

Human Reproduction

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6.3. Human Reproduction

6.3.1 Introduction

- Like other mammals, sexes are separate in human beings; male and female.
- Primary sex organs produce gametes and also secrete sex hormones.
- Secondary sex organs are important in reproduction, but do not produce gametes or sex hormones.
- By accessory sex characters both sexes can be distinguished externally but do not directly play any role in reproduction.
- The age of sexual maturity is called puberty.
- External or accessory sex characters first appear in puberty.
- Puberty occurs in girls at the age of 11 to 14 years.
- Puberty occurs in boys at the age of 14 to 16 years.
- At puberty women start producing ova.
- Sexual characteristics in human beings can be classified as follows-

SEX	Primary Sex Organ	Secondary Sex Organ	Accessory or External Sex Character
Male	Testis	Prostrate	Low-pitch Voice
		Seminal Vesicle	Beard
		Vas Deferens	Broad Shoulder
		Epididymis	Narrow hips
		Penis	
Female	Ovary	Fallopian Tubes	High-pitch voice
		Uterus	Smooth Face
		Vagina	Narrow Shoulder
		Mammary Glands	Broad Hips

6.3.2 Definition

"Human reproduction is any form of sexual reproduction resulting in the conception of a child, typically involving sexual intercourse between a man and a woman."

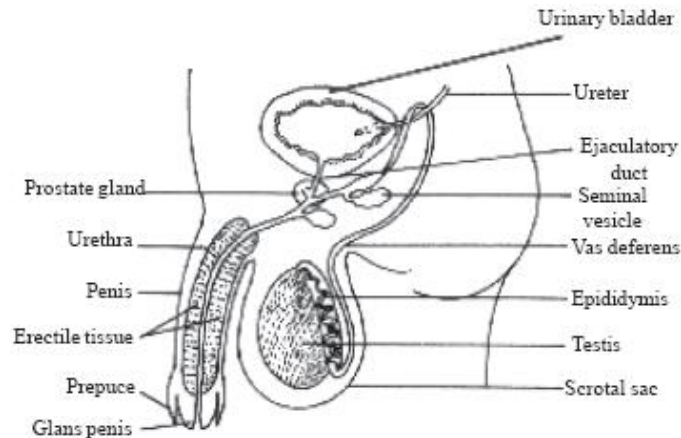
- During sexual intercourse, the interaction between the male reproductive system and the female reproductive system results in fertilization of the woman's ovum by the man's sperm, which after a gestation period is followed by childbirth?
- The fertilization of the ovum may nowadays be achieved by artificial insemination methods, which do not involve sexual intercourse.

6.3.3 The Male Reproductive System

- Male reproductive system of human consists of paired testes, a pair of epididymis, a pair of vasa deferentia, an ejaculatory duct, a urethra, penis and accessory glands

6.3.3.1 Testes

- Testes are the primary male sex organs.
 - Testes produce spermatozoa and secrete the male sex hormone testosterone.
 - In mammals, the testes are located in the extra-abdominal scrotal sacs.
 - Scrotum communicates with abdominal cavity through inguinal canal.
 - The temperature in scrotum is 2 to 4° C below the temperature of abdominal cavity.
 - Testes in mammals are present outside the abdominal cavity because maturation of sperm needs low temperature.
 - In bats, rats and otter, testes descend to scrotal sacs only during breeding season.
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- Whales and elephants have abdominal testes. Their body temperature is low and cooling of testes is not required.
- Cryptorchidism is nondescent of testes in scrotum. Person becomes sterile.
- Orchidectomy is the surgical removal of testes. It is also known as castration.
- Gubernaculum is the ligamentous connective cord which connects testes to scrotal sacs posteriorly.
- Gubernaculum represents mesorchium.
- The capsule enclosing testes of mammal is called tunica albuginea.
- Partitions of testes develop from tunica albuginea.
- Each testis of man contains about 750 convoluted seminiferous tubules which give rise to spermatozoa.
- Seminiferous tubules are separated by interstitial connective tissue.
- Cells of Leydig are found in interstitial connective tissue of testes. They secrete male hormone testosterone.
- The germinal epithelium lining of the seminiferous tubules is made of two kinds of cells.
- The most numerous are the smaller spermatogenic cells or spermatogonia which undergo spermatogenesis to produce sperms.
- A few larger, tall, columnar supporting cells are called Sertoli cells or sustentacular cells.
- Sertoli cells are located in seminiferous tubules which nourish spermatozoa.
- All the seminiferous tubules in each testis open into a network called rete testis leading to fine ductules called vasa efferentia.

6.3.3.2 Epididymis

- Several tubes called vasa efferentia arise from rete testis and conduct sperms into epididymis.
- Epididymis is an irregular, narrow and highly convoluted tubule found on the inner surface of testis.
- Wolffian duct of embryo gives rise to epididymis in adult.
- Epididymis has three parts-
 - anterior caput epididymis,
 - middle corpus epididymis
 - posterior cauda epididymis.
- Vasa efferentia enter into caput epididymis.
- Testis is attached with abdominal wall through spermatic cord.
- Caput epididymis is connected to the dorsal abdominal wall by a spermatic cord consisting of connective tissue, spermatic artery, spermatic nerve etc.,
- Sperms achieve maturity and motility in epididymis.
- Epididymis stores the sperms temporarily.

