

CUET (UG) Biology Notes: Human Reproduction

1. Male Reproductive System & Anatomy of Testis

The male reproductive system is located in the pelvis region and includes a pair of testes, accessory ducts, glands, and external genitalia.

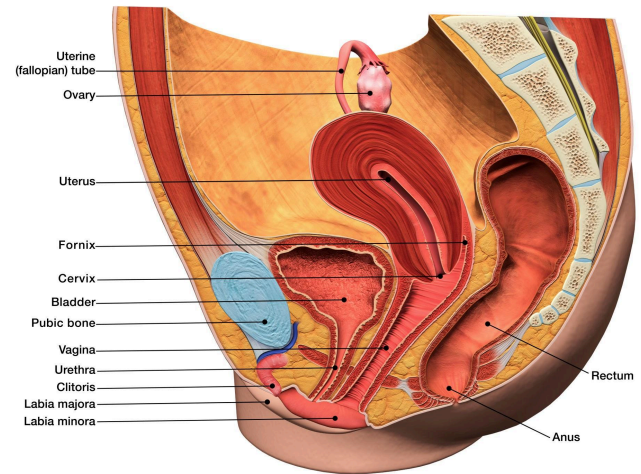
The Testes (Primary Sex Organs)

- **Location:** Situated outside the abdominal cavity within a pouch called the scrotum. This maintains the temperature of the testes $2 - 2.5^{\circ}\text{C}$ lower than normal internal body temperature, which is essential for spermatogenesis.
- **Structure:** Oval in shape. Each testis has about 250 compartments called testicular lobules.
- **Seminiferous Tubules:** Each lobule contains 1 to 3 highly coiled tubules where sperms are produced. The inside of the tubule is lined by two types of cells:
 1. Male Germ Cells (Spermatogonia): Undergo meiotic divisions to form sperms.
 2. Sertoli Cells: Provide nutrition to the germ cells.
- **Interstitial Space:** The region outside the seminiferous tubules contains blood vessels and Leydig cells (Interstitial cells), which synthesize and secrete testicular hormones called androgens (mainly testosterone).

Accessory Ducts & Glands

- **Duct System Pathway:** Seminiferous tubules \rightarrow Rete testis \rightarrow Vasa efferentia \rightarrow Epididymis \rightarrow Vas deferens \rightarrow Ejaculatory duct \rightarrow Urethra.
- **Accessory Glands:**
 - Paired Seminal vesicles
 - A single Prostate gland
 - Paired Bulbourethral glands (Cowper's glands) (secretions help in lubricating the penis).
- **Seminal Plasma:** The combined secretion of these glands, which is rich in fructose, calcium, and certain enzymes.

2. Female Reproductive System & Anatomy of Ovary



The Ovaries (Primary Sex Organs)

- **Function:** Produce the female gamete (ovum) and several steroid hormones (ovarian hormones).
- **Structure:** Solid organs covered by a thin epithelium enclosing the ovarian stroma. The stroma is divided into a peripheral cortex and an inner medulla.

Accessory Ducts (Fallopian Tubes, Uterus, Vagina)

- **Oviducts (Fallopian Tubes):** About 10-12 cm long.
 1. Infundibulum: Funnel-shaped part closer to the ovary; edges have finger-like projections (fimbriae) to collect the ovum after ovulation.
 2. Ampulla: The wider part of the oviduct. This is the site of fertilisation.
 3. Isthmus: The last part with a narrow lumen joining the uterus.
- **Uterus (Womb):** Shaped like an inverted pear. The uterine wall has three layers:
 1. Perimetrium: External thin membranous layer.
 2. Myometrium: Middle thick layer of smooth muscle (exhibits strong contraction during delivery).

3. Endometrium: Inner glandular layer (undergoes cyclical changes during the menstrual cycle).



Mammary Glands

- Consist of glandular tissue and variable amounts of fat.
- Glandular tissue is divided into 15-20 mammary lobes containing clusters of cells called alveoli (which secrete milk).
- Pathway: Alveoli \rightarrow Mammary tubules \rightarrow Mammary duct \rightarrow Mammary ampulla \rightarrow Lactiferous duct.

3. Gametogenesis

Feature	Spermatogenesis	Oogenesis
Site	Seminiferous tubules of the testes.	Ovaries.
Onset	Begins at puberty due to a significant increase in GnRH secretion.	Initiated during the embryonic development stage; millions of oogonia are formed within each fetal ovary. No more are formed after birth.

Multiplication Phase	Spermatogonia (2n) multiply by mitosis.	Oogonia (2n) multiply by mitosis to form primary oocytes.
Growth & Meiosis I	Primary spermatocytes (2n) undergo Meiosis I to form two equal, haploid Secondary spermatocytes (n).	Primary oocytes (2n) start Meiosis I but get arrested at Prophase I. At puberty, Meiosis I completes to form a large Secondary oocyte (n) and a tiny First polar body (n).
Meiosis II	Secondary spermatocytes undergo Meiosis II to form four equal, haploid Spermatids (n).	The secondary oocyte completes Meiosis II only upon entry of a sperm, forming an Ovum (n) and a Second polar body.
Transformation	Spermatids transform into spermatozoa (sperms) via spermiogenesis. Release of sperms is called spermiation.	No transformation phase; the ovum is directly functional.

