UNIVERSITY OF MEDICAL SCIENCES, ONDO

DEPARTMENT OF PHYSIOLOGY

REPRODUCTION

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OBJECTIVES

- Introduction
- Functional anatomy of male sex organ
- Functional anatomy of female sex organ

INTRODUCTION

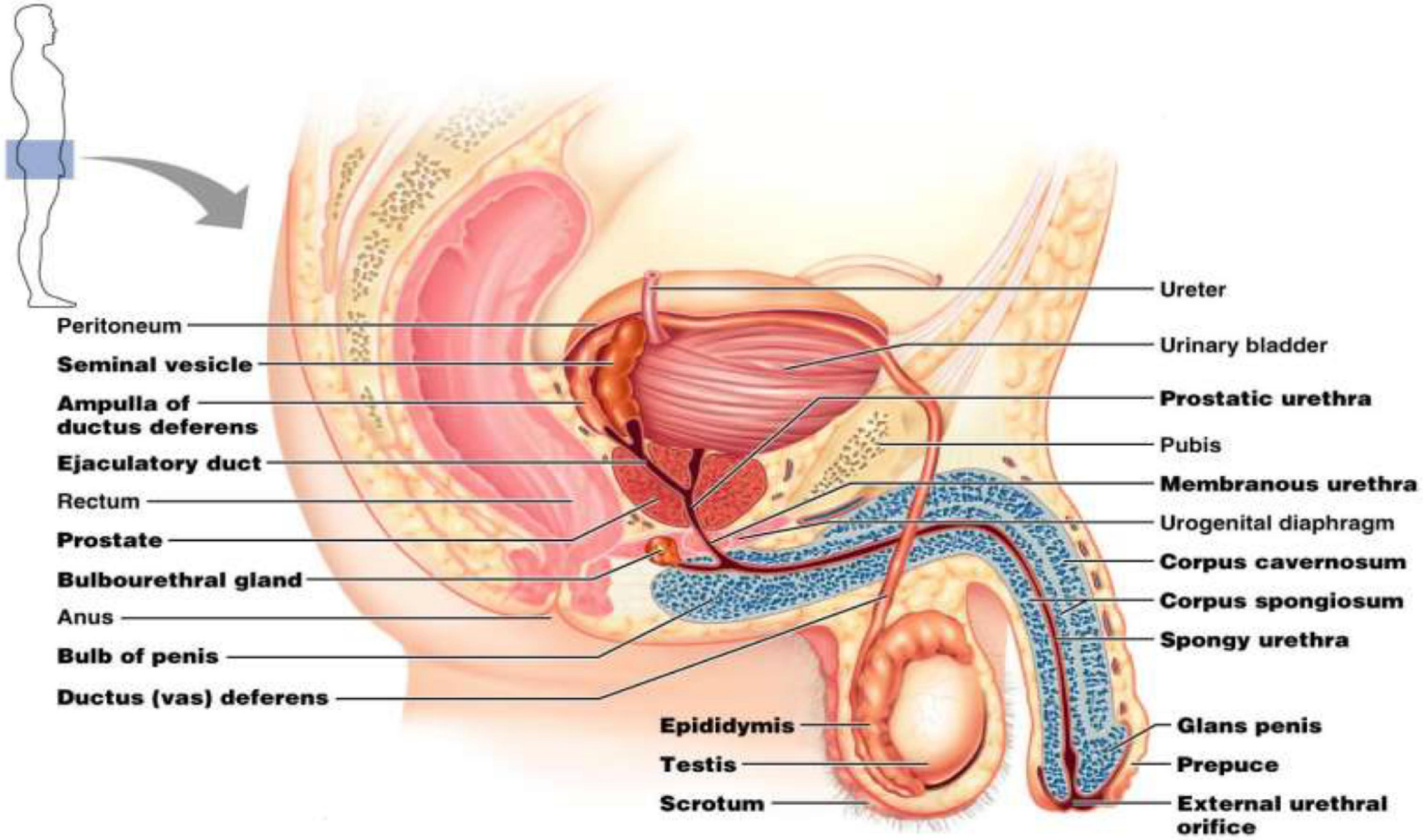
- Reproduction?
  - Organisms create descendants.
  - Organisms perpetuate themselves.
  - Continuation of species.
- Differentiate living things from nonliving things.
- In human sexual reproduction

- A male and a female of the same species are required to copulate and combine their genes in order to produce a new individual who is genetically different from his parents.
- It relies on meiosis to shuffle the genes, so that new combinations of genes occur in each generation, allowing some of the offspring to survive in the constantly changing environment.
- The male reproductive system produces, sustains, and delivers sperm cells (spermatozoa) to the female reproductive tract.
- The female reproductive system produces, sustains, and allows egg cells (oocytes) to be fertilized by sperm.
- It also supports the development of an offspring (gestation) and gives birth to a new individual (parturition).

- In male, reproductive organs or genitals, are both inside and outside the pelvis.

- In female, reproductive organs are entirely within the pelvis.