6.3.3.3 Vas Deferens

- Vas deferens or sperm duct arises from cauda epididymis, ascends to abdomen, passes over the urinary bladder and receive the duct from seminal vesicle behind the urinary bladder forming ejaculatory duct.
- Ejaculatory duct passes through the prostate to open into urethra shortly after its origin from urinary bladder.
- The urethra receives the ducts of prostate and Cowper's gland pass through penis and opens to outside.

6.3.3.4 Seminal Vesicles

- Seminal vesicles are situated behind the bladder. They are narrow, long pouches with muscular tissue on their wall.
- Uterus masculinus is situated at the junction of vas deferens and prostate gland.
- About 70% of the semen is seminal fluid produced by seminal vesicles.
- Seminal fluid has a pH of about 7.4 and contains fructose, citrate, ascorbic acid, prostaglandins and various enzymes.
- The fructose is a source of energy for the spermatozoa.

6.3.3.5 Prostate Gland

- Prostate is situated around the first part of the urethra. It contains prostatic utricle and acini and covered by a capsule.
- Enlargement of prostate results in prostatitis, urination is difficult or impossible.
- Prostatic secretion forms about 20% of the volume of semen.
- It is slightly acidic, pH 6.5 due to the presence of citric acid.
- Prostatic secretion contains substances important for sperm mobility notably albumin and proteolytic enzymes fibrinolysin and fibrinogenase.

6.3.3.6 Cowper's Glands

- These are also known as bulbourethral glands, situated beneath bladder and behind the urethra.
- Cowper's glands are present in male mammals.
- Cowper's glands open into urethra before entering into penis.
- Cowper's glands are yellow in colour. Their secretion is slightly alkaline and is produced during sexual stimulation.
- Cowper's glands secretion acts as a lubricant for the glans penis. It also neutralizes any urine in urethra.

6.3.3.7 Urethra

- Urethra is a thick-walled muscular duct and it is a common passage for both urine and semen and called urinogenital duct.
- Urethra traverse and opens at the tip of the penis as the male urinogenital aperture.

6.3.3.8 Penis

- Penis is the copulatory organ. It is vascular, spongy and erectile structure.
- It has glans penis at tip covered with a fold of skin called prepuce.
- Penis contains three longitudinal columns of spongy erectile tissue which becomes filled with blood during sexual excitement.
- Surrounding the urinogenital duct is corpus spongiosum and above it lie two corpora cavernosa.
- Penis serves to transmit sperms into the vagina of the female during sexual intercourse.

6.3.3.9 Ejaculation

- Ejaculation or seminal emission is the forceful expulsion of semen during sexual intercourse.
- At an average ejaculation, 3 ml of semen containing about 300 million spermatozoa is emitted in man.

6.3.4 The Female Reproductive System

Female reproductive system consists of the ovaries, oviducts (fallopian tubes), uterus, cervix, vagina, accessory genital glands, mammary glands, etc.

6.3.4.1 Ovary

- The ovary is the primary female sex organ.
- The ovary remains attached to the abdominal wall by a ligament called mesovarium.
- The ovary is solid, the blood vessels and nerve enter ovary at hilus.
- Ovary produces ova and secretes female sex hormones viz., estrogens and progesterone.
- Ovary is covered by a cubical epithelium called the germinal epithelium.
- Ovary contains connective tissue, stroma composed of an outer dense layer called cortex and an inner loose layer known as medulla.
- Cortex contains many small and large, spherical or oval ovarian follicles. A fully matured follicle is called Graafian follicle.
- Graafian follicle contains a large central follicular cavity or antrum with a fluid called liquor folliculi.
- The follicle cells lining the cavity are termed membrane granulosa.
- The hillock or mass of cells which surrounds and attaches the primary oocyte to the follicle wall is called discus proligerous.
- The oocyte of mammal is enclosed in a perforated membrane called zona pellucida.
- Next to zona pellucida, cells of inner margin of discus proligerous (cumulus) present a characteristic radial arrangement and is termed corona radiata.
- Graafian follicle secretes estrogen in the blood.
- Discharge of a mature ovum from Graafian follicle is known as ovulation.
- After ovulation, a ruptured follicle turns into a yellowish solid mass of cells called corpus luteum.
- Corpus luteum secretes the female hormone, progesterone.

6.3.4.2 Fallopian Tubes

- These are also called oviducts or uterine tubes.
- Ostium is the aperture present in the funnel-shaped lateral end called the infundibulum.
- Infundibulum is surrounded by finger-like fimbriae.
- Fallopian tube is lined by ciliated epithelium whose cilia beat towards uterus.
- Fertilisation in mammals occurs in fallopian tube.
- The embryo develops upto blastocyst stage in fallopian tube.
- Both fallopian tubes open into a strongly muscular sac called uterus.

