NEET RANK COMPANION

Practice Smart | Rank Higher

BIOLOGY

For NEET (UG)

Aligned with Latest NCERT & NEET Pattern

HUMAN REPRODUCTION

2. Human Reproduction

INTRODUCTION

To continue its own race, an organism by the process of reproduction, produces off springs like its own. In sexual reproduction the organisms produce male and female gametes which on combining, develop into a new individual. The formation of gametes takes place in the reproductive organs.

- **Embryology** is the branch of biology which deals with the study of all those processes, which take place during development of fetus.

A. PRIMARY SEX ORGAN

- **Essential** organs which form the gametes. In males, the gamete forming organs are the testes. In females, the corresponding organs are ovaries.
- The male gametes is spermatozoon. The female gamete is ovum.

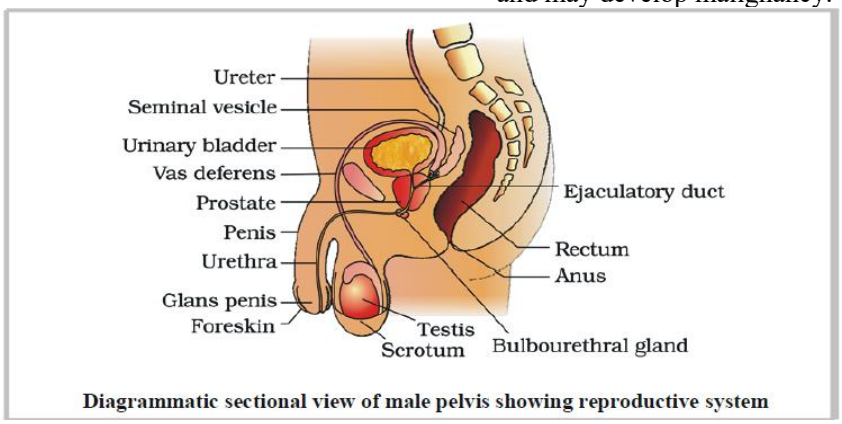
B. SECONDARY SEX ORGAN

- These organs from the passage for the gametes to help the union of male & female gametes.
- In male these include epididymis, vas deferens, seminal vesicles, prostate, bulbo-urethral glands & penis. In female these organs are fallopian tube, uterus and vagina.
- **Development of Sex organ :**
- During intra uterine life (IUL) testis & ovary develop from mesoderm. They develop in abdominal cavity. At the time of birth, testes descend down into scrotal sac but ovaries remain in abdominal cavity.

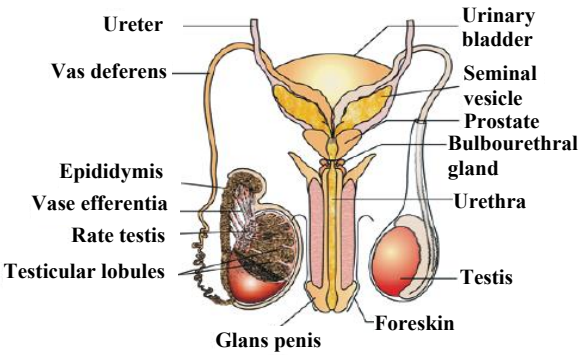
THE MALE REPRODUCTIVE SYSTEM

SCROTAL SAC & TESTES

- In man, one pair testes are the main or primary reproductive organ. Size 4-5 cm × 2-3 cm
- Both testes are located in a small bag like structure situated below & outside the abdominal cavity called as scrotum or scrotal sac. The temperature of scrotum is 2 to 2.5 lesser than body temperature.
- Internally scrotum is lined by darts muscle & spermatic fascia.
- Darts muscle helps in regulation of the temperature
  with in the scrotum during cold season,
- It becomes contracted in cold & during warm season, it becomes relaxed.
- Cremaster muscles line inside the wall of scrotal & inguinal canal region and help in elevation of testes.
- Each testis is attached to the walls of the scrotal-sac through flexible, elastic fibres. This group of fibres is called Gubernaculums or Mesorchium.
- Each testis is attached to the dorsal body wall of the abdominal-cavity through a cord termed as the **Spermatic-cord**. This cord is made up of elastin fibres & spermatic fascia. The contents of cord are vas deferens, gonadial veins, gonadial arteries, nerves and lymphatics.
- **Cryptorchidism :**
  During embryonic stage, testes develop in abdominal cavity & they descend to reach the scrotum at the time of birth. When the testes does not descend to reach the scrotum but remain in abdominal cavity at the time of birth this condition is called **undescended testes** or **cryptorchidism**. Such testis cannot develop and function properly and may develop malignancy.



Diagrammatic sectional view of male pelvis showing reproductive system



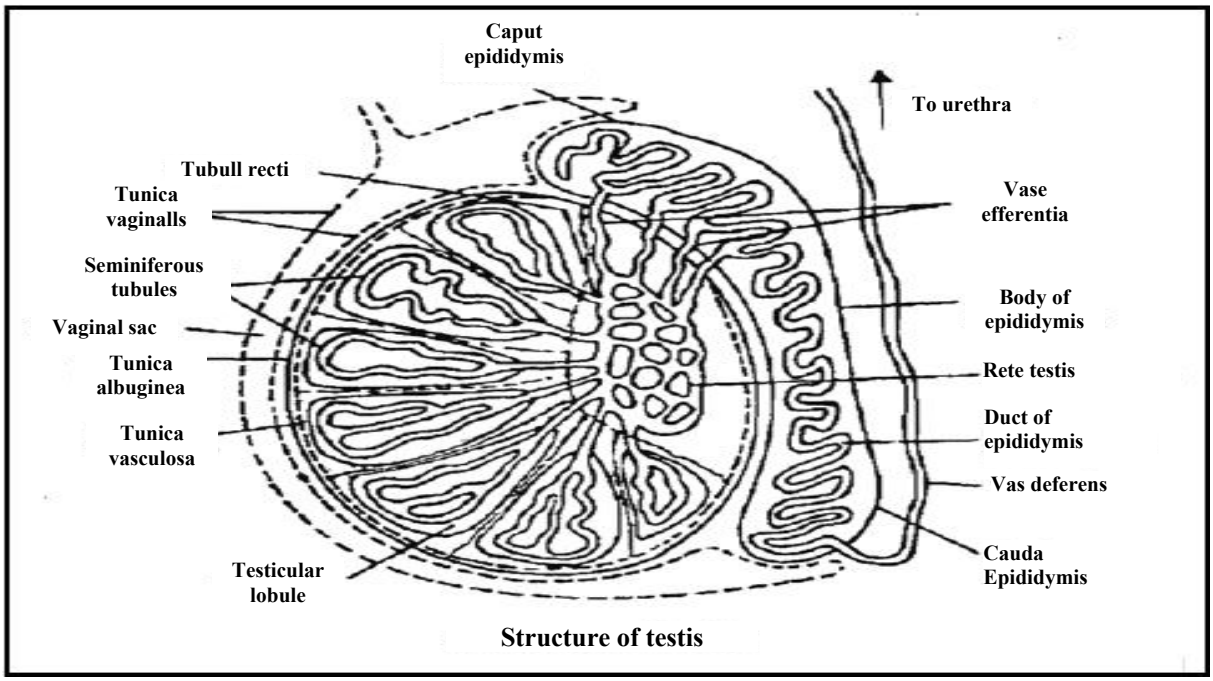
Diagrammatic view of male reproductive ststem (part of testis is open to show details)

- **Orchiopexy :**
  When the undescended testes are brought into scrotal sac by surgical process during childhood this process called as orchiopexy.
- **Castration :**
  Crushing of testes in bulls to convert them to bullocks. (This makes them more obedient due to fall in the level of testosterone)

- Each scrotum is connected to the abdominal cavity through a passage termed as inguinal-canal. Through this canal the testis descend down into the scrotal sacs at the time of birth.
- Spermatic cord in males passes through the inguinal canal.
- Sometimes the inguinal canal may tear leading to abnormal protrusion of abdominal contents like loops of intestine into the inguinal canal. This condition is called as **inguinal hernia**.

INTERNAL STRUCTURE OF TESTIS

- Testis is covered by three coats. Outer most is tunica vaginalis. Middle coat is tunica albuginea & inner most is tunica vasculosa.
- **Tunica vaginalis** has a parietal & visceral layer. It covers the whole testis except it's posterior border from where the testicular vessels & nerves enter the testis.
- The **Tunica albuginea** is a dense, white fibrous coat covering the testis all around. The posterior border tunica albuginea is thickened to form vertical septum called the **Mediastinum testis**.
- **Tunica vasculosa** is the inner most vascular coat of the testis lining testicular lobules.
- Each lobule has 2 to 3 seminiferous tubules, which join together at the apices of the lobules to form straight tubules or tubulirecti which enter the mediastinum.
  Here they form a network of tubules called as **rete testis**. Rete testis fuse to form 10 to 20 efferent ductule called as **vasa efferentia or ductuli efferentes**. These ductules come out from upper dorsal surface of testis & open into common tubules, which get highly coiled to form epididymis or ductus epididymis. This epididymis is responsible for functional maturation of sperm.



Structure of testis

- Total number of seminiferous tubules in each testis is about 750 to 1000.

EPIDIDYMIS

(i) Upper, highly coiled part - Caput epididymis or Globus-major

(ii) Middle part - Corpus epididymis

(iii) Basal, least coiled part - Cauda epididymis or Globus minor

- Cauda-epididymis, enters inside the abdominal-cavity from the scrotal-sac in the form of **Vas deferens** or ductus deferens. Terminal dilated part of vas deferens are called **ampulla**. Vas deferens and Epididymis both develop from the **wolfian-duct** of **mesonephros. Epididymis can temporarily store the sperms for as long as one month and here the functional maturation of sperms takes place**. 18 to 24 hr. after functional maturation of sperm, sperms proceed further to store in vas deferens, specially in its ampulla part.
- The wall of epididymis is made up of 2 layers-outer circular muscle layer and inner epithelium. Wall of vas-deferens is also made up of 2 layers-outer circular muscle layer and epithelium. The sperms reach the abdominal cavity due to the pulsation of the vasa deferens.
- Cutting of the vasa-deferens & tying it by a thread is termed as **vasectomy**. Cutting & tying of the oviducts is termed as the **tubectomy**.

VAS DEFERENS

Vas deferens runs upward & enter into abdominal cavity. Both vas deferens coil around the ureter of their respective sides and then dilate to form ampulla. Ampulla of each side receives the seminal vesicle of that side. The vas deferens now forms ejaculatory duct and opens into prostatic urethra.

- In human 1 pair of seminal vesicles are situated on dorsolateral side of urinary bladder which open separately before the terminal ends of vas deferens.

So terminal ends of vas deferens meet to form a single ejaculatory duct.

URETHRA

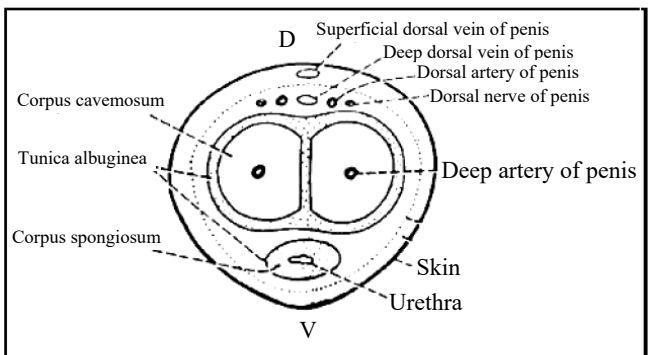
The male urethra provides a common pathway for the flow of urine and semen, the combined secretions of the male reproductive organs. It is about 19 to 20cm long and consists of three parts, prostatic urethra, membranous urethra and penile urethra. The first part starts at urethral orifice of bladder and pass through prostate gland. The second part is the shortest which extends from prostrate to penis. The penile urethra is located within the corpus spongiosum of the penis and terminates at the external urethral orifice in the glands penis. The sperms are carried to the urethra by the sperm duct. The urethra carries both sperm and urine.

PENIS

- Urethra continues in a muscular & tubular organ called as **penis**. Terminal part of shaft of penis is bulging, it is called as **Glans penis**. This glans penis is covered by a movable skin called as **prepuce or foreskin**.
- A special type of sebaceous gland is found on the prepuce called **preputial gland** which secretes **smegma**. Removal of prepuce by surgery is called is **circumcision**.
- Prepuce is attached to the base of glans with the help of an elastic cord like membrane called **Frenulum prepuce.**
- In penis of some animals a bone is present called **Baculum** and such a penis is called **Os-penis** e.g. Whale, Bat, Rat etc. The penis of opposum, Bandicoot etc. is double branched (Bifurcated).
- Penis is an erectile copulatory intromittent organ. Root of the penis containing muscles is called crura. Penis consists of a long shaft that enlarges to form an expanded tip called the glans penis.

Body of Penis :

- It is composed of three longitudinal cylindrical masses of erectile tissue. These masses are, the right & left corpora cavernosa & a median corpus spongiosum.
- The two corpora cavernosa do not reach the end of the penis. Each of them terminates under cover of the glans penis.
- The corpus spongiosum continues further, its terminal part is expanded to form a conical enlargement called the **glans penis**. Through out its whole length it is traversed by the **urethra**.
- The base of the glans penis has projecting margin the **corona glandis**.
- External opening of penis is called penile/urethral meatus.
- **Erection of Penis :**
- Erection of penis is purely vascular phenomenon and is controlled by A.N.S. It occurs due to increase of blood supply, due to dilation of penile arteries causing enlargement and hardening of penis during this time the muscles of crura are relaxed.

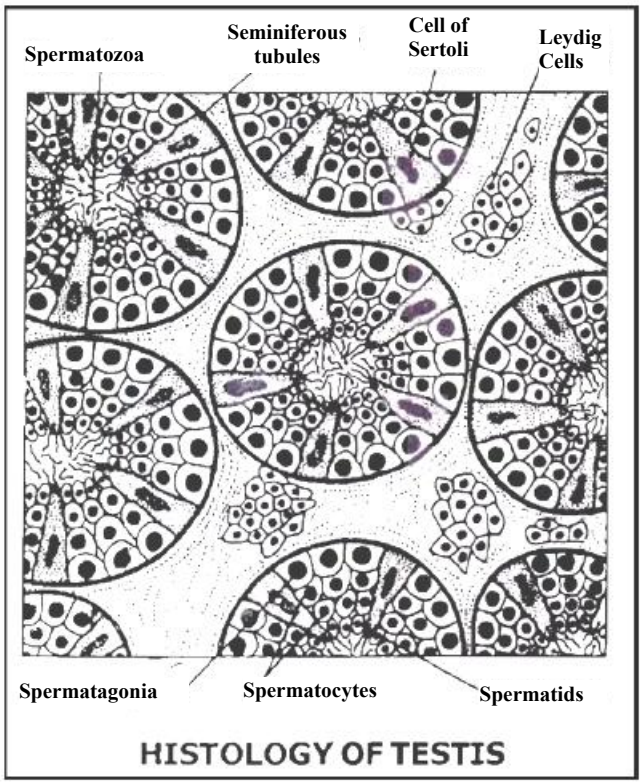


Transverse section through the body of the penis

HISTOLOGY OF SEMINIFEROUS TUBULES

- Outer surface of seminiferous tubules is composed of white fibrous connective tissues called as **tunica propria**. While inner surface is of cuboidal germinal epithelium. This epithelium is made of permatogenic cells which forms sperm by spermatogenesis. Some columnar cells are found in the layer of germinal epithelium called as **Sertoli cells**. These provide nutrition to sperm, so they are also called as **sub-tentacular or sustentacular** or **nurse cells** (these occur in mammals).

- **Other function of Sertoli cells –**
  (1) They phagocyte the injured or dead sperm cells
  (2) They are the basis of blood testis barrier
  (3) Sertoli cells produce inhibin and antimullerian hormone.



HISTOLOGY OF TESTIS

  (4) Sertoli cells can synthesize estrogen from testosterone. Some endocrine cells are found between Seminiferous tubules in inter-tubular space, these are called as **interstitial or Leydig cells**. These cells secrete **testosterone**. The testosterone from Leydig's cells enter the seminiferous tubules by diffusion under the effect of ABP & promotes spermatogenesis.

MALE ACCESSARY REPRODUCTIVE GLAND

The substances secreted by the accessory reproductive glands help in reproduction, these are–

1. **Seminal vesicle**
   It is also called **Uterus-masculinus**. It from the Mullerian-duct of the embryo. In females, these ducts form the oviducts. Internally, it is lined by glandular epithelium which secretes seminal fluid, which is lubricating, transparent & jelly like substance, which makes 60–70% part of semen. It is slightly alkaline (pH 7.3). **Fructose** is found in seminal fluid, it act as fuel to sperm. Fibrinogen, prostaglandin, citrate, and several proteins are also present in semen.
2. **Prostate gland**

- This gland is located below the urinary bladder. It is unpaired & made up of 5 lobes in man. In Rabbit 3 or 4 lobe are found. Each lobe opens into prostatic urethra through many fine apertures. It secretes slightly alkaline prostatic fluid which is milky, thick, sticky or jelly like. It makes about 30% part of semen and helps in sperm activation.
- In the secretion of prostate-gland citric acid, Calcium and phosphate, clotting enzyme and profibrinolysin are present. The secretion of the prostate gland combines with the secretion of seminal vesicle and so the semen gets coagulated. In the coagulated semen, the mobility of sperms is reduced and so their energy is conserved. After some time due to fibrinolysin, semen again liquefies and in this semen now the sperms can move.

3. **Cowper's glands**
   It is a pair of glands found on lateral side of urethra. It is also called as **bulbo-urethral gland**. It is situated in membranous part of urethra & opens into penile urethra. It secretes transparent, slimy, jelly like fluid. It is slightly alkaline (pH is 7.2). This destroys the acidity of the urethra and cleans it for the movement of sperms.
   Semen – Semen = Sperm + Accessory reproductive gland fluid Volume = 3 to 4 ml,
   pH = 7.3
   Normal sperm count 20 to 120 million/ml.
   Oligospermia < 20 million/ml.
   Azospermia – either absence or near absence of sperms. Asthenospermia – Reduced motility of sperms in semen
   Teratospermia – sperms with abnormal morphology

Note

The human male ejaculates about 200 to 300 million sperms during a coitus of which for normal fertility at least 60 percent sperms must have normal shape and size and at least 40 percent of them must show vigorous motility.

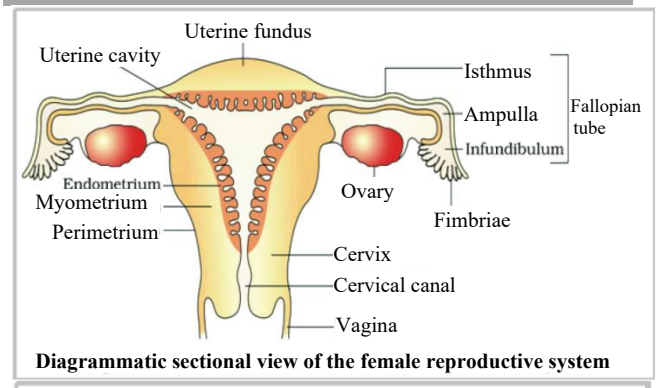
MEMORY BOSTER

1. **Orchiopexy :** When the undescended testes are brought into scrotal sac by surgical process during childhood this process called as orchiopexy.
2. Cutting of the vasa-deferens and ligation is termed as vasectomy.
3. Erection of penis is controlled by parasympathetic nervous system.
4. Ejaculation of semen is controlled by sympathetic nervous system.

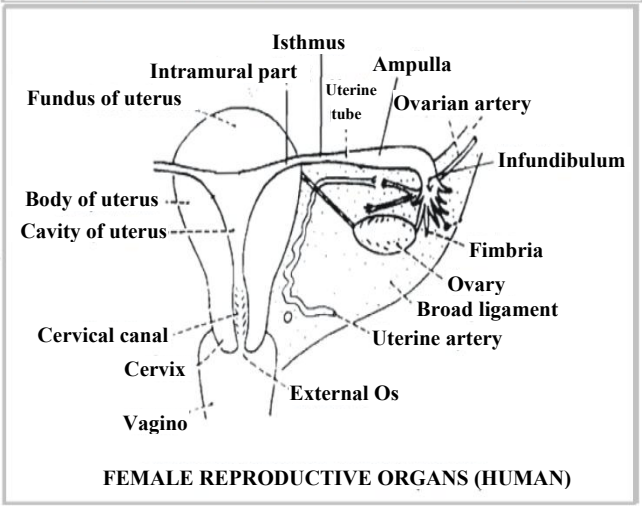
LEARNING BOOSTER-1

1. Partitions of testis develop from
   (1)tunica albuginea (2)tunica vasculosa
   (3)tunica vaginalis (4) rete testis
   [1]
2. Vas deferens arises from
   (1)cauda epididymis (2)caput epididymis
   (3)corpus epididymis (4) rete testis
   [1]
3. Testosterone is secreted by the
   (1) Leydig's cells (2) Sertoli cells
   (3) Pituitary gland (4) Testis
   [1]
4. In between spermatogonia are found
   (1) Germinal cells (2) Sertoli cells
   (3) Epithelial cells (4) Lymphatic space
   [2]

FEMALE REPRODUCTIVE SYSTEM



Diagrammatic sectional view of the female reproductive system



FEMALE REPRODUCTIVE ORGANS (HUMAN)

A. Ovary

- A pair of ovaries is the main or primary sex organ of female reproductive system. Both ovaries are located in abdominal cavity in the ovarian fossa. Each ovary is attached to the posterior layer of broad ligament (Peritoneal ligament) with the help of mesovarium. It is short fold of peritoneum & it is the route of vessels & nerves to ovary.

B. Oviduct

- A tubule is situated near the ovary. It is also attached with broad ligament, this tubule is called as **oviduct**. Oviducts develop from the Mullerian-duct of the embryo. In mammals this oviduct is differentiated into two part. It's proximal (towards ovary) narrow & thin part is called as **uterine tube or fallopian tube**.
- The lateral end of tube is funnel shaped & called as **infundibulum.** Its fimbriated & terminal end bears aperture called as **abdominal ostium** which opens into peritoneal cavity. The part medial to the infundibulum is called **ampulla**, it is a thin walled dilated part of tube. Fertilization takes place in the ampulla. The part medial to ampulla is called **isthmus.** The most medial part of this tube situated in the uterus is called **intramural or interstitial part of tube.** During ovulation, the ova are released in the peritoneal cavity, due to this it is called **coelomic egg.** The distal & dilated part of oviduct forms the **uterus**.

C. Uterus

It is pyriform (inverted pear) shape, the upper expanded part is called as body or fundus while lower cylindrical part is called as **cervix**.
Upper part of uterus forms the body while lower part forms cervix.

- The cervix communicates with the vagina through an opening called **external Os.**
- The uterus open into a fibro-muscular & non glandular tube like organ called **vagina** (Copulatory organ).

D. Vagina

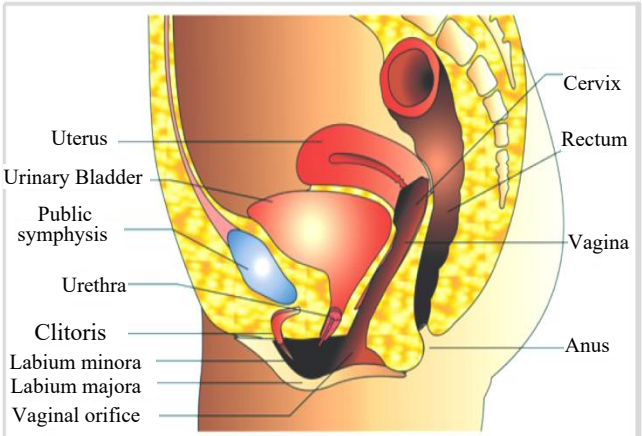
- The vagina is lined by a stratified squamous epithelium without any glands. During reproductive life the vagina contains lactobacillus acidophilus or dorderlein's bacilli which keeps the vaginal pH 'between 4 to 5 by producing lactic acid from glycogen.

