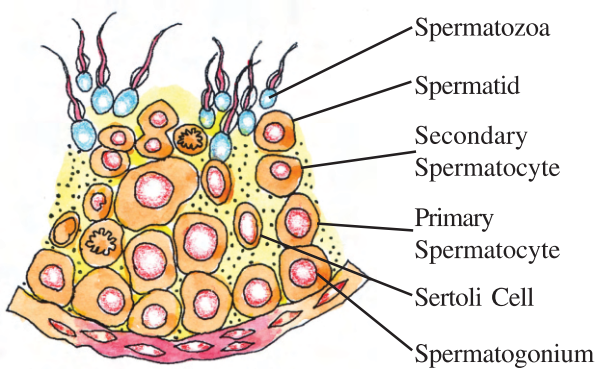


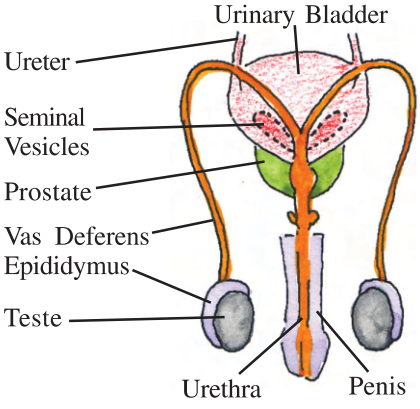
T.S. of Seminiferous tubule

The testes are paired oval-shaped glands measuring about 5cm in length and 2.5cm in diameter. A fibrous connective tissue, the tunica albuginea surround each testis. It extends inward and divides. Each testis into several lobules. Each lobule contains one to four tightly coiled seminiferous tubules, which produces sperms.

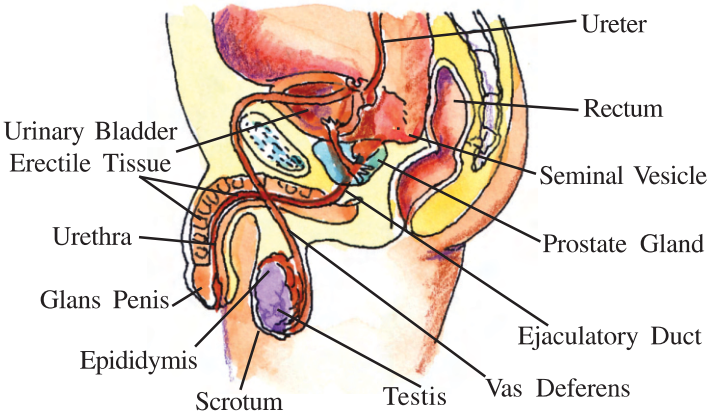
Each seminiferous tubule is lined by two types of cells (i) Germinal cells : They are arranged in 4-8 layers. These cells divide many times and differentiate into sperm, and (ii) Sertoli cells : They are placed in between the developing sperm cells and provides nutrition to the sperm cells. The cells present in the interstitial space between seminiferous tubules are known as interstitial cells or Leydig's cells. They secretes the male sex hormone testosterone.

Seminiferous tubules of each lobe empty sperms into the vasa efferentia. Sperms travel through the vasa efferentia to the epididymis, which surrounds the external surface of the testis.

The epididymis is a highly coiled tube, about 6 meters long. It provides a temporary storage site for the immature sperms, in which sperms complete their maturation process and gain the ability to swim. When a male is sexually stimulated, the walls of the epididymis contract and sperms are transported into vas deferens.



Front View



Lateral View

Male Reproductive System

The vas deferens is a tube which is about 45 cm long. It runs upward from the epididymis through the inguinal canal and enters the abdomen where it loops over the urinary bladder. This tube is connected with blood vessels and nerves. The distal end of vas deferens is expanded and in this region the seminal vesicle opens. Afterwards it is known as an ejaculatory duct. The duct of urinary bladder joins with the ejaculatory duct, now it is known as urethra. Before urethra passes through penis, duct from bulbourethral gland joins with it and finally urethra opens at the tip of the penis.