6.3.4.3 Uterus

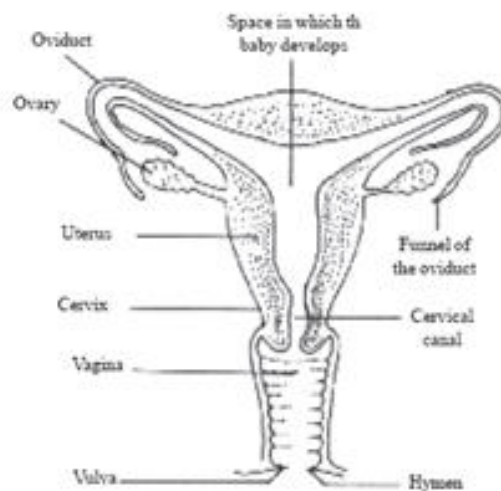
- Uterus is situated above and behind the urinary bladder and remains attached to the bodywall by ligaments.
- The wall of uterus is composed of smooth muscle fibres called myometrium.
- Lumen of the uterus is lined by a mucous membrane called endometrium.
- Endometrium is highly vascular and very rich in glands.

6.3.4.4 Cervix

- Lower narrow end of uterus is called cervix.
- The cervix communicates above with the body of the uterus by an aperture, the internal os and with the vagina below by an opening, the external os.
- The cavity of the cervix between the internal os and external os is called cervical canal which is about 2.5 cm long.
- The glands of the cervical canal secrete a protective mucous plug during pregnancy.
- The line demarcating the body and the cervix is called isthmus. It corresponds to the internal os.

6.3.4.5 Vagina

- Uterus opens into an elastic muscular tube called vagina.
 - The vagina is lined by a stratified squamous epithelium without any glands.
 - During reproductive life the vagina contains Lactobacillus acidophilus which keeps the vaginal pH between 4.9 and 3.5 by producing lactic acid from glycogen.
 - Vagina receives semen from male during mating. During childbirth, it conveys the child outside.
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6.3.4.6 Vestibule

- Vestibule contains opening of vagina, urethra and hymen.
- Numerous minute paraurethral glands or glands of Skene, homologous to prostate of male, are present around the urethral orifice.
- On either side of vaginal orifice is a greater vestibular gland or Bartholin's gland.
- Bartholin's gland of female corresponds to bulbourethral gland (Cowper's gland) of male.
- The hymen is a thin mucous membrane that stretches across the opening of the vagina.
- Vestibule opens to outside through vulva or urinogenital opening guarded by two labia majora.
- The scrotal sacs of a male mammal are homologous to labia majora of female.

6.3.4.7 Clitoris

- Clitoris is a small organ consisting of erectile tissue and is homologous to the penis of the male.

6.3.4.8 Vulva

- It is external genitalia of female. It has a depression, the vestibule in front of anus.
- Vestibule has two apertures – upper external urethral orifice of urethra and lower vaginal orifice of vagina.
- Vaginal orifice is partially covered by a membranous fold, called hymen, which is often torn during the first coitus or due to vigorous physical activity during horse riding, bicycling, etc.
- Vestibule is bounded by two pairs of moist skin folds with sebaceous glands-inner smaller pair is called labia minora and the outer larger pair is called labia majora.
- Labia minora fuse anteriorly to form a skin fold called prepuce in front of a small erectile organ, the clitoris which is homologous to penis as both are supported by corpora cavernosa.
- Labia minora also fuse posteriorly to form a membranous fold called fourchette.
- There is a fleshy elevation above the labia majora and is known as mons pubis which has pubic hairs.

6.3.4.9 Accessory Sex Glands of Female

- Bartholin's Glands (Bulbovestibular Glands)-
 - These are one pair ,small sized glands present just behind the labia minora, one on either side of vaginal orifice.
 - These secrete mucus to lubricate the vagina at the time of mating and parturition.
- Breasts-
 - These are one pair ,rounded structures present on ventral thoracic wall.

