
Hormones of reproductive system

Gonads are the primary reproductive organs which produce the gametes (egg or ovum); a pair of testes (singular = testis) produces sperms in males and a pair of ovaries produces ovum in females.

Reproductive organs include:

1. Primary sex organs
2. Accessory sex organs.

Primary Sex Organs in **males**

Testes are the primary sex organs or gonads in males.

Accessory Sex Organs

Accessory sex organs in males are:

1. Seminal vesicles
2. Prostate gland
3. Urethra
4. Penis.

ENDOCRINE FUNCTIONS OF TESTES - HORMONES SECRETED BY TESTES

Testes secrete male sex hormones, which are collectively called the androgens.

Androgens secreted by testes are:

1. Testosterone (main androgen)
2. Dihydrotestosterone
3. Androstenedione.
4. Estrogen and progesterone in small quantities.

Testosterone is a C19 steroid. In many target tissues, testosterone is converted into dehydrotestosterone,

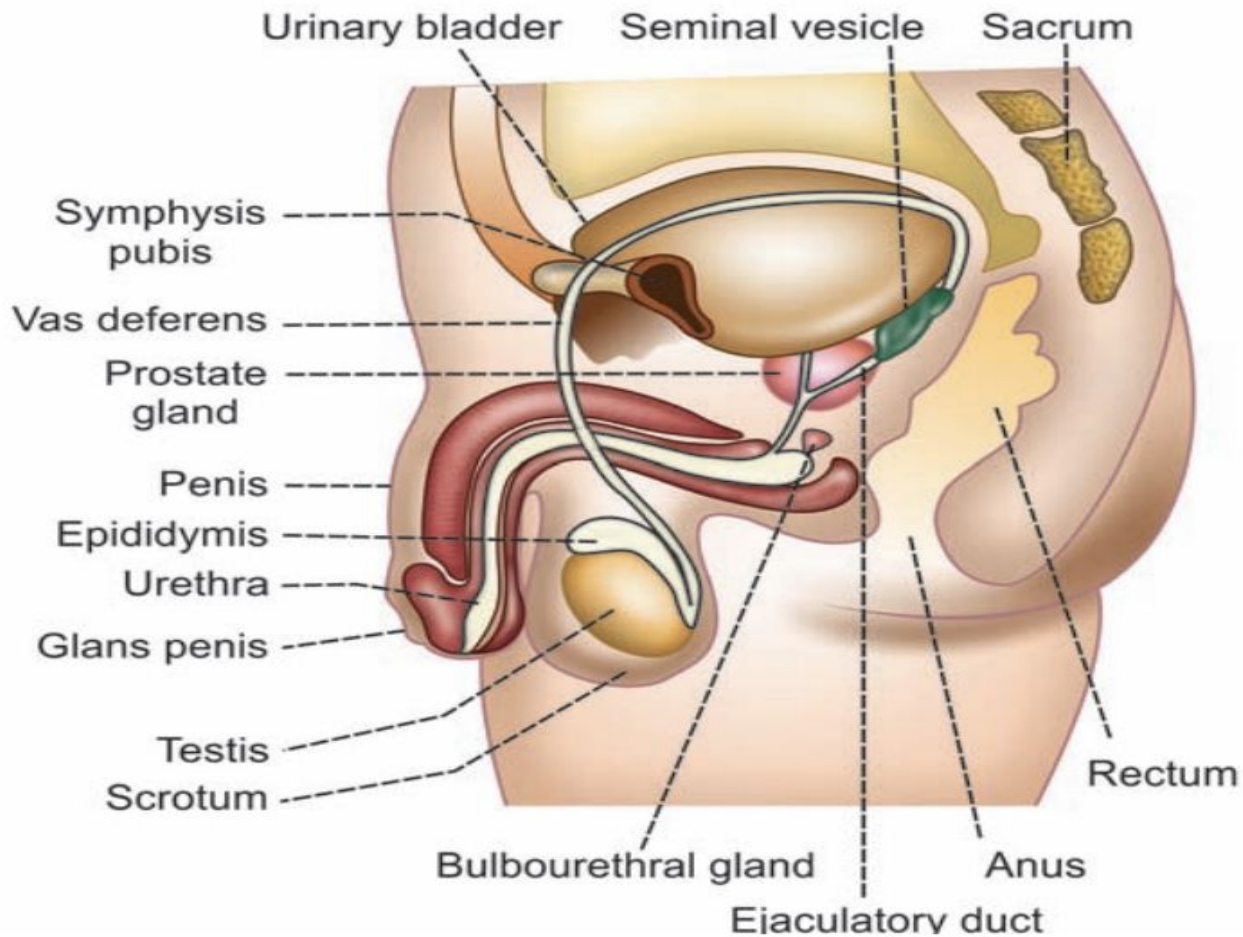


FIGURE 74.1: Male reproductive system and other organs of pelvis

FEMALE REPRODUCTIVE SYSTEM

Female reproductive system comprises of primary sex organs and accessory sex organs

PRIMARY SEX ORGANS

Primary sex organs are a pair of ovaries, which produce eggs or ova and secrete female sex hormones, the estrogen and progesterone.

Accessory sex organs in females are: Genital ducts, Fallopian tubes, uterus, cervix and vagina

SEXUAL LIFE IN FEMALES

Lifespan of a female is divided into three periods.

FIRST PERIOD First period extends from birth to puberty.

