

CHAPTER 2: MALE AND FEMALE REPRODUCTIVE SYSTEM

1. Male Reproductive System

The male reproductive system consists of the **testis**, ducts, associated **glands**, and the sexual organ, or **penis** (Figure 1). The main function of the male reproductive system is to produce and release sperm cells for sexual reproduction. Furthermore, it is an endocrine gland that releases **androgen hormones**, such as testosterone, which are responsible for secondary sexual features that result in sexual dimorphism.

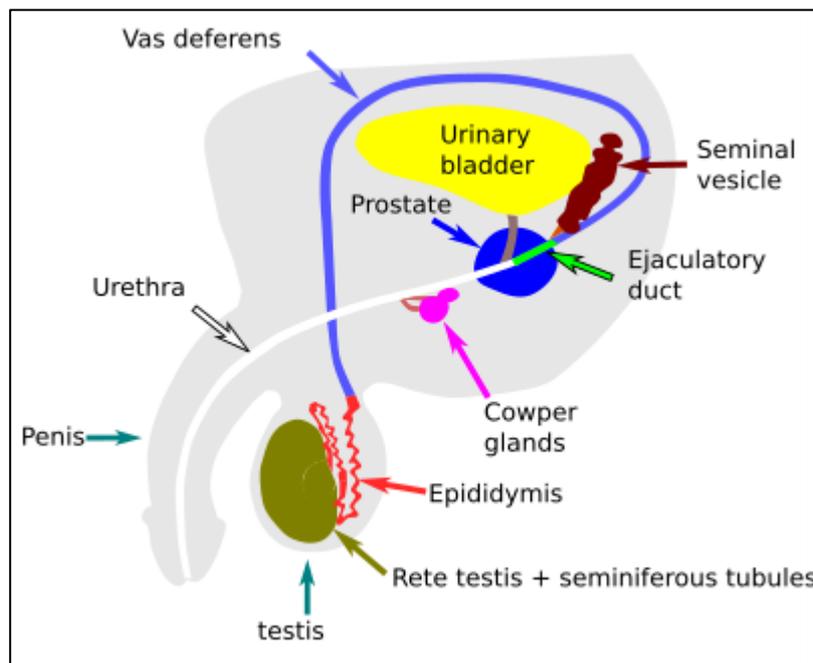


Figure 1. Drawing of the human male reproductive system.

Gonads – Testes (Singular: Testis): are oval male reproductive organs. They are located in the **scrotum**, outside the abdominal cavity. This position helps keep the testes at a temperature of about **2–3 °C** lower than the normal body temperature ($\approx 34\text{--}35\text{ °C}$ instead of 37 °C), which is essential for **normal sperm production (spermatogenesis)**.

The scrotum is an extension of the **peritoneum**. It contains two layers of **mesothelium** with a **serous fluid** between them. This fluid acts as a lubricant and allows the testes to move freely inside the scrotum.

Each testis is covered by a connective tissue layer called the **tunica albuginea**, located under the tunica vaginalis. The tunica albuginea has:

- an **outer fibrous layer** with elastic fibers and some smooth muscle cells

- an **inner vascular layer** called the **tunica vasculosa**, rich in blood vessels

At the posterior part of the testis, the tunica albuginea becomes thicker and forms the **mediastinum testis**. From this region, connective tissue walls called **septa** extend toward the front of the testis and divide it into small units called **lobules**.

Each lobule contains **one to four seminiferous tubules**, surrounded by connective tissue. The testis has two main compartments:

- the **seminiferous tubules**, where sperm are produced
- the **interstitial compartment**, which contains blood and lymph vessels, nerves, smooth muscle cells, macrophages, and **Leydig cells**

The **Leydig cells** are responsible for the secretion of the male hormone **testosterone**.