FUNCTIONAL ANATOMY OF MALE SEX ORGAN



MALE REPRODUCTIVE ORGAN

➢Male reproductive organs include:

- Primary sex organs (testes)
- Accessory sex organs (ducts and glands)

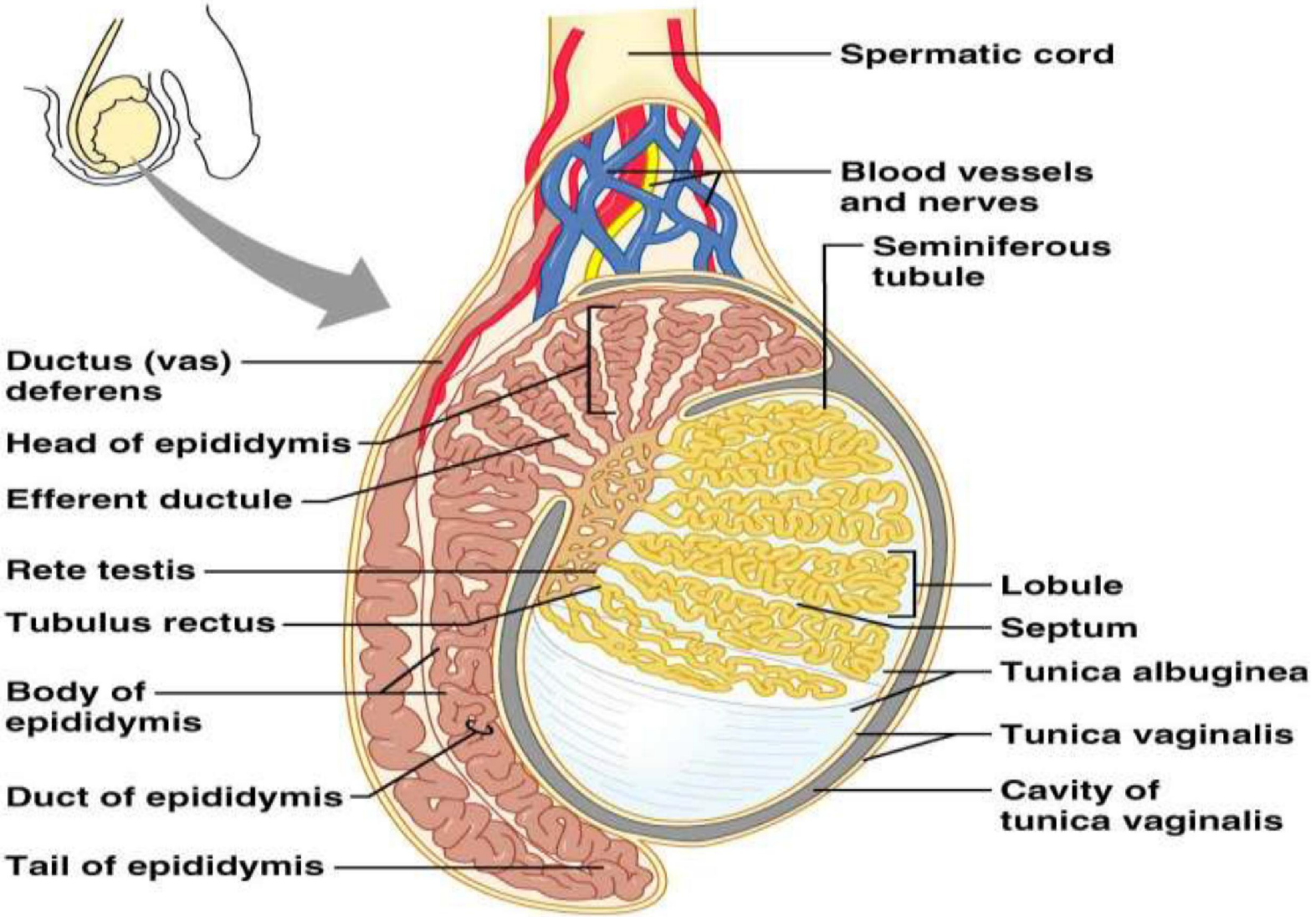
- Ducts - epididymis, ductus deferens, ejaculatory duct and urethra.

- Glands - seminal vesicles, prostate gland, and bulbourethral glands.

TESTES (singular, testis)

- Sex organ that produces sperm in a process called spermatogenesis, and male sex hormones (testosterone).
- Developed in a male fetus near the kidneys, and descend into the scrotum about 2 months before birth.
- Each testis is enclosed by a layer of fibrous connective tissue called tunica albuginea.
- Each testis contains about 250 functional units called lobules; each lobule contains about 4 seminiferous tubules where spermatogenesis occurs.
- All seminiferous tubules in a testis converge and form a channel called rete testis.

TESTIS


Spermatic cord
Blood vessels and nerves
Seminiferous tubule
Ductus (vas) deferens
Head of epididymis
Efferent ductule
Rete testis
Tubulus rectus
Body of epididymis
Duct of epididymis
Tail of epididymis
Lobule
Septum
Tunica albuginea
Tunica vaginalis
Cavity of tunica vaginalis

SCROTUM

- A pouch-like cutaneous extension that contains the two testes.
- Located outside of pelvic cavity to prevent overheating of testes.
- Internal temperature of scrotum is always about 3˚F below body temperature.
- Temperature has to be lower than normal body temperature in order for *spermatogenesis* (sperm production) to take place.

