FEMALE REPRODUCTIVE SYSTEM

- The female reproductive system consists of a pair of ovaries, a pair of Fallopian tubes or oviducts, uterus, vagina, external genitalia or vulva. A pair of mammary glands or breasts are also considered as part of reproductive system due to their role in child care.

Ovaries

- Ovaries are the **primary sex organs** in human female. They are paired structures located in the upper pelvic cavity.
- Each ovary is held in place within peritoneal cavity by several ligaments.

Structure of ovaries

- Anatomically, it is differentiated into following parts — **germinal epithelia**, the outermost layer of the ovary which forms oogonia in the fetus; is made up of squamous or cuboidal epithelium, **tunica albuginea**, sheath of dense connective tissue that lies below germinal epithelium and **ovarian stroma**, differentiated into dense outer **cortex** and less dense inner **medulla**.

At birth, the ovaries contain an estimated total of 2 to 4 million oogonia (egg mother cells). No more oogonia are formed and added after birth.

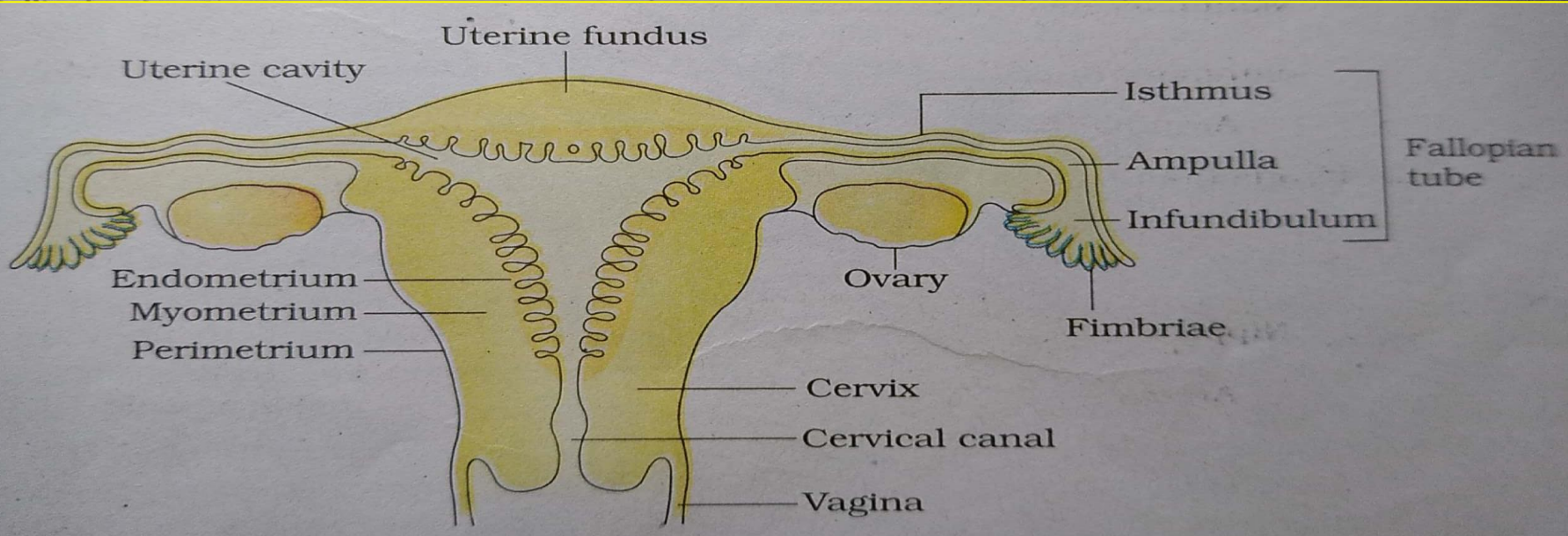

Figure 3.3 (b) Diagrammatic sectional view of the female reproductive system

Fallopian Tube

- The function of the Fallopian tube is to convey the ovum from the ovary to the uterus by peristalsis.
- Fertilisation of the ovum generally takes place in the upper portion of the Fallopian tube (ampulla).
- Each Fallopian tube (10 - 20 cm) consists of four parts : (i) **Infundibulum :** Funnel shaped free end of the oviduct bearing finger-like processes called fimbriae which help in collection of liberated ovum after ovulation; (ii) **Ampulla:** The widest and longest part of the Fallopian tube; (iii) **Isthmus :** Short, narrow, thick-walled portion following ampulla; and (iv) **Uterine part :** Passes through the uterine wall and communicates with the uterine cavity.

