

- **Sertoli cells:** Provide structural and metabolic support.

3. Duct System

Connects the testes to the exterior, facilitating sperm maturation, storage, and transport.

- **Epididymis:**
 - Stores and matures sperm.
 - Receives sperm from efferent ductules.
- **Vas deferens:**
 - Transports sperm from epididymis to ejaculatory duct.
- **Ejaculatory ducts:**
 - Formed by the union of vas deferens and seminal vesicle duct.
 - Opens into the urethra inside the prostate.
- **Urethra:**
 - Common passage for urine and semen through the penis.

4. Accessory Sex Glands

These glands secrete fluids that form part of semen, nourishing and transporting sperm.

1. **Seminal Vesicles**
 2. **Prostate Gland**
 3. **Bulbourethral (Cowper's) Glands**
- Their secretions mix with sperm and create **semen**.
 - **Semen:** A mixture of spermatozoa and glandular secretions.
 - Smooth muscle contractions during ejaculation help expel semen.

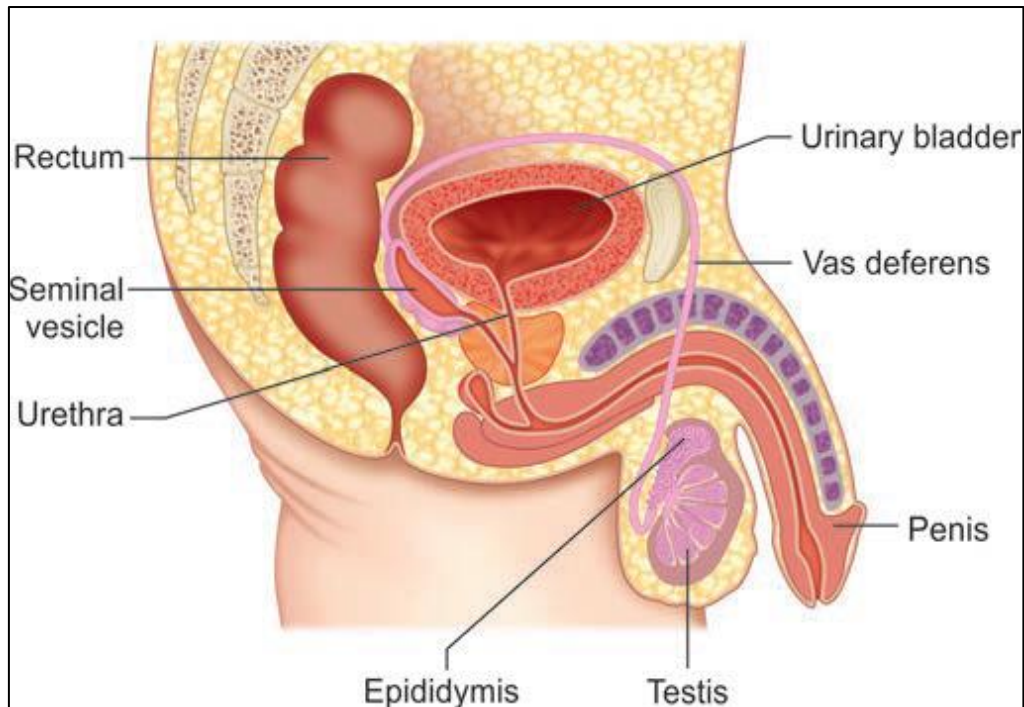


Fig. 2: Male reproductive system

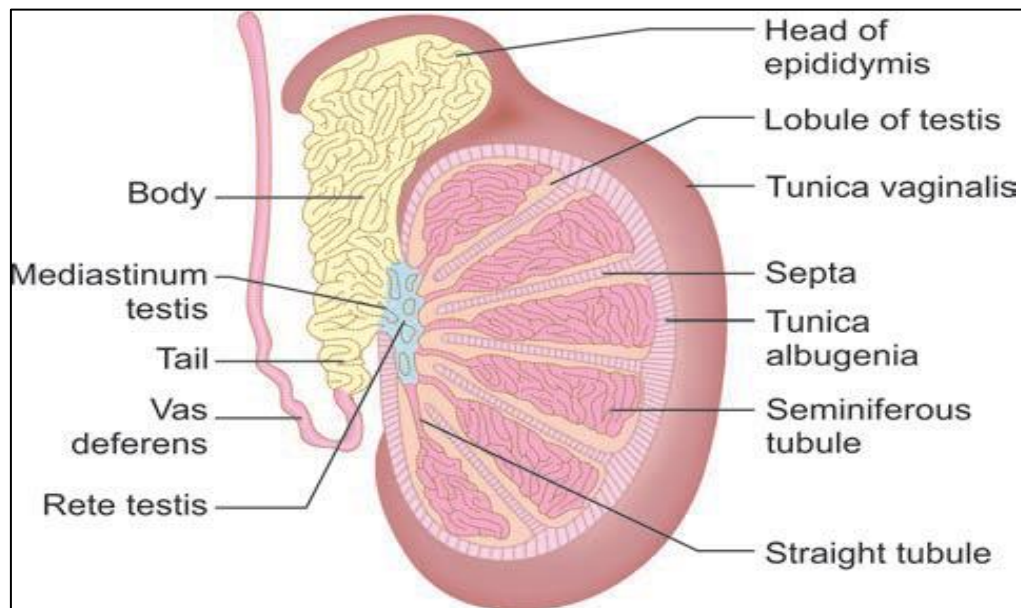
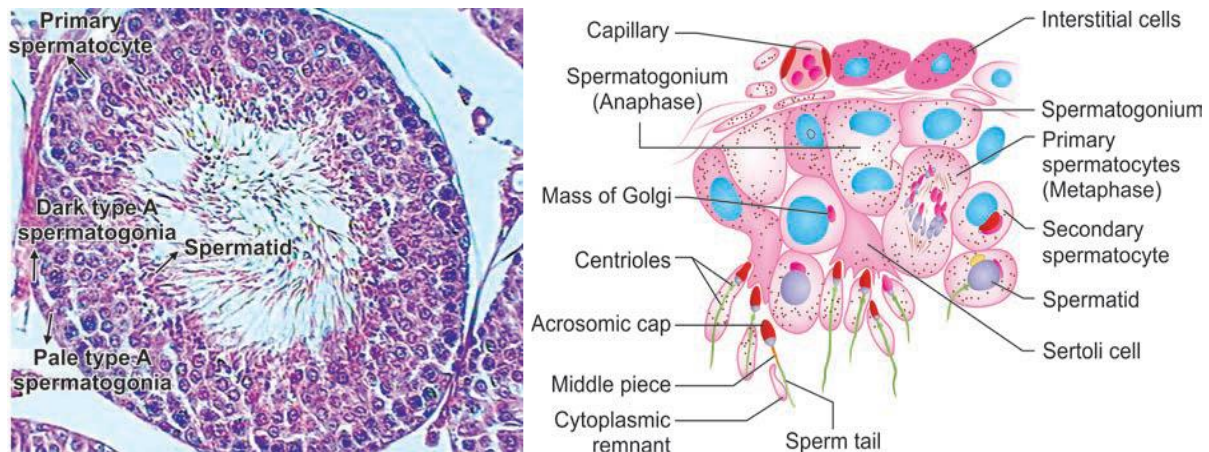


Fig. 3: Vertical section of testis, epididymis and vas deferens



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

1.2. Female Reproductive System

The female reproductive system is responsible for producing female gametes (oocytes), supporting fertilization, and enabling pregnancy and childbirth. It consists of **external** and **internal** genital organs (**Fig. 4**).

1. External Genital Organs (Vulva)

The external genitalia, collectively called the **vulva**, include structures such as:

- **Mons pubis**
- **Labia majora and minora**
- **Clitoris**
- **Vestibule of the vagina**
- **External openings of the urethra and vagina**

These structures protect internal organs, assist in sexual intercourse, and provide sensory input.

2. Internal Genital Organs

2.1. 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.

➤ **Important Processes**

- **Oogenesis:** Formation of female gametes (oocytes).
- **Folliculogenesis:** Development of ovarian follicles.
- Ovarian morphology varies across life stages: **prenatal, prepubertal, reproductive**, and **menopausal**.

2.2. Uterine (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.

2.3. 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.