EPIDIDYMIS

- An expanded tubule from the rete testis where sperm is stored (for about 3 days), matured and become fully functional.
- Contains cilia on its columnar epithelium that help move sperm toward vas deferens during ejaculation.
- Epididymis keeps sperms for sometimes and gives nourishment to it.

VAS DEFERENS (sperm duct or spermatic deferens).

- A tubule (about 10 inches long) that connects epididymis to the urethra for transporting sperm during ejaculation.
- Contains smooth muscle that undergoes rapid peristalsis during ejaculation.

ACCESSORY SEX GLANDS

SEMINAL VESICLES

- Secrete an alkaline solution that makes up 60% of the semen volume.
- The seminal fluid contains fructose (nutrient for the sperm) and prostaglandins (substances that stimulate uterine contraction during sexual excitation).

PROSTATE GLAND

- Secretes a slightly acidic, milky white fluid that makes up about 30% of semen volume.
- This fluid helps neutralize the pH of semen and vaginal secretion.

BULBOURETHRAL GLAND

- It is also called Cowper's glands
- It secretes a clear lubricating fluid that aids in sexual intercourse.

URETHRA

- A tubule located inside the penis for urine excretion and semen ejaculation.
- Contains smooth muscle that performs rapid peristalsis during ejaculation .

PENIS

- A copulatory organ that is responsible for delivering the sperm to the female reproductive tract.
- Contains 2 erectile tissues called corpus cavernosa and corpus spongiosum.
- The latter one enlarges and forms the glans penis, it's distal end.

- During sexual excitement, parasympathetic nerves cause vasodilatation in the penis, allowing erectile tissues to swell and erect the penis.
- During ejaculation, sympathetic nerves cause vas deferens, urethra and erectile tissues to contract, forcefully expelling semen (a mixture of sex gland fluids and about 300 million sperm) outward .

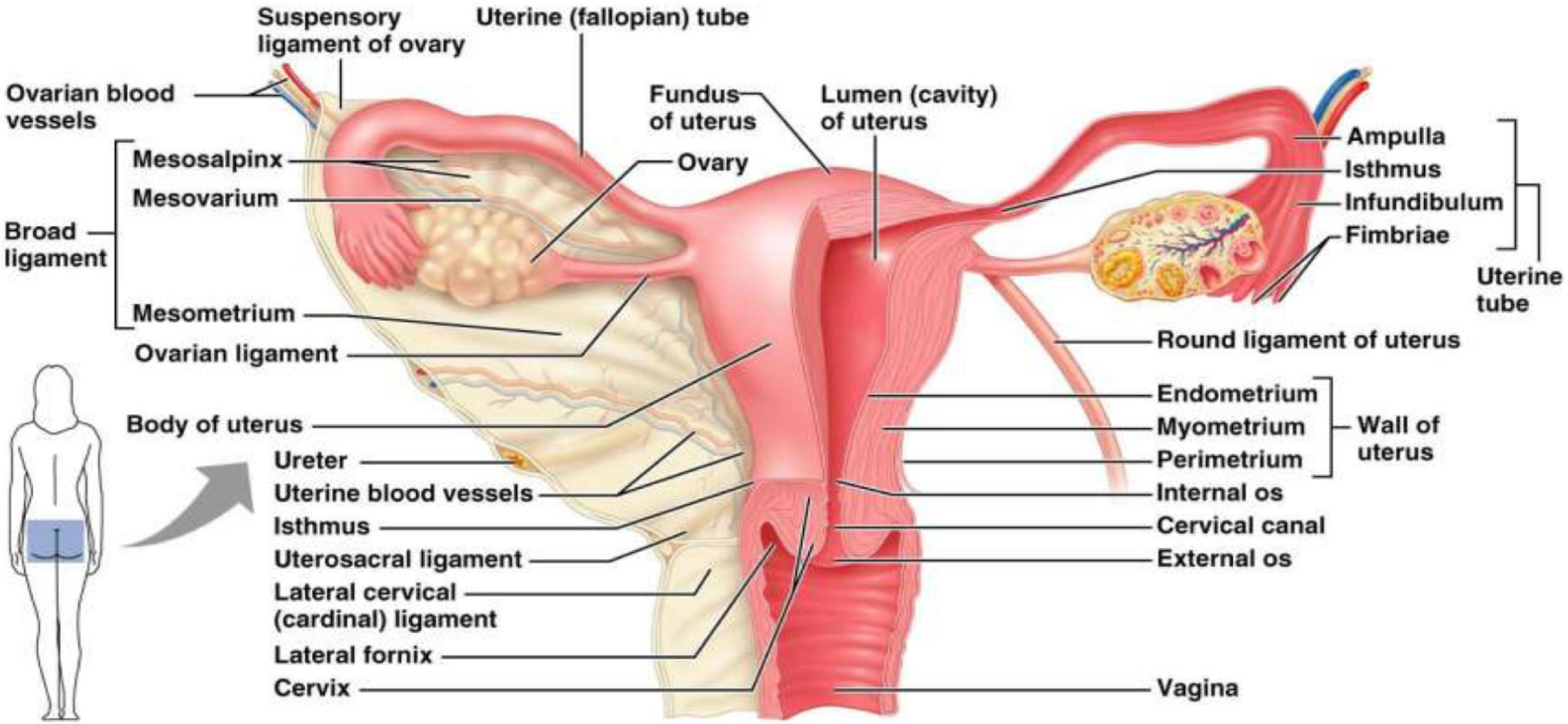
SEMINIFEROUS TUBULES

- About 1,000 seminiferous tubules in each testis conduct spermatogenesis.
- Between the tubules are specialized glandular cells called interstitial cells (or Leydig's cells) which produce testosterone.
- Inside the tubules are specialized cells called sertoli's cells which support and nourish the sperm.