SECOND PERIOD

Second period extends from onset of puberty to the onset of menopause. During the period between menarche and menopause, women menstruate and reproduce.

THIRD PERIOD -Third period extends after menopause to the rest of the life.

FUNCTIONS OF TESTOSTERONE

Testosterone is responsible for the distinguishing characters of masculine body. Functions of Testosterone in Fetal Life

Testosterone performs three functions in fetus:

1. Sex differentiation in fetus
2. Development of accessory sex organs
3. Descent of the testes.

Sex differentiation in fetus

Sex chromosomes are responsible for the determination of sex of the fetus whereas testosterone is responsible for the sex differentiation of fetus.

Fetus has two genital ducts:

- i. Müllerian duct, which gives rise to female accessory sex organs
- ii. Wolffian duct, which gives rise to male accessory sex organs

If testosterone is secreted from the genital ridge of the fetus at about 7th week of intrauterine life, the müllerian duct system disappears and male sex organs develop from Wolffian duct.

2. Development of accessory sex organs and external genitalia

Testosterone is also essential for the growth of the external genitalia, viz. penis and scrotum and other accessory sex organs, namely genital ducts, seminal vesicles and prostate.

3. Descent of testes

Descent of testes is the process by which testes enter scrotum from abdominal cavity. Initially, testes are developed in the abdominal cavity and are later pushed down into the scrotum just before birth. The process by which testes enter the scrotum is called the descent of testes. Testosterone is necessary for descent of testes.

Cryptorchidism is a congenital disorder characterized by the failure of one or both the testes to descent from abdomen into scrotum. In such case, the testes are called undescended testes.

Functions of Testosterone in Adult Life

Testosterone has two important functions in adult:

1. Effect on sex organs
2. Effect on secondary sexual characters.

Effect on sex organs

Testosterone increases the size of penis, scrotum and the testes after puberty. Testosterone is also necessary for spermatogenesis.

2. Effect on secondary sexual characters

Testosterone is responsible for the development of secondary sexual characters in males.

Which are as follows:

Effect on muscular growth-development of musculature after puberty, Muscle mass increases.

Effect on bone growth - After puberty, testosterone increases the thickness of bones. Effect on shoulder and pelvic bones. Testosterone causes broadening of shoulders and it has a specific effect on pelvis.

Effect on skin - Testosterone increases the thickness of skin and ruggedness of subcutaneous tissue.

Effect on hair distribution- Testosterone causes male type of hair distribution on the body,

Effect on voice - At the time of adolescence, the boys have a cracking voice.

HYPERGONADISM IN MALES

Hypergonadism is the condition characterized by hypersecretion of sex hormones from gonads.

Hypergonadism in males is mainly due to the tumor of Leydig cells. It is common in prepubertal boys who develop precocious pseudopuberty.

Symptoms

There is a rapid growth of musculature and bones.

There is excess development of sex organs and secondary sexual characters.

The tumors also secrete estrogenic hormones, which cause gynecomastia (the enlargement of breasts).

HYPOGONADISM IN MALES

Hypogonadism is a condition characterized by reduction in the functional activity of gonads.

Causes

1. Congenital nonfunctioning of testes
2. Under developed testes due to absence of human chorionic gonadotropins in fetal life
3. Cryptorchidism, associated with partial or total degeneration of testes
4. Absence of androgen receptors in testes
5. Disorder of the gonadotropes (cells secreting gonadotropins) in anterior pituitary.

OVARIAN HORMONES

Ovary secretes the female sex hormones estrogen and progesterone. Ovary also secretes hormones, namely inhibin, relaxin and small quantities of androgens.

ESTROGEN

In a normal non-pregnant woman, estrogen is secreted in large quantity by ovarian follicles and in small quantity by corpus luteum of the ovaries.

Estrogen is present in three forms in plasma:

1. β -estradiol
2. Estrone
3. Estriol.