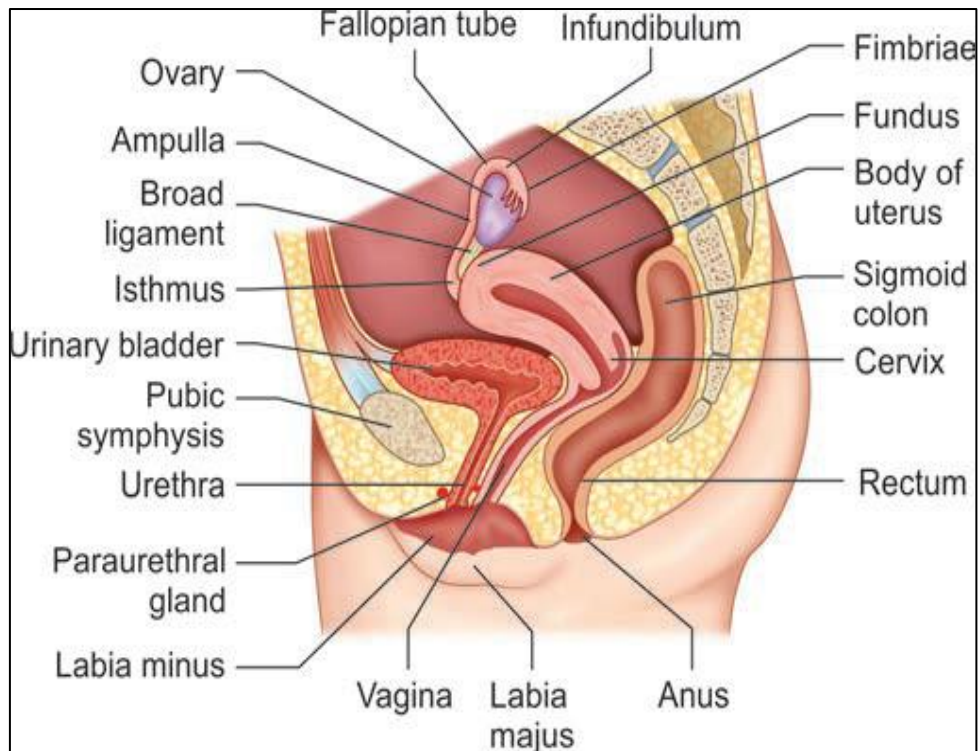


Fig. 5: Female reproductive system

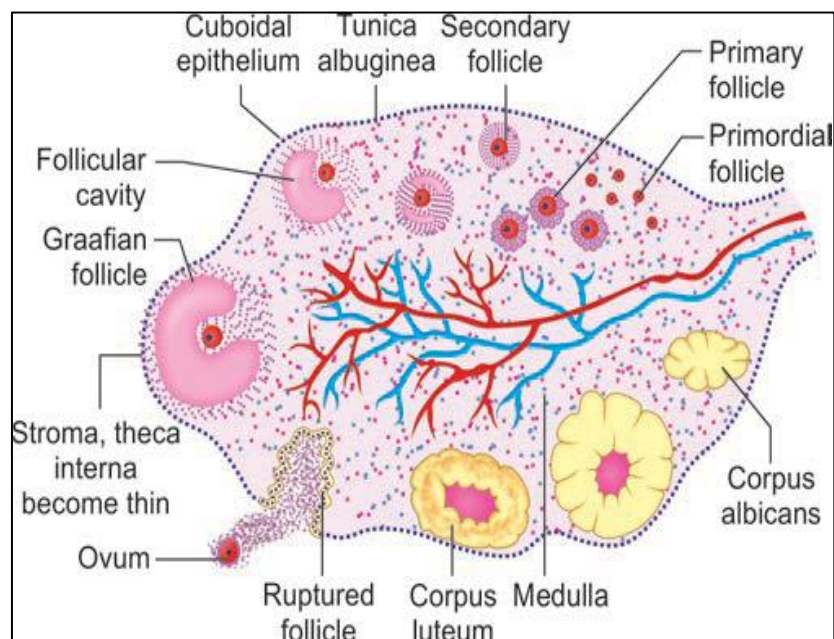


Fig. 6: Cut-section of ovary showing various stages of development of ovarian follicles, ovulation and degenerating corpus luteum

2. Process of Gametogenesis

1. Definition

Gametogenesis is the biological process through which **gametes (sex cells)** are formed. It involves the **conversion of primordial germ cells (PGCs)** into mature **male gametes (spermatozoa)** and **female gametes (ova)**.