Accessory Reproductive Glands

The accessory reproductive glands includes paired seminal vesicles, prostate gland and the bulbourethral glands. These glands produce semen.

Seminal Vesicle

The seminal vesicles are located at the base of the urinary bladder. They produce 60% fluid volume of semen. Their thick and yellowish secretion is rich in sugar, vitamin-C and other substances, which nourishes the sperms. The duct of each seminal vesicle joins with vas deferens and form the ejaculatory duct. Thus, sperms and seminal fluid enter the urethra together.

Prostate Gland

The prostate gland is located at the posterior region of the urinary bladder. The secretion of prostate gland is milky. It plays a major role in activating sperms. It enters the urethra through several small ducts.

Bulbourethral Gland

The paired bulbourethral glands are located beneath the prostate gland on lateral side of urethra. Like prostate gland, they secrete alkaline fluid which serves as a lubricant during sexual intercourse.

Semen

Semen is a milky white and sticky mixture of sperms and secretion of accessory glands. The relative alkalinity of semen as a whole (P^H 7.2 – 7.6) helps to neutralize the acidic environment (P^H 3.5 – 4.0) of the vaginal fluid thus protecting the delicate sperms and enhancing their motility. The average volume of semen for each ejaculation is 3 to 4 ml.

Penis

The penis is a cylindrical organ located at the frontal region of scrotal sacs. It is used to deposit sperms into the vagina of female. The distal end of the penis is slightly enlarged, called glans-penis. Glans-penis is covered by loosely fitting skin known as foreskin.

Internally, the penis is composed of three cylindrical masses of tissue bound together by fibrous tissue. Out of these two are located dorsally and one is located ventrally which contains the urethra. All three masses of tissue are spongelike and contain blood sinuses. It is filled with blood during sexual arousal. This causes the penis to enlarge and become rigid. This event is called erection.

Female Reproductive System

The female reproductive system consists of a pair of ovaries, fallopian tubes or oviducts or uterine tubes, uterus, vagina and external genitalia or vulva or pudendum. The mammary glands are also included in female reproductive system.

The ovaries are paired glands with the size and shape of almonds. They is about 3cm long, 2cm wide and 1cm thick. They are situated in the upper pelvic cavity, one on each side of the uterus. The ovaries maintain their position by a series of ligaments. Each ovary contains a hilus, the entry point for blood vessels and nerves. In sectional view, ovary consists of the following parts :

Germinal Epithelium : It is a layer of simple cuboidal epithelium which covers the ovary.

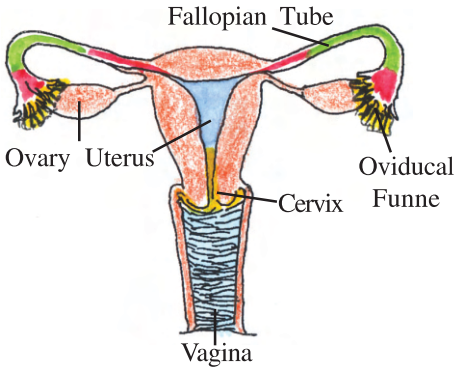
Tunica Albuginea : It is a capsule of collagenous connective tissue immediately after the germinal epithelium.

Stroma : This is a region of connective tissue deep to the tunica albuginea. It is composed by outer cortex and an inner medulla. The cortex contains ovarian follicles.