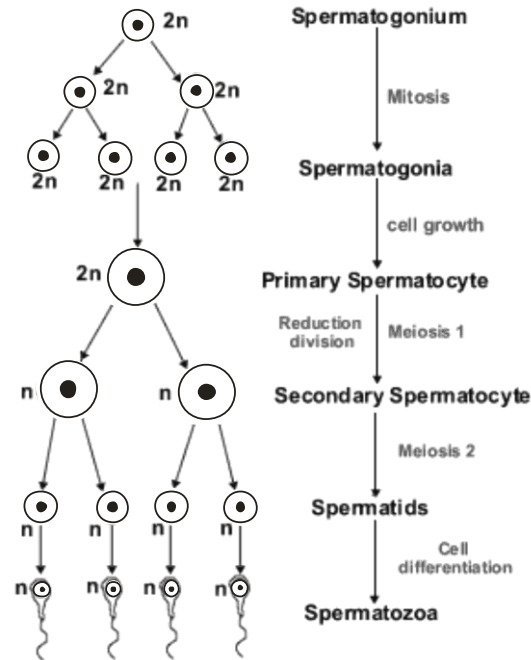
- Each breast is convex anteriorly and has an erectile nipple in its middle.
- The nipple has 15 to 25 openings of lactiferous ducts which carry milk from mammary glands to nipple.
- Lactiferous ducts dilate and form lactiferous ampullae just beneath the nipple to store milk.
- The base of nipple is deep pink to light brown in colour and is called areola.
- Mammary glands are compound tubule-alveolar and modified sweat glands.
- A breast is with about 15 to 25 lobes of milk glands.
- Each lobe is formed of many lobules, each of which contains groups of secretory cells called alveoli.
- These are functional in female and vestigial in male.
- In females the breasts are small sized upto puberty. Their size increases after puberty under stimulation of estrogens secreted by follicular cells of Graafian follicle of ovary.
- Size of breasts is further increased during pregnancy and after childbirth under the stimulation of prolactin hormone of anterior pituitary.

6.3.5 Gametogenesis

- Gametogenesis is the formation of gametes for sexual reproduction.
- Gametogenesis is carried out in the gonads.
- Germ cells belong to cuboidal epithelium.
- Germ cells in vertebrate gonads are produced by both mitosis and meiosis.
- Gametogenesis is controlled by gonadotropic hormones (FSH, LH, ICSH, etc.) secreted by pituitary glands.
- Spermatogenesis is the production of sperms in the testis.
- Oogenesis is the formation of ova in the ovary.

6.3.5.1 Spermatogenesis

- Spermatozoa are produced in the seminiferous tubules or the testes.
 - Spermatogenesis is the process of maturation of reproductive cells in the testes.
 - Spermatogenesis includes two stages-
 - Formation of spermatids
 - Metamorphosis of spermatids.
 - Spermatids are formed by three phases namely phase of multiplication (mitosis), phase of growth and phase of maturation (meiosis).
 - During phase of multiplication, the primordial germ cells divide repeatedly by mitosis to form diploid spermatogonia.
 - Each spermatogonium divides mitotically to form two primary spermatocytes.
 - During phase of growth, the primary spermatocyte enlarges in size and prepares to undergo maturation division.
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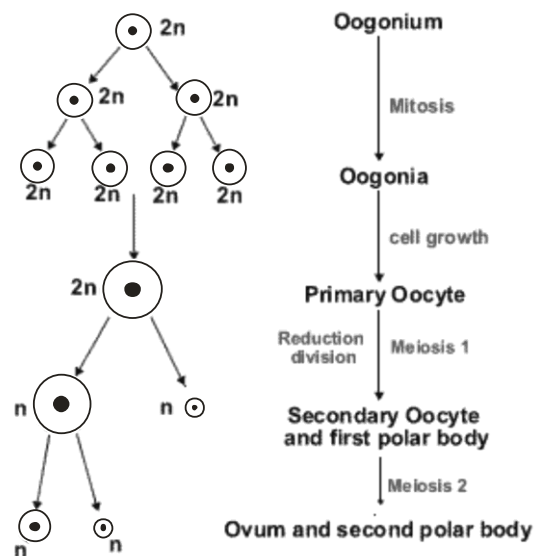


- During phase of maturation, the primary spermatocyte undergoes meiosis I giving rise to two haploid (n) secondary spermatocytes. The secondary spermatocytes undergo Meiosis II resulting in the formation of four spermatids.
- Metamorphosis of spermatid to sperms is termed spermiogenesis.
- A spermatid is non-motile and heavy. It has organelles like mitochondria, Golgi bodies, centrioles, nucleus, etc.
- During spermiogenesis, the weight of gamete is reduced along with development of locomotory structures.
- Nucleus becomes compact forming the major part of head of spermatozoa.
- Golgi complex of spermatid give rise to acrosome.
- Acrosome forms a cap in front of nucleus containing lytic agent which dissolves egg membrane during fertilization.
- Acrosome of mammalian sperm produces sperm lysins called hyaluronidase.
- If acrosome is removed from a sperm, it will fail to penetrate into ovum.
- The two centriole of the spermatids become arranged one after the other behind the nucleus. The anterior one is known as the proximal centriole.
- The proximal centriole is usually located on the neck of spermatozoa. During fertilization, it is introduced to egg.
- The proximal centriole is required for the first cleavage.
- The posterior centriole is known as the distal centriole. It changes into basal bodies.
- Distal centriole gives rise to the axial filament of the sperm.
- Mitochondria from different parts of spermatid get arranged in the middle piece around axial filament.
- Mitochondria in the middle piece provide energy and strength to the sperm for locomotion.
- Much of the cytoplasm of a spermatid is lost. It forms a thin layer around middle piece.
- Atypical mammalian sperm is flagellated, consisting of four parts namely head, neck, middle piece and tail.
- The human sperm was first seen by Hamm and Leeuwenhoek.
- Tail-less, nonflagellate amoeboid sperm is found in the roundworm *Ascaris*.

