

CHAPTER 3



HUMAN REPRODUCTION

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- 3.2 *The Female Reproductive System*
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- 3.4 *Menstrual Cycle*
- 3.5 *Fertilisation and Implantation*
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As you are aware, humans are sexually reproducing and viviparous. The reproductive events in humans include formation of gametes (gametogenesis), i.e., sperms in males and ovum in females, transfer of sperms into the female genital tract (insemination) and fusion of male and female gametes (fertilisation) leading to formation of zygote. This is followed by formation and development of blastocyst and its attachment to the uterine wall (implantation), embryonic development (gestation) and delivery of the baby (parturition). You have learnt that these reproductive events occur after puberty. There are remarkable differences between the reproductive events in the male and in the female, for example, sperm formation continues even in old men, but formation of ovum ceases in women around the age of fifty years. Let us examine the male and female reproductive systems in human.

3.1 THE MALE REPRODUCTIVE SYSTEM

The male reproductive system is located in the pelvis region (Figure 3.1a). It includes a pair of **testes** along with **accessory ducts**, **glands** and the **external genitalia**.

The testes are situated outside the abdominal cavity within a pouch called **scrotum**. The scrotum helps in maintaining the low temperature of the testes (2–2.5° C lower than the normal internal body temperature) necessary for spermatogenesis. In adults, each testis is oval in shape, with a length of about 4 to 5 cm and a width of about 2 to 3 cm. The testis is covered by a dense covering. Each testis has about 250 compartments called **testicular lobules** (Figure 3.1b).

Each lobule contains one to three highly coiled **seminiferous tubules** in which sperms are produced. Each seminiferous tubule is lined on its inside by two types of cells called **male germ cells** (*spermatogonia*) and **Sertoli cells** (Figure 3.2). The male germ cells undergo meiotic divisions finally leading to sperm formation, while Sertoli cells provide nutrition to the germ cells. The regions outside the seminiferous tubules called interstitial spaces, contain small blood vessels and **interstitial cells** or **Leydig cells** (Figure 3.2). Leydig cells synthesise and secrete testicular hormones called androgens. Other immunologically competent cells are also present.

The male sex accessory ducts include **rete testis**, **vasa efferentia**, **epididymis** and **vas deferens** (Figure 3.1b). The seminiferous tubules of the testis open into the vasa efferentia through rete testis. The vasa efferentia leave the testis and open into epididymis located along the posterior surface of each testis. The epididymis leads to vas deferens that ascends to the abdomen and loops over the urinary bladder. It receives a duct from seminal vesicle and opens into urethra as the ejaculatory duct (Figure 3.1a). These ducts store and transport the sperms from the testis to the outside through urethra. The urethra originates from the urinary bladder and extends through the penis to its external opening called **urethral meatus**.

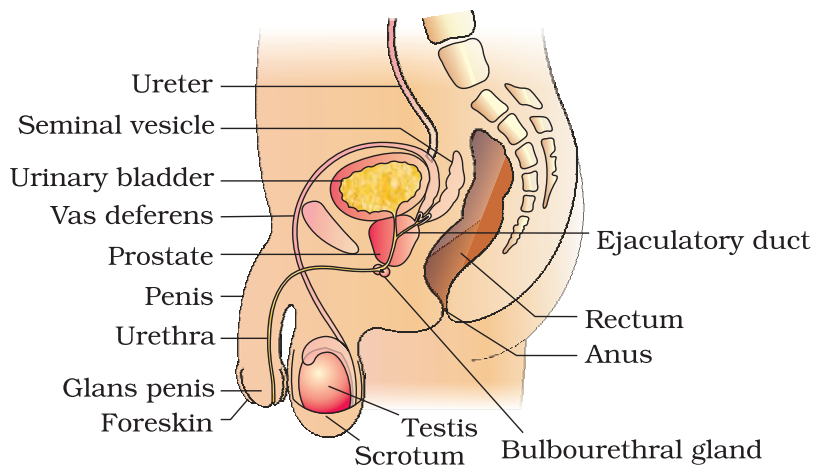


Figure 3.1(a) Diagrammatic sectional view of male pelvis showing reproductive system