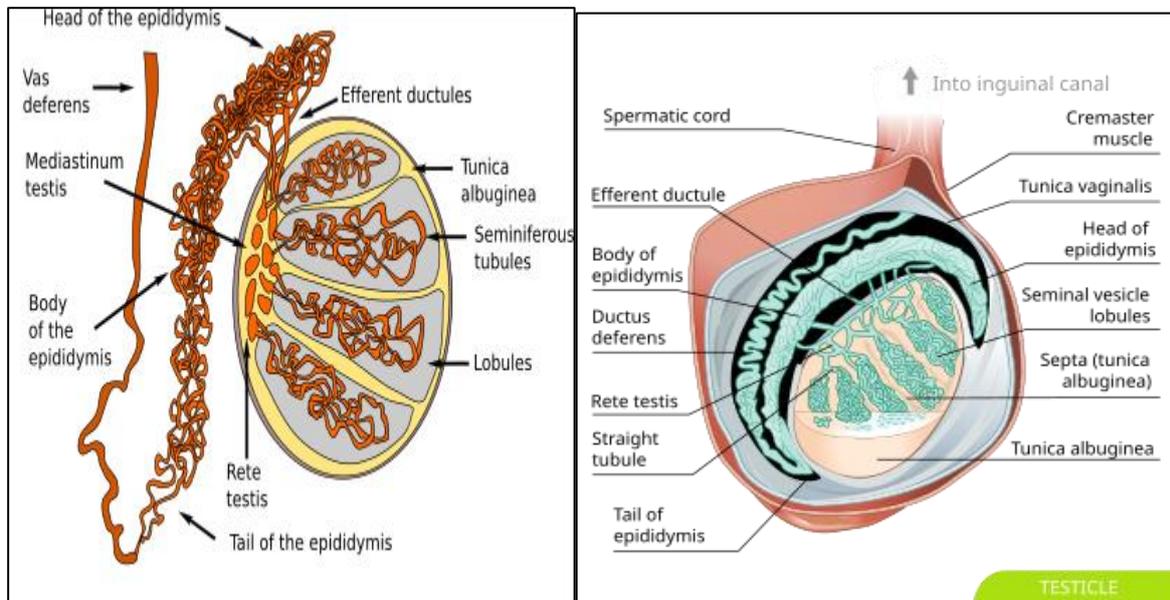


Figure 2. Drawing of a testicle. Anterior part is to the right.

In humans, seminiferous tubules are convoluted, about 0.2 μm in diameter, and from 30 to 70 cm long. One of the ends of the tubule may be closed or connected with the tubule of another testicular lobule. They are more straight toward the posterior part of the lobule, where the seminiferous tubules from the different lobules fuse to form a testicular network known as the **rete testis**.

The germinal epithelium forms the majority of the wall of the seminiferous tubules. It contains the male germinal cells, or **spermatogonia**, as well as scattered somatic cells known as **the Sertoli cells**.

Sertoli cells are specialized **somatic cells** in the seminiferous tubules. Their main roles are:

1. **Support and Nourishment** – They provide **structural support** and **nutrients** to developing germ cells (spermatogonia and spermatocytes).
2. **Blood-Testis Barrier** – They form a barrier that **protects germ cells** from harmful substances and the immune system.
3. **Phagocytosis** – They **digest residual cytoplasm** during spermiogenesis (the final stage of sperm development).
4. **Secretion of Fluids and Hormones** – They secrete **testicular fluid** that helps move sperm through the tubules and produce **hormones and growth factors** essential for spermatogenesis.
5. **Regulation of Spermatogenesis** – They release **inhibin** and respond to **FSH**, controlling the rate of sperm production.

The lumen is the central cavity of the seminiferous tubules. It is the space where mature spermatozoa are released after completing development inside the tubules.

2. Ducts

The male reproductive system consists of several ducts that produce, store, and drive the sperm cells from the seminiferous tube to outside the body.

Straight segments of the seminiferous tubules form the vertices of the posterior part of the testicular lobules. The sperm cells produced in the other parts of the seminiferous tubules are collected in these segments, which are short, have no germinal cells, and whose walls are made up of Sertoli cells. The straight segments fuse to one another and form an anastomosed network of tubes known as the **rete testis**, surrounded by connective tissue (the mediastinum testis). The tubes of this labyrinth show a simple cuboidal epithelium.

