

FEMALE REPRODUCTIVE SYSTEM – I

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PROFESSOR

Life of women

The life of a women can be divided into 3 periods:

- ❖ From birth to menarche (upto 12 years)
- ❖ From onset of puberty to the onset of menopause (12 – 45th year)
- ❖ Post menopausal period (46th year onwards)

From birth to menarche

- ▶ This is the asexual period of the female.
- ▶ Menarche is the first menstrual cycle and indicates the onset of puberty.

From onset of puberty to the onset of menopause

- ▶ This is the sexual fertile period of the women.
- ▶ Cessation of menstrual cycles is referred as menopause.
- ▶ The women can bear children during this period.

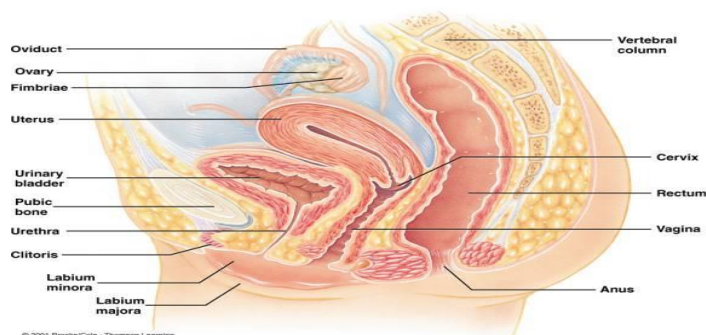
Post – menopausal period

- ▶ Menstrual cycles cease
- ▶ Women experiences a variety of symptoms – post – menopausal syndrome

The female reproductive system

consists of

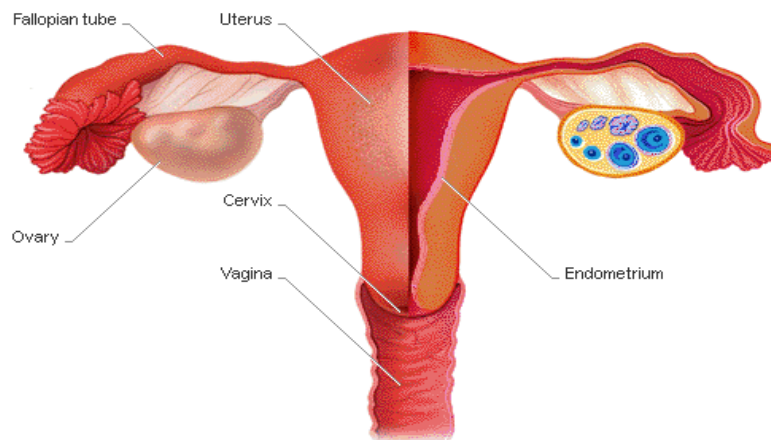
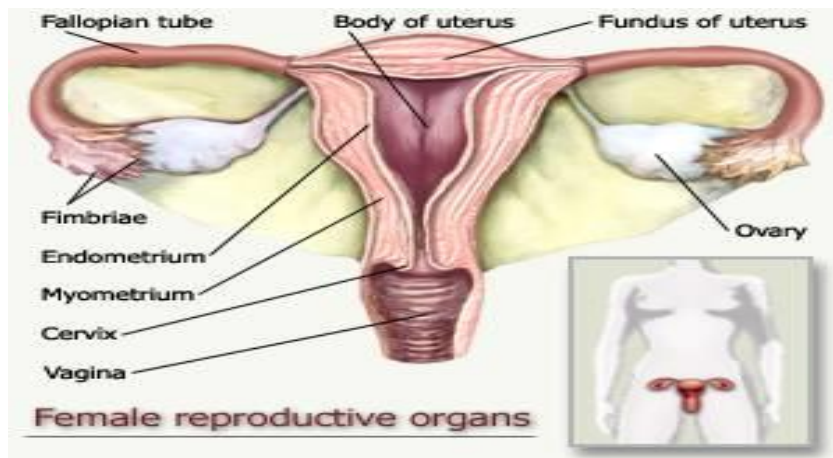
- ❖ Primary sex organs – two ovaries
- ❖ Internal and external accessory sex organs



Internal accessory sex organs

- ▶ Two fallopian tubes

- ▶ Uterus
- ▶ Vagina
- ▶ cervix



External accessory sex organs

- ▶ Mons pubis
- ▶ Labia majora
- ▶ Labia minora
- ▶ Clitoris
- ▶ Vestibule of the vagina
- ▶ Vestibular gland

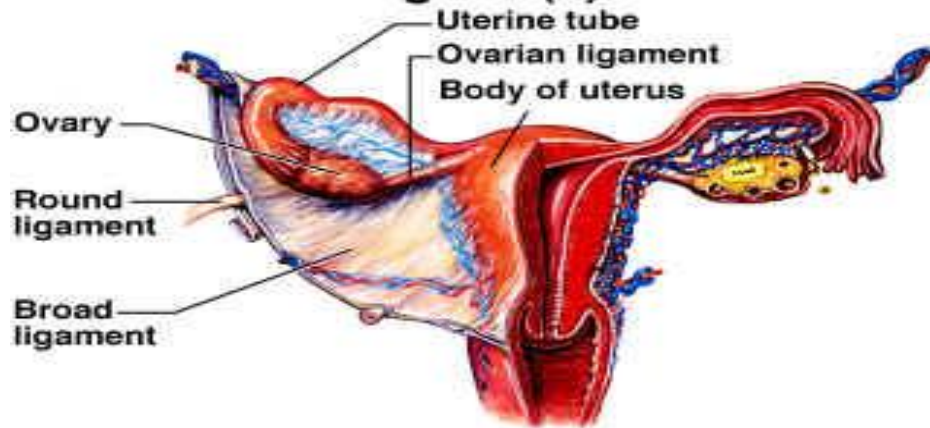
Ovary

It is the primary sex organ of the female.

- ▶ There are 2 ovaries, each weighing about 15 gms.
- ▶ Each ovary is invested by tunica albuginea.
- ▶ Ovarian stroma consists of blood vessels & lymphatics.

- ▶ The ovaries are covered by germinal epithelium.
- ▶ They are attached to both uterus and fallopian tubes by ligaments.

