

8. THE REPRODUCTIVE SYSTEM

!! JAY AMBE !!

8. THE REPRODUCTIVE SYSTEM

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THE REPRODUCTIVE SYSTEM

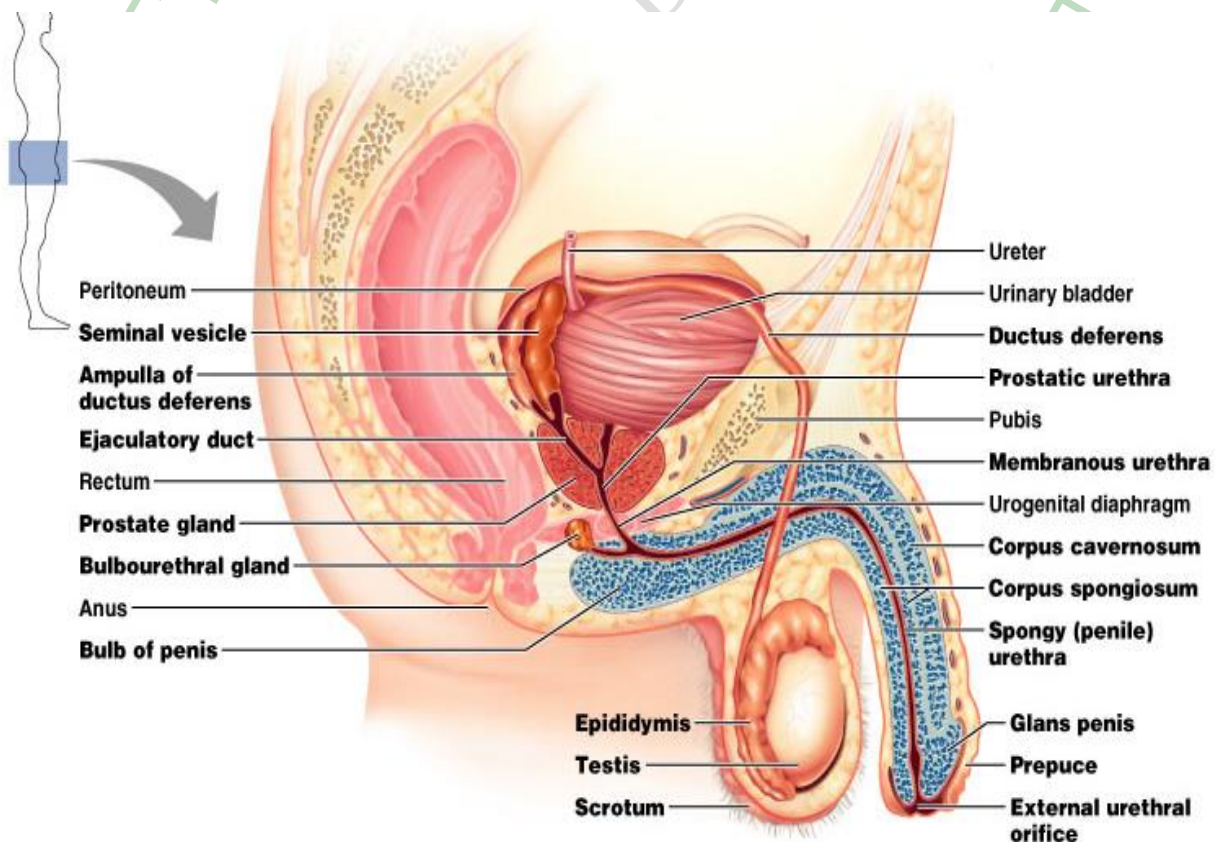
The **reproductive system** or **genital system** is a system of organs within an organism which work together for the purpose of reproduction.

Reproduction is the process by which new individuals of species are produced via which genetic material pass from generation to generation.

According to function, the male and female reproductive organ grouped as under

1. **Gonads (Seeds):** it includes testes and ovaries, the main function of testes are production of gametes and secretion of hormones.
Male gametes known as sperm
Female gametes known as oocytes
2. **The ducts:** It transport and store the gametes.
3. **Accessory sec gland:** It produces materials that support gametes.
4. **Supporting Structures:** It includes penis that have important role in reproduction.

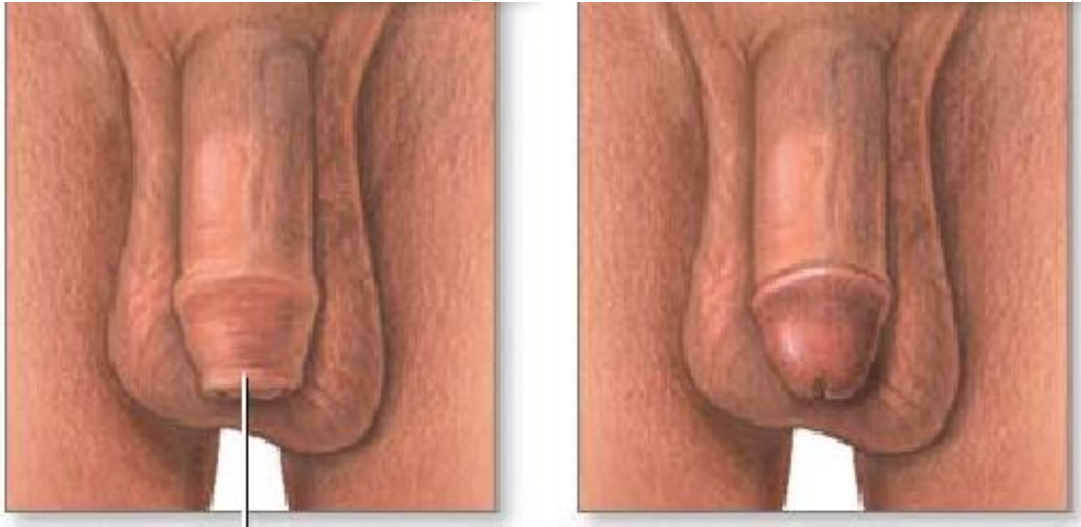
MALE REPRODUCTIVE SYSTEM:



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External Structures

- **Penis:** External male sex organ
 - **Uncircumcised:** Foreskin not removed
 - **Circumcised:** Removes some or all of foreskin



- **Scrotum:** Sac of skin and muscle containing testicles

Internal Structures

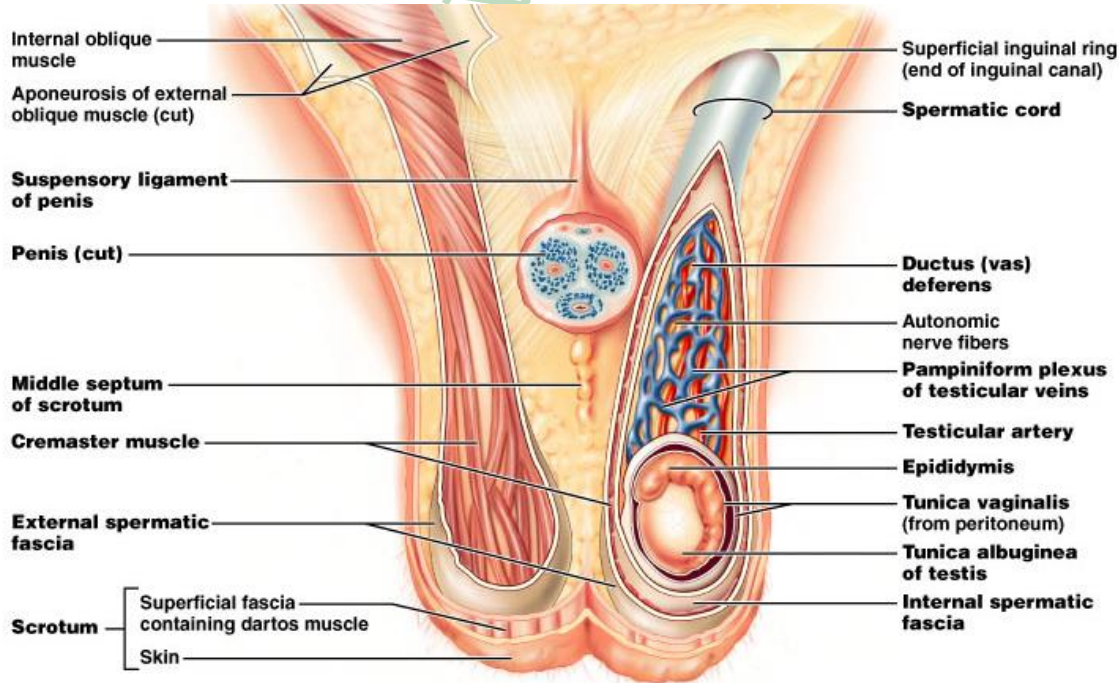
- **Prostate:** Exocrine gland of male reproductive system
- **Vas Deferens:** Tubes connecting epididymis to ejaculatory ducts
- **Epididymis:** Organ where sperm matures
- **Testicles:** Organ where sperm is created
- **Urethra:** Tube that connects bladder to outside of body