EJACULATORY DUCTS

- There are two ejaculatory ducts.
- Each receives sperm from the ductus deferens and the secretions of the seminal vesicle.
- Both ejaculatory ducts empty into the single urethra.

FUNCTIONAL ANATOMY OF FEMALE SEX ORGAN



Female reproductive organs and other organs of pelvis

FEMALE REPRODUCTIVE ORGAN

➢Female reproductive system include:

- Primary sex organs (a pair of ovaries).
- Accessory sex organs:

- A system of genital ducts: Fallopian tubes, uterus, cervix and vagina.
- External genitalia: Mon pubis, labia majora, labia minora, clitoris, bulb and glands of Bartholin (These structures are together called vulva).

OVARY

- A woman has two ovaries and each weighs 4 to 8 grams in adult.
- It is a primary sex organ that produces egg cells in a process called oogenesis, and also produces female sex hormones such as estrogens and progesterone.
- It is developed near the kidneys during fetal development, and toward the end of pregnancy descend into the pelvic cavity.
- Consists of ovarian cortex where the ovarian cycle occurs, and ovarian medulla where scar tissues and connective tissue are located.
- It is bound to the uterine tubes and uterus by ovarian ligaments.

ACCESSORY SEX ORGANS

FALLOPIAN TUBES (site of fertilisation)

- There are two of them.
- Also called the uterine tubes or the oviducts.
- Situated at the upper corners of the uterus.
- Consists of fimbriae (finger-like appendages that collect the ovum from the ovary during ovulation).
- Infundibulum channels the ovum from the fimbriae into the uterine tube.
- Ampulla is the curvature of the uterine tube where most fertilization occurs.
- The inner wall of uterine tube is made of ciliated mucosa, where the cilia propel the ovum toward the uterus.

UTERUS

- A pear-shaped cavity formed by the union of the two uterine tubes.
- It is about 7 cm long, 4 cm wide and 2.5 cm thick from front to back in a non-pregnant woman.
- The uterus contains some of the strongest muscles in the female body.
- Composed of 3 layers of tissue i.e. perimetrium (fibrous connective tissue), myometrium (smooth muscle), and endometrium (epithelial and connective tissues).
- After fertilization, embryo adheres to the endometrial layer for further development-an event called implantation.
- To prepare for implantation and development, endometrium is stimulated by estrogens to thicken and becomes vascularized (a process called the menstrual cycle).

- Myometrium, under the stimulation of oxytocin, contracts during labor to expel the fetus into the vagina.
- The base of uterus is closed by a narrow passageway called cervix to prevent the entry of foreign substances.
- The uterus is subdivided into:

- Fundus (upper portion)
- Body (mid portion)
- Cervix (lower portion that extends into the vagina).

CERVIX

- It is occasionally called "cervix uteri", or "neck of the uterus".
- It is the lower, narrow portion of the uterus where it joins with the top end of the vagina.
- It is cylindrical or conical in shape and protrudes through the upper anterior vaginal wall.
- The portion projecting into the vagina is referred to as the ectocervix.
- The ectocervix's opening is called the external os.
- The passageway between the external os and the uterine cavity is called the endocervical canal.
- The endocervical canal terminates at the internal os (the opening of the cervix inside the uterine cavity).

- During childbirth, contractions of the uterus dilate the cervix up to 10 cm in diameter to allow the child to pass through.
- During orgasm, the cervix convulses and the external os dilates.

VAGINA

- It is an elastic channel inferior to the cervix that serves as the "birth canal" during parturition.
- Also serves as the copulatory receptacle, where it receives the penis during sexual intercourse.
- In addition to the acids secretion from cervix, it also coveys uterine secretions (i.e. menstrual flow).
- A thin sheet of tissue with one or more holes in it (HYMEN), partially covers the opening of the vagina.
- Mucus is secreted by the vaginal epithelium during sexual excitation.
- It dilates to about 10 cm long and 6 cm wide during sexual excitation and can dilate much greater during coitus and parturition.

MON PUBIS

- It is the soft mound at the front of the vulva (fatty tissue covering the pubic bone).
- It protects the pubic bone and vulva from the impact of sexual intercourse.
- After puberty, it is covered with pubic hair, usually in a triangular shape.

LABIA MAJORA

- They are the outer "lips" of the vulva.
- They are pads of loose connective, adipose tissue and some smooth muscle.
- They wrap around the vulva from the mons pubis to the perineum.
- They generally hides, partially or entirely, the other parts of the vulva.
- These labia are usually covered with pubic hair.
- They contain numerous sweat and oil glands.
- It has been suggested that the scent from these oils are sexually arousing.