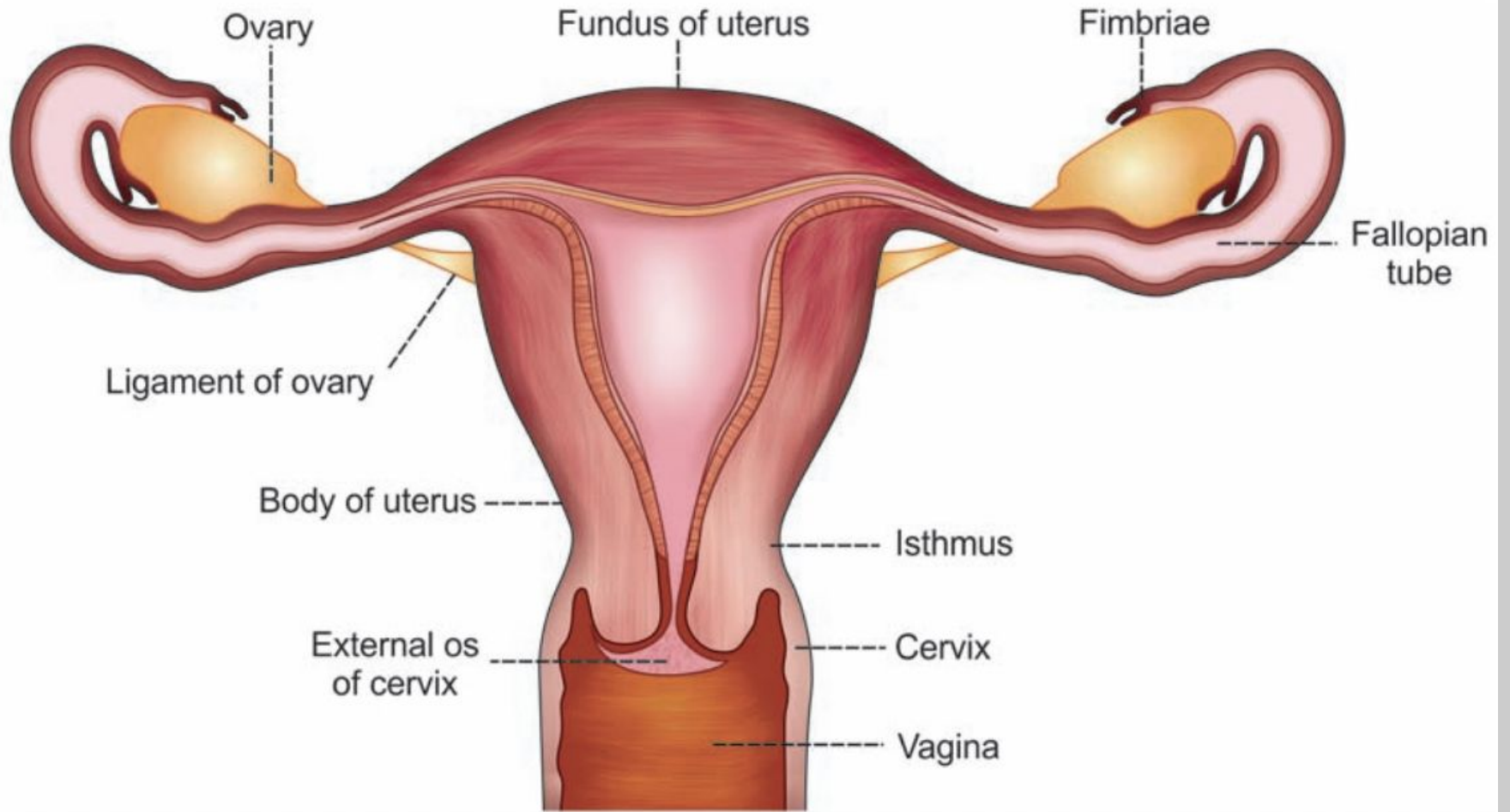


FIGURE 78.2: Female reproductive system

FUNCTIONS OF ESTROGEN

Major function of estrogen is to promote cellular proliferation and tissue growth in the sexual organs

1. Effect on Ovarian Follicles- Estrogen promotes the growth of ovarian follicles .

Effect on Uterus

Estrogen produces the following changes in uterus:

- i. Enlargement of uterus
- ii. Increase in the blood supply to endometrium
- iii. Deposition of glycogen and fats in endometrium
- iv. Proliferation and dilatation of blood vessels of endometrium
- v. Increase in the spontaneous activity of the uterine muscles and their sensitivity to oxytocin
- vi. Increase in the contractility of the uterine muscles.

All these changes prepare uterus for pregnancy.

Effect of Estrogen on Fallopian Tubes

- i. Acts on the mucosal lining of the fallopian tubes and increases the number and size of the ciliated epithelial cells lining the fallopian tubes.
- ii. Increases the activity of the cilia, so that the movement of ovum in the fallopian tube is facilitated.

Effect on Vagina

- i. Increases the layers of the vaginal epithelium by proliferation
- ii. Reduces the pH of vagina, making it more acidic.

All these changes are necessary for the prevention of certain common vaginal infections.

Effect on Secondary Sexual Characters

Estrogen is responsible for the development of secondary sexual characters in females.

Secondary sexual characters in female

- i. Hair distribution: Body hair growth is less. Scalp hair grows profusely
- ii. Skin: Skin becomes soft and smooth.
- iii. Body shape: Shoulders become narrow, hip broadens, Fat deposition increases in breasts and buttocks
- iv. Pelvis:
 - a. Broadening of pelvis
 - b. Round or oval shape of pelvis

Thus, pelvis in females is different from that of males, which is funnel shaped.

Voice: Larynx remains in prepubertal stage, which produces high-pitch voice.

Effect on Breast

- i. Development of stromal tissues of breasts
- ii. Growth of an extensive ductile system
- iii. Deposition of fat in the ductile system.

All these effects prepare the breasts for lactation.

Effect on Bones

Estrogen increases osteoblastic activity. So, at puberty, the growth rate increases enormously. But, at the same time, estrogen causes early fusion of the epiphysis with the shaft. As a result, the growth of the females usually ceases few years earlier than in the males.

Effect on Metabolism

- i. On protein metabolism , Estrogen induces anabolism of proteins
- ii. On fat metabolism, causes deposition of fat in the subcutaneous tissues, breasts, buttocks and thighs.

PROGESTERONE

Progesterone is a C21 steroid.

In non-pregnant woman, a small quantity of progesterone is secreted by ovaries during the first half of menstrual cycle, i.e. during follicular stage.

But, a large quantity of progesterone is secreted during the latter half of each menstrual cycle, i.e. during secretory phase by the corpus luteum.

In pregnant woman, large amount of progesterone is secreted by the corpus luteum in the first trimester. Placenta secretes large quantity of progesterone in second and third trimesters.

FUNCTIONS OF

PROGESTERONE

1. Effect on Fallopian Tubes

Progesterone promotes the secretory activities of fallopian tubes. Secretions of fallopian tubes are necessary for nutrition of the fertilized ovum.