1. Scrotum:

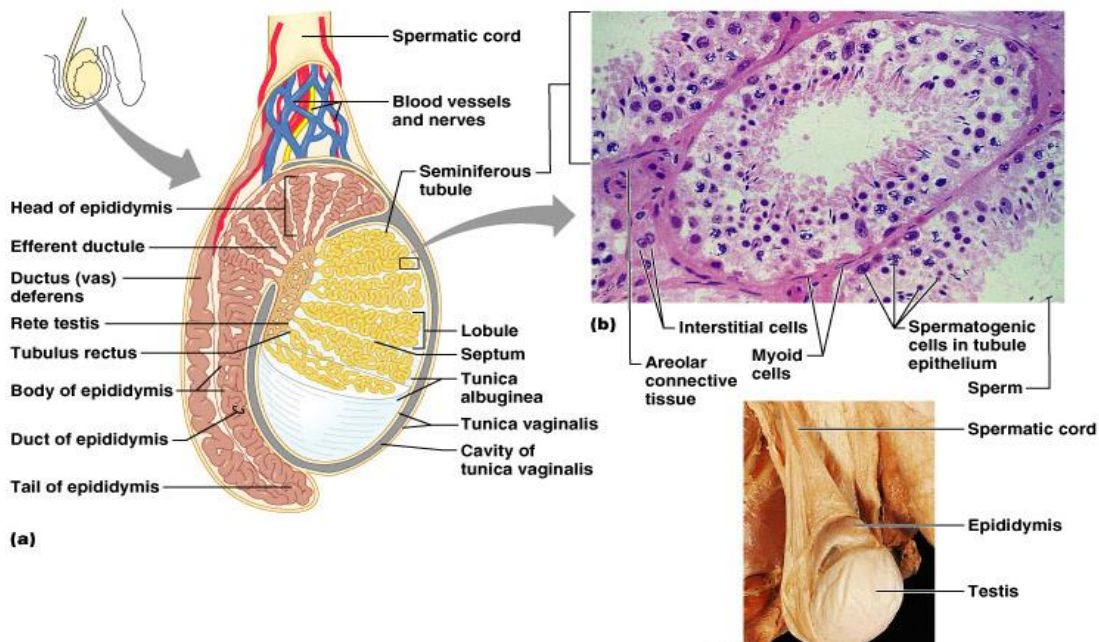
- Scrotum is a sac that hangs from the root of the penis and consists of loose skin and superficial fascia.
- It is a supportive structure of the penis.
- Internally scrotum consists of a vertical septum which divides it into two sacs.
- Each sac contains a single testis.
- Septum is covered by superficial fascia and muscle tissue known as dartos which consists of smooth muscle fibers.
- When dartos muscle contracts it produces a wrinkle in the skin of the scrotum.
- The location of the scrotum and contraction of its muscle fibers regulate the temperature of the testes.

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- Both production and survival of sperm required a temperature that is about 3°C lower than the normal body temperature.
- The cremaster muscles is a small band of skeletal muscle present in to the spermatic cord, during the cold and sexual arousal it elevate the testes and this action moves the testes near to the pelvic cavity where they can absorb the heat.



2. Testes:



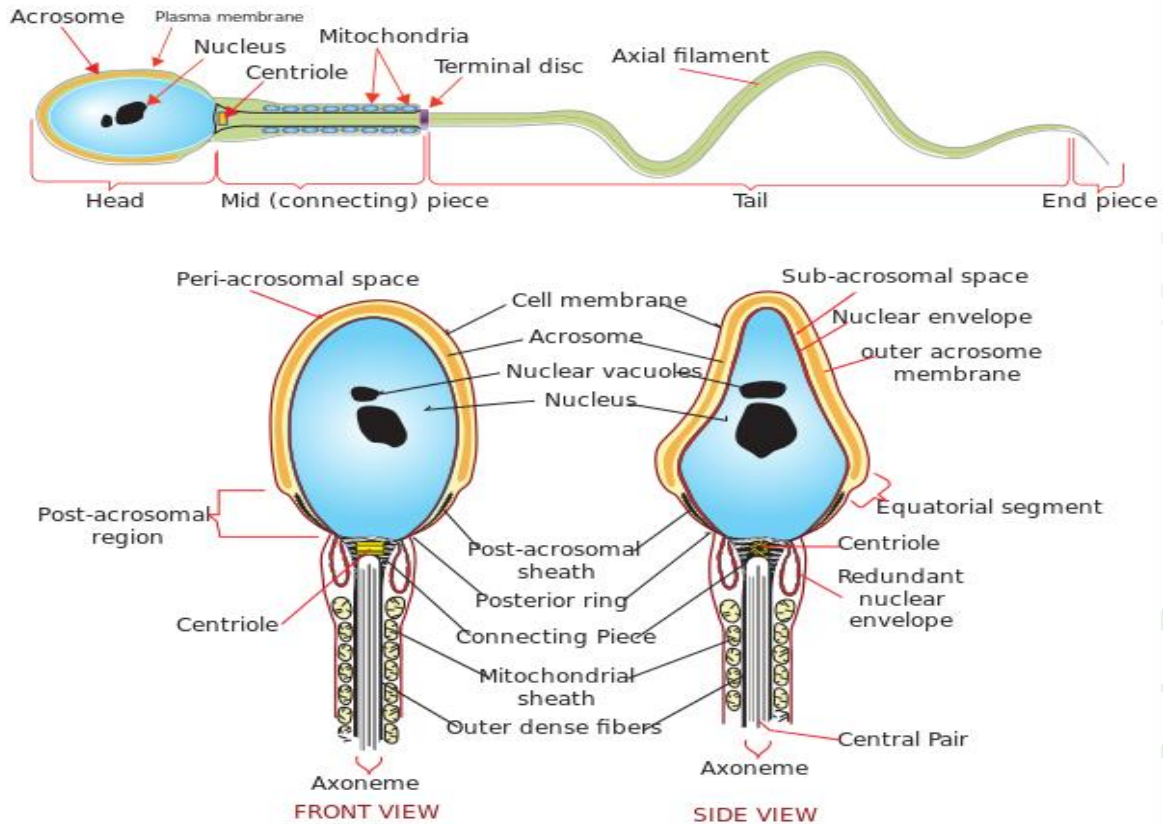
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- Testes are formed in abdomen and descend into scrotum at 7th month of development.
- The testes are paired oval glands.
- It is 5 cm length, 2.5 cm in diameter and 10-15 grams of weight of each testis.
- The outer covering of testes is known as tunica vaginalis made up from serous membrane.
- Internal to the tunica vaginalis dense white fibrous capsule known as tunica albuginea.
- Inside extending portion of the tunica albuginea produce lobules. There are 200 – 300 lobules present in each testis.
- Each lobule consist one to three tightly coiled tubules known as seminiferous tubules.
- Seminiferous tubule consist spermatogenic cell is taking part in the production of sperm cell, the process is known as spermatogenesis.
- There many sustentacular cells lie between the spermatogenic cell which produce the tight junction known as blood testes barrier.
- These barriers prevent the activation of immune system against the sperm because spermatogenic cell (sperm) consist surface antigen that are recognize as foreign particle by the immune system.
- The sustentacular cells also secrete the fluid for the sperm transport as well as it secrete the hormone inhibin which regulate the sperm production by inhibiting the secretion of FSH.