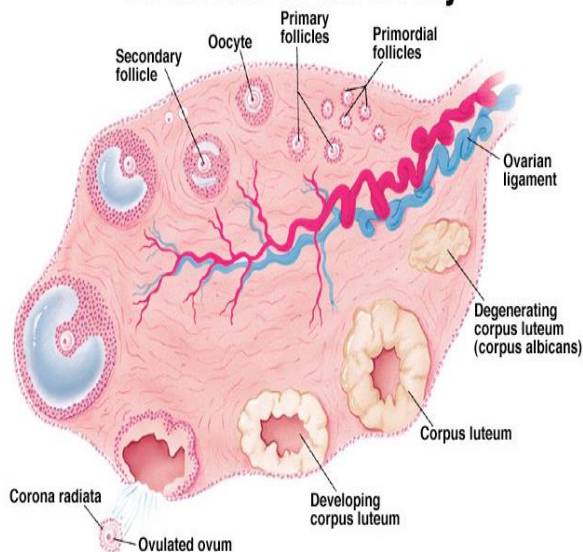
Female Internal Reproductive Organs (1)



Structure of the ovary

- ▶ It consists of 3 zones:
 - a) Cortex
 - b) Medulla
 - c) Hilum

Structure of an Ovary



Cortex

It consists of:

- ▶ A single-layered outermost germinal epithelium.
- ▶ Stromal tissue: It is a connective tissue and carries primordial follicles, blood vessels, lymphatic vessels and nerves.

Functions of the ovary

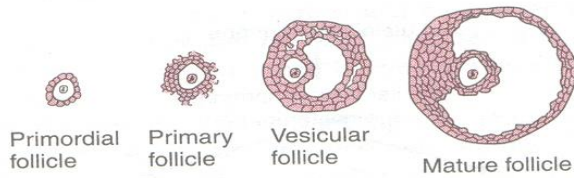
- ▶ **Oogenesis – production of the matured ova and their release**
- ▶ **Production of various hormones – Oestrogen, progesterone, androgen, inhibin, activin and relaxin. These are essential for**
- **Growth of uterus, fallopian tubes and vagina**
- **Development of secondary sexual characters**
- **Maintenance of pregnancy**

Oogenesis

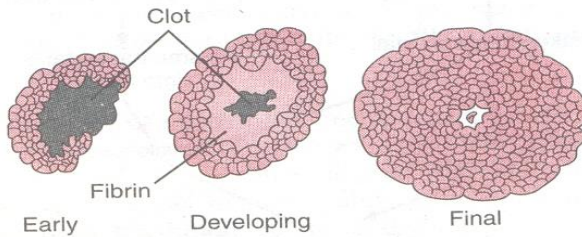
- ▶ **It is a continuous process starting from fetal stage and lasting till menopause.**
- ▶ **It is divided into 3 phases:**
- **Changes in fetal ovary**
- **Changes upto puberty**
- **Post-pubertal changes**

Changes in the fetal ovary

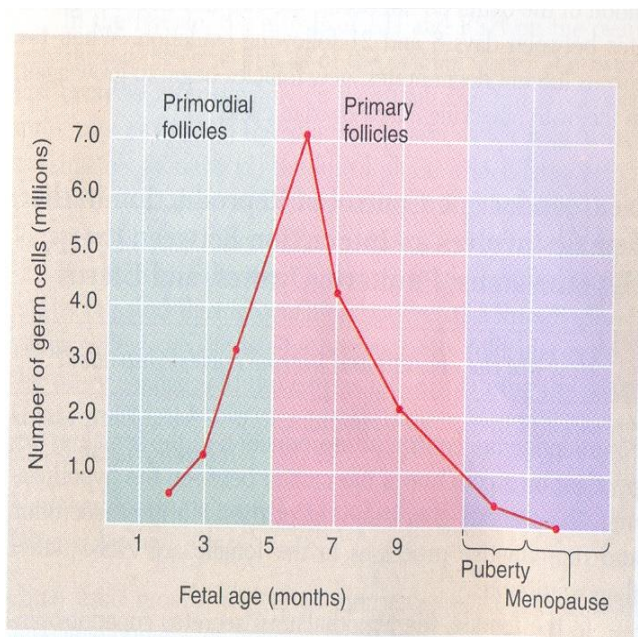
- ▶ **The primordial germ cells migrate from the yolk sac to the genital ridge around 5th week of gestation.**
- ▶ **By 5th month – 7 million oogonia are formed and become primary oocytes.**
- ▶ **No new primary oocytes are formed after birth.**
- ▶ **At the time of birth – 2 million ova.**
- ▶ **50% of these are atretic.**
- ▶ **Number of ova in both the ovaries at the time of puberty is < 3,00,000.**
- ▶ **Throughout the whole reproductive life of a female – 480 primordial follicles.**
- ▶ **Around 8th week, the primary oocyte is surrounded by a single layer of cells - primordial follicle.**
- ▶ **Around 6th month of IU life, these cells are converted into granulosa cells – primary follicle.**
- ▶ **At birth – the ovaries contain both primordial and primary follicles.**