From 15 to 20 **efferent ductules** leave the dorsal part of the rete testis and enter the so-called head of the epididymis, where they become very convoluted and surrounded by vascular connective tissue, forming what is known as vascular cones. In the head of the epididymus, efferent ductules converge to form **the epididymis duct**, which constitutes most of the next region known as the body of the epididymis. The epididymis is a very long and convoluted duct where sperm is stored. It shows a pseudostratified epithelium coated by a basal lamina and connective tissue. There is a thin layer of smooth muscle cells under the connective tissue that

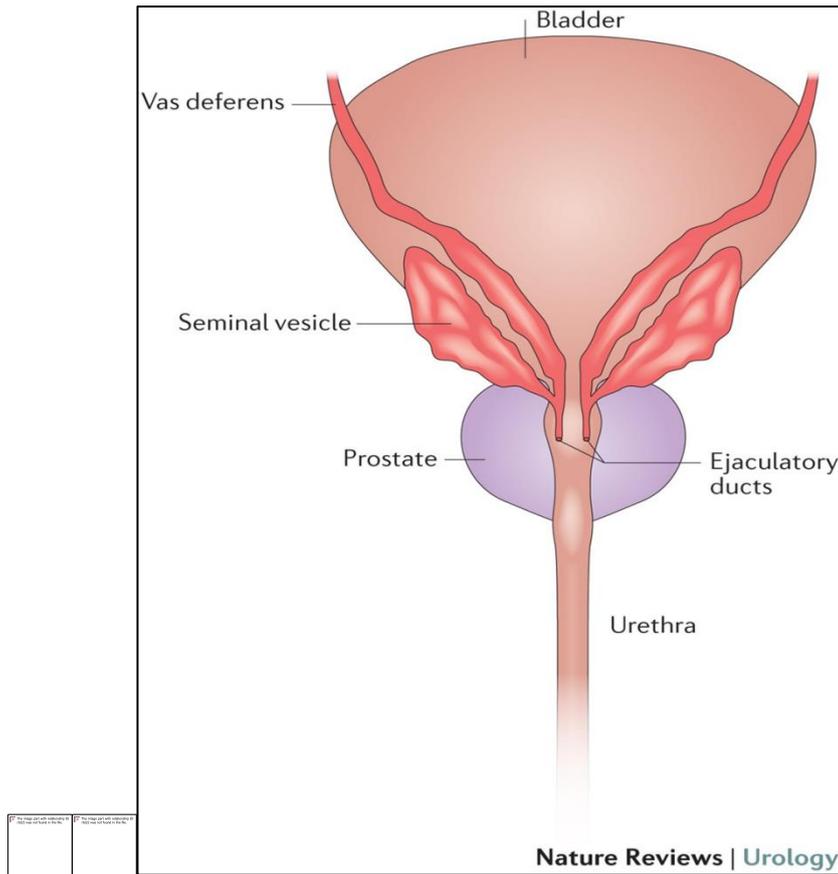
compresses the duct through peristaltic contractions. A layer of smooth muscle cells is also surrounded by the efferent ductules.

Role of the Epididymis Duct

- **Sperm Maturation:**
 - Sperm produced in the seminiferous tubules are **immature and non-motile**.
 - While passing through the **epididymis duct**, sperm **acquire motility** and the ability to **fertilize an egg**.
- **Sperm Storage:**
 - The epididymis duct serves as a **storage site** for mature sperm until ejaculation.
- **Transport of Sperm:**
 - During ejaculation, **smooth muscle contractions** in the epididymis help **push sperm into the ductus deferens**.
- **Secretion of Fluids:**
 - The epididymis epithelium secretes **nutrient-rich fluids** that help **maintain sperm viability**.

The epididymis becomes the **Vas\ ductus deferens**, which drives the sperm from the scrotum to the inguinal region, coursing the lateral wall of the pelvis toward the urethra. The ductus derferens has thick walls and a narrow lumen. It is made up of a pseudostratified epithelium, a basal lamina, a thin lamina propria, and a poorly delimited submucosa. There is also a well-developed smooth muscle layer divided into three sublayers. An adventitia layer coats the muscle layer. Near the end of the ductus deferens, there is an enlargement known as the ampulla.