3. Sperm:

- The mammalian sperm cell consists of a head, a midpiece and a tail. The head contains the nucleus with densely coiled chromatin fibres, surrounded anteriorly by an acrosome, which contains enzymes (hyaluronidase and proteinases) used for penetrating the female egg.
- The midpiece has a central filamentous core with many mitochondria spiralled around it, used for ATP production for the journey through the female cervix, uterus and uterine tubes.
- The tail or "flagellum" executes the lashing movements that propel the spermatocyte.
- Human sperm cells can survive within the female reproductive tract for more than 5 days post coitus. Semen is produced in the seminal vesicles, prostate gland and urethral glands.
- Sperm mature at the rate of about 300 million per day.

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4. Ducts:

A. Ducts of testis:

- After the production of sperm from the seminiferous tubules, release into the lumen and goes into straight tubules.
- Newly forming fluid produced by the sustentacular (Sertoli) cells produces pressure that moves the sperm ahead.
- These fluids contain potassium ions (K^+), glutamic acid and antigen-binding protein (ABP).
- From the straight tubules, fluid moves with sperm into the rete testis, which leads toward the epididymis.
- Epididymis is a comma-shaped organ about 4 cm long.
- Next to the epididymis is the ductus epididymis (Sperm get mature here in 10 – 14 days) is a straight coiled structure 6 m in length that continues with the tail of the epididymis.
- Within the tail of the epididymis, the ductus epididymis becomes less convoluted and its diameter increases. After this point, the duct is referred to as the ductus deferens, vas deferens or seminal duct.
- The ductus deferens (vas deferens) or seminal duct is 48 cm long; it stores sperm. The dilated terminal portion of this vas deferens is known as the ampulla.

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B. Ejaculatory ducts:

- Posterior to the urinary bladder are the ejaculatory ducts.
- Each ejaculatory duct is about 2 cm long and is formed by the union of the seminal vesicle and the ampulla.
- The ejaculatory duct ejects the sperm in to the urethra just before ejaculation.

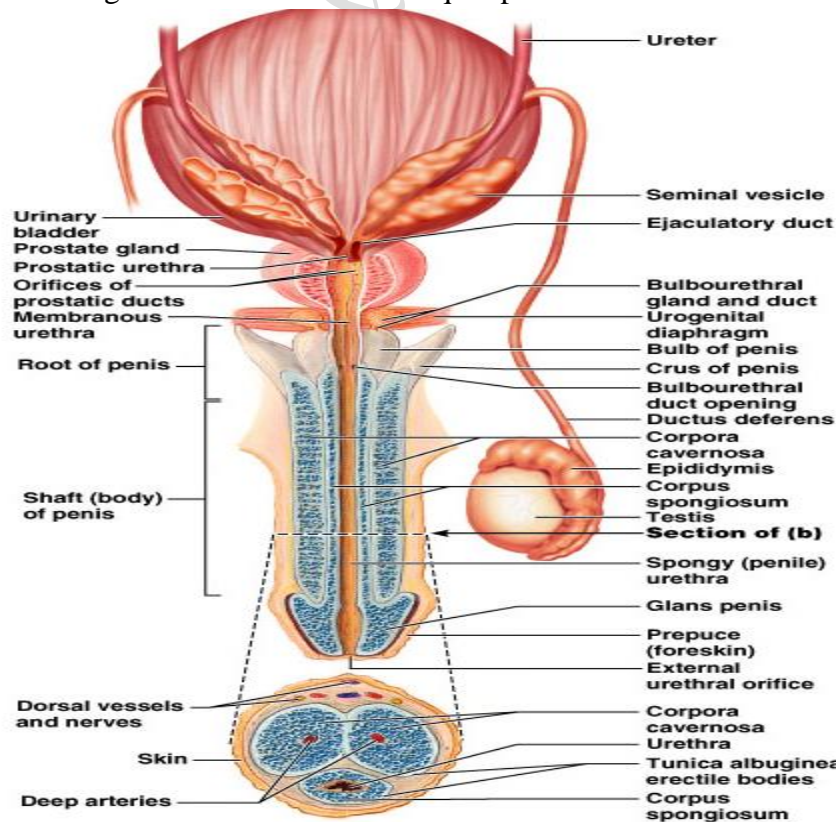
C. Urethra:

- In the male, Urethra is the shared terminal duct of the reproductive and urinary systems.
- It serves as a passageway for both semen and urine.
- The urethra passes through the prostate gland, the urogenital diaphragm and the penis.
- Its measure about 20 cm in length, divided in to three parts:
 - **The prostate urethra:** 2 – 3 cm long, passage from prostate gland.
 - **The membranous urethra:** 1 cm in length
 - **Spongy urethra:** 15-20 cm long.
- Spongy urethral end consist external urethral orifice.

5. Accessory sex gland:

The ducts of male reproductive system store and transport sperm cells while the accessory sex gland secret most of the liquid portion of

semen.



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A. The paired seminal vesicles:

- It is a convoluted pouch like structure, about 5 cm in length and lying posterior to the urinary bladder and anterior to the rectum.
- It secretes:
 - An alkaline,
 - Viscous fluid that contains fructose, prostaglandins and clotting protein (seminogelin) (differ than the blood clotting protein).
- The alkaline nature of the fluid neutralizes the acid in the female reproductive tract.
- The fructose is used for ATP production by sperm.
- Prostaglandin is useful for the sperm motility and viability also stimulate the muscular contraction in the female reproductive system.
- Seminogelin is the protein that causes the coagulation of semen after ejaculation.
- Seminal vesicle adds 60 % of fluid of the total volume of semen.

B. The prostate gland:

- It is a doughnut shaped gland.
- It is inferior to the urinary bladder and surrounds the prostate urethra.
- The prostate secretes milky and slightly acidic fluid which contains:
 - Citrate: Useful for the ATP production by the sperm.
 - Acid phosphate: Functions are not known
 - Proteolytic enzymes like Prostate specific antigen (PSA) – liquefy the coagulated semen, pepsinogen, lysozyme, amylase and hyaluronidase.
- The secretion of the prostate gland enters the prostatic urethra through many prostatic ducts.
- The secretion of the prostate gland adds 25 % of fluid out of total volume of semen.

C: The bulbourethral or Cowper's gland:

- It is about the size of pea and It lie inferior to the prostate gland.
- During sexual arousal, bulbourethral gland secretes alkaline substance that protect sperm by neutralizing acid in the urethra.
- It also secretes mucus that lubricates the end of penis and the lining of urethra.

6. Semen:

- Semen is the mixture of sperm and seminal fluid.
- The average volume of semen in each ejaculation is 2.5 – 5 mL.
- There are 50 – 150 million sperm present per milliliter (mL).
- When the sperm fall below the 20 million/mL, the male is likely to be infertile.
- The pH of semen is in the range of 7.2 – 7.7.

