- Human Reproductive System
- Gametogenesis and Menstrual Cycle
- Fertilisation and Pregnancy
- Quick Reference Table
- Common Mistakes and Misconceptions
- Glossary

Human Reproductive System

Structure of Male Reproductive System

Humans have separate male and female reproductive systems. The male reproductive system includes a pair of testes, accessory ducts, accessory glands, and external genitalia. Testes are oval-shaped organs located outside the abdominal cavity within the scrotum, which maintains a temperature 2-2.5□6C lower than the body to facilitate spermatogenesis. Each testis contains about 250 lobules filled with seminiferous tubules where sperm are produced. Spermatogenic cells called spermatogonia undergo meiosis to form sperm, supported by Sertoli cells that provide nourishment. Leydig cells in the interstitial spaces secrete testosterone, the primary male sex hormone.

Structure of Female Reproductive System

The female reproductive system consists of a pair of ovaries, accessory ducts, and external genitalia. Ovaries produce ova and secrete hormones like oestrogen and progesterone. Accessory ducts include fallopian tubes (oviducts), uterus, cervix, and vagina. The uterus is a hollow muscular organ with three layers: perimetrium (outer), myometrium (middle muscular), and endometrium (inner lining). The endometrium undergoes cyclic changes during the menstrual cycle. External genitalia, collectively

called the vulva, include mons pubis, labia majora, labia minora, hymen, and clitoris. Mammary glands in the chest produce milk for newborns.

Solved Examples

Example 1: Describe the role of Sertoli cells in the male reproductive system.
Solution: Sertoli cells, also called nurse cells, are located inside the seminiferous tubules. They provide structural support and nourishment to developing spermatogenic cells during spermatogenesis. They also help in the release of mature spermatozoa into the lumen of the tubules.

Example 2: Explain the structure and function of the uterus.
Solution: The uterus is an inverted pear-shaped muscular organ supported by ligaments. It has three layers: perimetrium (outer protective layer), myometrium (thick muscular middle layer responsible for contractions during childbirth), and endometrium (inner glandular layer that thickens during the menstrual cycle to support embryo implantation). The uterus opens into the vagina through the cervix, which forms the birth canal.

Practice Set

Conceptual Questions

- **Level 1:** What is the function of Leydig cells in the testes?
- **Level 2:** Describe the role of the endometrium during the menstrual cycle.

Application-based Question

- **Level 3:** A male patient has low testosterone levels. Explain how this might affect spermatogenesis and secondary sexual characteristics.

Answer Key

Conceptual Questions

- **Level 1:** Leydig cells produce testosterone, which stimulates spermatogenesis and development of male secondary sexual characteristics.
- **Level 2:** The endometrium thickens during the menstrual cycle to prepare for implantation of a fertilized ovum. If fertilization does not occur, it sheds during menstruation.

Application-based Question

- **Level 3:** Low testosterone would reduce stimulation of spermatogenesis, leading to decreased sperm production. It would also impair development of male secondary sexual characteristics such as facial hair and deepening of voice.

Gametogenesis and Menstrual Cycle

Gametogenesis

Gametogenesis is the process of formation of gametes (sex cells). It includes spermatogenesis in males and oogenesis in females. Spermatogenesis occurs in the seminiferous tubules of testes and produces four sperm cells from each spermatogonium through meiosis. Oogenesis occurs in the ovaries and produces one ovum and polar bodies from each oogonium.

Structure of Sperm

A mature sperm is about 60 □m long and consists of four parts: head, neck, middle piece, and tail. The head contains the nucleus and acrosome, which has enzymes to penetrate

the ovum. The neck contains centrioles. The middle piece has mitochondria that provide energy for motility. The tail propels the sperm forward.

Structure of Ovum

The ovum is a large, non-motile female gamete about 0.2 mm in diameter. It has four membranes: plasma membrane (oolemma), vitelline membrane, zona pellucida (a thick glycoprotein layer), and corona radiata (outer layer of follicle cells). The ovum is rich in cytoplasm and contains a nucleus.