2. Effect on the Uterus

Progesterone promotes the secretory activities of uterine endometrium during the secretory phase of the menstrual cycle. Thus, the uterus is prepared for implantation of the fertilized ovum.

Increases the thickness of the endometrium,

Increases the blood supply to endometrium.

Decreases the frequency of uterine contractions during pregnancy.

Because of this, the expulsion of the implanted ovum is prevented.

Effect on Cervix

Progesterone increases the thickness of cervical mucosa

Effect on the Mammary Glands

Progesterone promotes the development of lobules and alveoli of mammary glands It also makes the breasts secretory in nature.

Effect on Hypothalamus

Progesterone inhibits the release of LH from hypothalamus through feedback effect. This effect is utilized for its contraceptive action.

Thermogenic Effect

Progesterone increases the body temperature after ovulation.

Effect on Electrolyte Balance

Progesterone increases the reabsorption of sodium and water from the renal tubules.

MENSTRUAL CYCLE

CHANGES DURING MENSTRUAL CYCLE

During each menstrual cycle, series of changes occur in ovary and accessory sex organs.

These changes are divided into 4 groups:

1. Ovarian changes
2. Uterine changes
3. Vaginal changes
4. Changes in cervix.

OVARIAN CHANGES DURING MENSTRUAL CYCLE

Changes in the ovary during each menstrual cycle occur in two phases:

A. Follicular phase

B. Luteal phase.

Ovulation occurs in between these two phases.

FOLLICULAR PHASE

Follicular phase extends from the 5th day of the cycle until the time of ovulation, which takes place on 14th day. Maturation of ovum with development of ovarian follicles takes place during this phase. Ovarian follicles are glandular structures present in the cortex of ovary. The follicles gradually grow into a matured follicle through various stages.

Different follicles:

1. Primordial follicle
2. Primary follicle
3. Vesicular follicle
4. Matured follicle or graafian follicle.

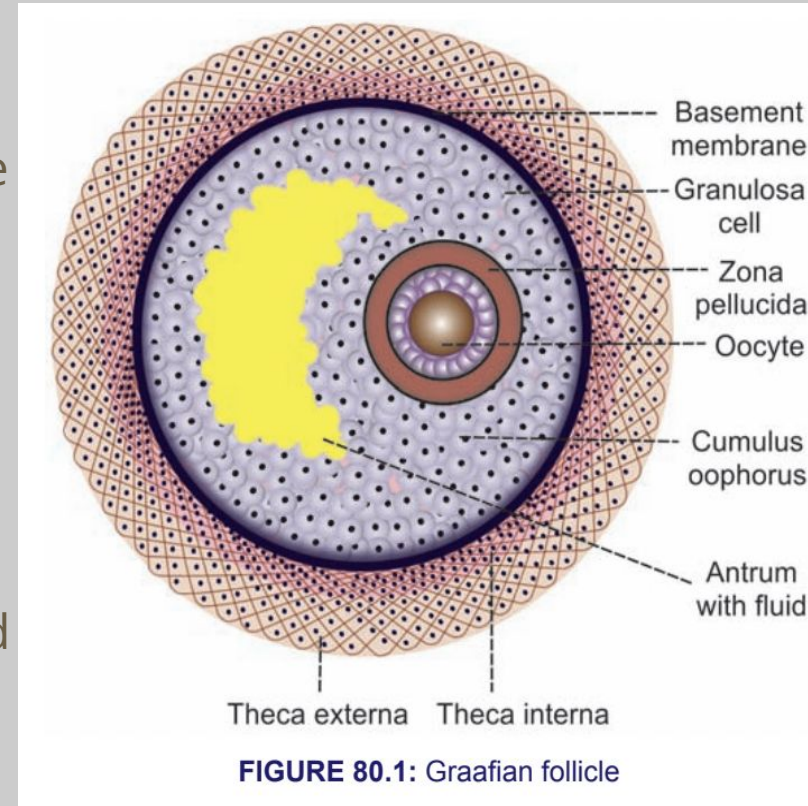
At the time of puberty, both the ovaries contain about 400,000 primordial follicles which contain ovum.

All the ova present in the ovaries are formed before birth. At the onset of puberty, under the influence of FSH and LH the primordial follicles start growing through various stages.

Primordial follicle becomes the primary follicle. During this stage, the follicle and the ovum increase in size.

Vesicular Follicle - Under the influence of FSH, about 6 to 12 primary follicles start growing and develop into vesicular follicles.

Graafian follicle is the matured ovarian follicle with maturing ovum



OVULATION

Ovulation is the process by which the graafian follicle ruptures with consequent discharge of ovum into the abdominal cavity. It is influenced by LH.

Ovulation occurs on 14th day of menstrual cycle in a normal cycle of 28 days. The ovum enters the fallopian tube.

LUTEAL PHASE

Luteal phase extends between 15th and 28th day of menstrual cycle. During this phase, corpus luteum is developed and hence this phase is called luteal phase

Corpus luteum is a glandular yellow body, developed from the ruptured graafian follicle after the release of ovum.

Soon after the rupture of graafian follicle and release of ovum, the follicle is filled with blood. Now the follicle is called corpus hemorrhagicum.

