Reproductive system

Male reproductive system

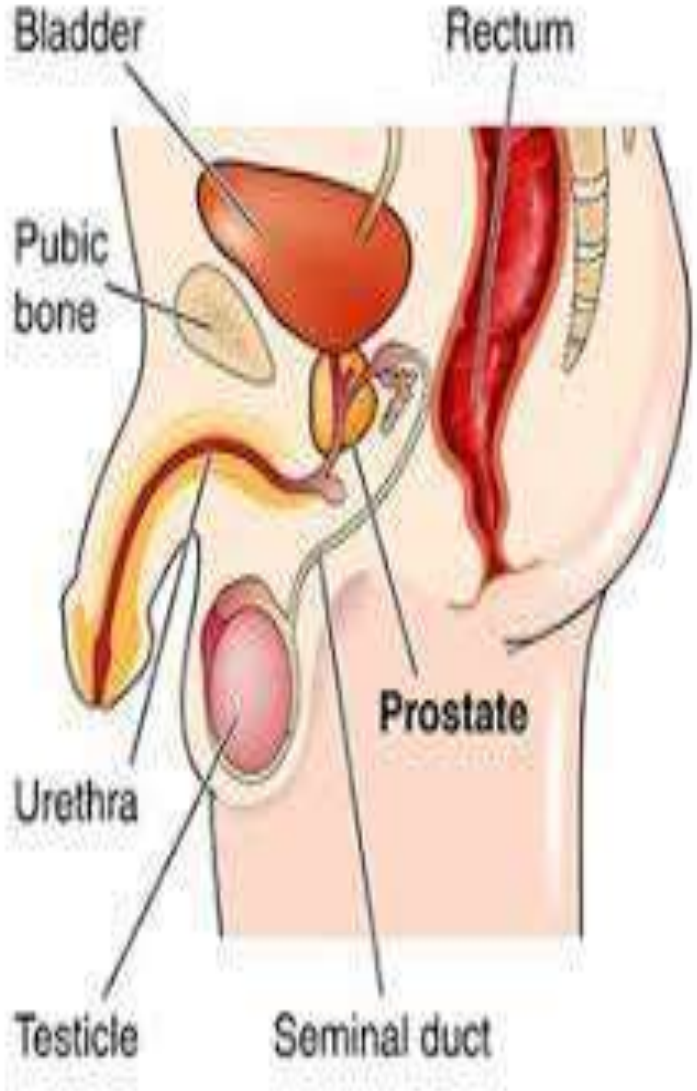
Testes are the primary sex organ or gonads in males

Accessory organs are seminal vesicles ,prostate gland ,urethra ,penis

External genitalia are scrotum ,penis and urethra ,remaining sex organ are internal genitalia

Functional anatomy of testes

Testes are primary sex organ or gonads in males ,there are two testes ,both the testes are ovoid or walnut shaped bodies suspended in sac like structure called **scrotum**


Bladder
Rectum
Pubic bone
Prostate
Urethra
Testicle
Seminal duct

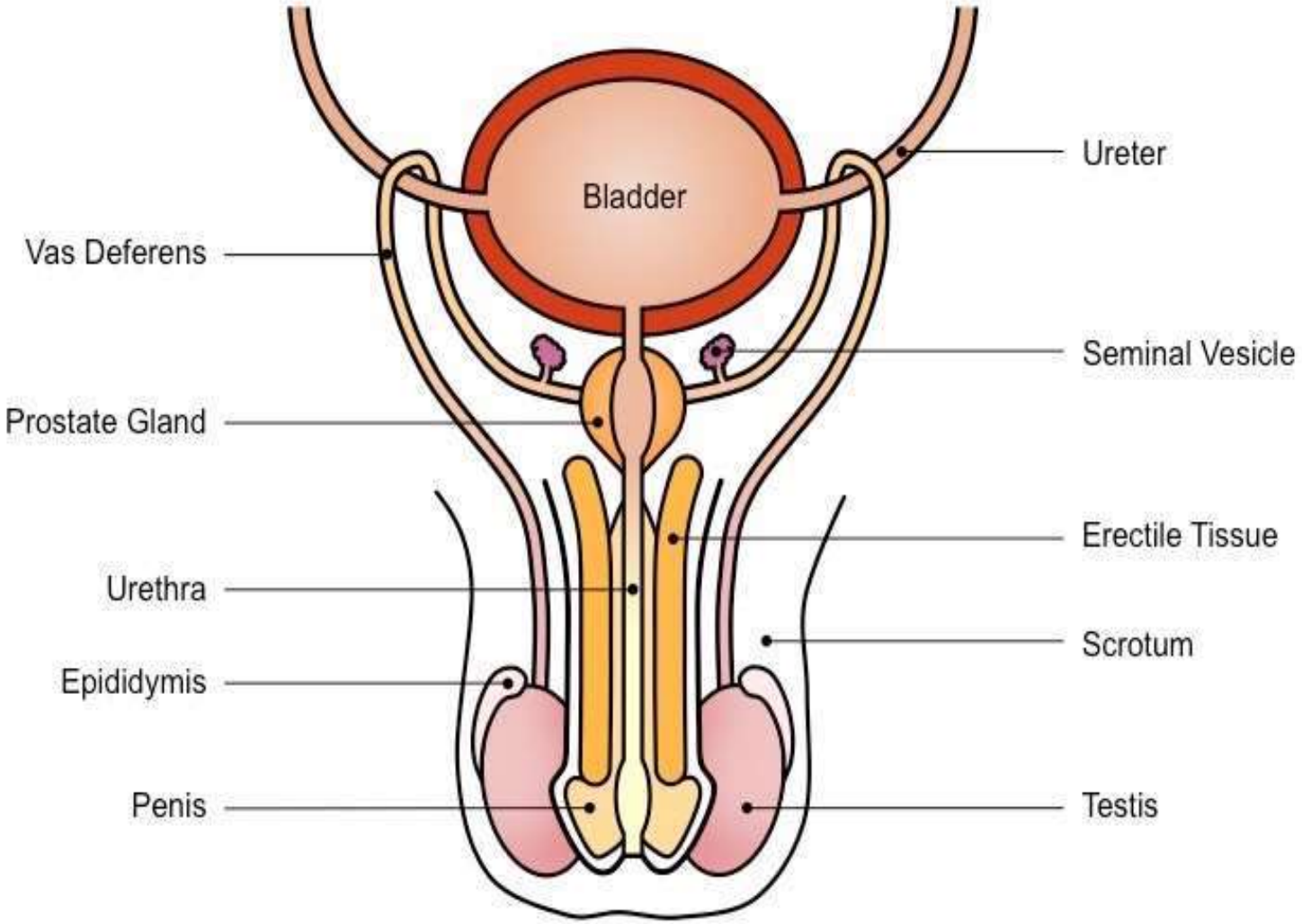
Each testis weigh about 15 to 19 g and measure about 5×3 cm

Testis is made up of about 900 coiled tubules known as seminiferous tubule, which produce sperm

Seminiferous tubule continue as vas efference which form the epididymis it is continued as vas deferens

Vas deference extends on its one side upwards into abdominal cavity via inguinal canal .

Terminal portion of it is called as ampulla


Bladder
Ureter
Vas Deferens
Seminal Vesicle
Prostate Gland
Erectile Tissue
Urethra
Scrotum
Epididymis
Penis
Testis

Ampulla of vas deference joins ducts of seminal vesicles of same side to form **ejaculatory duct**

There are **two ejaculatory duct each of which receive sperms from vas deferens and secretion of seminal vesicle** on its side Both ejaculatory ducts empty into single urethra in prostatic part

Testis is enclosed by three covering

1) Tunica vasculosa

2) Tunica albuginea

3) Tunica vaginalis

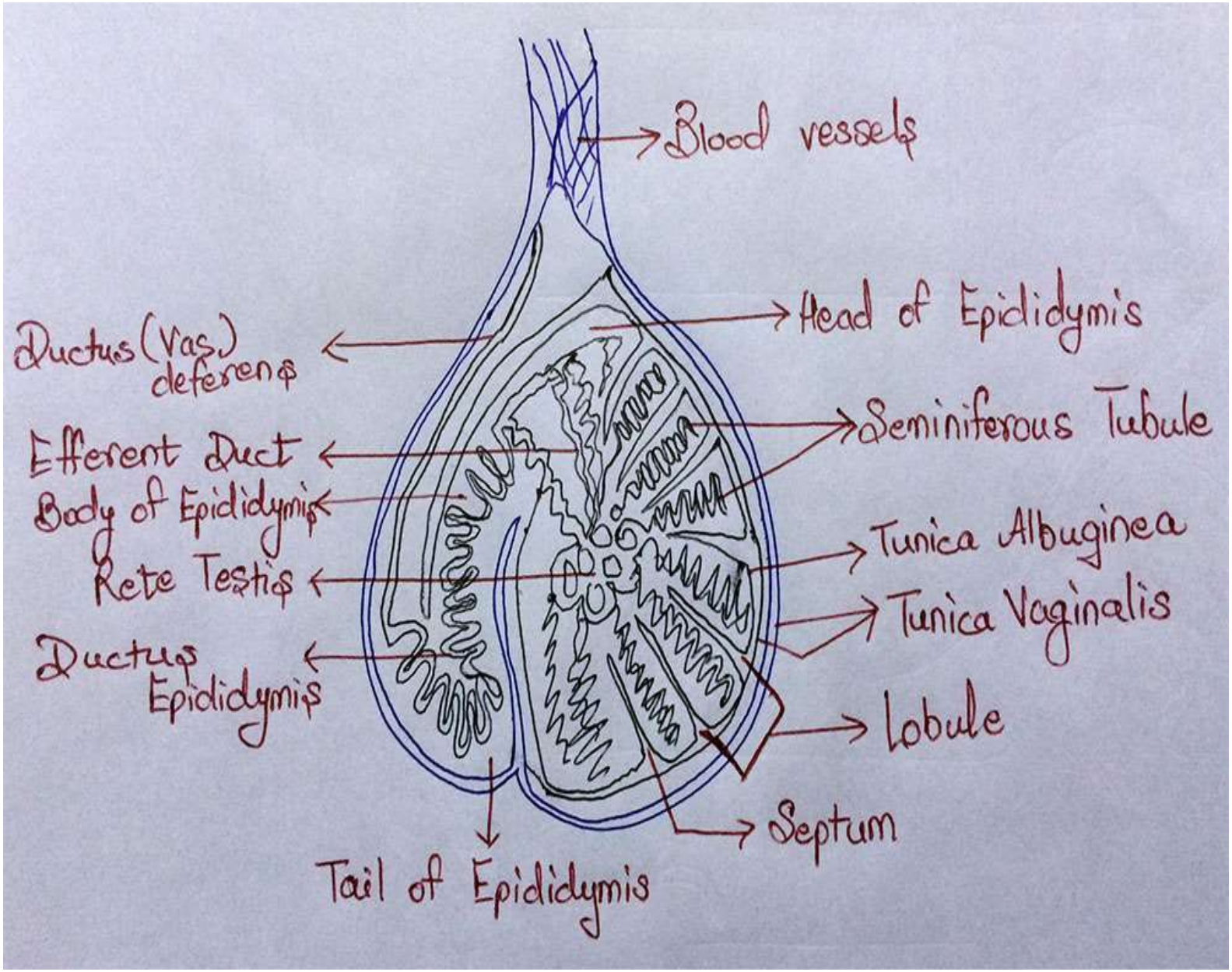
Tunica albuginea on the posterior surface of testis is thickened to form the mediastinum testis ,from this the connective tissue septa called septula testis radiate and bind with tunica albuginea at various points because of this testis is divided into number of pyrimidal lobules

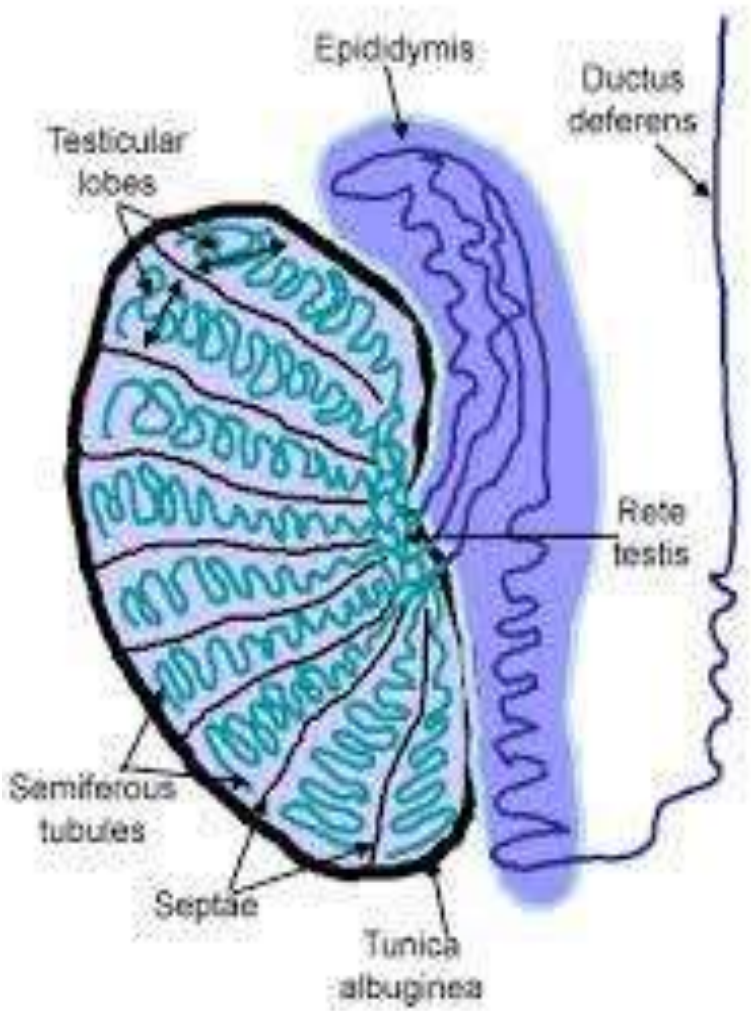
Testis is enclosed by three covering

1) Tunica vasculosa

2) Tunica albuginea

3) Tunica vaginalis


Blood vessels
Head of Epididymis
Ductus (Vas) deferens
Seminiferous Tubule
Efferent Duct
Body of Epididymis
Tunica Albuginea
Rete Testis
Tunica Vaginalis
Ductus Epididymis
Lobule
Septum
Tail of Epididymis


Epididymis
Ductus deferens
Testicular lobes
Rete testis
Seminiferous tubules
Septae
Tunica albuginea

Each lobule contains 1 to 4 coiled tubules known as the seminiferous tubules ,which us surrounded by interlobular connective tissue .

All seminiferous tubule opens **into rate testis**

Rate testis is network of thin walled channels present in mediastinum

From rete testis 8 to 15 tubules called vas efferens arise ….it join together and form the head of epididymis

Interstial cell of leydig are the hormones secreting cells of testis ,lying in between the seminiferous tubule

Seminiferous tubule -----rete testis ----vas efferens ---head epididymis ---duct of epididymis ---vas deferens ----ampulla –ejaculatory duct ---urethra

Seminiferous tubules

Are thread like convoluted tubular structure which produce the spermatozoa or sperms

There are about 400 to 600 seminiferous tubules in each testis **,spermatogenic cells present in seminiferous tubules are precursor cells of spermatozoa**

These cells lie in between **sertoli cell**

In children ,the testis is not fully develop .therefore the spermatogenic cells are in primitive stage called **speramatogonia.**

with onset of puberty spermatogonia develop into sperm through different stages

Stages of spermatogenic cells

1)Spermatogonium

2)Primary spermatocyte

3)Secondary spermatocyte

4)Spermatid

Sertoli cell are the supporting cells for spermatogenic cells in seminiferous tubules ,these cells also called sustentacular cells or nurse cells

Sertoli cells are the large and irregular columnar cells ,extending from basement membrane to lumen of seminiferous ,

Germ cell present in seminiferous tubules are attached to sertoli cell by means of cytoplasmic connection ,this attachment between germ cell and sertoli cell exists till the matured spermatozoa are released into lumen of seminiferous tubule

this attachment between germ cell and sertoli cell exists till the matured spermatozoa are released into lumen of seminiferous tubule

Sertoli cells provide support ,protection ,nourishment for the spermatogenic cells present in seminiferous tubules

Testes perform two functions

1)Spermatogenesis

2)Secretion of hormones

Spermatogenesis

Is the process by which the male gametes called spermatozoa (sperms)are formed from the primitive spermatogenic cells in testis

It takes 74 days for formation of sperm from primitive germ cell

Throughout the process of spermatogenesis ,the spermatogenic cell have cytoplasmic attachment with sertoli cell .

Sertoli cell supply all the necessary materials for spermatogenesis

Stages of spermatogenesis

1)Stage of proliferation

2)Stage of growth

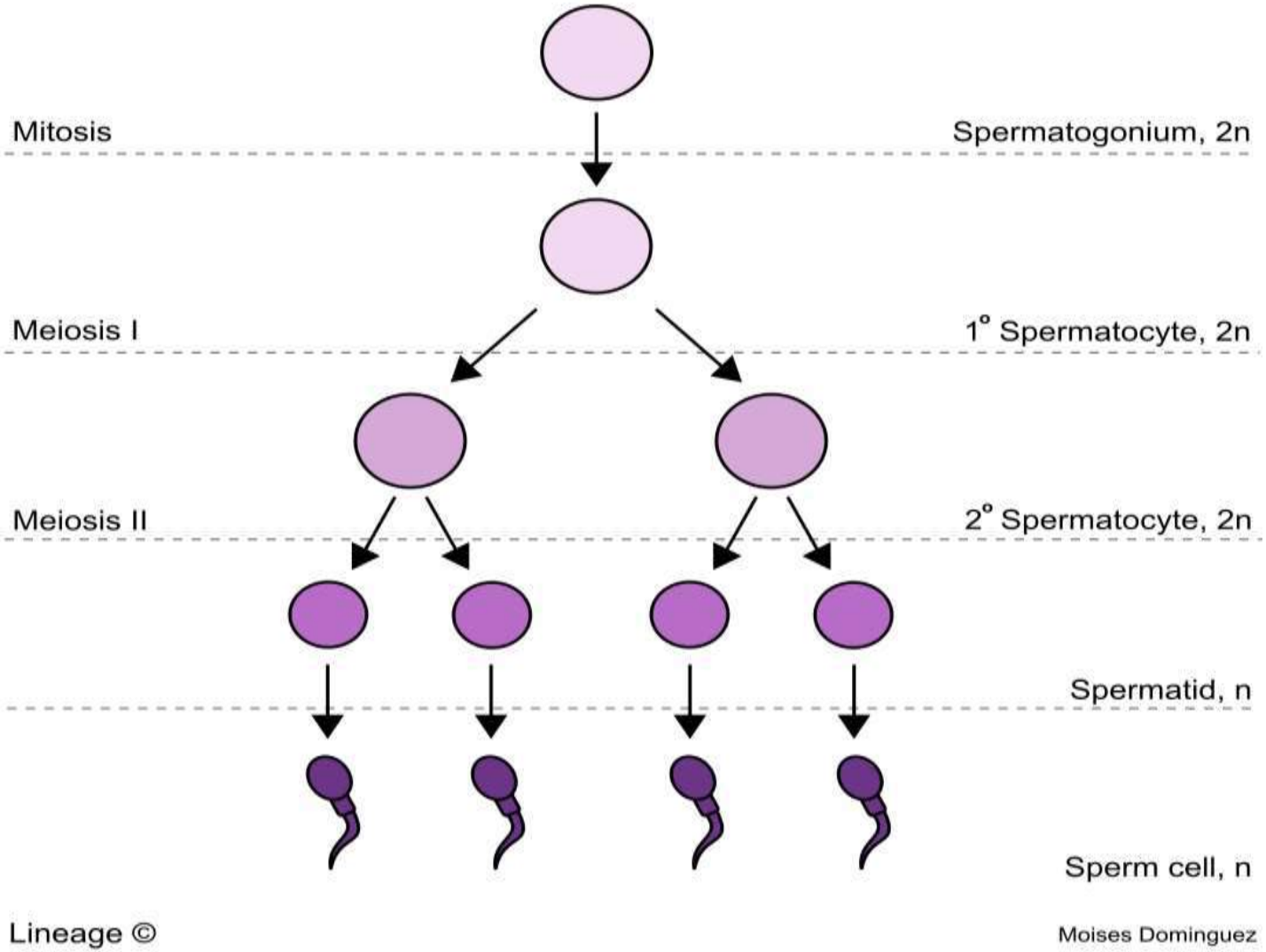
3)Stage of maturation

4)Stage of transformation

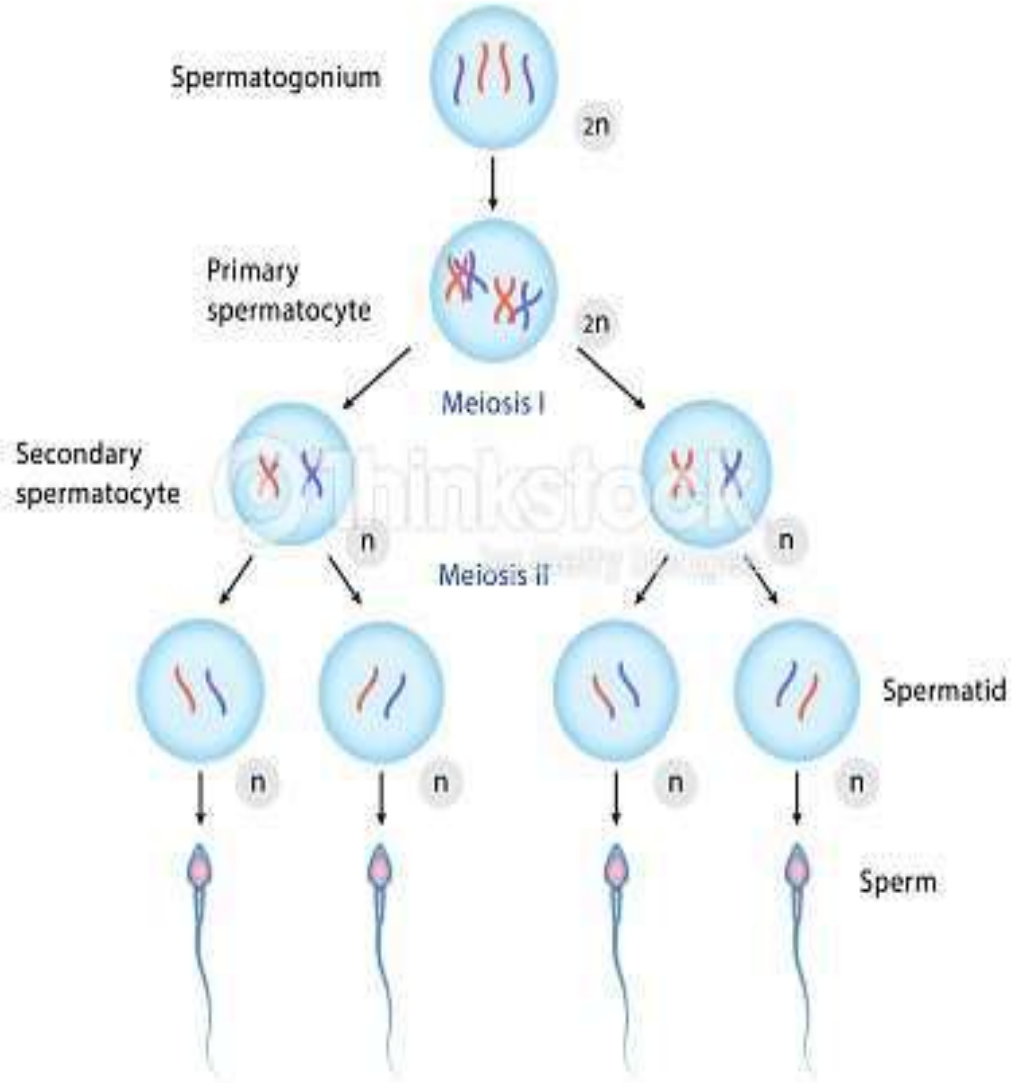
1)Stage of proliferation

Each spermatogonium contains diploid number (23 pairs)of chromosomes ,one member of each pair is from maternal origin and other is from paternal origin

Spermatogenesis



Spermatogenesis



The 23 pairs include 22 pairs of autosomal chromosome and one pair of sex chromosomes ,sex chromosome are one x chromosome and one Y chromosome

During the proliferation stage ,spermatogonia divide by mitosis ,without any change in chromosomal number .

In man there are usually seven generations of spermatogonia ,the last generation enter the stage of growth as primary spermatocyte

Stage of growth

in this stage ,the primary spermatocyte grows into a large cell .

- All chromosomes that are not sex chromosomes are called autosome

stores many thousands genes, each of which performs a unique function in the organism's cells.

Under normal circumstances, each chromosome follows a "map" that is shared across individuals in the species.