E. External Genitalia (Vulva)

- Vulva means external genitalia of female. They include mons-veneris, labia majora, labia minora, clitoris, vestibule & related perineum.

MONS VENERIS (MONS PUBIS) :-

- It is a pad of sub-cutaneous connective tissue, lying in front of pubis & is covered by pubic hairs in adult female.



Diagrammatic sectional view of female pelvis showing reproductive system

- On internal surface of cervix 2 types of constrictions are found which form the **Os–cervix.**
- The body of uterus communicates with the cervix through opening called **internal Os**.

Labia Majora:-

- Vulva is bounded on each side by the elevation and folds of skin & subcutaneous tissue.
  Its inner surfaceis hairless.
- Outer surface is covered by sebaceous gland, Sweat Gland & hair follicles.
  It is homologous with the Scrotum in the male.

Labia Minora:-

- They are two thin folds of skin present just within the labia majora. Lower portion of minora fuses across the midline & form a fold of skin called **four chette**.

Clitoris :-

- Small cylindrical & erectile body made by fusion Of two labia minora, situated in the most anterior part of vulva.
- Clitoris is a **homologous** to the penis in the male. It is also made up of two erectile bodies (corpora cavernosa). The skin which covers the glans of clitoris is called **prepuce**.
- At the terminal part of vagina the urethra opens separately, so they form a common chamber called **vaginal vestibule or urino genital sinus.** Vagina opens outside through a slit like aperture or triangular space called vestibule. The vulva has following openings :-

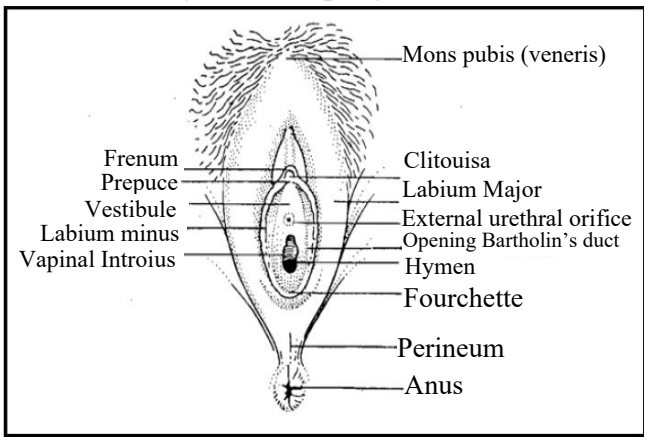
(a) Urethral opening – Lies on anterior end

(b) Vaginal orifice – Lies on posterior end.
It is incompletely closed by a septum of mucous membrane called **hymen,** but it may not be a true sign of virginity.

(c) Openings of Bartholin; duct on either side

Bartholin Glands :

- It is homologous to **Cowper gland** of male



HISTOLOGY OF OVIDUCT :

I. Serosa or the adventitia :-
It is the outermost layer of visceral-peritoneum **(Perimetrium)**

II. Muscle-layer :-
The middle layer of the oviduct is made up of unstripped-muscle. In uterus, thick smooth muscle bundles are found, these are called as **myometrium.**

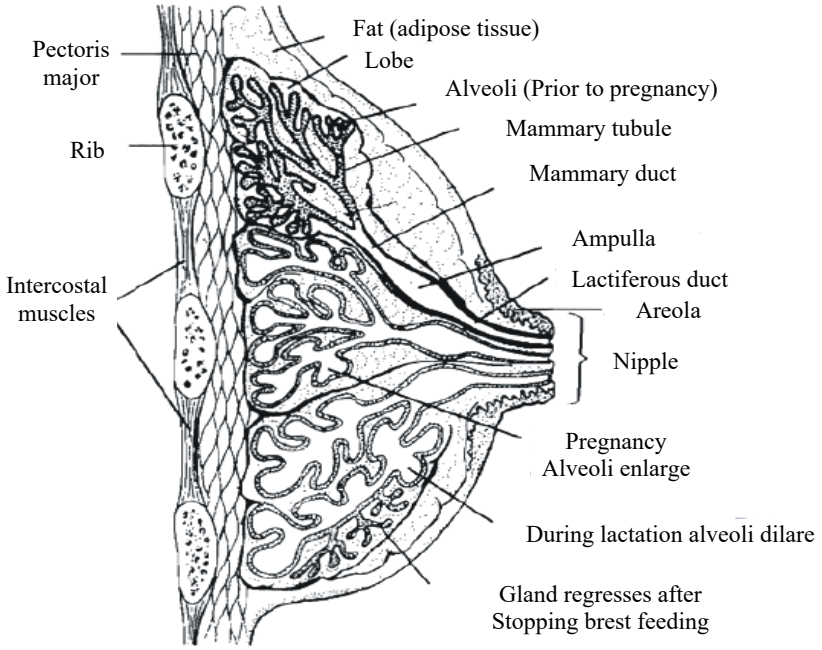
III. Mucous membrane :-
It is the innermost layer. Mucosa consists of simple columnar epithelium. Epithelium contains both ciliated cells & secretory cells. The secretory cells produce viscous liquid film that provides nutrition & protects the ovum. Mucosa of Uterus is called **endometrium**, it contains tubular glands, many fibroblasts & blood vessels. In the uterus, the embryo is attached to endometrium. Longest unstripped muscles of the body are found in the walls of uterus. (During pregnancy)

BREAST

- A functional mammary gland is characteristic of all female mammals. The mammary glands are paired structures (breasts) that contain glandular tissue and variable amount of fat.
- The glandular tissue of each breast is divided into 15-20 mammary lobes containing clusters of cells called alveoli (Figure). The cells of alveoli secrete milk, which is stored in the cavities (lumens) of alveoli.
- The alveoli open into mammary tubules. The tubules of each lobe join to form a mammary duct. Several mammary ducts join to form a wider mammary ampulla which is connected to lactiferous duct through which milk is sucked out.
- Mammary glands produce a nutritive fluid, milk for the nourishment of young ones. Milk protects the young ones from various infections upto some months after birth The mammary glands of the female undergo differentiation during pregnancy and starts producing milk towards the end of pregnancy by the process called lactation. This helps the mother in feeding the newborn. The milk produced during the initial few days of lactation is called colostrum which contains several antibodies absolutely essential to develop resistance for the new-born babies. Breast-feeding during the initial period of infant growth is recommended by doctors for bringing up a healthy baby.

Structure of a Lobule

Many alveoli or acini
↓
Many mammary tubules
↓
One mammary ducts
↓
One mammary ampulla
↓
One lactiferous duct which pens on surface of nipple



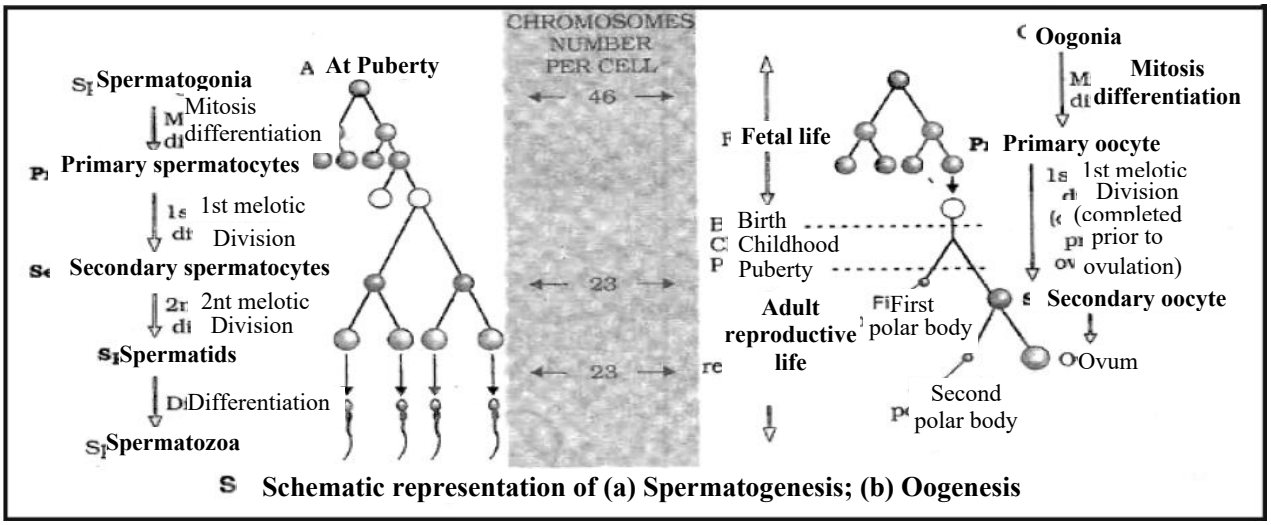
MEMORY BOOSTER

1. Longest unstripped muscles of the body are found in the walls of uterus. (During pregnancy)
2. Clitoris is a **homologous** to the penis in the male.
3. **Bartholin gland:** It is homologous to **Cowper's gland** of male
4. A functional mammary gland is characteristic of all female mammals.
5. The milk product during the initial few days of lactation is called **colostrum** which contains antibodies (IgA) absolutely essential to develop resistance for the new-born babies.

LEARNING BOOSTER-2

1. Vagina of the female reproductive system is
   (1) Primary sex organs
   (2) Essential sex organs
   (3) Secondary sex organs
   (4) Both (1)&(2) **[3]**
2. Development of foetus takes place in
   (1) Vagina (2) Uterus
   (3) Ovary (4) Oviduct **[2]**
3. Bartholin's glands occurs in
   (1) Females and help in vestibular lubrication
   (2) Females and produce oestrogen for regulating secondary sexual characters
   (3) Males and form liquid part of spermatic fluid
   (4) Males and produce alkaline fluid for neutralizing urethral acidity **[1]**
4. Ostium is the aperture present in
   (1) Oviduct
   (2) Fimbriated fallopian funnel
   (3) Ovisac
   (4) Cloaca **[2]**

GAMETOGENESIS FORMATION OF GAMETES:

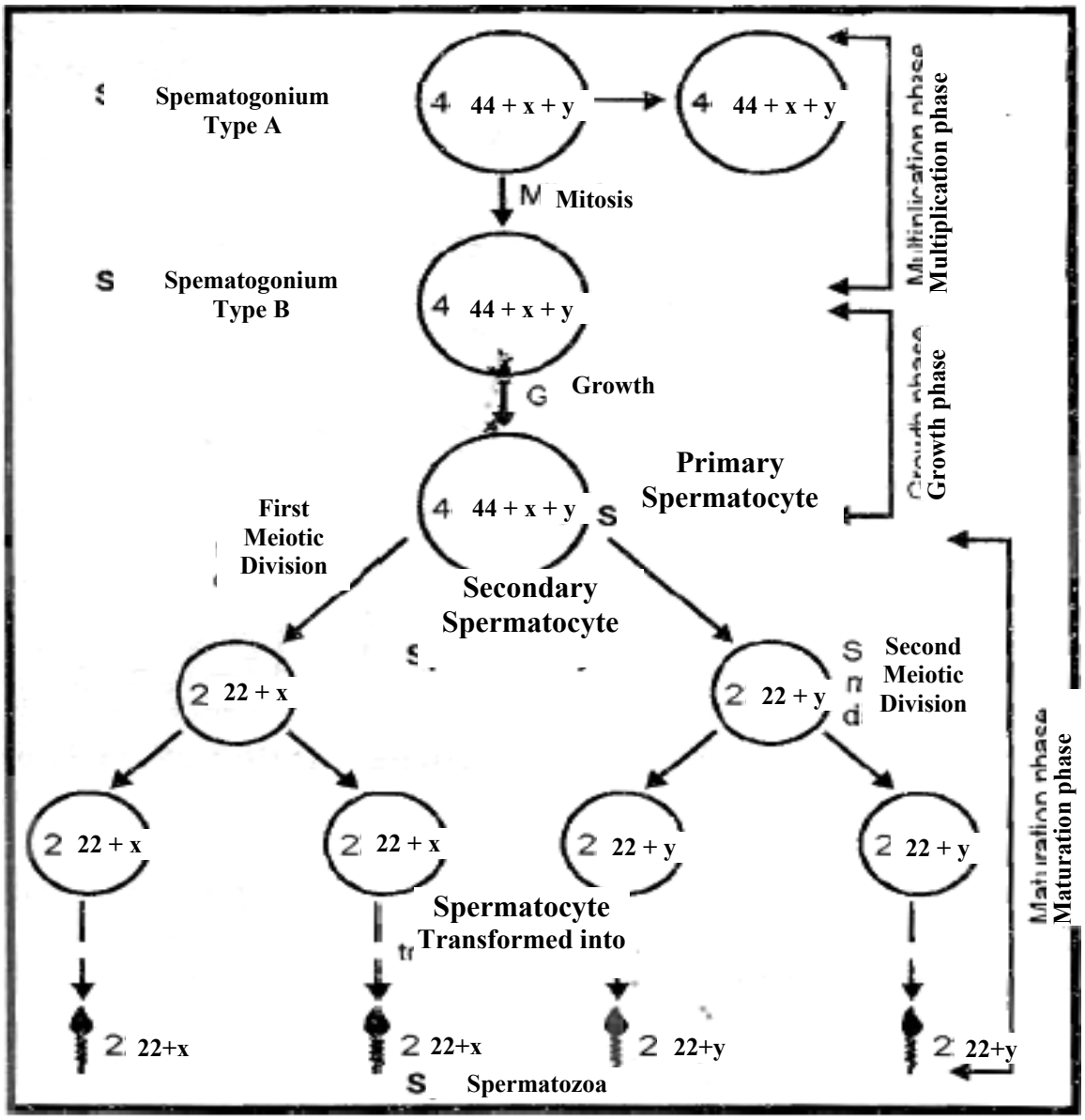


Schematic representation of (a) Spermatogenesis; (b) Oogenesis

- Follicle stimulating hormone stimulates gametogenesis. Besides this hormone vitamin E is also essential for gametogenesis. Deficiency of vitamin E leads to sterility. Vitamin A is also required for the formation of healthy gametes. Gametogenesis is divided in three stages:
  (i) Multiplication phase
  (ii) Growth phase
  (iii) Maturation phase.
- As there are two types of gametes, the spermatozoa
  and ova, gametogenesis can be studied under two broad headings: **spermatogenesis** and **oogenesis**. Spermatogenesis is the formation of spermatozoa, whereas oogenesis is the formation of ova. Both spermatozoa and ova originate from **primordial germ cells** or **PGCs**, which are extra-gonadal in origin. In humans, the PGCs originate during early embryonic development from the extra-embryonic mesoderm. Eventually, they migrate to the yolk sac endoderm, and ultimately, to the gonads of the developing embryo, where they undergo further development. You can recall that spermatogenesis occurs in the Seminiferous tubules of the testes and oogenesis occurs in the follicles of ovary. Formation of gametes starts at puberty.

Spermatogenesis

- Spermatogenesis: i.e. formation of sperms. In most of the animals spermatogenesis takes place in testes, (exception-earthworm). Mammalian testes contain seminiferous tubules and wall of seminiferous tubule is composed of germinal epithelium. It contains some special types of cells called primordial germ cells and these cells start spermatogenesis. On the basis of origin, primordial germ cells are extra embryonic mesodermal. Besides these cells, germinal epithelium contains some large sized cell called sertoli cells. Occurrence of sertoli cells is the unique feature of mammalian testis. Sertoli cells provide nutrition to developing sperm i.e. developing sperms are embedded in cytoplasm of sertoli cells and absorb nutrition. After maturation sperms comes out from sertoli cells and liberate in seminiferous tubules.
- Liberation of sperms from Sertoli cells is called **spermiation**.
- Liberation of sperms from testes is called **semination**.
- Liberation of sperms from body of male is called **ejaculation**.
- Mammalian sperms are transferred to vagina offemale by the process called **insemination**.
- Sertoli cells form 'blood testes barrier' and protect the sperm from immune system of the body. (because antibody may attack on haploid cells and destroy them.
  (Sperms are haploid and other cells of body are diploid).
- Sertoli cells function as an endocrine gland. i.e. secrete three types of hormones :
  (i) Antimullerian hormone:
  function of this hormone is degradation of female gonads in male embryo. (In male seminal vesicle is the ruminant part of oviduct of female).
  (ii) lnhibin hormone:
  Function of this hormone is to control excess secretion of pituitary gland and prevent the over-production of sperms .
  (iii) Androgen binding protein:
  Function of this hormone is to concentrate testosterone in seminiferous tubules because testosterone is must for spermatogenesis in seminiferous tubules.
- Spermatozoa are formed in the wall of the seminiferous tubules of the testes The various cell stages in spermatogenesis are as follows (the number of chromosomes at each stage is given in brackets) An adult male produces over $10^{12} – 10^{13}$sperm cells each day. These gradually move into the epididymis and the first portion of the vasa-deferens, where they undergo further maturation and are stored.



A. The spermatogonia (type A) or germ cells (44 X+Y) divide mitotically, to give rise to more spermatogonia of type A (spermatogenic lineage) and also spermatogonia of type B.

B. The spermatogonia (type B) (44 + X + Y) enlarge, to form primary spermatocytes.

C. The primary spermatocytes (44 + X + Y) now divide so that each of them forms two secondary spermatocytes. This is the first meiotic division: it reduces the number of chromosomes to half.

D. Each secondary spermatocyte has 22 + X or 22 + Y chromosomes. It divides to form two spermatids. This is the second meiotic division and this time there is no reduction in chromosome number (spermatocytogenesis).

E. Each spermatid (22 + X or 22+Y) gradually changes its shape to become a spermatozoan.This process of transformation of a circular spermatid to a spermatozoon is called spermiogenesis

F. In human beings maturation phase is the longest phase of **spermatogenesis.**

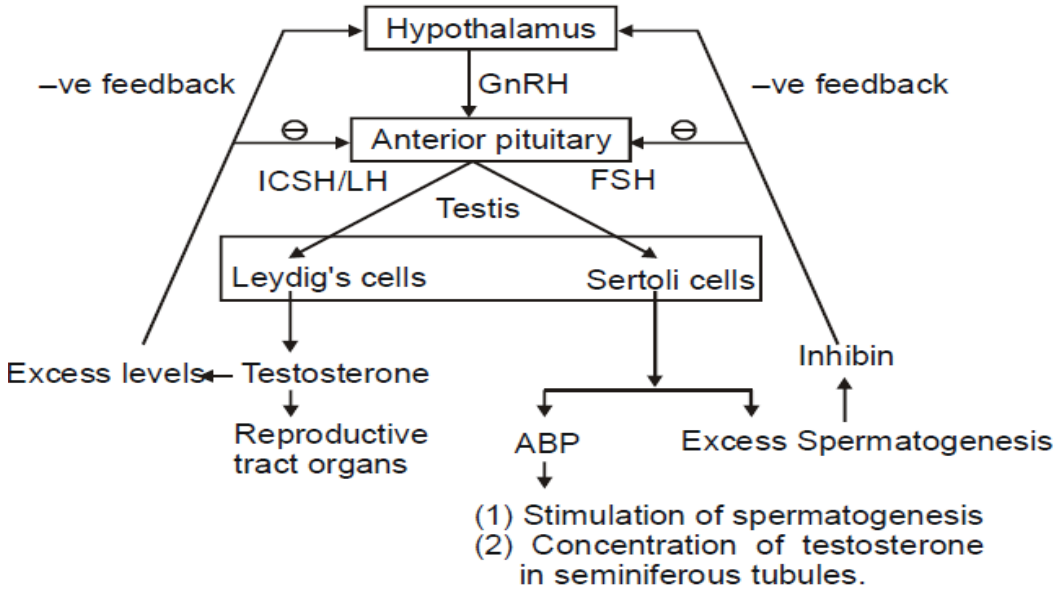
MALE REPRODUCTIVE HORMONES FSH:

Binds with FSH receptors attached to the Sertoli cells in seminiferous tubules. This causes these cells to grow and secrete various spermatogenic substances and androgen binding proteins (ABP)

- **ABP :**

Concentrates the testosterone inside seminiferous tubules.

- **LH / ICSH :**
  It stimulates the Leydig cells to secrete testosterone. Leydig's cells mature at 10 yrs. of age.
- **Inhibin :**
  It is secreted by Sertoli cells in response to excess spermatogenesis. The inhibin gives a negative feedback to the hypothalamus and anterior pituitary, this results in suppression of synthesis and release of FSH (•Spermatogenesis decreases).
- **Testosterone :**
  Secreted by Leydig cells. It is essential for
  (1) Sperm production
  (2) development of secondary sexual characters
  (3) ABP secretion
  (4) It also gives –ve feedback to hypothalamus and anterior pituitary in its excess concentration to suppress GnRH, FSH & LH release.
  (5) It is secreted in foetal stage in as low as 30 mg/ml plasma concentration to cause descent of testis in last trimester of intrauterine life.



STRUCTURE OF SPERM

The spermatozoon has three parts :

(i) Head **(ii)** Middle Piece **(iii)** Tail

(i) Head :

The **head** is covered by a cap called the acrosomic cap, anterior nuclear cap, or galea capitis. Acrosome is a bag like structure filled with lytic enzymes called sperm lysins. In the anterior part of middle piece neck is present. The neck is narrow : it contains a proximal & distal centriole (or Basal body).

An axial filament begins just behind this centriole, it passes through the middle piece and extends into the tail. At the point where the middle piece joins the tail, this axial filament passes through a ring-like structure called the annulus (or ring centriole or zensons ring). That part of the axial filament which lies in the middle piece, is surrounded by a spiral sheath made up of mitochondria. (Neben-kern sheath) Nuclear part of head of spermatozoa consist of chromatin (mostly DNA) that is extremely condensed. It contains a basic nature protein called protamin.

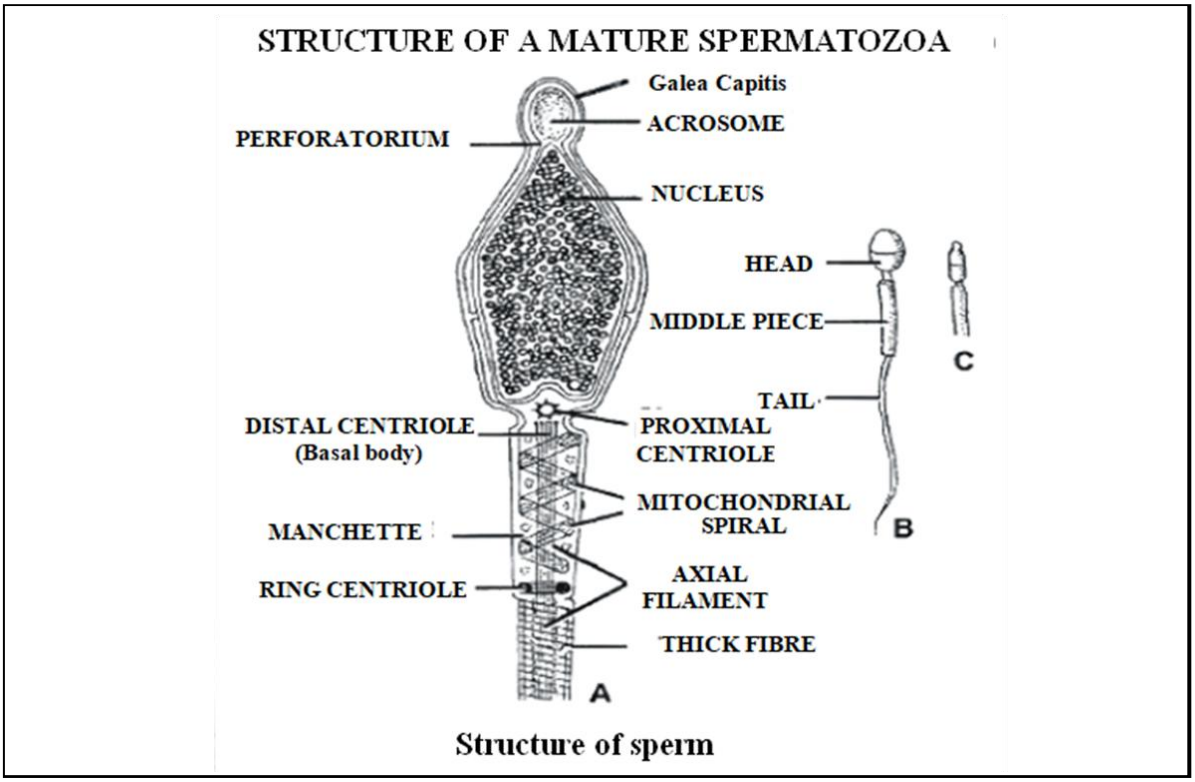
- The axial filament, that passes through the middle piece and most of the tail, is actually composed of several fibrils arranged. There is a pair of central fibrils ,'surrounded by nine pairs (doublets) arranged in a circle around the central pair

(ii) Middle piece

(also called as the energy chamber) is surrounded by spirally arranged mitochondria (Neben-kern sheath). Finally, the entire sperm is enclosed in a plasma membrane.