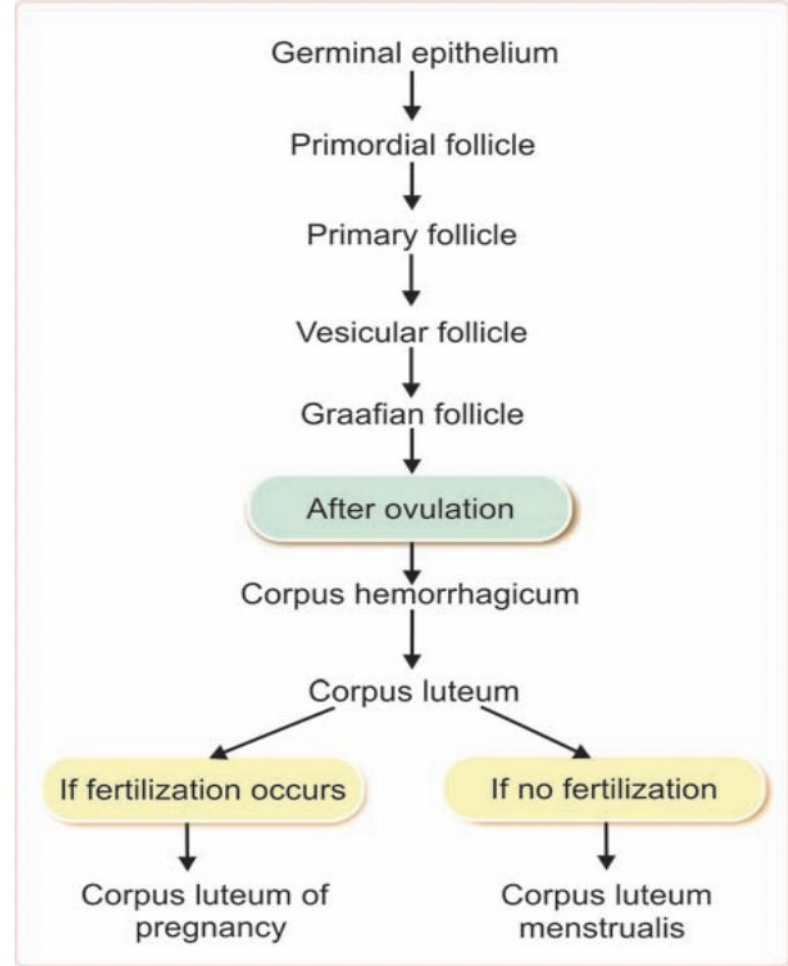


FIGURE 80.2: Ovarian follicle

Fate of Corpus Luteum

1. If the ovum is not fertilized the corpus luteum reaches the maximum size about one week after ovulation. During this period, it secretes large quantity of progesterone with small quantity of estrogen. Then, it degenerates into the corpus luteum menstrualis. The process by which corpus luteum undergoes regression is called luteolysis.
2. If ovum is fertilized pregnancy occurs, the corpus luteum persists and increases in size. and it is transformed into corpus luteum of pregnancy. It remains in the ovary for 3 to 4 months. During this period, it secretes large amount of progesterone with small quantity of estrogen, which are essential for the maintenance of pregnancy. After 3 to 4 months, placenta starts secreting these hormones and corpus luteum degenerates.

UTERINE CHANGES DURING MENSTRUAL CYCLE

During each menstrual cycle, along with ovarian changes, uterine changes also occur simultaneously

Uterine changes occur in three phases:

1. Menstrual phase
2. Proliferative phase
3. Secretory phase.

MENSTRUAL PHASE

After ovulation, if pregnancy does not occur, the thickened endometrium is shed. This endometrium is expelled out through vagina along with blood and tissue fluid. The process of shedding and exit of uterine lining along with blood and fluid is called menstruation or menstrual bleeding. It lasts for about 4 to 5 days. This is called **menstruation**.

Changes in Endometrium during Menstrual Phase

Lack of estrogen and progesterone causes sudden involution of endometrium. It leads to reduction in the thickness of endometrium.

During the next 24 hours, the blood vessels in the endometrium undergo severe constriction.

Vasoconstriction leads to hypoxia, which results in necrosis of the endometrium.

Necrosis causes rupture of blood vessels and oozing of blood.

During normal menstruation, about 35 mL of blood along with 35 mL of serous fluid is expelled.

Menstruation stops between 3rd and 7th day of menstrual cycle.