LABIA MINORA

- They are medial to the labia majora.
- They are the inner lips of the vulva.
- They are thin stretches of tissue within the labia majora that fold and protect the vagina, urethra, and clitoris.
- There is no pubic hair on the labia minora, but there are sebaceous glands.
- The two smaller lips of the labia minora come together longitudinally to form the prepuce, a fold that covers part of the clitoris.
- The labia minora protect the vaginal and urethral openings.
- Both the inner and outer labia are quite sensitive to touch and pressure.

CLITORIS

- It is a small body of spongy tissue that functions solely for sexual pleasure.
- Only the tip or glans of the clitoris shows externally, but the organ itself is elongated and branched into two forks (the crura), which extend downward along the rim of the vaginal opening toward the perineum.
- The clitoral glans or external tip of the clitoris is protected by the prepuce, or clitoral hood, a covering of tissue similar to the foreskin of the male penis.
- Unlike the penis, the clitoris does not contain any part of the urethra.
- During sexual excitement, the clitoris erects and extends, the hood retracts, making the clitoral glans more accessible.

BARTHOLIN'S GLAND

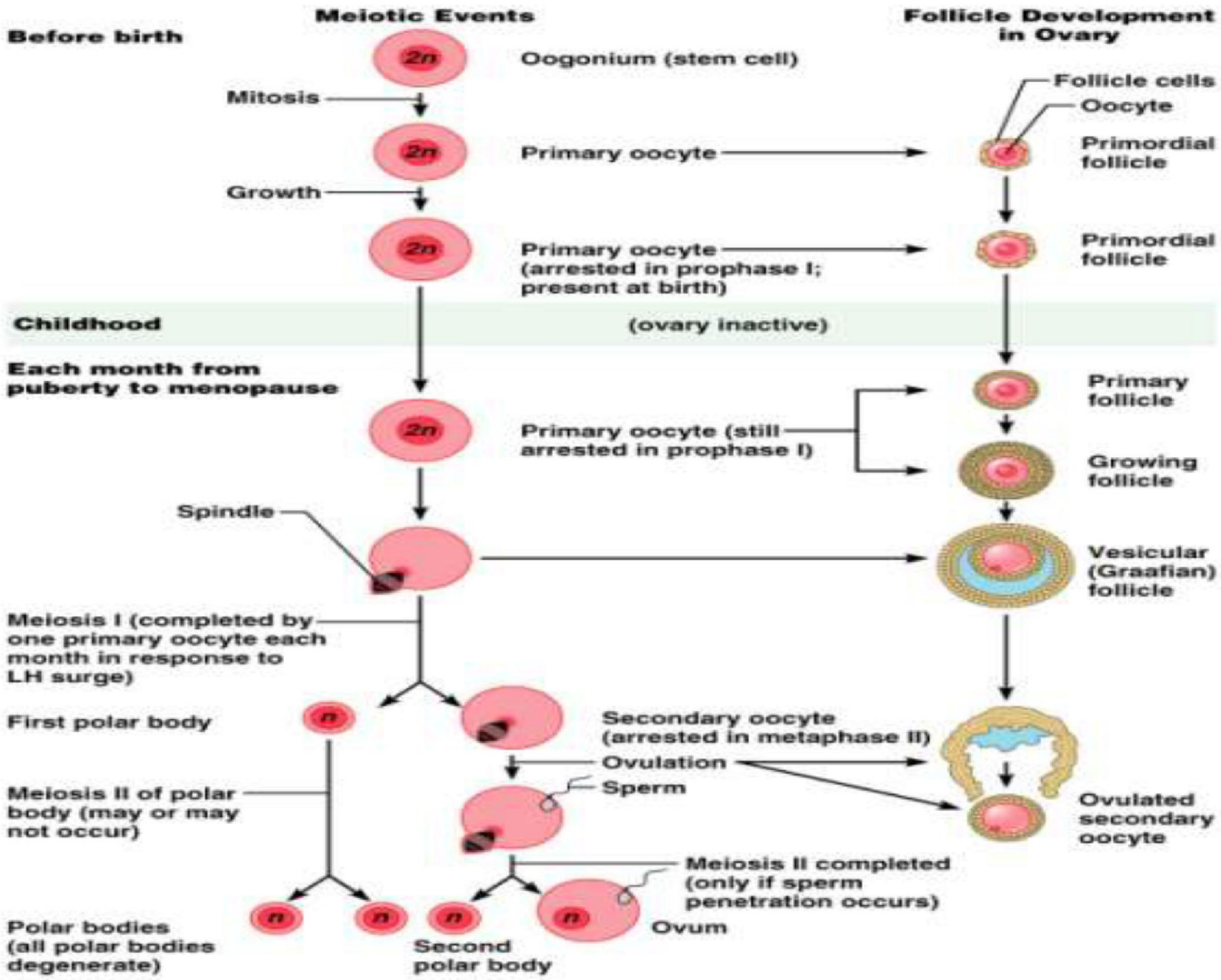
- It is also called Bartholin glands or greater vestibular glands.
- They are two pea sized glands located slightly posterior and to the left and right of the opening of the vagina.
- It is homologous to the bulbourethral glands in males.
- They are located in the superficial perineal pouch in females, unlike the bulbourethral glands that are located in the deep perineal pouch in males.
- They secrete mucus to provide vaginal lubrication.
- The fluid may slightly moisten the labial opening of the vagina, serving to make contact with this sensitive area more comfortable.