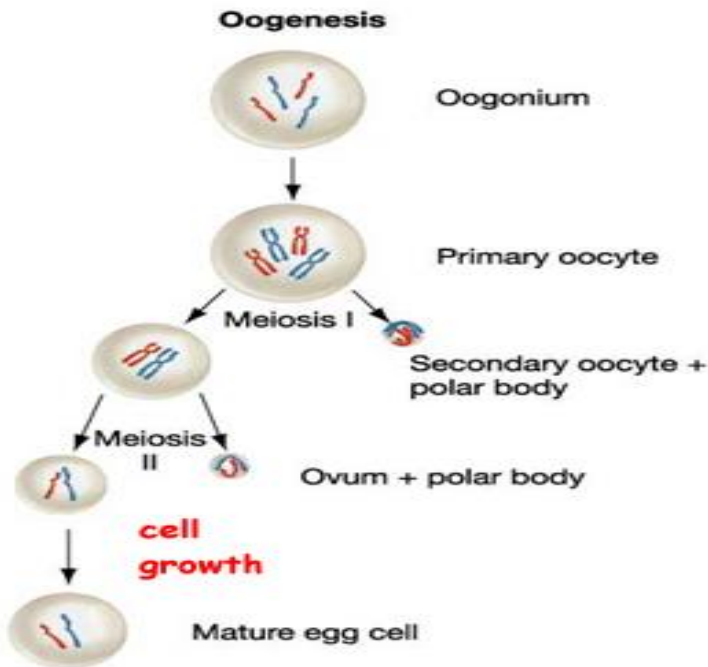
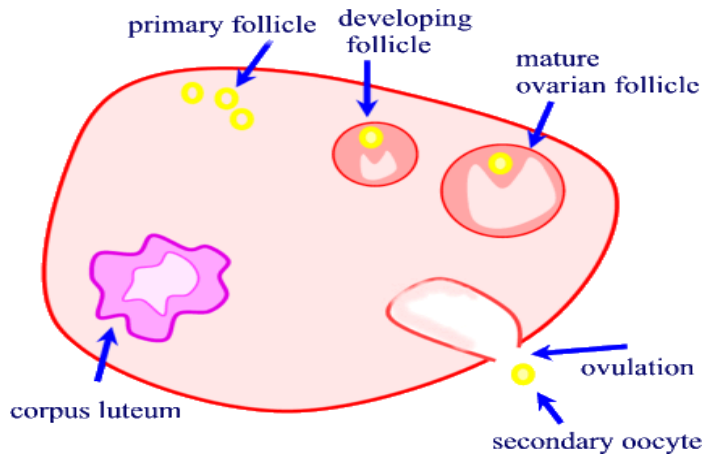
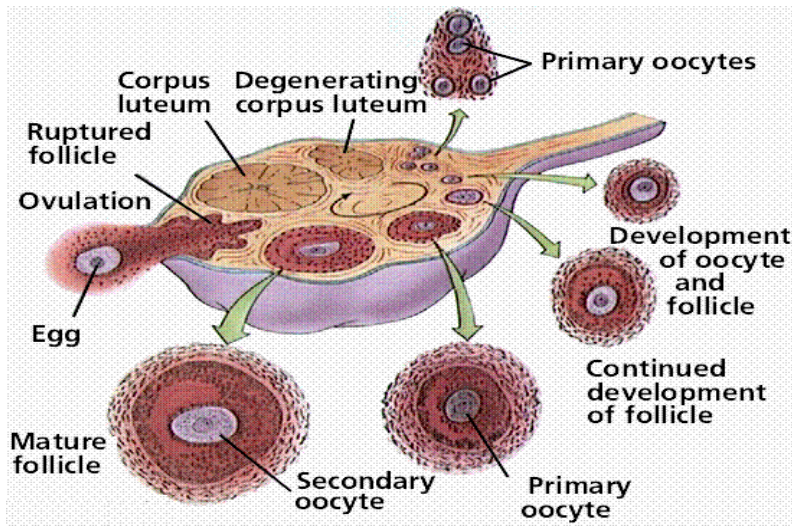
Follicular Growth

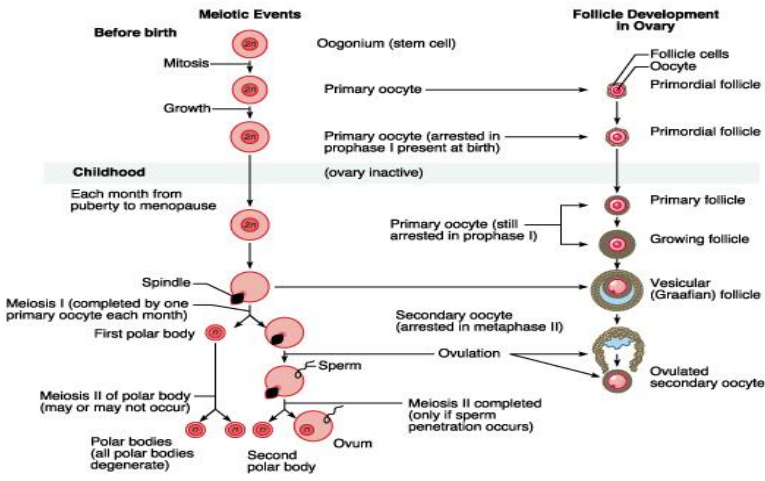


Corpus Luteum

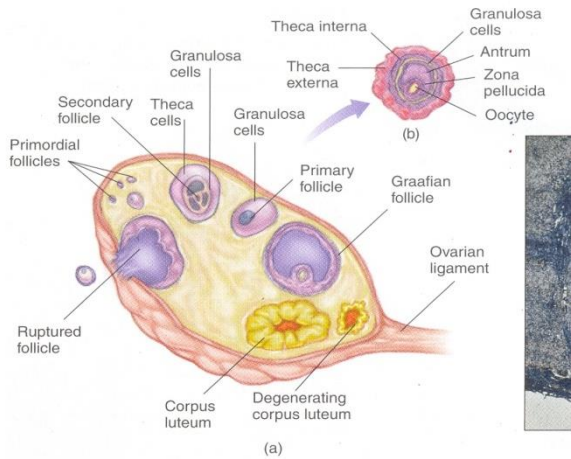


- ▶ **At birth in the female child, each ovum is surrounded by a single layer of granulosa cells – Primary follicle.**
- ▶ **The granulosa cells provide nourishment for the ovum & secrete oocyte maturation inhibiting factor.**
- ▶ **They undergo 1st meiotic division but is arrested in prophase I (just before ovulation).**
- ▶ **1st meiotic arrest – Oocyte maturation inhibiting factor.**
- ▶ **Just before ovulation, I meiotic division is completed, with the formation of secondary oocyte and first polar body.**
- ▶ **Secondary oocyte begins 2nd meiotic division but stops at metaphase II and is completed only when a sperm penetrates the oocyte- matured ovum and 2nd polar body.**
- ▶ **Arrest at metaphase – pp39^{mos} encoded by c-mos proto-oncogene (calpain).**





