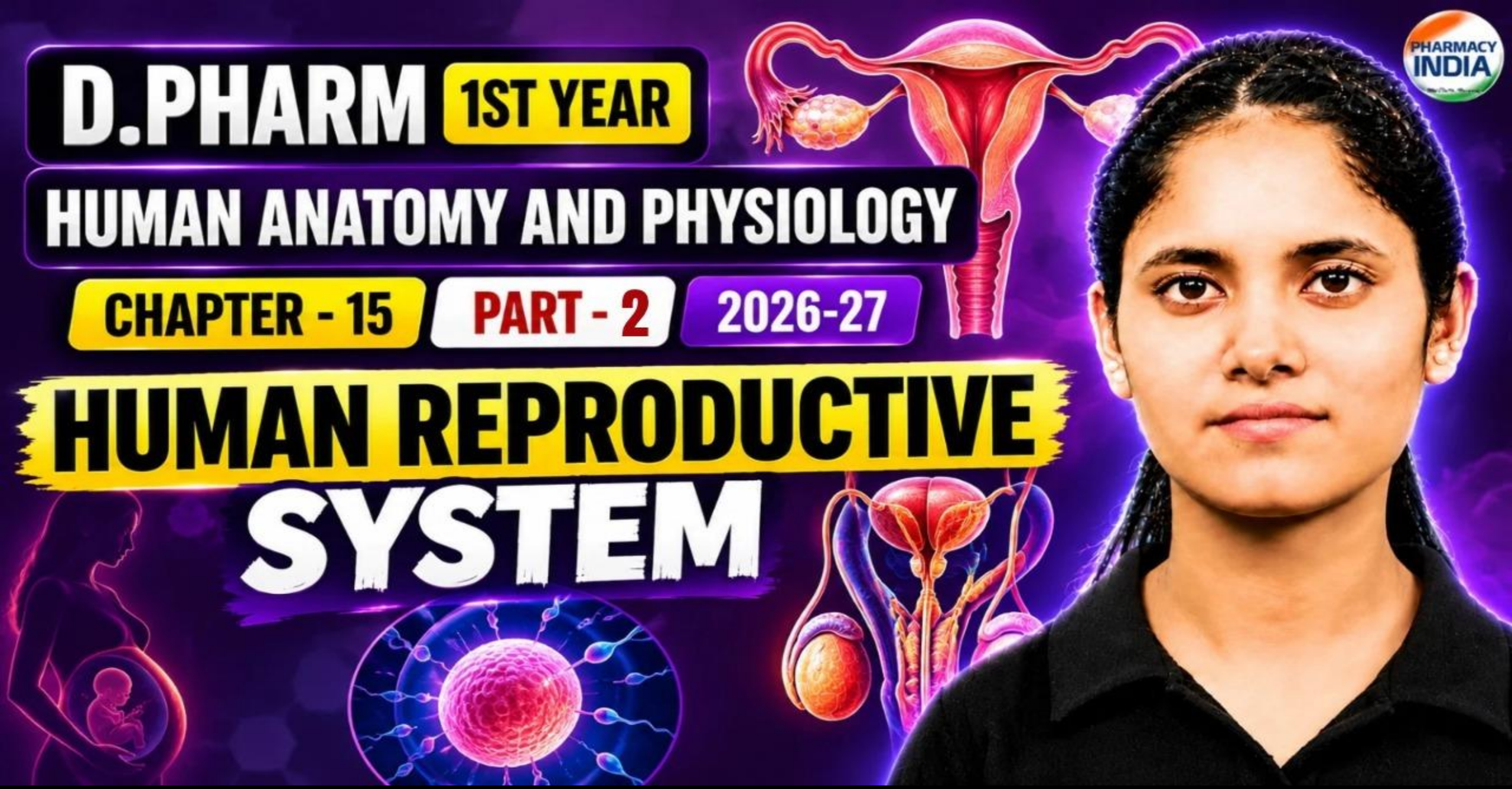
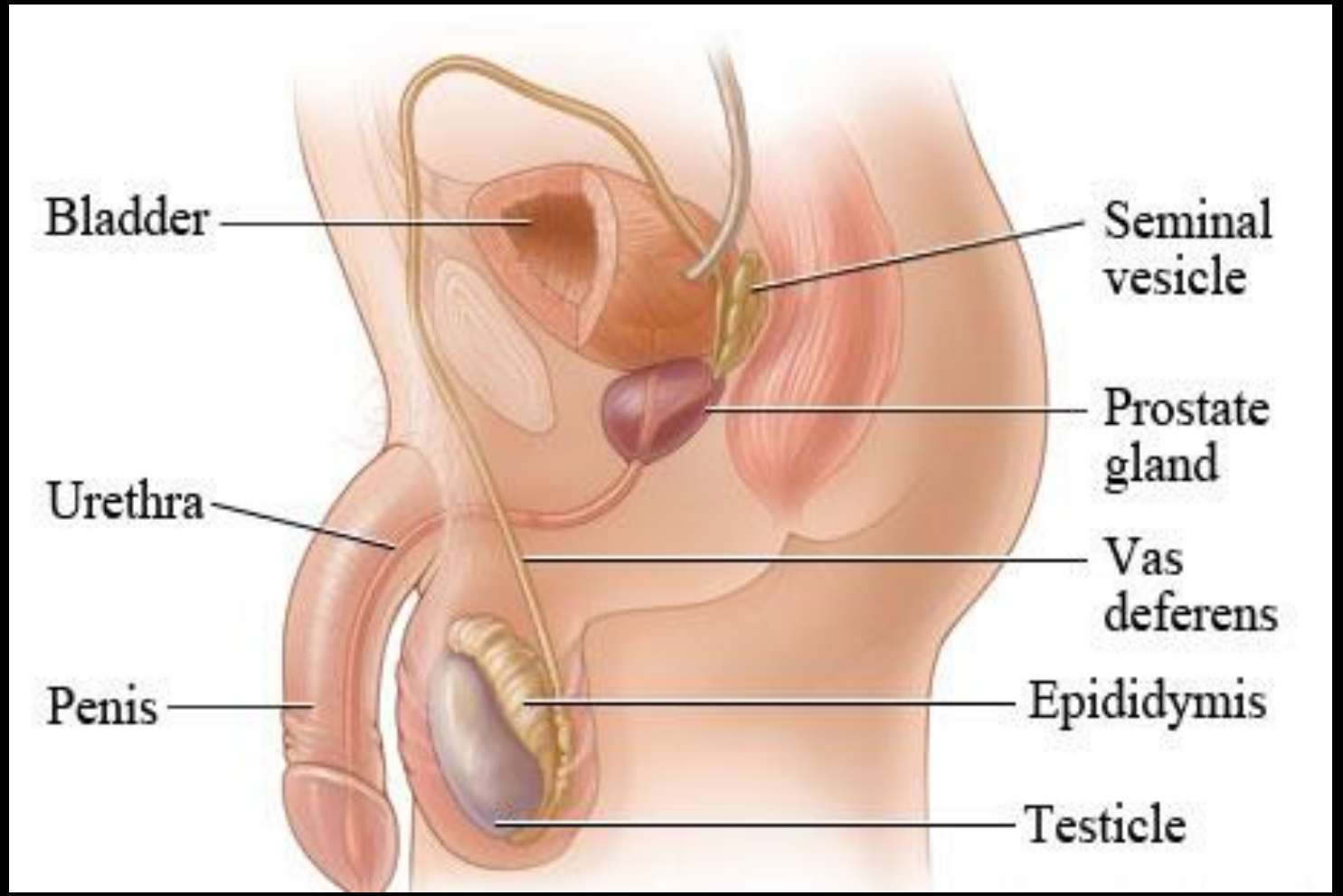