Stage of maturation

After reaching the full size ,each primary spermatocyte quickly undergoes meiotic or maturation division ,which occurs into two phases

First phase

In the first phase ,each primary spermatocyte divides into two secondary spermatocyte ,by meiotic division each secondary spermatocyte receives only the haploid or half the number chromosomes

23 chromosome include 22 autosome and one sex chromosome X OR Y

Second phase

During this phase ,each secondary spermatocyte undergoes second meiotic division ,resulting in two smaller cells called **spermatids**

Each spermatid has haploid number of chromosome

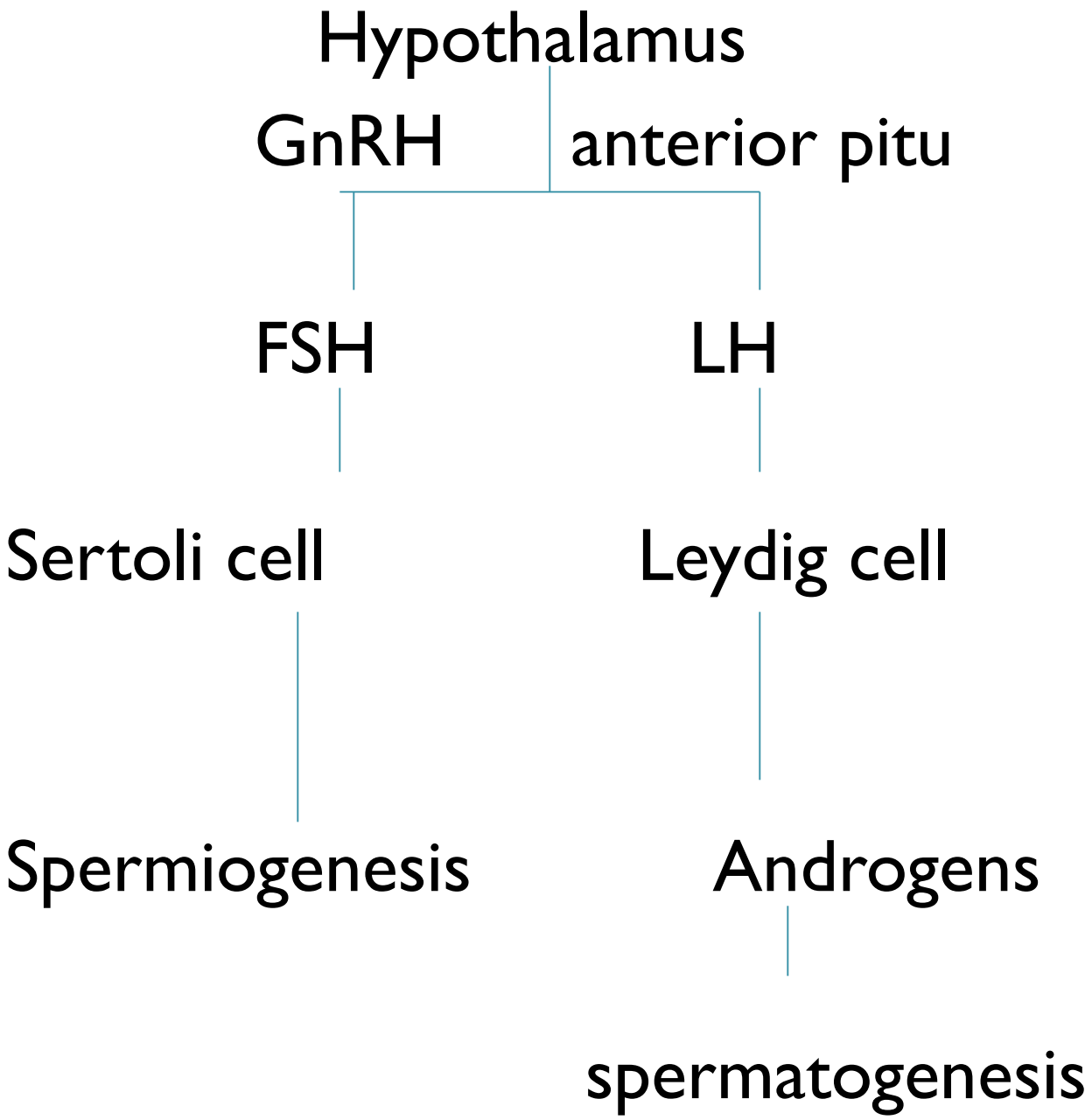
Stage of transformation

There is no further division .spermatids are transformed into matured spermatozoa (sperm)by means of spermatogenesis and released by spermination

Spermeogenesis is the process by which spermatids become matured spermatozoa

And spermination is the process by which the matured sperm are released from sertoli cells into lumen of seminiferous tubule

Stages of spermatogeisis	Hormones necessary
Stage of proliferation	FSH &GH
Stage of growth	TESTESTERONE &GH
Stage of maturation	TESTESTERONE &GH
Stage of transformation	TESTESTERONE &ESTROGEN


Hypothalamus
GnRH
anterior pitu
FSH
LH
Sertoli cell
Leydig cell
Spermiogenesis
Androgens
spermatogenesis

Sertoli cells support and nourishing germ cells .

Releasing sperm into lumen of seminiferous tubule

Inhibin secreted by sertoli cell plays important role in regulation of spermatogenesis

Increased in body temperature prevents spermatogenesis ,temperature in scrotum is about 2 ° c less than normal body temperature ,which is essential for spermatogenesis ,when temperature increase spermatogenesis stops .

(mumps, cryptorchidism causes denegation of s.tubule …stoppage of spermatogenesis .)

2)Secretion of hormones

Testes secret male sex hormones ,which are collectively called the androgens

Androgens secreted by testes are

1)Testosterone

2)Di hydro testosterone

3)Andros tenedione

Testosterone is secreted in large quantity ,dihydro-testosterone is more active

Hormones secreted by interstial cell of leydig ,adrenal cortex

Functions of testosterone

1)In fetal life –

sex differentiation, development of accessory sex organs and external genitalia ,descent of testis

Testis develop in abdominal cavity and later descent in scrotum through inguinal canal just before birth

Cryptorchidism

Is congenital disorder characterized by the failure of one or both testis to descent from abdomen into scrotum

2)In adult

a) Effects on sex organ
b) Effects on secondary sexual characters

a)Effects on sex organ

Testosterone increases size of penis ,scrotum and the testis after puberty

Testosterone is also necessary for spermatogenesis

b)Effects on secondary sexual characters

Secondary sexual characters are the physical and behavioral characteristics that distinguish male from female ,these appear at the time of puberty ,testosterone is responsible for secondary sexual characteristics in male

Secondary sexual characters in males

1) Development of musculature ,muscle mass increases by about 50% ,due to anabolic effects of testosterone on proteins
2) Testosterone increases the thickness of bone matrix and deposition of calcium

Testosterone cause fusion of epiphysis of long bones with shaft

3) Testosterone causes broadening of shoulder ,lengthening of pelvis ,narrowing of pelvic outlet .

4) Increases thickness of skin and roughness of subcutaneous tissue

5) Increases melanin

6) Testosterone enhances the secretory activity of sebaceous glands ,so at the time of puberty when body expose to sudden increase in testosterone secretion ,excess secretion of sebum leads to acne

8) Hair growth over the pubis ,along linea alba up to umbilicus ,decreases hair growth on head so baldness if genetic background

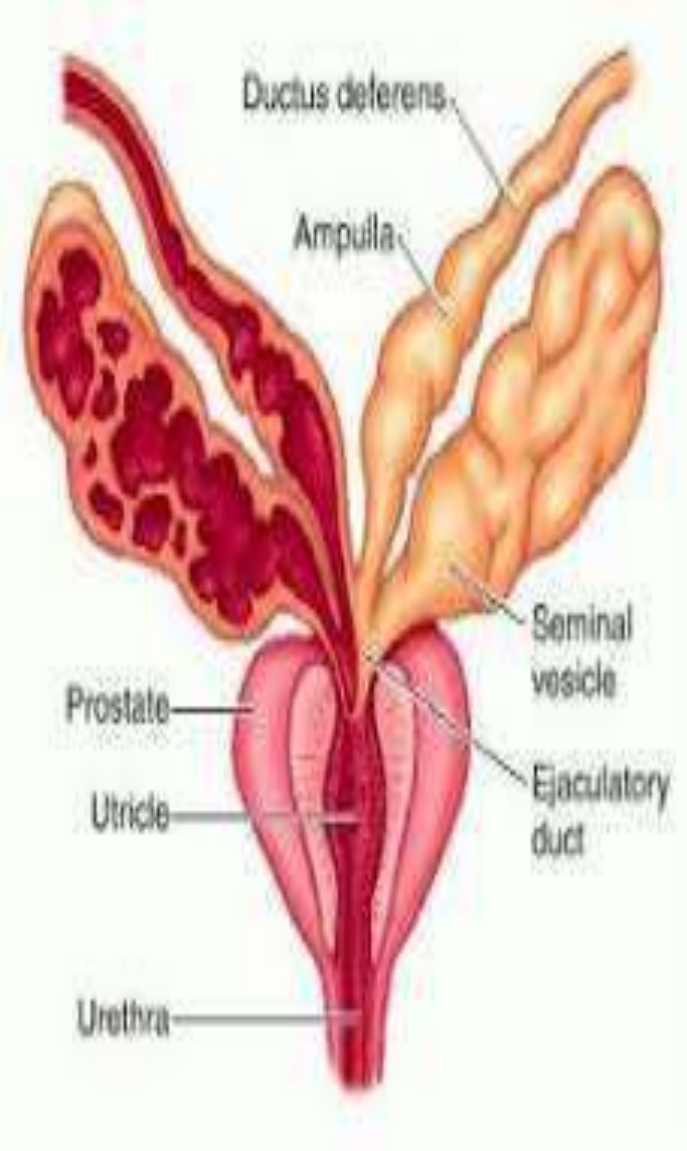
9) Thickening of vocal cord causes change in voice

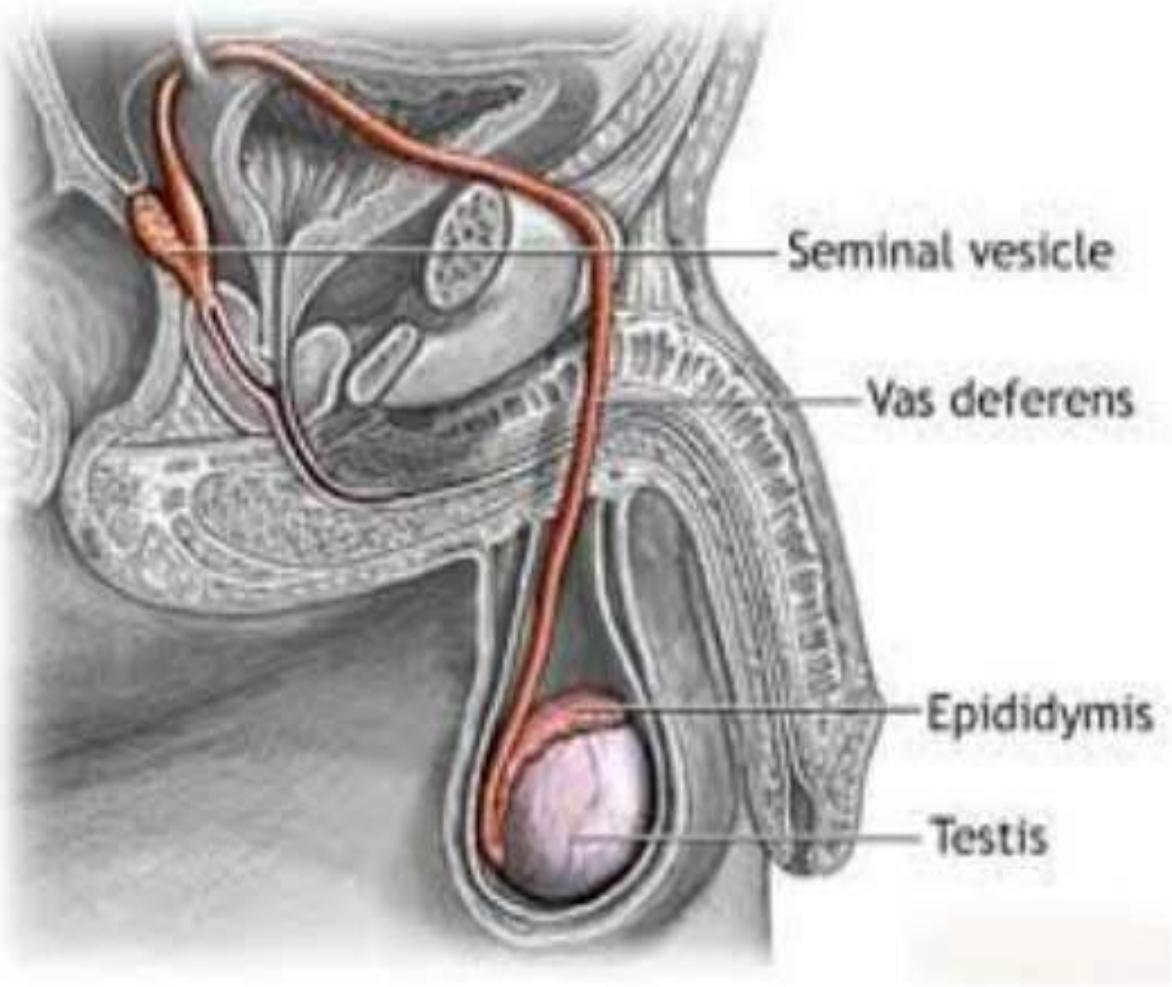
10) Increase BMR

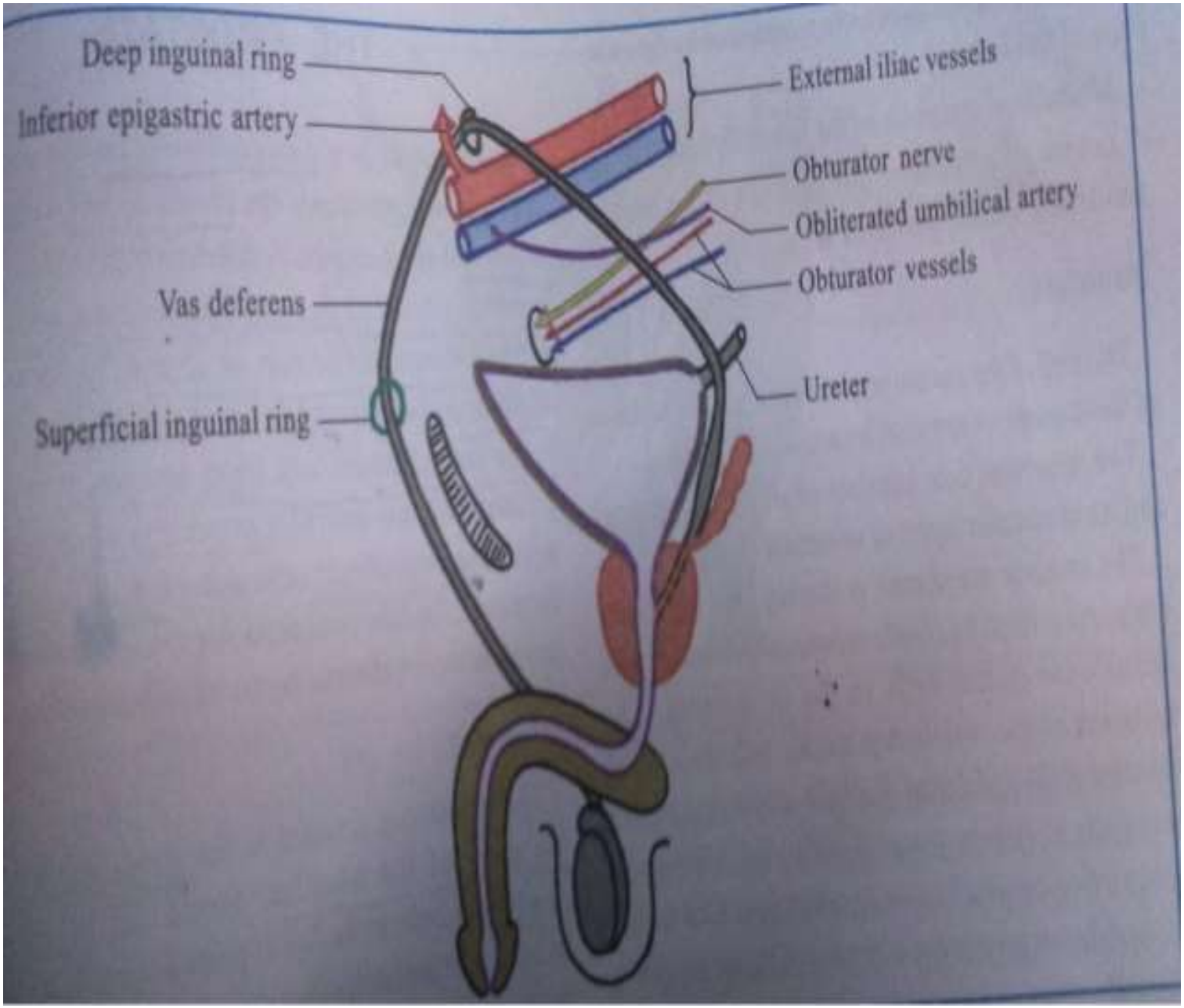
11) Increase sodium reabsorption from renal tubule

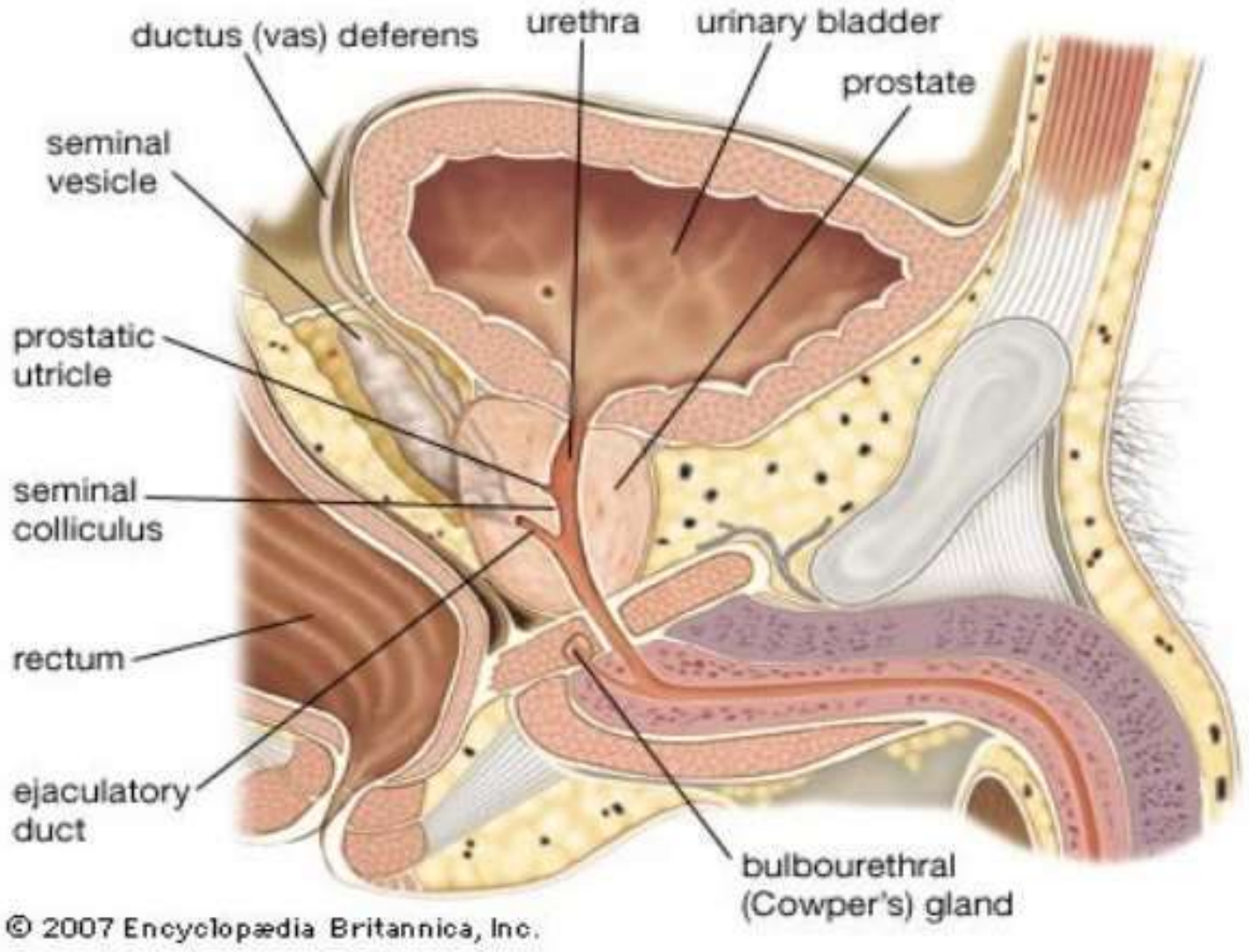
12) Erythropoietic action

Accessory sex organ seminal vesicles and prostate gland ,urethra ,penis


Ductus deferens
Ampulla
Seminal vesicle
Prostate
Ejaculatory duct
Utricle
Urethra


Seminal vesicle
Vas deferens
Epididymis
Testis


Deep inguinal ring
Inferior epigastric artery
Vas deferens
Superficial inguinal ring
External iliac vessels
Obturator nerve
Obliterated umbilical artery
Obturator vessels
Ureter


ductus (vas) deferens
urethra
urinary bladder
prostate
seminal vesicle
prostatic utricle
seminal colliculus
rectum
ejaculatory duct
bulbourethral (Cowper's) gland
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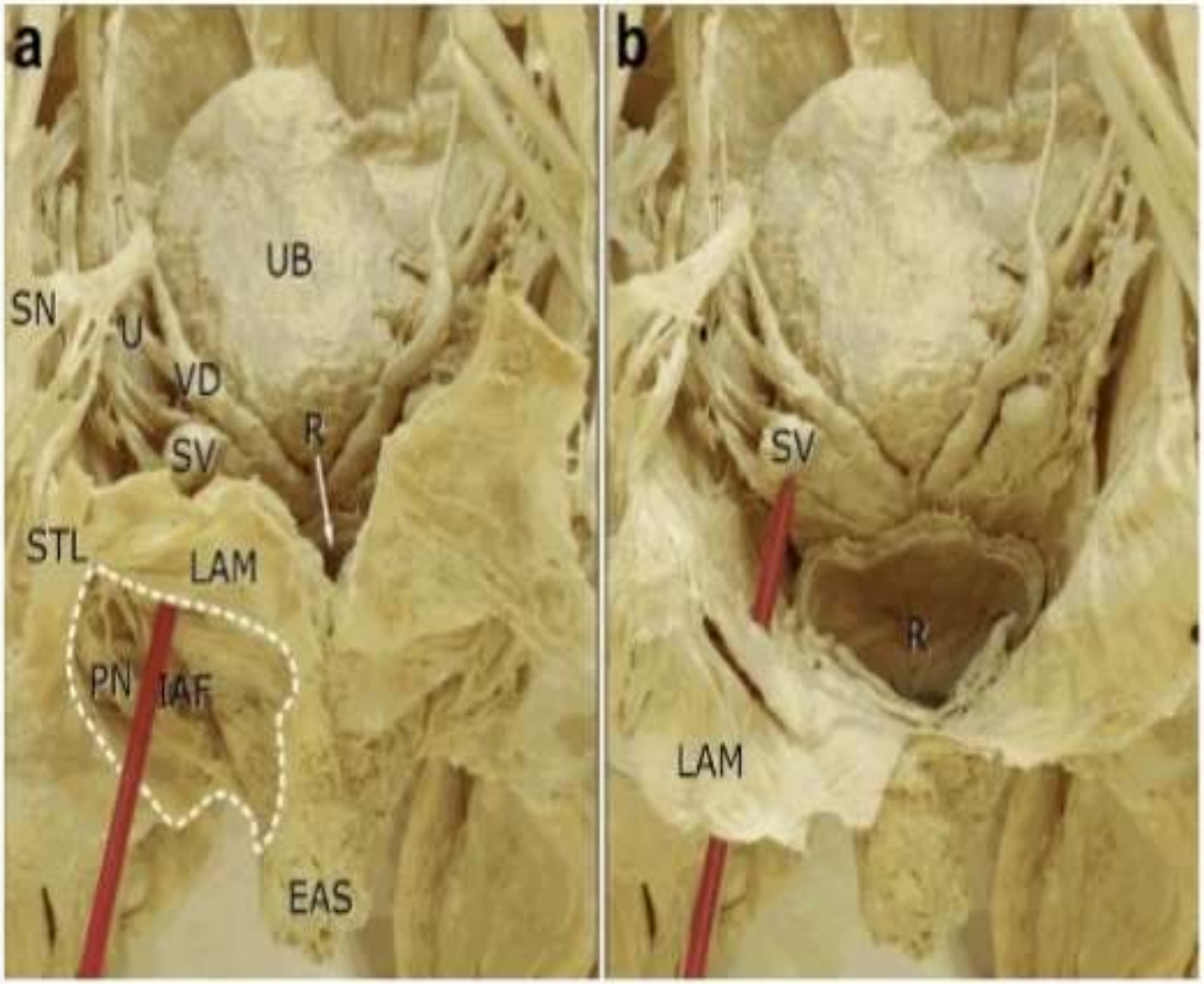
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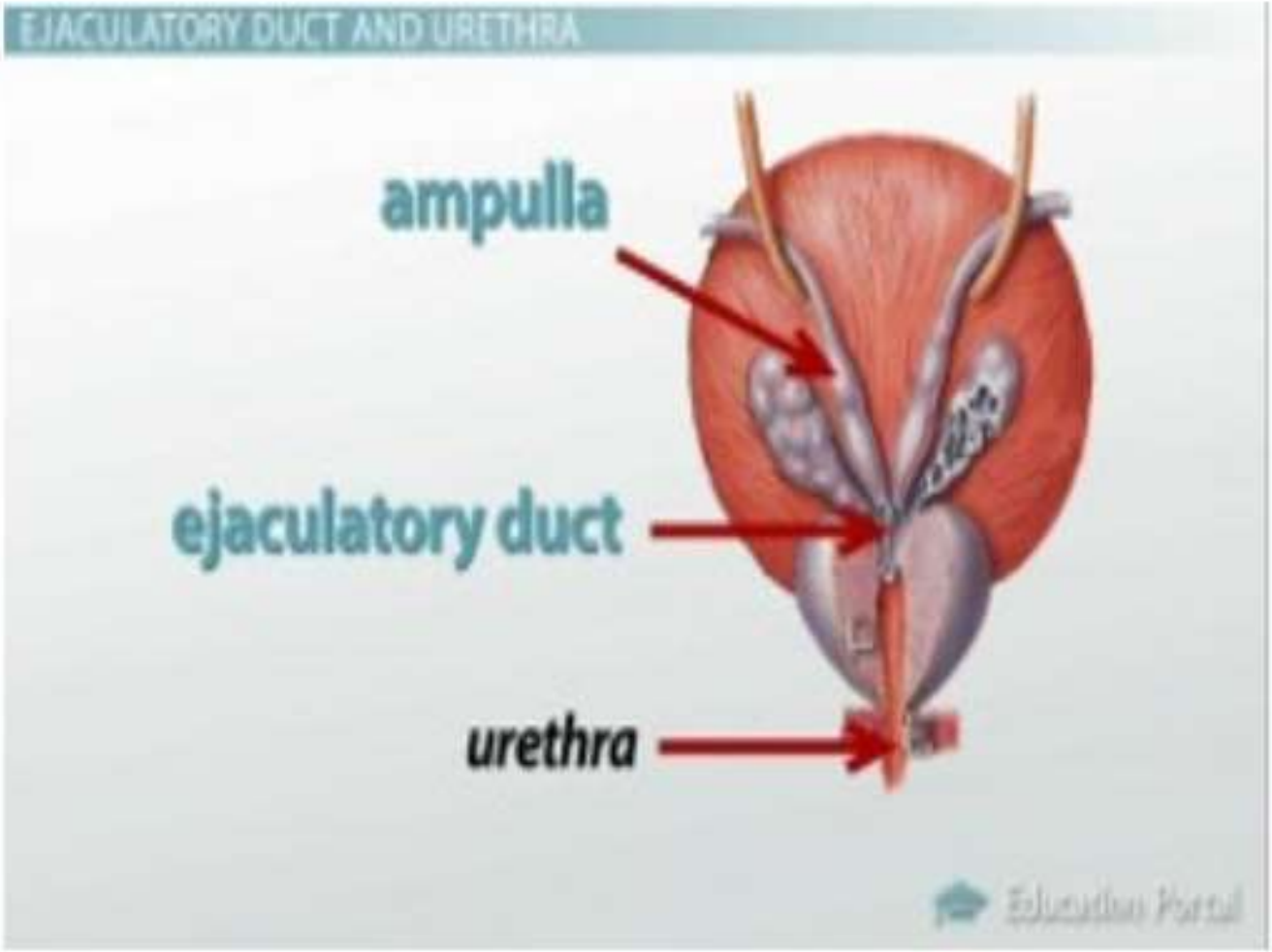