CROSS SECTION OF OVARY & GRAAFIAN FOLLICLE

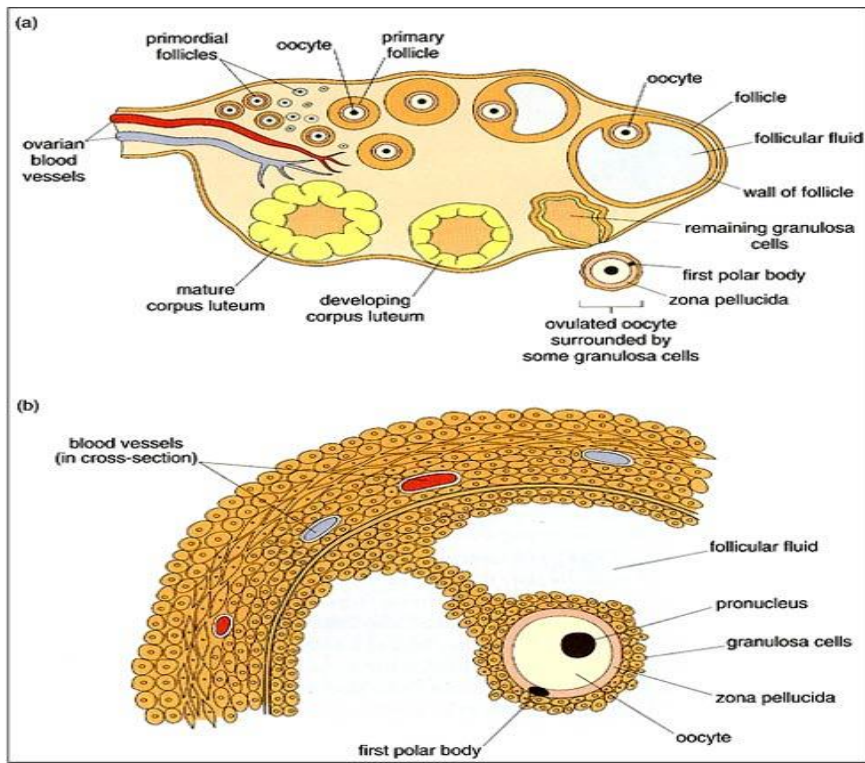


CROSS SECTION OF DEVELOPING FOLLICLE



Changes upto puberty

- ▶ The granulosa cells secrete mucopolysaccharides that forms zona pellucida around the oocyte.
- ▶ The cytoplasmic processes of granulosa cells penetrate zona pellucida and provide nutrients – secondary follicle.
- ▶ Follicular size – 150 μm , theca interna.
- ▶ Granulosa cells secrete fluid – preantral follicle.



Menstrual Cycle – Ovarian Cycle

FEMALE HORMONAL SYSTEM

- ▶ **GnRH** (HYPOTHALAMUS)
- ▶ **FSH & LH** (ANTERIOR PITUITARY)
- ▶ **ESTROGEN& PROGESTERONE** (OVARIES)

THE FEMALE SEXUAL CYCLE

- ▶ The monthly rhythmical changes in females during reproductive age group constitute female sexual cycle.
- ▶ Most conspicuous feature is periodic vaginal bleeding called Menstruation.
- ▶ Humans & primates – Menstrual cycle
- ▶ Other mammals – Estrus cycle
- ▶ DURATION: 28 days (20 – 45)
- ▶ First day of bleeding is considered as the first day of the menstrual cycle.

MENSTRUAL CYCLE

- ▶ Rhythmic changes occur in:
 - **Ovaries - Ovarian cycle**
 - **Endometrium - Uterine / endometrial cycle**
 - **Cervical cycle**

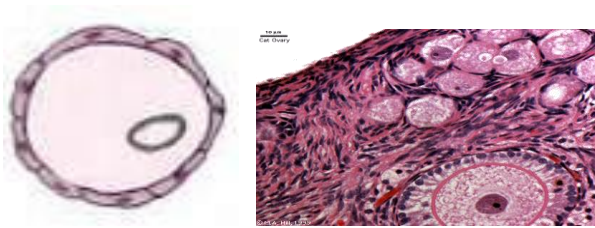
- **Vaginal cycle**
- **Breast cycle**
- **Hormonal cycle**

OVARIAN CYCLE

- ▶ 3 phases:
 - ▶ Follicular phase
 - ▶ Ovulation
 - ▶ Luteal phase

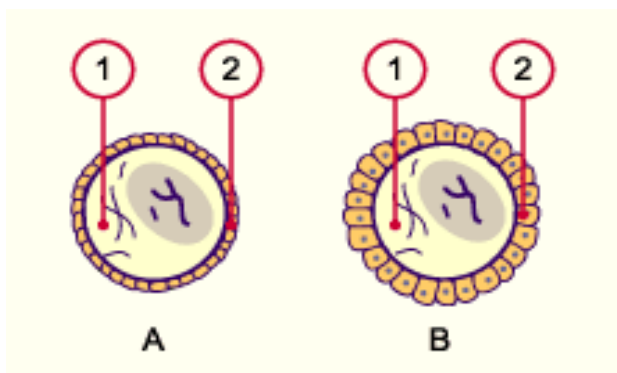
PRIMORDIAL FOLLICLE

- ▶ Fetal life → ovum with single layer of granulosa cells → **primordial follicle**
- ▶ Granulosa cells secrete **oocyte maturation – inhibiting factor** which keeps ovum suspended in primordial state till puberty



PRIMARY FOLLICLE

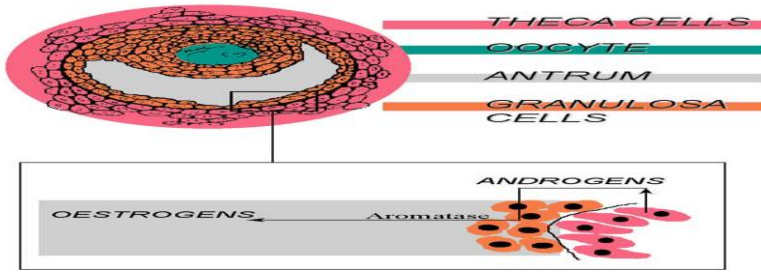
- ▶ Around 5th month of intrauterine life, spindle shaped cells are converted into granulosa cells - **primary follicles**



SECONDARY AND PREANTRAL FOLLICLE

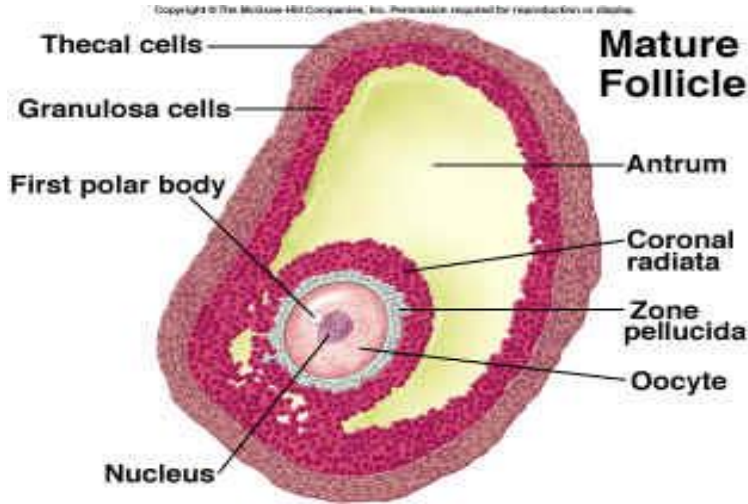
- ▶ FSH causes rapid growth of 6 -12 primary follicles
- ▶ Rapid proliferation of granulosa cells
- ▶ Cavity formation in between granulosa cells
- ▶ ovarian stromal cells give rise **to theca interna outside the granulosa cells**