D.PHARM
1ST YEAR
HUMAN ANATOMY AND PHYSIOLOGY
CHAPTER - 15
PART - 2
2026-27
HUMAN REPRODUCTIVE SYSTEM
PHARMACY INDIA
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Male Reproductive System

- The male gametes, i.e., **sperms** are produced within the male reproductive system.
- Sperms are small **unicellular** structures with a **head, middle piece, and a tail**.
- Unlike the female reproductive system, most parts of the male reproductive system are located **outside** the body.


Bladder
Seminal vesicle
Prostate gland
Urethra
Vas deferens
Penis
Epididymis
Testicle

The male reproductive system consists of the following organs:

- ❑ 2 testes in the scrotum
- ❑ 2 epididymides
- ❑ 2 deferent ducts (vas deferens)
- ❑ 2 spermatic cords
- ❑ 2 seminal vesicles
- ❑ 2 ejaculatory ducts
- ❑ I prostate gland
- ❑ 1 penis.

Penis

- It is the male **external genitalia**.
- The two of which are larger, the corpora cavernosa lie side by side and the third one is the sinus, called corpus spongiosum covers the urethra.
- The penis becomes **rigid** when these spaces are filled with blood.
- The tissues help in the **erection** of the penis and **facilitate insemination.**
- The foreskin covers the enlarged end of the penis called **glans penis.**

Scrotum

- It is a sac of thick skin that protects and surrounds the testes.
- It also controls the **temperature** of the testes since they have to be at a slightly lower temperature than the body temperature for suitable sperm creation.
- The muscles in the wall allow the testes to hang far from the body or shrink to pull them closer for protection and warmth.

Testes

- A pair of testes are present in humans.
- Testes are present outside the body in a pouch called the **scrotum.**
- They are oval bodies, around **4 to 5 cm in length** and **2 to 3 cm wide.**
- Generally, the left testis hangs slightly **lower** than the right one.
- The two primary functions of tests are as follows:

❑**Producing testosterone**

❑**Producing sperms or spermatogenesis**

- Each testis contains about **250 testicular lobules** or compartments.
- Each testicular lobule contains **one to three seminiferous tubules.**
- **Leydig cells** or **interstitial cells** are present outside the seminiferous tubules in the interstitial spaces.
- They secrete male sex hormones or androgens, e.g. **testosterone.**

- Seminiferous tubules are lined by two types of cells:

❑**Spermatogonia or male germ cells** – They undergo spermatogenesis to produce sperm.

❑**Sertoli cells** – They provide nutrition to germ cells.

Male Sex Accessory Ducts

- **Rete testis, vasa efferentia, epididymis and vas deferens** are male sex accessory ducts.
- Seminiferous tubules open into **rete testis**, which leads to **vasa efferentia.**
- Vasa efferentia opens into the **epididymis** and epididymis leads to **vas deferens.**
- It leads to the **ejaculatory duct** along with a duct from the seminal vesicle.
- Sperms mature in these ducts.
- Sperms are stored and transported through these ducts.

Male Accessory Glands

- The male accessory glands include **seminal vesicles, prostate and bulbourethral glands.**
- The Seminal vesicles are present over the prostate, linked with the vas deferens to create the ejaculatory ducts that travel through the prostate.
- The male accessory glands generate fluid that **nourishes** the sperm.
- It is called **seminal plasma**.
- This fluid is rich in **fructose, calcium and certain enzymes**.