EJACULATORY DUCT AND URETHRA
ampulla
ejaculatory duct
urethra

The **seminal vesicles**

vesicular glands, or seminal glands, are a pair of simple tubular glands posteroinferior to the urinary bladder

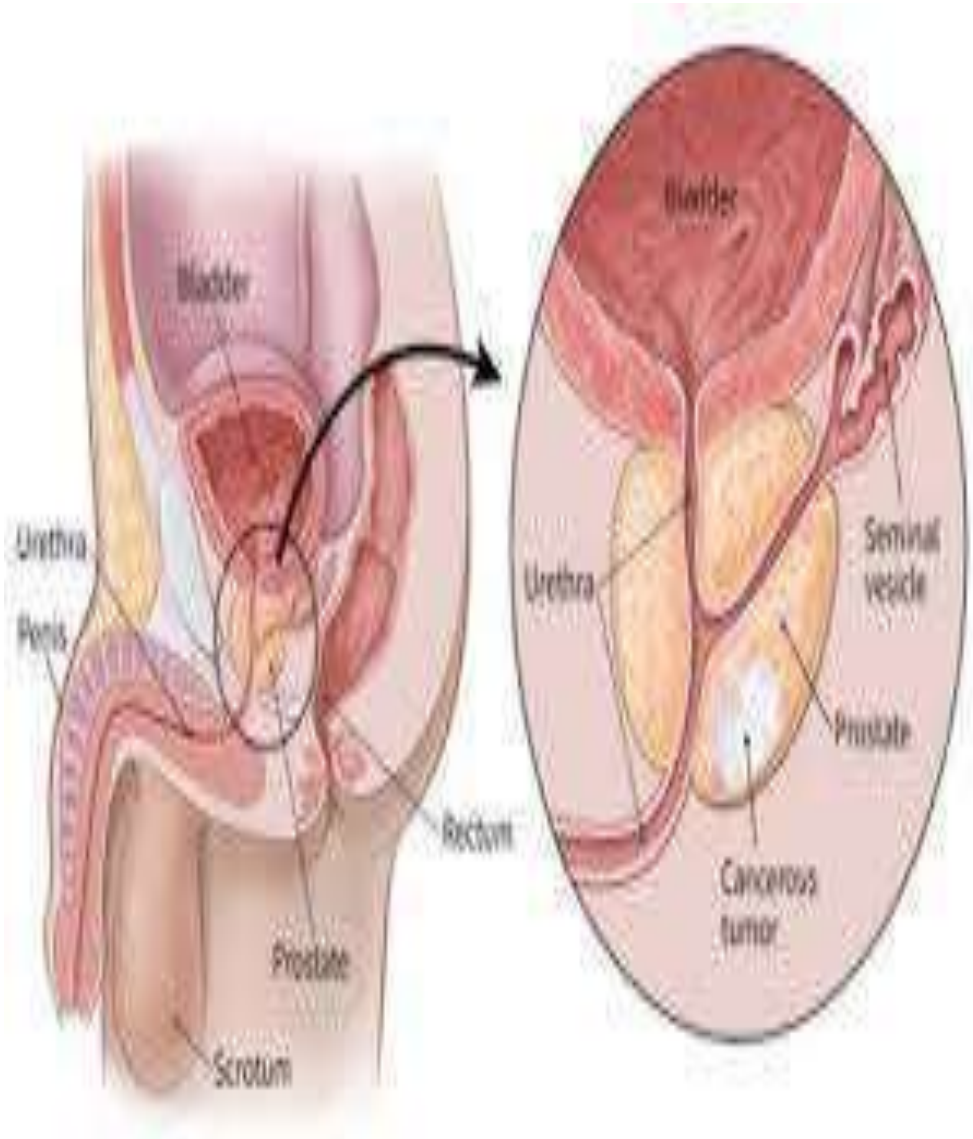
They secrete fluid that partly composes the semen.

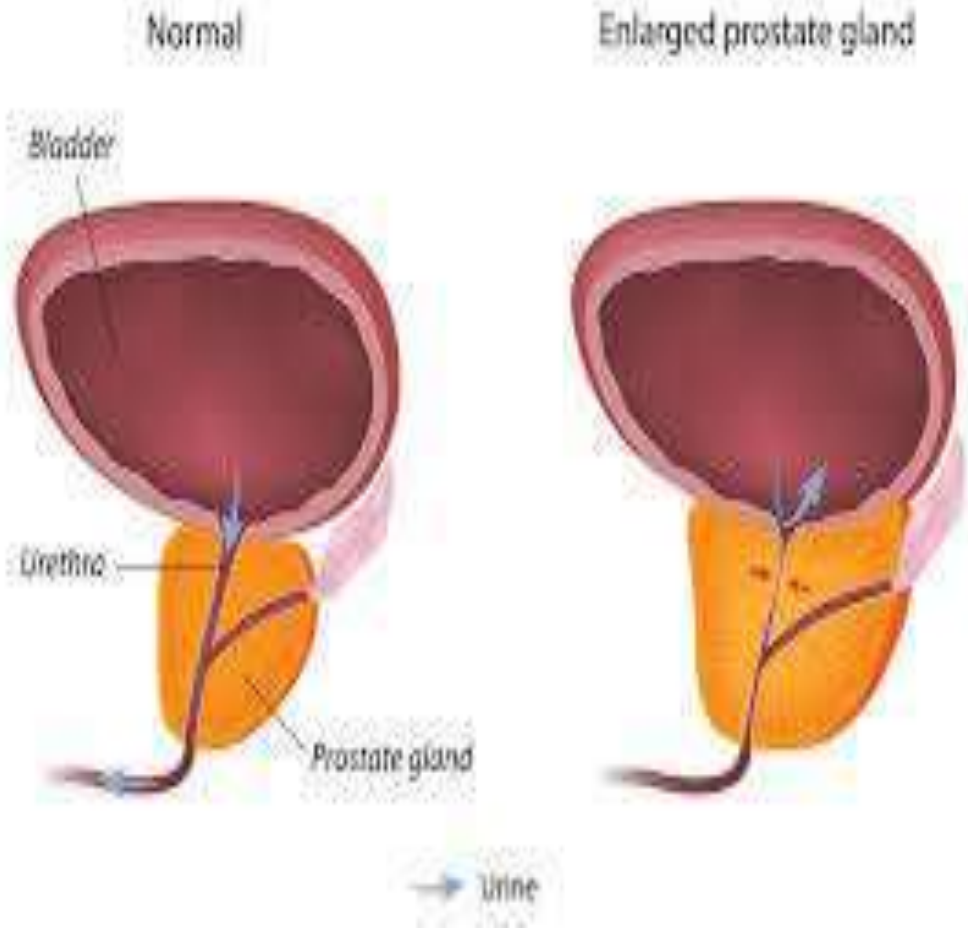
The seminal vesicles are a pair of glands that are positioned below the urinary bladder and lateral to the vas deferens. Each vesicle consists of a single tube folded and coiled on itself.

The excretory duct of each seminal gland unites with the corresponding vas deferens to form the two ejaculatory ducts, which immediately pass through the substance of the prostate gland

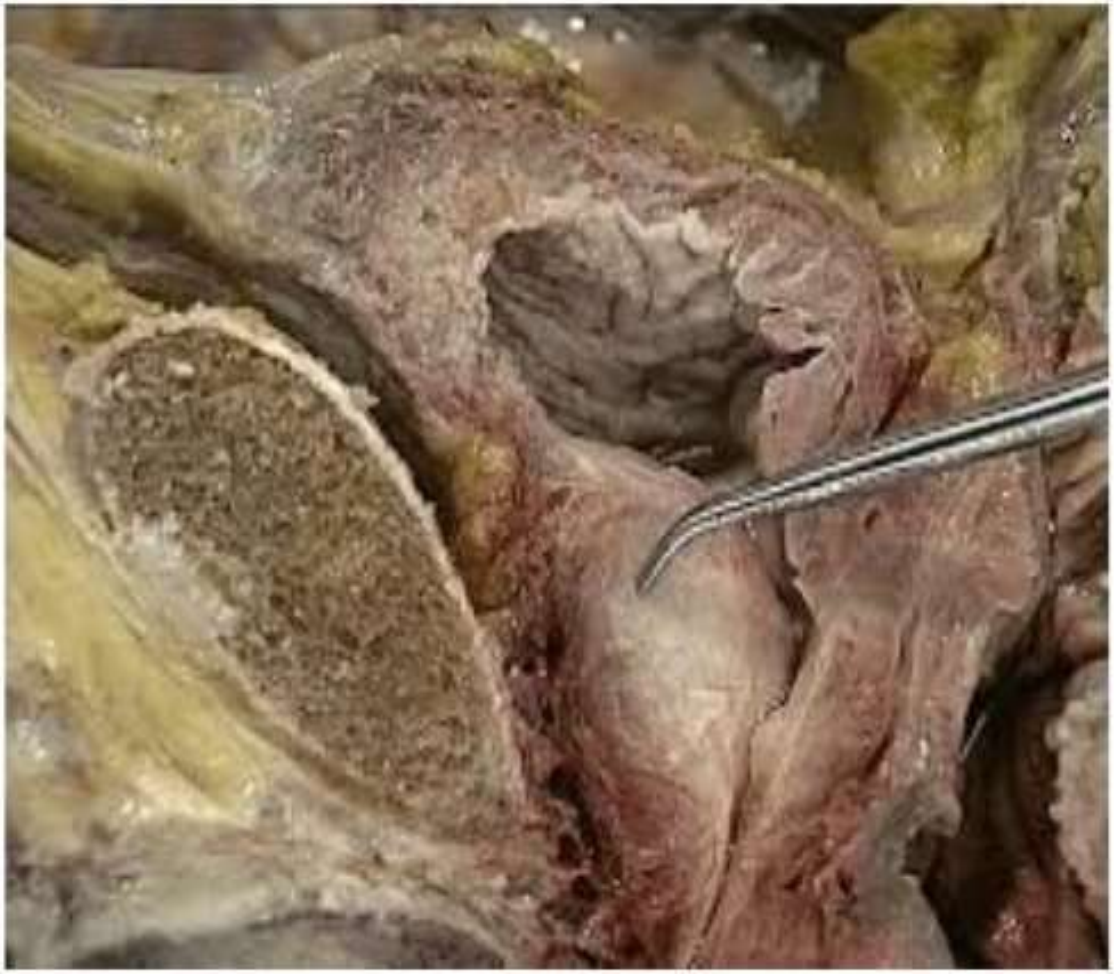
The seminal vesicles secrete a significant proportion of the fluid that ultimately becomes semen

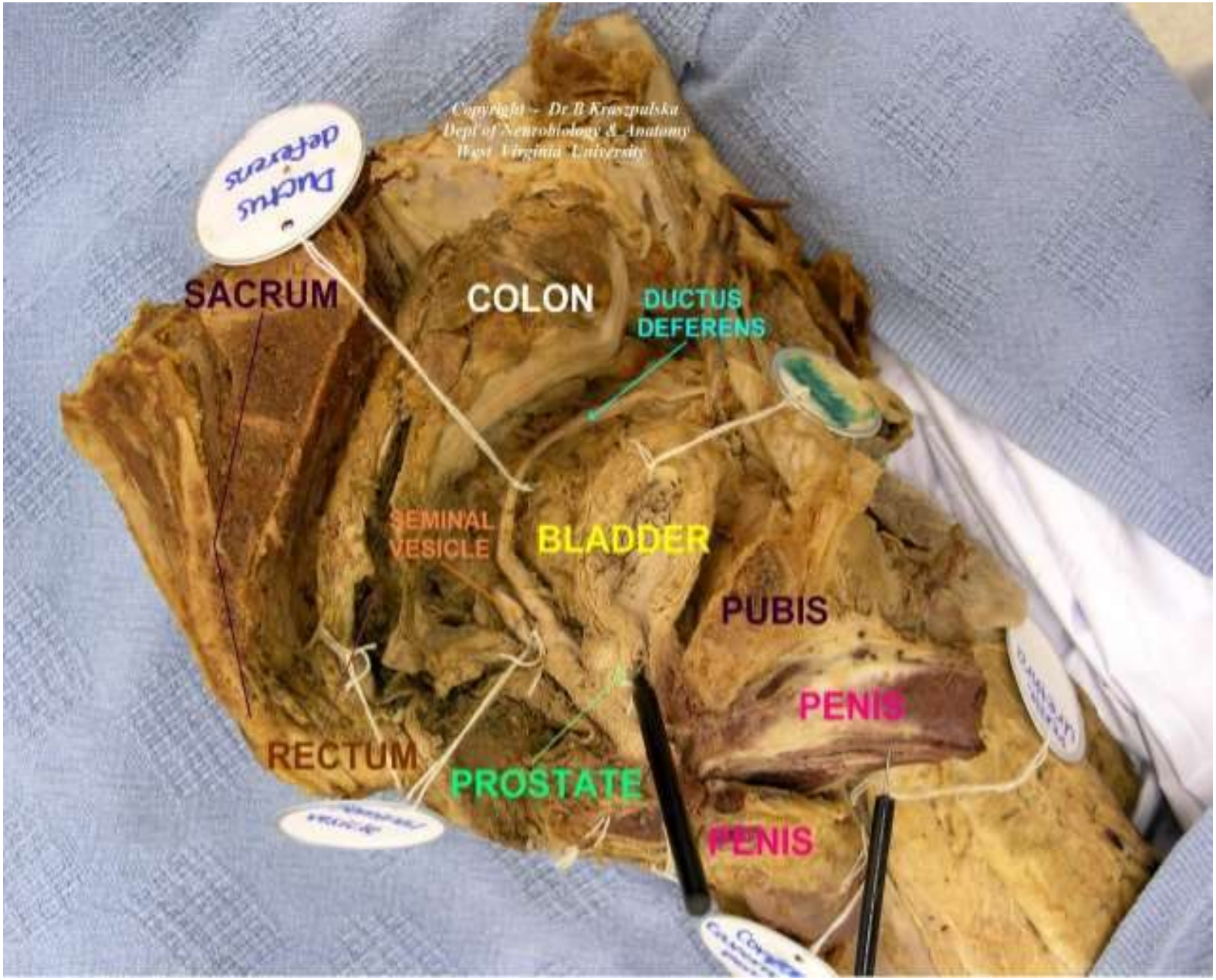
Lipofusci granules from dead epithelial cells give the secretion its yellowish color. About 70-85% of the seminal fluid in humans originates from the seminal vesicles


Bladder
Urethra
Penis
Rectum
Prostate
Scrotum
Bladder
Urethra
Seminal vesicle
Prostate
Cancerous tumor


Normal
Enlarged prostate gland
Bladder
Urethra
Prostate gland
Urine

Prostate gland, chestnut-shaped reproductive organ, located directly beneath the urinary bladder in the male, which add secretions to the sperm during the ejaculation of semen

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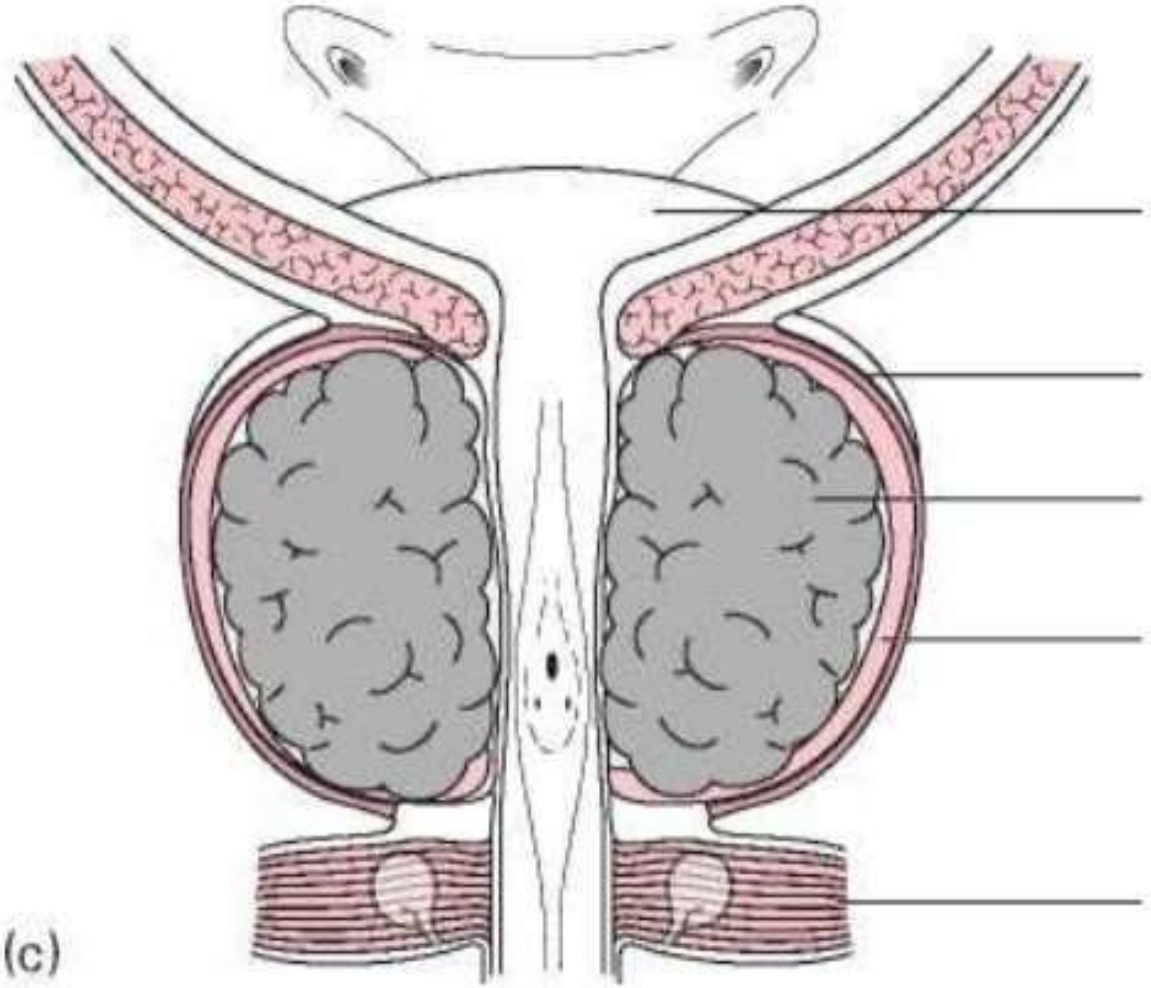
Dept of Neurobiology & Anatomy
West Virginia University
SACRUM
COLON
DUCTUS DEFERENS
SEMINAL VESICLE
BLADDER
PUBIS
PENIS
RECTUM
PROSTATE
PENIS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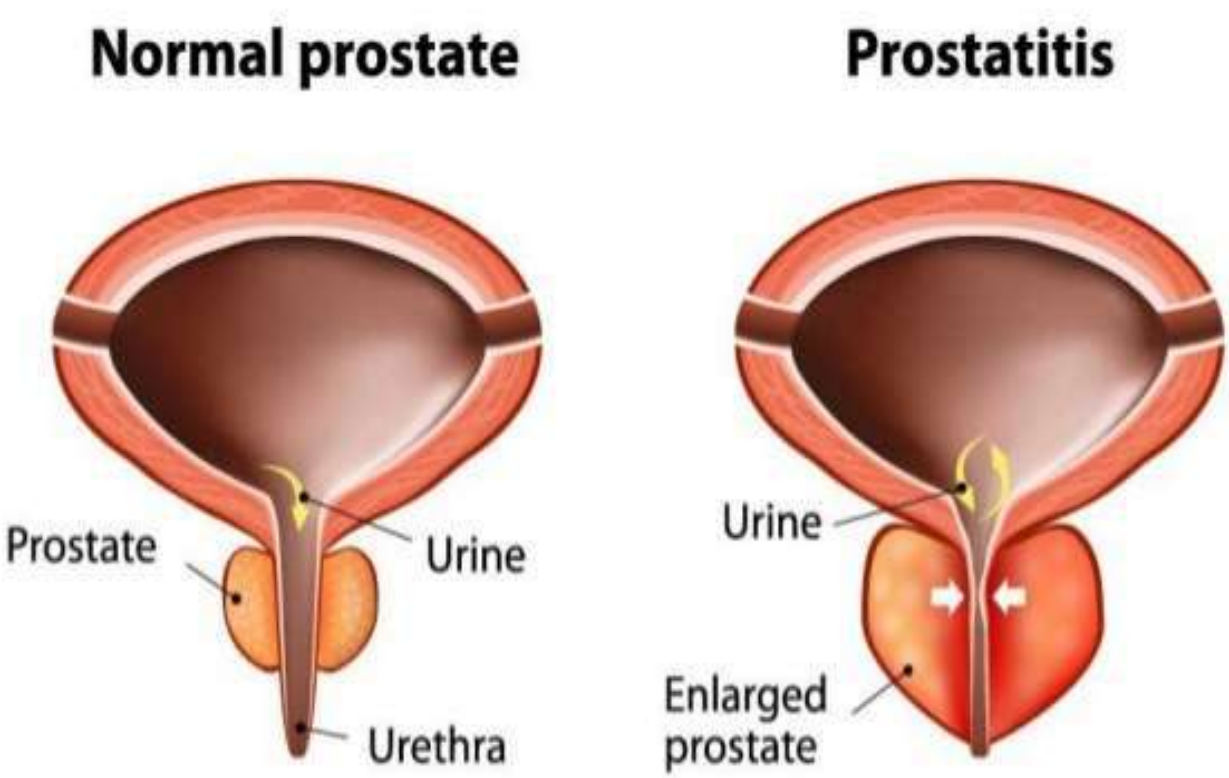

Normal prostate
Prostatitis
Prostate
Urine
Urethra
Urine
Enlarged prostate

The gland surrounds the urethra, the duct that serves for the passage of both urine and semen.

he two ejaculatory ducts, which carry sperm and the fluid secreted by the seminal vesicles, converge and narrow in the centre of the prostate and unite with the urethra. The urethra then continues to the lower segment of the prostate and exits near the apex.

In man, the prostate contributes 15–30 percent of the semen secreted by the male. The fluid from the prostate is clear and slightly acidic. It is composed of several protein-splitting enzymes

- fibrolysin, an enzyme that reduces blood and tissue fibres; citric acid and acid phosphatase, which help to increase the acidity; and other constituents, including ions and compounds of sodium, zinc, calcium, and potassium.