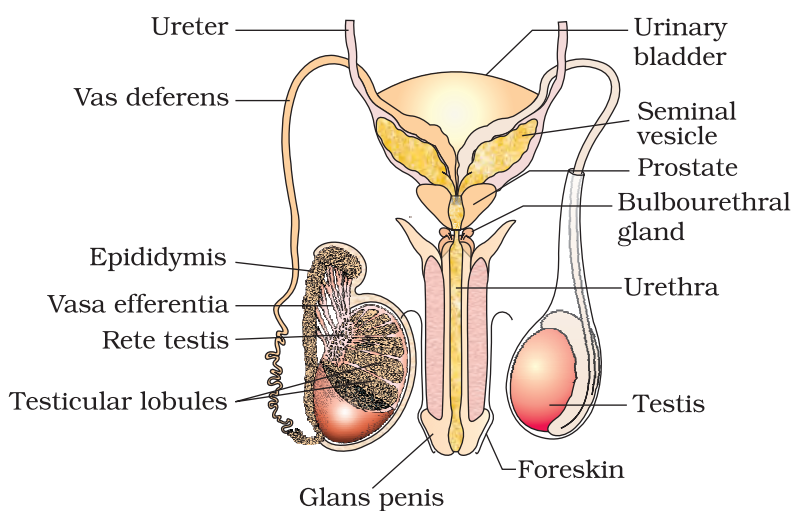


Figure 3.1(b) Diagrammatic view of male reproductive system (part of testis is open to show inner details)

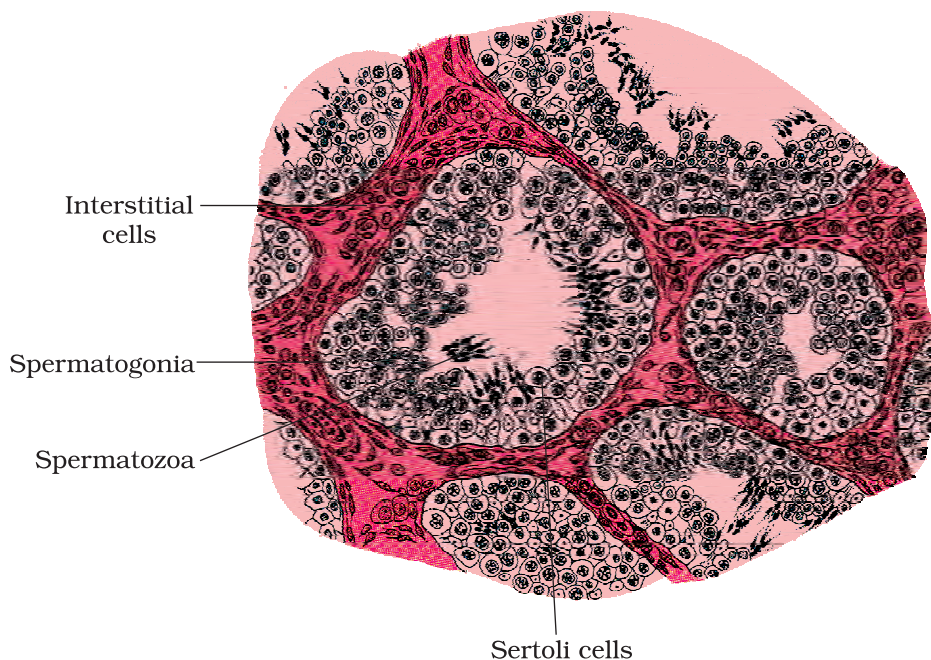


Figure 3.2 Diagrammatic sectional view of seminiferous tubule

The penis is the male external genitalia (Figure 3.1a, b). It is made up of special tissue that helps in erection of the penis to facilitate insemination. The enlarged end of penis called the glans penis is covered by a loose fold of skin called **foreskin**.