Uterus

- It is an inverted pear-shaped highly elastic large part of female reproductive system where development of fetus takes place.
- Uterine wall have three layers : **Perimetrium**, an outer thin covering of peritoneum; **myometrium**, middle thick layer of smooth muscle fibres that shows strong contraction during delivery of the baby and **endometrium**, inner glandular layer lining the uterine cavity.
- Uterus is differentiated into three regions — The upper dome-shaped region called **fundus**, the broad main part called **body** and a small, narrow, cylindrical inferior extremity called **cervix**. Cervix connect to the vagina through external os.

Vagina

- The vagina is a tube, about 10 cm long, that extends from the cervix to the outside of the body. It provides a passage for the menstrual flow, serves as the receptacle for sperm during intercourse and forms part of the birth canal during labour.
- The opening of the vagina is called the **vaginal orifice**. It is partially covered in virgins by a perforate membrane called **hymen**.

External Genitalia

- The female external genitalia include the **mons pubis**, **labia majora**, **labia minora**, **clitoris**, **vestibule of the vagina**, and **vestibular glands**. External genitalia are collectively called vulva.

Female Accessory Glands

- The lesser vestibular glands (**Paraurethral glands or glands of Skene**) are numerous minute glands that are present on either side of the urethral orifice, secreting mucus.
- The greater vestibular glands (**Bartholin's glands**) are a pair of small glands occurring one on each side of vaginal opening, secreting thick, viscous, alkaline fluid.

Mammary Glands

- Mammary glands are modified sweat glands that lie over the pectoralis major muscle.
- Its **glandular tissue** comprises about 15-20 mammary lobes. Each lobe consists of a number of **lobules**, which contain glandular alveoli that produce milk in lactating woman.

Questions

1. Where are fimbriae present in a human female reproductive system. Give their function.
2. Draw a labelled diagram of the human female reproductive system.
3. Name the layers of uterine wall of human and write their function.
4. Fertilisation of ovum generally takes place in which part of female reproductive system?

Oogenesis

- Oogenesis is the process of formation of **functional haploid ova** from the diploid germinal cells in the ovary.
- Unlike sperm formation that starts at puberty, egg formation begins during embryonic developmental stage but is completed only after fertilization.
- It consists of three phases : multiplication, growth and maturation.

Multiplication phase

- During foetal development, certain cells of the germinal epithelium of ovary which are larger than others function as **germ cells.**
- They undergo repeated mitotic divisions to produce undifferentiated germ cells called **oogonia,** or **egg mother cells** (2N).
- The oogonia multiply by mitotic divisions and project into the stroma as a cord, the egg tube of Pfluger, which later becomes a round mass, the egg nest.
- One cell in the egg nest grows and becomes the **primary oocyte.**