OOGENESIS

- In fetus, immature egg cells (oogonia) multiply by mitosis until 5th month of gestation.
- During reproductive years, 10-20 primary oocytes and follicles begin to develop each month.
- Normally just one of these reaches maturity and ovulates and the rest degenerate.
- As follicle cells develop, egg develops within under the influence of FSH & LH from anterior pituitary.
- Egg undergoes meiosis but stops as secondary oocyte (metaphase II) until fertilization.
- Only 400-500 follicles will ever develop into mature ova and be released by ovaries during a woman's reproductive years.
- When woman reaches menopause (50-55 yrs) very few primary follicles are left in ovaries.

- After ovulation, the follicle collapses and becomes the corpus luteum which secretes large amounts of progesterone.
- Maturation of more than one oocyte is a factor in multiple births.

EVENTS OF OOGENESIS



HORMONAL CONTROL OF FEMALE REPRODUCTIVE FUNCTION

- Hormones from the hypothalamus, anterior pituitary gland and ovaries, play important roles in the control of sex cell maturation, and development and maintenance of female secondary sex characteristics.
- Female sex hormones:

- A female body remains reproductively immature until about 10 years of age when gonadotropin secretion increases.
- The most important female sex hormones are estrogen and progesterone.

- Estrogen is responsible for the development and maintenance of most female secondary sex characteristics.
- Progesterone causes change in the uterus .

HORMONAL CONTROL OF FEMALE SECONDARY SEX CHARACTERISTIC

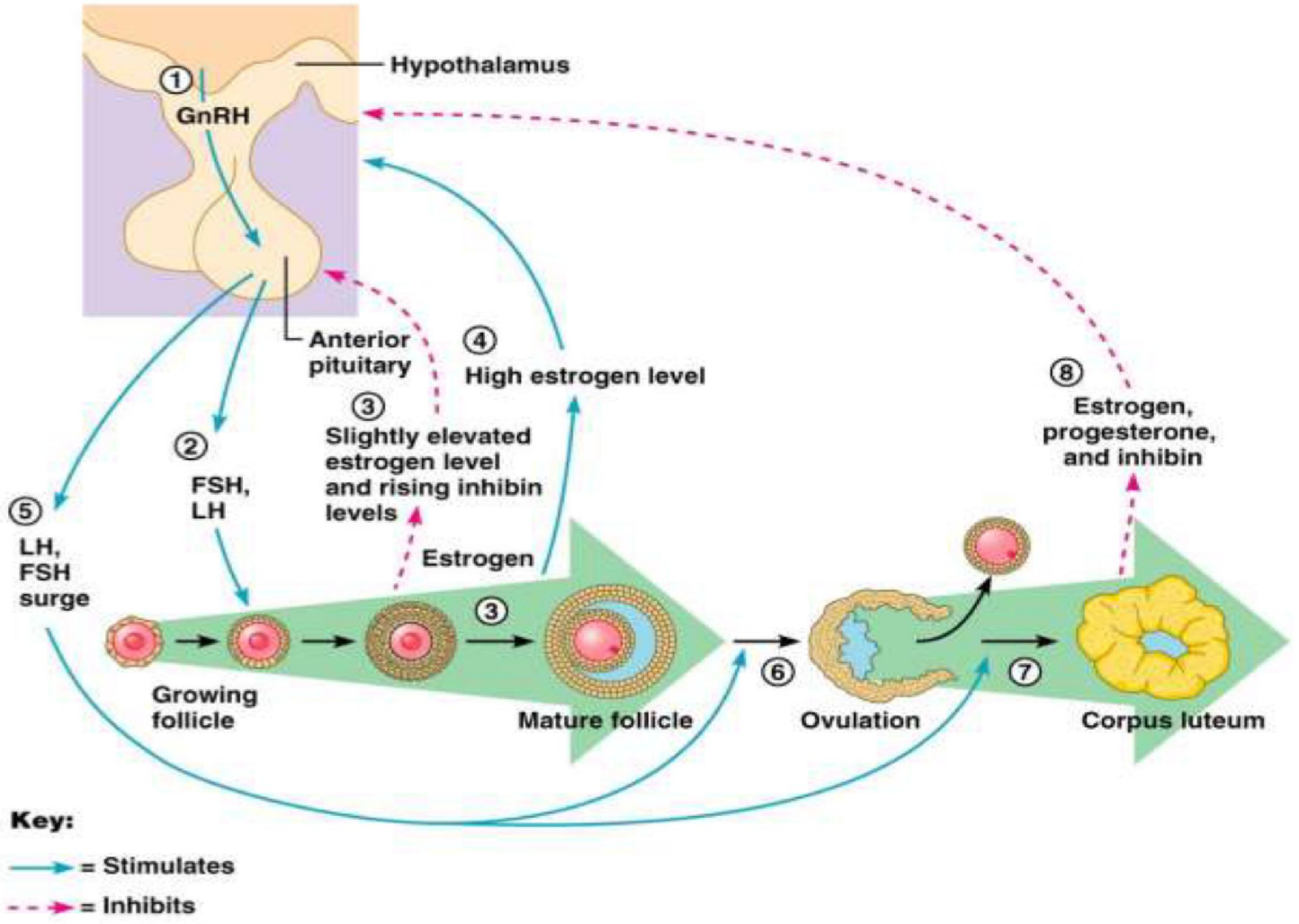
- The hypothalamus releases GnRH, which stimulates the anterior pituitary gland.
- The anterior pituitary gland secretes FSH and LH.
- FSH stimulates the maturation of a follicle.
- Granulose cells of the follicle produce and secrete estrogen; LH stimulate certain cells to secrete estrogen precursor molecules.
- Estrogen is responsible for the development and maintenance of most female secondary sex characteristics.
- Progesterone, secreted by the ovaries, affect cyclical changes in the uterus and mammary glands.