(iii) Tail :

The longest part of sperms. Sperm moves by help of tail. The basal granule of tail is distal centriole.



Oogenesis

Primordial germ cells

↓ Mitosis

Oogonia (by 25 th week of IUL)

↓

Primary oocyte
(44, XX)

↓

Arrested first meiotic division in prophase stage at birth (upto puberty)

↓

Maturation Graffian follicle (After puberty)

↓

Completion of Ist meiotic division

↓

Secondary oocyte
22 + X

↓

II Meiotic div. arrested at metaphase stage

↓

Ovulation

↓

Not fertilized

↓

Degneration

During Fertilization

↓

Completion of second meiotic division

↓

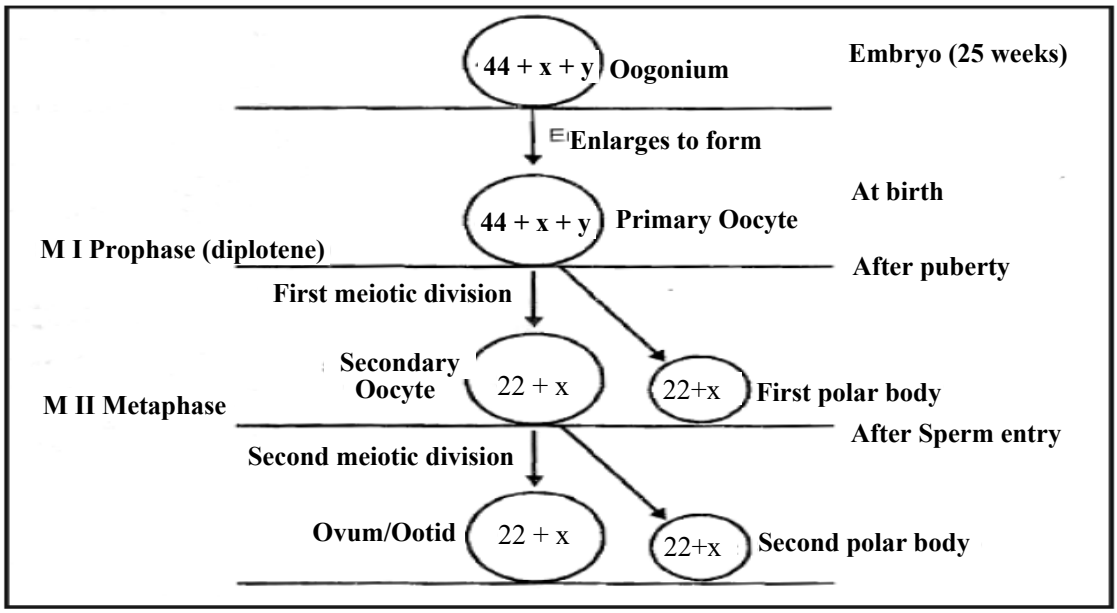
Ovum
22+X

II polar body
22+X

Ist polar body
22 + X

↓

May undergo degeneration or divide in two daughter polar bodies



OOGENESIS

Like spermatogenesis oogenesis process also can be divided into three stages:

(1) Multiplication phase

(2) Growth phase

(3) Maturation phase

(1) Multiplication phase:

In this stage primordial germ cells or ovum mother cells repeatedly divide by mitosis to form large number of diploid oogonia.

This process completes in embryo stage of female inmost higher animals.

(2) Growth phase:

Like spermatogenesis, in this process oogonia grow in size and form primary oocytes. The growth phase is the longest phase in oogenesis (except -in humans maturation is longest phase). During growth phase size of egg increases many times.

(3) Maturation phase :

- It is the longest phase in human.
- In contrast to males the initial steps in egg production occur prior to birth. By the time the foetus is 25 weeks old, all the oogonia that she will ever produce are already formed by mitosis. Hundreds of these diploid cells develop into **primary oocytes,** begin the first steps of the first meiotic division, proceed up to diplotene and then stop any further development. The oocytes grows much larger and completes the meiosis I, forming a large **secondary oocyte** and a small **polar body** that receives very little amount of cytoplasm but one full set of chromosomes.
- First polar body may undergo degeneration due to lack of cytoplasm or may divide.
- Whereas the secondary oocyte proceeds as far as The **metaphase** stage of meiosis II. However, it then stops advancing any further, it awaits the arrival of

  the spermatozoa for completion of second meiotic division.
- Entry of the sperm restarts the cell cycle breaking Down **MPF** (Metaphase promoting factor and turning on the **APC** (Anaphase promoting complex).

  Completion of meiosis II converts the secondary oocyte into a fertilised egg or zygote and also a second polar body)

MEMORY BOOSTER

1. Liberation of sperms from Sertoli cells of seminiferous tubules is called **spermiation**.
2. Liberation of sperms from testes is called **semination**.
3. Liberation of sperms from body of male is called **ejaculation**.
4. Mammalian sperms are transferred to vagina of female by the process called **insemination**.

5. In 1 ml of semen, 20 to 120 millions of sperms are present in human being.
6. Leydig's cells mature at 10 yrs. of age.
7. In humans (and most vertebrates), the first polar body does not undergo meiosis II.
8. The first polar body is, therefore, formed merely to get rid of unwanted chromosomes.
9. 65-74 days are required to complete the cycle of spermatogenesis in human being .

LEARNING BOOSTER-3

1. The human sperm was first discovered by :-
(1) Von Baer
(2) Leeuwenhoek
(3) Robert hook
(4) Darwin **[2]**

2. "Spermiogenesis" is a process in which :-
(1)Spermatids change into spermatozoa
(2)Spermatogonia produce a spermatid
(3)Spermatocytes give rise to spermatozoa
(4) Dormant spermatozoa become active just Before ejaculation . **[1]**

3. Spermatogenesis and sperm differentiation are under the control of
(1) FSH
(2) LH
(3) Progesterone
(4) Parathyroid Harmone **[1]**

4. Spermatogenesis process occur in
(1) Rete testis
(2) Seminiferous Tubules
(3) Septula testis
(4) Media stinum testis **[2]**

5. Acrosome formation in spermatogenesis occurs in which stage?
(1) First meiotic division
(2) Second meiotic division
(3) Growth phage
(4) Spermiogenesis **[4]**

6. 10 oogonia yield 10 primary oocytes, then how many ova are produced on completion of oogenesis.
(1) 5 (2) 10
(3) 20 (4) 40 **[2]**

7. The minute cells which separate from the developing ova during their maturation are called
(1) Primary Oogonia
(2) Secondary Oogonia
(3) Polar bodies
(4) Primary spermatogonia **[3]**

8. Human egg are :
(1) Microlecithal
(2) Alecithal
(3) Macrolecithal
(4) Mesolecithal **[2]**

9. Sperm differs from egg in having
(1) Power of motility
(2) No stored food
(3) More in numbers
(4) All of the above **[4]**

10. How many polar bodies are produced during the entire process of oogenesis in unmarried human female?
(1) Three (2) Two
(3) One (4) Four **[3]**

STRUCUTRE OF OVARY

- Outer most layer of ovary is called germinal epithelium while the inner layer called T. albuginea is made up of White fibrous connective tissue.
- The inner part of ovary is called as stroma. It is differentiated into 2 parts, outer peripheral part is cortex & inner part is called medulla. Stroma consists of follicular cells, connective tissues, blood vessels & lymphatics.
- Numerous oogonial are found in cortical region in intrauterine life.

FORMATION OF OVARIAN OR GRAAFIAN FOLLICLE

- Ova develop from oogonia present in the cortex of the ovary.
  The oogonia are surrounded by other cells that form a stroma for them. These stromal cells forms the ovarian or Graafian follicle that surrounds the ovum and protects it.
  The stages of formation of **Graafian** follicle are as follows :

(1) PRIMORDIAL FOLLICLE
(Developing primary follicle)

- Firstly some cells of the stroma become flattened and surround a primary oocyte (which develops from oogonia). These flattened cells ultimately form the ovarian follicle and are therefore called follicular cells.
- The flattened follicular cells now become columnar. Follicles up to this stage of development are called primordial follicle.

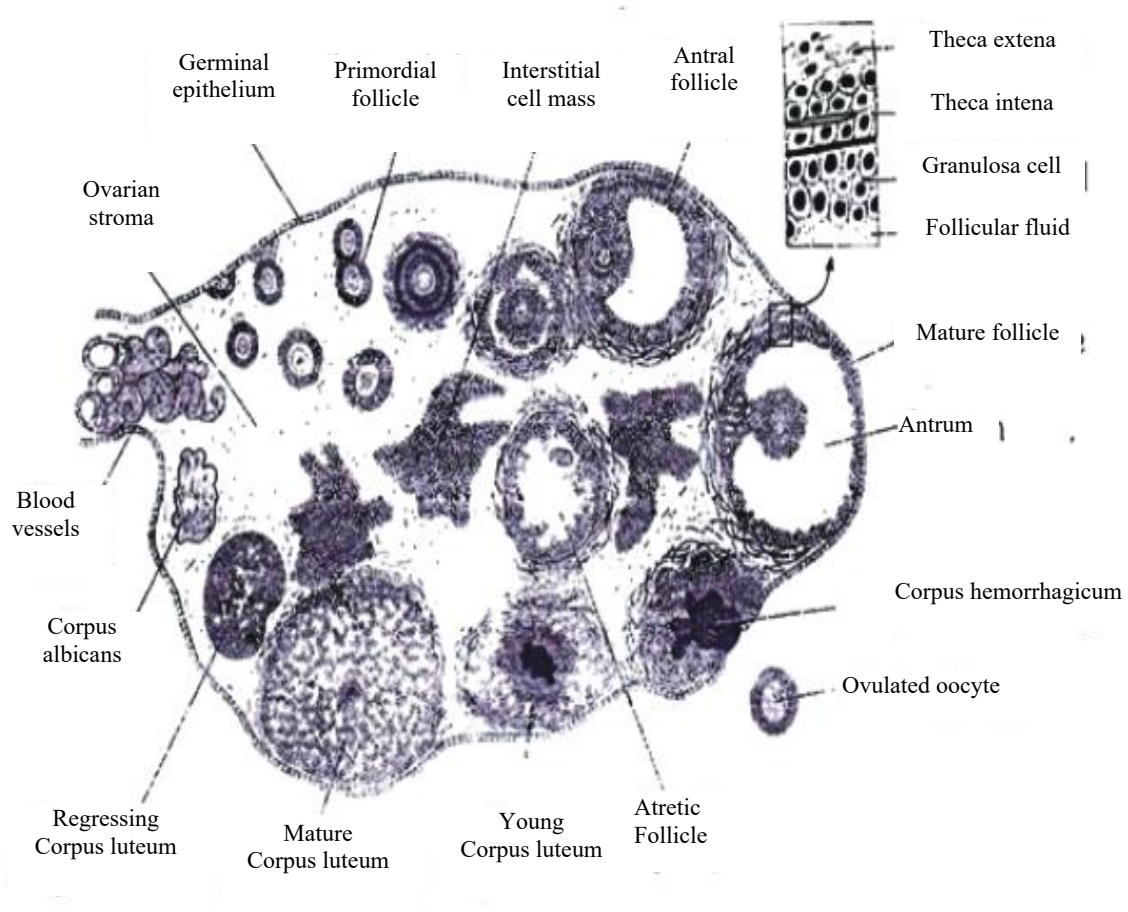
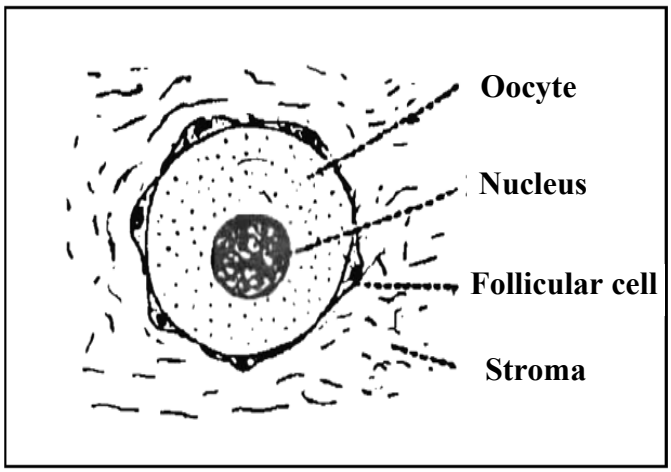
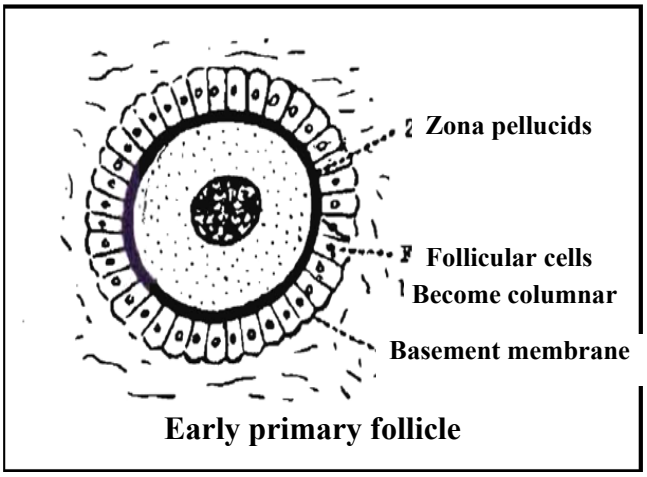


Diagram of a mammalian ovary

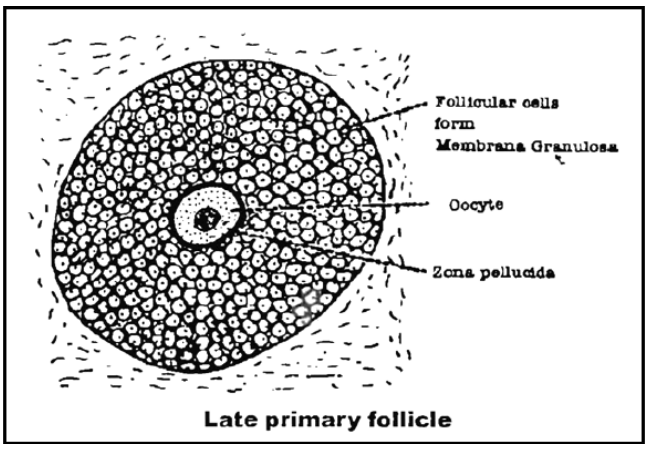


(2) PRIMARY FOLLICLE

- A membrane called the zona pellucida, now appears between the follicular cells and the oocyte.



Early primary follicle



Late primary follicle

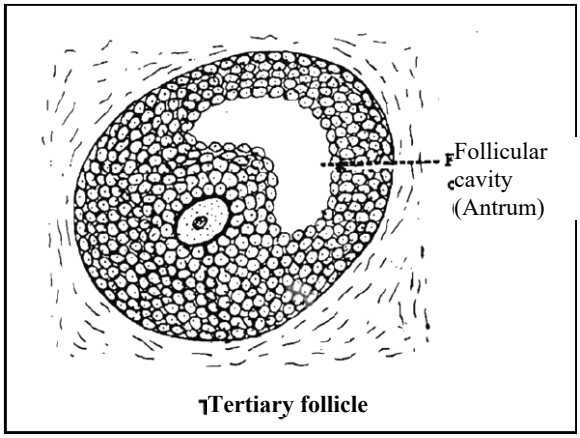
- The follicular cells proliferate now to form several layers of cells to form the membrana granulosa. These cells are now called granulosa cells.

(3) SECONDARY FOLLICLE

- As the follicle expands, the stromal cells surrounding the membrane granulosa become condensed to form a covering called the theca Interna. The cells of theca interna (Thecal cells) afterwards secrete a hormone called oestrogen.
- Outside the theca interna some fibrous tissue become condensed to form another covering called the theca externa.

(4) TERTIARY FOLLICLE

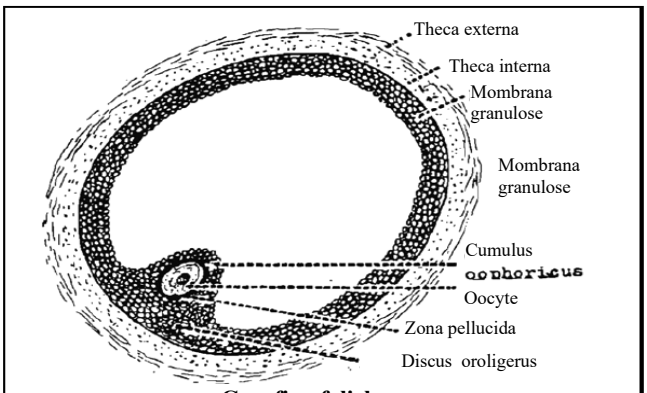
- A cavity appears within the membrana granulosa. It is called the **antrum.** With the appearance of this cavity, the follicle is formed (follicle means a small sac). Theca layer is organised clearly into an inner theca interna and outer theca externa.



Tertiary follicle

(5) MATURE TERTIARY FOLLICLE/GRAAFIAN FOLLICLE

- The cavity of the follicle rapidly increases in size and gets filled with a fluid called liquor folliculi. Due to increase in the size of the cavity the wall of the follicle (formed by granulosa cells) becomes relatively thin. The oocyte now lies eccentrically in the follicle, surrounded by some granulosa cells that are called as cumulus oophoricus. The cells that attached it to the wall of the follicle are called as discus proligerus or Germ hill.
- The ovarian follicle is now fully formed and is now called the Graafian follicle.
- **The granulosa cells lying in the close vicinity of the zona pellucida, becomes elongated to form the corona radiata.**



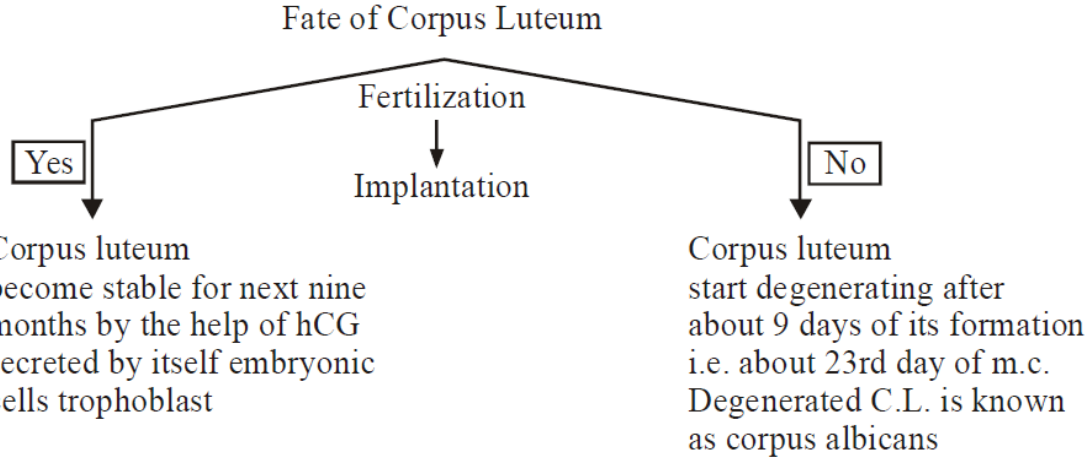
Graafian folicle

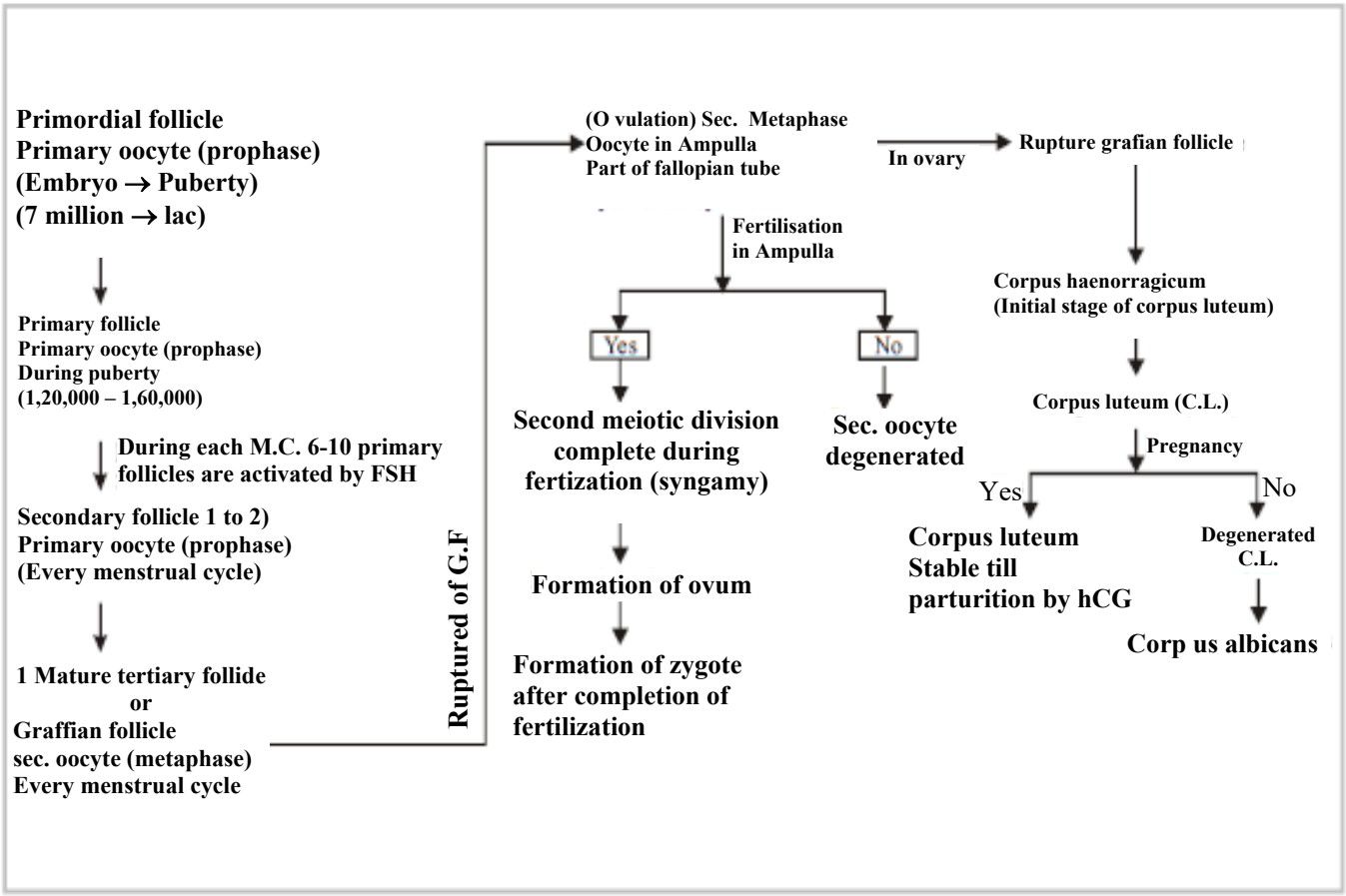
- After 13 days of menstrual cycle (on 14th day when cycle is ideally for 28 days) Graafian follicle is ruptured & egg is released.