THE OVARIAN FOLLICLE



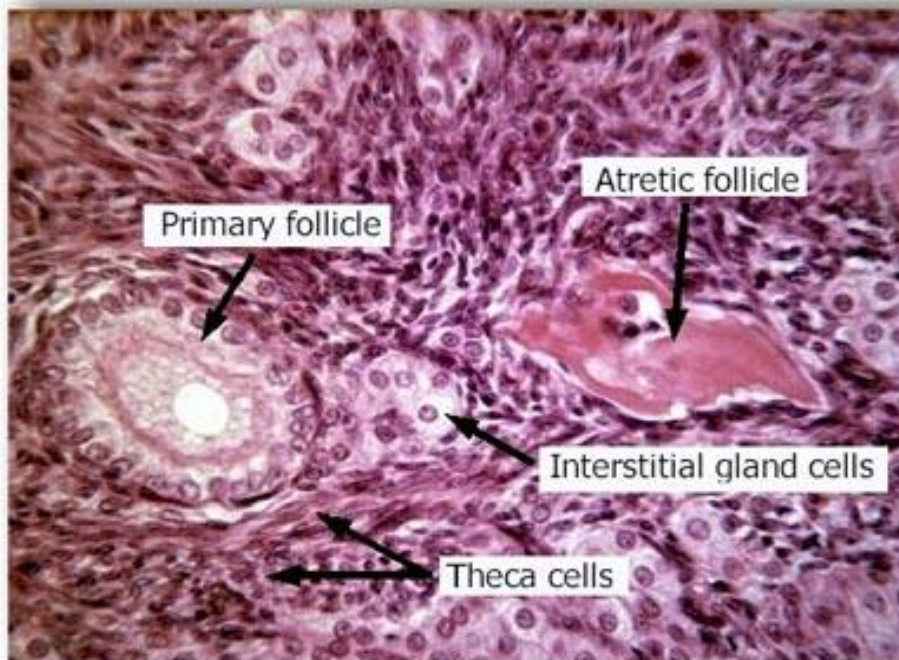
I. FOLLICULAR PHASE

- II. During each cycle 20-25 antral follicles start growing as a group under the influence of FSH, but after a week of growth, only one follicle becomes dominant & others become atretic. Single follicle reaches a diameter of 1- 1.5 cm on 14th day



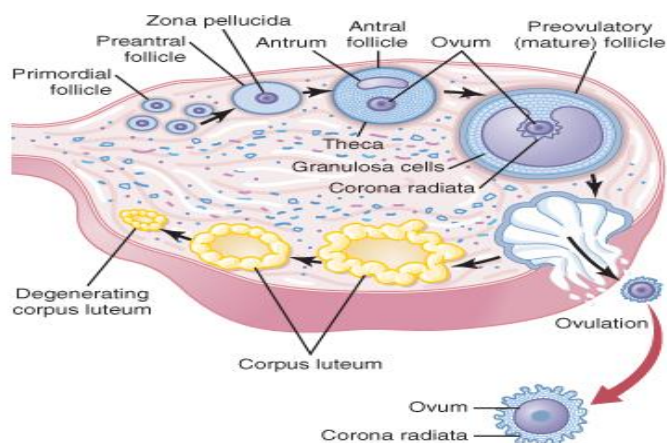
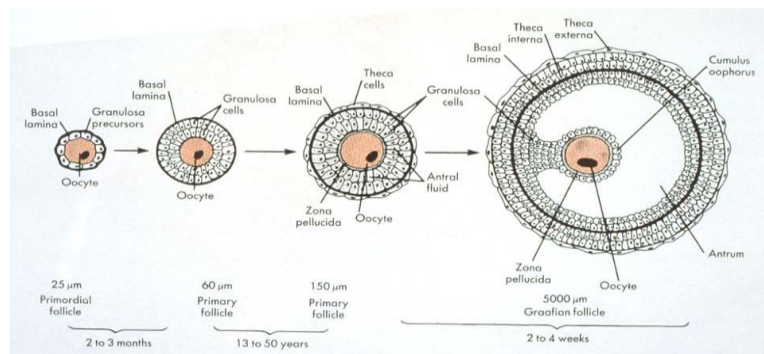
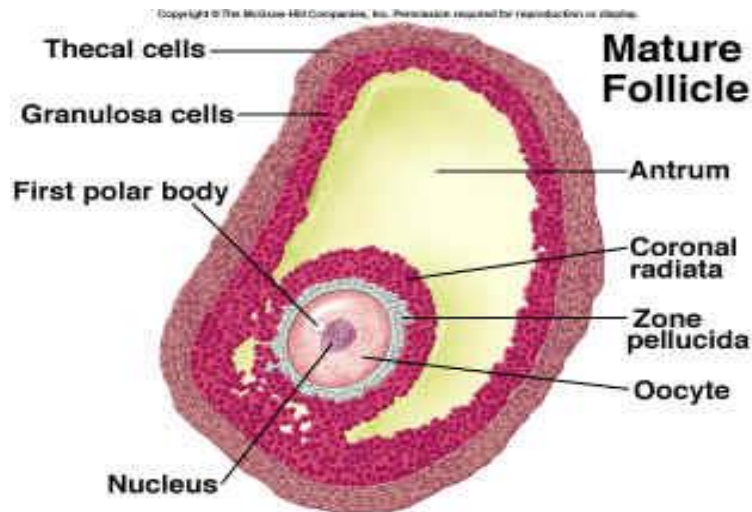
ATRETIC FOLLICLE

- ▶ Estrogen from rapidly growing follicle causes -ve feedback on FSH & LH secretion, which in turn leads to reduced growth of well developed follicles
- ▶ Therefore only one follicle ovulates ensuring development of single fetus



GRAFFIAN FOLLICLE

- ▶ Ovum surrounded by zona pellucida to provide nutrients.
- ▶ Ovum pushed to one side.
- ▶ Finally formation of mature Graffian follicle
- ▶ 1st meiotic division completed (secondary oocyte).
- ▶ Ovulation takes place.



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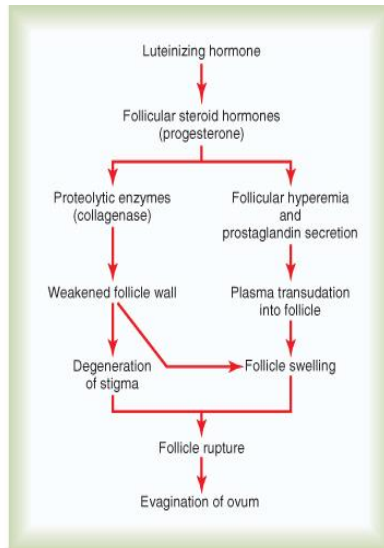
III. Ovulation

- IV. Release of secondary oocyte into peritoneal cavity called ovulation.
- V. Shortest & lasts for 1-2 days.
- VI. Sharp rising estrogen from dominant follicle increases sensitivity of FSH & LH receptors on granulosa cells.