OVARIAN CYCLE

- A series of events which occur in the ovarian cortex in order to produce a mature ovum and sex hormones.
- Lasts for about 28 days, where from day 1 to 13 the mature ovum is developed and estrogens are released, on day 14 ovulation occurs to discharge the ovum, and from day 15 to 28 scar tissues are formed and progesterone is released.
- On day 1, hypothalamus secretes gonadotrophin releasing hormone (GnRH) to the anterior pituitary gland, which in turn secretes follicle stimulating hormone (FSH) to the ovaries.
- Upon receiving FSH, about 20-25 primary follicles develop into secondary follicles (primary oocytes are located inside primary follicles, undergo meiosis I and become secondary oocoytes which is contained in secondary follicles).

- Follicular cells in secondary follicles begin to secrete estrogens (for communicating with hypothalamus and anterior pituitary and for developing the endometrium).
- With continuous stimulation of FSH and some Luteinizing hormone (LH), secondary follicles continue to grow larger and develop multiple layers of follicular cells (while the secondary oocytes within are unchanged).
- By day 13, only 1 secondary follicle will fully mature and become the graafian follicle (or mature follicle) which secretes a large amount of estrogens to the hypothalamus – anterior pituitary system for signaling ovulation (using a positive feedback mechanism).
- On day 14, large amounts of LH ("LH surge") will be secreted by anterior pituitary, inducing ovulation where the graafian follicle ruptures and releases the secondary oocyte into uterine tube .