Normally, the prostate reaches its mature size at puberty, between ages 10 and 14. Around age 50, the size of the prostate and the amount of its secretions commonly decrease

- Enlargement of the prostate in size after midlife, often making urination difficult, may occur as a result of inflammation or malignancy. Prostate cancer is the second most common cancer diagnosed in men worldwide.

Semen

Is white or grey fluid contains sperm .it is the collection of fluid from testis ,seminal vesicles ,prostate gland ,

semen is discharged during sexual act and process of discharged of semen is called **ejaculation**

At the time of ejaculation ,semen is liquid in nature immediately ,it coagulates and after some time it become liquid once again

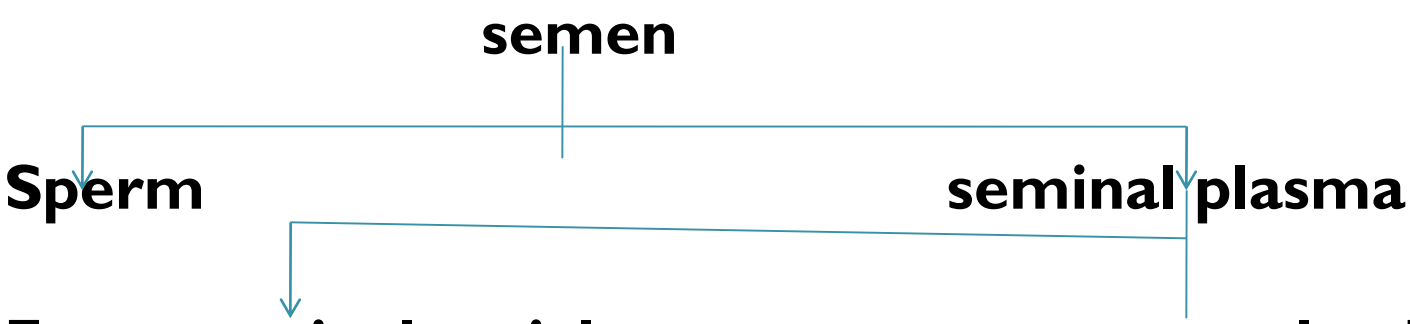
When semen is ejaculated ,the sperm are non motile due coagulum .when the coagulum dissolve dissolves ,the sperm become motile

Specific gravity of semen is 1.028 ,2ml to 6ml per ejaculation ,it is alkaline ,Ph 7.5

Composition of semen

Semen contains 10%of sperm and 90% of fluid part i.e. seminal plasma

Seminal plasma contains the products from seminal vesicles and prostate gland



From seminal vesicles

Ascorbic acid ,fibrinogen ,flavin
Fructose ,inositol ,pepsinogen
Phosphorylcholine ,citrate
Citric acid ,prostaglandin

prostate gland

acid phosphatase
cholesterol ,seminin
clotting enzyme
glucose ,phospholipids
calcium ,citrate ,sodium
zinc, bicarbonate

Sperm is the male gamete (reproductive cell) developed in testis ,it also called spermatozoon ,mature sperm is 60µ

Total count of sperm is about 100 to 50 million of semen

Sterility occur when sperm count falls below 20 million /ml

After ejaculation the survival time is only about 24 to 48 hours

Sperm reach the fallopian tube in about 30 to 60 min. after sexual intercourse ,uterine contractions during sexual act facilitate the movements of sperm

Structure of sperm

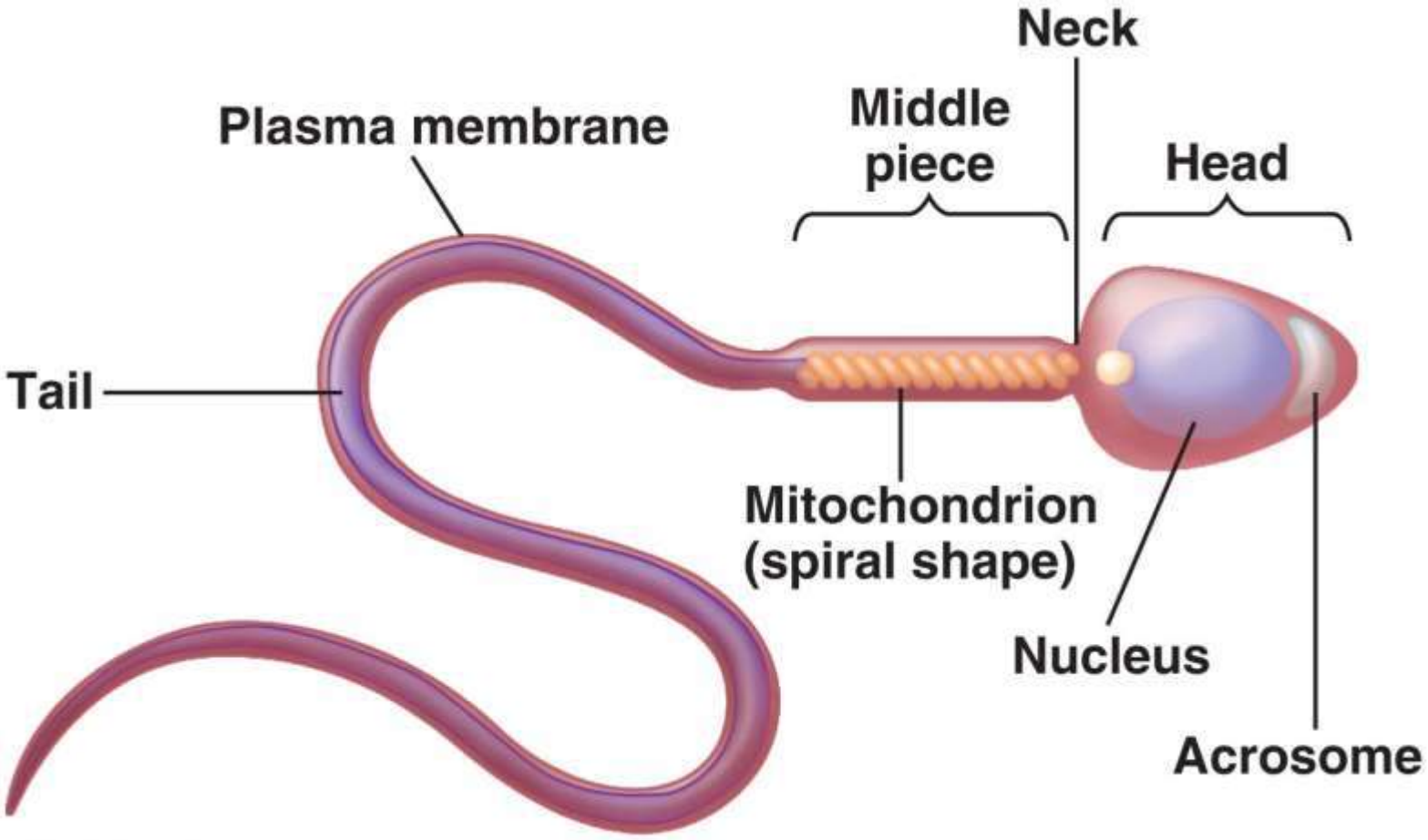
Sperm consists of four parts

1)Head

2)Neck

3)Body

4)Tail



Head of sperm is oval in shape with length of 3 to 5 μ and width of up to 3μ ,anterior portion is thin

Head is covered by thin cell membrane and it is formed by a condensed nucleus with thin cytoplasm. anterior two third of the head is **called acrosome or galea capitis**

Acrosome Is the thick cap like anterior part sperm head ,it develop from Golgi apparatus ,it is made up to mucopolysaccride and acid phosphatase .

Acrosome also contains hyauronidase and Proteolytic enzyme ,which are essential for the sperm to fertilize the ovum

Neck

Head is connect to the body a short neck ,its anterior end formed by thick disk – shaped anterior end knob ,which is also called proximal centrioles . Posterior end formed by another similar structure known as posterior end knob ,it gives rise to the axial filament of body ,it gives rise to the axial filament of body

Body

Is cylindrical with a length of 5 to 9 μ and the thickness of 1μ .the body of the sperm consists of central core called **axial filament** ,covered by thin cytoplasmic capsule

Axial filament starts from posterior end knob of the neck ,it passes through the body and a perforated disc called end disk or end ring centriole

Finally the axial filament reaches the tail as **axial thread**

In the body ,the axial filament is surrounded by a closely wound spiral filament consisting of mitochondria

Tail

Consists of two segments

1)Chief or main piece

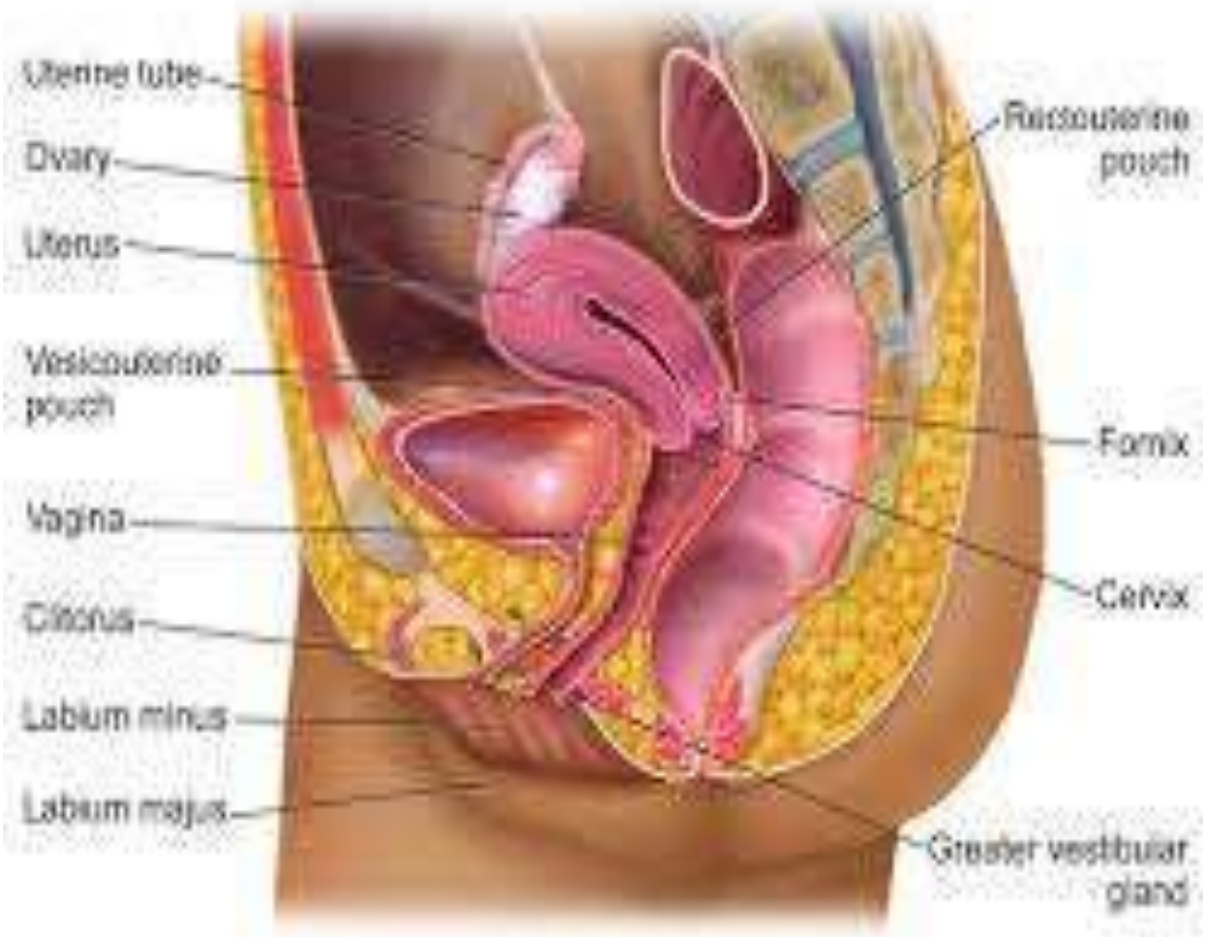
2)Terminal or end piece

Azoospermia

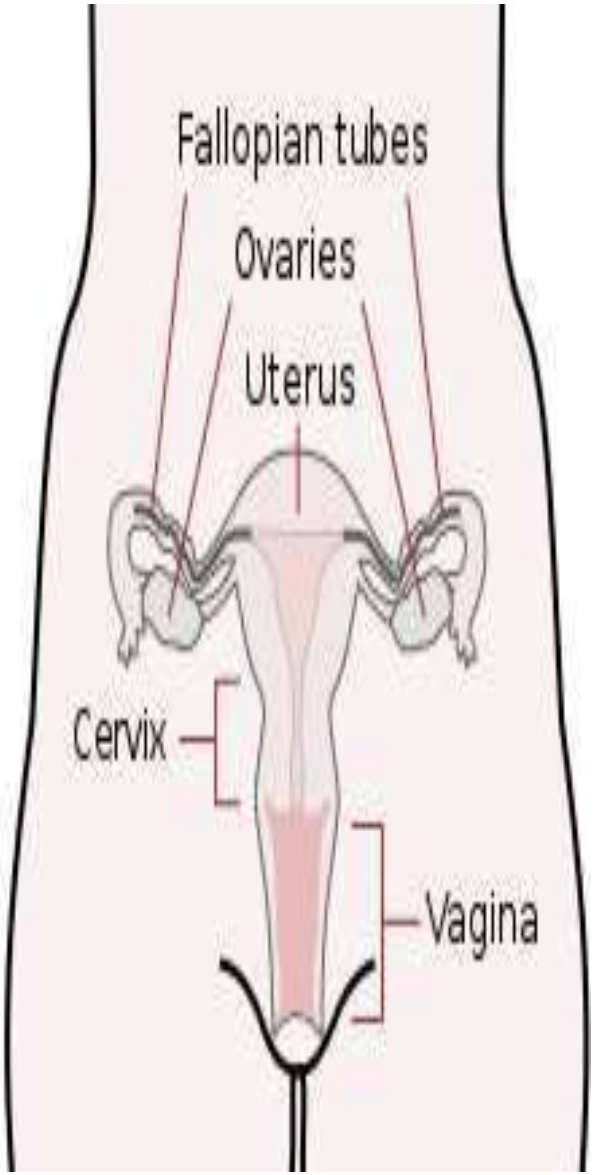
Is the condition characterized by lack of sperm in semen

Oligospermia

Is low sperm count ,less than 20 million



The Female Reproductive System

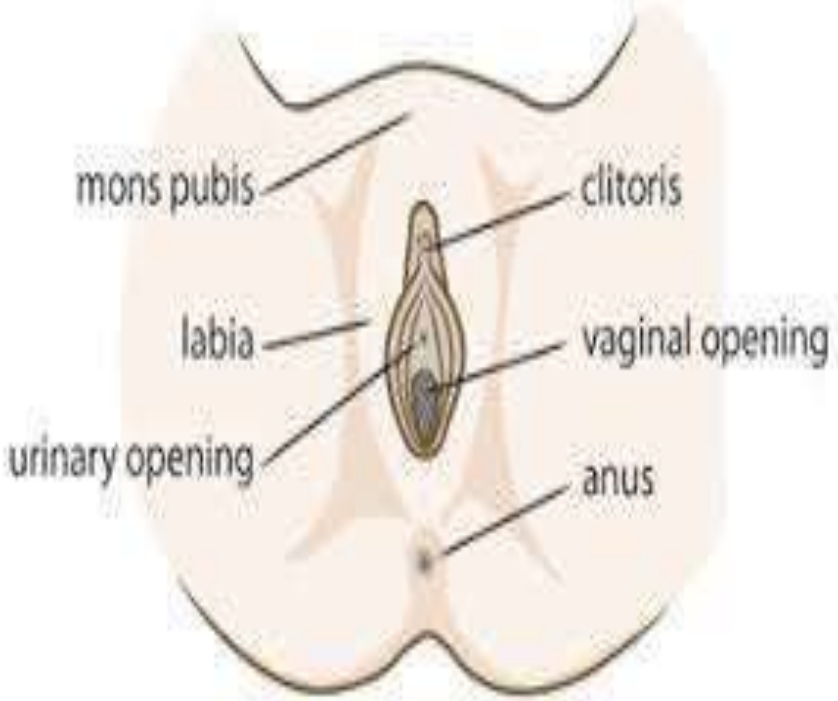

Fallopian tubes
Ovaries
Uterus
Cervix
Vagina

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

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

Accessory sex organs are –fallopian tubes uterus ,cervix and vagina

External genitals are labia majora ,labia minora and clitoris


mons pubis
clitoris
labia
vaginal opening
urinary opening
anus

- **Uterus otherwise known as womb** ,it lies in pelvic cavity in between the rectum and bladder ,it is hollow muscular organ with thick wall
- Uterus is made up of serous layer ,myometrium, endometrium

It has central cavity which opens into vagina through cervix

On either side at its upper part the fallopian tubes open

Cervix

Is the lower constricted part of uterus

Vagina

Is short tubular organ

Ovary

Ovary is the gonad or primary sex organs in females

A woman has two ovaries ,

production and release of ovum or egg and secretion of female sex hormones are the functions of ovary

Ovaries are flattened ovoid bodies with dimensions of 4cm in length and 1 cm thickness .each ovary attached at hilum to the broad ligament by means of mesovarium and ovarian ligament

Each ovary has two parts

1)Medulla

2)Cortex

Medulla is central deeper portion of the ovary .it has stroma of loose connective tissues .it contain blood vessels ,lymphatics ,nerve fibers and bundles of smooth muscle fiber near hilum .

Cortex is outer portion and has compact cellular layers .it is interrupted at the hilum ,where the medulla is continues with mesovarium .cortex is lined by the germinal epithelium underneath a fibrous layer known as tunica albugenia

---Cortex having glandular structure which represent ovarian follicle at different stages

-----Connective tissue cells

---Interstitial cells

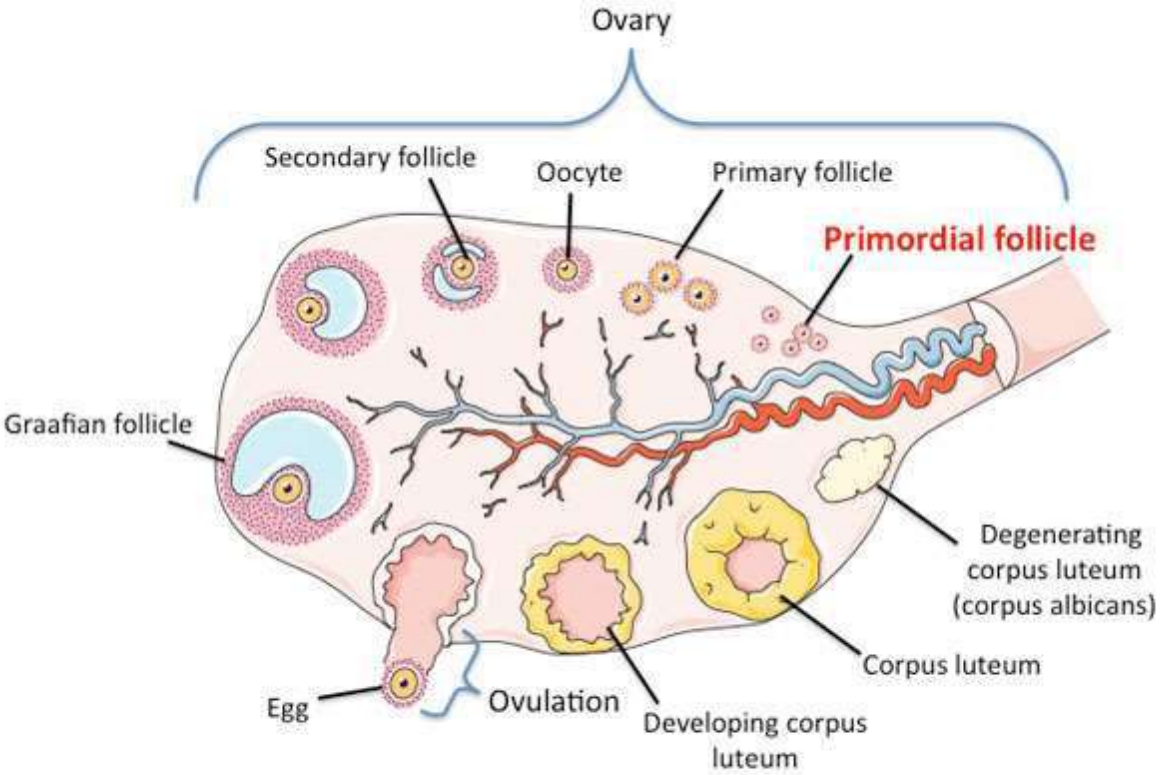
In the intrauterine life ,outer part of cortex contains the germinal epithelium ,

which is derived from the germinal ridges ,when fetus develops the germinal epithelium, give rise to a number of primordial ova .

Primordial ova move towards the inner substance of cortex .

A layer of spindle cells called granulose cells from the ovarian stroma surround the ova

Primordial ovum along with granulosa cells is called the **primordial follicle**



Figures were produced using Servier Medical Art: www.servier.com

At the 7^{th} or 8^{th} month of intrauterine life about 6 million primordial follicles are seen in both the ovaries and rest of follicles degenerate

At the time of puberty ,the number decreases further to bout 3000 00 to 400000 .

after menarche ,during M.C. one of the follicle matures and release ovum .

During every menstrual cycle only one ovum is released from any one of the ovaries .

During every cycle many of follicles degenerate.

The degeneration follicles is called **atresia**

The degenerated follicles are known as **atretic follicles**

Atretic follicles become fibrous **and fibrotic follicles are called corpus fibrosa .**

Usually the degenerated follicles disappear without leaving any scar

Functions of ovaries

Ovaries are primary sex organs in females functions of ovaries are

1)Secretion of female sex hormones

2)Menstrual cycle

Ovarian hormones

1)Estrogen

Estrogen is secreted by in large quantity from theca interna cells of ovarian follicles and in small quantity by corpus luteum of the ovaries .

Estrogen secretion is predominant at the later stage of follicular phase before ovulation

A small quantity of estrogen is secreted by adrenal cortex ,in pregnant woman ,a large amount of estrogen is secreted by the placenta

3)It also increases secretory activity of theca cells

B)Effects on uterus

1)Estrogen produces enlargement of uterus to about double its childhood size due to proliferation of endometrial cell

2)Increase in the blood supply to endometrium

3)Proliferation and dilation of the endometrial glands ,which become more tortuous with increase blood flow

4)Increase in spontaneous activity of the uterine muscle and their sensitivity to Oxytocin

5) Increase in the contractility of the uterine muscle

All these changes prepare uterus for pregnancy

C)Effects on fallopian tube

1)Estrogen acts on the mucosal lining of the fallopian tubes and increase the number and size of the epithelial cells lining the fallopian tubes

2)Increase activity of the cilia ,so that the movements of the ovum in fallopian tube is facilitated

3)Enhances the proliferation of glandular tissues in fallopian tube

All these changes are necessary for fertilization of ovum

D)Effects on vagina

1)Estrogen changes the vaginal epithelium from cuboidal into stratified type ,the stratified epithelium is more resistant to trauma and infection

2)Increases the layer of the vaginal epithelium by proliferation

3)Reduces the pH of vagina ,making it more acidic

All these changes are necessary for the prevention of certain common vaginal infections such as gonorrheal vaginitis

5)Effects on secondary sexual characters

Estrogen responsible for the development of secondary sexual character in females

Secondary sexual character in females are

i)Hair develop in the pubic region and axila

ii)Skin become soft and smooth

iii)Shoulders become narrow ,hip broadens ,thigh converge and arm diverge ,fat deposition in increases in breast and buttocks

Secondary sexual character in females are

i)Hair develop in the pubic region and axila

ii)Skin become soft and smooth

iii)Shoulders become narrow ,hip broadens ,thigh converge and arm diverge ,fat deposition in increases in breast and buttocks

iv)Broadening of pelvis with increased transverse diameter ,round or oval shape of pelvis .

v)High pitch voice

F) Estrogen causes osteoblastic activity

so at the time of puberty the growth rate increases but same time fusion of epiphysis with the shaft ,

2)Progesterone

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

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

Small amount of progesterone is secreted from adrenal cortex also

In pregnant woman ,large amount of progesterone is secreted by corpus luteum in the first trimester .in the second trimester ,corpus luteum degenerates.

Placenta secrete large quantity of progesterone in second and third trimester.

Functions of progesterone

Progesterone is concern mainly with the final preparation of the uterus for pregnancy and the breasts for lactation

---increases thickness of endometrium by increasing number and size the of cells

----increases the size of uterine glands.

----increase the secretory activities of epithelial cells of uterine glands

----increase blood supply to endometrium

----decreases the frequency of uterine contractions because of this ,the expulsion of implanted ovum is prevented

3)Progesterone increase the thickness of cervical mucosa and thereby inhibits the transportation of sperm into uterus

4)Progesterone promotes the development of lobules and alveoli of mammary glands by proliferating and enlarging the alveolar cells.

5) Progesterone inhibits the release of LH from hypothalamus through feedback effect

6) Progesterone increases body temperature after ovulation

Menstrual cycle

Is defined as cyclic events that take place in rhythmic fashion during the reproductive period of a woman's life

Menstrual cycle ceases at the age of 45 to 50 years ,permanent cessation of menstrual cycle in old age is called **menopause**

Menstrual cycle is usually 28 days

Changes during menstrual cycle

1)Ovarian changes

2)Uterine changes

3)Vaginal changes

4)Changes in cervix

Changes take place simultaneously .