2. Origin of Gametes

- **Gametes** are derived from **primordial germ cells (PGCs)**, also called **primitive sex cells**.
- PGCs **appear in the wall of the yolk sac** around the **4th week** of embryonic development.
- During the **5th week**, PGCs **migrate** from the yolk sac to the **developing gonads**, originating from:
 - **Coelomic epithelium**
 - **Adjacent mesenchyme**
- While migrating, PGCs undergo **mitotic division**, increasing their number.

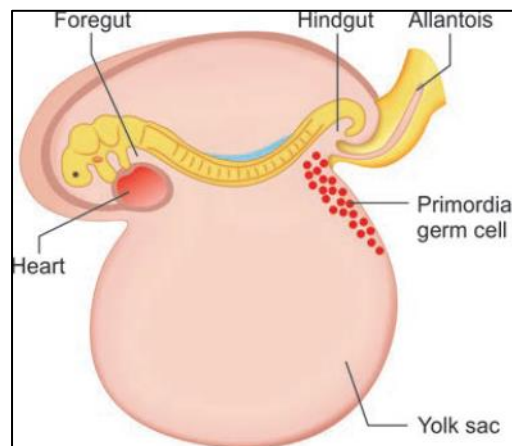


Fig. 7: Migrating primordial germ cells at the caudal end of yolk sac

3. Gonadal Differentiation

- Occurs during the **6th week** of development.

- Once in the gonads, PGCs differentiate into:
 - **Spermatogonia** in males – within the **seminiferous tubules** of the **testis**.
 - **Oogonia** in females – within the **cortex** of the **ovary**.

4. Phases of Gametogenesis

The process involves four key events:

1. **Formation and migration** of PGCs and their differentiation into male or female sex cells.
2. **Mitotic divisions** of germ cells to increase their population.
3. **Meiotic divisions** that reduce the **chromosome number (diploid → haploid)**.
4. **Differentiation and maturation** of germ cells into functional gametes.

❖ *Note:* Phases 1 and 2 are **similar in both sexes**, whereas **Phases 3 and 4** differ in **timing and pattern** between males and females.

5. Table 1: Types of Gametogenesis:

Type	Description	Location
Spermatogenesis	Formation of spermatozoa from spermatogonia	Seminiferous tubules of testis
Oogenesis	Formation of ova from oogonia	Cortex of the ovary

6. Table 2: Differences between Spermatogenesis and Oogenesis

Feature	Spermatogenesis	Oogenesis
Location	Seminiferous tubules of testis	Cortex of the ovary
Onset	Begins at puberty	Begins during fetal development
Continuity	Continuous throughout life	Discontinuous, arrested at certain stages
Gametes per cycle	Millions of sperm produced daily	Usually one ovum released per cycle
Duration	~64 days (human males)	Can span decades (from fetal life to menopause)

2.1. Spermatogenesis

1. Definition

Spermatogenesis is the process of **maturation of male gametes** (spermatozoa) that occurs in the **wall of seminiferous tubules** of the testes. It involves a sequence of developmental changes through which **spermatogonia** are transformed into **mature, motile spermatozoa**.

➤ General Overview

- **Time of Onset:** Begins at **puberty** (approximately 12–16 years of age)
- **Duration of Process:** Approximately **64–74 days**
- **Site:** **Seminiferous tubules** of the **testis**

2. Stages of Spermatogenesis

Spermatogenesis occurs in **three major stages**, each with specific processes and cellular changes:

2.1. Spermatocytosis

Duration: ~16 days

Definition: Conversion of **spermatogonia** into **primary spermatocytes** through **mitotic divisions**.

➤ Key Events:

- **Formation of Spermatogonial Stem Cells** from primordial germ cells (PGCs)
- **Type A Spermatogonia:** Formed by mitosis from stem cells; act as reserve cells
- **Type B Spermatogonia:** Paler cells derived from Type A, undergo final mitosis
- Type B spermatogonia enlarge to become **Primary Spermatocytes** ($44 + X + Y$)

2.2. Meiotic Divisions

Duration: ~24 days

Definition: Conversion of **primary spermatocytes** into **spermatids** via **two meiotic divisions**.