FORMATION OF CORPUS LUTEUM

- Before ovulation the inner side of follicle is a vascular but soon after ovulation blood vessels grow and ruptured graffian follicle becomes filled with blood which is known as corpus heamorrhagium or blood filled corpus luteum.

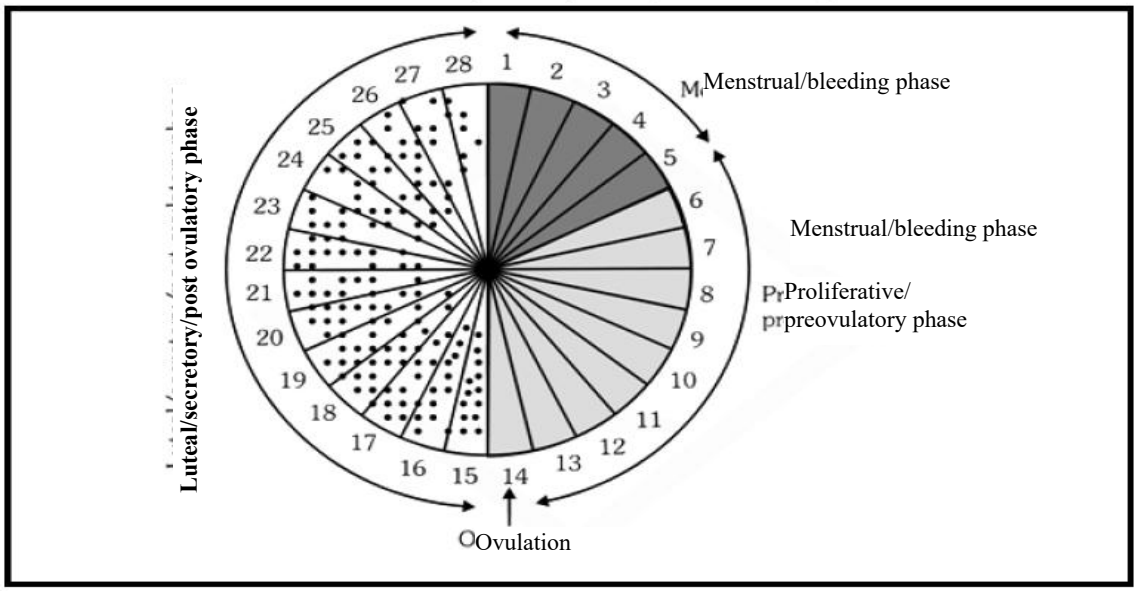
- The granulosa cells of ruptured graafian follicle proliferate and these cells become yellow due to accumulation of pigment called lutein.
  These cells are called lutein/luteal cells. Lutein cells secrete progesterone. Estrogen is also secreted by corpus luteum.
- Progesterone hormone maintains pregnancy and repairs the wall of uterus to make its surface adhesive to help in implantation.
- Due to action of estrogens and progesterone, the endometrium of uterus is prepared for implantation. By the 6th to 7th day of fertilization, embryo is implanted into endometrium (most commonly at the **fundus**).
- The total number of follicles in the two ovaries of a normal young adult woman is about four lakhs. However most of them undergo regression and disappear due to death and are disposed off by the phagocytes during the reproductive years of the females. This is termed as **follicular atresia.** This is responsible for limited number of gamete production in females. Generally, only one ovum is liberated in each menstrual cycle, by alternate ovaries.
- After copulation oxytocin hormone is secreted form pituitary gland. This hormone promotes the peristalsis in the fallopian tube & uterus. Due to this the semen is sucked into fallopian tube.

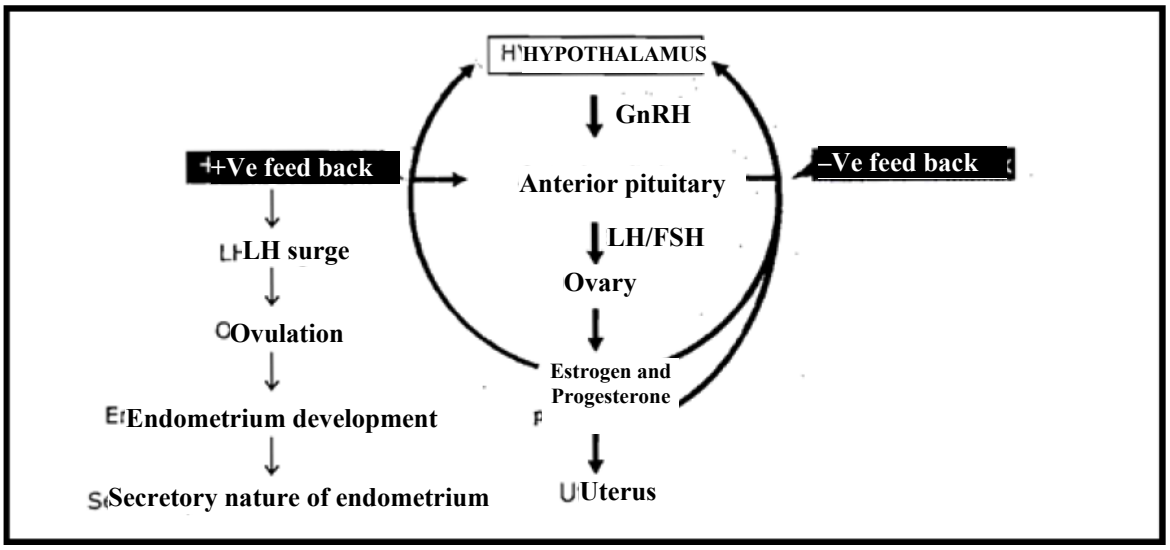




MENSTRUAL CYCLE

Duration – 28 days Ideally (Range - 22 to 32 days)





Estrogen		Progesterone (Antiabortion or pregnancy hormone)	
1	Endometrical hyperplasia	**1**	Increase secretory nature of endometrium (Development of glands)
2	Increase vascularity of endometrial (Uterine arteriole become tortuous)	**2**	Increase adhesive nature of endometrium
3	Myometrial hypertrophy	**3**	Decrease myometrial contraction
4	Ultimately increase thickness of uterine wall	**4**	Maintain thickness of uterine wall

- This is exhibited by primate group of animals. In this cycle the female body prepares itself for a possible pregnancy. It the pregnancy does not occur then the body aborts all preparation done and restarts the preparation for pregnancy again in a monthly cyclic manner. Menstrual cycle has three main phases :

(i) Bleeding phase or menstruation phase.

(ii) Proliferative/pre-ovulatory/follicular phase or oestrogenic phase.

(iii) Secretary/post ovulatory/luteal phase or Progesteronic phase.

Phase	Hormonal changes	Ovarian changes	Uterine changes
1. BLEEDING PHASE (4.5 DAYS)			
Initial stage	GnRH, FSH, LH Estrogen and Progesterone are low	Complete degeneration of corpus luteum (Corpus albicans)	Due to withdrawal of sex hormone, Prostaglandins are formed in uteru which cause arteriolar vasoconstriction. It leads to decreased blood supply to Stratum functionalis that result in its degeneration and separation. Prostaglandin also cause contractions of myometrium which leads to sloughing of dead endometrium tissue (stratum functionalis) with blood from uterine Cavity through vagina. This bleeding continues up to 4-5 days and clotting does not occur due to presence of fibrinolytic enzymes. Average 40 to 80 ml blood loss per cycle.
Terminal stage	GnRH↑, FSH↑ LH↑, due to negative feedback of low level of estrogen and progesterone	6-12 primary follicle are stimulated start formation of secondary follicle.	Uterine bleeding is gradually reduced

2. FOLLICULAR / PROLIFERATIVES / ESTROGENIC / PREOVULATORY PHASE			
Initial stage	GnRH↑, FSH↑, LH↑, Estrogen↑	1-2 secondary follicle → 1 Tertiary follicle	• Uterine bleeding is stopped • Endometrial hyperplasia. • Formation of stratum functionalis
Terminal stage	PTO (refer next page)	Tertiary follicle → 1 mature tertiary follicle (Graffian follicle)	• Thickness of uterine wall Increased • Myometrium hypertrophy.
Initial stage	GnRH, LH, FSH, are comparatively low then terminal stage of follicular phase.	Ruptured graffian follicle ↓ Corpus hemorrhagicum ↓ Corpus luteum (maximum developed on 22nd day)	• More secretary (glandular) nature of endometrium. • Thickness of uterine wall maximum (23rd days)
Terminal stage	Increased progesteronegive negative feedback ↓ GnRh, LH significantly low Further decrease of progesterone and estrogen due to degeneration of corpus luteum	Corpus luteum degeneration (Corpus albicans on 28th does not secrete any hormone)	• size of stratum functionalis decrease. • Thickness of uterine wall decrease. • Myometrial atrophy.

Terminal stage of hormone ranges of pre-ovulatory phase/follicular phase

Extreme high concentration of Oestrogen

+ve feedback

GnRH

Inhibin released by membrana granulosa

⊖

↑ FSH (2-3 folds) FSH-surge

Increased L.H. surge (6-10) folds

Oogenesis

Ist meiotic division completed in G.F.

II meiotic division but arrested at metaphase

Secondary oocyte (metaphase)

Progesterone released by theca and membrana granulosa and ↓ Oestrogen

Synthesis of proteolytic enzymes (Collagenase enzyme)

Secretory nature of membrana granulosa

↑ antral fluid, swelling of Graffian follicle

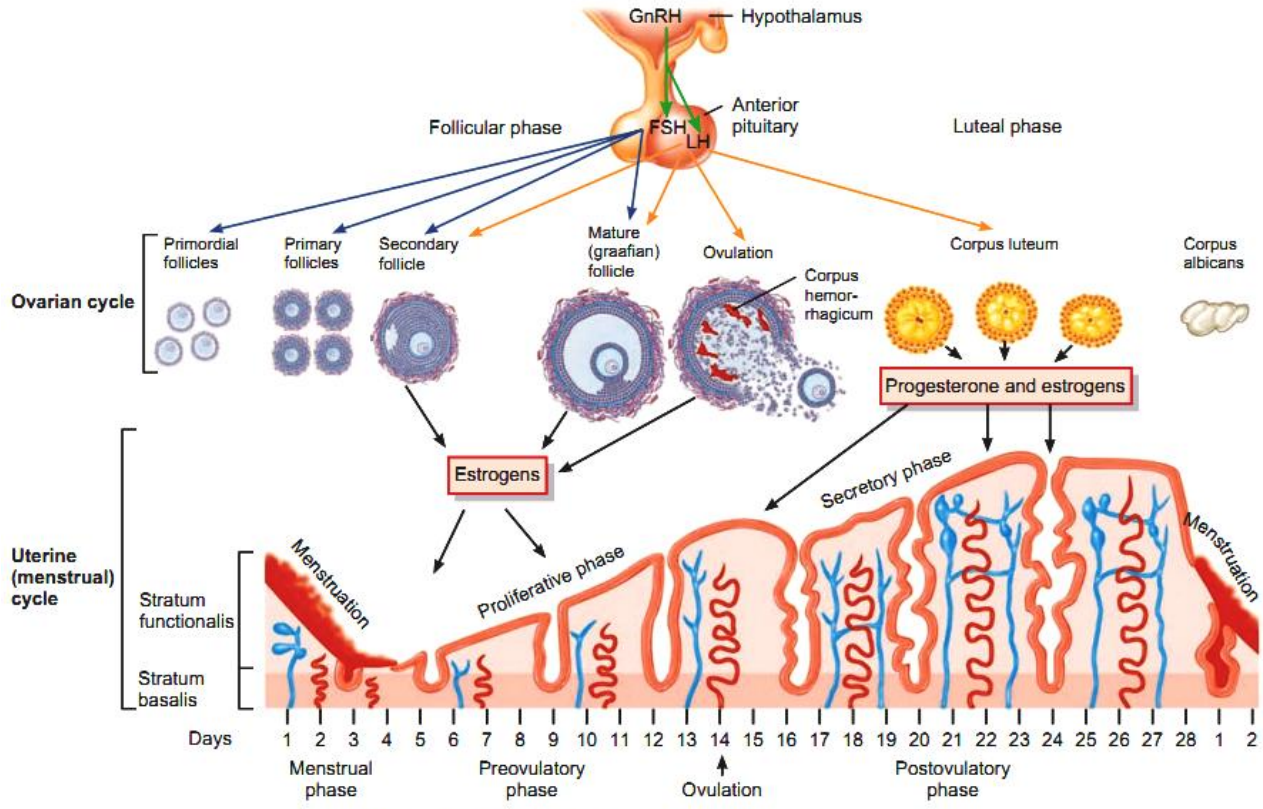
Rupture of graffian follicle or ovarian layer

Ovulation

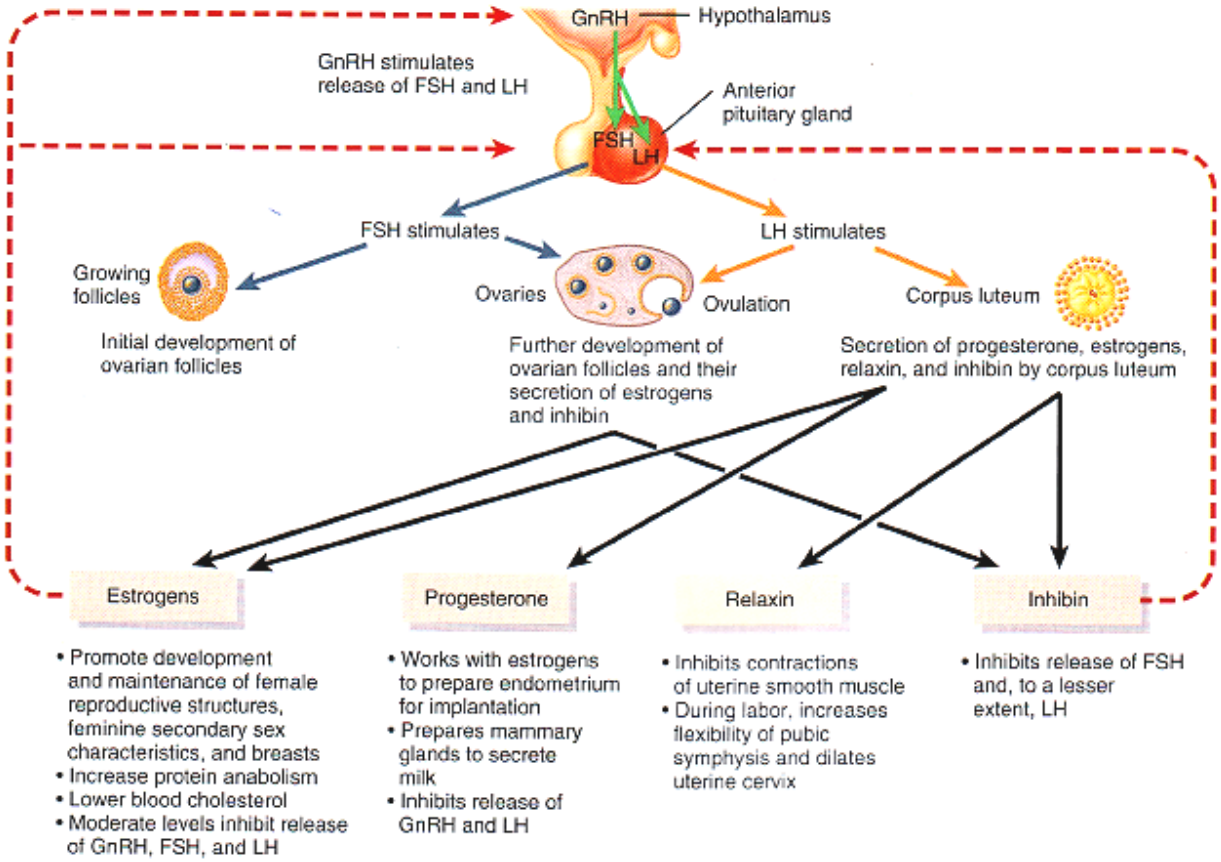
Secondary oocyte (metaphase)

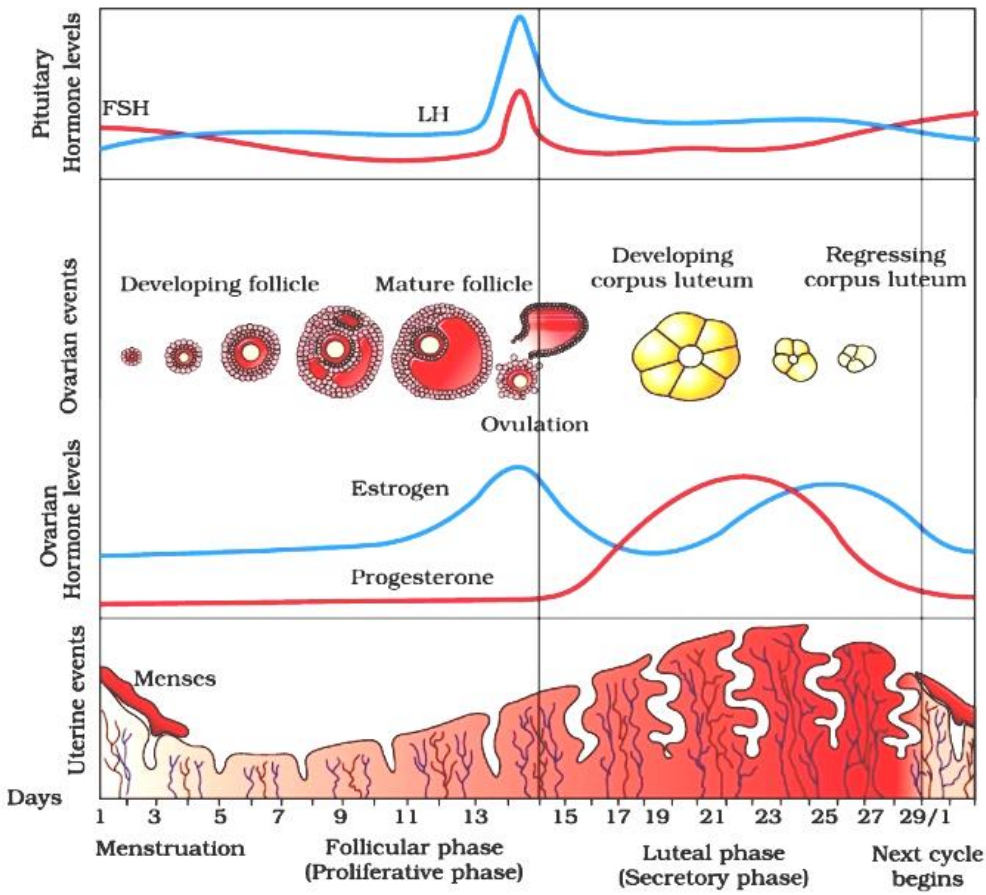
via peritoneal cavity

Fallopian tube



(a) Hormonal regulation of changes in the ovary and uterus





Diagrammatic presentation of various events during a menstrual

MEMORY BOOSTER

1. Only about 450 ova are produced by a human female over the entire span of her reproductive life which lasts till about 40-50 years of age.
2. In rabbit ovulation occurs after 12-24 hour of copulation. That means copulation is necessary for ovulation.
   Females in which coitus induction is compulsory for ovulation are called as induced or reflex ovulator.
3. In human female ovulation occurs in presence of FSH & LH. Coitus is not necessary for inducing ovulation. Such a female is called as spontaneous ovulator.
4. In human beings, menstrual cycles ceases around 50 years of age; that is termed as menopause Cyclic menstruation is an indicator of normal reproductive phase and extends between menarche and menopause.
5. Although most of the follicular cells and the oocytes undergo degeneration during follicular atresia, some thecal cells, formed from the stroma and located around the follicle, persist and become active. These are called **interstitial cells.** These cells secrete small amount of androgen.
   No specific breeding season is found in human being.
6. In eutherian mammals (other than primates) reproductive cycle is oestrus cycle which occurs during specific breeding season.
7. **Amenorrhoea -**Absence of menstruation cycle_
8. **Precocious puberty:** Menstruation occurs before the age of 8 years.
9. Pregnancy is detected with the help of HCG in urine of pregnant lady.
10. **Dysmenorrhoea:** Painful menstruation is called Dysmenorrhoea.
11. **Menorrhagia:** A normal menstrual blood loss is 50-80 ml, and does not exceed 100 mL In menorrhagia the menstrual cycle is unaltered but the duration and quantity of the menstrual blood loss are increased.
12. **Polymenorrhoea:** In polymenorrhoea or epimenorrhoea, the menstrual cycle is reduced from the normal of twenty-eight days to a cycle of two to three weeks and remains constant at that increased frequency.

LEARNING BOOSTER-4

1. Estrogen is secreted by
   (1) Corpus luteum
   (2) Theca interna of Graafian follicle
   (3) Germinal epithelium of ovary
   (4) Pituitary **[2]**
2. Atretic follicle is
   (1) Which are not developed completely and degenerate
   (2) Other name of corpus luteum
   (3) Which extruded its oocytes
   (4) Graafian follicle **[1]**
3. Number of eggs released in the life time of a woman is approximately
   (1) 40 (2) 400
   (3) 4000 (4) 20000 **[2]**
4. Corpus luteum develops from
   (1) Oocyte
   (2) Nephrostome
   (3) Graafian follicle
   (4) Antrum **[3]**
5. Process by which Graffian follicles are formed in the ovary is known as
   (1) Oogenesis
   (2) Luteinisation
   (3) Folliculogenesis
   (4) All **[3]**
6. First menstrual cycle starts at
   (1) Parturition
   (2) Menopause
   (3) Puberty
   (4) Implantation **[3]**
7. Menstrual cycle is generally of
   (1) 21 days (2) 28 days
   (3) 38 days (4) 40 days **[2]**
8. Mainly which type of hormones control the menstrual cycle in human beings:
   (1) FSH
   (2) LH
   (3) FSH, LH, Estrogen
   (4) Progesterone only **[3]**
9. In the human female, menstruation can be deferred by the administration of :.
   (1) FSH only
   (2) LH only
   (3) Combination of FSH and LH
   (4) Combination of estrogen and progesterone **[4]**

STRUCTURE OF OOCYTE

- The nucleus of egg is also called germinal vesicle.
- Oocyte is surrounded by membranes termed as the egg-membranes.
- Oocyte / Ovum along with the egg-membrane are termed as the egg.

Egg = Ovum / Oocyte + Egg membrane.

- Majority eggs are oval but the eggs of insects are long and cylindrical. Smallest eggs are of 5011 in polychaeta and the largest eggs are of an Ostrich.

Classification of egg -membranes :

On the basis of origin, egg-membranes are of 3 types:

(1) Primary egg membrane:

This membrane is secreted by the oocyte itself.
eg. Vitelline membrane, Zona Pellucida (mammals).

(2) Secondary egg membrane :

This is found outside the primary egg membrane and is secreted by the ovary.
(eg. Corona radiata, Chorion)

(3) Tertiary egg membrane :

This is present outside the primary egg membrane. It Is either secreted by the uterus or the oviduct. (eg. Jelly coat, Shell & Shell membrane)

Functions of Egg-membranes

(i) To provide protection
(ii) To check polyspermy
(iii) To provide buoyancy to the amphibian eggs

EGG OF MAMMALS

- Mammalian eggs have very less amount of yolk, so the eggs are oligolecithal and isolecithal or microlecithal and homolecithal.The egg has 2 egg-membranes:-

(1) Zona pellucida :-

This is a transparent membrane like covering and is a primary membrane secreted by the ovum/oocyte itself.

(2) Corona radiata :-

This is a layer of follicular cells" and these cells are attached to the surface of egg through" hyaluronic acid" This is a secondary membrane, which is secreted by the ovary. These eggs don't have tertiary membrane. Mammalian eggs are approx 0.1 mm in size.

TYPES OF EGGS

(1) On the basis of amount of yolk

(i) Alecithal -In this type of egg, yolk is negligible. Ex. Human egg.

(ii) Microlecithal or Oligolecithal eggs -

The amount of yolk is very small in these types of eggs.