Urethra

- It is a tube-like structure that connects the **urinary bladder to the urinary meatus.**
- In males, the urethra travels through the penis and is mainly involved in two main functions.
- This region is included in the urinary tract that takes **urine from the bladder** where semen is ejaculated.
- The Prostate exists beneath the bladder and covers the urethra.
- The prostate grows **larger with age.**

Oogenesis

- This process begins inside the fetus before birth.
- The steps in oogenesis up to the production of primary oocytes occur before birth.
- Primary oocytes do not divide further either become secondary oocytes or degenerate.
- Oogenesis occurs in the outermost layers of the ovaries.
- Oogenesis starts with a germ cell called oogonium undergoes mitosis to increase in number and has 3 stages:

❑**Pre-natal**

❑**Antral**

❑**Pre-ovulatory**

Process of Oogenesis

❑Pre-natal Stage

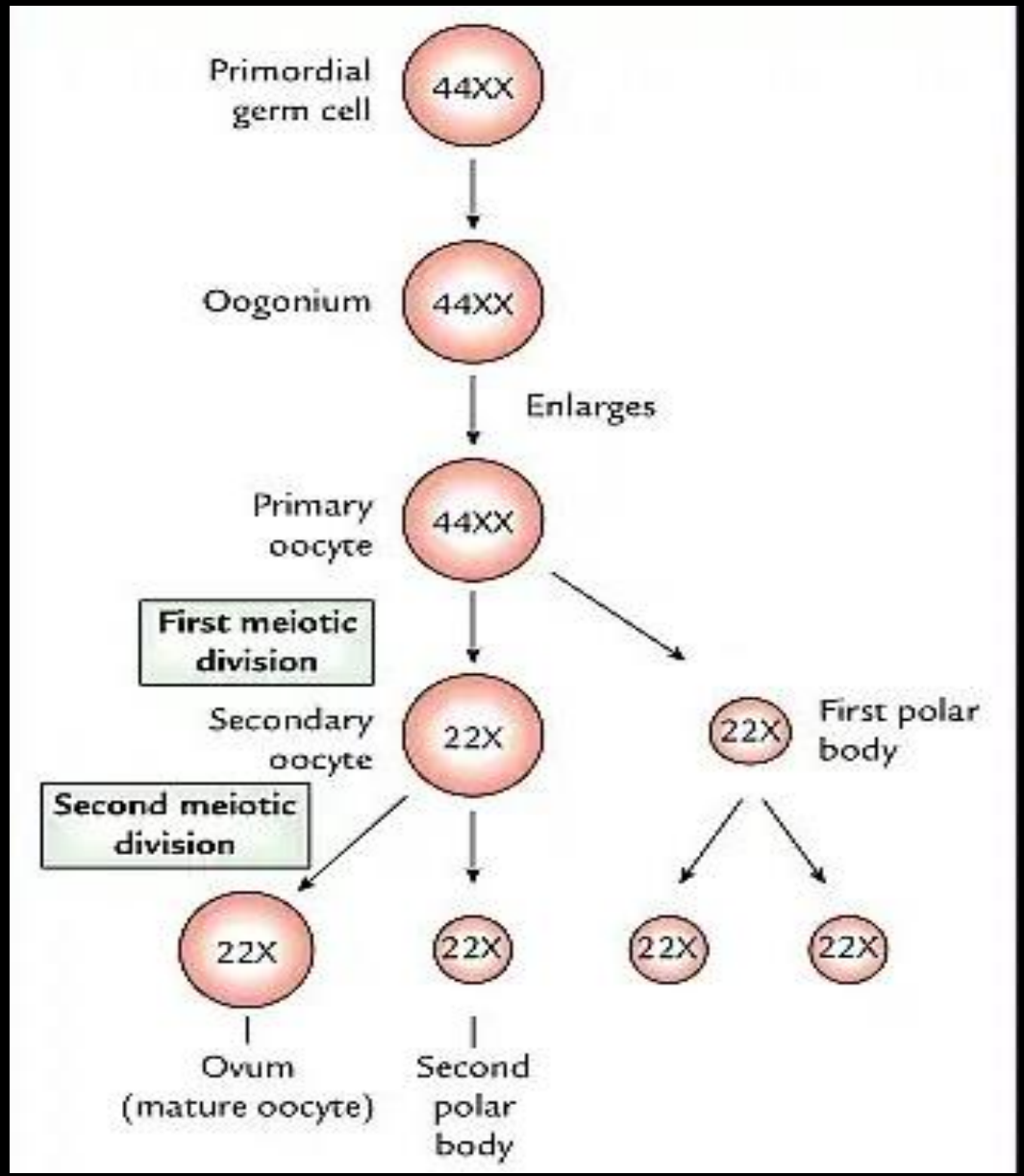
- The primary oocyte grows while being arrested in meiosis-I.
- The follicular cells proliferate and form a stratified cuboidal epithelium.
- Such cells are known as granulosa cells.
- These cells secrete glycoproteins to form zona pellucida around the primary oocyte.

❑Antral Stage

- The fluid-filled area, present between granulosa cells, combines to form a central fluid-filled space called the antrum.
- These are known as secondary follicles.
- In every month cycle, these secondary follicles develop under the influence of **follicle-stimulating hormone and luteinizing hormone.**

❑Pre-Ovulatory Stage

- This stage is induced by LH surge, and meiosis-I completes here.
- Two haploid cells of unequal sizes are formed within the follicle.
- One of the daughter cells that receive less cytoplasm forms a polar body and it does not participate in ovum formation.
- The other daughter cell is known as the secondary oocyte.
- The two daughter cells undergo meiosis-II.
- The polar body replicates to form two polar bodies, while the secondary oocyte arrests in the metaphase stage of meiosis-II.