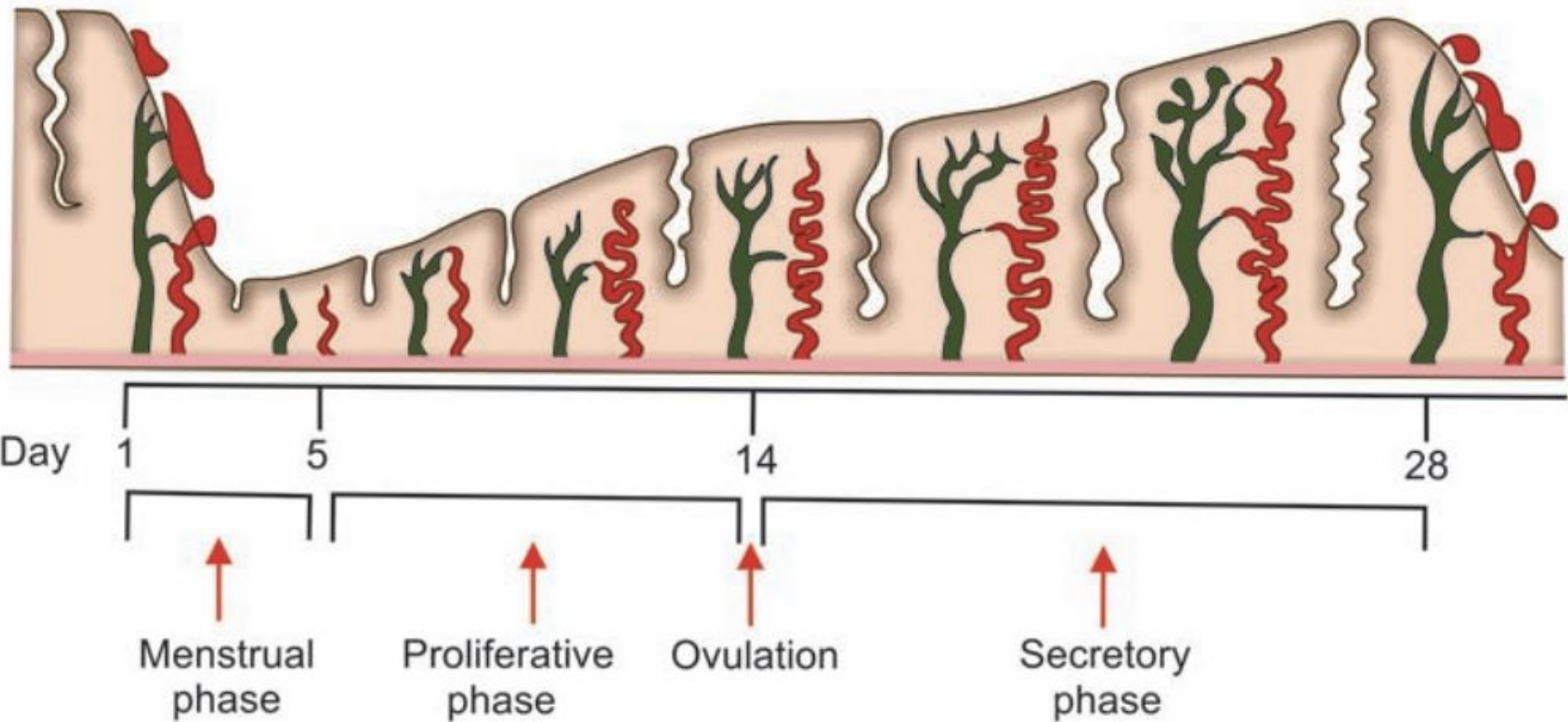


FIGURE 80.3: Uterine changes during menstrual cycle

PROLIFERATIVE PHASE

Proliferative phase extends usually from 5th to 14th day of menstruation, i.e. between the day when menstruation stops and the day of ovulation. It corresponds to the follicular phase of ovarian cycle.

Changes in Endometrium during Proliferative Phase

- i. Endometrial cells proliferate rapidly and thickness increases.
- ii. Epithelium reappears on the surface of endometrium within the first 4 to 7 days
- iii. Blood vessels appear in the stroma

All these uterine changes during proliferative phase occur because of the influence of estrogen released from ovary. On 14th day, ovulation occurs under the influence of LH. This is followed by secretory phase.

Hormones involved in the regulation of menstrual cycle are:

1. Hypothalamic hormone: GnRH
2. Anterior pituitary hormones: FSH and LH
3. Ovarian hormones: Estrogen and progesterone.

Hypothalamic Hormone – GnRH

GnRH triggers the cyclic changes during menstrual cycle by stimulating secretion of FSH and LH from anterior pituitary.

Anterior Pituitary Hormones – FSH and LH

FSH stimulates the recruitment and growth of immature ovarian follicles.

Maintains the secretory activity of corpus luteum

LH triggers ovulation and sustains corpus luteum.

LH is important for ovulation with a large quantity of FSH.