The ejaculatory duct is a short terminal duct that extends from the ampulla of the ductus deferens, crosses the prostate, and ends in the urethra. The epithelium of the ejaculatory duct is columnar or pseudostratified.



1. Glands

Glands associated with the male reproductive system are the seminal, prostate, and bulbourethral glands (Cowper's glands).

Seminal vesicles are long structures situated behind the prostate. Their excretory ducts join the ductus deferens and together form the ejaculatory duct. The pseudostratified epithelium of the seminal vesicles is a secretory epithelium that produces and releases the **seminal fluid**. This solution contains many substances, like fructose for sperm cell feeding and prostaglandins that influence the female reproductive system. The activity of the epithelium is modulated by testosterone.

The prostate is a complex gland that, in humans, consists of 30 to 50 compound tubuloalveolar glands releasing their content into the prostatic urethra. This gland is surrounded by fibromuscular stroma. The prostate is divided into **four regions** of different sizes: the transition zone that coats the urethra, the central zone that surrounds the ejaculatory ducts, the peripheral zone, which is the largest part of the gland, and the non-glandular fibromuscular stroma occupying the anterior part. **The prostatic liquid** solution contains enzymes like fibrinolins that help to decrease the viscosity of the semen.

Bulbourethral glands, or Cowper's glands, are small glands found behind the urethra. They are compound tubulo-alveolar glands that release their content into the urethra. The secretory parts consist of a cuboidal or columnar simple epithelium, surrounded by connective tissue containing striated muscle cells. The connective tissue sends tissue expansions that form septa between the secretory parts of the glands. Secreted substances are mostly **lubricants**, and they are released independently of ejaculation.

4. Reproductive organ

The penis is the male reproductive organ. It is organized into two dorsal columns known as **corpora cavernosa** and one ventral column, or the corpus spongiosum, which contains the urethra. There are connective and fibroelastic tissues covering these three structures, forming the tunica albuginea, which provides strength and support. Corpora cavernosa is a network of large anastomosed blood cavities that are filled with blood during penis erection. The cavities are coated by smooth muscle. **The glans** is the distal end of the penis, which is covered by the foreskin, known as **the prepuce**.