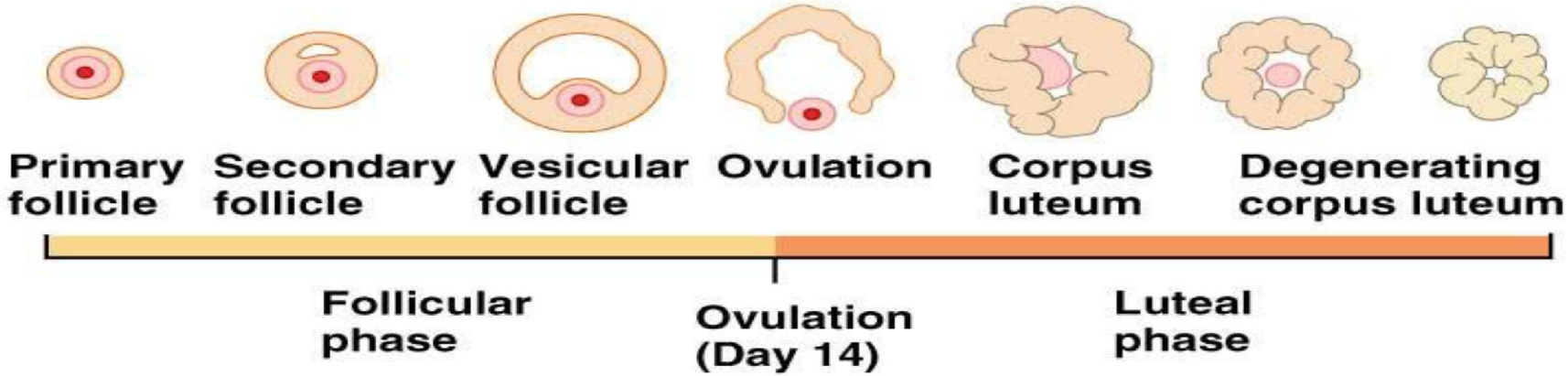
REGULATION OF OVARIAN FUNCTION



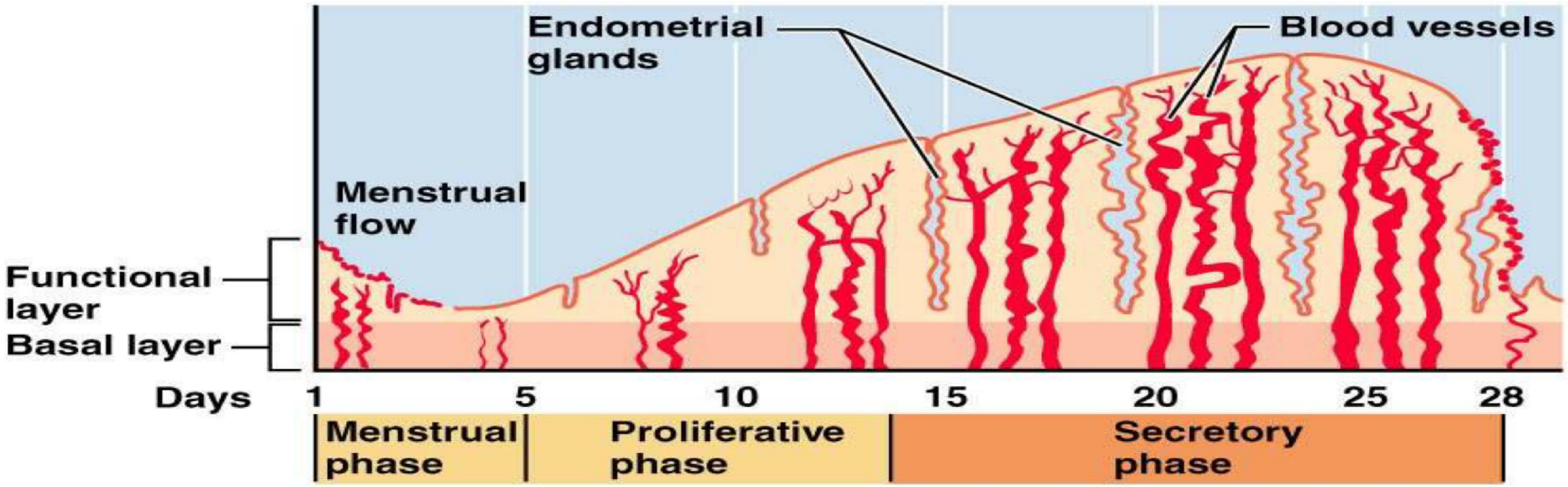
- From days 15 to 25, graafian follicle degenerates and becomes corpus hemorrhagicum ("a bleeding body") then corpus luteum ("a yellow body"; containing lutein cells that secrete progesterone and some estrogens to continue stimulating the development of endometrium).
- By day 26, if no fertilization occurs to the secondary oocyte, resulting in a lack of human chorionic gonadotropin hormone (HCG) from the embryo, corpus luteum degenerates into corpus albicans. (if fertilization did occur, HCG will continuously stimulate corpus luteum for 2-3 months, allowing high levels of estrogens and progesterone to maintain pregnancy in the first trimester).
- When corpus luteum degenerates, the declining levels of estrogens and progesterone will signal the hypothalamus-anterior pituitary system to initiate another ovarian cycle.

MENSTRUAL CYCLE

- A series of events that occurs in the uterus in order to prepare the endometrial layer for implantation and fetal development.
- Occurs simultaneously with the ovarian cycle, but is about 1 week behind; and also lasts about 28 days.
- From days 1 to 6, the menstrual phase occurs where the top portion of a thickened endometrial called stratum functionalis is shed off from the previous cycle.
- Along with the stratum functionalis, tissue, mucus, blood, and the secondary oocytes are discarded as "menses".
- From days 7 to 13, increasing levels of estrogens from secondary and mature follicles stimulate the endometrial to thicken and vascularize – in a stage called the pre-ovulatory phase.



(c) Ovarian cycle



(d) Uterine cycle

- From days 15 to 28, continuous secretion of estrogens and progesterone from corpus luteum causes the endometrium to continue thickening and vascularizing (the postovulatory phase).
- Toward the end of this phase, if no fertilization occurs, resulting in a lack of HCG stimulation to corpus luteum, the declining levels of estrogens and progesterone will cause the endometrium to degenerate and ultimately shedding off the stratum functionalis layer.
- If fertilization did occur, high levels of estrogens and progesterone from the corpus luteum (in the first trimester) and from the placenta (in the second and third trimesters) will sustain the thickness and vascularization of endometrium until the end of pregnancy.

MAJOR EVENTS IN MENSTRUAL CYCLE

- The anterior pituitary gland secretes FSH and LH.
- FSH stimulates maturation of a follicle, granulosa cells of the follicle produce and secrete estrogen; estrogen maintains secondary sex traits and causes the uterine lining to thicken.
- The anterior pituitary gland releases a surge of LH, which stimulates ovulation. Follicular and thecal cells become corpus luteum cells which secrete estrogen and progesterone.
- Estrogen continues to stimulate uterine wall development.
- Progesterone stimulates the uterine lining to become more glandular and vascular.
- Estrogen and progesterone inhibit secretion of FSH and LH from the anterior pituitary gland.

- If the egg is not fertilized, the corpus luteum degenerates and no longer secretes estrogen and progesterone (24th day of the cycle).
- As the conc. of luteal hormones decline , blood vessels in the uterine lining constrict.
- The uterine lining disintegrates and sloughs off, producing a menstrual flow (28th day of the cycle).
- The anterior pituitary gland, no longer inhibited, again secretes FSH and LH.
- The menstrual cycle repeats.

THE MENSTRUAL CYCLE