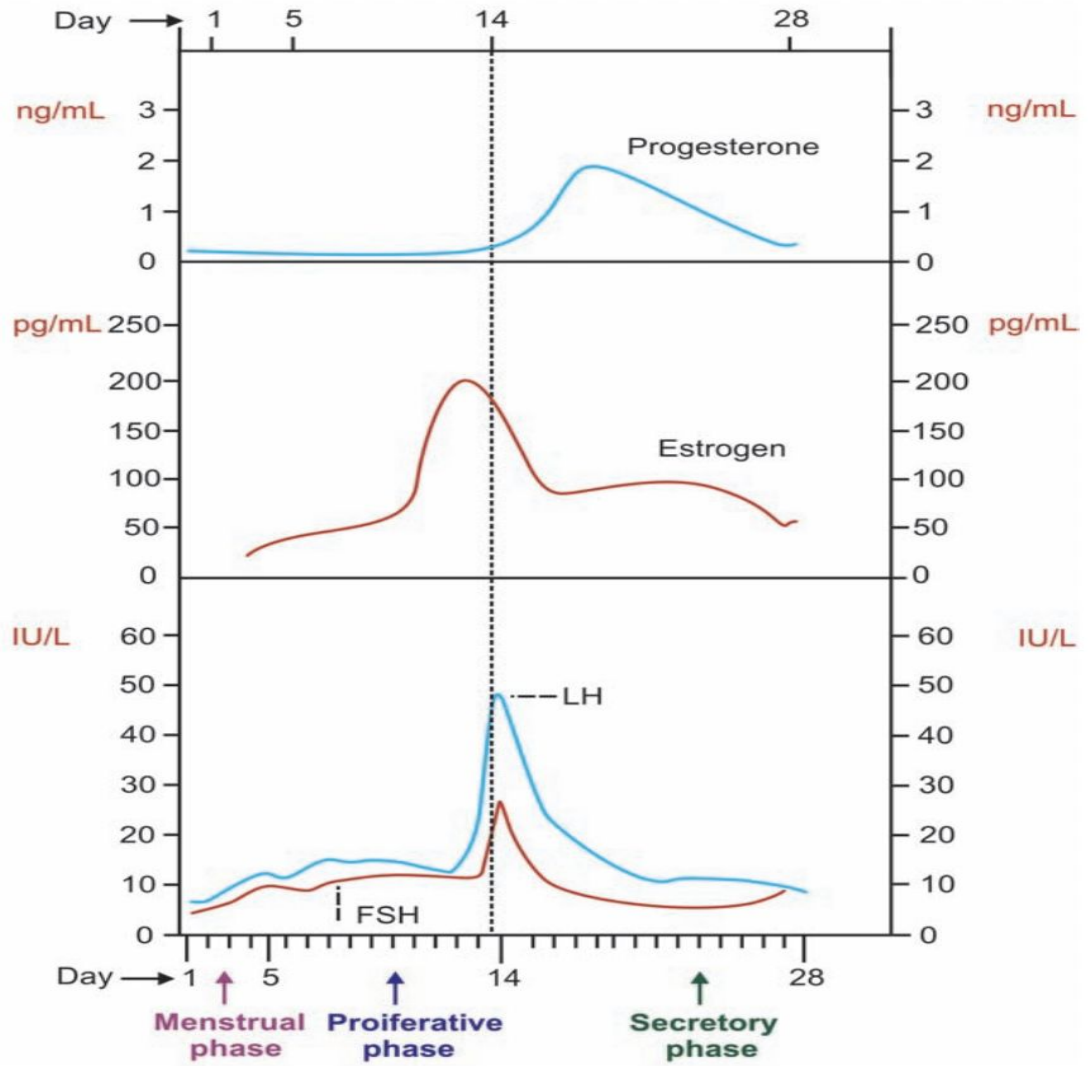
Ovarian Hormones – Estrogen and Progesterone

Ovarian follicle secretes large quantity of estrogen and corpus luteum secretes large quantity of progesterone.

Estrogen secretion reaches the peak twice in each cycle; once during follicular phase just before ovulation and another one during luteal phase.

Progesterone is virtually absent during follicular phase till prior to ovulation. But it plays a critical role during luteal phase.

Hormonal level during menstrual cycle.



Follicular Phase

1. Pulsatile release of GnRH from hypothalamus stimulates the secretion of FSH and LH from anterior pituitary
2. LH and FSH induces the synthesis of estrogen from theca cells of growing follicle.
3. Estrogen is responsible for development and growth of graafian follicle.

Ovulation

LH is important for ovulation. The need for excessive secretion of LH for ovulation is known as ovulatory surge for **LH or luteal surge**.

Luteal Phase

Ovarian changes during luteal phase depend mainly on LH.

1. Induces development of corpus luteum from the follicle
2. Stimulates corpus luteum to secrete progesterone and estrogen
3. Necessary for the maintenance of corpus luteum.

UTERINE CHANGES

Uterine changes during menstrual cycle are influenced by estrogen and progesterone.

Proliferative Phase

During proliferative stage, the repair of the damaged endometrium occurs mainly by estrogen.

Secretory Phase

Under the influence of FSH and LH from anterior pituitary, the corpus luteum secretes large amount of progesterone and small amount of estrogen.

Progesterone stimulates:

1. Growth of endometrial glands
2. Growth of blood vessels and leading to increase in blood flow to endometrium
3. Secretory activities of endometrial glands.