Primordial germ cell
44XX
Oogonium
44XX
Enlarges
Primary oocyte
44XX
First meiotic division
Secondary oocyte
22X
22X
First polar body
Second meiotic division
22X
22X
22X
22X
Ovum (mature oocyte)
Second polar body

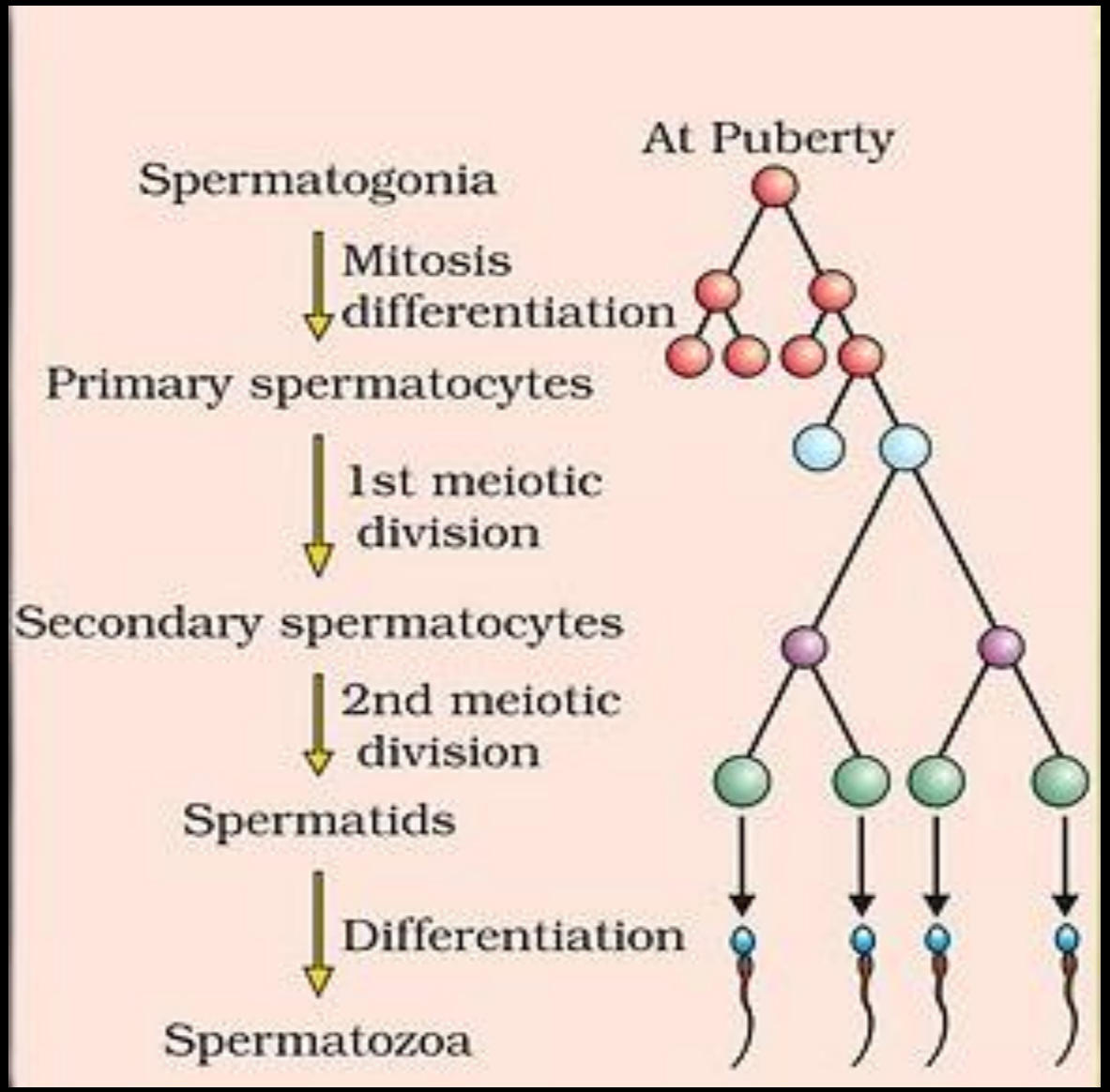
Spermatogenesis

- Spermatogenesis is the process of formation of haploid male gametes or sperms or spermatozoa from male germ cells or spermatogonia.
- Sperms are formed in the seminiferous tubules of testes, the male reproductive organ.
- Spermatogenesis starts at puberty in males.
- It gives rise to mature male gametes, which can undergo fertilization with an ovum to form a zygote.
- Spermatogenesis is important for maintaining the number of chromosomes in the offsprings.

Process of Spermatogenesis

- The male germinal cells or spermatogonia present in seminiferous tubules undergo proliferation by mitotic division.
- Some of the spermatogonia cells undergo meiotic division and are known as Primary spermatocytes (diploid, 2n=46).
- Secondary spermatocytes (haploid, n=23) are formed after the first meiotic division of primary spermatocytes.
- Secondary spermatocytes undergo second meiotic division forming four haploid spermatids.