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7. Penis:

- The penis contains the urethra, a passage for ejaculation of semen and for excretion of urine.
- It is cylindrical in shape and consist body, root and gland penis.
- the consensus is that the average erect human penis is approximately 12.9–15 cm (5.1–5.9 in) in length with 95% of adult males falling within the interval 10.7–19.1 cm (4.2–7.5 in). Neither age nor size of the flaccid penis accurately predicts erectile length.
- The longest officially documented human penis was found by Doctor Robert Latou Dickinson. It was 34.3 cm (13.5 in) long and 15.9 cm (6.26 in) around.

A. Body of penis:

- It is composed by the three cylindrical masses of tissue:
 - Tunica albuginea
 - Corpora cavernosa penis (Paired dorsolateral masses)
- Tunica albuginea consist corpus spongy penis at the middle part and spongy urethra.
- All the three masses are covered by the facia and skin with the erectile tissue permeated by blood sinuses.
- During the sexual stimulation, which may be:
 - Visual,
 - Tactile,
 - Auditory,
 - Olfactory,
 - Or Imagination large quantities of blood enter in to the penis due to the dilation of arteries (effect of nitric oxide).
- These vascular effects produce erection in penis.
- Ejaculation is the sympathetic reflex. As a part of reflex the smooth muscle spincter at the base of urinary bladder close.
- Thus urine is not expelled during ejaculation.

B. Root of penis:

- It is the attached part, consisting of the bulb of penis in the middle and the crus of penis, one on either side of the bulb. It lies within the superficial perineal pouch.

C. Gland penis:

- The distal end of the corpus spongiosum penis is slightly enlarged, acorn shaped region known as gland penis.
- The margin of gland penis is known as corona.
- Gland penis consist the external urethral orifice.

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THE FEMALE REPRODUCTIVE SYSTEM:

The female reproductive system include

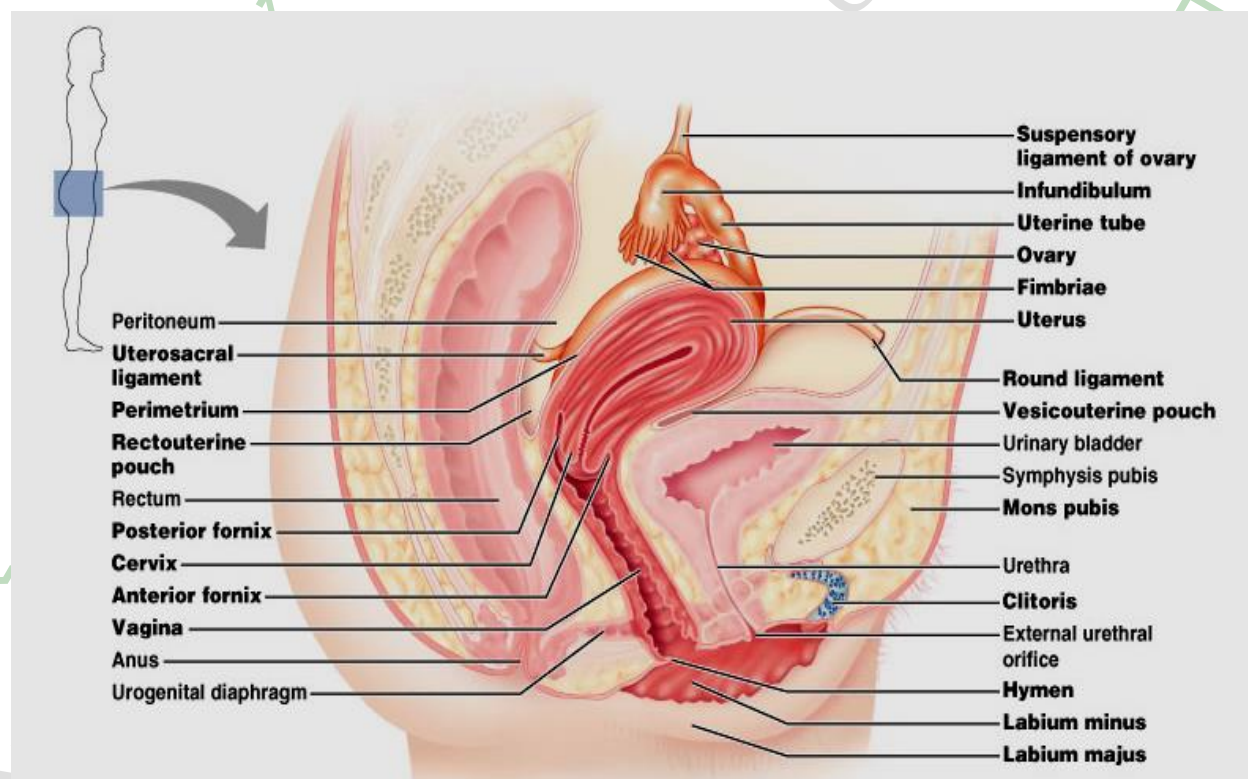
A. Internal genitalia:

- 2 ovaries
- 2 oviducts (uterine or Fallopian tubes)
- Uterus
- vagina

B. External genitalia

- clitoris
- labia minora
- labia majora

C. Breasts and mammary glands

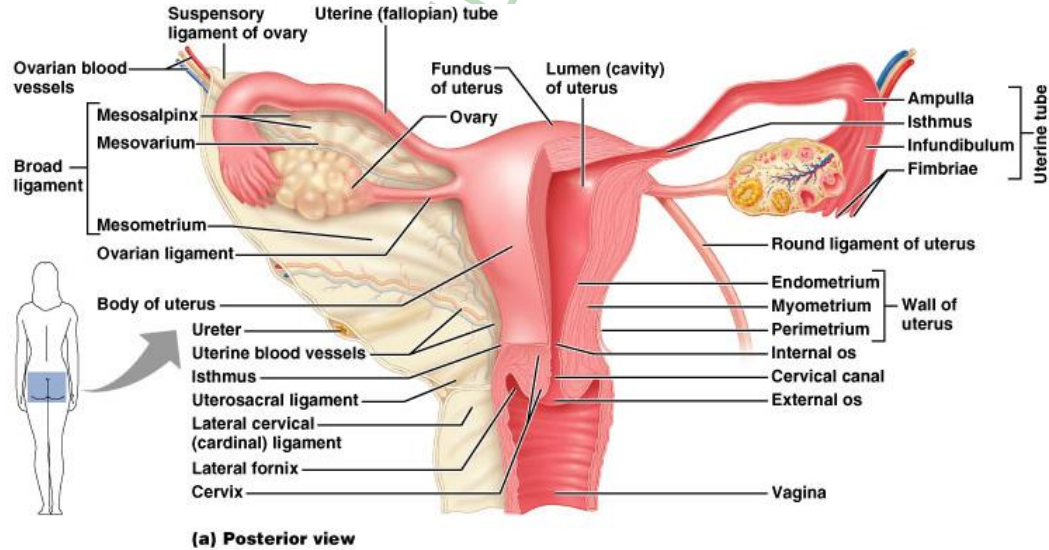


1. Ovaries:

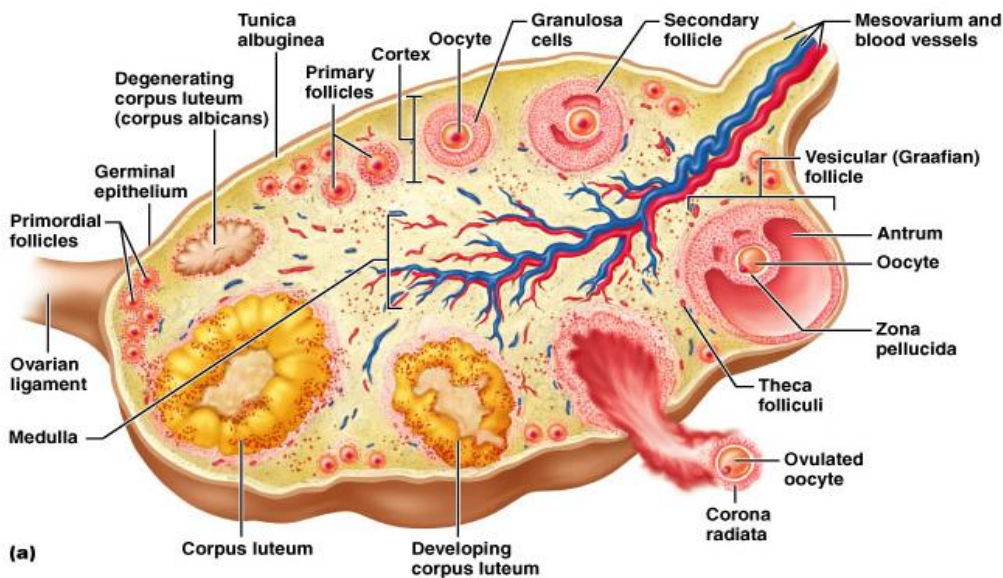
- The paired ovaries are paired glands that resemble unshelled almonds in shape and size.
- Because of the same origins ovaries are homologues to testis.

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- The broad ligament of uterus, which is the part of partial peritoneum, attached to ovaries by double layer fold of peritoneum known as mesovarium.
- The ovarian ligament anchors the ovaries to uterus and the suspensory ligament attach them to the pelvic wall.



A. Structure of ovary:



i) Germinal epithelium:

- It covers the surface of the ovary and it continues with the mesothelium that cover the mesovarium.

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ii) Tunica albuginea:

- It is a whitish capsule of dense irregular connective tissue extended deep to germinal epithelium.

iii) Stoma:

- Deep to the tunica albuginea known as stroma.
- It divided in to the two portions, superficial portion known as cortex and deep portion known as medulla.

iv) Ovarian follicle:

- It is lie in to the cortex region of stoma.
- Here the oocytes pass from the various steps of their development with their surrounding cells.
- The surrounding cells produce single layer known as follicular cells.
- Later in developing stage of oocyte, it produces several layers known as granulose.
- These surrounding cells secrete estrogen and other fluid so follicle grow larger.

v) Mature (Graafian) follicle:

- It is a large fluid filled follicle after the rupture of this follicle secondary oocyte get expelled out.

vi) Corpus luteum:

- It is the remnant of an ovulated mature follicle.

B. The Ovarian Cycle

i) Follicular phase

- 1st approx 14 days but variable
- Egg develops in a follicle
- Stimulated by **FSH**
- Estrogen produced

ii) Ovulation

- Egg released from follicle (**LH** surge)
- Egg in abdominal cavity
- Picked up by fimbria of fallopian tube
- Not necessarily halfway point

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iii) Luteal phase

- Postovulatory phase 14 days (more constant)
- Corpus luteum develops from exploded follicle
- Produces progesterone as well as estrogen
- Progesterone stimulates uterus to be ready for baby
- If no pregnancy, corpus luteum degenerates into corpus albicans

2. Uterine (Fallopian) Tubes:

- Female have two fallopian tubes. It stretches from the uterus to the ovaries and measure about 8 to 13 cm in length. It transport the secondary oocytes to the uterus.
- The open, funnel shaped portion of each tube is known as infundibulum, close to the ovary.
- At the end portion of infundibulum has finger like projection known as fimbria, which hold the ovary.
- Widest and longest portion of the uterine tube is known as ampulla and short, narrow, thick walled portion known as isthmus that join the uterus.

3. Uterus:

- The uterus is located inside the pelvis immediately dorsal (and usually somewhat rostral) to the urinary bladder and ventral to the rectum.
- The human uterus is pear-shaped and about 3 in. (7.6 cm) long, 4.5 cm broad (side to side) and 3.0 cm thick (anteroposterior).
- A nonpregnant adult uterus weighs about 60 grams.
- Layers of the uterus:

Perimetrium: it is the outer layer of the uterus.

Myometrium: It is the middle layer of the uterus.

Endometrium: The lining of the uterine cavity is called the "endometrium".

- Parts of uterus:

Fundus: The dome shaped portion superior to the uterine tube known as fundus.

Body: The major tapering central portion is known as body.

Cervix: The inferior narrow portion opens in to the vagina known as cervix

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4. Vagina:

- Vagina is the passage for the menstrual flow and child birth.
- It also receives semen from the penis during the sexual intercourse.
- It is 10 cm in length, situated between the urinary bladder and the rectum.
- The vaginal mucosa secrete the acidic fluid as well as the mucosal cells of vagina have the antigen presenting cells (APCs) from where the HIV (AIDS) virus gets transmitted.
- The next layer is muscularis is composed of an outer circular layer and inner longitudinal layer of smooth muscle that can stretch considerably to receive the penis during sexual intercourse and allow for birth of a fetus.
- The adventitia is the superficial layer of the vagina.
- At the end of vagina there is vaginal orifice covered by the mucosal membrane known as hymen.
- Sometimes the hymen completely covers the orifice, a condition known as imperforated hymen, which may require surgery to open the orifice and permit the discharge of the menstrual flow.

5. Vulva:

It is known as the external genital organ of the female reproductive system.

i) Mons pubis:

Anterior to the vaginal and urethral opening portion is known as mons pubis. It is an elevation of adipose tissue covered by the skin and hair.

ii) Labia majora:

From the mons pubis, two longitudinal folds of skin known as labia majora. It is homologous to the scrotum and are covered by the pubic hair.

iii) Labia minora:

Inside to the labia majora is two smaller folds of skin called the labia minora. But it does not consist of hair and fat. They have few sudoriferous (sweat) glands and sebaceous (oil) gland.

iv) Clitoris:

It is the small, cylindrical mass of erectile tissue and nerve. It is located at the anterior junction of the labia minora. It is homologous to the penis and capable of enlargement upon tactile stimulation and it plays an important role in sexual excitement of the female.

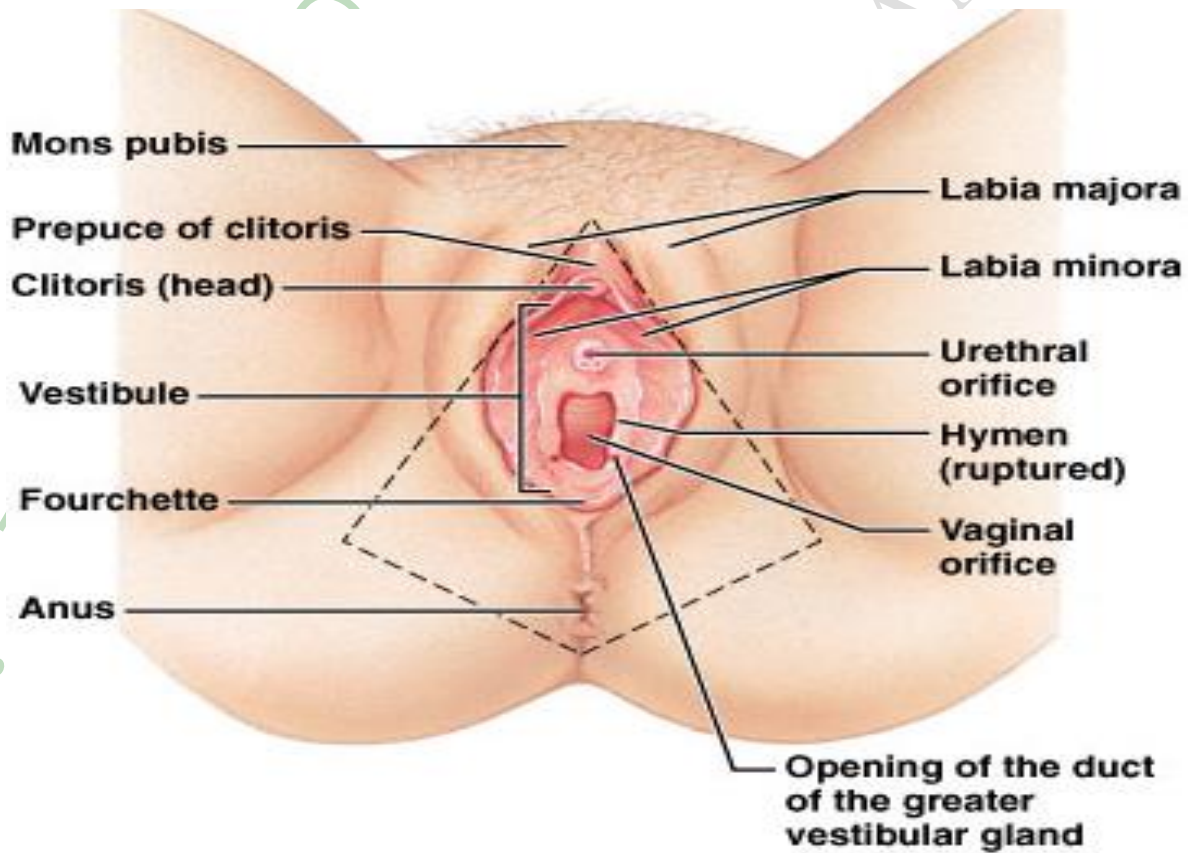
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v) Vestibules:

The region between labia minora is known as the vestibules. Hymen, Vaginal orifice, external vaginal orifice are located between the vestibules. The bulb of the vestibules consists of two elongated masses of erectile tissue, during the sexual intercourse it narrowing the vaginal orifice and placing pressure on the penis. Anterior to the vaginal orifice and posterior to the clitoris is the external urethral orifice.

vi) Perineum:

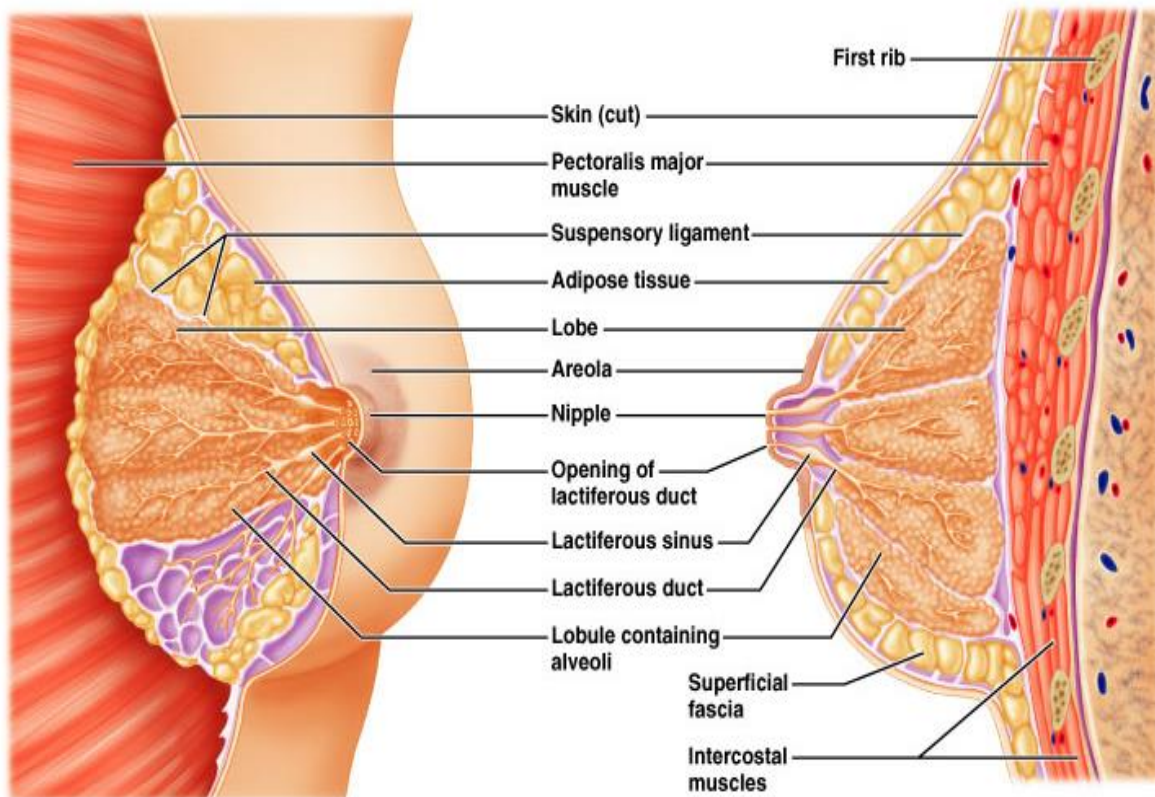
It is the diamond shaped area medial to the thigh and buttocks of both males and females. That contains the external genital and anus.



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6. Mammary glands:

- Mammary gland is an organ in female mammals that produces milk to feed baby located in to the breast.
- Each breast has one pigmented projection known as nipple, it have closely spaced opening known as lactiferous ducts from where milk emerges.
- The circular pigmented area of the skin surrounding the nipple known as areola. It appears rough because it contains modified sebaceous (oil) glands.
- Within each breast the mammary glands consists 15 – 20 lobes separated by adipose tissue.
- Each lobe have smaller compartment known as lobules composed of grapelike clusters of milk secreting glands known as alveoli.
- Surrounding the alveoli are spindle shaped cells known as myoepithelial cells, whose contraction helps to propel milk towards the nipple.
- Milk path: alveoli – secondary tubules – mammary ducts – lactiferous sinus – lactiferous duct.
- Milk secretion is stimulated by the hormone prolactin as well as with the contribution of estrogen and progesterone.



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MENSTRUAL CYCLE:

- The duration of the female reproductive cycle is 24 – 35 days.
- Menstrual cycle is divided into three phases:
 - i) Menstrual Phase ii) Preovulatory Phase iii) Postovulatory Phase

i) Menstrual Phase:

This phase is also known as menstruation or menses phase, takes first 5 days of the cycle.

a) Events in the ovaries:

- During the menstruation phase, about 20 so small secondary follicles try to being enlarge.
- In this phase, follicular fluid secret from the granulosa cells and oozing from blood capillaries and oocyte remain near the edge of the follicle.

b) Event in the uterus:

- In this phase, decrease the hormone level of estrogen and progesterone. Because of this reason, produce contraction of uterine spiral arteries.
- So the blood supply of the Endometrium cell gets interrupt and start to die. It start the menstruation flow consists about the volume of 50 – 150 ml of blood, tissue fluid, mucus and epithelial cells derived from the Endometrium.

ii) Preovulatory Phase:

It is the second phase of the female reproductive cycle. It is the phase between the menstruation and ovulation phase.

If we consider 28 days menstrual cycle, it takes 6 to 13 days of period.

a) Events in the ovaries:

- In this phase, the secretion of FSH produces effects on 20 secondary follicle and its grow secret estrogen and inhibin.
- Out of 20 secondary follicles, one follicle in one ovary has outgrown all others so it is known as the dominant follicle.
- Estrogen and inhibin secretion by the dominant follicle cell decrease the secretion of FSH and this effect stop the development of other follicle cells.
- Dominant follicle cell produce the mature follicle about the size of 20 mm in diameter and ready for the ovulation.
- In this phase the secretion of LH also increase the secretion of estrogen and start the secretion of progesterone also.

b) Events in the uterus:

- In this phase, estrogen liberate in to the blood by growing ovarian follicle cell.

