HUMAN REPRODUCTION

Humans are sexually reproducing viviparous organisms, i.e. give birth to young ones. They are unisexual organisms, i.e. male and female sexes are separate.

1. Human Reproductive Organs

These organs are divided into primary sex organs and secondary sex organs. Primary sex organs produce gametes and sex hormones while secondary sex organs play an important role in reproduction.

2. Male Reproductive System

It is located in the pelvis region. It consists of following organs

A. **Primary Sex Organs**Testes are the primary sex organs in men.

(i) **Testes** are the site where formation of male gametes or sperms takes place. These are suspended in the scrotum by spermatic cords. Each testis is divided into 200-300 compartments called testicular lobules. Each lobule contains 1-3 convoluted seminiferous tubules, blood vessels and nerves.

(ii) **Scrotum** is a pouch of deeply pigmented skin arising from the lower abdominal wall present between legs. It keeps the temperature of testes about 2-2.5°C lower than the internal body temperature, which is essential for sperm production, i.e. spermatogenesis. It remains connected with abdomen or pelvic cavity by inguinal canals.

(iii) **Seminiferoustubule** is the structural and functional unit of testis consisting of two specialised cells. They are as follows

(a) **Sertoli cells** (nurse cells) are pyramidal cells which provide nutrition to germinal cells.

(b) **Male germcells** produce spermatogonia by mitotic division which grow into primary spermatocytes. Region outside the seminiferous tubules called **interstitial spaces** contain blood vessels and **Leydig cells** (Interstitial cells). These cells secrete hormones called **androgens**.

B. Secondary sex organs consist of the following organs

(i) **The tubuli recti** are straight tubules which join at the end of seminiferous tubules. These open into a network of wider irregular tubules called rete testis which opens in vasa efferentia. It opens into epididymis and carry sperms outside the body.

(ii) **Epididymis** is a mass of long narrow closely coiled tubules lying along the innerside of each testis. It temporarily stores immature sperms. It helps the sperms in attaining maturity, acquiring increased motility and fertilising capacity.

(iii) **Vasa deferentia** emerges from cauda epididymis on each side, leaves the scrotal sac and enters the abdominal cavity through inguinal canal.

(iv) **Ejaculatory ducts** are two short tubes each formed by the union of the duct from a seminal vesicle and a vas deferens.

(v) **Urethra** provides a common pathway for the flow of urine and semen.

C. Male accessory glandsare of two types. These are described below

(i) Prostate gland is a single large gland that surrounds the urethra. It secretes a slightly acidic, milky secretion with pH 6.5 which forms 20-30% of semen volume. The secretion contains lipids, enzymes, citric acid, etc.

(ii) Seminal vesicles are paired tubular glands, secreting mucus and a watery alkaline fluid that contain fructose (acts as an energy source for sperms). It accounts for 60% of semen volume. Prostaglandins in secretion stimulate uterine contractions for sperm movement.

(iii) Bulbourethral or Cowper's gland secretes mucus and alkaline fluid into urethra. The mucus helps in lubrication of penis and neutralises urinary acids present in urethra.

D. External genitaliaconsists of penis. It is the male copulatory organ.

3. Female Reproductive System

It is located in the pelvic cavity. It consists of following organs

A. **Primary sex organs**Ovaries are primary sex organs in women.

(i) **Ovaries** produce female gametes (ovum) and several female hormones, i.e. ovarian hormones. The broad ligament of uterus attaches ovaries by double-layered fold of peritoneum called mesovarium.

(ii) These are covered by cubical epithelium, i.e. **germinal epithelium**. These cubical epithelium enclose ovarian stroma and it is divided into two zones, i.e. peripheral cortex and inner medulla.

B. **Secondary sex organs**constitute following organs

(i) **Fallopian tubes** (oviducts) are 10-12 cm long and consist of

(a) **Infundibulum** is broad and funnel-shaped with its motile and finger-like projections called fimbriae.