➤ First Meiotic Division (Reduction Division):

- **Primary spermatocytes** ($44 + X + Y$) → **2 Secondary spermatocytes** ($22 + X$ or $22 + Y$)
- **Second Meiotic Division (Equational Division):**
 - Each **secondary spermatocyte** → **2 Spermatids** (haploid: $22 + X$ or $22 + Y$)
 - Total: One primary spermatocyte produces **4 spermatids**

2.3. Spermiogenesis (a.k.a. Spermateleosis)

Duration: ~24 days

Definition: The **metamorphosis of spermatids into spermatozoa**, involving morphological and structural transformation.

Table 3: Cellular Events of Spermiogenesis

Component	Transformation During Spermiogenesis
Nucleus	Condenses and moves to one pole to form the head
Golgi Apparatus	Forms the acrosomal cap that covers the anterior 2/3 of the nucleus
Centrioles	Divide into proximal (forms part of neck) and distal centrioles (forms annulus); involved in axoneme (tail) formation
Mitochondria	Arrange helically around the axoneme in the middle piece to form the mitochondrial sheath for energy
Cytoplasm	Excess cytoplasm is shed as residual bodies of Renaud , which are phagocytosed by Sertoli cells
Cell Membrane	• Remains as a protective envelope; contains specializations essential for: • Sperm-egg recognition • Sperm-egg binding • Sperm-egg fusion

- **Summary of Major Events in Spermiogenesis**
 1. **Nuclear morphogenesis and condensation**
 2. **Acrosome formation** from Golgi complex

3. **Tail formation** from centrioles and flagellar development
4. **Organelle rearrangement** (especially mitochondria around the tail)
5. **Shedding of excess cytoplasm**

➤ **Microscopic View**

- A seminiferous tubule shows cells at various developmental stages:
 - **Spermatogonia**
 - **Primary and secondary spermatocytes**
 - **Spermatids**
 - **Spermatozoa**
 - **Sertoli cells** (supporting cells)

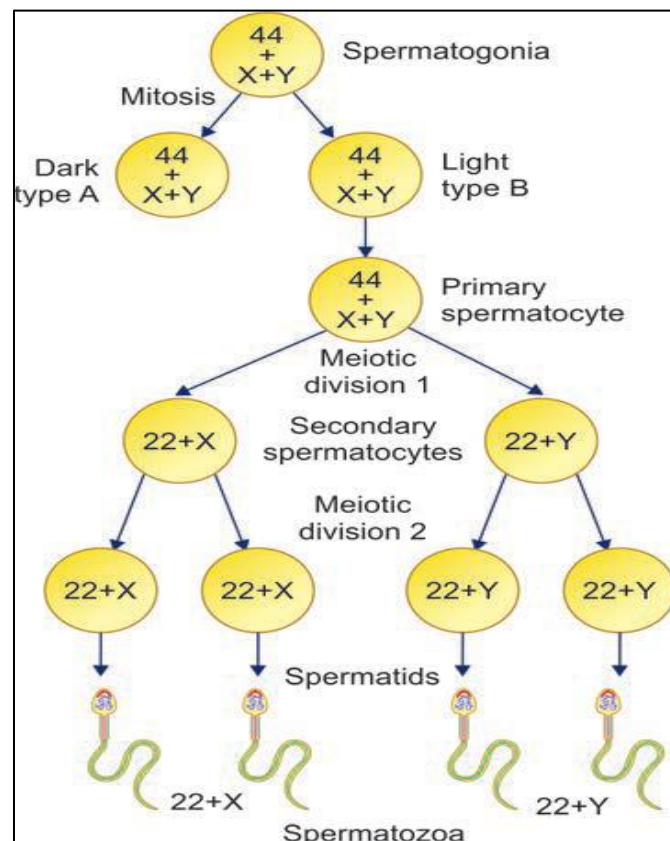


Fig. 8: Stages in spermatogenesis. Note the number of chromosomes at each stage