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- It stimulates the repair of endometrium damage. It produces the neovascularization, cell proliferation and differentiation so increase the thickness of endometrium, this phase is also known as the proliferative phase.

Ovulation:

- In this phase, the mature follicle cell gets rupture and releases the secondary oocyte in to the pelvic cavity, usually occur in the day 14 of 28 days cycle.
- It generally takes 20 days (last 6 days of the previous cycle and first 14 days of the current cycle).
- During this phase, primary oocyte complete the meiosis – I and enter in to the meiosis – II.

iii) Post ovulation phase:

It takes last 14 days, from days 15 to 28. It represent the time between ovulation and the onset of the next menses. Corpus luteum formed in this phase and it increases the secretion of estrogen and progesterone.

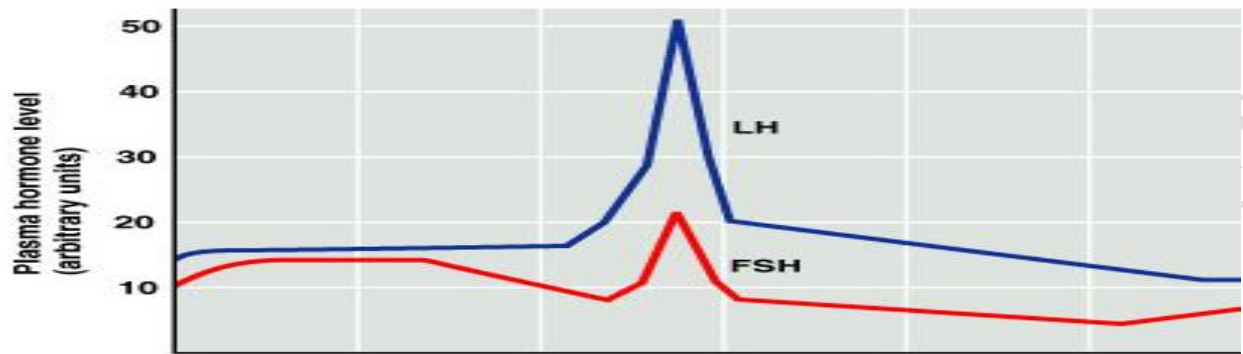
a) Events in the ovary:

- In this phase if the secondary oocyte get fertilize and begins to divide, the corpus luteum persists past its normal 2 week life span and it is maintained by the human chorionic gonadotropin (hCG).
- This hormone is produce by the chorion of the embryo after 8 – 12 days of fertilization.
- The hCG level in to the blood or urine confirm the pregnancy.
- If the hCG will not release (because of no fertilization) than corpus luteum decrease their secretion and produce scar known as corpus albicans.
- Decrease level of estrogen and progesterone again start the menstruation.

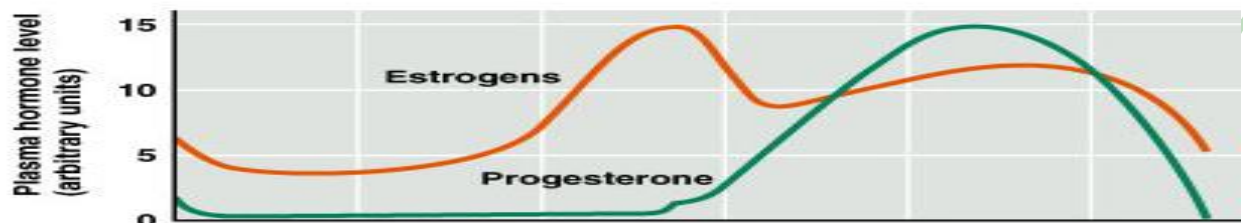
b) Event in the uterus:

- Progesterone and estrogen secretion produce by the corpus luteum promote the growth and coiling of the endometrium gland, which begins to secrete glycogen, vascularization of the superficial endometrium, thickening of the endometrium and increase the amount of tissue fluid.

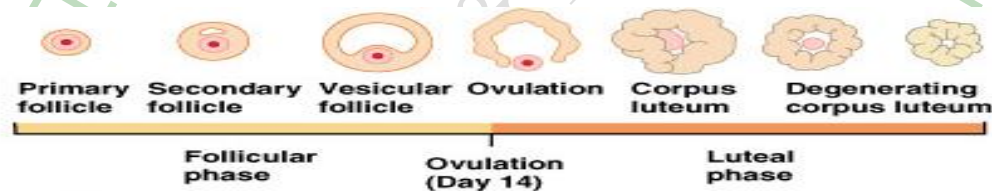
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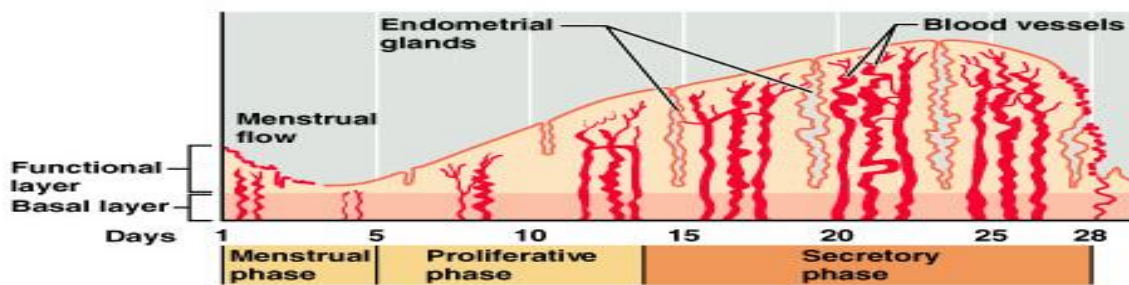
(a) Fluctuation of gonadotropin levels