6.3.5.2 Oogenesis

- Oogenesis is the process of maturation of reproductive cells in ovary.
- Oogenesis is basically similar to spermatogenesis. It includes phase of multiplication, phase of growth and phase of maturation.

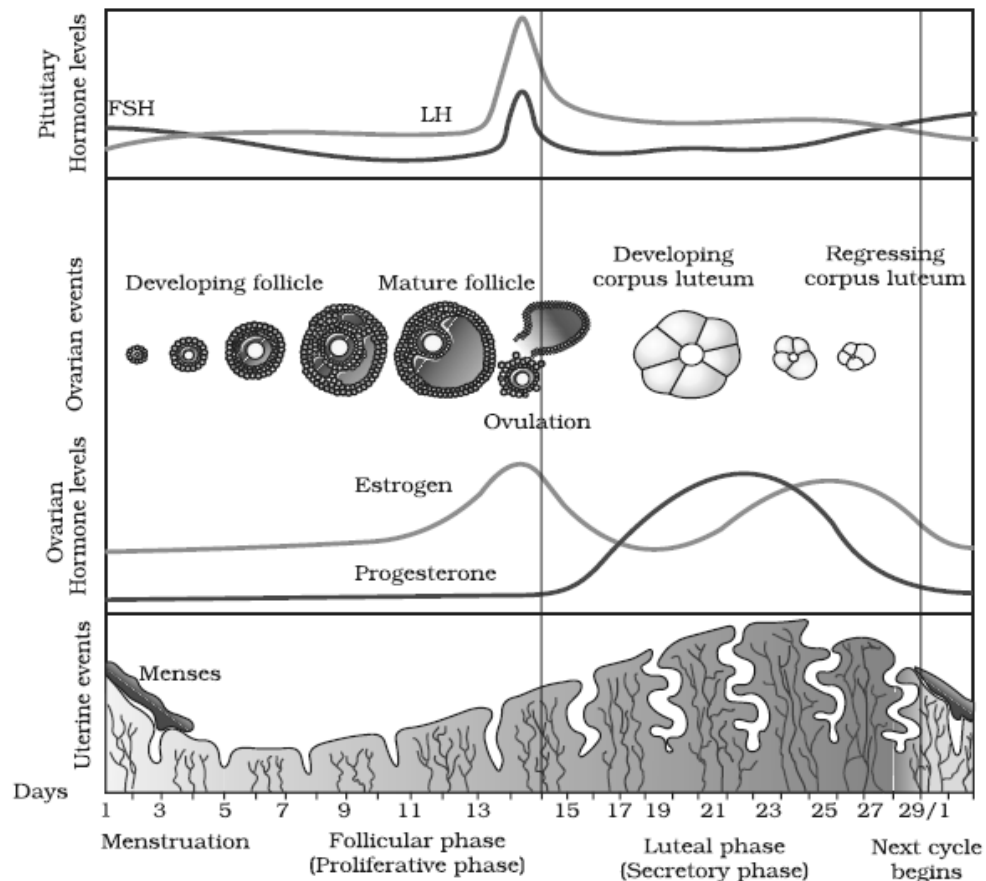
- During phase of multiplication, the primordial cells in the ovary divide mitotically to form oogonia (egg mother cells).
- Each oogonium divides mitotically to form two primary oocytes.
- Primary oocytes undergo growth, the growth phase during oogenesis is comparatively longer. The size of oocytes increases very much.
- In the primary oocyte of frog, the growth will be about 20 to 40 times. The growth phase last for three years. A large amount of fats and proteins become accumulated in the form of yolk.
- During maturation phase, the primary oocyte ($2n$) undergoes Meiosis I producing two haploid cells (n), the larger one is secondary oocyte and the smaller one is first polar body.
- Meiosis II of secondary oocyte results in the formation of functional egg or ovum and a second polar body.
- In oogenesis, only one of the four products of meiosis becomes a functional egg. The rest three are non-functional polar bodies which finally degenerate.
- Vitellogenesis is the formation and deposition of yolk in the egg.
- Major chemical components of yolk are phospholipids and proteins.



6.3.6 Menstrual Cycle

- Menstrual cycle is the cyclic changes in the reproductive tract of primate females.
- Menstruation is the periodic shedding of the endometrium of the uterus with bleeding.
- In healthy women, menstruation occurs at intervals of about 28 days.
- Menarche is the starting of menstruation in girls at about 13 years.
- Menstrual cycle consists of menstrual phase, proliferative phase (follicular phase) and secretory phase (luteal phase).
- Proliferative phase (5th to 14th day) consists of growth of endometrium of uterus, fallopian tube and vagina.
- In ovary, a Graafian follicle grows, matures and secretes estrogen during this phase.
- Estrogen is the hormone active during proliferative phase.
- The ovum is ejected from the follicle near the end of proliferative phase, i.e. 14th day or midway during menstrual cycle.
- Ovulation occurs under the influence of LH from pituitary.
- The subsequent 14 days in which corpus luteum is active is referred to as the secretory phase.
- Progesterone secreted by corpus luteum is active during secretory phase.
- The uterine endometrium and glands grow further during secretory phase.