Examples :-

Egg of Amphioxus, Eutheria, Metatheria and sea-urchin.

(iii) Mesolecithal Eggs :-

In this type of egg, the amount of yolk is moderate i.e. medium, neither more nor less.

Example –

Eggs of Amphibia, Petromyzon and lungfishes.

(iv) Polylecithal or Macrolecithal or Megalecithal eggs :-

Eggs are with large amount of yolk. e.g. Insect's egg, Birds, reptiles and prototherian mammals

(2) On the basis of distribution of yolk :

(i) Isolecithal or homolecithal eggs :

The yolk is evenly or homogenously distributed in these eggs.
eg. : micro, alecithal eggs.

(ii) Telolecithal eggs :

The yolk is concentrated in one part of the egg. eg. : mesolecithal eggs of amphibia. (Moderately telolecithal)

- **Discoidal eggs** A type of telolecithal and megalecithal eggs, Where the yolk is in enormous quantity and concentrated in one part of the egg. Thus only a disc of cytoplasm called geffilinal disc remains in the egg which is located at the other pole of egg. (Heavily telolecithal)
  eg.:Eggs of reptiles, birds and prototherian mammals.

(iii) Centrolecithal eggs :

Megalecithal eggs where the enormous amount of yolk is located in the centre and cytoplasm is in the form of superficial layer around the yolk.
eg.: Insects egg.

(3) Classification of Eggs on the basis of Shell:-

On the basis of shell, eggs are of 2 types :-

(i) Cleidoic eggs:-

eggs surrounded by a hard shell are known as cleidoic eggs. These eggs are found in those animals which have a terrestrial mode of life or which lay eggs on land.

These eggs have more amount of yolk. These are adaptations to terrestrial mode of life. Shell prevents the egg form dessication. e.g. :- eggs of "Reptiles", "Birds", "Terrestrial Insects " and "Prototherians".

- Reptilian eggs are leathery eggs.

(ii) Non - Cleidoic eggs :-

Eggs which are not surrounded by a hard shell are called non-cleidoic eggs.

eg.:- all viviparous animals (Mammals) and all oviparous animals which lay eggs in water (Amphibians).

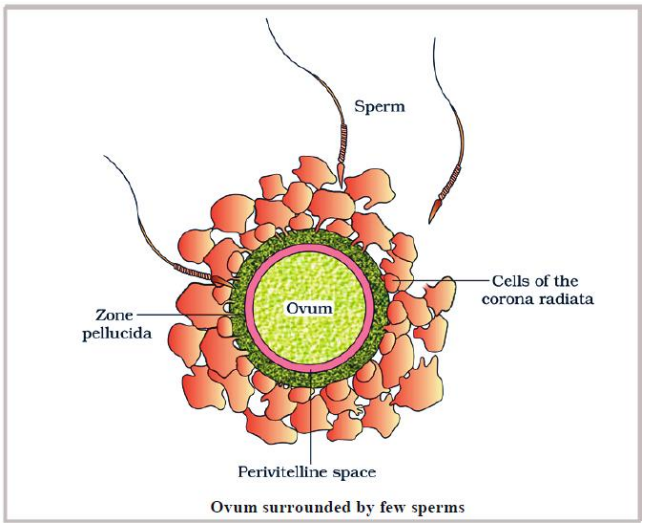
FERTILIZATION

- The process in which union of male and female gametes (formed by gametogenesis) and fusion of pro-nuclei of sperm and ovum takes place thus diploid zygote is formed, is called fertilization.

Fertilization has following processes :-

- The union of male and female gametes is called **Syngamy**, where as intermixing of their cytoplasm is called **plasmogamy**. The fusion of pro-nuclei of sperm and ovum is called **karyogamy**. The intermingling of their chromosomes is called **amphimixis**.
- Due to fertilization, a diploid zygote is formed, by the union of two different types of gametes.

MECHANISM - We can understand the process of fertilization in following steps.



Ovum surrounded by few sperms

MECHANISM OF FERTILIZATION :

1. Movement of sperms towards the secondary oocyte.↓
2. Penetration of corona radiata by the hyaluronidase enzyme.↓
3. Adherence of sperm to the **ZP3 receptors** on zona pellucida, the glycoprotein layer surrounding the oocyte.↓
4. Sperm bind to a sperm receptor on the zona and this leads to initiation of acrosomal reaction. Various enzymes are released. eg. **Acrosin (Zona lysin).**↓
5. **Acrosin** facilitate the penetration of sperm through zona pellucida.↓
6. Fusion of sperm and membrane of secondary oocyte **(Syngamy)**↓
7. Phagocytosis of sperm by the secondary oocyte↓
8. Completion of meiosis-II of secondary oocyte during phagocytosis to form ovum and simultaneously it releases 2nd polar body.↓
9. Structural changes in zona pellucida through **cortical reaction** and discharge of cortical. granules in perivitelline space forms **fertilization membrane.**↓
10. In the event of fertilization complete sperm enters inside the ovum, (By phagocytosis)↓
11. It is followed by plasmogamy, karyogamy and amphimixis [i.e. completion of fertilization.]

Fate of sperm in egg:

- In majority of animals, only head and middle piece enter inside the egg and tail is left outside.
- In mammals, whole sperm enters in the egg.
- All the structures of sperm dissolve in egg cytoplasm except sperm nucleus and proximal centriole.
- The centriole of egg itself degenerates at the time of second maturation division . So proximal centriole of sperm starts division, it divides into 2 daughter centrioles, which migrate towards opposite pole and start forming spindles.

Fate of sperm nucleus :-

- The nucleus of sperm absorbs water from egg cytoplasm and becomes enlarged. Now it is called **male pronucleus.**

- Male pronucleus and female pronucleus migrate through kidney routes and close to each other. These routes are called fertilization path.

SIGNIFICANCE OF FERTILIZATION

1. Oocyte completes its second maturation division on coming in contact with the sperm.
2. Amphimixis process leads to the formation of a diploid zygote to restore the normal diploid number of the chromosomes.
3. The centriole of sperm after entering into egg induces the egg to undergo cleavage.
4. The paternal and maternal characters are transmitted to the off-springs through the process of fertilization.
5. The peripheral changes occurring in the egg prevent the further entry of sperm into the ovum, thus checking polyspermy.

LEARNING BOOSTER-5

1. In mammals, egg is fertilized in :-
   (1) Ovary
   (2) Fallopian tube
   (3) Uterus
   (4) Vagina **[2]**

2. Fertilization is :
   (1) Union of diploid spermatozoon with diploid ovum to form diploid zygote
   (2) Union of haploid sperm with haploid ovum to form haploid zygote
   (3) Union of haploid sperm with haploid ovum to form diploid zygote
   (4) Union of diploid sperm with haploid ovum to form triploid zygote **[3]**

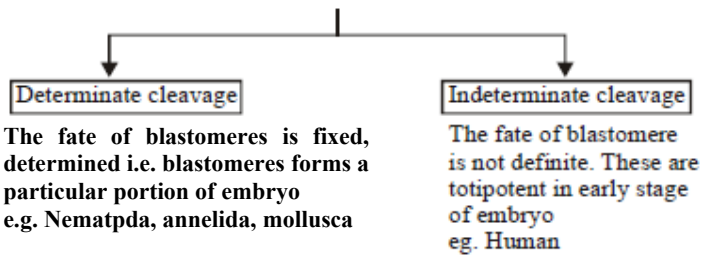
3. External fertilization occurs in animals, which
   (1) Lay eggs on land
   (2) Lay eggs in water
   (3) Oviparous
   (4) Viviparous **[2]**

CLEAVAGE (CELLULATION OR SEGMENTATION)

- The term 'Cleavage' was given by "Von Baer".
- In fertilized egg or activated egg , the egg undergoes repeated cell divisions which occur rapidly producing a multi-cellular structure without changing its size.
  All these rapid mitotic cell divisions are collectively called cleavage or segmentation Due to the process of cleavage, a single celled zygote, through a successive mitotic cell divisions changes into a complex multi-cellular structure. Cells produced as a result of cleavage are termed as blastomeres.

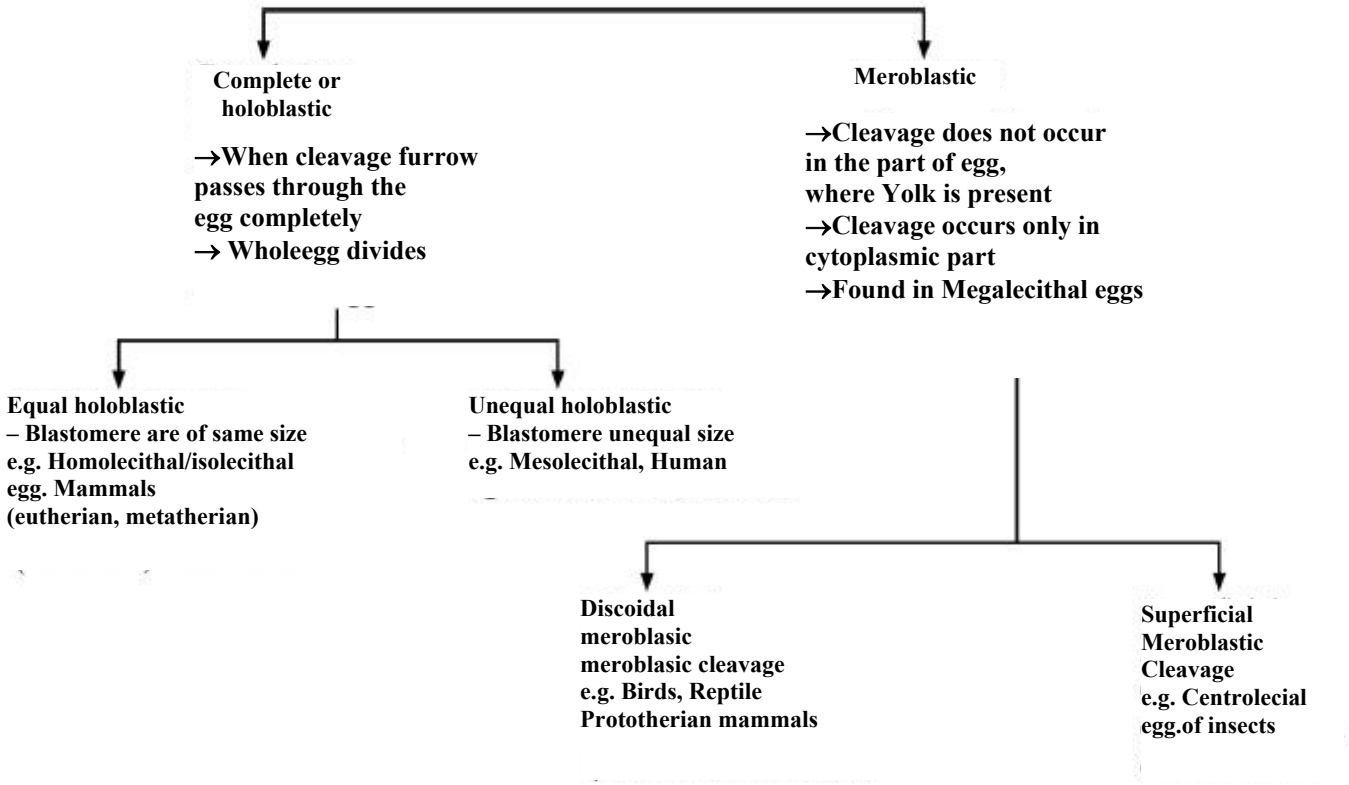
	Cleavage	Normal Mitosis
(1)	Newly formed cells are known as blastomeres	Newly formed cells are known as daughter cell
(2)	Interphase is short, only 'S' phase are present	Interphase are long G, S, G_2 phase are present
(3)	Karyoplasmic index increases	Karyoplasmic index remain constant

CLASSIFICATION OF CLEAVAGE



CLASSIFICATION OF CLEAVAGE

- **On the basis of amount of Yolk :-**
- A scientist named Balfour gave a law. According to him, rate of cleavage is inversely proportional to amount of yolk present in the egg. The yolk present in egg, disturbs the rate of cleavage. The rate of cleavage is slow in that part of egg, in which amount of yolk is more, and the rate of cleavage is faster in the portion of egg in .which yolk is in lesser amount. Mostly cleavage is of 2 types :-



- **Significance of Cleavage -**

1. There is no change in shape and size of developing embryo till end stage of gastrula stage comes then it remains just like undivided egg in shape.
2. As a result of cleavage, unicellular zygote changes into multi-cellular structure.

GENERAL STAGES OF EMBRYONIC DEVELOPMENT

MORULA

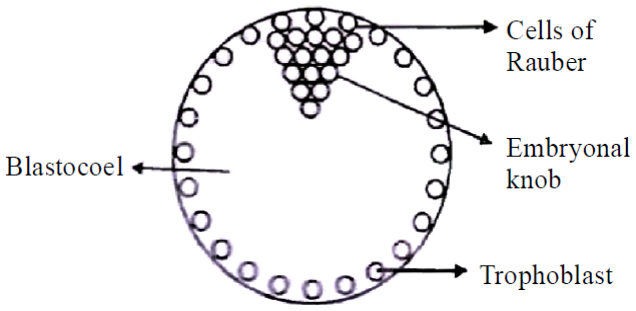
As a result of segmentation or cleavage activities, unicellular zygote changes into a solid ball like multicellular structure. In the later stage of cleavage, clusters of sticky, cohering, protruding (outside) blastomere are produced, which look like mulberry. This stage is termed as morula stage. The mitotic division starts as the zygote moves through the isthmus of the oviduct called cleavage towards the uterus and forms 2, 4, 8, 16 daughter cells called blastomeres. The embryo with 8 to 16 blastomeres is called a morula.

BLASTULATION

- **Blastocyst –**

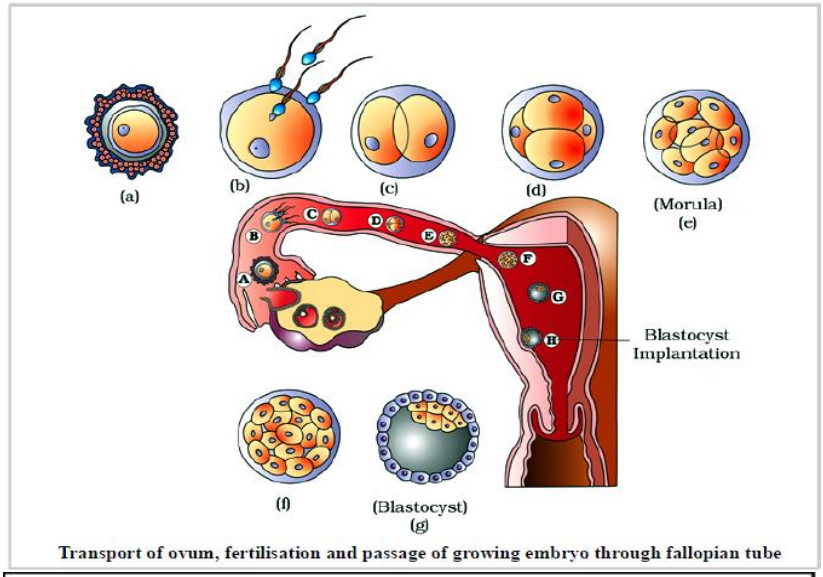
  Blastula of eutherian and metatherian mammals is called blastocyst, because blastula is in the form of a cyst.

- The blastomeres in the blastocyst are arranged into an outer layer called trophoblast and an inner group of cells attached to trophoblast called the inner cell mass. The trophoblast layer then gets attached to the endometrium and the inner cell mass gets differentiated as the embryo.

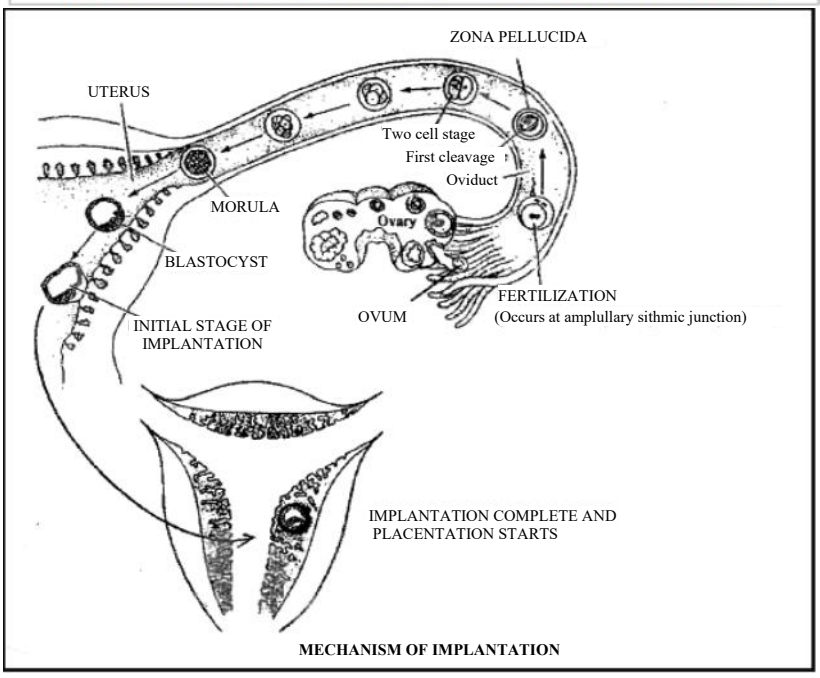


[Blastocyst]

IMPLANTATION



Transport of ovum, fertilisation and passage of growing embryo through fallopian tube



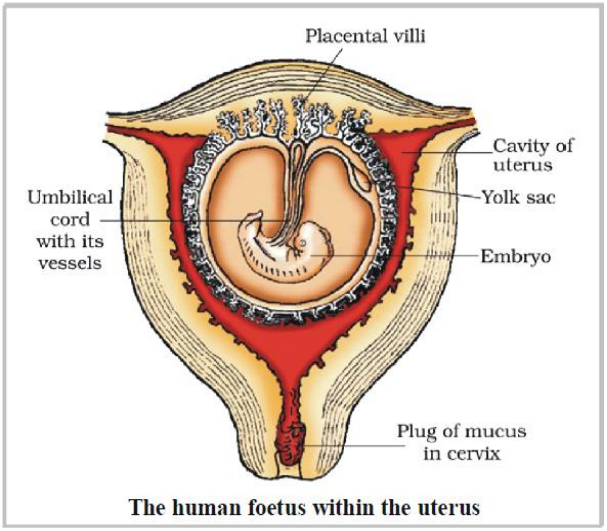
MECHANISM OF IMPLANTATION

- Initially the oocyte after its release from ovary, comes into fallopian tube where the process of fertilization is completed. Just after fertilization, embryonic development starts and a blastocyst is formed after cleavage and morulation.

  In human being, the blastocyst gets attached with the uterine endometrium in about four days after entering in uterus. At the same time, the cells of endometrium of implantation area separate out and adhere with embryonic cells with the help of certain enzymes secreted by the cells of trophoblast. In human, the site of implantation is generally mid-dorsal/fundus part of uterus. Implantation of blastocyst takes about 7-8 days after fertilization in human and by 12^{th} day it is completely buried in the wall of the uterus.

  The place of entry through which the embryo enters into the wall, is completely closed by a fibrous and cellular plug, known as closing coagulum.

  Function of the zona pellucida - It prevent implantation of the blastocyst at an abnormal site. The trophoblast has the property of being able to stick to the uterine (or other) epithelium and its cells have the capacity to eat up other cells.



The human foetus within the uterus

- After implantation, the wall of uterus is called as decidua, instead of endometrium. The part of decidua, where placenta is formed is called deciduas basalis whereas, the part separating the embryo from lumen of uterus is called decidua capsularis. The remaining part of lumen of uterus is called **decidua parietalis**.

Interstitial implantation- The blastocyst is buries deeply inside the wall of uterus and covered by the endodermal tissues lying under epithelium. This type of implantation occurs in human being .

GASTRULATION

- **Gastrula :**
  In gastrula state rate of cleavage division is slow and ultimately stops at the end of gastrula. Gastrula stage is the most important stage in embryonic development because two main events take place during gastrula stage.

(a) Differentiation **of blastomere :**
As a result of differentiation of blastomere; three germinal layers i.e., ectoderm, mesoderm and endoderm are formed. Formation of three germinal layers is the significance of gastrula stage. All the preparation of differentiation of blastomere are completed in late blastula stage.

(b) Morphogenetic Movements :
During gastrula stage blastomere perform amoeboid movement and reach to their definite place in embryo because after the gastrulation organogenesis has to start in embryo. Morphogenetic movement requires enormous energy. So respiratory activity of egg increases.

- **Method of Gastrulation:**
  (a) Epiboly :
  Movement of ectoderm forming blastomere
  (b) Emboly :
  Movement of mesoderm and endoderm forming blastomere. In same animals new cavity if formed in gastrula this is called gastrocoel or archenteron cavity. Immediately after implantation, the inner cell mass (embryo) differentiates into ectoderm endoderm and mesoderm (between the ectoderm and the endoderm). These three layers give rise to all tissues (organs) in adults. It needs to be mentioned here that the inner cell mass contains certain cells called stem cells which have the potency to give rise to all the tissues and organs.

Summary of developmental stages in human

- After one month of pregnancy, the embryo's heart is formed.
- By the end of the second month of pregnancy the foetus develops limbs and digits.
- By the end of 12 weeks (First trimester), most of the major organ system are formed.
- The first movements of the foetus and appearance of hair on the head are usually observed during the fifth month.
- By the end of 24 weeks (Second trimester), the body is covered with fine hair, eye-lids separate and eye lashes are formed.
- By the end of nine months of pregnancy, the foetus is fully developed and is ready for delivery.

PLACENTA

- The eggs of viviparous animals are unable to develop into their embryos outside the uterus independently. This is because of the very little or negligible amount of yolk present in these eggs, which can not fulfill the nutritional and other physiological demands of a developing embryo. Here the embryo depends upon maternal tissues for shelter, nutrition, respiration etc. These animals therefore, have developed adaptation, respiratory and other physiological requirements from mother's body.
- Placenta is found in all viviparous (except sub-class Prototheria; oviparous) animals.

Hormones of Human Placenta

- The placenta of human mainly secretes two steroid hormones like estradiol and progesterone, and two protein hormones like human chorional gonadotropin HCG and human placental somatomammotropin HCS. Large amount of HCG hormone is secreted, during early pregnancy, from the placenta. Because of this reason its quantity increases in the urine of pregnant lady. On the basis of this fact, pregnancy test is performed. The above hormones are also held responsible for keeping the corpus luteum active, protection of embryo, prevention of abortion and growth of mammary glands.
- In addition, during pregnancy the levels of other hormones like estrogens, progesterons, cortisol, prolactin; thyroxine, etc., are increased several folds in the maternal blood.

Structure of Placenta

- Placenta is not a simple membrane. It is made up of the tissues from two different sources-

Maternal tissue-These include uterine epithelium, connective tissues and blood capillaries.

Embryonic tissue- These include extra embryonic membranes (mainly chorion). Yolk sac and allantois may also take part in placenta formation. Embryonic connective tissues and blood capillaries are also constituents of it.

Chorio-allantoic placenta in mammals.

1. In this type of placenta, allantoic mesoderm and the mesoderm of umbilical cord jointly form the blood vessels of umbilical cord. The endodermal part of the allantois remains as a very small cavity.
2. To obtain nutrition from maternal blood several finger like processes or villi are formed by chorion which penetrate deeply into the crypts of uterus. Initially the villi are scattered over the whole surface of chorion but later they become restricted in the decidua basalis region. The chorionic villi on the remaining surface disappear shortly. The part of chorion, which helps in placenta formation is known as **chorionic frondosum**.