During menstrual cycle changes occur in ovaries and accessory sex organ

Ovarian changes occur during menstrual cycle

Changes in ovary during each menstrual cycle occur in two phases

1)Follicular phase

2)Luteal phase

Ovulation occur in between these two phases

Ovarian follicles

Are glandular structures present in cortex of ovary .each follicles consists of the ovum surrounded by epithelial cells, namely granulosa cell ,the follicles gradually grow onto a matured follicle trough various stages

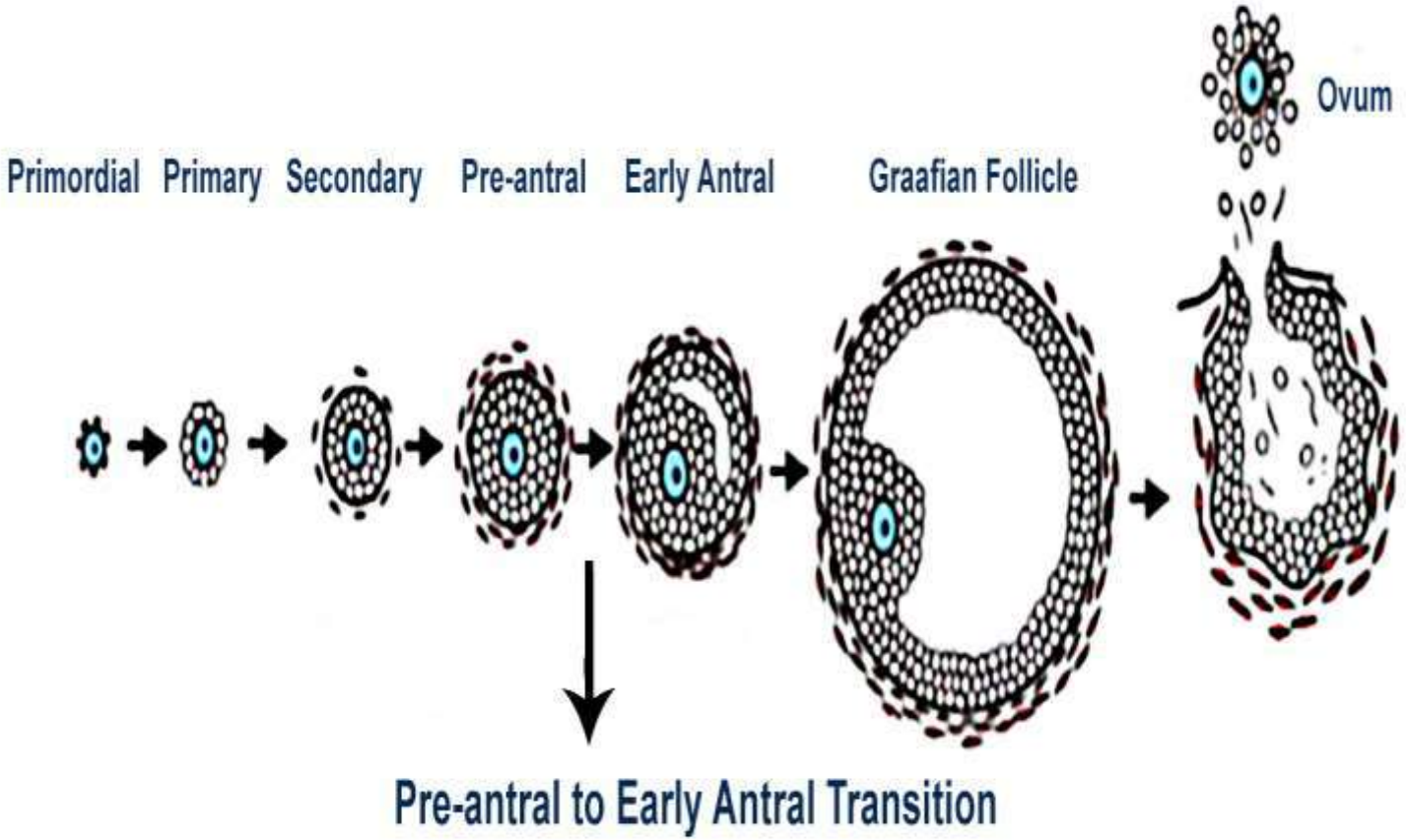
1)Primordial follicle

2)Primary follicle

3)Vesicular follicle

4)Matured follicle or grafian follicle

Follicular Development during Follicular Phase of Menstrual Cycle



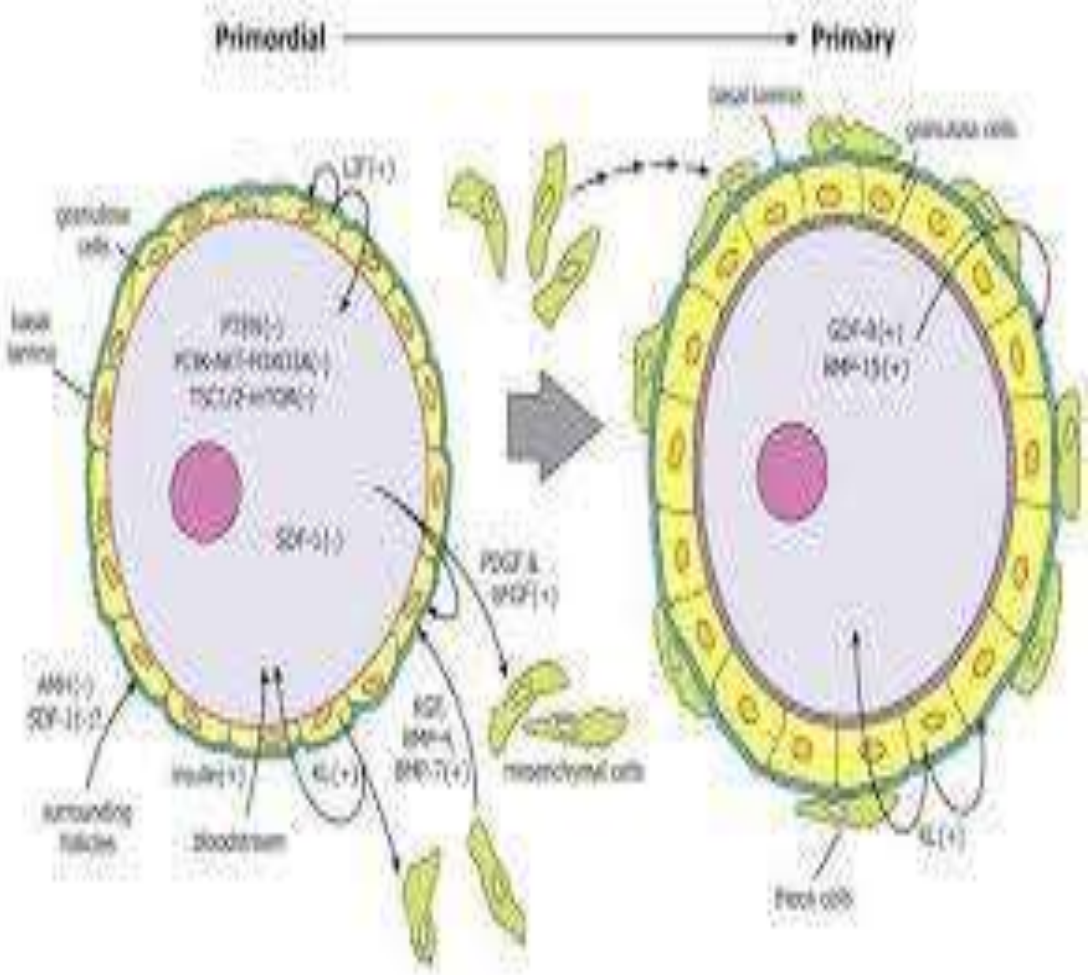
Modified From:
https://embryology.med.unsw.edu.au/embryology/index.php/File:Ovary-_follicle_stages.jpgry_Development

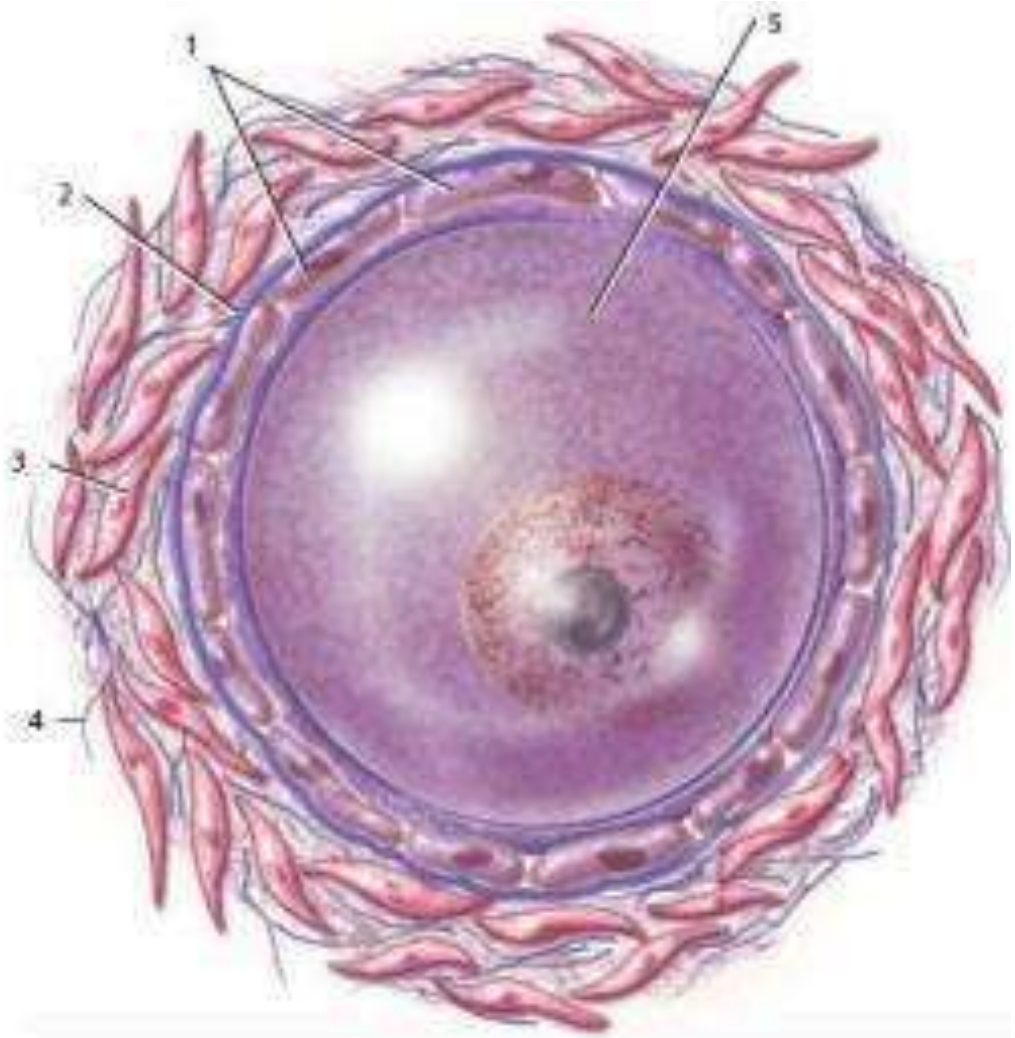
Primordial follicle

At the time of puberty both the ovaries contain about 400000 primordial follicles.

Diameter of it is 15 to 20 μ and that of ovum is about 10 μ

Each primordial follicle has an ovum ,which is incompletely surround by granulosa cells ,these cell provide nutrition to ovum

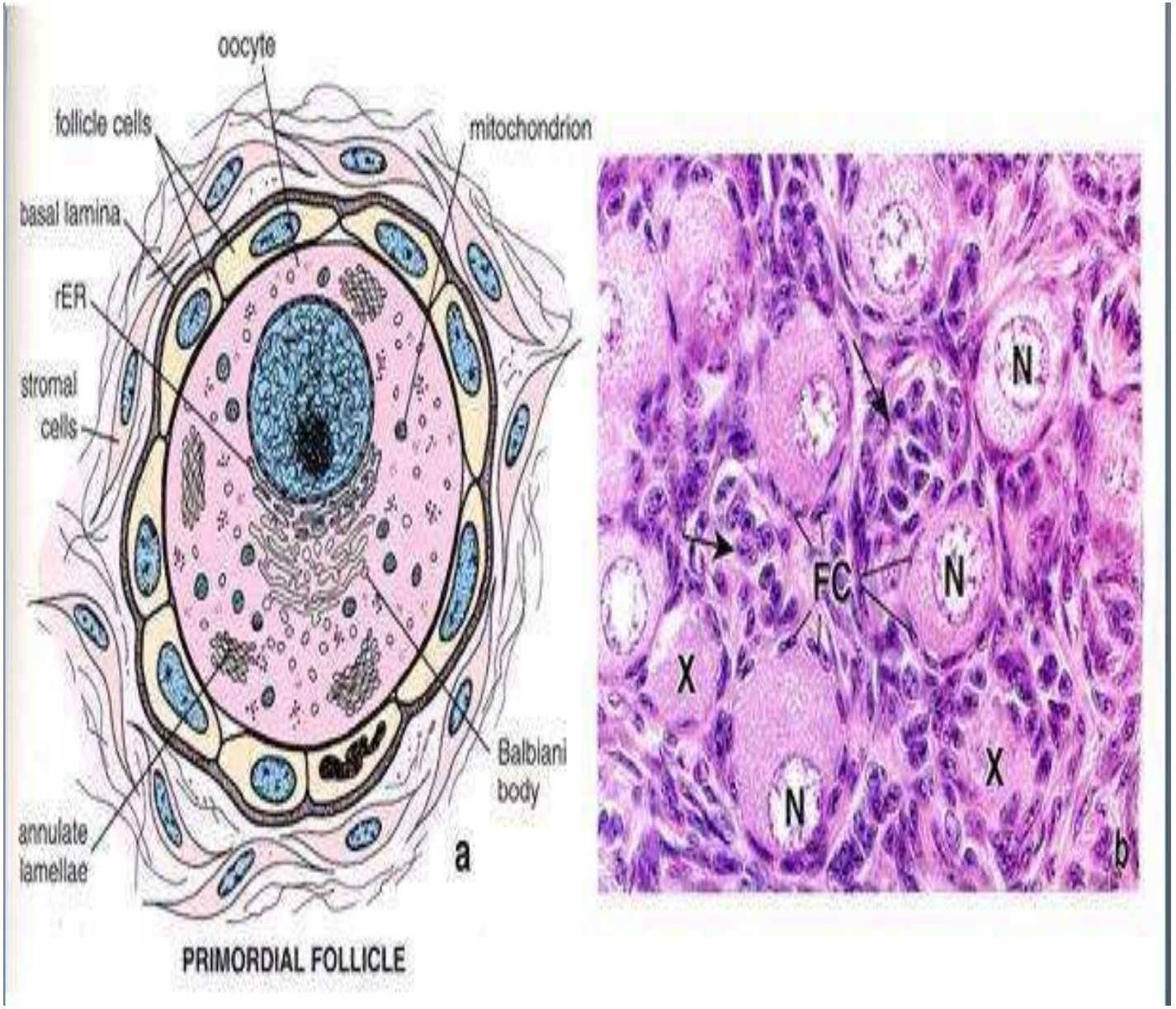

Primordial
Primary
granulosa cells
basal lamina
KL(+)
PTEN(-)
PI3K-AKT-FOXO3A(-)
TSC1/2-mTOR(-)
SDF-1(-)
PDGF &
bFGF(+)
AMH(-)
SDF-1(-)?
surrounding
follicles
insulin(+)
bloodstream
KGF,
BMP-4,
BMP-7(+)
mesenchymal cells
basal lamina
granulosa cells
GDF-9(+)
BMP-15(+)
KL(+)
theca cells


1
2
3
4
5

Granulosa cells also secrete the oocyte maturation inhibiting factor ,which keeps the ovum in the immature stage .

All the ova present in the ovaries are formed before birth ,no new ovum is developed after birth .

At the onset of puberty ,under the influence of FSH and LH the primordial follicles start growing through various stage


oocyte
follicle cells
mitochondrion
basal lamina
rER
stromal cells
Balbiani body
annulate lamellae
a
PRIMORDIAL FOLLICLE
N
FC
N
X
X
N
b

2)Primordial follicle becomes the primary follicle ,when ovum is completely surrounded by the granulosa cells .

During this stage ,the follicle and the ovum increase in size ,diameter of the follicle increases to 30 to 40 μ and that of ovum increases to about 20 μ.

Follicle is not covered by a definite connective tissue capsule .

Changes in primary follicles

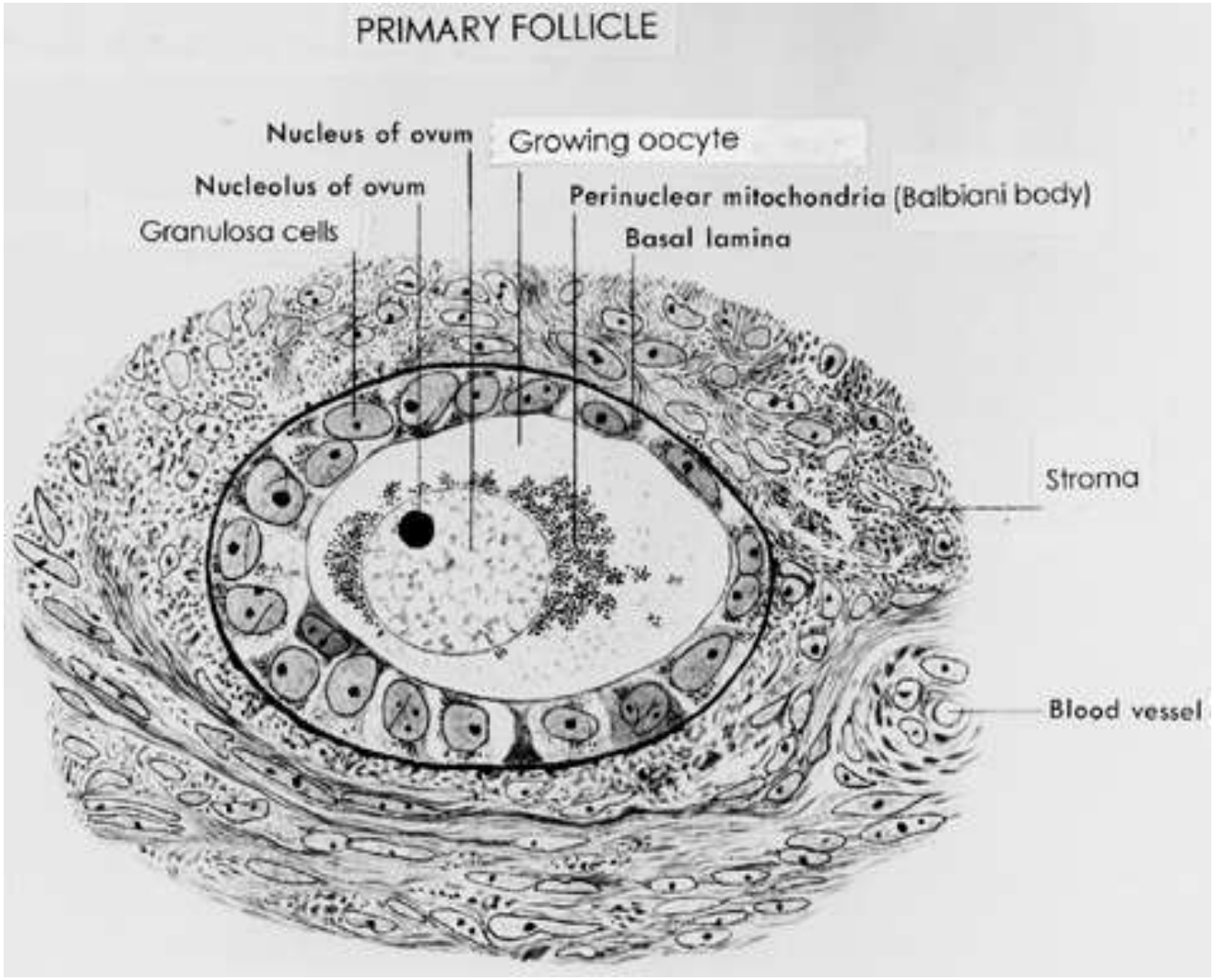
During development of primary follicle – there is proliferation of granulosa cells and increase in size of the follicle

----increase in size of the ovum

----onset of formation of connective tissue capsule around the follicle

Primary follicles develops into vesicular follicular

A **granulosa cell** or **follicular cell** is a somatic **cell** of the sex cord that is closely associated with the developing female gamete (called an oocyte or egg) in the ovary of mammals.


PRIMARY FOLLICLE
Nucleus of ovum
Growing oocyte
Nucleolus of ovum
Perinuclear mitochondria (Balbiani body)
Granulosa cells
Basal lamina
Stroma
Blood vessel

3)Vesicular follicle

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

Changes taking place during the development of vesicular follicles .

I)Changes in granulosa cells

II)Changes in ovum

III)Formation of capsule

1)Changes in granulosa cells

---first the proliferation of granulosa cells occurs

---a cavity called follicular cavity or antrum is formed between the granulosa cell

---with continuous proliferation of granulosa cells ,the follicle increase in size

Changes in ovum

First ovum increase in size and its diameter increases to 100 to 150 µ

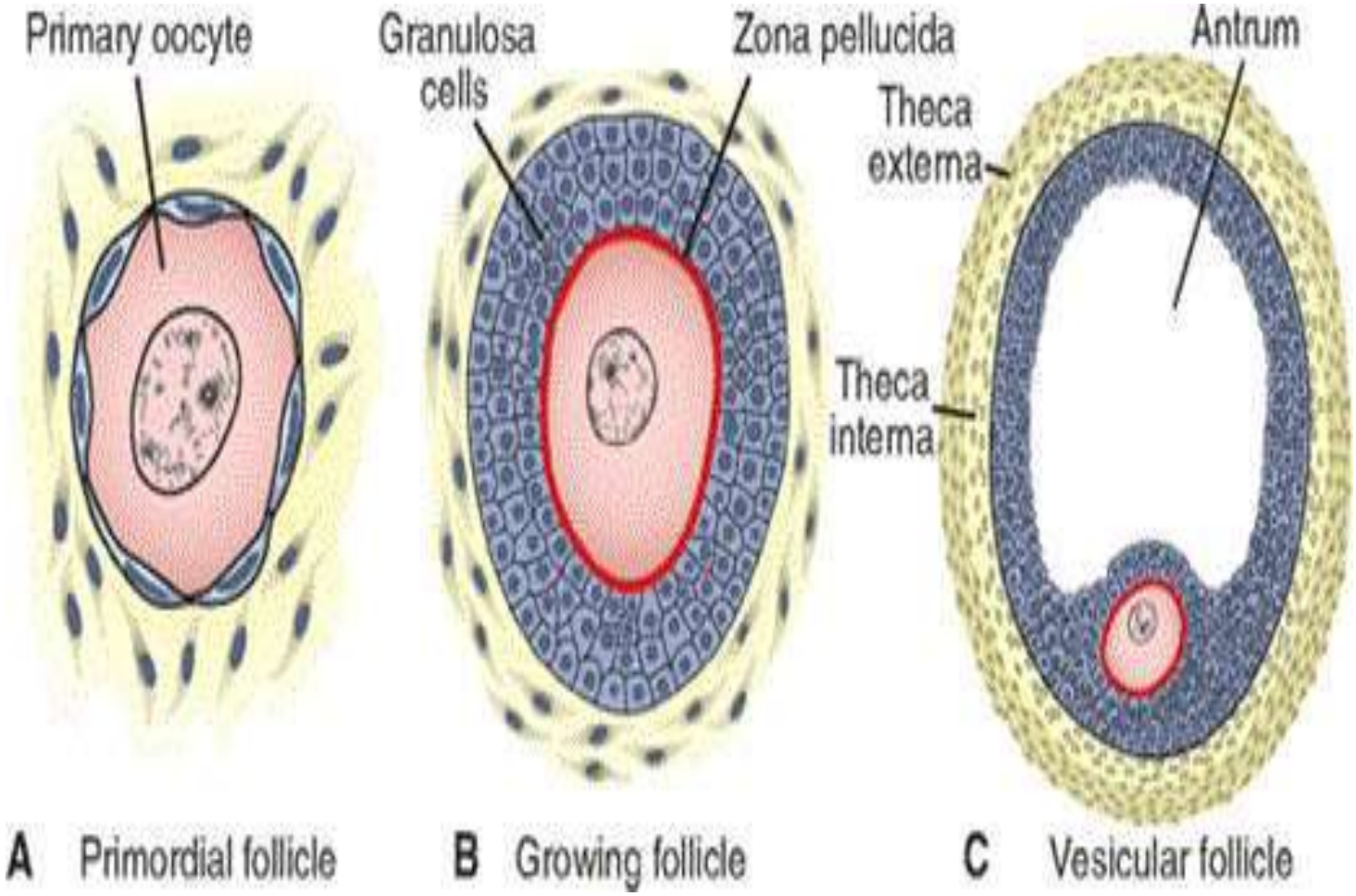
Thick membrane formed around the ovum ,which is called zona pellucida

Changes in capsule spindle cells from the stroma of ovarian cortex are modified and form a covering sheath around the follicle .