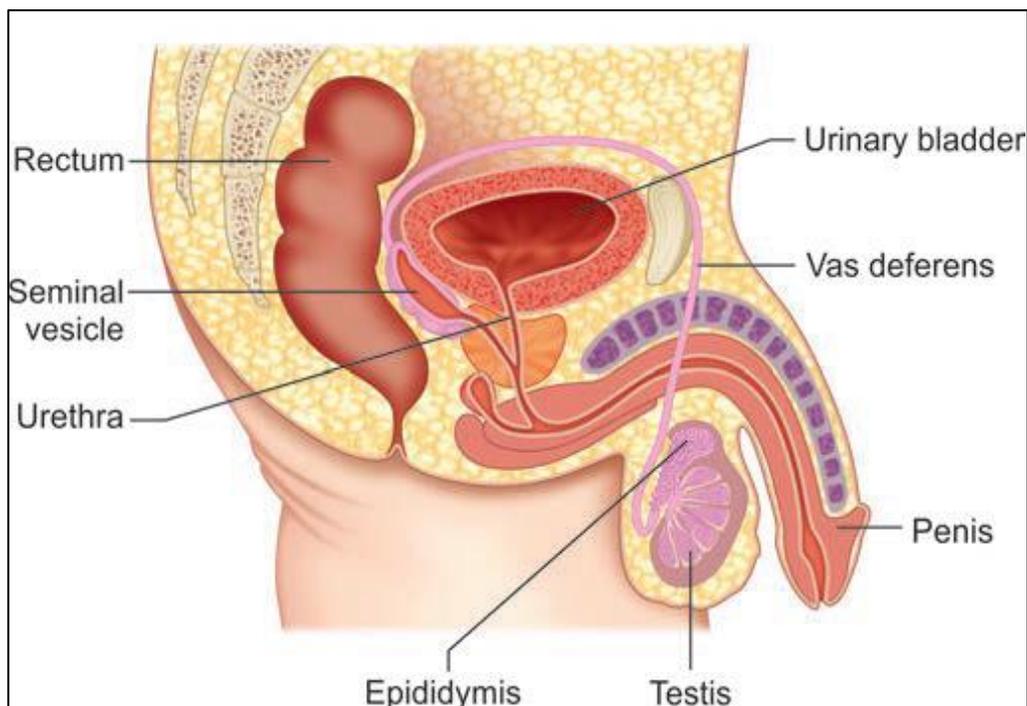


Fig. 2: Male reproductive system

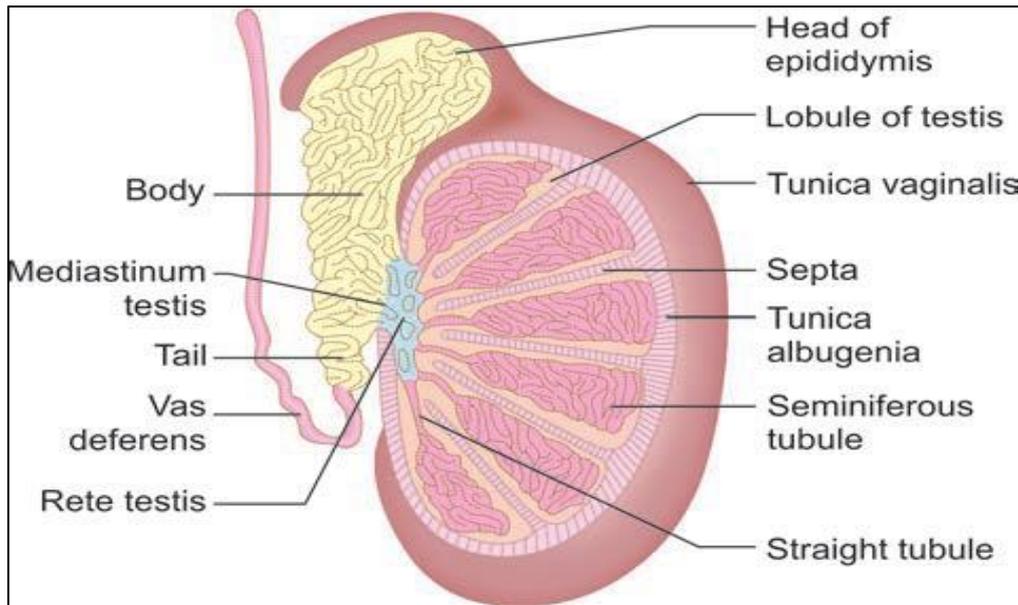
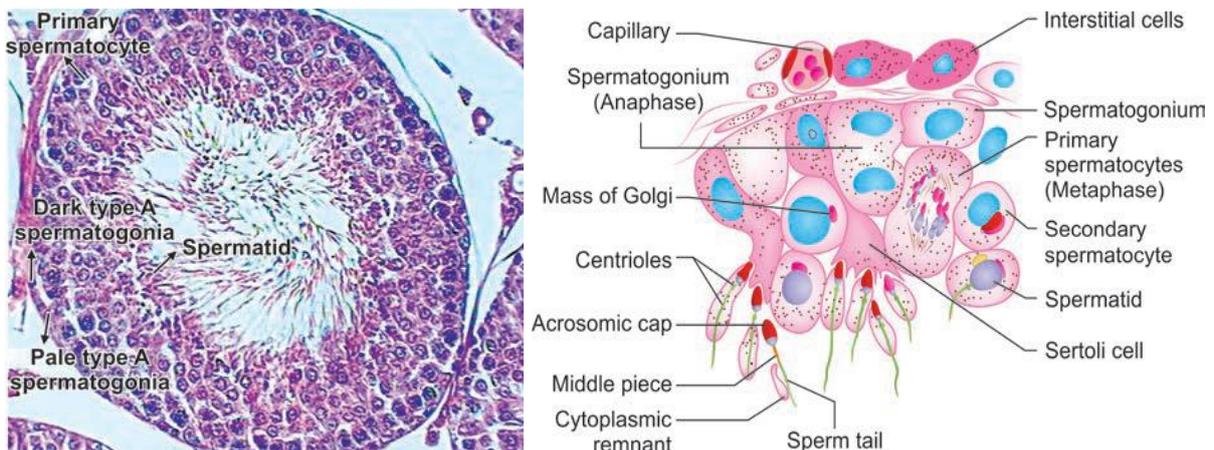