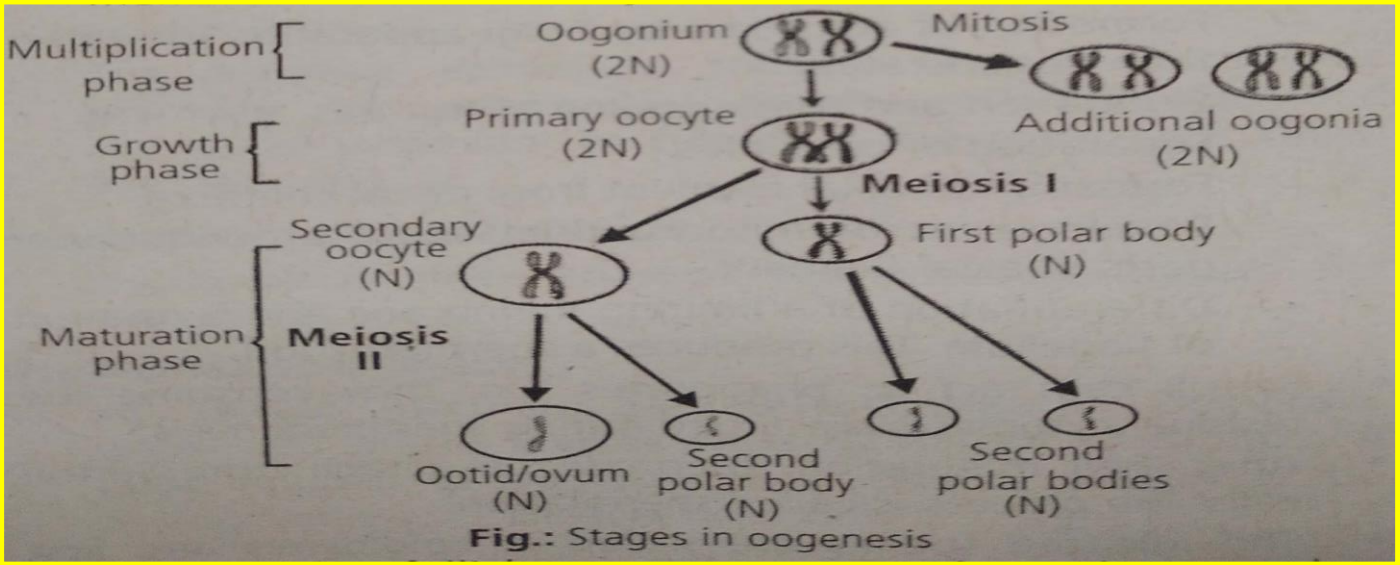

Fig.: Stages in oogenesis

Growth phase

- This phase of the primary oocyte is very long. It may extend over many years.
- The oogonium grows into a large **primary oocyte** by taking food from the surrounding follicle cells. It happens after puberty.
- Meiosis begins in the primary oocytes soon after their formation. However, the oocytes are temporarily arrested in the early part of meiotic prophase I (diplotene stage).
- Each primary oocyte then gets surrounded by a layer of granulosa cells and then called the **primary follicle.**