Menstrual Cycle

The menstrual cycle is a roughly 28-day cycle in females involving changes in the ovary and uterus. It has four phases: menstrual phase (shedding of endometrium), follicular phase (growth of follicles and endometrium), ovulation (release of ovum), and luteal phase (formation of corpus luteum and secretion of progesterone). Hormones like FSH, LH, estrogen, and progesterone regulate these phases. Menstruation occurs if fertilization does not happen.

Solved Examples

Example 1: How many sperm cells are produced from one primary spermatocyte?
Solution: One primary spermatocyte undergoes meiosis I to form two secondary spermatocytes, each undergoes meiosis II to form two spermatids, totaling four spermatids. These mature into four sperm cells.

Example 2: What triggers ovulation during the menstrual cycle?
Solution: A surge in luteinising hormone (LH) around day 14 triggers the rupture of the mature Graafian follicle and release of the secondary oocyte (ovum).

Practice Set

Conceptual Questions

- **Level 1:** Define spermatogenesis.
- **Level 2:** What is the role of FSH in the menstrual cycle?

Application-based Question

- **Level 3:** Explain why only one ovum is produced from each primary oocyte during oogenesis.

Answer Key

Conceptual Questions

- **Level 1:** Spermatogenesis is the process of formation of sperm cells in the testes through meiosis and differentiation.
- **Level 2:** FSH stimulates the growth of ovarian follicles and secretion of estrogen during the follicular phase.

Application-based Question

- **Level 3:** During oogenesis, the cytoplasm divides unequally during meiosis, producing one large ovum with most cytoplasm and smaller polar bodies that degenerate. This ensures the ovum has sufficient nutrients for early development.

Fertilisation and Pregnancy

Fertilisation

Fertilisation is the fusion of male (sperm) and female (ovum) gametes to form a zygote. It occurs in the ampullary-isthmic junction of the fallopian tube. After insemination, sperms swim through the cervix and uterus to reach the ovum. The acrosome enzymes help the sperm penetrate the zona pellucida of the ovum. The sperm and ovum nuclei fuse to form a diploid zygote.

Implantation

The zygote undergoes mitotic divisions (cleavage) forming blastomeres and develops into a blastocyst. The blastocyst attaches to the endometrium of the uterus in a process called implantation. The trophoblast layer of the blastocyst forms the placenta, and the inner cell mass develops into the embryo.

Pregnancy and Placenta

Pregnancy lasts about nine months. The placenta is a functional unit between mother and fetus, allowing exchange of nutrients, gases, and wastes. It also secretes hormones like human chorionic gonadotropin (hCG), human placental lactogen (hPL), estrogen, progesterone, and relaxin. The umbilical cord connects the fetus to the placenta.

Parturition and Lactation

Parturition is the process of childbirth, initiated by signals from the fetus and placenta that stimulate uterine contractions via oxytocin release. After birth, the placenta and umbilical cord are expelled. Lactation is milk production by mammary glands, starting with colostrum rich in antibodies to protect the newborn.

Solved Examples

Example 1: Where does fertilisation occur in the female reproductive tract?
Solution: Fertilisation occurs at the ampullary-isthmic junction of the fallopian tube.

Example 2: What is the role of the placenta during pregnancy?
Solution: The placenta facilitates exchange of nutrients, oxygen, and waste between mother and fetus, acts as a barrier, and secretes hormones to maintain pregnancy.

Practice Set

Conceptual Questions

- **Level 1:** Define implantation.
- **Level 2:** Name two hormones secreted by the placenta.

Application-based Question

- **Level 3:** Explain how oxytocin contributes to the process of parturition.

Answer Key

Conceptual Questions

- **Level 1:** Implantation is the attachment and embedding of the blastocyst into the endometrium of the uterus.
- **Level 2:** The placenta secretes human chorionic gonadotropin (hCG) and progesterone among other hormones.

Application-based Question

- **Level 3:** Oxytocin stimulates uterine muscle contractions, which help expel the baby during labor. These contractions also stimulate further oxytocin release, creating a positive feedback loop until delivery.

Quick Reference Table

Common Mistakes and Misconceptions

Glossary