Fig. 3: Vertical section of testis, epididymis and vas deferens



Figs. 4: Cut-section of seminiferous tubule showing cells of spermatogenic lineage and Sertoli cells

1.1. Female Reproductive System

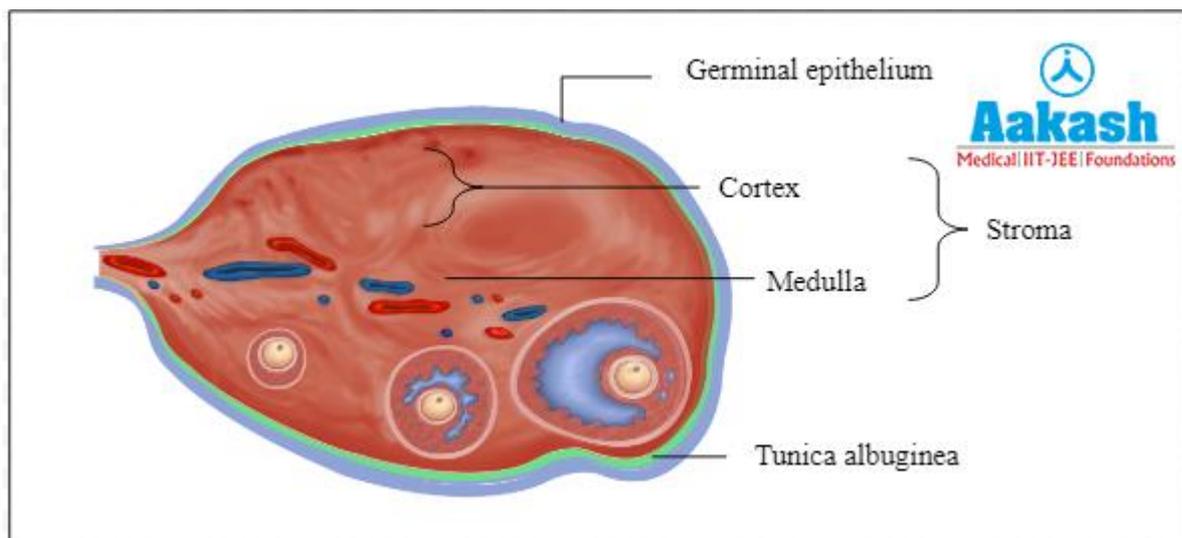
1. Ovaries (Gonads) (Fig. 5):

- **Shape and Location:** Almond-shaped organs located on either side of the uterus, attached to the posterior layer of the **broad ligament**.
- **Function:**
 - **Gamete production:** Ovaries produce **oocytes**, which mature into **ova** after fertilization.

- **Hormone secretion:** Produce **estrogen** and **progesterone**, essential for:
 - Oocyte maturation
 - Endometrial preparation for implantation
 - Growth and maintenance of pregnancy

➤ **Microscopic Structure of the Ovary :**

- **Germinal epithelium:** Outer layer of simple cuboidal epithelium.
- **Tunica albuginea:** Dense connective tissue beneath the germinal epithelium.
- **Cortex:** Contains connective tissue stroma and ovarian follicles in various stages of development; site of **ovarian cycle** during reproductive age.
- **Medulla:** Inner region with loose connective tissue, blood vessels, lymphatics, and nerves.