(b) **Ampulla** the widest and longest part of Fallopian tube.

(c) **Isthmus** a short , narrow and thick-walled portion that follows ampulla.
(d) **Uterine part** passes through uterine wall and communicates with uterine cavity.

(ii) **Uterus** is 7.5 cm long and 5 cm wide. It is like an inverted pear in shape. It lies between urinary bladder and rectum. It receives ovum from the Fallopian tube and forms placenta for the development of foetus. The cervix is a narrow opening of uterus into vagina.

(iii) **Vagina** is about 10 cm long. It is adapted for receiving male's penis during copulation, for allowing menstrual flow and for serving as a birth canal during parturition.

C. **Accessory glands**contain a pair of **Bartholin's gland**. It occurs on each side of vaginal orifice. These correspond to Cowper's gland of the male and secrete a clear and viscous fluid under sexual excitement. It serves as a lubrication during copulation.

D. **Mammary glands**are paired structures, i.e. breast in females. Breasts are rounded paired structures located over the pectoral muscles on the front wall of thorax.

- The glandular tissue of each breast is divided into 15-20 mammary lobes containing clusters of mammary alveoli, which open into mammary tubules.
- Each breast contains a nipple in its middle, which is surrounded by circular and pigmented area called areola.

E. **External genitalia**are collectively known as vulva which consists of Mons pubis, clitoris and hymen.

4. Gametogenesis

It is the process of formation of haploid gametes from the undifferentiated diploid germ cells in the gonads for sexual reproduction. It is of two types, i.e. spermatogenesis in males and oogenesis in females.

A. **Spermatogenesis** is formation of spermatozoa (sperms) in testes which originate from Primordial Germ Cells (PGCs). It includes following stages

(i) **Multiplication Phase** In this phase, the undifferentiated germ cells present on the inner wall of seminiferous tubules of the testes increase in number by repeated mitotic divisions.

(ii) **Growth Phase** In this phase, some of the spermatogonia differentiate into primary spermatocytes.

(iii) **Maturation Phase** Each of these primary spermatocytes undergoes first meiotic division and produces two secondary spermatocytes (23 chromosomes) each. They further undergo second meiotic division to produce haploid spermatids. The spermatids transform into spermatozoa (sperms) by the process of spermiogenesis.

(iv) **Differentiation Phase** After spermiogenesis, sperms get embedded in Sertoli cells and are finally released from the seminiferous tubules by spermiation.

Note

• Structure of Sperm A mature spermatozoa (sperm) is microscopic and tadpole-shaped, about 2-5 µm in diameter and 6 µm long. It consists of head, neck, middle piece and a tail.

• A cap-like structure called acrosome is present over the head of sperm. It contains hydrolytic enzymes that help in sperm penetration during fertilisation.

B. **Oogenesis** is the process of formation of a mature female gamete. The production of eggs in females begins before birth, i.e. during embryonic development stage but is completed only after fertilisation. The following phases complete the process

(i) **Multiplication Phase** Cells of germinal epithelium undergo mitotic division producing undifferentiated germ cells called oogonia or egg mother cells. They get temporarily arrested at prophase-I of meiotic division. These cells (at this stage) are called primary oocytes.

(ii) **Growth Phase** Each primary oocyte when gets surrounded by a single layer of granulosa cells is called primary follicle. At puberty stage, 60,000-80,000 primary

follicles are left in each ovary. The primary follicles get surrounded by more layers of granulosa cells and new theca to form secondary **follicles**.

(iii) **Maturation Phase** During this phase, the secondary follicle transforms to tertiary follicle. These are characterised by a fluid cavity called antrum.

The primary oocyte within tertiary follicle grows in size and completes its meiotic division to produce two daughter nuclei, i.e. **secondary oocyte** (larger haploid cell) and **first polar body** (tiny cell). The tertiary follicle further changes into a mature follicle or Graafian follicle. The secondary oocyte forms a new membrane called zona pellucida around it and starts its second meiotic division but remains in metaphase-II till it enters into sperm. The release of the secondary oocyte from the ovary is called ovulation.