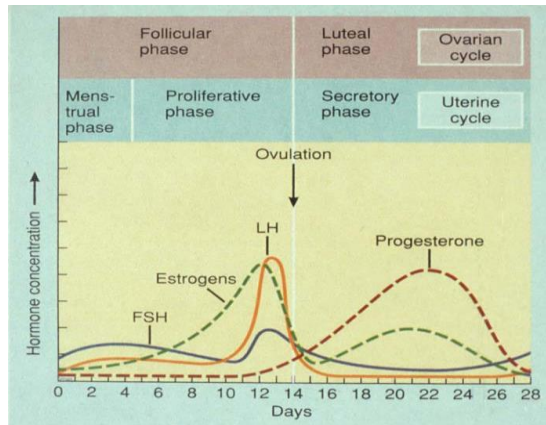
- VII. Both FSH & LH act synergistically to cause rapid swelling of follicle.
- VIII. From 11th-13th day estrogen levels increase till it reaches critical value 200pg/ml- then LH surge occurs, which triggers ovulation.

LH SURGE

- ▶ Estrogen exerts +ve feedback on LH secretion from anterior pituitary.
- ▶ FSH also increases 2 -3 fold – FSH surge
- ▶ Both surges (18 hours before ovulation) cause ovulation on 14th day.
- ▶ LH causes granulosa & theca cells to secrete progesterone.
- ▶ Therefore prior to ovulation , progesterone secretion increases.



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III- LUTEAL PHASE

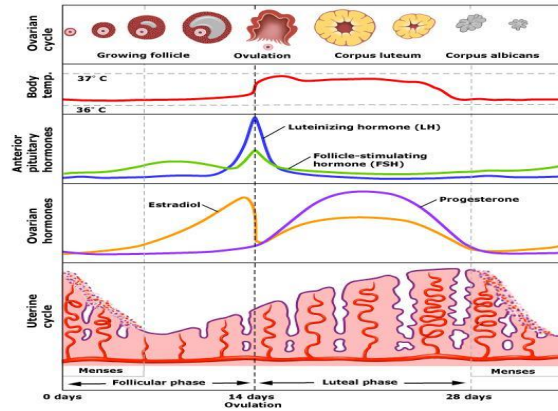
- ▶ After ovulation ruptured follicle fills with blood- **corpus hemorrhagicum**
- ▶ Granulosa & theca interna cells rapidly proliferate and become filled with lipid droplets in cytoplasm – **luteinization**.
- ▶ Formation of **corpus luteum**
- ▶ Corpus luteum normally grows to 1.5 cm till 24th day.
- ▶ Produces high amount of estrogen and progesterone under influence of LH

CORPUS ALBICANS

- ▶ If no fertilisation from 25th day onwards corpus luteum **degenerates** & is replaced by scar tissue.
- ▶ Hormone levels decline and reach basal level by 28th day.
- ▶ Menstrual bleeding starts.

If fertilised, it will continue upto 6-8 weeks of pregnancy (till placenta takes over), no menstruation till delivery

MENSTRUAL CYCLE



Endometrial Changes

1. **The Proliferative phase** (Oestrogen Phase) of the endometrial cycle occurring before ovulation (6th-14th)
2. **The Secretory phase** (Progestational Phase) of the endometrial cycle occurring after ovulation (15th-28th)
3. **Menstruation/bleeding phase** (1st-5th)

Endometrium

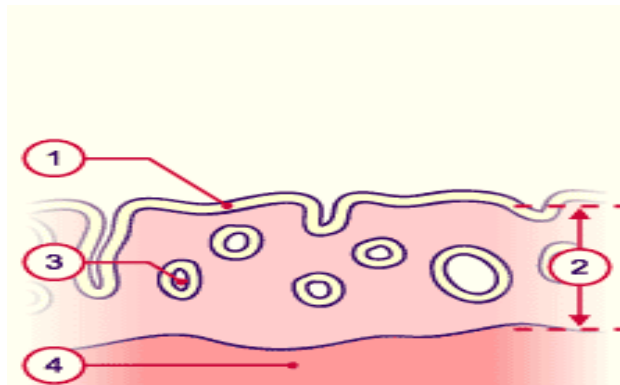
- ▶ Innermost layer of uterus
- ▶ Two parts-
 - i) Stratum basale (basal 1/3rd of endometrium), in contact with myometrium, does not change during menstrual cycle (basal artery)
 - ii) Stratum functionale (inner 2/3rd of endometrium), periodically shed off and regenerated completely once in a month under influence of hormones (spiral artery)

PROLIFERATIVE PHASE (6th-14th)

- ▶ Corresponds with follicular phase in ovary.
- ▶ Oestrogen secreted from developing ovarian follicle under influence of FSH responsible for regeneration of endometrium.
- ▶ After menstruation, the stratum basale, 2mm thick, consists of a thin layer of endometrial glands & ciliated columnar epithelium.
- ▶ Thickening and proliferation of endometrium.

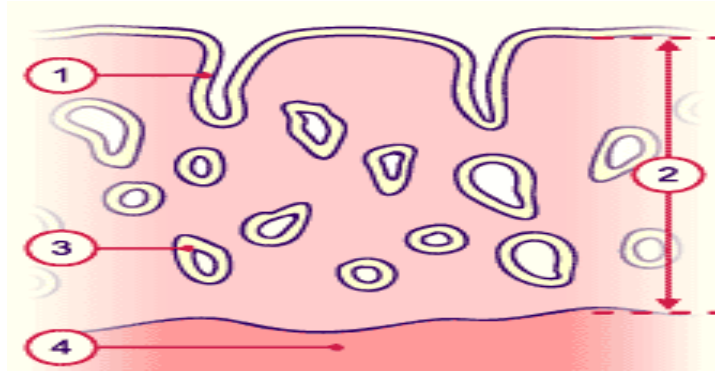
Early Proliferative Phase

- 1) Rapid proliferation of stromal & epithelial cells.
- 2) Growth of blood vessels (Spiral artery)
- 3) Growth of endometrial glands.