The male accessory glands (Figure 3.1a, b) include paired **seminal vesicles**, a **prostate** and paired **bulbourethral** glands. Secretions of these glands constitute the seminal plasma which is rich in fructose, calcium and certain enzymes. The secretions of bulbourethral glands also helps in the lubrication of the penis.

3.2 THE FEMALE REPRODUCTIVE SYSTEM

The female reproductive system consists of a pair of **ovaries** alongwith a pair of **oviducts**, **uterus**, **cervix**, **vagina** and the **external genitalia** located in pelvic region (Figure 3.3a). These parts of the system alongwith a pair of the **mammary glands** are integrated structurally and functionally to support the processes of ovulation, fertilisation, pregnancy, birth and child care.

Ovaries are the primary female sex organs that produce the female gamete (ovum) and several steroid hormones (ovarian hormones). The ovaries are located one on each side of the lower abdomen (Figure 3.3b). Each ovary is about 2 to 4 cm in length and is connected to the pelvic wall and uterus by ligaments. Each ovary is covered by a thin epithelium which encloses the ovarian stroma. The stroma is divided into two zones – a peripheral cortex and an inner medulla.

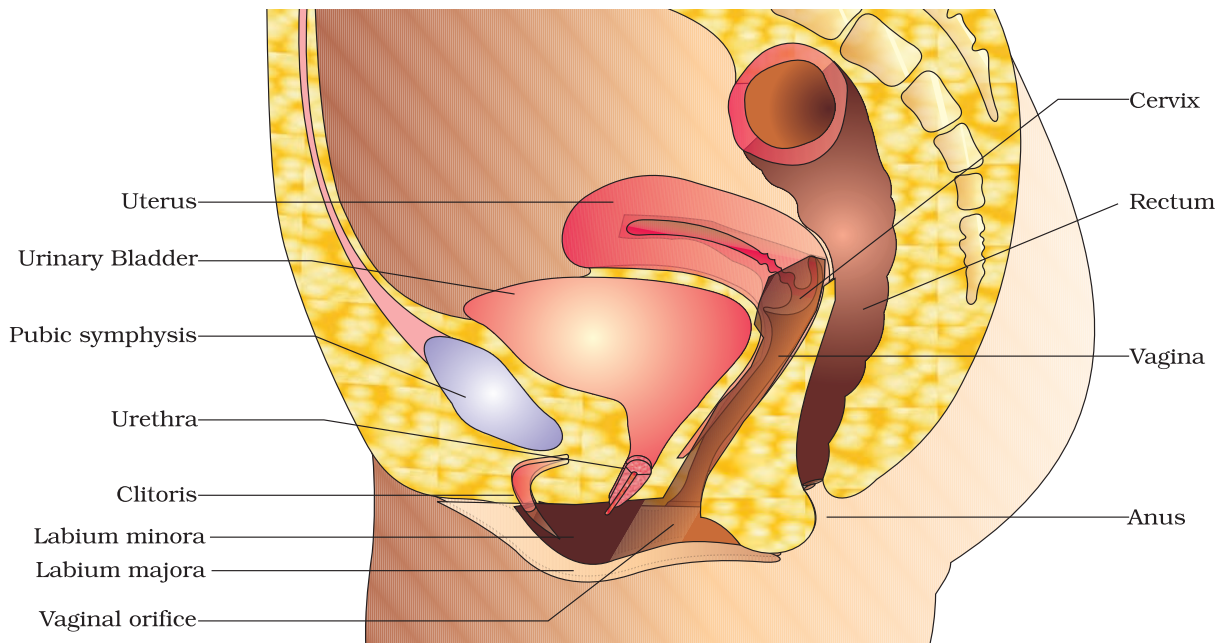


Figure 3.3 (a) Diagrammatic sectional view of female pelvis showing reproductive system

The oviducts (fallopian tubes), uterus and vagina constitute the female accessory ducts. Each fallopian tube is about 10-12 cm long and extends from the periphery of each ovary to the uterus (Figure 3.3b), the part closer to the ovary is the funnel-shaped **infundibulum**. The edges of the infundibulum possess finger-like projections called **fimbriae**, which help in collection of the ovum after ovulation. The infundibulum leads to a wider