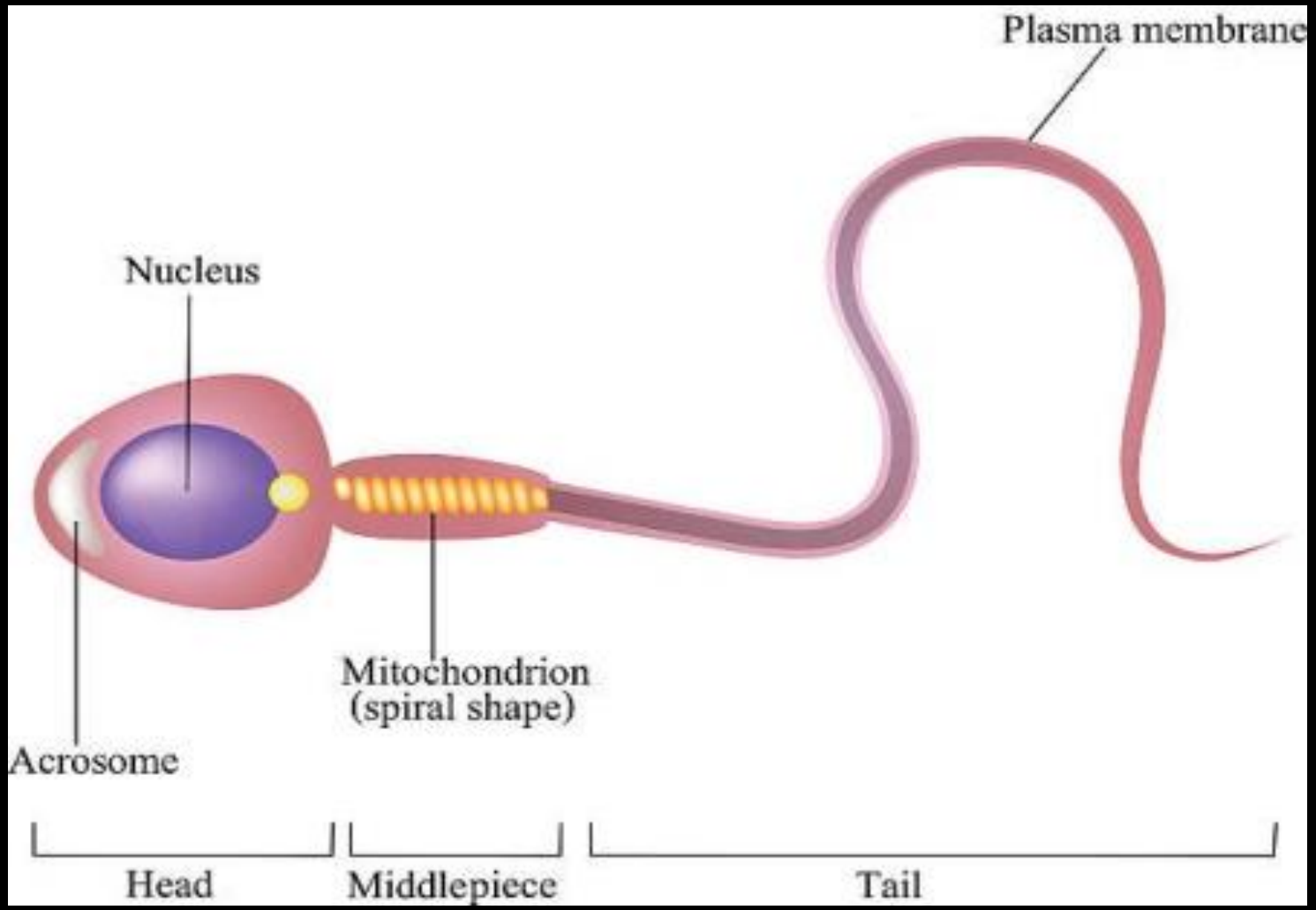
- **Spermiogenesis-** the transformation of spermatids to mature sperms or spermatozoa.
- **Spermiation**- The process of release of mature sperms from seminiferous tubules.


At Puberty
Spermatogonia
Mitosis
differentiation
Primary spermatocytes
1st meiotic
division
Secondary spermatocytes
2nd meiotic
division
Spermatids
Differentiation
Spermatozoa

Structure of Sperm

- Sperm is composed of a head, neck, middle piece and tail.
- Whole body of sperm is enclosed by plasma membrane.
- The head contains as enlongated haploid nucleus, the anterior portion is covered by a cap-like structure called as acrosome.
- This acrosome is filled with enzymes that help fertilisation of the ovum.
- The middle piece possesses numerous mitochondria, which produce energy for the movement of tail that facilitate sperm motility essential for fertilisation.

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


Plasma membrane
Nucleus
Mitochondrion
(spiral shape)
Acrosome
Head
Middlepiece
Tail

Ovum

- The ovum is one of the largest cells that measures approximately 120 µm in diameter.
- The ovum has a large, centrally located nucleus which is covered by cytoplasm.
- This oocyte nucleus and nucleolus are termed germinal vesicle and germinal disc respectively.
- It has less amount of yolk (in humans) and hence it is alecithal.
- This ooplasm is enclosed by a peripheral layer called the cortex which has many microvilli.