Structure of Ovum Human female produces non-motile and rounded cell called ovum. It is yolk-free, i.e. alecithal. It contains abundant cytoplasm called ooplasm with large nucleus called germinal vesicle.

5. Menstrual Cycle

It is the reproductive cycle in female primates, e.g. monkeys, apes and human beings. At puberty, the first menstruation begins and it is called menarche. In females, menstruation is repeated at an average interval of about 28/29 days. The cycle stops at 50 years of age and the stage is called menopause. The cycle consists of the following four phases

(i) **Menstrual** (Bleeding) Phase It lasts for 3-5 days. The unfertilised egg undergoes autolysis which reduces LH level and causes regression of corpus luteum. The endometrial lining of uterus breaks down due to the deficiency of progesterone. The blood vessels rupture causing bleeding through vagina.

(ii) **Proliferative** (Follicular) Phase It lasts for 14 days. The primary follicles in ovary grow to become fully mature Graafian follicles. The endometrium regenerates through proliferation. The changes in the ovary and uterus induce changes in FSH and oestrogen. The secretion of LH and FSH increases gradually during follicular phase.

(iii) **OvulatoryPhase** Both LH and FSH attain a peak in the middle of cycle (about 14th day). Rapid secretion of LH induces rupture of Graafian follicle and thereby release of ovum, i.e. ovulation.

(iv) **Luteal** (Secretory) Phase It lasts for about 10 days. The remaining parts of Graafian follicle transform into corpus luteum. It secretes large amounts of progesterone essential to maintain the endometrium.

6. Fertilisation

It takes place in the ampullary-isthmic junction of the Fallopian tube. The process of fusion of sperm with an ovum resulting in formation of zygote (2n) is called fertilisation.

7. Implantation

After fertilisation, meiotic division starts as zygote moves through the isthmus of the oviduct towards the uterus, forming 2, 4, 8, 16 daughter cells called blastomeres. This process is called cleavage. The embryo with 8-16 blastomeres forms morula (32 cells) which at later stage transforms into blastocyst. This process is known as blastulation. The outer layer arrangement of blastomeres in blastocyst is called trophoblast and inner group of cells is called inner cell mass. The blastocyst (64 cells) becomes embedded in endometrium of uterus. This is called implantation which leads to pregnancy.

8. Placenta

It is the structural and functional unit formed between mother and foetus. Its functions are as follows

- Provides nutrients and oxygen to the developing embryo.
- Removes CO_2 and waste material from the embryo.
- Acts as an endocrine tissue and produces several hormones like hCG, hPL, oestrogen, progesterone, etc.

9. Embryonic Development

Following changes take place in embryo after implantation. Inner cell mass of blastula differentiates into an outer layer called ectoderm and inner layer called endoderm. Mesoderm develops between these two layers.

Note • Kidney, heart, gonads and blood originate from mesodermal layer.

• These three layers give rise to tissues and organs. By the end of 9 months of pregnancy, the foetus becomes fully developed and is ready for delivery.

10. Extraembryonic Membrane

These are the thin protective layers enclosing the embryo inside the uterus. There are four layers–the amnion, yolk sac, allantois and chorion. The chorion is outermost layer that helps in formation of placenta. It also helps in attachment of embryonic blastula to the uterine wall.

11. Parturition

It is the process of delivery of the foetus. It is induced by complex neuroendocrine mechanism and the oxytocin hormone, produced due to foetal-ejection reflexes.

12. Lactation

The production and release of milk by the mammary glands of female after birth of a young one is called lactation.

13. Colostrum

It is the first milk, produced by mammary gland after delivery, under influence of prolactin hormones. It is rich in proteins, energy and antibodies like I_gA. Thus, it provides passive immunity to the newborn.