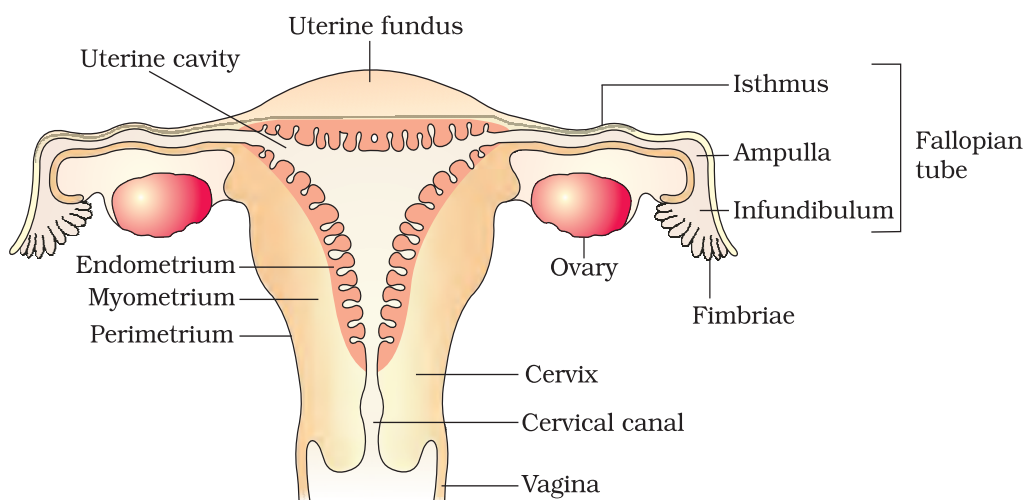


Figure 3.3 (b) Diagrammatic sectional view of the female reproductive system

part of the oviduct called **ampulla**. The last part of the oviduct, **isthmus** has a narrow lumen and it joins the uterus.

The uterus is single and it is also called **womb**. The shape of the uterus is like an inverted pear. It is supported by ligaments attached to the pelvic wall. The uterus opens into vagina through a narrow cervix. The cavity of the cervix is called **cervical canal** (Figure 3.3b) which alongwith vagina forms the birth canal. The wall of the uterus has three layers of tissue. The external thin membranous **perimetrium**, middle thick layer of smooth muscle, **myometrium** and inner glandular layer called **endometrium** that lines the uterine cavity. The endometrium undergoes cyclical changes during menstrual cycle while the myometrium exhibits strong contraction during delivery of the baby.

The female external genitalia include mons pubis, labia majora, labia minora, hymen and clitoris (Figure 3.3a). **Mons pubis** is a cushion of fatty tissue covered by skin and pubic hair. The **labia majora** are fleshy folds of tissue, which extend down from the mons pubis and surround the vaginal opening. The **labia minora** are paired folds of tissue under the labia majora. The opening of the vagina is often covered partially by a membrane called **hymen**. The **clitoris** is a tiny finger-like structure which lies at the upper junction of the two labia minora above the urethral opening. The hymen is often torn during the first coitus (intercourse). *However, it can also be broken by a sudden fall or jolt, insertion of a vaginal tampon, active participation in some sports like horseback riding, cycling, etc. In some women the hymen persists even after coitus. In fact, the presence or absence of hymen is not a reliable indicator of virginity or sexual experience.*