Late proliferative phase

- Progressive growth of stromal & epithelial cells.
- Appearance of new blood vessels (neovascularisation)
- Growth of secretory glands in length (straight) but do not secrete.
- Endometrium becomes 3 – 5 mm thick.



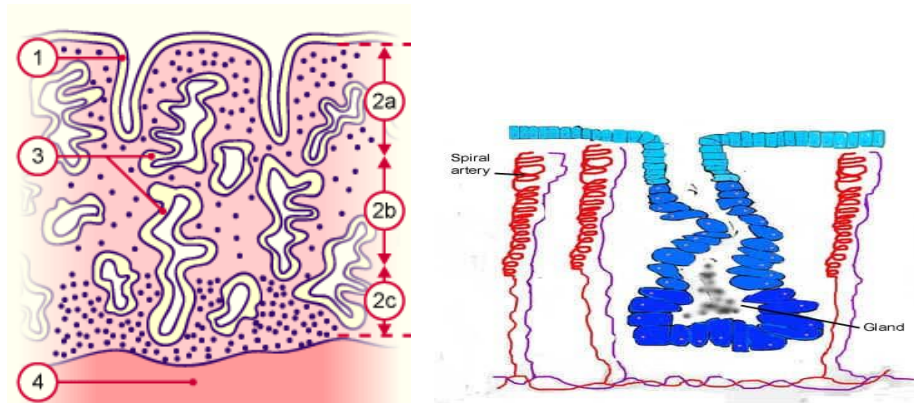
SECRETORY PHASE (15th-28th)

- ▶ Starts after ovulation and lasts for 14 days.
- ▶ Corresponds with luteal phase in ovary.
- ▶ Progesterone secreted from corpus luteum under influence of LH responsible for this phase.
- ▶ Here endometrium becomes prepared for the implantation of the fertilised ovum.

Secretory phase

- ▶ Thickening of mucosa due to cellular proliferation.
- ▶ Glands become coiled, tortuous & secrete mucus.
- ▶ Increased lipid & glycogen content of stromal cells.
- ▶ ↑ Vascularity of endometrium & spiral arteries become long, coiled & highly tortuous.
- ▶ Endometrium is 5-6 mm thick at the peak of secretory phase & edematous.

Endometrium in the late secretory phase



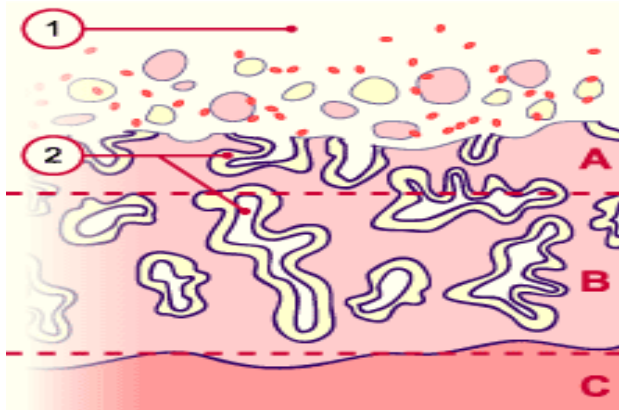
MENSTRUAL/BLEEDING PHASE (1st-5th)

- ▶ If no fertilisation, then corpus luteum degenerates and hormonal support is withdrawn resulting in menstruation.
- ▶ Local release of prostaglandin (PGF₂α) from lysosomes
- ▶ Vasoconstriction of long coiled spiral arteries of stratum functionale
- ▶ Desquamation of endometrium

MENSTRUAL/BLEEDING PHASE

- ▶ Further necrosis of walls of spiral arteries → leads to hemorrhage into stratum functionale.
- ▶ So vasospasm causes necrosis and sloughing of endometrium resulting in bleeding.
- ▶ Further uterine contractions → expulsion of menstrual blood.
- ▶ Basal endometrium preserved.

Endometrium in the Menstruation phase



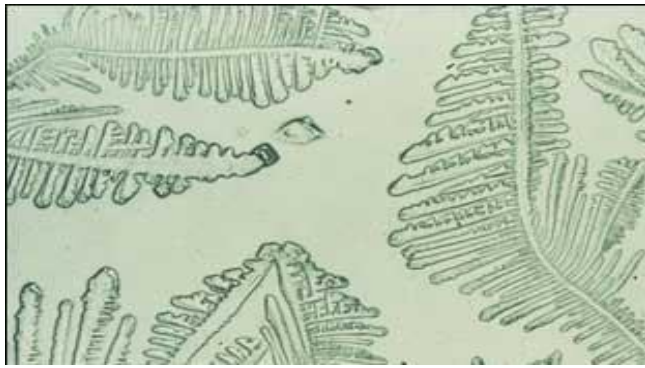
MENSTRUAL/BLEEDING PHASE

- ▶ Menstrual blood consists of blood, mucus, sloughed endometrium and unfertilised ovum.
- ▶ Average blood loss 30-50ml, >80ml pathological.
- ▶ Predominantly arterial, 25% venous.
- ▶ Does not clot due to presence of fibrinolysin.
- ▶ Duration – 3-5 days.

CHANGES IN CERVIX

- ▶ Mucosa does not undergo cyclical desquamation but changes occur.
- ▶ Just before ovulation, mucus thin & alkaline due to estrogen for survival & transport of sperms.
- ▶ At time of ovulation mucus shows increased elasticity & dries in an arborizing 'fern like' pattern
- ▶ After ovulation, due to progesterone the mucus becomes thick, tenacious & cellular, provides barrier for sperms.

FERN TEST



Changes in the breasts

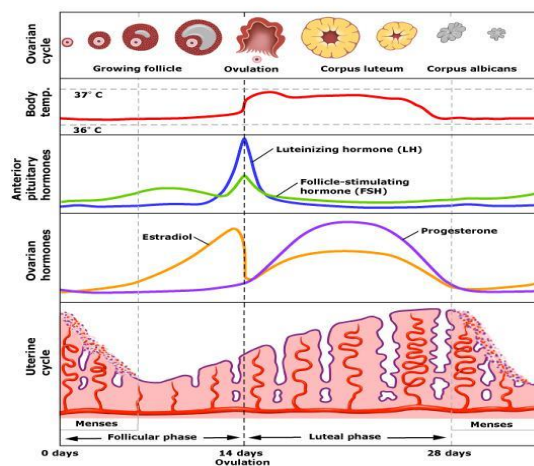
- ▶ Estrogen → proliferation of mammary ducts.
- ▶ Progesterone → growth of lobules & alveoli.
- ▶ Distension of ducts, hyperemia & edema cause premenstrual pain & heaviness due to salt and water retention.