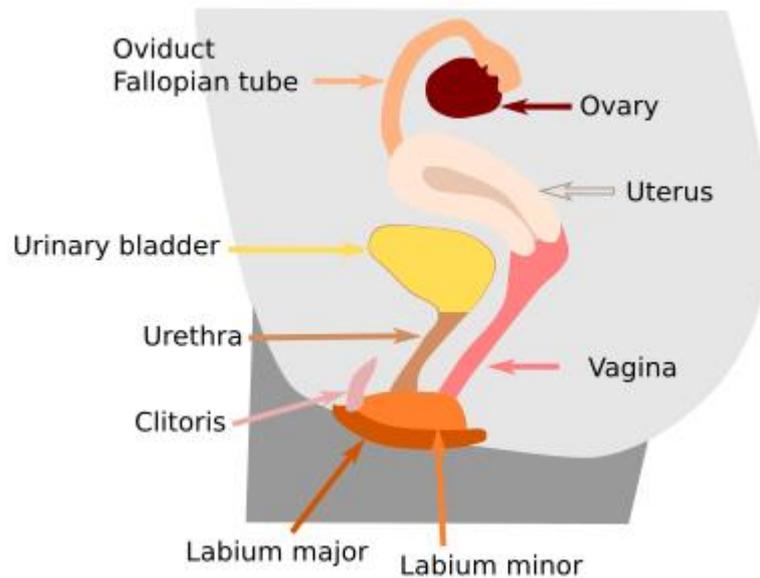


Figure 1. Drawing of the female reproductive system of humans.

2. Fallopian Tubes / Oviducts

- A pair of ducts that:
 - Transport **oocytes** from the ovaries to the uterus.
 - Serve as the **site of fertilization**.
 - Facilitate movement of **sperm** toward the oocyte.
 - Move the **fertilized ovum** to the uterine cavity.

3. Uterus

A hollow, **pear-shaped muscular organ** responsible for:

- **Implantation** of the fertilized ovum.
- **Nourishment and growth** of the embryo/fetus during pregnancy.
- **Labor and childbirth**.

➤ Parts of the Uterus

1. **Fundus** – Dome-shaped area above the uterine tube openings.
2. **Body** – Main portion that contains the uterine cavity.
3. **Cervix** – Lower, cylindrical portion that projects into the vagina.

➤ Wall of the Uterus

1. **Perimetrium** (Outer layer): Composed of peritoneum.
2. **Myometrium** (Middle layer): Thick, smooth muscle layer.
 - Highly vascular and composed of fibers running in multiple directions.

- Undergoes **hypertrophy** and **hyperplasia** during pregnancy.
- 3. **Endometrium** (Inner mucosal layer): Undergoes cyclical changes known as the **menstrual cycle**.

➤ **Structure of the Endometrium**

- **Epithelium**: Simple columnar lining.
- **Stroma**: Connective tissue between epithelium and myometrium.
- **Uterine (endometrial) glands**: Simple tubular glands that secrete mucus and support embryo implantation.

2.4. Vagina

- A muscular, **intromittent organ** that:
 - Receives the **penis** during copulation.
 - Acts as a **passageway for sperm**.
 - Serves as the **birth canal** during childbirth.

3. External genitalia

The vulva is the external female reproductive organ. It includes the mons pubis, labia major, labia minor, clitoris, and the vulva vestibule. **Mons pubis** is a rounded elevation produced by subcutaneous adipose tissue. **Labia** are cutaneous folds with sweat and sebaceous glands. The external labia (labia major) have hair follicles and smooth muscle. **Clitoris** is an erectile structure homologous to the penis, with cavernous bodies and a clitoral glans (hood). **The vulvar vestibulus** is covered by stratified squamous epithelium with many small mucous glands and other more complex tubule-alveolar glands that release their content into the vaginal opening. These glands lubricate the external part of the female external organ. The external genitalia contain many touch and pressure sensory receptors, like Meissner corpuscles, Pacini corpuscles, and free-ending axons.