Functions of placenta

1. Exchange of important materials between foetal and maternal blood.
2. The essential materials are exchanged by diffusion, pinocytosis or active transport.
3. The small molecules like O2, CO2, H2O etc. and other inorganic substances like chlorides, phosphates, sodium, potassium, magnesium etc. are also diffused through placenta.
4. Large molecules like lipids, polysaccharides, carbohydrates, proteins etc. are obtained by pinocytosis process.
5. The nutritional substances are supplied to embryo from the mother through placenta.
6. Placenta also serves as a respiratory medium for exchange of O2 and CO2 between embryo and mother.
7. The nitrogenous and metabolic wastes from foetus are released into the blood of mother by diffusion through placenta.
8. The antibodies for measles, chicken-pox, polio etc. present in the blood of mother reach the embryo through placenta.
9. Pathogenic viruses may also enter in embryo through placenta.
10. If a female takes some harmful chemicals, liquor, drugs etc.during pregnancy, these may cross the placenta and on reaching into foetus may cause deformity during organogenesis. (eg. Thallidomide)
11. Placenta itself secretes some hormones like progesterone, estrogen, lactogen, HCG, HCS etc.
12. Progesterone, maintains and supports the foetus during the whole pregnancy period . At the time of parturition, relaxin is secreted by placenta which lubricates, and widens the birth canal to facilitate child birth.

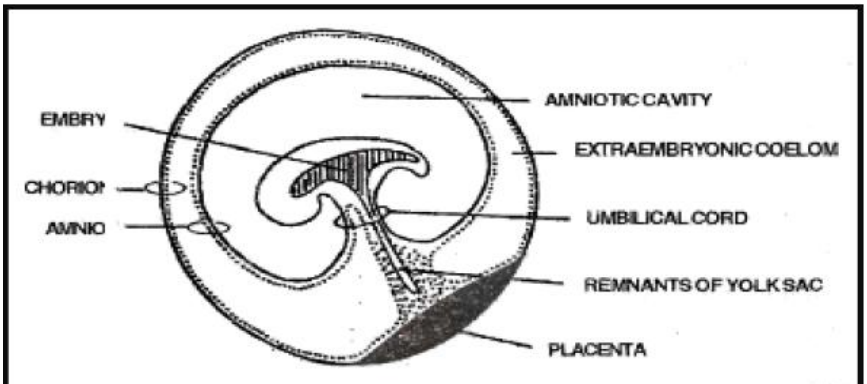
EXTRA EMBRYONIC MEMBRANES AND PLACENTA

- The cellular layer formed of blastomeres remains as blastoderm. The central part of blastoderm gives rise to embryo proper, while the peripheral portion does not take part in the formation of embryo. This peripheral part is known as extra embryonic region. This region takes part in the formation of certain membranes called extra embryonic membranes. These extra embryonic membranes provide facilities for nutrition, respiration and excretion to the embryo. Extra embryonic membranes are of four types—

1. Amnion **2.** Chorion
3. Yolk sac **4.** Allantois

- On the basis of presence or absence of amnion, two groups of vertebrates are categorized

1. **Amniota-**
   This group is characterized with the presence of amnion in the embryos of its members.
   For example members of class Reptilia, Aves and Mammalia
2. **Anamniota-**
   Animals of this group are devoid of amnion in their embryos. For example class cyclostomata, pisces and amphibia.



Formation of extraembryonic membranes in human

1. **Amnion-**
   It is formed by the layer of amniogenic cells present around the amniotic cavity and the extra embryonic mesoderm. Extra embryonic mesoderm layer surrounds the amnion. The connecting stalk is also attached with it. With a gradual increase in size the amnion covers the embryo from all sides. After about eight weeks of fertilization, amnion is completely incorporated into connecting stalk, which finally forms the umbilical cord. Embryo, in this stage, is called as foetus remains hanging in amniotic fluid.

2. **Chorion-**
   It is formed by the extra embryonic parietal layer of mesoderm and the cell of trophoblast. After implantation of blastocyst, the trophoblast gives out several finger like processes, the chorionic villi which get embedded into uterine endometrium Mesoderm also contributes in the formation of these villi. After a period of four months these villi disappear from all parts except the connecting stalk where they grow rapidly and participate in the formation of placenta.

3. **Yolk sac-**
   Yolk sac is formed by the cells of extra embryonic visceral mesoderm and endoderm. Initially the size of yolk sac is larger as compared to that of the embryo. About eight weeks after fertilization, the yolk is reduced in size and changes into a tubular structure.

4. **Allantois-**
   It is a solid and cylindrical mass formed by embryonic mesoderm. A small cavity lined by Endodermal cells develops in it. The mesoderm of allantois forms many small blood vessels in this region. These vessels connect the embryo with placenta and ensure nutritional and respiratory supply to embryo. In human, allantois does not function to store the excretory wastes as it does in reptiles, birds and prototherians.

ORGANOGENESIS

Important Developmental Changes in the Human Embryo

Times from fertilization	Organs formed
Week 1	Fertilisation cleavage status about 24 hours after fertilisation. Cleavage to from a blastocyst 4-5 days after fertilisation. More than 100 cells. Implantation 6-9 days after fertilisation. The three primary germ layers (ectoderm, endoderm and mesoderm) develop.
Week 2	The three primary germ layers (ectoderm, endoderm and mesoderm) develop.
Week 3	Woman will not have a period. This may be the first sign that she is pregnant. Beginnings of the backbone. Normal tube develops, the beginning of the brain and spinal card (first organs).
Week 4	Heart, blood vessels, blood. This can be seen on an ultrasound scan.
Week 5	Brain developing, Limb buds', small swellings which are the beginnings of the arms and legs. Heart is a large tube and starts to beat, pumping blood. This can be seen on an ultrasound scan. Eyes and ears start to form.
Week 6	Eyes and ears start to form.
Week 7	All major internal organs developing. Face forming. Eyes have some colour. Mouth and tongue develop. Beginnings of hands and feet.
Week 12	Foetus fully formed, with all organs, muscles, bones. toe and fingers. Sex organs well developed Foetus is moving.
Week 20	Hair beginning to grow, including eyebrows and eyelashes. Fingerprints developed. Fingernails and toenails growing. Firm hand grip. Between 16 and 20 weeks baby usually felt moving for first time.
Week 24	Eyelids open. Legal limit for abortion in most circumstances.
By week 26	Has a good chance of survival if born prematurely.
By week 28	Baby moving vigorously. Responds to touch and loud noice. Swallowing amniotic fluid and urinating.
By week 30	Usually lying head down ready for birth.
40 weeks	Birth

PARTURITION AND LACTATION

- The average duration of human pregnancy is about 9 months which is called the gestation period. Vigorous contraction of the uterus at the end of pregnancy causes expulsion/delivery of the foetus. This process of delivery of the foetus (childbirth) is called **parturition.** Parturition is induced by a complex neuro-endocrine mechanism.
- Parturition is a **hormonal process.** Many hormonal changes take place during it.

1. The progesterone secretion stops, so the placenta dissolves and the foetus is separated from the walls of the uterus.
2. The signals for parturition originate from the fully developed fetus and the placenta which induce mild uterine contractions called **foetal ejection reflex**.

3. Pituitary gland secretes **Oxytocin** in more amount This hormone induces intense contractions in the uterus. Due to these contractions, the foetus starts moving towards the vagina. The labour pain during child-birth, is due to this hormone. Oxytocin is the main parturition hormone. After parturition, Oxytocin stimulates milk-let down by **milk ejection reflex.**

4. **Relaxin** hormone is secreted by the placenta and the ovary. This hormone relaxes the pubic symphysis i.e. the joint between the pelvic-girdles. So more space is available to the foetus to move out.

- The mammary glands of the female undergo differentiation during pregnancy and starts producing milk towards the end of pregnancy by the process called **lactation.** This helps the mother in feeding the new-born. The milk produced during the initial few days of lactation is called **colostrum** which contains several antibodies absolutely essential to develop resistance for the new-born babies. Breast-feeding during the initial period of infant growth is recommended by doctors for bringing up a healthy baby.

MEMORY BOOSTER

1. After gastrulation, cleavage is completely checked. Nucleus appears stage. The consumption of oxygen is increased during cleavage.
2. Embryo consumes maximum O_2 during gastrula stage.
3. The part of decidua where placenta is formed is known as decidua basalis.
4. During pregnancy the levels of other hormones like estrogens, progestogens, cortisol, prolactin, thyroxine etc., are increased several folds in the maternal blood.
5. Maximum growth in human embryo occurs in fourth month of pregnancy and minimum in last months.
6. Pathogenic viruses may also enter in embryo through placenta.
7. **Perianal glands** These are found both in male and female rabbits. Perianal gland is found around external genital organ & perineal region. During the breeding season, these glands secrete odoriferous liquid which has **pheromones of Ectohormones** in it. The pheromone develops sexual attraction between opposite sexes & also develops desire for copulation.

Note

In human, Perianal glands are absent.

LEARNING BOOSTER-6

1. Three germ layers are formed during which stage of embryonic development :-
   (1) Morula (2) Blastula
   (3) Gastrula (4) In any two stages **[3]**
2. Movement of blastomeres usually seen in which embryonic stage :-
   (1) Morula (2) Blastula
   (3) Gastrula (4) In all embryonic stage **[3]**
3. The first movements of the foetus and appearance of hair on the head are usually observed during the
   (1) 3rd (2) 4th month
   (3) 5th mont (4) 8th month **[3]**
4. Archenteron is cavity in
   (1) Blastula (2) Gastrula
   (3) Zygote (4) Morula **[2]**
5. Parturition is induced by
   (1) A complex neuro endocrine mechanism
   (2) A Neural mechanism
   (3) A neuro exocrine mechanism
   (4) A physio-chemical mechanism **[1]**
6. Which hormone is secreted in women only during the pregnancy :-
   (1) Progesterone
   (2) HPL
   (3) Estrogen
   (4) Thyroxin **[2]**

Male	Female
• Wolfian duct or Mesonephric duct → Epididymis & Vas deferens	• Mullerian duct - Fallopian tube, uterus and vagina (Oviduct)
• Regression of Mullerian duct or Paramesonephric duct → Seminal Vesicle	• Urogenital sinus — Paraurethral gland of skin
• Urogenital sinus - Prostate	
• Genital tubercle - Penis	• Genital tubercle - Clitoris

HOMOLOGUS ORGANS		
	Male	**Female**
1.	Scrotal sac	Labia majora
2.	Penis	Clitoris
3.	Prostatic utricle	Vagina
4.	Seminal vesicle	Uterus (Oviduct)
5.	Prostate gland	Paraurehral gland of skin
6.	Cowper's gland	Bartholin's glands

Extra points

Puberty-

- The age of sexual maturity is called puberty.
- Accessory sex characters first appear in puberty
- Puberty occurs in girls at the age of 11 to 14 year
- Puberty occurs in boys at the age of 12-15 year
- At puberty, women starts producing ova.

Gestation period —

Duration between fertilization and Parturition.

(1) Rabbit = 28 – 32 days.
(2) Man = 270 – 290 days
(3) Dog = 60 – 65 days
(4) Cat = 62 – 72 days
(5) Elephant = 607 – 641 days

Gynaecomastia - Development of breast in the male.
Amenorrhoea - Absence of menstruation cycle.
Hysterectomy - Surgical removal of uterus.
Oopherectomy - Removal of ovaries.

Path of sperms in mammals –

Seminiferous tubules →Rete testis →Vasa efferentia →
Epididymis →Vasa deferens →Urino-genital Chamber →Urethra →Vagina.

- Use of antibiotics, smoking marijuana, alcohol, hot bath, high fever can also cause temporary drop in sperm count.

Spontaneous ovulator –

Ovulation occurswithout any induction. **Ex.** Most animals (Human)**Induced ovulator** (Reflex ovulator) = ovulation occurs after copulation
Ex. Rabbit.

SPECIAL POINT

1. In human Gametogenesis, maturation phase is longest.

2. The acrosome of sperm are produced by golgi bodies.

3. Formation of yolk in oogenesis takes place in the growth phase.

4. Largest egg is of Ostrich (16 cm long with its shell)

5. Although normal number of sperm are present in semen but if these are completely non motile. This condition is known as necrospermia.

6. Smallest egg in birds is of humming bird.

7. Due to high mortality rate in lower animals, the production of egg is more.

8. The life span of eggs in female reproductive organism human being is 48 hrs.

9. The nucleus of egg is known as germinal vesicle.

10. At the age of 45-50 yrs. in female the ovulation process will stop which is known as menopause.

ARTIFICIAL PARTHENOGENESIS :-

This type of parthenogenesis is done by artificial methods. Artificial parthenogenesis is done by putting eggs in different atmospheres or by giving special stimulus to the eggs. Different artificial methods used for this purpose are as follows -

(1) If we place eggs in brine or salt solution KCl solution. Then eggs show parthenogenesis e.g .eggs of sea urchins.
(2) By short exposure of radiations on eggs or exposure of silk insect egg to sunlight.
(3) If eggs are given shocks of temperature.
(4) If eggs are pierced by needle dipped in the blood of some animal. The eggs of frog show parthenogenesis by this method.

EXERCISE # 1

Based On **MALE REPRODUCTIVE SYSTEM**

1. Which one is a primary sex organ?
(1) Scrotum (2) Penis
(3) Testis (4) Prostate gland

2. Secondary sex organ is
(1) Testis (2) Ovary
(3) Beard (4) Vas deferens

3. Vasa deferens is cut for
(1) Female sterilization
(2) Male sterilization
(3) Both of the above
(4) Temporary sterilization

4. The function of seminal fluid is -
(1) sexual attraction
(2) to provide stability to egg
(3) to provide a medium for the movement of sperms
(4) to provide acidic medium

5. Vasa efferentia connect the
(1) testes with epididymis
(2) kidneys with cloaca
(3) testes with urinogenital duct
(4) None of the above

6. Common duct formed by union of vas deferens and duct from seminal vesicle is
(1) urethra (2) tunica-vasculosa
(3) ejaculatory duct (4) spermatic duct

7. Tunica albuginea is the covering around
(1) Oviduct (2) Testis
(3) Kidney (4) Heart

8. The functional unit of testis of man is
(1) Uriniferous tubules
(2) Malpighian tubules
(3) Seminiferous tubules
(4) Acini or lobules

9. Seminiferous tubules are composed of
(1) Spermatogonia
(2) Glandular epithelium
(3) Sensory epithelium
(4) Germinal epithelium

10. In mammals, the testes are located in
(1) Abdominal cavity
(2) Thoracic cavity
(3) Extra-abdominal cavity
(4) Pericardial cavity

11. Sustentacular cells are found in
(1) Testis of mammal
(2) Ovary of mammal
(3) Testis of Ascaris
(4) Pancreas of frog

12. Glans penis is covered by
(1) Areolar membrane
(2) Prepuce
(3) Metrium
(4) None

13. Scrotal sacs of man is connected with the abdominal cavity by-
(1) Inguinal canal
(2) Haversian canal
(3) Vagina cavity
(4) Spermatic canal

14. In mammals, the testes occur in scrotal sacs, outside the viscera because of the
(1) presence of urinary bladder
(2) presence of rectum
(3) long vas-deferens
(4) Requirement of low temperature for spermatogenesis

15. Sertoli cells are found in
(1)testis of cockroach
(2)liver of mammals
(3)testis of mammals
(4)testis of frog

16. Cells of Leydig occur in
(1) Liver (2) Ovary
(3) Testis (4) Spleen

17. Which accessory genital gland occurs only in male mammal?
(1) Bartholin's gland (2) Perineal gland
(3) Prostate gland (4) All of the above

18. Seminal vesicle is present at the junction of
(1)prostate and urethra
(2)prostate and vas-deferens
(3)prostate and cowper's gland
(4)vas deferens and testis

19. Seminiferous tubules occur in the
(1)liver (2) kidney
(3)ovary (4) testis

20. Sugar fructose is present in the secretion of
(1) Seminal vesicle
(2) Perineal gland
(3) Cowper's gland
(4) Bartholin's gland

21. What happens after vasectomy?
(1) Absence of semen formation.
(2) Sperm are dead or inactive.
(3) Sperm immediately disappears in semen.
(4) Sperm gradually disappears in semen

22. Sertoli cells occur in
(1) human testis
(2) frog testis
(3) human ovary
(4) frog ovary

23. Temperature of scrotum as compared to abdominal cavity is less by
(1) 1°C (2) 5°C
(3) 3°C (4) 10°C

24. Cowper's glands are found in
(1) Male mammals
(2) Female birds
(3) Male amphibians
(4) Female amphibians

25. A female gland corresponding to prostate of males is
(1) Bartholin's' gland
(2) Bulbourethral gland
(3) Clitoris
(4) None

26. Secretions from which one of the following are rich in fructose, calcium and some enzymes?
(1) Salivary glands
(2) Female accessory glands
(3) Male accessory glands
(4) Liver

27. Which is unpaired gland in male reproductive system of human?
(1) Bartholin gland
(2) Seminal vesicle
(3) Prostate gland
(4) Cowper's gland

28. In mammals, maturation of sperm take place at a temperature
(1)equal to that of body
(2)higher than that of body
(3)lower than that of body
(4)at any temperature

29. Prostate gland produces a secretion for
(1) Attracting sperms
(2) Stimulating sperm activity
(3) Attracting egg
(4) None of the above

30. Seminal vesicles are located in
(1) Caput epidydimis
(2) Uterus
(3) Above Cowper's glands
(4) Glans penis.

31. Testes descend into scrotum in mammals for
(1) Spermatogenesis
(2) Fertilization
(3) Development of sex organs
(4) Development of visceral organs.

32. Spermatozoa are nourished during their development by
(1) Sertoli cells
(2) Interstitial cells
(3) Connective tissue cells
(4) None

33. Sperms and ova are
(1) Ectodermal in origin
(2) Mesodermal in origin
(3) Endodermal in origin
(4) All of the above

Based On FEMALE REPRODUCTIVE SYSTEM

34. A secondary sexual character is
(1) Breast (2) Ovary
(3) Testis (4) Thyroid

35. Which is not a secondary sex organ-
(1) Vagina
(2) Penis
(3) Prostate
(4) Mammary gland

36. At puberty woman start producing
(1) Sperms (2) Urine
(3) Young ones (4) Ova

37. Eggs from ovary are released in
(1) Oviduct (2) Kidney
(3) Ureter (4) Coelom

38. Lower narrow end of uterus is called
(1) Urethra (2) Cervix
(3) Clitoris (4) Vulva

39. Germinal epithelial cells are cuboidal and these are found in
(1) Testes (2) Ovary
(3) Both (4) None

40. In the female which structure is homologous to penis of male?
(1) Cervix (2) Vagina
(3) Uterus (4) Clitoris

41. Puberty occurs in females at the age of
(1) 8 -10 years (2) 11-14 years
(3) 15-17 years (4) 18-20 years

42. Capacitation of sperm is provided by
(1) Urethra (2) Vas deferens
(3) Vagina (4) Seminal vesicle

43. Degenerative process of follicles or eggs in ovary is called
(1) Metagenesis (2) Atresia
(3) Regression (4) None

44. Central stroma of ovary is made up of
(1) Fibrous connective tissue
(2) Reticular tissue
(3) Adipose connective tissue
(4) None

45. Endometrium is lining of
(1) Testis (2) Urinary bladder
(3) Uterus (4) Ureter

Based On SPERMATOGENESIS AMD SPERM

46. During differentiation the spermatids remain associated with
(1) Leydig's cells
(2) Kupffer's cells
(3) Spermatogonia
(4) Sertoli cell

47. In gametogenesis, reduction division take place during
(1) Multiplication phase
(2) Growth phase
(3) First maturation division
(4) Second maturation

48. Which types of division take place during second maturation division?
(1) Reduction division
(2) Equational division
(3) Amitosis
(4) None

49. Longest phase of spermatogenesis is -
(1) Multiplication phase
(2) Growth phase
(3) Maturation phase
(4) Germinal phase

50. During spermatogenesis how many spermatozoa are formed from a single primary spermatocyte
(1) 1 (2) 2
(3) 4 (4) 8

51. Which of the following part of spermatozoan arise from centriole?
(1) Apical cap (2) Head
(3) Middle piece (4) Tail

52. Which piece of a sperm is called power house?
(1) Head piece (2) Neck piece
(3) Middle piece (4) Tail piece

53. Which part of sperm enters in egg in human?
(1) Complete sperm
(2) Only head
(3) Head and middle piece
(4) Head and acrosome

54. Normally in the head of a mature sperm cytoplasm is
(1) Present in large amount
(2) Present in very moderate amount
(3) Present in very little amount
(4) Absent

55. The acrosome plays a role in :-
(1) Fusion of nuclei of gametes
(2) Motility of sperm
(3) Penetration of sperm into ovum
(4) All of the above

56. The head of a mature sperm is mainly composed of
(1) elongated nucleus and acrosomal material.
(2) mitochondria, cytoplasm & nucleus.
(3) two centriole & the axial filament.
(4) all of the above.

57. A mature sperm has
(1) A pair of flagella
(2) A nucleus, an acrosome and a centriole
(3) A nucleus, an acrosome, a pair of centrioles
(4) A nucleus, an acrosome, a pair of centrioles and a tail.

58. Which part of the spermatid forms acrosome of sperm ?
(1) Mitochondria (2) Golgi body
(3) Nucleus (4) Lysosome

Based On OOGENESIS AND OF EGGS

59. At the time of birth, ovum arrested in the form of
(1) Oogonia
(2) Primary oocyte
(3) Secondary oocytes
(4) Egg

60. A human female has the maximum number of primary oocytes in her ovaries :-
(1) at menopause
(2) at puberty
(3) at birth
(4) early in her fertile years

61. Eggs liberated from ovary in human in
(1) Secondary oocyte stage
(2) Primary oocyte stage
(3) Oogonial stage
(4) Mature ovum stage

62. First meiotic division during Oogenesis occurs in :
(1) First polar body
(2) Second polar body
(3) Primary oocytes
(4) Secondary polar body

63. Which of the following is haploid?
(1) Primary spermatocytes and primary oocytes
(2) Secondary spermatocytes and sec. oocytes
(3) Spermatogonia and oogonia
(4) Germinal cells

64. The process of spermatogenesis and oogenesis in most vertebrates are under the influence of which hormone?
(1) Oxytocin (2) FSH
(3) ACTH (4) ICSH

65. During which stage of gametogenesis meiosis occurs?
(1) Growth phase
(2) Multiplication phase
(3) Maturation phase
(4) None of the above

66. The primary egg membrane of mammalians egg is termed as :–
(1) Chorion
(2) Corona radiata
(3) Zona pellucid
(4) Vitelline membrane

67. Which of the following is diploid?
(1) Secondary spermatocytes
(2) Spermatozoa & ova
(3) Spermatogonia, Oogonia, Primary spermatocyte
(4) Secondary oocytes

68. Polar body is produced during the formation of
(1) Sperm (2)Secondary oocyte
(3) Oogonium (4) Spermatocytes

Based On **FORMATION OF OVARIAN OR GRAFIAN FOLLICLE AND MENSTRUAL CYCLE**

69. Graffian follicle are found in
(1) Testis of mammal
(2) Ovary of frog
(3) Ovary of cockroach
(4) Ovary of mammals

70. Graffian follicle contains
(1) Many oocytes
(2) Many sperms
(3) A single oocyte
(4) Site for egg fertilisation

71. In mammals, corpus luteum is found in which organ
(1) Brain (2) Ovary
(3) Liver (4) Eyes

72. Antrum is filled with fluid and is found in
(1) Bone-marrow of bone
(2) Cavity of brain
(3) Graffian follicle of ovary
(4) Pericardium of heart

73. One of the following is fibrous layer of follicle
(1) Theca externa
(2) Zona pellucida
(3) Membrana grunulosa
(4) Vitelline membrane

74. In case of non fertilization, corpus luteum
(1) Stops secreting progesterone
(2) Changes to corpus albicans
(3) Starts producing progesterone
(4) None of the above

75. Lutein cells are found in
(1) Primary follicle (2) Corpus albicans
(3) Corpus luteum (4) All

76. Corpus luteum is
(1) Excretory (2) Endocrine
(3) Digestive (4) Reproductive

77. Luteal phase is the other name of
(1) Follicular phase
(2) Proliferative phase
(3) Menstrual flow phase
(4) Secretary phase

78. Follicular phase of menstrual cycle is the other name of :
(1) Proliferative phase
(2) Secretory phase
(3) Luteal phase
(4) Menstruation

79. Loss of reproductive capacity in women after age of 45 years is
(1) Menstruation (2) Ageing
(3) Menopause (4) Menarche

80. Which induces the development of corpus luteum
(1) LH (2) Oestrogen
(3) FSH (4) LTH

81. The process of releasing the ripe female gamete from the ovary is called
(1) Ovulation (2) Parturition
(3) Implantation (4) Fertilisation

82. Ovulation hormone is :-
(1) FSH (2) ICSH
(3) LH (4) Testosterone

83. Onset of pregnancy
(1) Stimulates testosterone secretion
(2) Inhibits further ovulation
(3) Leads to degeneration of ovary
(4) Inhibits fusion of egg and sperm nuclei.