Hormonal control of female sexual cycle

- ▶ Depends on hypothalamo-pituitary-gonadal axis and feedback actions of estrogen and progesterone.
- ▶ Pulsatile secretion of GnRH required for normal secretion of gonadotrophins.
- ▶ GnRH (HYPOTHALAMUS)
- ▶ FSH & LH (ANTERIOR PITUITARY)

Estrogen, Progesterone & Inhibin (OVARIES)

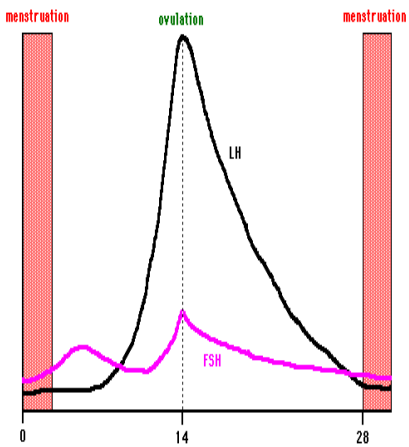
MENSTRUAL CYCLE



Hormonal control of female sexual cycle

- ▶ At the beginning of cycle estrogen and progesterone are at basal level, so FSH & LH secreted from anterior pituitary under influence of GnRH.
- ▶ FSH promotes development of graffian follicle.
- ▶ Rise in oestrogen leads to proliferative changes in endometrium simultaneously.

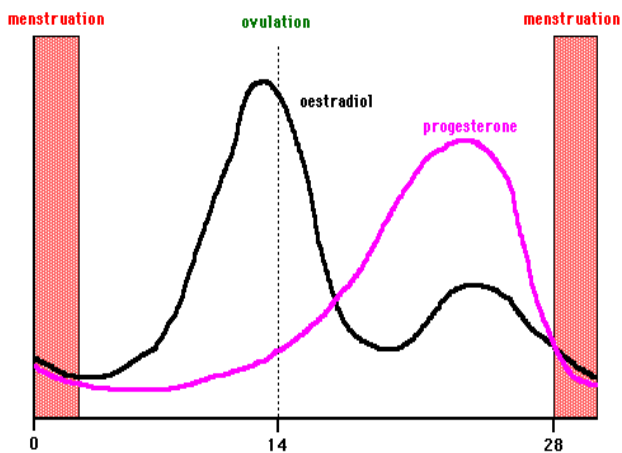
FSH & LH in the normal menstrual cycle



Hormonal control of female sexual cycle

- ▶ Thus rise in FSH increases the serum concentration of estrogen to reach a peak at 11th-13th day producing LH surge.
- ▶ After ovulation, corpus luteum formation occurs, starts secreting progesterone.

Oestradiol & progesterone in the menstrual cycle

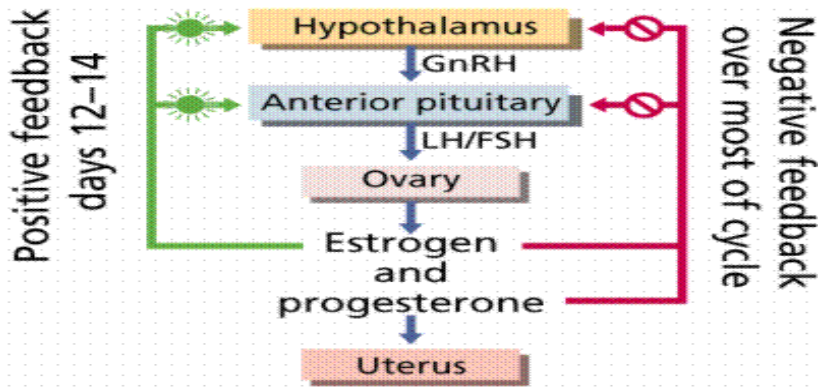


Hormonal control of female sexual cycle

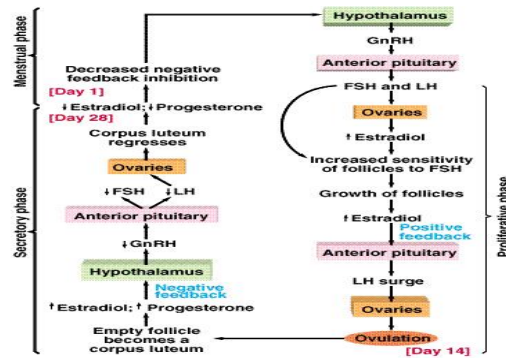
- ▶ So estrogen, progesterone and inhibin levels inhibit FSH & LH by negative feedback.
- ▶ Progesterone leads to secretory changes in endometrium.
- ▶ If pregnancy occurs corpus luteum continues to secrete progesterone and estrogen till development of placenta.

Hormonal control of female sexual cycle

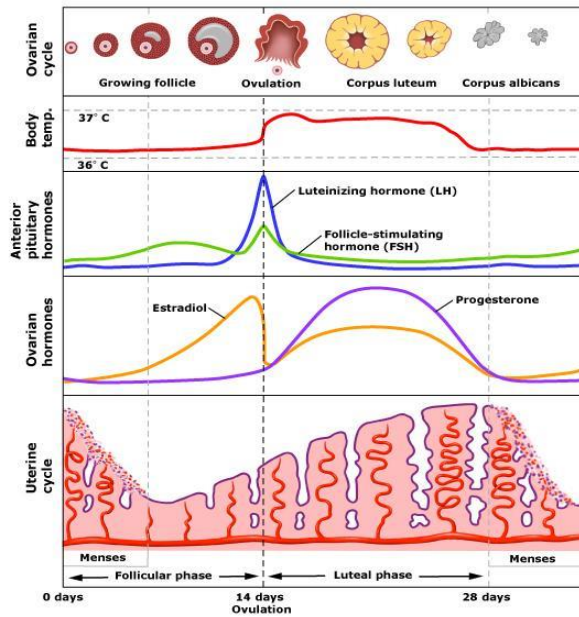
- ▶ If no fertilisation, corpus luteum regresses (luteolysis).
- ▶ So estrogen and progesterone levels fall sharply leading to onset of menstrual bleeding.
- ▶ This stimulates release of FSH & LH and next cycle starts.



Endocrine Control of Ovarian Cycle



MENSTRUAL CYCLE



Indicators of ovulation

- ▶ Basal body temperature
- ▶ Cervical mucus test
- ▶ Endometrial biopsy
- ▶ Ultrasonography
- ▶ Vaginal cytology
- ▶ Blood gonadotropin

▶ Mid-cycle pain