- At the end of secretory phase, corpus luteum degenerates in the ovary, progesterone secretion fails, the overgrown uterine endometrium breaks down and menstruation takes place.
 - Menstrual cycle is controlled by FSH, LH, estrogen and progesterone.
 - The menstrual cycle and menstruation remain suspended during pregnancy and lactation.
 - Menopause (climacteric) is the period of life when menstruation naturally stops.
 - Menopause occurs in females at the age of 45-50 years.
 - Cessation of menstrual cycle is called menopause.
 - Ability to reproduce is lost in the female after menopause.
 - The events in a menstrual cycle can be studied under four phases-
 - Menstrual Phase
 - ❖ The cycle starts with this phase and the menstrual flow lasts for 3-5 days.
 - ❖ It results due to the breakdown of endometrial lining of the uterus and its blood vessels, along with the unfertilized ovum.
 - Follicular Phase/Proliferative Phase
 - ❖ In this phase, the primary follicles in the ovary grow and become a fully mature Graafian follicle.
 - ❖ The endometrium of the uterus is regenerated by proliferation of its cells.
 - ❖ These changes are due to an increased level of pituitary hormones, FSH and LH and ovarian hormone, estrogen.
 - ❖ FSH controls the follicular phase; it stimulates the growth of follicles and secretion of estrogen by the growing follicles.
 - ❖ Both FSH and LH reach their peak level in the middle of the cycle.
 - Ovulatory Phase
 - ❖ The peak level of LH (called LH surge) induces the rupture of the mature Graafian follicle and thereby the release of ovum; this process is called ovulation.
 - Luteal Phase/ Secretory Phase
 - ❖ During this phase, the ruptured follicle is transformed into corpus luteum.
 - ❖ It secretes large quantities of progesterones.
 - ❖ The endometrium thickens further and their glands secrete a fluid into the uterus.
 - ❖ In the absence of fertilisation, corpus luteum degenerates and this causes disintegration of the endometrium leading to menstruation.
 - ❖ The menstrual cycles cease at the age of about 45-50 years; it is called menopause.
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6.3.6.1 Estrous Cycle

- The estrous cycle consists of cyclic changes in the female reproductive system of non-primate mammals.
- There is no menstruation at the end of estrous cycle.
- The estrogen level in blood increases resulting strong sex urge in the female. This is called 'period of heat'.
- The estrous cycles run only during the breeding season.
- The suspension of estrous cycles is called the state of anestrus.
- Those animals that have only a single estrous during the breeding season are called monoestrous, example- Dog, Fox, Deer, Bat, etc.
- The animals that have a recurrence of estrous during breeding season are called polyestrous, example-Mouse, Squirrel, Cow, Sheep, Pig, Horse, etc.

6.3.7 Fertilisation and Implantation

- During copulation, the semen is transferred into vagina.
- The motile sperms move through the cervix, enter the uterus and reach the ampullary-isthmic junction of the fallopian tube.
- The ovum released from the ovary also reaches the ampullary-isthmic junction, where fertilization takes place.
- A sperm comes in contact with the zona pellucida layer of the ovum and induces changes in the membrane to block entry of other sperms.
- The enzymes of the acrosomes of sperm help to dissolve zona pellucida and plasma membrane of the ovum to gain entry of the sperm into cytoplasm of the ovum (i.e. secondary oocyte).
- The entry of sperm induces the completion of second meiotic division of the secondary oocyte that results in the formation of a haploid ootid and a small second polar body.
- Even before the nucleus of the ootid is organised, it fuses with the sperm nucleus (fertilisation) to form a diploid zygote.

- Cleavage-The zygote undergoes successive (mitotic) divisions called cleavage, as it moves through the isthmus of fallopian tube towards the uterus.
- The daughter cells are called blastomeres.
- Morula-At the 16-celled stage the embryo is a solid sphere and is called a morula.
- Blastocyst-Cell divisions continue in the morula and the blastomeres become arranged along the periphery leaving a central cavity called blastocoel. The embryo at this stage is called a blastocyst.
- The cells now become arranged as an outer layer called trophoblast and projecting into the blastocoel.
- Implantation-The trophoblast layer gets attached to the endometrium.
- The cells of endometrium divide rapidly and cover the blastocyst.
- The blastocyst gets embedded in the endometrium, this process is called implantation.
- The cells of inner cell mass differentiate to form the embryo proper.