84. Which is correct ?
(1) Menstrual cycle is present in all mammals
(2) Menstrual cycle is present in all primates
(3) Estrous cycle occurs in all mammals
(4) Most mammals are ovoviviparous

85. Yellow corpus luteum occurs in a mammals in
(1) Heart to initiate heart beat
(2) Skin to function as pain receptor
(3) Brain and connects cerebral hemispheres
(4) Ovary for secretion of progesterone.

86. Progesterone level falls leading to
(1) Gestation (2) Menopause
(3) Lactation (4) Menstruation

87. In uterus, endometrium, proliferates in response to
(1) Relaxin (2) Oxytocin
(3) Progesterone (4) Oestrogen
(5) LH

88. Pregnancy hormone is :-
(1) Estrogen (2) Progesterone
(3) LH (4) FSH

89. During pregnancy, the urine of female would contain
(1) LH (2) Progesterone
(3) FSH (4) HCG

Based On FERTILIZATION

90. Site of fertilization in mammal is
(1)ovary (2) uterus
(3)vagina (4) fallopian tube

91. Polyspermy is normally prevented by
(1) The fertilizin and antifertilizin reaction
(2) Repulsion of excess number of sperm by ova
(3) Inability of some sperm to penetrate ova
(4) Formation of fertilization membrane

92. Type of fertilization (external or internal) depends on :
(1) Structure of egg
(2) Site of embryo development
(3) Type of sperm
(4) A and B both

93. Adaptation for approach of sperm of egg in mammals
(1) Sperm kept inactive till ejaculation
(2) Very high number of sperm
(3) Peristalsis of oviduct
(4) All the above

94. In which of the following fertilization occurs externally in water?
(1) Hydra (2) Frog
(3) Both (4) None

Based On CLEAVAGE

95. Cleavage start in
(1) Fallopian tube (2) Uterus
(3) Vagina (4) None

96. After which stage cleavage stopped :–
(1) After morula
(2) After blastula
(3) After gastrula
(4) Any time it stops

97. Cells formed as a result of cleavage are called
(1) Megameres (2) Micromeres
(3) Blastoderm (4) Blastomeres

98. Which of the following characteristics does not belong to cleavage?
(1) Decrease in size of blastomeres
(2) Rapid mitotic cell division
(3) Interphase of very short duration
(4) Differention of blastomeres

99. Cleavage in the fertilized egg of humans :
(1)Starts in uterus
(2)Is meroblastic
(3)Starts when egg is in fallopian tube
(4)Is discoidal

100. What is true for cleavage :-
(1) Size of embryo increases
(2) Size of cells decrease
(3) Size of cells increase
(4) Size of embryo decreases

Based On GENERAL STAGES OFEMBUYENIC EMBRTONIC DEVELOPMENT AND GASTRULATION

101. Solid ball of cell produced by repeated cleavage is called
(1) Gastrula (2) Blastula
(3) Morula (4) Neurula

102. In which stage rate of cell-division decreases?
(1) Morula (2) Gastrula
(3) Blastula (4) Zygote

103. In gastrula stage which layers are formed
(1) Ectoderm (2) Mesoderm
(3) Endoderm (4) All

104. Which statement is not correct for gastrulation
(1) Formation of archenteron
(2) Cell division stops
(3) Oxidation reaction increase
(4) Elongation of embryo starts

105. Cavity formed during gastrulation and found in mature gastrula is
(1) Blastocoel (2) Archenteron
(3) Neurocoel (4) Pseudocoel

106. Gastrulation is a process
(1) Which begins the segregation of germ layers
(2) That occurs just after morulation
(3) That occur just after cleavage
(4) Of rapid growth in blastomeres

107. In which stage of development the embryonic cells form the germinal layers by the movement
(1) Morula (2) Blastula
(3) Gastrula (4) Zygote

108. Which of the following is not the correct for gastrulation?
(1) Archenteron is formed
(2) All germinal layers are formed
(3) Morphogenetic movements
(4) Some blastomeres & blastocoel degenerate

109. Preparation of cell differentiation are completed in:-
(1) Morula (2) Blastula
(3) Gastrula (4) Neurula

110. Sexually reproducing multicellular animals start their development from :-
(1) Gastrula
(2) Morula
(3) Unicellular zygote
(4) Ova

Based On **EXTRA EMBRYONIC MEMBRANES AND PLACENTA**

111. Placenta is the region where
(1) Foetus is attached to mother by spermatic cord
(2) Foetus is provided with mother's blood
(3) Foetus receives nourishment from mother's blood
(4) Foetus is covered by membranes.

Based On **PARTURITION**

112. The expulsion of completely developed foetus from the uterus is known as
(1) ovulation (2) oviposition
(3) gestation (4) parturition

113. Parturition canal in female is called :–
(1) Uterus (2) Oviduct
(3) Vagina (4) Urethra

114. In parturition process, which of the following does not happen?
(1) Oxytocin hormone is secreted by posterior pituitary
(2) Relaxin hormone responsible for narrowing of pelvic cavity
(3) Progesterone hormone secretion is stopped
(4) General position of foetus is occipitoanterior

115. Foetal ejection reflex in human female is induced by
(1) Differentiation of mammary glands
(2) Pressure exerted by amniotic fluid
(3) Release of oxytocin from pituitary
(4) Fully developed foetus and placenta

116. Oxytocin is mainly help in :-
(1) Milk production
(2) Child birth
(3) Urine formation
(4) Gametogenesis

117. Human beings are
(1) Ovoviviparous
(2) Oviparous
(3) Parthenogenetic
(4) Viviparous,

Based On **MISCELLANEOUS**

118. External/accessory sexual characters first appear in
(1) Childhood
(2) Puberty
(3) Foetus
(4) Adulthood

119. Voice is high pitched in :–
(1) Aged persons
(2) Adult males
(3) Boys
(4) Females

120. Which is not correct about secondary sexual characters of female?
(1) Development of mammary gland
(2) Presence of pubic hair
(3) Low pitched voice
(4) Menarche

EXERCISE # 2

1. Each testis has how many testicular lobules :-
(1) About 100 (2) About 150
(3) About 250 (4) Infinite

2. The male accessory glands include :–
(1) Prostate gland
(2) Bulbourethral gland
(3) Seminal vesicles
(4) All of above

3. In male penis is covered by a loose fold of skin is called :–
(1) Foreskin
(2) Urethral meatus
(3) External genitalia
(4) Fimbriae

4. The function of fimbriae :-
(1) Collection of the ovum after ovulation
(2) Maintain the shape of ovary
(3) Provide the path to sperm during fertilization
(4) None of these

5. Which statement is wrong?
(1) Mammary lobes containing clusters called alveoli
(2) Uterus is also called womb
(3) The last part of the oviduct is called ampulla
(4) Stroma of ovary divided into two zone

6. Secretion of which hormone induce/start spermatogenesis :–
(1) GnRH (2) LTH
(3) Oxytocin (4) Relaxin

7. Antrum is :–
(1) Fluid filled follicle cavity
(2) An Inner theca interna
(3) The mature follicle
(4) Fluid less follicle cavity

8. Ovulation is :-
(1) Releasing of secondary oocyte from ovary
(2) Releasing of primary oocyte from ovary
(3) Releasing of polar body
(4) Releasing of graafian follicle

9. For normal fertility, how many percentage of sperm must have normal shape and size :–
(1) 50% (2) 25%
(3) 40% (4) 60%

10. In which duration menstrual cycle both LH & FSH attain a peak level
(1) In last week
(2) Middle of cycle
(3) Initial days of cycle
(4) 4th day of cycle

11. Which statement is not correct :-
(1) In the absence of fertilization, the corpus luteum degenerates
(2) During pregnancy all events of menstrual cycle stop
(3) The secretion of LH and FSH decreases gradually during the follicular phase
(4) The menstrual flow results due to breakdown of endometrial lining

12. In which phase of menstrual cycle Graafian follicle transform as the corpus luteum.
(1) Luteal (2) Proliferation
(3) Follicular (4) Growth

13. Which hormones is essential for maintenance of the endometrium .
(1) FSH (2) LH
(3) Progesterone (4) Testosterone

14. Which of the following is an indicator of normal reproductive phase and extends between menarche and menopause.
(1) Menstruation cycle
(2) Estrous cycle
(3) Ovulation
(4) Implantation

15. Fertilization takes place at :-
(1) Cervix (2) Ampulla
(3) Isthmus (4) Vagina

16. The embryo with 8 to 16 blastomeres is called :
(1) Morula (2) Blastula
(3) Gastrula (4) Foetus

17. During Implantation, the blastocyst becomes embedded in which layer of the uterus?
(1) Trophoblast (2) Endometrium
(3) Myometrium (4) Perimetrium

18. The mitotic division starts as the zygote moves through the _____ of the oviduct called cleavage.
(1) Ampulla (2) Isthmus
(3) Fimbriae (4) Infundibulum

19. In human during fertilisation a sperm firstly comes in contact with which layer of ovum?
(1) Jelly coat
(2) Zona pellucida
(3) Vitelline membrane
(4) Perivitelline space

20. Function of placenta is-
(1) Supply of O_2 to embryo
(2) Removal of CO_2 produced by the embryo
(3) Produces several hormones
(4) All of the above

21. Stem cells are found in :-
(1) Inner cell mass (2) Ectoderm
(3) Endoderm (4) Mesoderm

22. The first sign of growing foetus may be noticed by:–
(1) Listening to the heart sound carefully through the stethoscope
(2) Appearance of hair
(3) Appearance of head
(4) Appearance of eyelids

23. Placenta contains :–
(1) Only chorionic villi
(2) Only uterine tissue
(3) Chorionic villi + uterine tissue
(4) Trophoblast + chorionic villi

24. The average duration of human pregnancy is about nine months which is called :–
(1) Gestation period (2) Parturition
(3) Lactation (4) Implantation

25. The signals for parturition originate from
(1) Fully developed foetus (2) Placenta
(3) Both (1)&(2) (4) Uterus

26. Which hormone acts on the uterine muscles during parturition?
(1) Oxytocin (2) LH
(3) Estrogen (4) Relaxin

27. Which gland of female undergo differentiation during pregnancy?
(1) Thyroid (2) Mammary
(3) Pituitary (4) Thymus

28. Which is correct for colostrum?
(1) It contains several antibodies
(2) It produced during the last days of lactation
(3) It is a pheromone
(4) It is white in colour

29. What would happen if vasa deferentia of man are cut
(1) Sperms become non nucleated
(2) Spermatogenesis does not occur
(3) Semen is without sperms
(4) Sperm are non motile.

30. If the epididymis is being removed, then what will happen?
(1) Short life span of sperm
(2) Early cross the pathway
(3) Functional maturation is early
(4) Sperm win be incapable for fertilization

31. If cowper's gland is removed which of the following will be affected
(1) Sexual attraction
(2) Capacitation of sperms
(3) Hardness of penis
(4) Copulation

32. The sperm producing substance of enzymatic nature of sperm lysine. In mammals it is called
(1) Hyaluronidase (2) Hyaluronic acid
(3) Androgamone (4) Gyanogamone

33. Correct order of spermatogenesis is:-
(1) Spermatocytes, Spermatogonia, Spermatid, Sperm
(2) Spermatogonia, Spermatid, Spermatocytes, Sperm
(3) Spermatid, Spermatogonia, Spermatocytes, Sperm
(4) Spermatogonia, Primary Spermatocytes, Sec. Spermatocytes, Spermatid, Sperm

34. Hyaluronic acid which binds corona radiata cells is a
(1) Homopolysaccharide
(2) Amino acid
(3) Mucopolysaccharide
(4) Glycoprotein

35. How many secondary spermatocytes will form 400 spermatozoa :-
(1) 100 (2) 400 (3) 40 (4) 200

36. In which of the following animals the sperm can survive for a longer period in the body of female?
(1) Mammals (2) Aves
(3) Reptiles (4) Amphibia

37. At which stage of spermatogenesis sperm acquire their whole structural maturity and they contain a haploid nucleus & other organs :-
(1) Spermiogenesis
(2) Growth phase
(3) Multiplication phase
(4) Maturation phase

38. An egg of bird was coated with varnish and then incubated. The egg did not hatch because the developing embryo
(1)could not excrete and died
(2) could not yolk in the presence of excess amount of nitrogenous wastes
(3) died because of depleted O2 supply
(4) died because of toxic effect of varnish

39. How many sperm and ova will be formed from 50 secondary oocytes and 50 secondary spermatocytesin human :-
(1) 50 ova & 200 sperm
(2) 50 ova & 100 sperm
(3) 100 ova & 200 sperm
(4) 100 ova & 400 sperm

40. Human egg has :
(1) One V-chromosome
(2) One X-chromosome
(3) Two V-chromosome
(4) One X-chromosome and one V-chromosome.

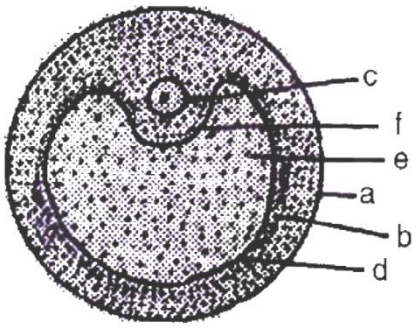
41. Oocyte is liberated from ovary under the influence of LH, after completing :
(1) Meiosis and before liberating polar bodies
(2) Meiosis I and before liberating second polar bodies
(3) Meiosis
(4) Meiosis II after release of first polar body

42. Extrusion of second polar body from egg nucleus occurs:
(1) After entry of sperm before completion of fertilization
(2) After completion of fertilization
(3) Before entry of sperm
(4) Without any relation of sperm entry.

43. When both ovary are removed from rat then which hormone is decreased in blood :
(1) Oxytocin
(2) Prolactin
(3) Estrogen
(4) Gonadotrophic releasing factor

44. In a 30 year old lady, eggs are released in form of
(1) Oogonia
(2) Primary oocyte
(3) Secondary oocyte
(4) Atretic follicle

45. In the diagram of section of Graafian follicle different parts are indicated by alphabets. Choose the correct combination



(1) a-membrana granulosa, b-theca interna, c-ovum, d-cumulus oophorus, e-antrum, f-theca externa
(2) a-theca externa, b-theca interna, c-ovum, d-membrana granulosa, e-antrum, f-cumulus oophorus
(3) a-theca externa, b-theca interna, c-ovum, d-cumulus oophorus, e-antrum, f-membrana granulosa
(4) a-membrana granulosa, b-theca externa, c-ovum, d-cumulus oophorus, e-antrum, f-theca interna

46. Stages in menstrual cycle are
(1) Recovery and proliferative phase
(2) Proliferative and secretory phase
(3) Proliferative, secretory and menstrual phase
(4) Recovery phase, secretory phase and phase of menstrual flow

47. If the menstrual cycle is of 35 days then what is risk period (cycle start on 1st day) :-
(1) 9th to 17th days (2) 11th to 18th days
(3) 16th to 24th days (4) 18th to 35th days

48. After ovulation follicles converted into :-
(1) Corpus luteum (2) Corpus albicans
(3) Corpus cavernosa (4) Corpus callosum

49. Ovulation in the human female normally takes place during the menstrual cycle
(1) At the end of the proliferative phase
(2) At the mid secretory phase
(3) Just before the end of the secretory phase
(4) At the beginning of the proliferative phase

50. Correct sequence of hormone secretion from beginning of menstruation is
(1) FSH, progesterone, estrogen
(2) Estrogen, FSH, progesterone
(3) FSH, estrogen, progesterone
(4) Esterogen, progesterone, FSH

51. At ovulation, the mammalian egg is covered by a membrane called :
(1) Chorion (2) Zona pellucida
(3) Corona radiate (4) Both B and C

52. How many cleavages are required for formation of 16 blastomeres?
(1) 2 (2) 4 (3) 6 (4) 8

53. The blastomeres in the blastocyst are arranged into an outer layer called __A__, and inner group of cells attached to trophoblast called the ___B__.
(1) A is trophoblast and B are inner cell mass
(2) A are inner cell mass and B is trophoblast
(3) Both are trophoblast
(4) Both are inner cell masses

54. During cleavage, what is true about embryo?
(1) Nucleocytoplasmic ratio remains unchanged
(2) Size does not increase
(3) There is less consumption of oxygen
(4) The division is like meiosis.

55. Amount of yolk and its distribution are changed in the egg. Which one is affected?
(1) Pattern of cleavage
(2) Formation of zygote
(3) Number of blastomeres
(4) Fertilisation.

56. Correct sequence in development is :
(1) Fertilization →Zygote →Cleavage →Morula →Blastula →Gastrula
(2) Fertilization →Zygote →Blastula →Morula → Cleavage →Gastrula
(3) Fertilization →Cleavage →Morula →Zygote →Blastula →Gastrula
(4) Cleavage →Zygote →Fertilization →Morula →Blastula →Gastrula

57. Which following homologous structures are mis-matched?
(1) Clitoris and penis
(2) Vagina and prostatic utricle
(3) Scrotum and labia majora
(4) Fallopian tube and prostate

58. What will happen to spermatozoa at 0°C temperature ?
(1) All sperm will die
(2) There will be no change
(3) They will become inactive temporarily
(4) Tails will be lost

59. The lytic enzyme present in semen is :-
(1)ligase
(2)estrogenase
(3)androgenase
(4)hyaluronidase

60. In the urinogenital organs of human which one of following part is present in male but not in female
(1) Urethra (2) Fallopian tube
(3) Vagina (4) Vasa deferens

61. Accessory sexual character in female is promoted by:-
(1) Androgen (2) Progesterone
(3) Estrogen (4) Testosterone

62. The cellular layer that disintegrates and regenerates again and again in humans is :-
(1) Endometrium of uterus
(2) Cornea of eye
(3) Dermis of skin
(4) Endothelium of blood vessels

63. The functional maturation of sperms takes place in :-
(1) Oviduct (2) Epididymis
(3) Vagina (4) All of these

64. Surgical removal or cutting and ligation of the ends of oviduct is known as :-
(1) tubectomy (2) oviductomy
(3) castration (4) vasectomy

65. In mammals the estrogens are secreted by the Graafian follicle from its :-
(1) External theca (2) Internal theca
(3) Zona pellucid (4) Corona radiata

66. Supporting cells found in the germinal epithelium of testis are called :-
(1) Interstitial cells of leydig
(2) Sertoli cells
(3) Granular cells
(4) Phagocytes

67. Atretic follicles are found in the :-
(1) Fallopian tube
(2) Uterus
(3) Labia majora
(4) Ovary

68. In mammals the female secondary sexual characters are developed mainly by the hormone
(1) Relaxin (2) Estrogens
(3) Progesterone (4) Gonadotropins

69. Which of the following undergoes spermiogenesis?
(1) Spermatids
(2) Spermatogonia
(3) Primary spermatocytes
(4) Secondary spermatocytes

70. Various changes in mammalian sperm which prepare it to fertilise the ovum are called :
(1) Capacitation
(2) Regeneration
(3) Growth
(4) None of these

71. In gastrulation, which is (are) formed:
(1) Endoderm
(2) Mesoderm
(3) Ectoderm, endoderm
(4) Ectoderm, mesoderm, endoderm

72. During oogenesis, the small structure separated from egg is :
(1) Polar bodies
(2) Secondary endosperm
(3) Herring bodies
(4) Hela cells

73. Foetal sex is determined by examining cells from amniotic fluid looking for:
(1) Chiasmata
(2) Autosomes
(3) Sex-chromosomes
(4) Nucleus

74. Which of the following is not correct for gastrulation?
(1) Archenteron is formed
(2) All germinal layers are formed
(3) Morphogenetic movements
(4) Blastomeres and gastrocoel degenerate

75. In human foetus, the heart begins to beat at developmental age of :
(1) 4th week (2) 3rd week
(3) 6th week (4) 8th week

76. Development of animal embryo from egg without fertilization is called :-
(1) Parthenogenesis
(2) Parthenocarpy
(3) Apospory
(4) Apomixis

77. During embryonic development, endoskeleton and muscle develop from which germinal layer :
(1) Ectoderm (2) Endoderm
(3) Mesoderm (4) Blastopore

78. Polar bodies are produced during the formation of:
(1) Sperm (2) Oogonium
(3) Spermatocytes (4)Secondary oocyte

79. The part where fertilization of ovum occurs in placental mammals is :
(1) Ovary (2) Uterus
(3) Vagina (4) Fallopian tube

80. In a vertebrate which germ layer forms the skeletal muscles:
(1) Ectoderm (2) Endoderm
(3) Mesoderm (4) Both 'A' and 'B

81. Acrosome of spermatozoa is formed from:
(1) Lysosomes (2) Golgi bodies
(3) Ribosome (4) Mitochondria

82. The nervous system of vertebrates is derived from:
(1) Ectoderm (2) Endoderm
(3) Mesoderm (4) All of these

83. In a sperm, the mitochondria occur:
(1) In tail (2) In acrosome
(3) In middle piece (4)In head

84. Identical twins will be produced when:
(1) One spermatozoan fertilizes two ova
(2) One ovum is fertilized by two spermatozoa
(3) Two eggs are fertilized
(4) One fertilized egg divides into two blastomeres and they become separate

85. Which set of enzymes is found in the acrosome of mammalian spermatozoa:
(1) Hyaluronidase, Corona Penetrating Enzyme (CPE)
(2) Hyaluronidase, CPE, Zona lysin
(3) Hyaluronidase, CPE, Peptidase
(4) Hyaluronidase only

86. Fixing up of the blastocyst in the wall of the terus isknown as:
(1) Fertilization
(2) Implantation
(3) Impreganation
(4) Placentation

87. Placenta in human beings is formed by:
(1) Amnion
(2) Chorion
(3) Allantois
(4) Allantois, chorion and uterine wall

88. The phenomenon of nuclear fusion of sperm and egg is known as.
(1) Karyogamy (2) Parthenogenesis
(3) Vitellogenesis (4) Oogenesis

89. Mammalian placenta originates from:
(1) Allantois and chorion
(2) Yolksac
(3) Allantois
(4) Amnion

90. Sertoli cells are involved in :-
(1) Respiration
(2) Nutrition of sperms
(3) Excretion
(4) Development of sex organs

91. In mammals corpus luteum is found in which organ
(1) Brain (2) Ovary
(3) Liver (4) Eyes

92. Purpose of tubectomy is to prevent :-
(1) Fertilization
(2) Coitus
(3) Egg formation
(4) Embryonic development

EXERCISE # 3

Based On **Previous year (AIPMT) - 2006**

1. Sertoli cells are regulated by the pituitary hormone known as –
(1) FSH (2)GH
(3) Prolactin (4)LH

2. Withdrawal of which of the following hormones is the immediate cause of menstruation?
(1) Estrogen (2) FSH
(3) FSH–RH (4) Progesterone

Based On **Previous year (AIPMT) - 2007**

3. In the human female, menstruation can be deferred by the administration of :-
(1) FSH only
(2) LH only
(3) Combination of FSH and LH
(4) Combination of estrogen and progesterone

4. Which part of ovary in mammals acts as an endocrine gland after ovulation ?
(1) Vitelline membrane
(2) Graffian follicle
(3) Stroma
(4) Germinal epithelium

Based On **Previous year (AIPMT) - 2008**

5. Which one of the following statements is ***incorrect*** about menstruation?
(1) At menopause in the female, there is especially abrupt increase in gonadotropic hormones
(2) The beginning of the cycle of menstruation is called menarche
(3) During normal menstruation about 40 ml blood is lost
(4) The menstrual fluid can easily clot

6. Which extraembryonic membrane in humans prevents desiccation of the embryo inside the uterus
(1) Yolk sac (2) Amnion
(3) Chorion (4) Allantois

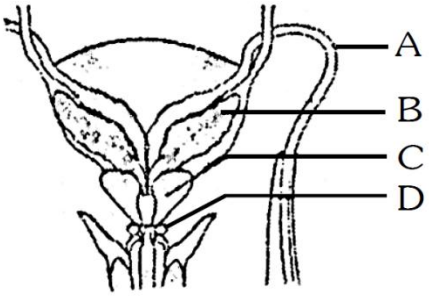
7. In human adult females oxytocin :-
(1) Stimulates pituitary to secrete vasopressin
(2) Causes strong uterine contractions during parturition
(3) Is secreted by anterior pituitary
(4)Stimulates growth of mammary glands

8. In humans, at the end of the first meiotic division, the make germ cells differentiate into the :-
(1) Spermatids
(2) Spermatogonia
(3) Primary spermatocytes
(4) Secondary spermatocytes

Based On **Previous year (AIPMT) - 2009**

9. Seminal plasma in humans is rich in :-
(1) Fructose and certain enzymes but poor in calcium
(2) Fructose, calcium and certain enzymes
(3) Fructose and calcium but has no enzymes
(4) Glucose and certain enzymes but has no calcium

10. Given below is a diagramatic sketch of a portion of human male reproductive system. Select the correct set of the names of the parts labelled A, B, C, D:-



(1) A-Ureter, B-Seminal vesicle, C-Prostate, D-Bulbourethral gland
(2) A-Ureter, B-Prostate, C-Seminal vesicle, D-Bulbourethral gland
(3) A-Vas deferens, B-Seminal vesicle, C-Prostate, D-Bulbourethral gland
(4) A-Vas deferens, B-Seminal vesicle, C-Bulbourethral gland, D-Prostate

11. Which one of the following is the *correct* matching of the events occuring during menstrual cycle?
(1) Menstruation : Breakdown of myometrium and ovum not fertilised
(2) Ovulation : LH and FSH attain peak level and sharp fall in the secretion of progesterone.
(3) Proliferative : Rapid regeneration of phase myometrium and maturation of Graafian follicle.
(4) Development of : Secretory phase and corpus luteum increased secretion of progesterone.

