-ovulatory peak



## Actions :

1- **In the embryonic life** : Development of **uterus** and **vagina** .

2- **Pre-pubertal effect** : ↓ **Gonadotropin releasing factors**, due to high sensitivity of hypothalamic feedback mechanism.

3- **After puberty**:

a- **On the ovary** : growth and maturation of **oocyte** and **corpus luteum** .

b- **Effect on Secondary sex organs** :

- Estrogen stimulate the growth of **secondary sex organs**

- (uterus, tubes, vagina, external organs ) .

- They stimulate the proliferation of endometrium and vascularity (it responsible for proliferative phase of uterine cycle) .

- They **increase** the motility of the fallopian tubes and excitability of uterine muscles and their sensitivity to oxytocin *during intercourse* .

- They stimulate the **synthesis of progesterone** receptors in the uterine tissues





## ~~e~~ Effect on Female Sex characters :

- They stimulate the development of the breast (duct system, increase the blood supply and pigmentation of areolae & nipples) .
- [ They are responsible for the female type of Fat and hair distribution . hip / Breast ]
- [ They keep the female voice high pitched . ]
- [ They are responsible for the broad female pelvis. ]





## \* Metabolic effects :

- They stimulate union of the epiphysis and maturation of ossification centers .
- Estrogens are mild anabolic agents .
- They cause retention of  $Ca^{++}$  and ph-3 and formation of bone matrix .

Period أكبر تتكون قشرية  
إلى سنجيها أو

\* They include mild  $Na^{+}$  and water retention responsible for the premenstrual tension .

- They decrease circulating cholesterol levels, they could be one of the factors responsible for lower incidence of atherosclerosis in females .

\* Alters hepatic production of clotting factors so, promote thrombosis \*

- Secretion of angiotensinogen .

e- **Behavioral effect** : increase lipido in human





## 2- PROGESTERONE

- Steroid hormone.

- Secreted from :

- \***Ovary** : corpus luteum .

- \***Non ovarian sources** : placenta and suprarenal cortex.

- Transported in blood 2 % free & 98% bound to albumin and globulins.

- \*Metabolism mainly in liver and excreted in urine in the form of **pregnandiole**.



# Actions Of Progesterone

1. It is responsible for the **secretory phase** in the endometrium.
2. It changes the **stroma cells** of the endometrium into **decidual cells**. <sup>تحويل الخلايا</sup>
3. ✱ It is responsible for the **formation of placenta** and imbedding of the fertilized ovum .
4. ✱ It maintains pregnancy by **inhibiting uterine contraction** . It is antagonistic to the effect of estrogens , so that the excitability of myometrium cells decreases as does their sensitivity to oxytocin .
5. ✱ Inhibition of ovulation via inhibition of anterior pituitary gonadotropins secretion .
6. ✱ It stimulates the **growth of the secretory alveoli of mammary glands** & increase blood supply to the breast with more hyperemia.



7. **progesterone** has a natriuretic effect when present in high concentrations.  
*excretion*

8. Increase **basal body temperature** by about 0.5 °C due to its effect on hypothalamus and its permissive action on thyroid hormone.  
*↑↑ basal metabolic rate.*

9. **Behavioral effect** :

~~1.~~ Increase appetite .

~~2.~~ participates in onset and maintenance of maternal behavior.

~~3.~~ Stimulate respiration due to increased sensitivity of respiratory center to CO<sub>2</sub>.



**THank you**