Menstrual Phase

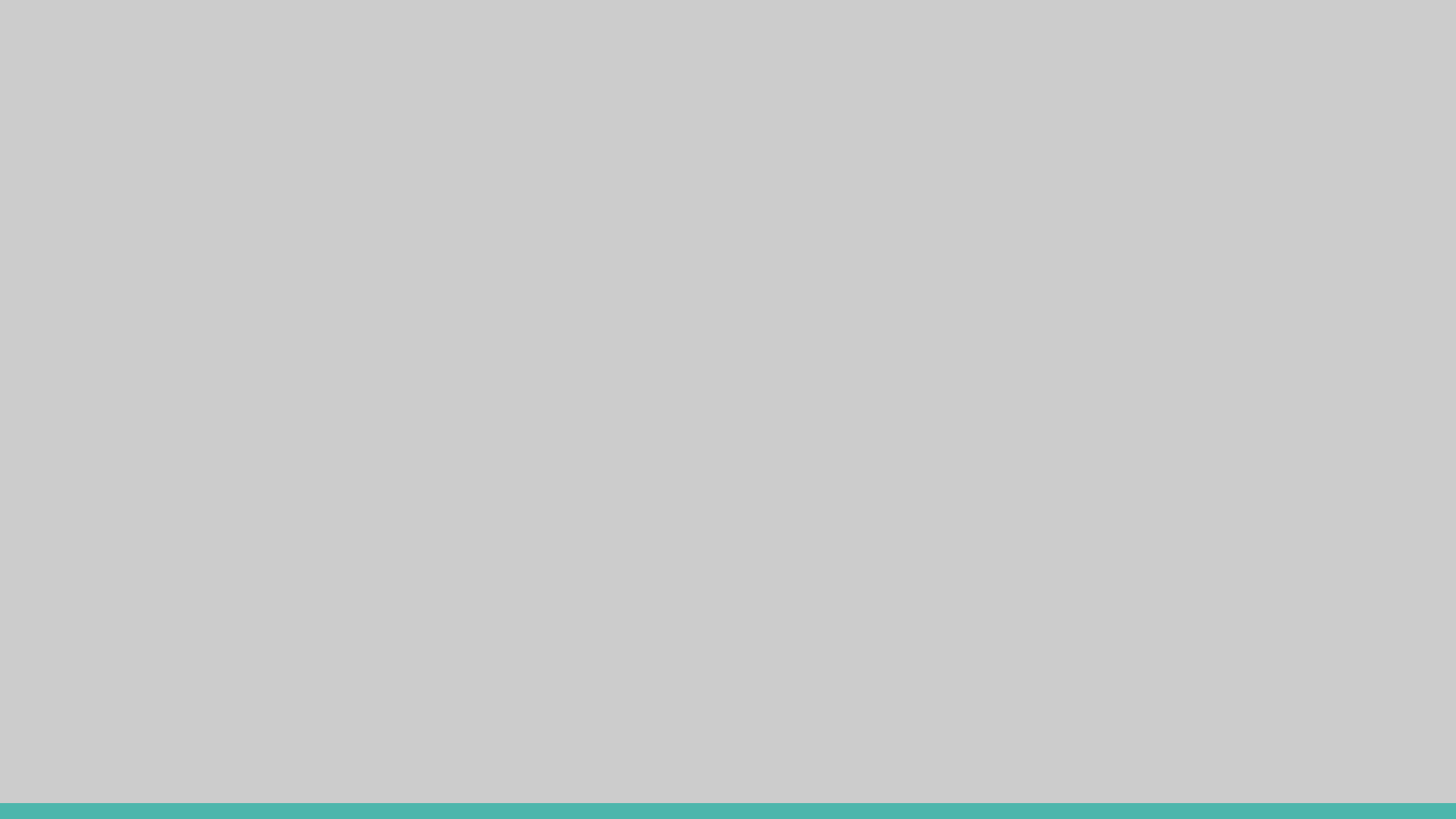
If pregnancy does not occur, menstrual phase occurs:

1. During the last two days of secretory phase, i.e. two days prior to onset of menstruation, the secretion of large quantity of progesterone and estrogen from corpus luteum inhibits the secretion of FSH and LH from anterior pituitary.
2. In the absence of LH and FSH, the corpus luteum becomes inactive and starts regressing.
3. Sudden withdrawal (absence) of ovarian hormones progesterone and estrogen occurs.
4. It leads to menstrual bleeding.

ABNORMAL MENSTRUATION

1. Amenorrhea: Absence of menstruation
2. Hypomenorrhea: Decreased menstrual bleeding
3. Menorrhagia: Excess menstrual bleeding
4. Oligomenorrhea: Decreased frequency of menstrual bleeding
5. Polymenorrhea: Increased frequency of menstruation
6. Dysmenorrhea: Menstruation with pain

Thank u



Ovarian cycle-Menstrual Cycle

- It is a series of cyclic changes occurring in the reproductive tract of female with the periodicity of 28 days
- It is also known as **menstrual cycle**, also known as **endometrial cycle**
- It occur From puberty to menopause
- It is characterized by loss of vaginal blood (breaking of endometrium wall of uterus)
- The cycle is under Influenced of hormones secreted by pituitary gland (**FSH and LH**), and ovary (**progesterone and oesterogen**).

Three phases

Menstrual phase

Proliferative phase or follicular or ovulatory phase

Luteal or secretory phase

Menstrual phase

- This phase is characterized by discharge of blood, connective tissues and mucus due to cast off of epithelial lining of endometrium wall
- It Lasts for **3-5 days**
- Ovum remain unfertilized,
- At this time level of oestrogen and progesterone is very low in blood resulting in Breaking of endometrium wall of uterus
- About 50-100 ml blood with mucus are discharges as menstrual flow.

Proliferative phase

- This phase is characterized by rapid proliferation and repair of damaged endometrium wall
- It Lasts for **9-10 days** (5th – 14th days)
- Anterior pituitary gland release **Follicular stimulating Hormone (FSH)** which stimulates development and maturation of graafian follicle. So, it is also known as Follicular Phase.
- Mature graafian follicle secrete **oestrogen**. Its level gradually increases and maximize at 12th day
- Oestrogen stimulate endometrium repair and proliferation. It also stimulate Ovulation
- Endometrium become 2-3 mm thick and highly vascular

Luteal phase

- This phase is characterized by release of Ovum from mature graffian follicle which is stimulated by the secretion of **luteinizing hormone** (LH) by pituitary gland.
- It Lasts for **12-14 days** (14th-28th day)
- LH along with FSH stimulate ovulation.
- Mature graffian follicle release ovum and the rapture follicular cell form **corpus luteum**
- Corpus luteum secrete progesterone, high level of progesterone inhibit maturation of any other follicles
- Progesterone also stimulate thickening of endometrium wall
- When ovum remain unfertilized, corpus luteum degenerate; level of both hormone (progesterone and oestrogen) decreases, causing breaking of endometrium wall continuing the menstrual phase.