6.3.8 Pregnancy and Embryonic Development

- The trophoblast differentiates into two layers; the outer layer secretes enzymes to dissolve the endometrium of uterus.
- The inner layer grows out as finger-like projections called chorionic villi into the uterine stroma; they are surrounded by the uterine tissue and maternal blood vessels.
- The chorionic villi and the uterine tissue become interdigitated to form the structural and functional unit, called placenta.
- The placenta secretes hormones like human chorionic gonadotropin (hCG), human placental lactogen (hPL), estrogen and progesterones that are necessary to maintain pregnancy.
- Umbilical cord, the structure that connects the placenta with the foetus, is formed.
- Simultaneously with this, the inner cell mass differentiates into an outer layer called ectoderm, and an inner layer called endoderm.
- A middle layer called mesoderm appears between the ectoderm and endoderm.
- These primary germ layers give rise to all the tissues and organs of the adult.
- After one month of pregnancy, the heart is formed; the first sign of growing foetus is the heart beat.
- By the end of second month, the foetus develops limbs and digits.
- By the end of third month (first trimester) most of the organ systems are formed.
- During the fifth month eruption of hair on the head is observed; the foetus also shows movements.
- By the end of six months of pregnancy, the body is covered with fine hair; eyelids separate and eyelashes are also formed.
- By the end of eight months of pregnancy, the testes (in case of a male foetus) descend into the scrotum.
- By the end of nine months of pregnancy, the foetus is completely developed and is ready for its delivery.

6.3.9 Parturition and Lactation

- The average duration of pregnancy (gestation period) is about 9.5 months.
 - A fully distended uterus, with the completely developed foetus initiates the secretion of certain hormones.
 - The ovary at this period secretes a hormone called relaxin that facilitates parturition by softening the connective tissue of symphysis pubica.
 - Mild contractions called foetal ejection reflex is induced.
 - This triggers the release of oxytocin from the posterior pituitary.
 - Oxytocin induces stronger contractions of the uterine muscles which ultimately leads to the expulsion of the baby from the uterus, through the birth canal.
 - It is followed by the expulsion of placenta and the remains of umbilical cord.
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- The mammary glands also undergo certain development during pregnancy under the influence of hormones like prolactin (hPL) and progesterone.
- They start producing milk towards the end of pregnancy by the process called lactation.
- The milk that comes out of the mammary glands of the mother just after child birth, is called colostrum; it is rich in nutrients and certain antibodies for the baby.