12. The correct sequence of spermatogenetic stages leading to the formation of sperms in a mature human testis is :-
(1) Spermatogonia – Spermatid – Spermatocyte –Sperms
(2) Spermatocyte – Spermatogonia – Spermatid – Sperms
(3) Spermatogonia – Spermatocyte – Spermatid – Sperms
(4) Spermatid – Spermatocyte – Spermatogonia – Sperms

13. A change in the amount of yolk and its distribution in the egg will effect :–
(1) Fertilization
(2) Formation of zygote
(3) Pattern of cleavage
(4) Number of blastomeres produced

Based On **Previous year (AIPMT) - 2010**

14. Which one of the following statement about human sperm is correct ?
(1) Acrosome serves no particular function
(2) Acrosome has a conical pointed structure used for piercing and penetrating the egg, resulting in fertilisation
(3) The sperm lysins in the acrosome dissolve the egg envelope facilitating fertilisation
(4) Acrosome serves as a sensory structure leading the sperm towards the ovum

15. The part of fallopian tube closest to the ovary is :
(1) Ampulla (2) Isthmus
(3) Infundibulum (4) Cervix

16. The signals for parturition originate from :
(1) Fully developed foetus only
(2) Placenta only
(3) Placenta as well as fully developed foetus
(4) Oxytocin released from maternal pituitary

17. The second maturation division of the mammalian ovum occurs :
(1) In the Graafian follicle following the first maturation division
(2) Shortly after ovulation before the ovum makes entry into the Fallopian tube
(3) Until after the ovum has been penetrated by a sperm
(4) Until the nucleus of the sperm has fused with that of the ovum

18. Which of the following statements about morula in humans is correct?
(1) It has more cytoplasm and more DNA than an uncleaved zygote
(2) It has almost equal quantity of cytoplasm as an uncleaved zygote but much more DNA
(3) It has for less cytoplasm as well as less DNA than in an uncleaved zygote
(4) It has more or less equal quantity of cytoplasm and DNA as in uncleaved zygote

Based On **Previous year (AIPMT) - 2011**

19. Given below is an incomplete table about certain hormones, their source glands and one major effect of each on the body in humans. Identify the correct option for the three blanks A, B and C.

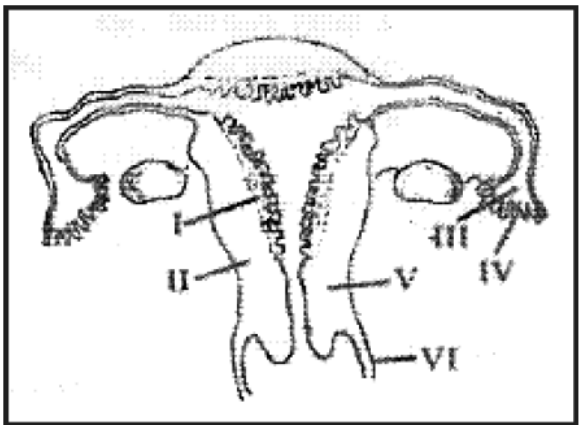
Glands	Secretion	Effect on body
A	Oestrogen	Maintenance of secondary sexual character
Alpha cells of Islets of Langerhans	B	Raises blood sugar level
Anterior pituitary	C	Over secretion leads to gigantism

(1) A – Placenta B- Glucagon C- Calcitonin
(2) A –Ovary B –Glucagon C–Growth Harmone
(3) A – Placenta B -Insulin C - Vasopressin
(4) A –Ovary B -Insulin C - Calcitonin

20. If for some reason, the vasa efferentia in the human reproductive system get blocked, the gametes will not be transported from
(1) Testes to epididymis
(2) Epididymis to vas deferens
(3) Ovary to uterus
(4) Vagina to uterus

21. The testes in humans are situated outside the abdominal cavity inside a pouch called scrotum. The purpose served is for
(1) Maintaining the scrotal temperature lower than the internal body temperature
(2) Escaping any possible compression by the visceral organs
(3) Providing more space for the growth of epididymis
(4) Providing a secondary sexual feature for exhibiting the male sex

22. The figure given below depicts a diagrammatic sectional view of the female reproductive system of humans. Which one set of three parts out of I-VI have been correctly identified



(1) (II) Endometrium, (III) Infundibulum, (IV) Fimbriae
(2) (III) Infundibulum, (IV) Fimbriae, (V) Cervix
(3) (IV) Oviducal funnel, (V) Uterus, (VI) Cervix
(4) (I) Perimetrium, (II) Myometrium, (III) Fallopian tube

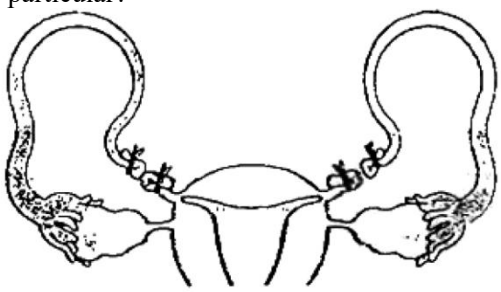
Based On **Previous year (AIPMT) - 2012**

23. In a normal pregnant woman, the amount of total gonadotropin activity was assessed. The result expected was
(1) High level of FSH and LH in uterus to stimulate endometrial thickening
(2) High level of circulating HCG to stimulate estrogen and progesterone synthesis
(3) High level of circulating FSH and LH in the uterus to stimulate implantation of the embryo
(4) High level of circulating HCG to stimulate endometrial thickening

24. Signals for parturition originate from:
(1) Placenta only
(2) Fully developed foetus only
(3) Both placenta as well as fully developed foetus
(4) Oxytocin released from maternal pituitary

25. Which one of the following statements is false in respect of viability of mammalian sperm ?
(1) Viability of sperm is determined by its motility
(2) Sperms must be concentrated in a thick suspension
(3) Sperm is viable for only up to 24 hours
(4) Survival of sperm depends on the pH of the medium and is more active in alkaline medium

26. What is the figure given below showing in particular?



(1) Tubectomy (2) Vasectomy
(3) Ovarian cancer (4) Uterine cancer

Based On **Previous year (NEET) - 2013**

27. Select the answer which correctly matches the endocrine gland with the hormone it secretes and its function/deficiency symptom :

	Endocrine gland	Hormone	Function/deficiency symptoms
(A)	Corpus luteum	Testosterone	Stimulates spermatogenesis
(B)	Anterior pituitary	Oxytocin	Stimulates uterus contraction during child birth
(C)	Posterior pituitary	Growth Hormone (GH)	Oversecretion stimulates abnormal growth
(D)	Thyroid gland	Thyroxine	Lack of iodine in diet results in goitre

28. Which one of the following is not the function of placenta ?It :-
(1)secretes oxytocin during parturition
(2) facilitates supply of oxygen and nutrients to embryo
(3) secretes estrogen
(4) facilitates removal of carbon dioxide and waste material from embryo

29. Menstrual flow occurs due to lack of :
(1) Vasopressin (2) Progesterone
(3) FSH (4) Oxytocin

Based On **Previous year (AIPMT) – 2014**

30. The main function of mammalian corpus luteum is to produce :
(1) estrogen only
(2) progesterone
(3) human chorionic gonadotropin
(4) relaxin only

31. Select the correct option describing gonadotropin activity in a normal pregnant female :
(1) High level of FSH and LH stimulates the thickening of endometrium.
(2) High level of FSH and LH facilitate implantation of the embryo.
(3) High level of hCG stimulates the synthesis of estrogen and progesterone.
(4) High level of hCG stimulates the thickening of endometrium.

Based On **Previous year (AIPMT) - 2015**

32. Capacitation refers to changes in the :-
(1) Ovum before fertilization
(2) Ovum after fertilization
(3) Sperm after fertilization
(4) Sperm before fertilization

33. Hysteresctomy is surgical removal of :
(1) Prostate gland (2) Vas-deferens
(3) Mammary glands (4) Uterus

34. Which of the following cell during gametogenesis is normally diploid ?
(1) Spermatid (2) Spermatogonia
(3) Secondary polar body
(4) Primary polar body

35. Which of these is not an important component of initiation of parturition in humans ?
(1) Synthesis of prostaglandins
(2) Release of oxytocin
(3) Release of prolactin
(4) Increase in estrogen and progesterone ratio

36. Ectopic pregnancies are referred to as :
(1) Pregnancies terminated due to hormonal imbalance
(2) Pregnancies with genetic abnormality
(3) Implantation of embryo at site other than uterus
(4) Implantation of defective embryo in the uterus

37. Which of the following events is not associated with ovulation in human female?
(1) LH surge
(2) Decrease in estradiol
(3) Full development of Graffian follicle
(4) Release of secondary oocyte

38. In human females,meiosis-II is not complete until?
(1) birth (2) puberty
(3) fertilization (4) uterine implantation

39. Which of the following layers in an antral follicle is acellular ?
(1) Zona pellucid (2) Granulosa
(3) Theca interna (4) Stroma

Based On **Previous year (NEET) - 2016**

40. Fertilization in humans is practically feasible only if:
(1) the sperms are transported into vagina just after he release of ovum in fallopian tube
(2) the ovum and sperms are transported simultaneously to ampullary - isthmic junction of the fallopian tube
(3) the ovum and sperms are transported simultaneously to ampullary - isthmic junction of the cervix.
(4) the sperms are transported into cervix within 48 hrs of release of ovum in uterus.

41. Select the incorrect statement:
(1) FSH stimulates the sertoli cells which help in spermiogenesis.
(2) LH triggers ovulation in ovary
(3) LH and FSH decrease gradually during the follicular phase.
(4) LH triggers secretion of androgens from the Leydig cells.

42. Which of the following is incorrect regarding vasectomy?
(1) Irreversible sterility
(2) No sperm occurs in seminal fluid
(3) No sperm occurs in epididymis
(4) Vasa deferentia is cut and tied

43. Embryo with more than 16 blastomeres formed due to in vitro fertilization is transferred into
(1)cervix (2)uterus
(3)fallopian tube (4)fimbriae

44. Which of the following depicts the correct pathway of transport of sperms?
(1) Efferent ductules →Rete testis →Vas deferens →Epididymis
(2) Rete testis →Efferent ductules →Epididymis →Vas deferens
(3) Rete testis →Epididymis →Efferent Ductules →Vas deferens
(4) Rete testis →Vas deferens →Efferent ductules →Epididymis

45. Match Column-I with Column-II and select the correct option using the codes given below:

Column-I	**Column-II**
A. Mons pubis	(i) Embryo formation
B. Antrum	(ii Sperm
C. Trophectoderm	(iii) Female external genitalia
D. Nebenkern	(iv) Graafian follicle

Codes :

	A	**B**	**C**	**D**
(1)	(i)	(iv)	(iii)	(ii)
(2)	(iii)	(iv)	(ii)	(i)
(3)	(iii)	(iv)	(i)	(ii)
(4)	(iii)	(i)	(iv)	(ii)

46. Several hormones like hCG, hPL, estrogen, progesterone are produced by
(1) pituitary (2) ovary
(3) placenta (4) fallopian tube

Based On **Previous year (NEET) - 2020**

47. Which of the following hormone levels will cause release of ovum (ovulation) from the graffian follicle?
(1) Low concentration of FSH
(2) High concentration of Estrogen
(3) High concentration of Progesterone
(4) Low concentration of LH

Based On **Previous year (NEET) - 2021**

48. Match the following columns and select the correct option.

Column-I	**Column-II**
(1) Placenta	(i) Androgens
(2) Zona pellucida	(ii) Human Chorionic Gonadotropin (hCG)
(3) Bulbo-urethral glands	(iii) Layer of the ovum
(4) Leydig cells	(iv) Lubrication of the Penis

(1)1-(ii), 2-(iii), 3-(iv), 4-(i)
(2) 1-(iv), 2- (iii), 3- (i), 4-(ii)
(3) 1-(i), 2- (iv), 3-(ii), 4-(iii)
(4) 1-(iii), 2- (ii), 3- (iv), 4-(i)

49. Meiotic division of the secondary oocyte is completed :
(1) At the time of fusion of a sperm with an ovum
(2) Prior to ovulation
(3) At the time of copulation
(4) After zygote formation

50. Which of these is not an important component of initiation of parturition in humans?
(1) Increase in estrogen and progesterone ratio
(2) Synthesis of prostaglandins
(3) Release of Oxytocin
(4) Release of Prolactin

Based On **Previous year (NEET) - 2022**

51. Given below are two statements:
Statement I : The release of sperms into the seminiferous tubules is called spermiation.
Statement II : Spermiogenesis is the process of formation of sperms from spermatogonia.
In the light of the above statements, choose the most appropriate answer from the options given below :
(1) Both Statement I and Statement II are incorrect
(2) Statement I is correct but Statement II is incorrect
(3) Statement I is incorrect but Statement II is correct
(4) Both Statement I and Statement II are correct

52. Which of the following statements are true for spermatogenesis but do not hold true for Oogenesis?
(a) It results in the formation of haploid gametes
(b) Differentiation of gamete occurs after the completion of meiosis
(c) Meiosis occurs continuously in a mitotically dividing stem cell population
(d) It is controlled by the Luteinising hormone (LH) and Follicle Stimulating Hormone (FSH) secreted by the anterior pituitary
(e) It is initiated at puberty
Choose the most appropriate answer from the options given below:
(1) (b) and (c) only
(2) (b), (d) and (e) only
(3) (b), (c) and (e) only
(4) (c) and (e) only

53. At which stage of life the oogenesis process is initiated?
(1) Embryonic development stage
(2) Birth (3) Adult (4) Puberty

Based On **Previous year (NEET) - 2023**

54. Which of the following statement are correct regarding female reproductive cycle?
(A) In non-primate mammals cyclical changes during reproduction are called oestrus cycle.
(B) First menstrual cycle begins at puberty and is called menopause.
(C) Lack of menstruation may be indicative of pregnancy.
(D) Cyclic menstruation extends between menarche and menopause.
Choose the most appropriate answer from the options given below :
(1) A, C and D only (2) A and D only
(3) A and B only (4) A, B and C only

55. Given below are two statements:
Statement I: Vas deferens receives a duct from seminal vesicle and opens into urethra as the ejaculatory duct.
Statement II: The cavity of the cervix is called cervical canal which along with vagina forms birth canal.
In the light of the above statements, choose the correct answer from the options given below:
(1) **Statement I** is incorrect but **Statement II** is true.
(2) Both **Statement I** and **Statement II** are true.
(3) Both **Statement I** and **Statement II** are false.
(4) **Statement I** is correct but **Statement II** is false.

56. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R**.
Assertion A: Endometrium is necessary for implantation of blastocyst.
Reason R: In the absence of fertilization, the corpus luteum degenerates that causes disintegration of endometrium.
In the light of the above statements, choose the **correct** answer from the options given below:
(1) **A** is false but **R** is true.
(2) Both **A** and **R** are true and **R** is the correct expiation of **A**.
(3) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**.
(4) **A** is true but **R** is false.

Based On **Previous year (NEET) - 2024**

57. Match List I with List II :

	List I		**List II**
A.	Non-medicated IUD	I.	Multiload 375
B.	Copper releasing IUD	II.	Progestogens
C.	Hormone releasing IND	III.	Lippes loop
D.	Implants	IV.	LNG-20

Choose the correct answer from the options given below:
(1) A-IV, B-I, C-II, D-III (2) A-III, B-I, C-IV, D-II
(3) A-III, B-I, C-II, D-IV (4) A-I, B-III, C-IV, D-II

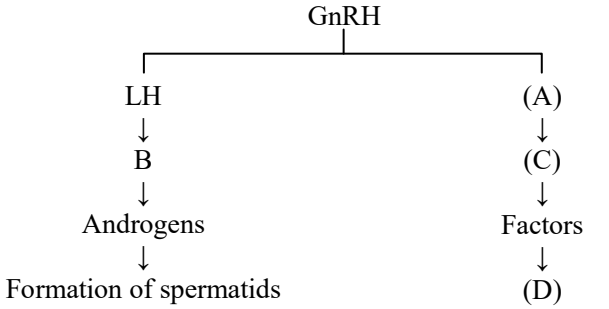
58. Given below are two statements :
Statement I: The presence or absence of hymen is not a reliable indicator of virginity.
Statement II : The hymen is torn during the first coitus only.
In the light of the above statements, choose the correct answer from the options given below :
(1) Statement I is true but Statement II is false
(2) Statement I is false but Statement II is true
(3) Both Statement I and Statement II are true
(4) Both Statement I and Statement II are false

59. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R :
Assertion A : FSH acts upon ovarian follicles in female and Leydig cells in male.
Reason R : Growing ovarian follicles secrete estrogen in female while interstitial cells secrete androgen in male human being.
In the light of the above statements, choose the correct answer from the options given below :
(1) A is true but R is false
(2) A is false but R is true
(3) Both A and R are true and R is the correct. explanation of A.
(4) Both A and R are true but R is NOT the correct explanation of A.

60. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R:
Assertion A : Breast-feeding during initial period of infant growth is recommended by doctors for bringing a healthy baby.
Reason R : Colostrum contains several antibodies absolutely essential to develop resistance for the new born baby.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) A is correct but R is not correct.
(2) A is not correct but R is correct.
(3) Both A and R are correct and R is the correct explanation of A.
(4) Both A and R are correct but R is NOT the correct explanation of A.

61. Which of the following is not a component of Fallopian tube?
(1) Infundibulum (2) Ampulla
(3) Uterine fundus (4) Isthmus

62. Identify the correct option (A), (B), (C), (D) will respect to spermatogenesis.



(1) FSH, Sertoli cells, Leydig cells, spermatogenesis.
(2) ICSH, Leydig cells, Sertoli cells, spermatogenesis
(3) FSH, Leydig cells, Sertoli cells, spermiogenesis
(4) ICSH, Interstitial cells, Leydig cells, spermiogenesis

Based On **Previous year (NEET) - 2025**

63. Match List-I with List-II.

List-I	List-II
A. Progesterone	I. Pars intermedia
B. Relaxin	II. Ovary
C. Melanocyte stimulating hormone	III. Adrenal Medulla
D. Catecholamines	IV. Corpus luteum

Choose the correct answer from the options given below :
(1) A-II, B-IV, C-I, D-III (2) A-III, B-II, C-IV, D-I
(3) A-IV, B-II, C-I, D-III (4) A-IV, B-II, C-III, D-I

64. The first menstruation is called :
(1) Diapause (2) Ovulation
(3) Menopause (4) Menarche

65. Find the correct statement :
(A) In human pregnancy, the major organ systems are formed at the end of 12 weeks.
(B) In human pregnancy the major organ systems are formed at the end of 8 weeks.
(C) In human pregnancy heart is formed after one month of gestation.
(D) In human pregnancy, limbs and digits develop by the end of second month.
(E) In human pregnancy the appearance of hair is usually observed in the fifth month.
Choose the correct answer from the options given below :
(1) B, C, D and E only (2) A, C, D and E only
(3) A and E only (4) B and C only

66. Match List I with List II:

List-I	List-II
A. Head	I. Enzymes
B. Middle piece	II. Sperm motility
C. Acrosome	III. Energy
D. Tail	IV. Genetic material

Choose the correct answer from the options given below :
(1) A-III, B-IV, C-II, D-I
(2) A-III, B-II, C-I, D-IV
(3) A-IV, B-III, C-I, D-II
(4) A-IV, B-III, C-II, D-I

67. Consider the following :
A. The reductive division for the human female gametogenesis starts earlier than that of the male gametogenesis.
B. The gap between the first meiotic division and the second meiotic division is much shorter for males compared to females.
C. The first polar body is associated with the formation of the primary oocyte.
D. Luteinizing Hormone (LH) surge leads to disintegration of the endometrium and onset of menstrual bleeding.

Choose the **correct** answer from the options given below:
(1) B and D are true (2) B and C are true
(3) A and B are true (4) A and C are true

68. Twins are born to a family that lives next door to you. The twins are a boy and a girl. Which of the following must be true?
(1) They were conceived through in vitro fertilization.
(2) They have 75% identical genetic content.
(3) They are monozygotic twins.
(4) They are fraternal twins.

ANSWER KEY

EXERCISE # 1

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	4	2	3	1	3	2	3	4	3	1	2	1	4	3	3	3	2	4	1
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	1	3	1	4	3	3	3	2	3	1	1	2	1	4	4	4	2	3	4
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	3	2	1	3	4	3	2	3	3	4	3	1	3	3	1	4	2	2	3
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	3	2	2	2	3	3	2	4	3	2	3	1	2	3	2	4	1	3	1
Que.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	2	2	4	4	4	4	4	4	4	3	4	4	3	1	3	4	4	3	2
Que.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	3	2	4	2	2	1	3	4	2	3	3	4	3	2	4	2	4	2	4	3

EXERCISE # 2

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	4	1	1	3	1	1	1	4	2	3	1	3	1	2	1	2	2	2	4
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	3	1	3	1	2	1	3	4	4	1	4	3	4	1	1	3	2	2
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	1	3	3	2	3	3	1	1	3	4	2	1	2	1	1	4	3	4	2
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	1	2	1	2	2	4	2	1	1	4	1	3	4	1	1	3	4	4	3
Que.	81	82	83	84	85	86	87	88	89	90	91	92								
Ans.	2	1	3	4	2	2	4	1	1	2	2	1								

EXERCISE-3

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	4	4	2	4	2	2	4	2	3	4	3	3	3	3	3	3	2	2	1
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	2	2	3	3	1	4	1	2	2	3	4	4	2	3	3	2	3	1	2
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	3	2	2	3	3	2	1	1	4	2	3	1	1	2	3	2	1	2	3
Que.	61	62	63	64	65	66	67	68												
Ans.	3	3	3	4	2	3	3	4												