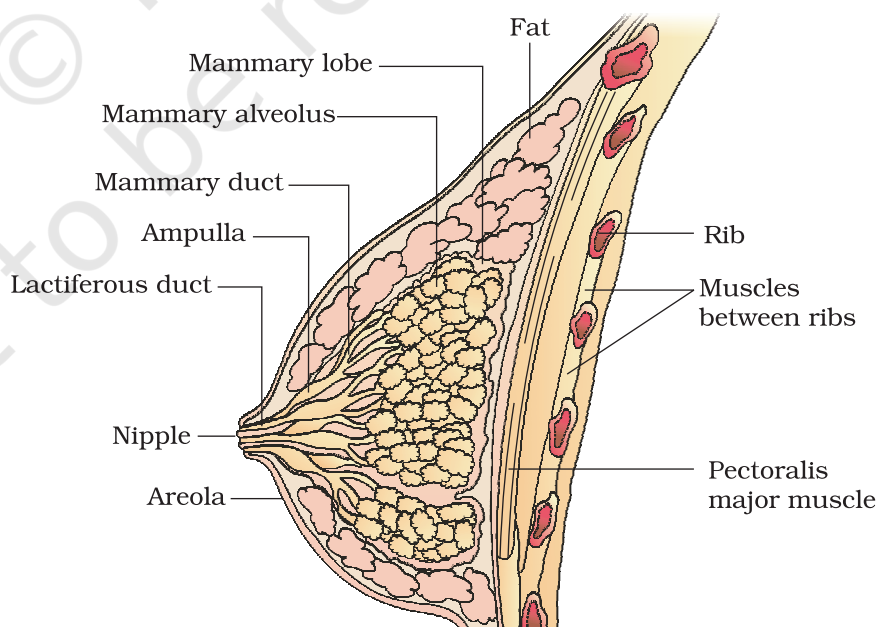


Figure 3.4 A diagrammatic sectional view of Mammary gland

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 3.4). 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.

3.3 GAMETOGENESIS

The primary sex organs – the testis in the males and the ovaries in the females – produce gametes, i.e, sperms and ovum, respectively, by the process called gametogenesis. In testis, the immature male germ cells (spermatogonia) produce sperms by **spermatogenesis** that begins at puberty. The **spermatogonia** (sing. spermatogonium) present on the inside wall of seminiferous tubules multiply by mitotic division and increase in numbers. Each spermatogonium is diploid and contains 46 chromosomes. Some of the spermatogonia called **primary spermatocytes** periodically undergo meiosis. A primary spermatocyte completes the first meiotic division (reduction division) leading to formation of two equal, haploid cells called **secondary spermatocytes**, which have only 23 chromosomes each. The secondary spermatocytes undergo the second meiotic division to produce four equal, haploid **spermatids** (Figure 3.5). *What would be the number of chromosome in the spermatids?* The spermatids are transformed into **spermatozoa (sperms)** by the process called **spermiogenesis**. After spermiogenesis, sperm heads become embedded in the **Sertoli cells**, and are finally released from the seminiferous tubules by the process called **spermiation**.

Spermatogenesis starts at the age of puberty due to significant increase in the secretion of gonadotropin releasing hormone (GnRH). This, if you recall, is a hypothalamic hormone. The increased levels of GnRH then acts at the anterior pituitary gland and stimulates secretion of two gonadotropins – luteinising hormone (LH) and follicle stimulating hormone (FSH). LH acts at the Leydig cells and stimulates synthesis and secretion of androgens. Androgens, in turn, stimulate the process of spermatogenesis. FSH acts on the Sertoli cells and stimulates

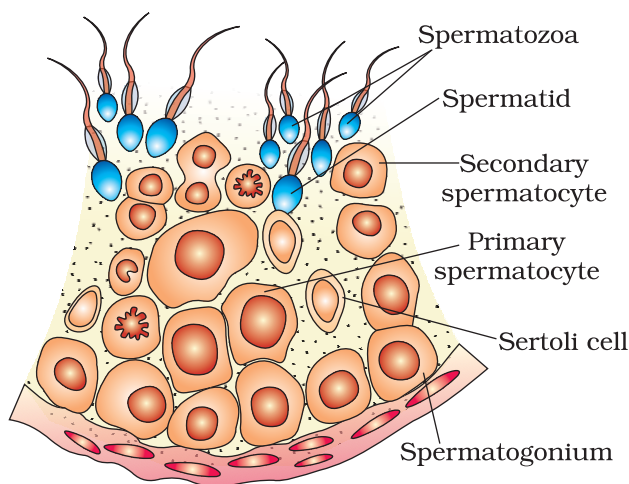


Figure 3.5 Diagrammatic sectional view of a seminiferous tubule (enlarged)