The covering sheath is follicular sheath having two layer

1)Theca interna

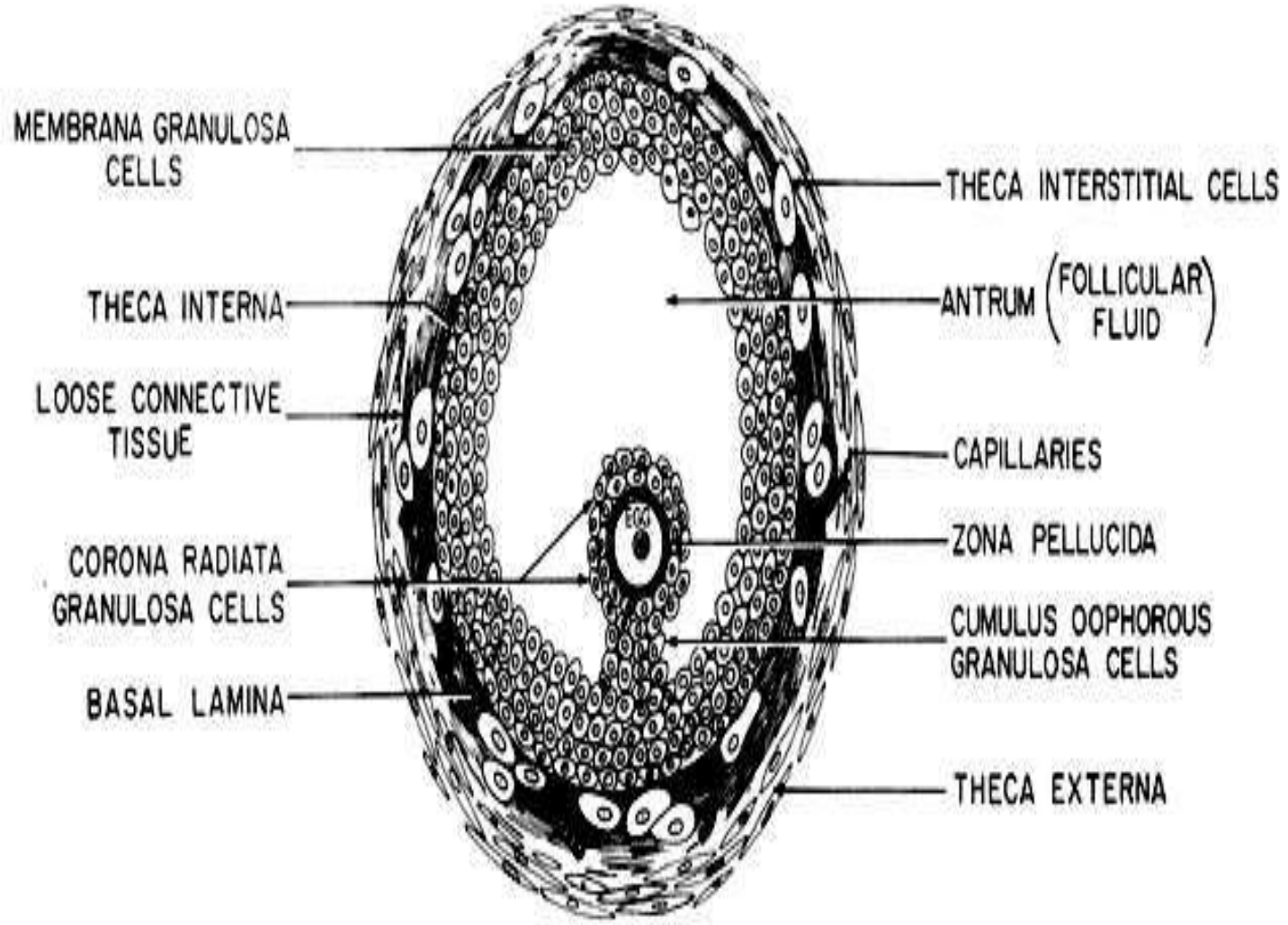
2)Theca externa

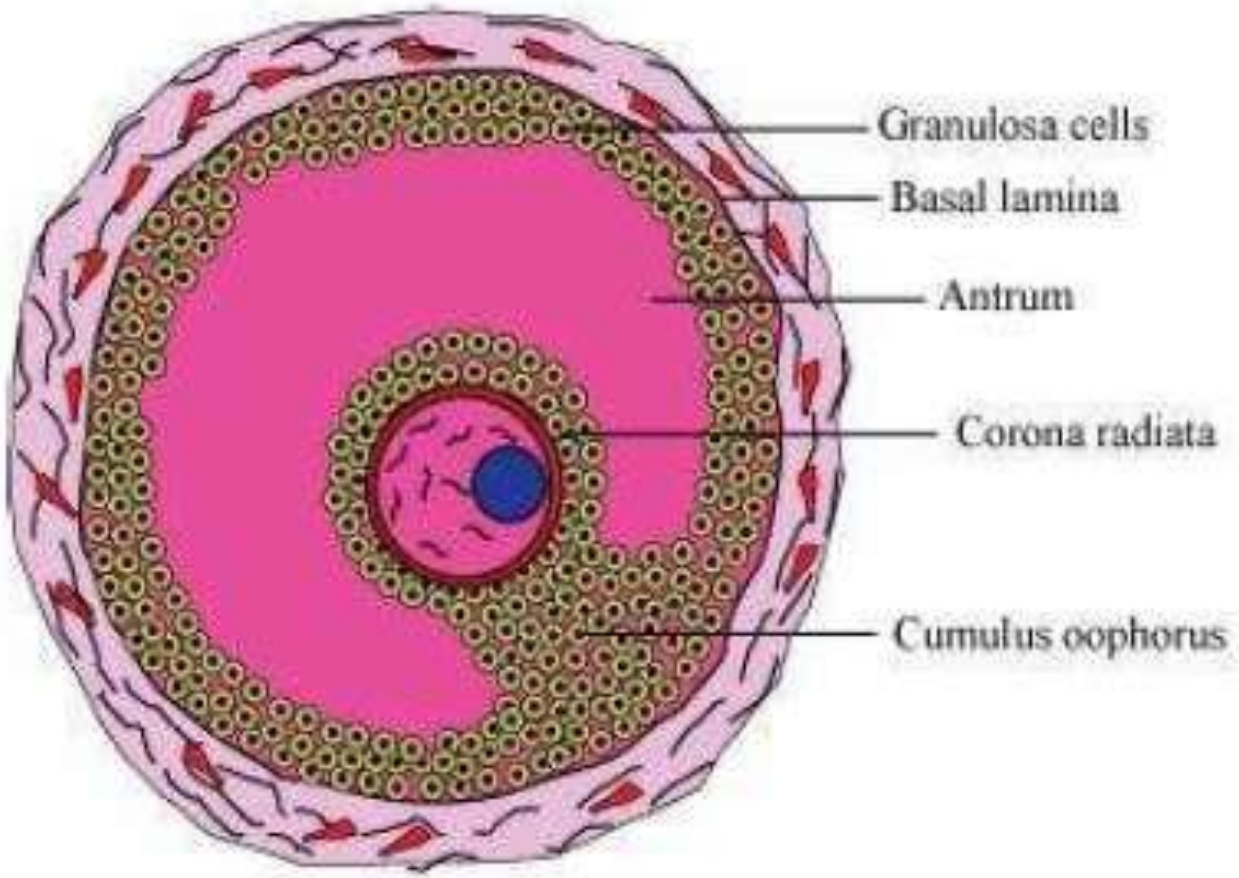

Primary oocyte
Granulosa cells
Zona pellucida
Antrum
Theca externa
Theca interna
A Primordial follicle
B Growing follicle
C Vesicular follicle

4)Grafian follicle

Is the matured ovarian follicle with maturing ovum

HISTOLOGIC ARCHITECTURE OF GRAAFIAN FOLLICLE





Structure of the Graafian follicle

Changes taking place during the development of grafian follicle

---size of follicle increases

---the follicle encroaches upon tunica albuginea and protrude on surface of the ovary this protrusion called as **stigma**

----Theca interna becomes prominent

----on the 14th day of menstrual cycle grafian follicle is ready for the process of ovulation

Ovulation

Is the process by which the grafian follicle ruptures with consequent discharge of ovum into abdominal cavity

It is influenced by LH .

Ovulation occurs on the 14th day of menstrual cycle in a normal cycle of 28 days ,ovum enter the fallopian tube

Process of ovulation

??????????????????????????????????

Stages of ovulation

1)Ruptures of grafian follicles take place at the stigma

2) Follicular fluid oozes out

3)Germ hillock is freed from wall

4)Ovum is expelled out into the abdominal cavity along with some fluid and granulosa cell

5) From abdominal cavity ,the ovum enters the fallopian tube through fimbriated end

Stages of ovulation

1)Movements of grafian follicle to periphery of ovary

↓

LH& progesterone

↓

2)Formation of new blood vessels in ovary

↓

3)Protrusions of blood vessels into follicular cavity (prostaglandin from granulosa cell)

4) Increased blood flow to follicle

5) Leakage of plasma into follicle

6) Swelling of follicle

7) Protrusion of follicle against ovarian capsule

8)Formation of stigma in ovarian capsule

activation of Proteolytic enzyme

9)Weakening and rupture of follicular capsule

10)Degeneration of stigma

11)Oozing of follicular fluid

12)Release of ovum

Luteal phase

Extend between 15th and 28th day of menstrual cycle .during this phase corpus luteum is developed and hence this

Phase is called **as Luteal phase**

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

It is also called yellow body .

Soon after the rupture of grafian follicle and release of ovum the follicle filled with blood ,now the follicle is called **corpus haemorrahigicum ,**

The blood clots slowly ,corpus haemorrahigicum is transformed into corpus luteum .

Follicular cavity closes gradually by the healing of the wound .blood clot replace by a serous fluid containg fibrin ,corpus luteum remains in ovary till the end of the cycle .

Corpus luteum secrete progesterone and estrogen in little quantity ,if pregnancy occur it remain active for 3 month ,until placenta develops .hormone secreted by corpus maintain the pregnancy

Abortion occur if corpus luteum become inactive or removed before third month of pregnancy . Before placenta secreting the hormones .

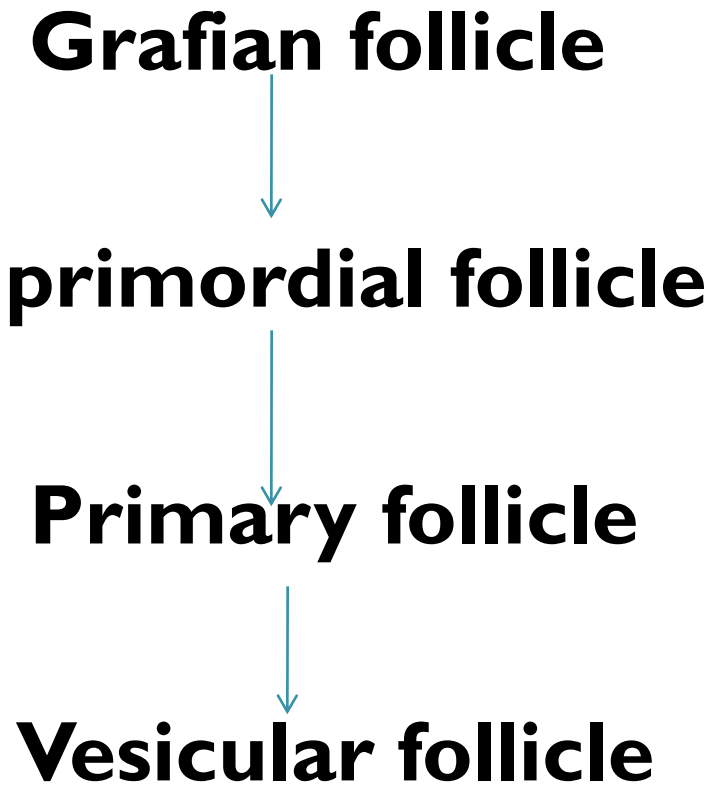
If fertilization doesn't take place ,the corpus luteum reaches the maximum size about one week after ovulation .

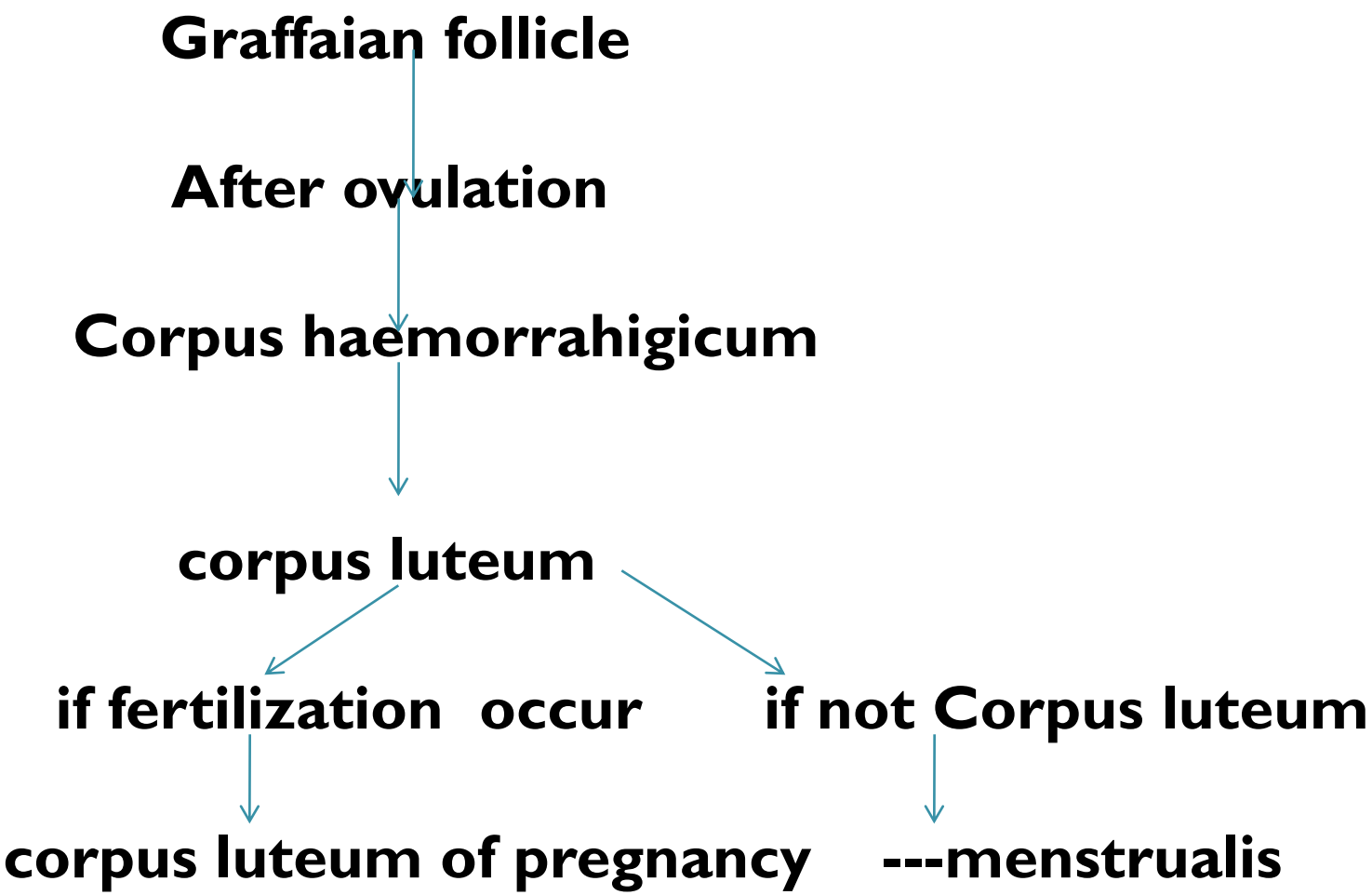
Then it degenerate into the corpus luteum menstrualis .

The cells decrease in size and the corpus luteum becomes smaller and involuted.

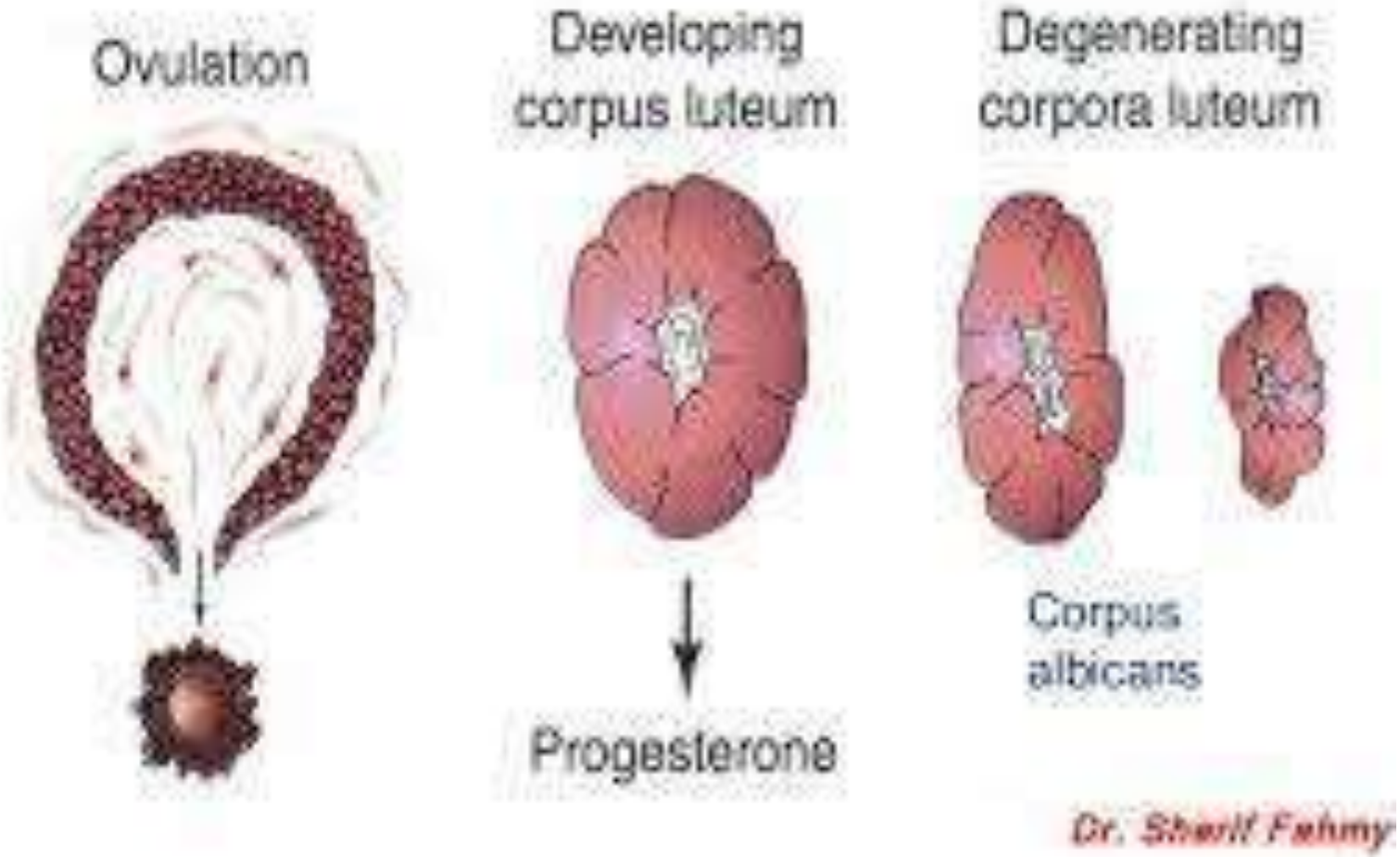
Afterwards **the corpus luteum menstrualis** is transformed into whitish scar called corpus albicans ,the process by which corpus luteum undergoes regression is called luteolysis.

If ovum is fertilized and pregnancy occur the corpus luteum persists and increase in size .is transformed into corpus luteum of pregnancy.


Grafian follicle
primordial follicle
Primary follicle
Vesicular follicle


Graffaian follicle
After ovulation
Corpus haemorrahigicum
corpus luteum
if fertilization occur
if not Corpus luteum
corpus luteum of pregnancy
---menstrualis

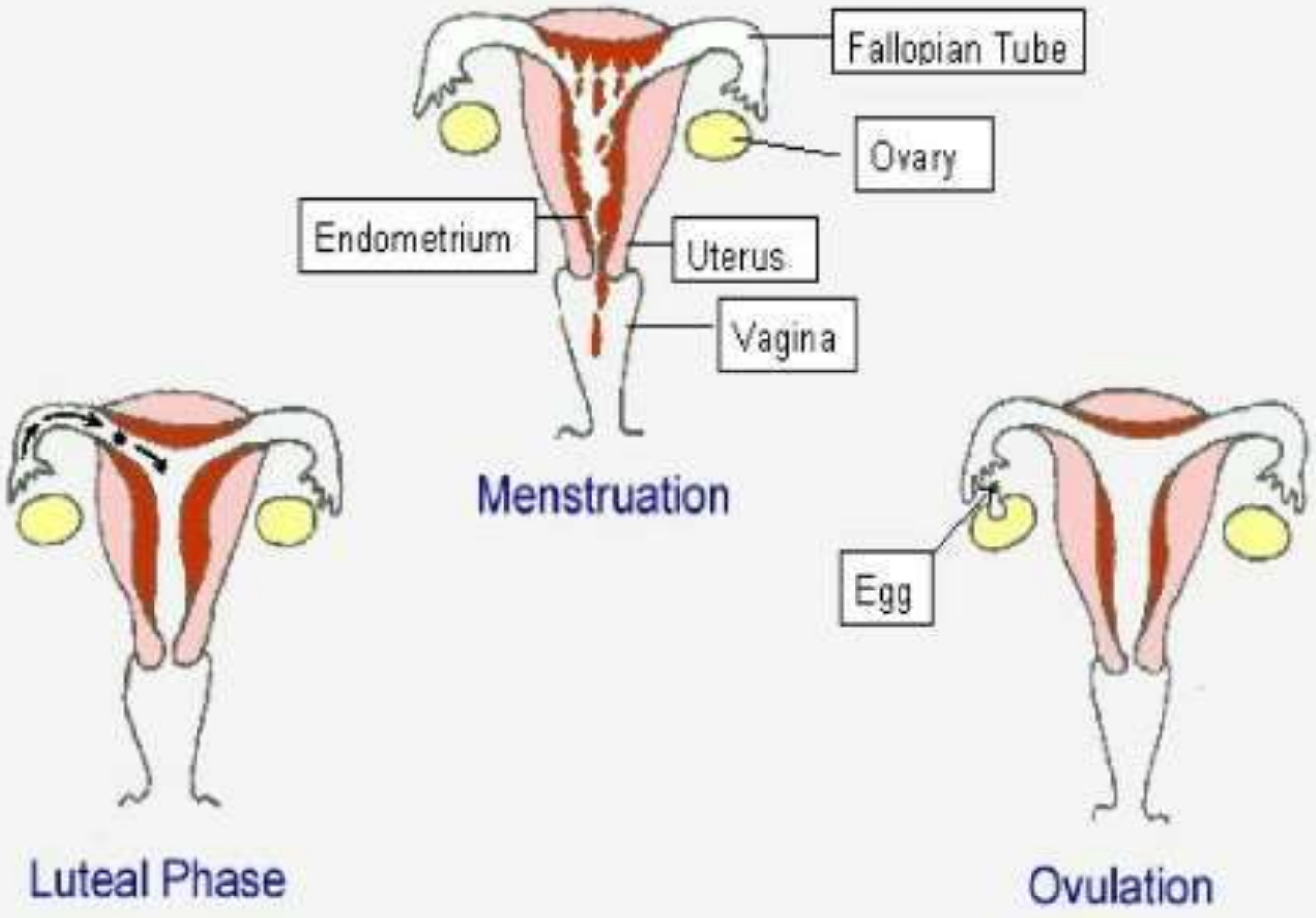
CORPUS LUTEUM



Uterine changes during menstrual cycle

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

Phases Of Menstrual Cycle



Uterine changes occur

1)Menstrual phase

2)Proliferative phase

3)Secretory phase

Menstrual phase

After ovulation ,if pregnancy doesn't occur

,the thickened endometrium is shed or desquamated .this desquamated 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 menstruation bleeding

This is last for 4 or 5 days ,this period is called menstrual phase or menstrual period ,it is also called as menses

On the 27^{th} and 28^{th} day of cycle estrogen and progesterone decreases which is responsible for bleeding

Changes in endometrium during menstrual cycle

1)Lack of hormones cause involution of endometrium

2)It leads to reduction in thickness of endometrium

- 3)During next 24 hours ,the tortuous blood vessels in the endometrium undergoes severe constriction

4) Vasoconstriction leads Hypoxia which result into necrosis of endometrium

5) Necrosis causes rupture of blood vessels and oozing of blood

6)Outer layer of necrotic endometrium is separated and passes along with blood

This process continue for about 24 to 36 hrs

7)---within 48 hrs after reduction in estrogen and progesterone endometrium is completely desquamated (come off in the form of scales)

8)Desquamated tissue and the blood in endometrial cavity initiate the contraction of uterus

- 9)Uterine contraction expel the blood along with desquamated uterine tissue to the exterior through vagina

During normal menstruation about 35 ml of blood and 35 ml of serous fluid is expelled ,the blood clot as soon as oozes in uterine cavity ,due to fibrinolysin clot get dissolve in uterine cavity itself