6.3.10 Points to Remember

- Reproduction is the formation of new individuals of their own kind by living organisms.
 - It is means to perpetuate the race.
 - It occurs by asexual and sexual methods in animals.
 - The reproductive system of a sexually reproducing animal consists of 3 types of organs-
 - Primary sex organs which produce the gametes, namely testes and ovaries
 - Secondary sex organs which include ducts to convey the gametes to appropriate site for fertilisation and glands to provide useful secretions
 - Accessory or external sex characters which distinguish the two sexes in appearance.
 - Male reproductive system comprises a pair of testes suspended in a scrotum, a pair of ducts, each differentiated into an epididymis, a vas deferens, and an ejaculatory duct, a male urethra passing through an erectile penis, and 3 types of glands, viz, a pair of seminal vesicles, a prostate gland, and a pair of Cowper's glands. The secretions of glands mix with sperms to form semen.
 - Female consists of a pair of ovaries, a pair of fallopian tubes (oviducts), each differentiated into infundibulum ,ampulla ,isthmus and uterine part- a uterus (womb) differentiated into fundus ,body and cervix, a vagina, a vulva comprising vestibule, labia minora ,labia majora and clitoris , and a pair of breasts.
 - A testis consists of convoluted seminiferous tubules and small groups of interstitial or Leydig's Cells.
 - Spermatogenesis occurs in the seminiferous tubules.
 - Spermatogonia (2N) divide mitotically into primary spermatocytes (2N), which divide by meiosis-I into secondary spermatocytes (1N).
 - The latter divide by meiosis-II into spermatids (1N) which are transformed into spermatozoa (1N) by spermiogenesis.
 - A spermatozoan is a long, flagellated, motile piece having mitochondria, and a vibratile tail.
 - Ovary consists of connective tissue, the stroma, containing ovarian or Graafian follicles, each enclosing an ovum.
 - Oogenesis occurs in Graafian follicles.
 - A primary oocyte (2N) divides by meiosis-I into a secondary oocyte (1N) and a polar body (1N).
 - The secondary oocyte divides by meiosis-II into ootid (1N) and a second polar body (1N).
 - The ootid develops into an ovum (1N).
 - Polar bodies disintegrate.
 - The ovum is a rounded nonmotile cell enclosed by 2 egg coats-inner zona pellucida and outer corona radiata.
 - Menstrual cycle involves cyclic changes in the female's reproductive tract culminating in menstruation that is flow of cast off uterine and fallopian tube lining along with blood and tissue fluid through the vagina.
 - It consists of 3 phases-
 - Proliferating Phase- It lasts for about 14 days. Lining of the uterus and fallopian tubes proliferates and its Vascularization increases. A Graafian follicle grows, matures and secretes oestrogen. It ruptures to release its egg after about 14 days.
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- Secretory Phase- It lasts for about 10 days. The empty Graafian follicle forms corpus luteum in it, which secretes progesterone. The lining of uterus and fallopian tubes undergoes further hypertrophy. Endometrial glands of the uterus secrete a nutritive fluid for the foetus.
 - Menstrual (Bleeding) Phase-It lasts for about 4 days. If fertilisation does not occur, the corpus luteum regresses, and the lining of uterus and fallopian tube breaks down, resulting in menstrual flow. This occurs after about 25 days and continues for 3 to 5 days.
 - The basal part of endometrial lining remains intact during menstruation and produces new uterine lining.
 - Union of a spermatozoon (male gamete) with an ovum (female gamete) to form a zygote in sexual reproduction is called fertilization or syngamy.
 - In humans, fertilization involves –
 - Release of semen by the male into the vagina of female during copulation.
 - Capacitation of a spermatozoon in the female genital tract.
 - Movement of a spermatozoon to secondary oocyte in the fallopian tube.
 - Passing of spermatozoan between the cells of the corona radiata to zona pellucida and penetration of zona pellucida with its acrosomal lysins.
 - Entry of spermatozoon into the secondary oocyte through the cone of reception.
 - Change of secondary oocyte into an ovum by completion of meiosis-II.
 - Release of chromosomes of the male and the female pronuclei.
 - Mixing up of the chromosomes of the two gametes.
 - After fertilization, the zygote gradually moves down to the uterus for implantation.
 - Polyspermy is checked by depolarization of ovum's plasma membrane and hardening of zona pellucida.
 - Formation of a young one from a zygote by a series of mitotic divisions is called development.
 - Development has two distinct periods-
 - Embryonic or prenatal
 - postembryonic or postnatal.
 - Embryonic period is passed in the egg or mother's womb, and extends from fertilization to hatching or birth.
 - The study of events occurring in this period is called embryology.
 - Postembryonic period extends from hatching or birth to the death of the animal.
 - The study of the changes taking place in the zygote during embryonic period and in the young one during postembryonic period is known as developmental biology.
 - Cleavage converts the zygote into a solid, spherical morula of 16 to 32 blastomeres in about 3 or 4 days after fertilization in the fallopian tube.
 - Morula is still about the same size at the zygote as the blastomeres do not grow in size.
 - This is so because cleavage is also aimed at restoring the cell size and nucleo cytoplasmic ratio characteristic of the species.
 - Between days 3 and 6, the morula arrives at the uterus.
 - It hollows out to form the blastocyst that consists of a layer of cells called trophoblast enclosing a fluid-filled cavity, the blastocyst cavity, and an inner cell mass on one side.
 - As the blastocyst enlarges by absorbing nutritive uterine secretion with trophoblast, the inner cell mass aggregates into an embryonal knob and the zona pellucida thins and finally disappears.
 - Around the day 6 or 7, the blastocyst implants in the endometrium, and the trophoblast cells form rudiment of chorion which secretes hCG, which prevents menstruation and causes hypertrophy of endometrium.
 - Gastrulation occurs during the second week.
 - Cells covering the free surface of the embryonal knob flatten and form endoderm.
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- Embryonal knob stretches into an embryonic disc composed of a single layer of cells, the epiblast (ectoderm+ mesoderm).
 - Cells proliferate at the hind end of the epiblast, detach from it and spread between the endoderm and epiblast.
 - The later now forms ectoderm as mesoderm has separated from it.
 - Each of the three germ layers is defined to develop into specific organs and organ-systems by differentiation of cells at different lactations.
 - Four embryonic membranes-yolk sac, amnion, allantois and chorion, develop to assist the further development of the embryo.
 - The yolk sac encloses fluid, not yolk.
 - It forms blood corpuscles during early development.
 - Amnion contains amniotic fluid which cushions the embryo, protecting it from shocks and injury.
 - Allantois also forms red corpuscles in early embryo.
 - Chorion forms placenta.
 - Later amnions expand and meet the chorion.
 - Placenta is an intimate connection between chorion and uterine wall, bringing foetal blood vessels very close to the maternal blood vessels to allow exchange of materials between the two.
 - Placenta provides food and oxygen to the foetus from the mother's blood and removes carbon dioxide and nitrogenous wastes from the foetal to the maternal blood.
 - Placenta does not prevent the passage of harmful materials from the maternal blood into the foetal blood.
 - Nicotine, addictive drugs and viruses pass from the mother's blood into that of the foetus .
 - Hence, the mother should not take these materials and should protect herself from viral infections.
 - Gestation is completed in about 280 days from the start of the mother's last menstruation.
 - At this time, forceful uterine contractions, called labour pain start.
 - Amnion and chorion rupture and amniotic fluid passes out, lubricating the vagina.
 - The foetal placenta is pulled out from the uterine wall, making the baby free.
 - The uterine contractions now push the baby out, with the head foremost.
 - Later, the placenta and foetal membranes are expelled as the 'afterbirth'.
 - Within 24 hours after parturition, milk secretion from mammary glands begins to feed the baby.
 - Breast feeding is essential for the health of the infant.
 - Hormones play an important role in pregnancy, parturition and lactation.
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