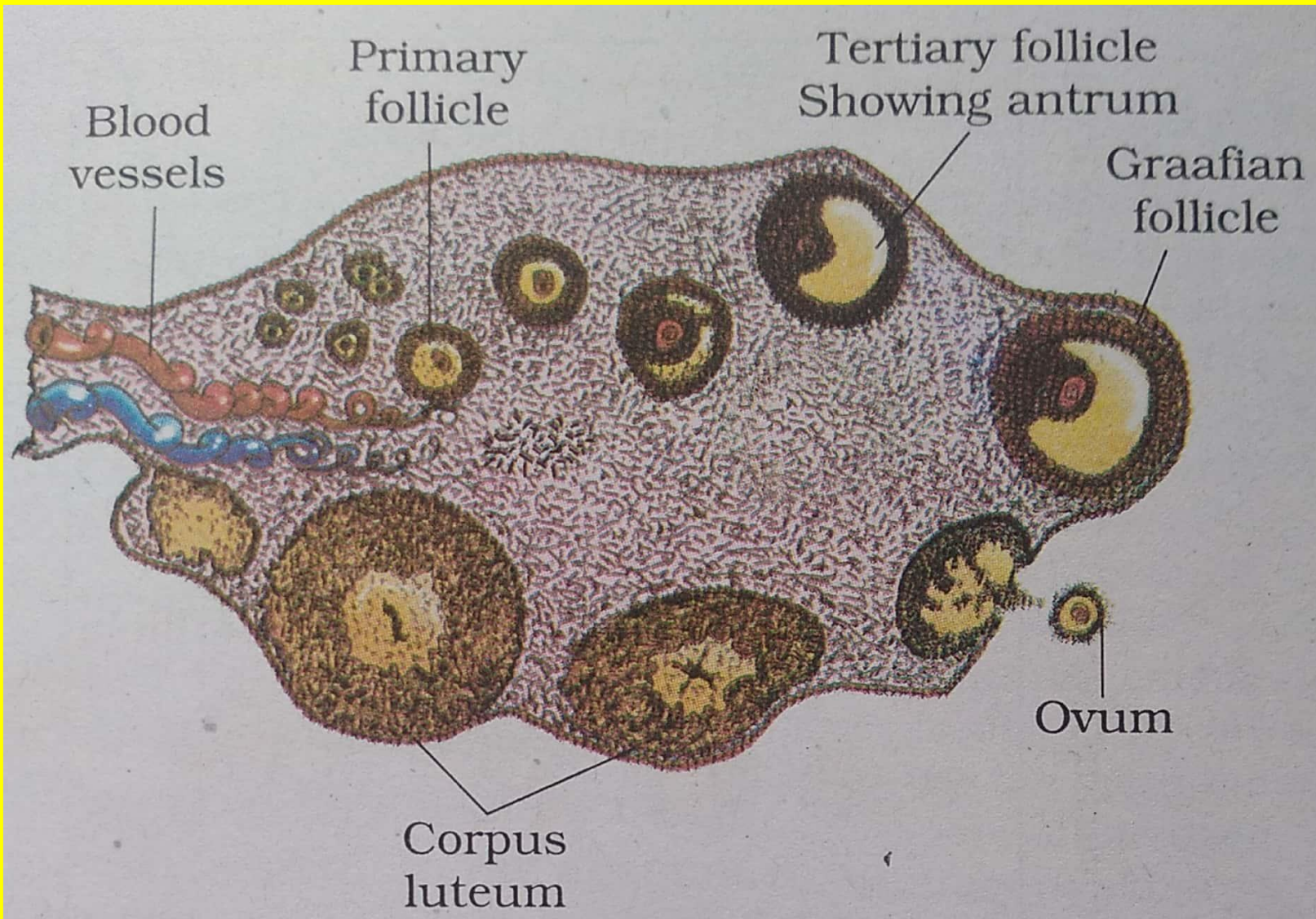

Figure 3.7 Diagrammatic Section view of ovary

A large number of these follicles degenerate during the phase from birth to puberty. Therefore, at puberty only 60,000-80,000 primary follicles are left in each ovary.

Maturation phase

- After attainment of puberty, follicles and their contained oocytes resume development.
- Another layer called **theca** develops from cortex. With the formation of theca, primary follicle is transformed into **secondary follicle.**
- Theca differentiates into two layers, an inner **theca interna** and outer **theca externa.**
- Granulosa cells secrete fluid that cause the development of a **cavity or antrum** around the primary oocyte. The stage is called **tertiary follicle.**
- Primary oocyte grows further and completes meiosis I. It produces a large **secondary oocyte** and a small polar body. Both are haploid.
- The polar body has a very small amount of cytoplasm but the whole chromosome set. The bulk of nutrient rich cytoplasm is retained in the secondary oocyte.
- The tertiary follicle further changes into the mature follicle or **Graafian follicle.** The secondary oocyte forms a new membrane called **zona pellucida** surrounding it.

- The Graafian follicle now ruptures to release the secondary oocyte (ovum) from the ovary by the process called **ovulation** (In human ovulation occurs about 14 days before the onset of the next menstruation.
- Ovum passes into oviduct, where in the ampulla part, cell cycle will resume only after the entry of sperm.
- It triggers the breakdown of M-phase promoting factor (MPF) and promotes synthesis of anaphase promoting complex (APC). Meiosis II is completed.
- A second polar body is extruded. The first polar body may divide to form two-second polar bodies.
- Thus from one oogonium, one ovum and three polar bodies are formed.

- The oocyte is now changed into ovum or ootid. The ovum, is the actual female gamete.
- The polar bodies take no part in reproduction and soon degenerate due to lack of cytoplasm and food.