So that expelled blood don't contain clot

But in pathological condition involving uterus there may be clot with menses

Menstruation stops between 3rd and 7th day of MC

At the end of menstrual phase ,the thickness of endometrium is only about 1mm ,this is followed by proliferative phase

2)Proliferative phase

This phase extend from 5^{th} to 14^{th} day of menstruation ,i.e. between the days of menstruation stop and the day of ovulation

It corresponds to the follicular phase of ovarian cycle

at the end of menstrual phase only thin layer of endometrium remains as most of the endometrial stroma is desquamated

During proliferative phase

---endometrial cells proliferate rapidly

---epithelium reappear on the surface endometrium within the first 4 to 7 days

---uterine glands start developing within the endometrial stroma

Blood vessels appear in the stroma

---proliferation of endometrium occurs continually it reaches 3 to 4mm

This is because estrogen release from ovary

On the 14th day ovulation occur under influence of LH

This is followed by secretory phase

Secretory phase

This phase extend from 15th to 28th day of menstrual cycle

After ovulation corpus luteum develop in the ovary

It secrete large quantity of progesterone

Which cause enlargement of endometrial stroma and uterine glands

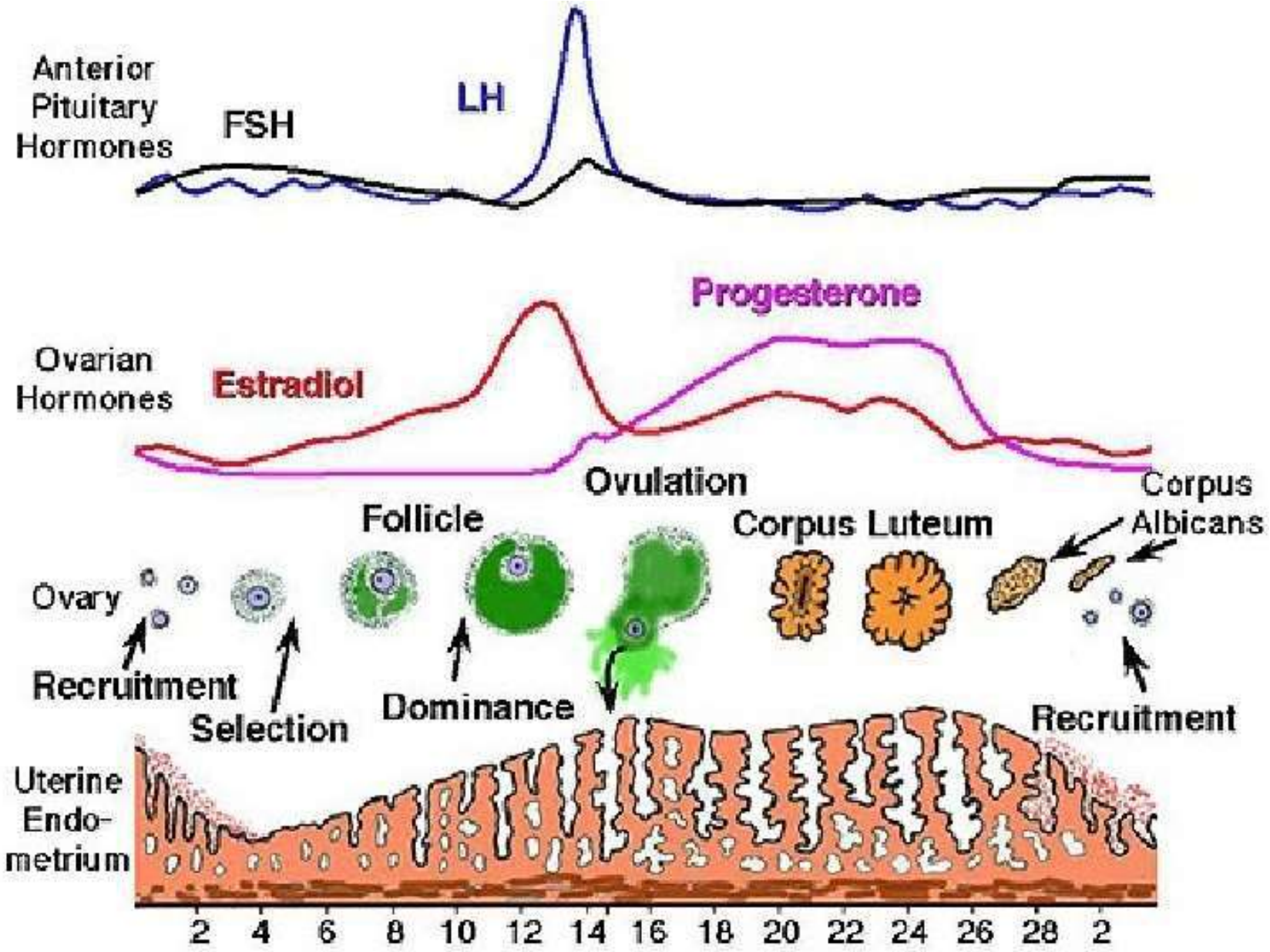
Small quantity secreted of estrogen causes proliferation of cells of uterus ,so that endometrium become thick .

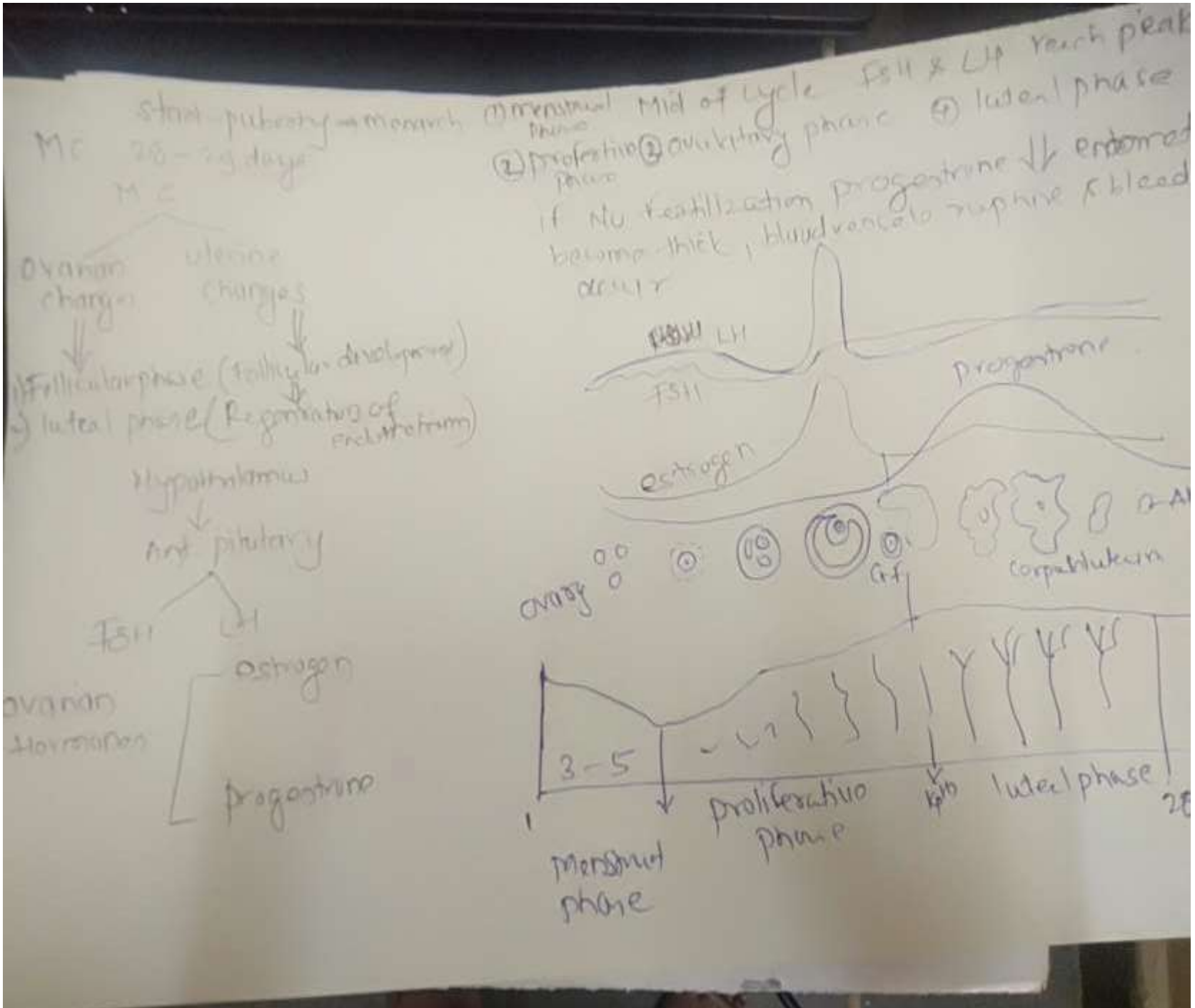
Actually secretory phase is the preparatory period, during which uterus is prepared for Implantation of ovum ,all theses changes occur due to influence of estrogen and progesterone .

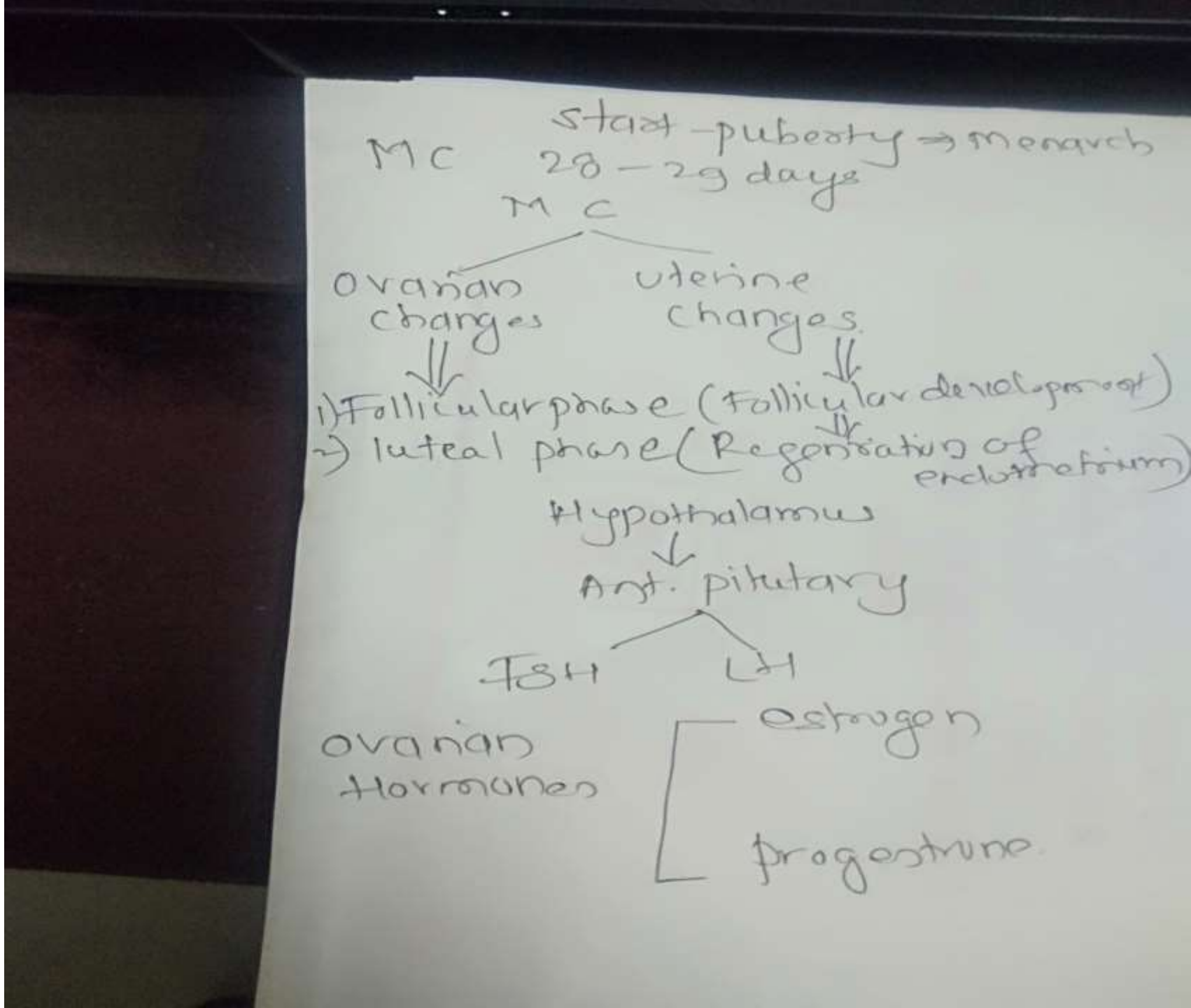
Estrogen is responsible for repair of damaged endometrium and growth of the glands

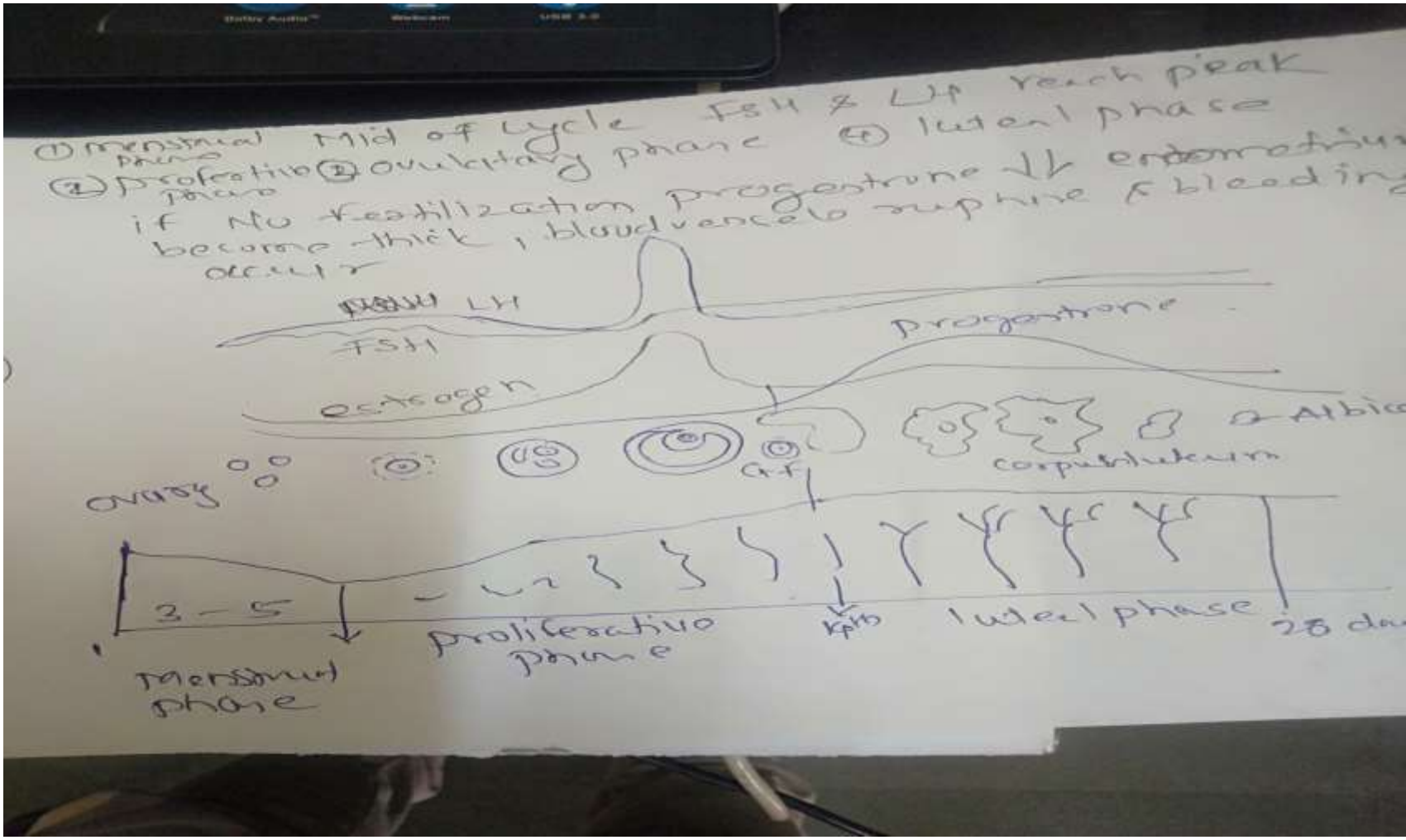
Progesterone is responsible for further growth of these structures and secretory activities in the endometrium

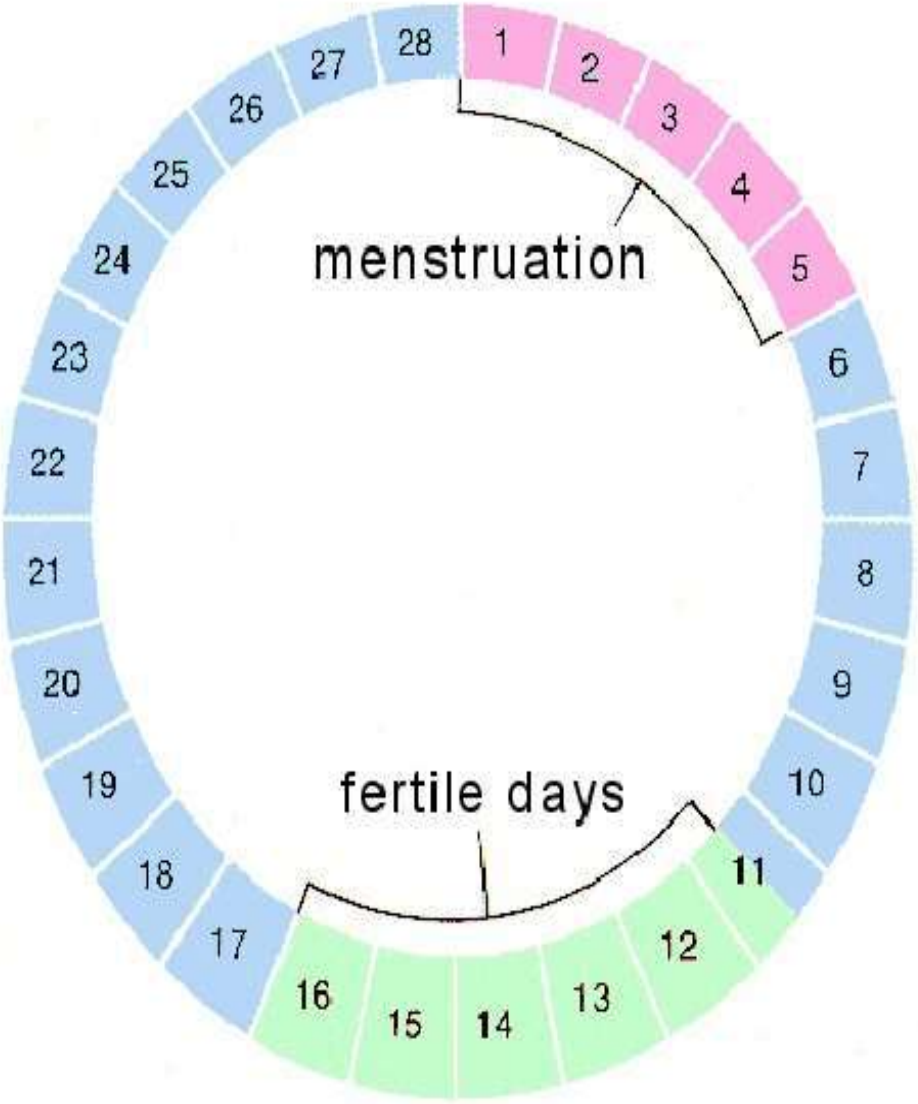
If the fertilized ovum is implanted during this phase and if the implanted ovum starts developing into a fetus ,then further changes occur in the uterus for the survival of the developing fetus


Anterior Pituitary Hormones
FSH
LH
Progesterone
Ovarian Hormones
Estradiol
Ovulation
Follicle
Corpus Luteum
Corpus Albicans
Ovary
Recruitment
Selection
Dominance
Recruitment
Uterine Endo-metrium
2 4 6 8 10 12 14 16 18 20 22 24 26 28 2


start puberty → menarch
MC 28 – 29 days
MC
Ovarian changes
uterine changes
Follicular phase (follicle development)
luteal phase (Regenerating of endometrium)
Hypothalamus
Ant pituitary
FSH
LH
ovarian Hormones
estrogen
progestrone
1) menstrual phase
2) proliferative phase
3) ovulatory phase
4) luteal phase
Mid of cycle FSH & LH reach peak
if NO fertilization progestrone ↓↓ endometrium become thick, blood vessels rupture & bleed occur
LH
FSH
Progestrone
estrogen
ovary
corpus luteum
3 – 5
menstrual phase
proliferative phase
luteal phase


start - puberty ⇒ menarch
MC 28 - 29 days
MC
ovarian changes
uterine changes
1) Follicular phase (follicular development)
2) luteal phase (Regeneration of endometrium)
Hypothalamus
Ant. pituitary
FSH
LH
ovarian Hormones
estrogen
progesterone


① menstrual phase
② proliferative phase
③ ovulatory phase
④ luteal phase
Mid of cycle FSH & LH reach peak
if No fertilization progestrone ↓↓ endometrium
become thick, blood vessels rupture & bleeding occur
LH
FSH
estrogen
Progestrone
ovary
corpus luteum
3 - 5
menstrual phase
proliferative phase
luteal phase



Menstrual cycle of 28 days

Changes in cervix and vagina during menstrual cycle

During proliferative changes m.m .of cervix becomes thinner& more alkaline ,it helps in the survival and motility of spermatozoa

During proliferative phase vaginal epithelium proliferates due to progesterone and these changes prevents infections of vagina

Hormones

GnRH stimulates secretion of FSH and LH

LH is important for ovulation

1)PMS

2)Amenorrhea

Is absence of menses

3)Menorrhagia

Is excess menstrual bleeding

4)Oligomenorrhea

Decreased frequency of menstrual bleeding

5)Dysmenorrhea

Menstruation with pain

Infertility is inability to produce offspring

Placenta is temporary membranous vascular organ that develops in females during pregnancy ,it is expelled after child birth

It is link between fetus and mother

1)PMS

2)Amenorrhea

Is absence of menses

3)Menorrhagia

Is excess menstrual bleeding

4)Oligomenorrhea

Decreased frequency of menstrual bleeding

5)Dysmenorrhea

Menstruation with pain

Pregnancy test

Test is to detect or confirm pregnancy .the basis of pregnancy test is to determine the presence of the human chorionic gonadotropin (hCG)in the urine of woman suspected for pregnancy

Immunological test

Presence of hCG is also determined by using immunological technique ,these test are based on double antigen –antibody reactions ,commonly done immunological test are known as gravindex test

Procedure

1. One drop of urine of hCG antiserum is taken on glass slide

One drop of urine from the woman who wants to confirm pregnancy is added to this and both are well mixed

2)Now one drop of latex particles is added to this and mix

(Latex agglutination is observed when a sample containing the specific antigen (or antibody) is mixed with an antibody (or antigen) which is coated on the surface of latex particles.

Result is determined by observing the agglutination of latex particles added to mixer of hCG antiserum and woman's urine

If hCG is present in urine ,it is agglutinated by antibodies of antiserum and all the antibodies are fully used up .no free antibody is available

Agglutination of hCG molecules by antibodies is not visible because it is colorless .

Later when latex particle are added ,these particles are not agglutinated because ,free antibody is not available ,thus absence of agglutination of latex particles indicate that woman is preganant

If urine without hCG is mixed with antiserum ,the antibodies are freely available ,when latex particles are added ,the antibodies cause agglutination of these latex particles ,agglutination of latex particles can be seen clearly even with naked eye ,thus presence of agglutination of latex particle indicate ,that the woman is not preganant

hCG antiserum

Urine from woman

latex particles

Agglutination	no agglutination
Pregnancy --	pregnancy positive

What is enzyme ?classification of enzymes ??actions of enzymes ????

Enzymes are soluble organic catalyst manufactured by living cell but their activities don't depend upon life of cell

All enzymes are protein in nature ,enzymes consists of two parts

1)Characteristic prosthetic group

2)Protein

Enzymes are soluble ,inactive at 0 °c

Destroy by moist heat at 100 °

Clinically the enzymes can be divided into two group

1)Simple protein enzymes

2)Complex protein enzymes or conjugated protein containing enzymes

There are six major classes of enzymes

1)Oxidoreductase

Enzymes catalyzing oxidoredction process between substrate A and B

(reversible chemical reaction in which one reaction is an oxidation and the reverse is a reduction)

- **Oxidoreductases** catalyze oxidation-reduction reactions. For **example**, an alcohol dehydrogenase catalyzes the oxidation reaction of ethanol to form an aldehyde.

Photosynthesis involves the reduction of carbon dioxide into sugars and the oxidation of water into molecular oxygen. The reverse reaction, respiration, oxidizes sugars to produce carbon dioxide and water.