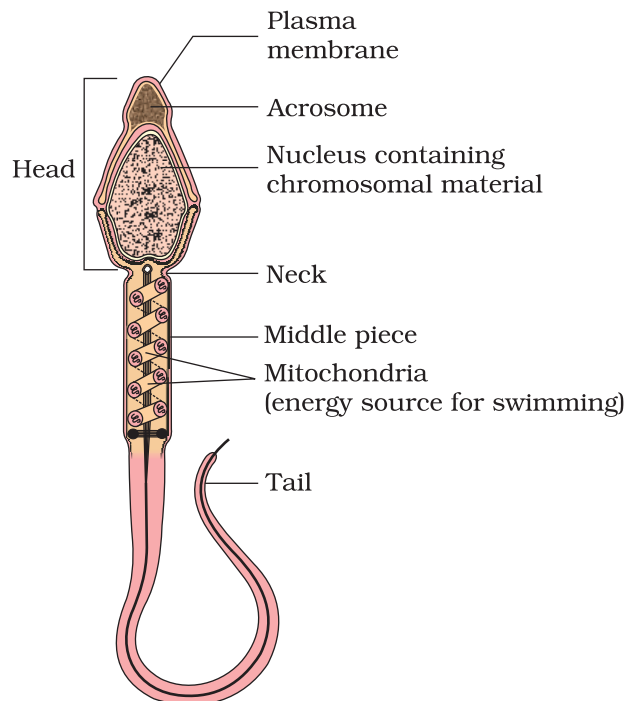


Figure 3.6 Structure of a sperm

secretion of some factors which help in the process of spermiogenesis.

Let us examine the structure of a sperm. It is a microscopic structure composed of a **head**, **neck**, a **middle piece** and a **tail** (Figure 3.6). A plasma membrane envelops the whole body of sperm. The sperm head contains an elongated haploid nucleus, the anterior portion of which is covered by a cap-like structure, **acrosome**. The 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 of which, for normal fertility, at least 60 per cent sperms must have normal shape and size and at least 40 per cent of them must show vigorous motility.

Sperms released from the seminiferous tubules, are transported by the accessory ducts. Secretions of epididymis, vas deferens, seminal vesicle and prostate are essential for maturation and motility of sperms. The seminal plasma along with the sperms constitute the **semen**. The functions of male sex accessory ducts and glands are maintained by the testicular hormones (androgens).

The process of formation of a mature female gamete is called **oogenesis** which is markedly different from spermatogenesis. Oogenesis is initiated during the embryonic development stage when a couple of million gamete mother cells (**oogonia**) are formed within each fetal ovary; no more oogonia are formed and added after birth. These cells start division and enter into prophase-I of the meiotic division and get temporarily arrested at that stage, called **primary oocytes**. Each primary oocyte then gets surrounded by a layer of granulosa cells and is called the **primary follicle** (Figure 3.7). 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. The primary follicles get surrounded by more layers of granulosa cells and a new theca and are called **secondary follicles**.

The secondary follicle soon transforms into a tertiary follicle which is characterised by a fluid filled cavity called **antrum**. The theca layer is organised into an inner theca interna and an outer theca externa. It is important to draw your attention that it is at this stage that the primary oocyte within the tertiary follicle grows in size and completes its first meiotic division. It is an unequal division resulting in the formation of a large haploid **secondary oocyte** and a tiny first polar body (Figure 3.8b). The

secondary oocyte retains bulk of the nutrient rich cytoplasm of the primary oocyte. *Can you think of any advantage for this?* Does the first polar body born out of first meiotic division divide further or degenerate? At present we are not very certain about this. The tertiary follicle further changes into the mature follicle or **Graafian follicle** (Figure 3.7). 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**. *Can you identify major differences between spermatogenesis and oogenesis?* A diagrammatic representation of spermatogenesis and oogenesis is given below (Figure 3.8).