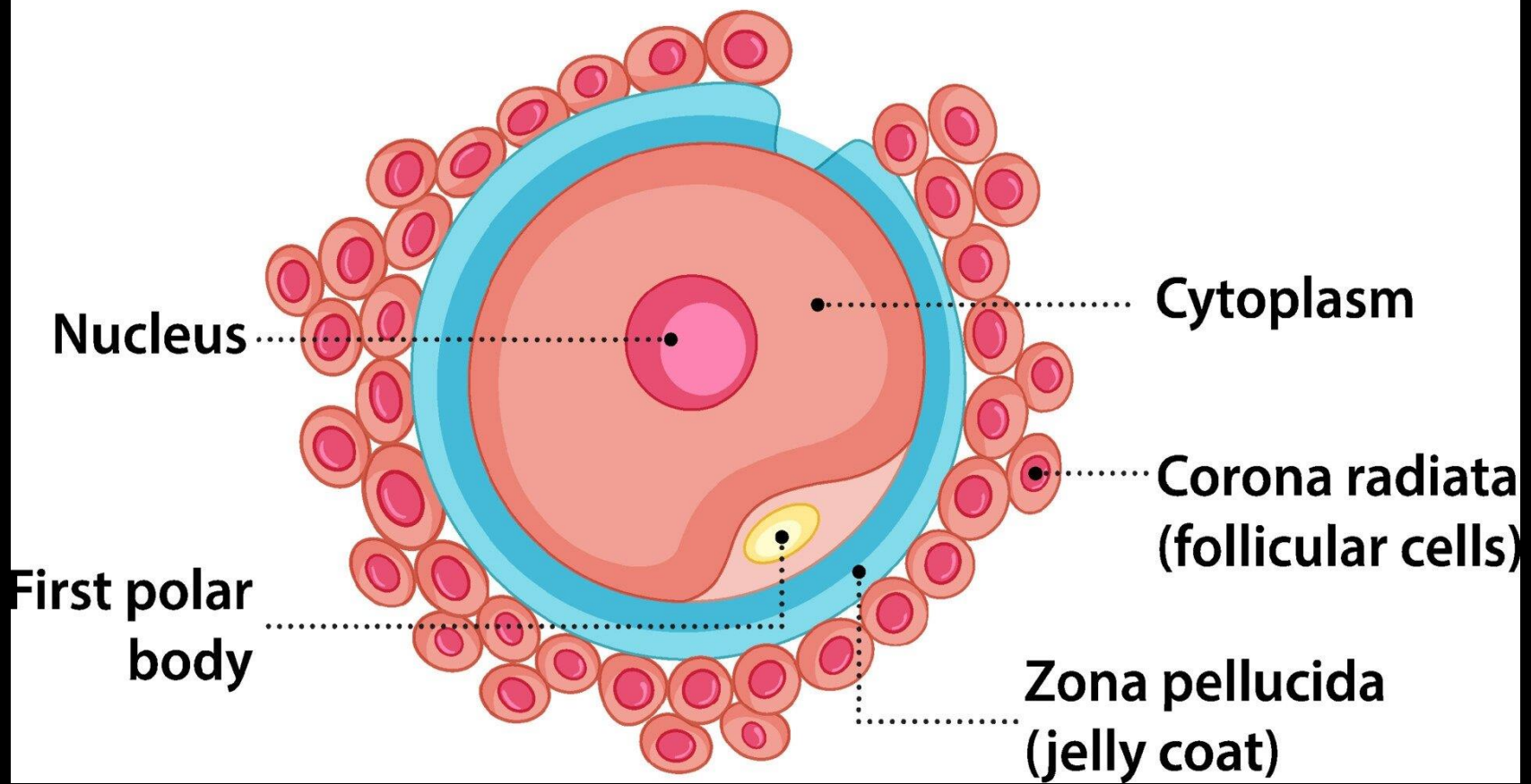
- These microvilli are tubular projections of the plasmalemma that aids in the transportation of substances in and out of the cytoplasm.
- The human ovum is typically covered by 3 layers:

❑**Inner: Thin vitelline membrane**

❑**Middle: Zona pellucida**

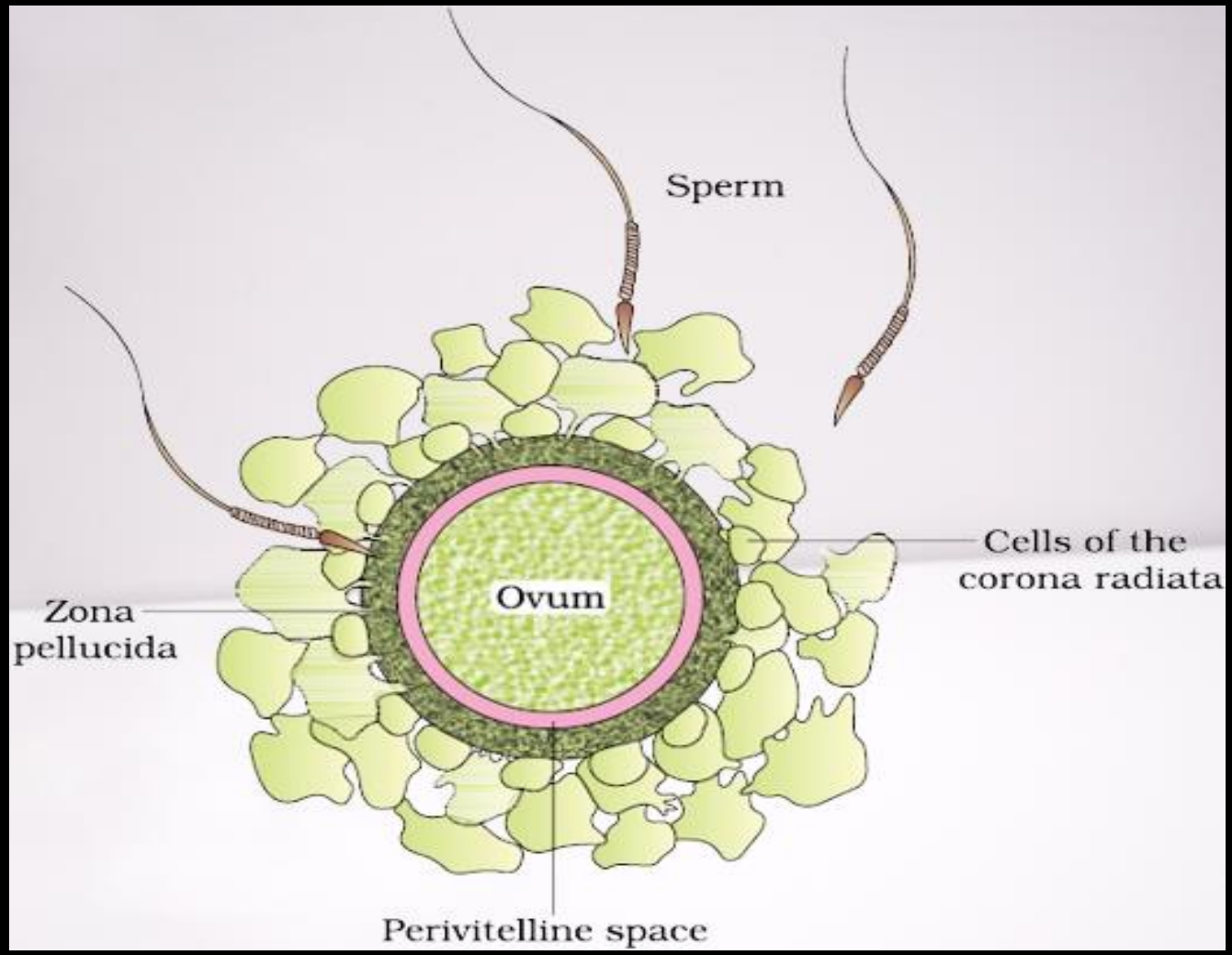
❑**Outer: Corona radiata**

HUMAN EGG (OVUM)



Fertilisation

- Fertilization is the natural life process, which is carried out by the fusion of both male and female gametes, which results in the formation of a zygote.
- During this process, semen comprising thousands of sperms are inseminated into the female vagina during coitus.
- The sperms move towards the uterus and reach the opening of the fallopian tube.
- Only a few sperms will succeed in reaching the opening of the fallopian tube.
- The secondary oocyte releases from the matured Grafian follicle of the ovary and enters into the fallopian tube, where it is fertilized within 24 hours, after which it is released from the ovary.


Sperm
Cells of the
corona radiata
Ovum
Zona
pellucida
Perivitelline space

Menstrual Cycle

- In a life cycle, a woman's body is vulnerable to a variety of changes.
- The cycle of these changes occur in women every month, positively for pregnancy is called the menstrual cycle.
- When an ovum is unfertilized, the uterus lining sheds and leads to a haemorrhage, called menstruation.
- In a girl, menstruation starts from the age of 10 to 15 when she attains puberty and this beginning is known as menarche.
- The ending of menstruation is known as menopause which takes place at the age range of 50.

Implantation

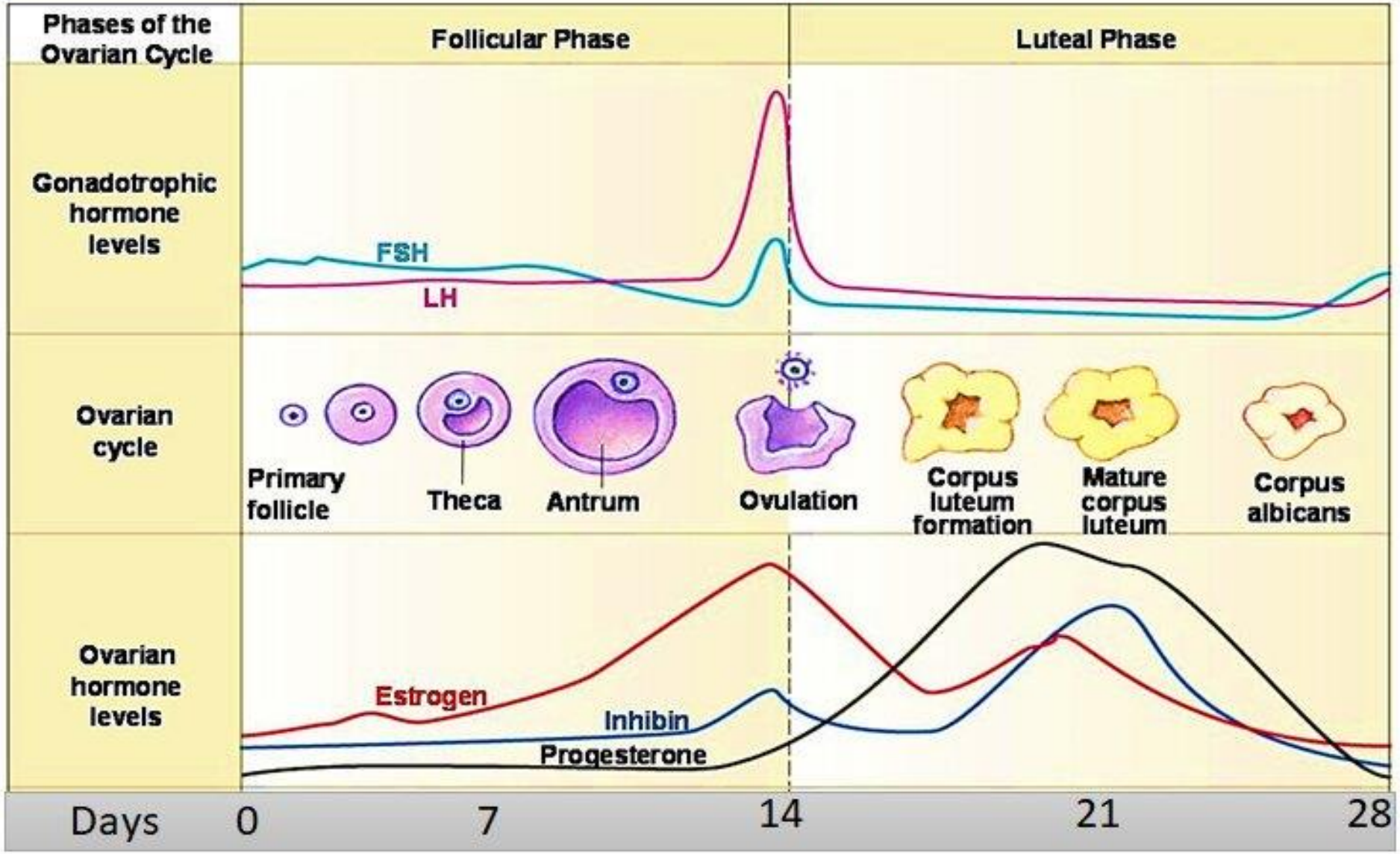
- Morula is the stage with 8-16 blastomeres in the embryo
- The blastocyst is formed due to continuous division after the morula stage.
- At this stage, blastomeres get arranged in the outer layer called trophoblast and inner cells forming inner cell mass
- The trophoblast gets attached to the endometrium lining of the uterus and the inner cell mass gets differentiated into the embryo
- The blastocyst gets embedded in the endometrium as the dividing uterine cells completely cover it.
- The process is known as implantation.