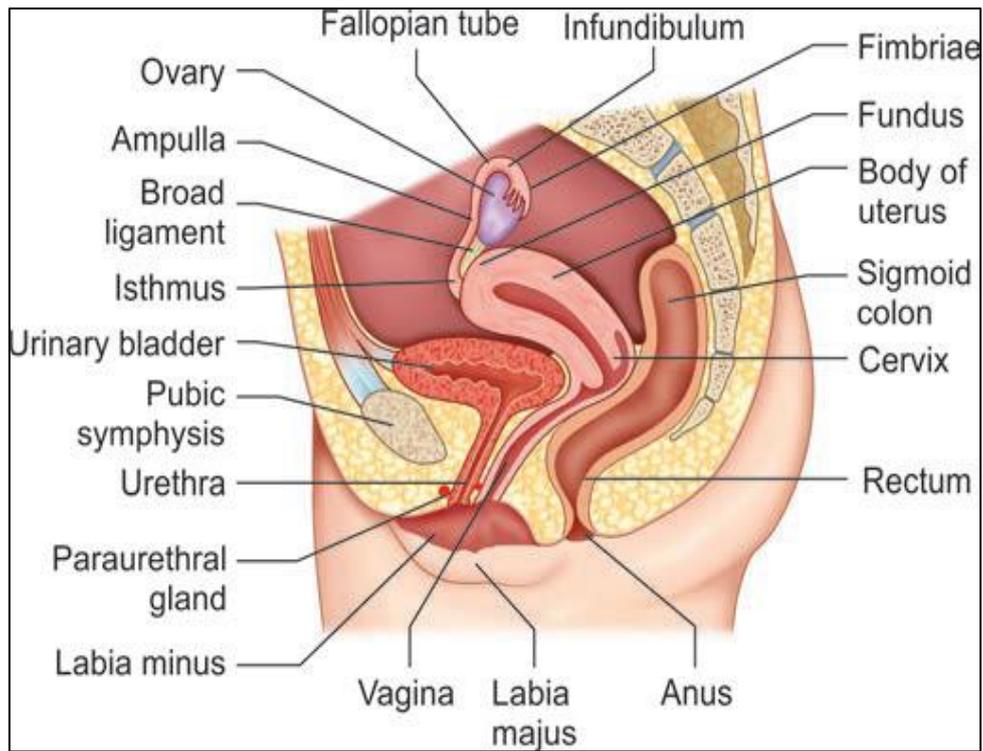


Fig. 5: Female reproductive system

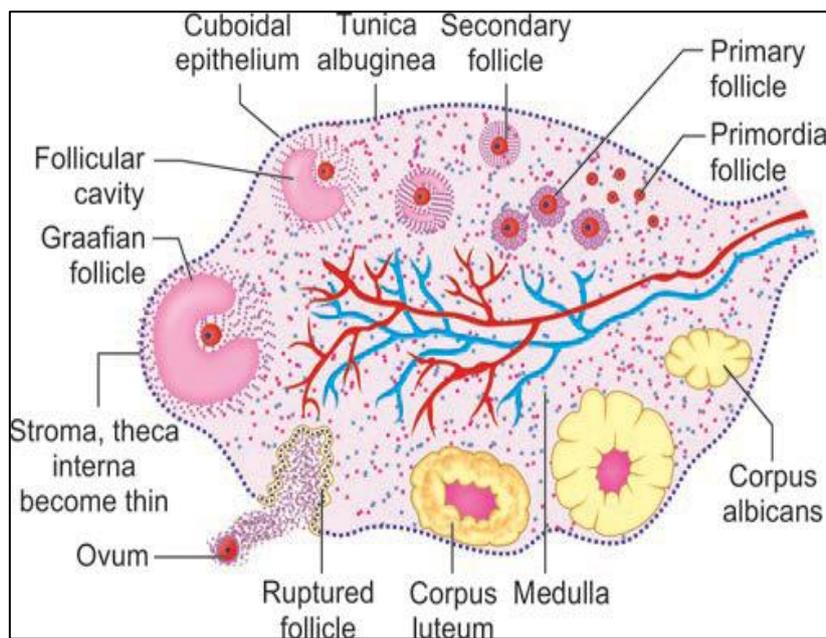


Fig. 6: Cut-section of ovary showing various stages of development of ovarian follicles, ovulation and degenerating corpus luteum