Oxidoreductase are

a)Oxidases

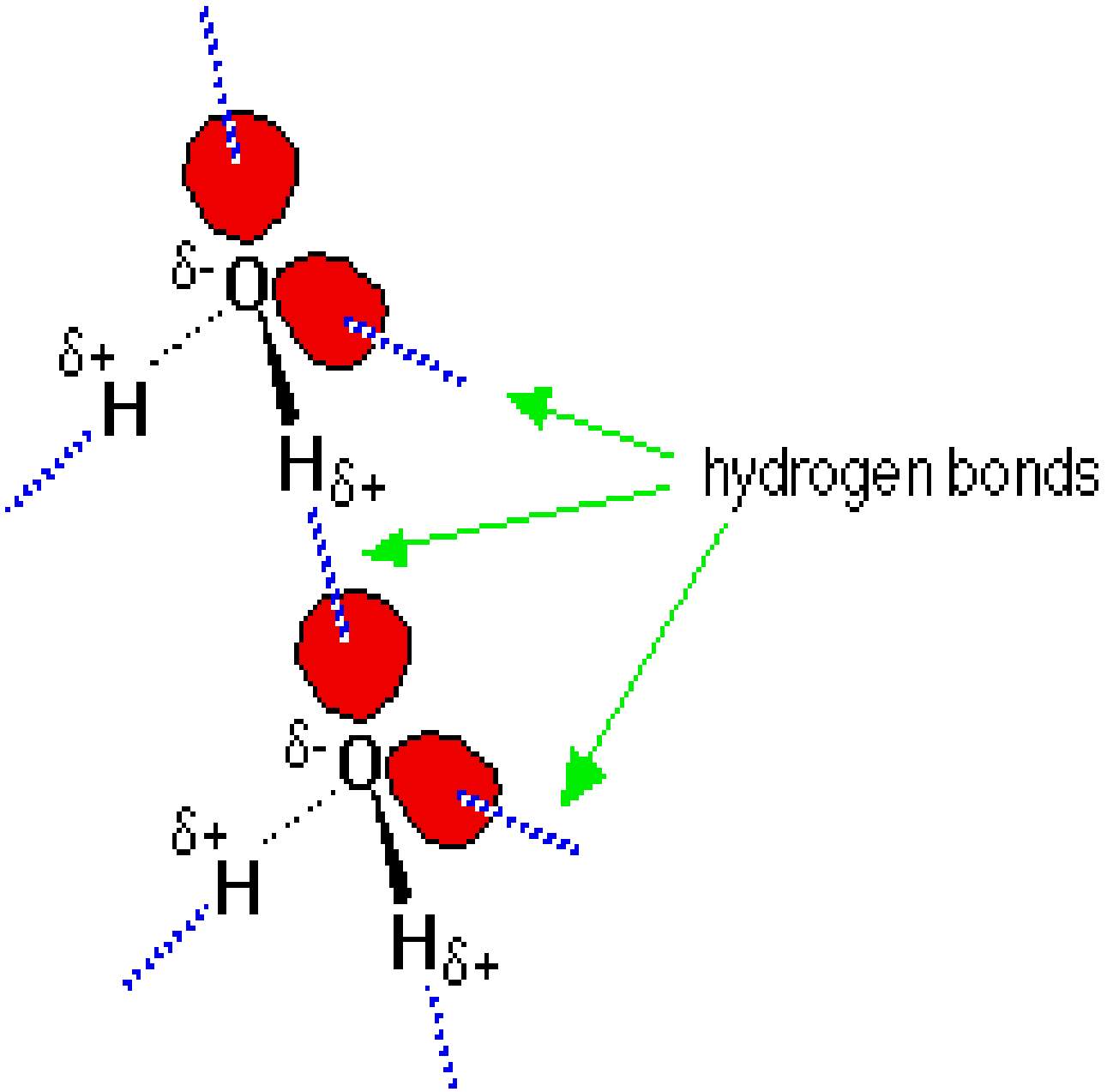
The enzyme which use O2 as hydrogen acceptor

- glucose oxidase
- Monoamine oxidase
- cytochrome P450 oxidase
- NADPH oxidase
- Xanthine oxidase
- L-gulonolactone oxidase
- Uricase

b) Anaerobic dehydrogenase

The enzyme which use some other substance as hydrogen acceptor

(The **hydrogen acceptor** is the neighboring electronegative ion or molecule)


δ-
O
δ+
H
H
δ+
hydrogen bonds
δ-
O
δ+
H
H
δ+

for **example**,

lactate **dehydrogenases**,

isocitrate **dehydrogenases**,

c)Hydroperoxidases

This enzyme which use hydrogen peroxidase as substrate

Example :

Peroxidase

d)A reobic dehydrogenases

The enzyme which use either O2 or another hydrogen acceptor

Dehydrogenation is a chemical reaction that involves the removal of hydrogen from an organic molecule. It is the reverse of hydrogenation. .r substance as hydrogen acceptor

Example :

Aldehyde oxidase

Xanthine oxidase

2)Transfereses enzyme

which catalyses the transfer of a particular group from one molecule to another.

This include

a)Trans phosphorylases

(phosphorylation of a molecule is the attachment of a phosphoryl group)

Hexokinases ,phosphoglyeracte

b) Trans glycosidase

Phospho-Phosphorylases

c) Transaminases

Glutamate pyruate transaminase

d) Transacylse

Choline acetyl transferase

3)Hydrolyses

Enzyme catalyzing hydrolysis of ester ,ether or peptide

(the chemical breakdown of a compound due to reaction with water.)

ex…. Renin ,chymotrypsin

A class of lyases comprising enzymes that remove H and OH as water; the process leads to formation of new double bonds within the affected molecule

4)Isomerases

Isomerase are a general class of enzymes that convert a molecule from one isomer to another.

Isomerase facilitate intermolecular rearrangements in which bonds are broken and formed

Ex. retinine isomerase

- each of two or more compounds with the same formula but a different arrangement of atoms in the molecule and different properties.

isomerization (also **isomerisation**) is the process by which one molecule is transformed into another molecule which has exactly the same atoms, but the atoms have a different arrangement

5)Lyases

Enzymes catalyze removal group from substrate by mechanism other than hydrolysis leaving double bonds

Or an enzyme which catalyses the joining of specified molecules or groups by a double bond.

Example :

Aldehyde lyases i.e. aldolases

Carbon oxygen lyases i.e.fumerase

6) ligase

is an enzyme that can catalyze the joining of two large molecules by forming a new chemical bond

Enzymes catalyzing formation of c-s bond i.e. succinate thiokanse

Properties of enzymes

1)Enzymes are proteins

2)Protein part apoprotein and prosthetic group --coenzymes

Combination of apoenzymes and co enzymes are called **haloenzymes**

3) Enzymes are biological **catalysts** that carry out thousands of **chemical reactions**, which occur in living cells.

4) Enzymes are large **protein molecules** with specific three-dimensional **structures**

How enzymes act?????

The following are the facts about mode of enzymes

1)During enzymes action

Chemical or physical union between the enzymes and the substrate

Substrate means the main chemical compound undergoes alteration in a chemical reactions ,upon which enzyme exerts its influence

2) The active radical of enzyme probably attacks some characteristic grouping in the substrate

3) Enzymes work with the help of substance ,such **as co-enzymes**

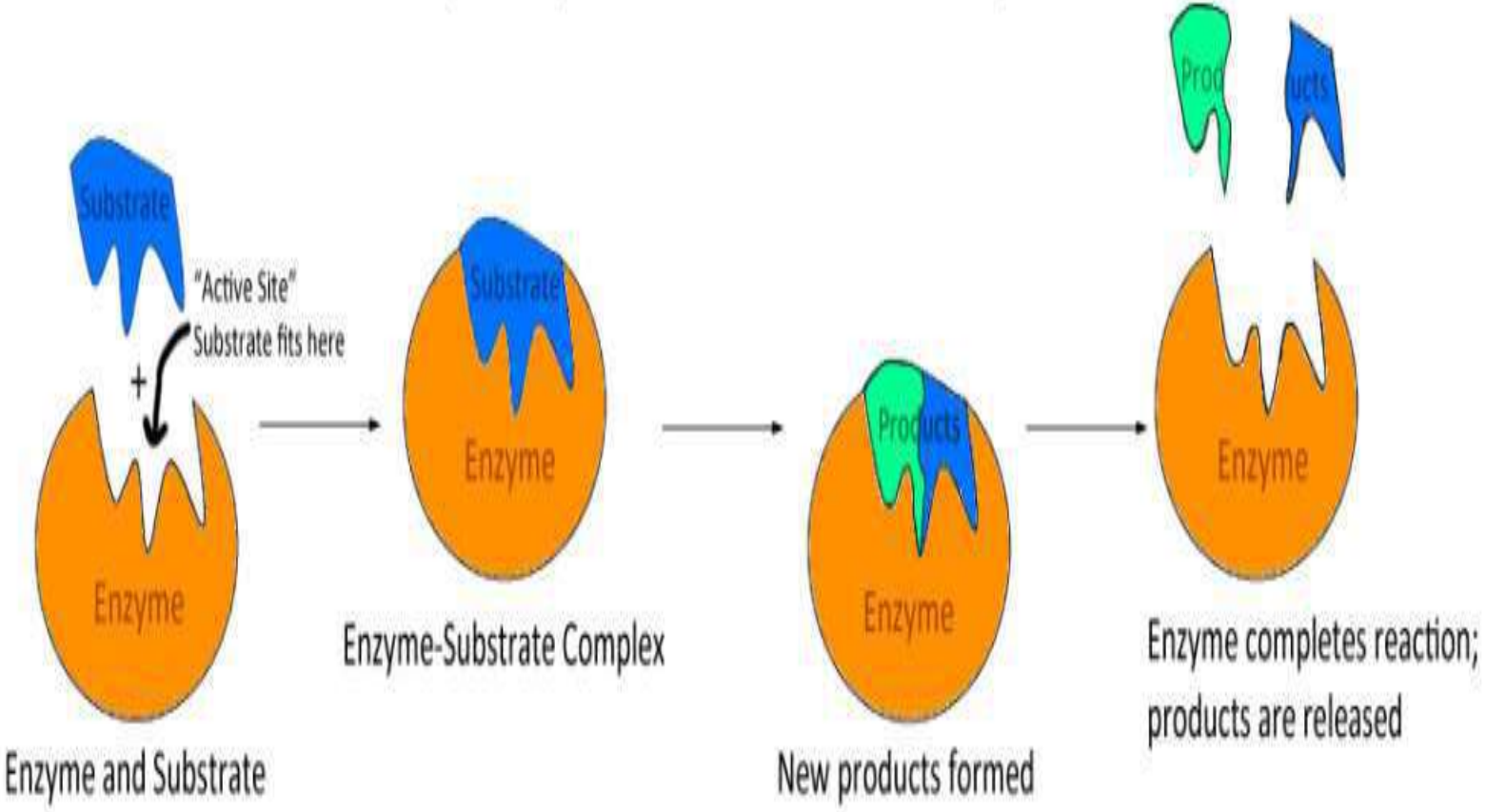
Enzymes may cause both synthetic as well as breakdown process

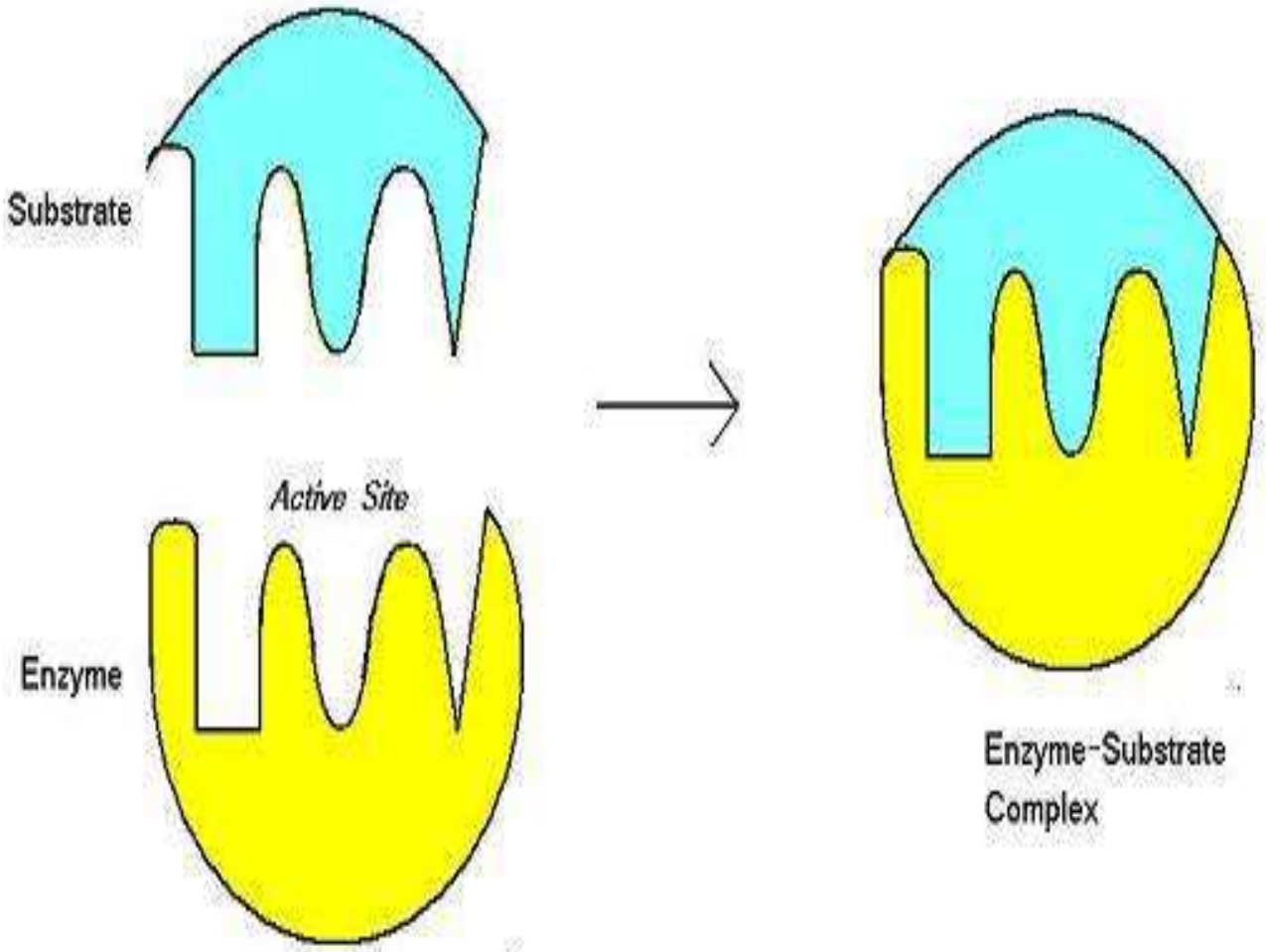
Mechanism of action of enzyme is based on **Michaelis-Menten** kinetic **theory of enzyme action**

Enzyme –substrate complex theory

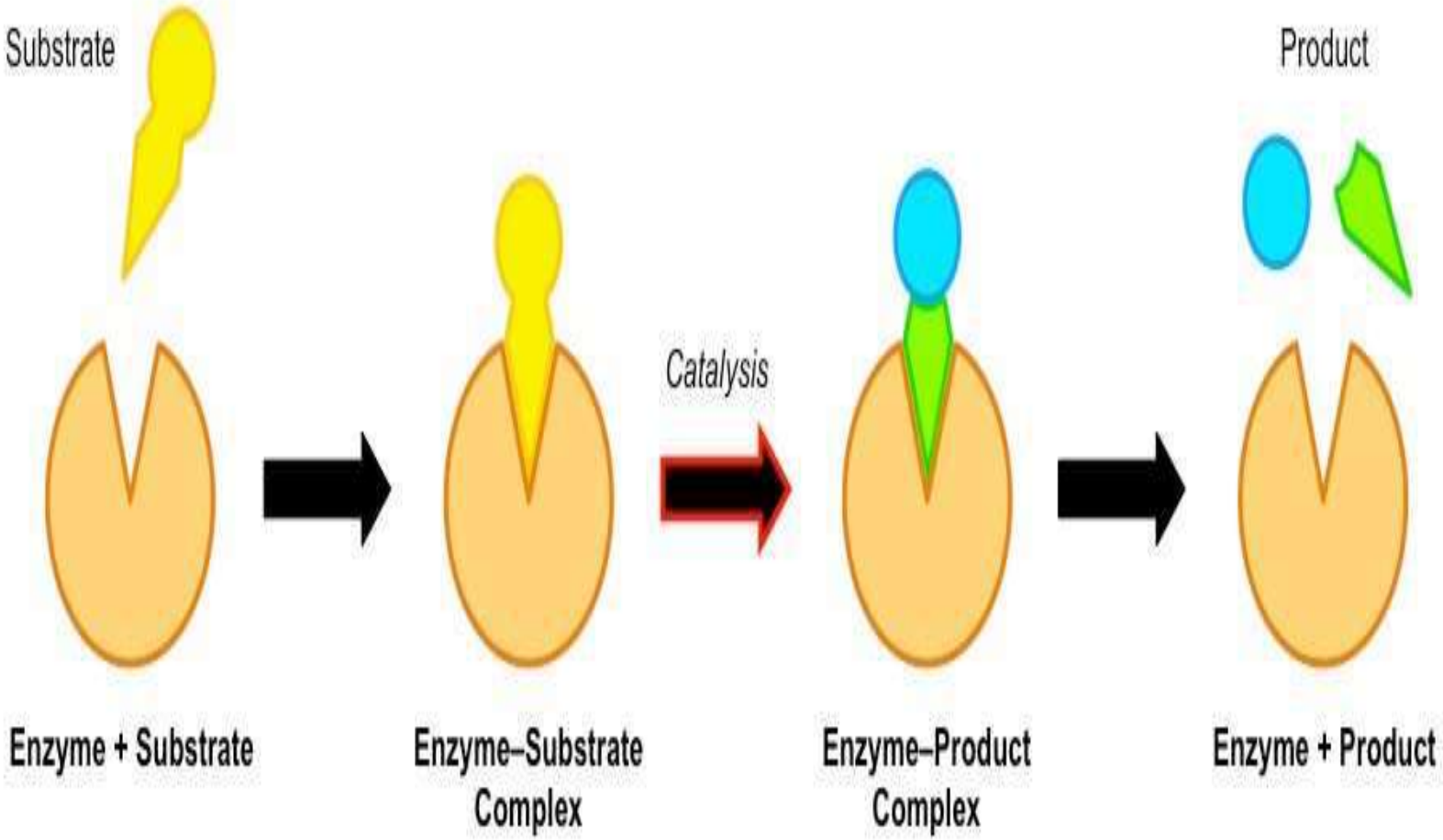
The Lock and Key Theory of Enzymes and Substrates

Substrate= "Key" Enzyme= "Lock" Active Site= "Key hole"





Lock-and-key Model.- The substrate and enzyme active site have complementary shapes


Substrate
Product
Catalysis
Enzyme + Substrate
Enzyme–Substrate Complex
Enzyme–Product Complex
Enzyme + Product

Factors affecting enzymes

1) Relation between enzymes and substrate on which they act
2) Effects of temp.
3) Effects of PH
4) Effects of activators
5) Feects of inhibitors

Pregnancy test

Test is to detect or confirm pregnancy .the basis of pregnancy test is to determine the presence of the human chorionic gonadotropin (hCG)in the urine of woman suspected for pregnancy

Introduction:

- Pregnancy tests are based on the detection of the human chorionic gonadotropin (hCG).

- Human chorionic gonadotropin (**hCG**) is produced by the placenta shortly after fertilization and reaches detectable levels in urine and serum about 1 week after **implantation** attachment of the early embryo to the uterine lining.

- Levels of hCG continue to rise during the first trimester of pregnancy, making it an excellent marker for pregnancy.

Specimens :

- Pregnancy tests can be done by either in **urine** or in **blood** samples.

- Both tests detect the presence of a hormone called human chorionic gonadotropin (hCG).

HUMAN CHORIONIC GONADOTROPIN

- Hormone secreted by the chorionic cells after fertilization of ovum.
- Primary function is to support the corpus luteum until the placenta produces amounts of progesterone sufficient to support the pregnancy.
- The hormones appears in urine and serum after 9 days of conception, reaches a peak between 7^{th} and 12^{th} week of gestation, after which it decreases

Immunological test

Presence of hCG is also determined by using immunological technique ,these test are based on double antigen –antibody reactions ,commonly done immunological test are known as gravindex test

- Latex particle agglutination inhibition assay
- In his assay, latex particles coated with hCG serum and patients urine.
- In pregnancy, the hCG in urine will neutralize with hCG, so there will be no agglutination with hCG coated latex particle.
- Thus no agglutination indicates a positive test (ie., presence of hCG in patients urine) and agglutination indicates a negative test.

Urine Tests :

- Urine specimen must be collected without preservatives in a clean dry container. First morning urine usually contains the highest concentration of hCG, however, urine collected at any time during the day may be used.

- If the sample put the collection container into the refrigerator (fridge), the sample will be rejected. fridge urine leads to less accurate results because stone forming salts become crystallized (from the cold) and thus the results are less viable.

Blood Tests:

- A quantitative blood test measures the exact amount of **Beta** hCG in the blood by ElectroChemiLuminescence (ECL)-based immunoassays.
- And a qualitative hCG blood test gives a simple positive or negative result to whether pregnant or not (By **stripes** & **cassettes).**

1-Pregnancy Test by Strips or Cassette

- It is a rapid chromatographic immunoassay for the qualitative detection of human chorionic gonadotropin in urine or serum to aid in the early detection of pregnancy.

- These pregnancy tests are specifically designed for professional users (doctors, clinics, family planning centers) for determination of early pregnancy, but have also found a place in **home pregnancy testing** applications due to ease of use and low cost.

- The specificity is 98% meaning that test is highly selective for hCG glycoprotein.

Principle:

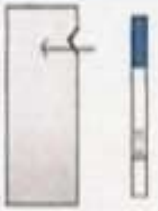
- The test uses two lines to indicate results; this test is conductive by immersing the test strip in a urine or serum specimen and observing the formation of colored lines.

- The specimen migrates via capillary action along the membrane to react with the colored conjugate.

- Positive specimens reacts with the specific antibody –hCG colored conjugate to form a colored line at the test line region of the membrane. Absence of this colored line suggests a negative result.

Procedure:

1. Remove the testing device from the foil pouch by tearing at the notch. Hold the strip by the colored end.



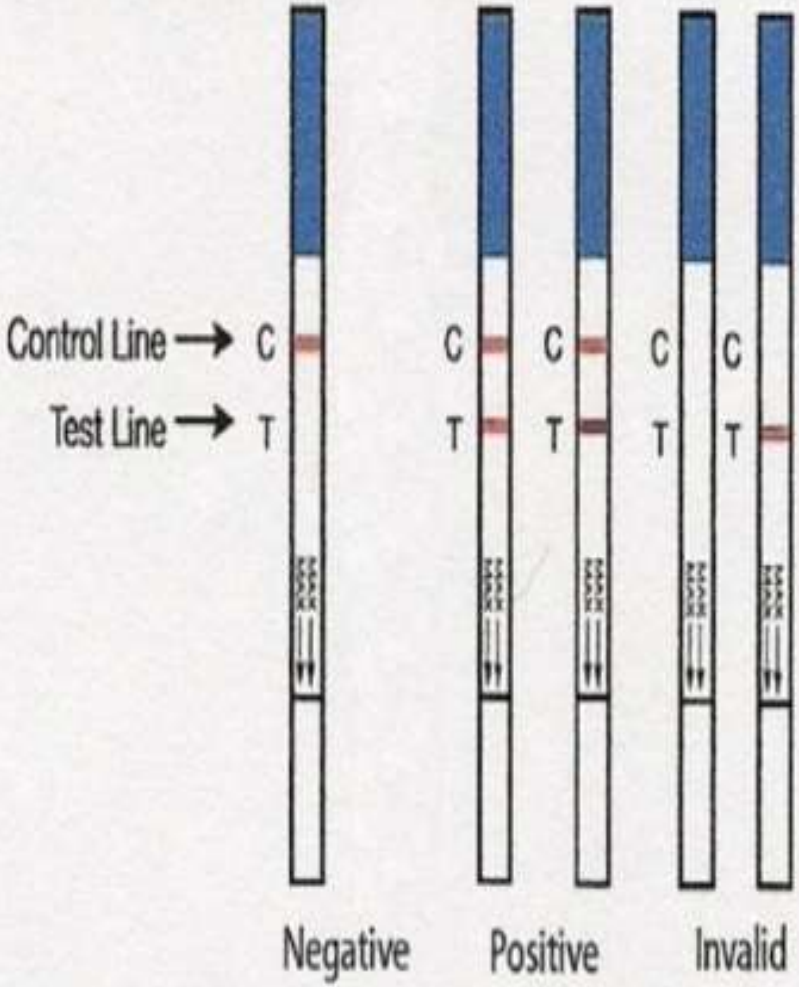
2. Immerse the strip into the urine with the arrow end pointing towards the specimen. Do not immerse past the MAX line.

3. Take the strip out after a minimum of 10 sec. and lay the strip (MAX side facing up) flat on a clean, dry, non-absorbent surface.

4. Read the test result in 10 minutes. Ensure that the background of the test area is white before interpreting the result.

DO NOT INTERPRET RESULTS AFTER 30 MINUTES

RESULT INTERPRETATIONS



Negative
Only one pink colored band appears at the control region

Positive
Distinct pink colored bands appear at the control and test line regions, and the test band is equal to or darker than the control band.

Invalid
No visible band at control region. Repeat with a new test device.

Not Pregnant

Pregnant

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- Thus no agglutination indicates a positive test (ie., presence of hCG in patients urine) and agglutination indicates a negative test.

METHODS FOR MEASURING β-Hcg LEVEL

1. Bio-assays
2. Immuno-assays
3. Radio immuno-assays
4. Radio receptor assays
5. Immuno metric assays