Phases of the Menstrual Cycle

- **Menstrual phase:** Day 1, uterus lining which is prepared for implantation starts to shed which lasts 3 to 5 days.
- **Follicular phase**: In this phase, the primary follicle starts developing into a mature Graffian follicle.
  - The endometrium also starts proliferating.
  - The uterus starts preparation for another pregnancy.

- **Ovulatory phase**: Mid-cycle phase, this is the phase in which ovulation takes place i.e., day 13-17.
  - The end of the follicular phase along with the ovulation period defines the fertilisation period.
- **Luteal phase:** It is the post-ovulation phase, where the fate of the corpus luteum is decided.
  - If fertilisation occurs, pregnancy starts.
  - If fertilisation doesn't occur, it marks the onset of another cycle.

Menstrual cycle



Parturition

- The process of childbirth is known as parturition.
- Parturition is initiated by neuroendocrine signals.
- Mild uterine contractions start when the foetus is fully developed.
- This is followed by secretion of oxytocin from the pituitary gland.
- Contractions become stronger and stronger as more oxytocin is secreted resulting in childbirth.
- After the infant, the placenta is also delivered.

- **Lactation:** Increased secretion of prolactin from the pituitary gland induces milk production in the mammary glands.

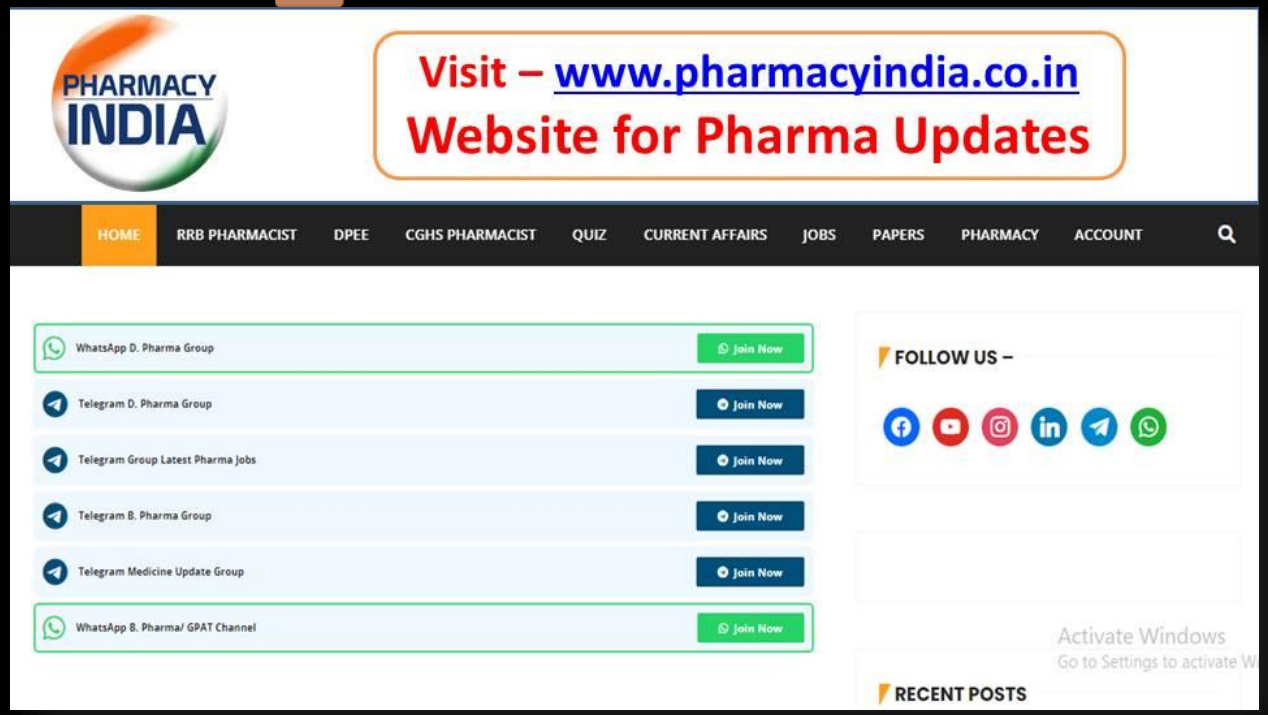
- **Colostrum:** It is the first formed (yellowish) milk from the mammary glands.
  - It is rich in antibodies and proteins and essential for the immunity of infants

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