Structure of a Sperm

- Head: Contains an elongated haploid nucleus. The anterior portion is covered by a cap-like structure, the acrosome, filled with enzymes that help in fertilisation.
- Middle Piece: Possesses numerous mitochondria, providing energy for tail movement.
- Tail: Facilitates sperm motility essential for fertilisation.

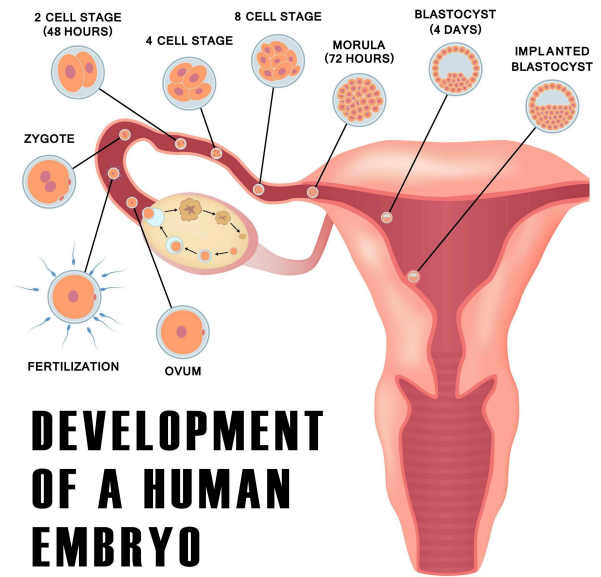
4. Menstrual Cycle

The reproductive cycle in female primates. The average duration is 28/29 days.

Phase	Days (Approx.)	Key Events & Hormonal Changes

1. Menstrual Phase	1 - 5	Breakdown of endometrial lining and its blood vessels, resulting in bleeding. Occurs if the released ovum is not fertilised. Fall in progesterone and estrogen.
2. Follicular (Proliferative) Phase	6 - 13	Primary follicles grow to become fully mature Graafian follicles. Endometrium regenerates through proliferation. LH and FSH gradually increase, stimulating follicle development and estrogen secretion.
3. Ovulatory Phase	14	Both LH and FSH attain a peak level. Rapid secretion of LH (LH Surge) induces the rupture of the Graafian follicle, releasing the ovum (Ovulation).
4. Luteal (Secretory) Phase	15 - 28	Ruptured follicle transforms into the Corpus Luteum. It secretes large amounts of Progesterone, which is essential for maintaining the endometrium for implantation.

rapidly divide and cover the blastocyst, embedding it in the uterus.



5. Fertilisation & Embryo Development

- **Fertilisation:** The fusion of a sperm with an ovum. Takes place in the ampullary region of the fallopian tube. The acrosomal secretions help the sperm enter the cytoplasm of the ovum through the zona pellucida.
- **Cleavage:** The zygote undergoes rapid mitotic divisions (cleavage) as it moves through the isthmus toward the uterus, forming 2, 4, 8, 16 daughter cells called blastomeres.
- **Morula:** The embryo with 8 to 16 blastomeres (looks like a mulberry).
- **Blastocyst:** The morula continues dividing and transforms into a blastocyst. The blastomeres arrange into an outer layer called the trophoblast and an inner group of cells attached to the trophoblast called the inner cell mass.
- **Implantation:** The trophoblast attaches to the endometrium, and the inner cell mass differentiates into the embryo. The uterine cells



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6. Pregnancy, Placenta, Parturition & Lactation

The Placenta

- After implantation, finger-like projections called chorionic villi appear on the trophoblast. They interdigitate with uterine tissue to form the placenta.
- **Functions:** Facilitates supply of oxygen and nutrients to the embryo and removal of carbon dioxide and excretory materials.

- **Endocrine Role:** The placenta acts as an endocrine tissue, producing:
 - Human chorionic gonadotropin (hCG)
 - Human placental lactogen (hPL)
 - Estrogens and progestogens.
 - (Note: Relaxin is secreted by the ovary in the later phases of pregnancy).

Embryonic Development Milestones

- 1st Month: Embryo's heart is formed.
- 2nd Month: Fetus develops limbs and digits.
- 3rd Month (First Trimester): Most major organ systems are formed (e.g., limbs, external genital organs).
- 5th Month: First movements of the fetus and appearance of hair on the head.
- 6th Month (Second Trimester): Body covered with fine hair, eyelids separate, eyelashes are formed.

Parturition & Lactation

- **Parturition (Childbirth):** A complex neuroendocrine mechanism. Signals arise from the fully developed fetus and the placenta, inducing mild uterine contractions called the fetal ejection reflex. This triggers the release of oxytocin from the maternal pituitary, causing stronger uterine contractions leading to expulsion of the baby.
- **Lactation:** The mammary glands undergo differentiation during pregnancy and start producing milk. The milk produced during the initial few days is called colostrum, which is absolutely essential for the newborn because it contains abundant antibodies (IgA) to provide passive immunity.