(b) Fluctuation of ovarian hormone levels



(c) Ovarian cycle



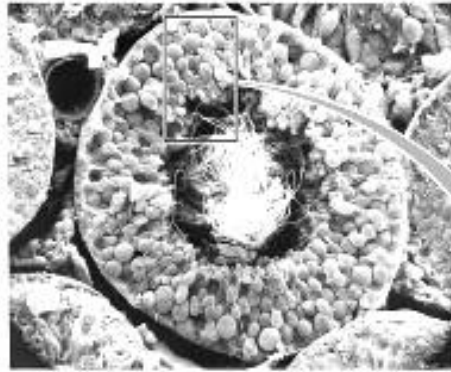
(d) Uterine cycle

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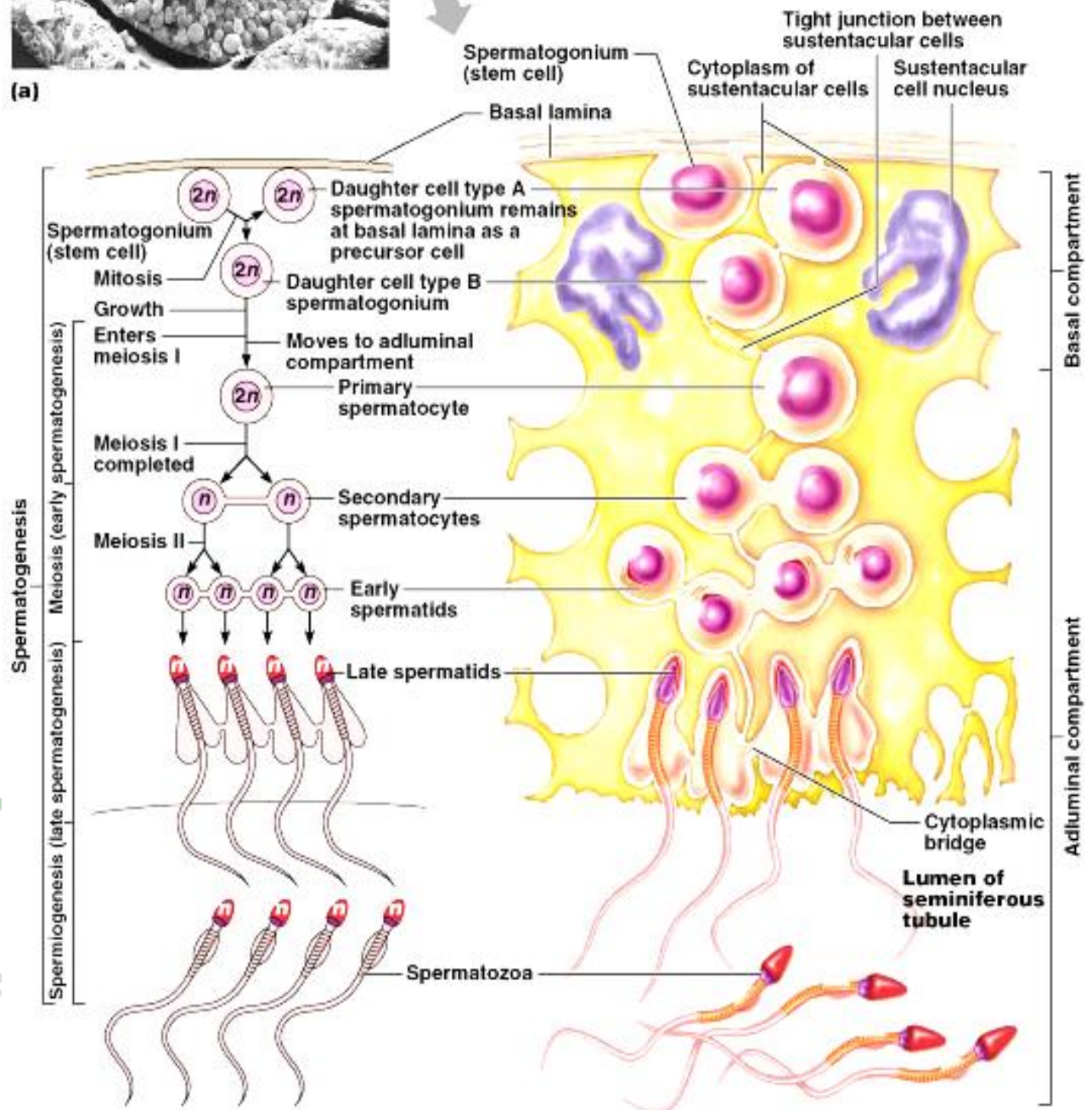
SPERMATOGENESIS:

- 1st stage: formation of spermatocytes
 - Spermatogonia are stem cells
 - Least differentiated (earliest in the process)
 - Lie in basal lamina
 - Divide continuously by mitosis (result $2n$ or diploid): daughter cells A (remains a stem cell) or B (goes on)
 - When start to undergo meiosis are by definition called *spermatocytes*
- 2nd stage: meiosis I
 - Each primary spermatocytes ($2n$) undergoes meiosis I to become 2 secondary spermatocytes:
 - Each secondary spermatocyte undergoes meiosis II to become 2 spermatids
 - Therefore 4 total spermatids from each spermatogonium
- 3rd stage: spermiogenesis
 - Spermatids differentiate into sperm

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(a)

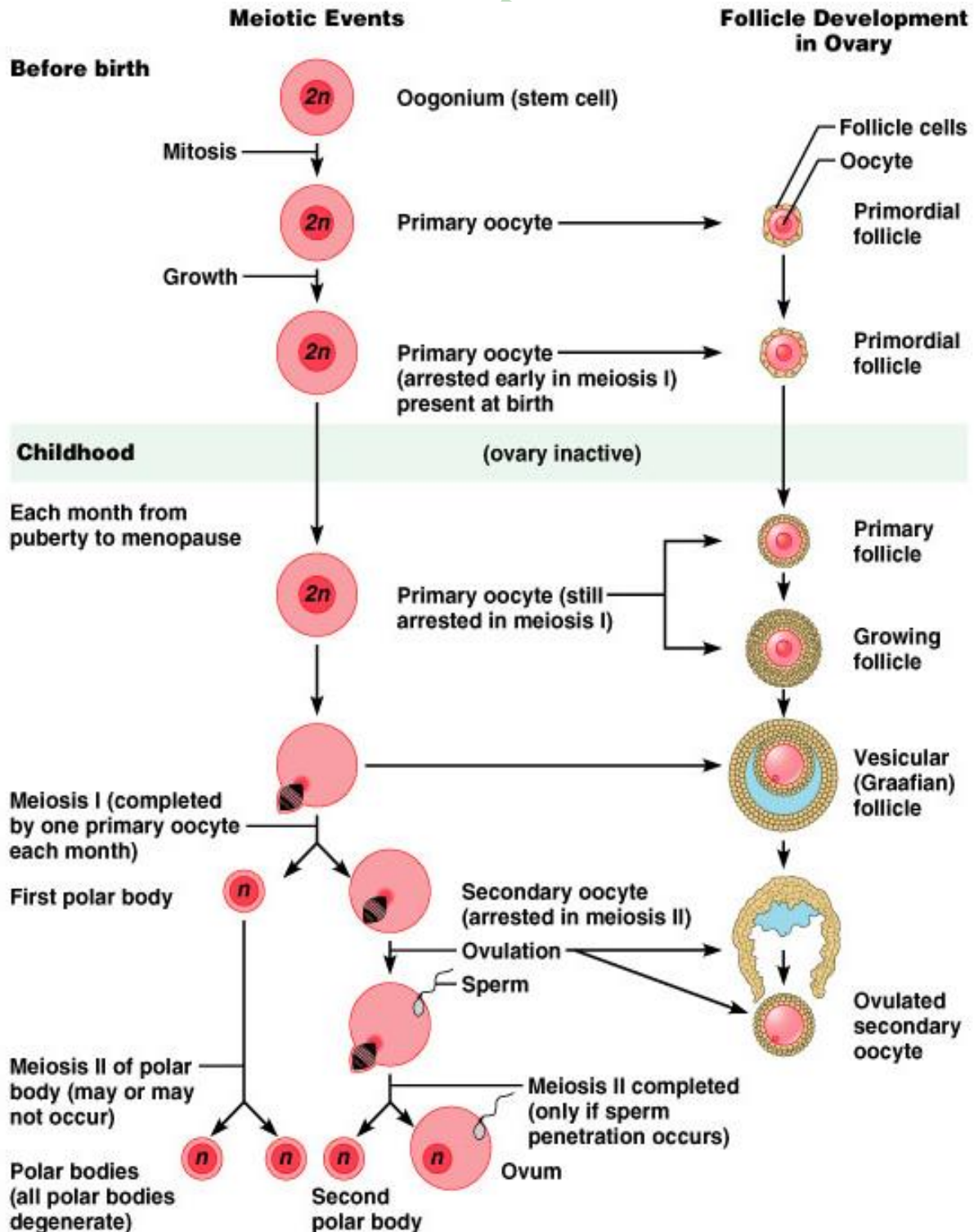


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OÖGENESIS:

- Starts in fetal period
 - No more *oocytes* made after about 7th month
 - Developed only to early stage of meiosis I by birth and stops (called *primary oocyte*)
- 6-12 primordial oocytes each cycle selected to develop for ovulation (most die)
 - Only then is meiosis I completed
 - *Secondary oocyte* is then arrested in meiosis II
- Meiosis II not completed (now an *ovum*) unless sperm penetrates its plasma membrane
- Of the 4 daughter cells, only one becomes ovum (needs a lot of cytoplasm)
 - The other 3 become “*polar bodies*”

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“Prayer without study would be empty. Study without prayer would be blind.”