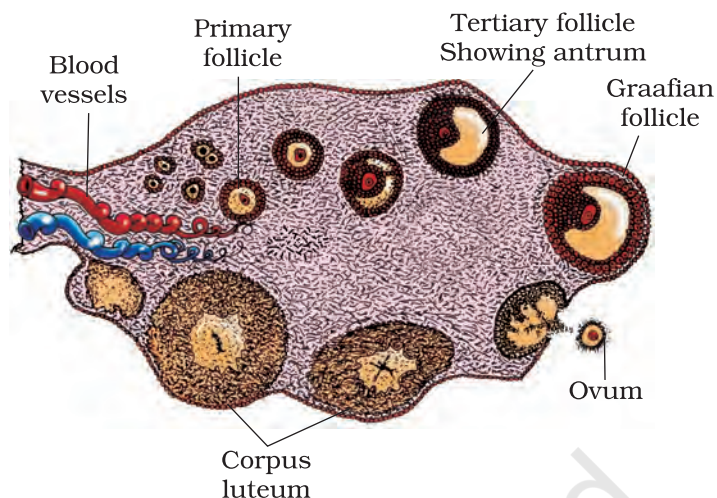


Figure 3.7 Diagrammatic Section view of ovary

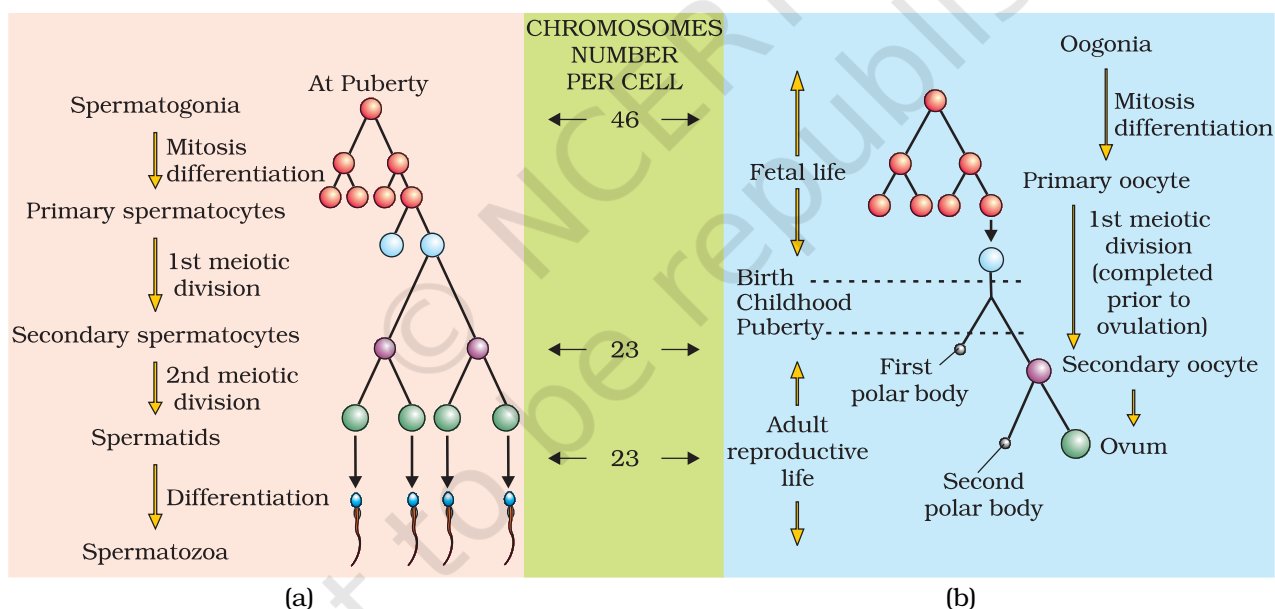


Figure 3.8 Schematic representation of (a) Spermatogenesis; (b) Oogenesis

3.4 MENSTRUAL CYCLE

The reproductive cycle in the female primates (e.g. monkeys, apes and human beings) is called menstrual cycle. The first menstruation begins at puberty and is called **menarche**. In human females, menstruation is repeated at an average interval of about 28/29 days, and the cycle of events starting from one menstruation till the next one is called the **menstrual cycle**. One ovum is released (ovulation) during the middle