Ovum

- It is the nonmotile female gamete. Human ovum is rounded **non-cleidoic** (without shell) and **alecithal** (without yolk). Ovum is covered by its own membrane called **plasmalemma** or **oolemma.** Its cytoplasm is called ooplasm.
- In the outer region ooplasm contains a number of mucopolysaccharide **cortical granules.** It contains microtubules, mitochondria, ribosomes, RNA, proteins, glycogen particles and lipid globules.
- Nucleus is large and is also called **germinal vesicle.**
- Egg or ovum has a polarity. There is an **animal pole** and a **vegetal pole.** One or two small **polar bodies** occur outside the plasma membrane near the area of animal pole. The space where the polar bodies occur is known as **perivitelline space.**
- Ovum has two coverings, a non-cellular, **zona pellucida** and a multicellular **corona radiata.**

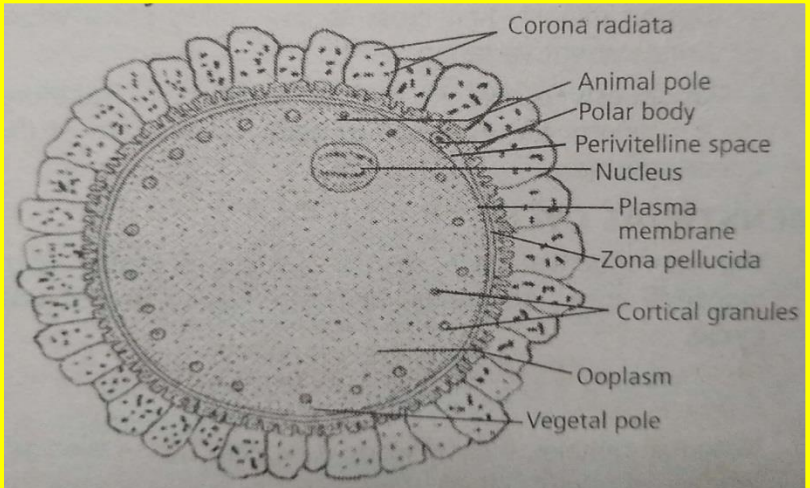

Fig.: Structure of ovum

Differences between spermatogenesis and oogenesis

	Spermatogenesis	Oogenesis
1.	It occurs inside testis.	It occurs inside ovary.
2.	All stages are completed inside testis.	Major part of oogenesis occurs inside ovary but last stages occur inside oviduct.
3.	It is a continuous process.	It is discontinuous process with early stages taking place in foetus and the rest later in life.
4.	Spermatogonia develop from germinal epithelium lining the seminiferous tubules.	Oogonia develop from the germinal epithelium overlying the ovary.
5.	Some cells of the germinal epithelium function as support or sustentacular cells, also called Sertoli cells	There is no such differentiation.
6.	All the spermatogonia divide to form spermatocytes.	Only some oogonia give rise to oocytes.
7.	Growth phase is short.	Growth phase is prolonged.
8.	Primary spermatocyte divides by meiosis I to form two secondary spermatocytes.	Primary oocyte undergoes meiosis I to form one secondary oocyte and one polar body.
9.	Secondary spermatocyte divides by meiosis II to produce two spermatids.	Secondary oocyte divides by meiosis II to form one ovum and one polar body.
10.	A spermatocyte forms four spermatozoa.	An oocyte forms only one egg or ovum.
11.	Sperms are smaller than spermatocytes.	Eggs are larger than oocytes.
12.	Nucleus undergoes condensation in the sperm.	Nucleus remains uncondensed in the ovum.
13.	Reserve food is little in the sperms.	Ovum collects a lot of reserve food and other biochemicals.
14.	It produces motile male gametes.	It forms nonmotile female gametes.

Significance of oogenesis

- The significances of oogenesis are given below:
  - One oogonium produces one ovum and three polar bodies.
  - Polar bodies have small amount of cytoplasm. It helps to retain sufficient amount of cytoplasm in the ovum which is essential for the development of early embryo. Formation of polar bodies maintains half number of chromosomes in the ovum.
  - During meiosis first crossing over takes place which brings about variation.
  - Oogenesis occurs in various organisms. Therefore, it supports the evidence of basic relationship of the organisms.

Questions

1. How is a primary oocyte different from a secondary oocyte?
2. Mention the changes taking place during the transition of a primary follicle to Graafian follicle in the oogonia.
3. Write the main function of ovary.
4. Write the main differences between oogenesis and spermatogenesis.
5. Briefly explain the stages involve in Oogenesis.