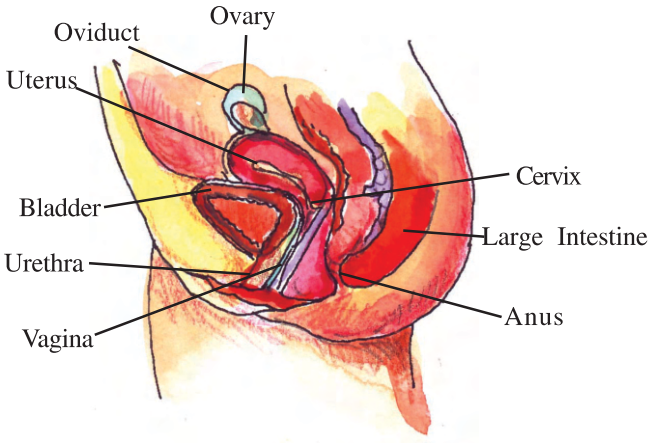
Ovarian Follicles : It consist of ova and their surrounding tissues in various stages of development.

Graffian Follicle : It consist of mature ovum and its surrounding tissues.

Corpus Luteum : Graffion follicle after ovulation produces glandular body. It produces the hormone progesterone.



Female Reproductive System (Front View)



Female Reproductive System (Lateral View)

The ovaries produces ova and secrete female sex hormones. Uterine or fallopian tube or oviduct transports ova from ovaries to uterus. It is 10cm long and situated between the folds of the ligaments of the uterus. It has funnel-shaped open end, called the infundibulum (Oviducal Funnel) which lies very close to the ovary but not attached to it. About once a month ovum is released from ovary near the infundibulum of the uterine tube, this process is called ovulation. The collected ovum run forward in uterine tube by ciliary action. The uterine tube from side runs forwards and becomes associated with the uterus. If an ovum is fertilized, the fertilization occurs in the uterine tube. The uterine tubes from both side join and form the uterus.

The uterus is situated in between the urinary bladder and rectum. It is an inverted, pear-shaped and thick walled muscular structure, where menstruation, implantation of a fertilized ovum and development of the embryo occurs. The wall of the uterus is made of three layers:

(i) Endometrium : It is an innermost layer. If fertilization occurs, the fertilized egg is implanted here and resides there for further development. If the woman does not conceive, the endometrial lining sloughs off periodically, usually after every 28 days.

(ii) Myometrium : It is bulky middle layer of the uterus. It is composed of bundles of smooth muscle. This layer plays an active role during the delivery of a baby.

(iii) Epimetrium : It is the outermost layer of the uterus.

The distal narrow end of the uterus is called cervix, which connect uterus to the vagina.

Vagina is a thin walled tube, it lies between urinary bladder and rectum and it extends from cervix to the outside of the body. Vagina provides a passageway for the delivery and for the menstrual flow to leave the body. The distal end of the vagina is partially closed by a thin fold of the mucosal membrane called the hymen. It can break at anytime either due to vigorous exercise or due to other reasons.

Females have external genitalia. They are Mons pubis, Labia majora, Labia minora and clitoris. Mons pubis is a cushion of fatty tissue which is covered by skin and pubic hair. The labia majora are folds of tissue, which are located below the mons pubis and surround the vulva. The labia minora are also a fold of tissue under the labia majora. The clitoris is a tiny finger like structure which lies at the upper junction of the two labia minora. It contains erectile tissue and is considered equivalent to the male penis. The clitoris differs from the penis in that it lacks a reproductive duct.

Mammary glands are present in both sexes, but normally they are functional in females only. The biological role of the mammary glands is to produce milk and nourish a newborn baby. In the puberty stage, the female mammary glands increase in size, this is stimulated by sex hormone estrogen. They are also considered as accessory reproductive glands.

Gametogenesis

The gametogenesis is the process of gamete formation in the sexually reproducing animals. The animals have two types of cells in their body : Somatic cells and Germinal cells. Somatic cells form various organs of the body, and divide by mitotic division. The germinal cells produce gametes by successive mitotic and meiotic divisions. The male gamete is known as spermatozon or sperm and female gamete is known as ovum or egg. The process of sperm production is known as the spermatogenesis, and the process of production of ovum is known as oogenesis.

Spermatogenesis

The process of spermatogenesis occurs in male gonads or testes.

The Spermatogenesis is a continuous process but for the sake of convenience this process can be studied in two different stages.

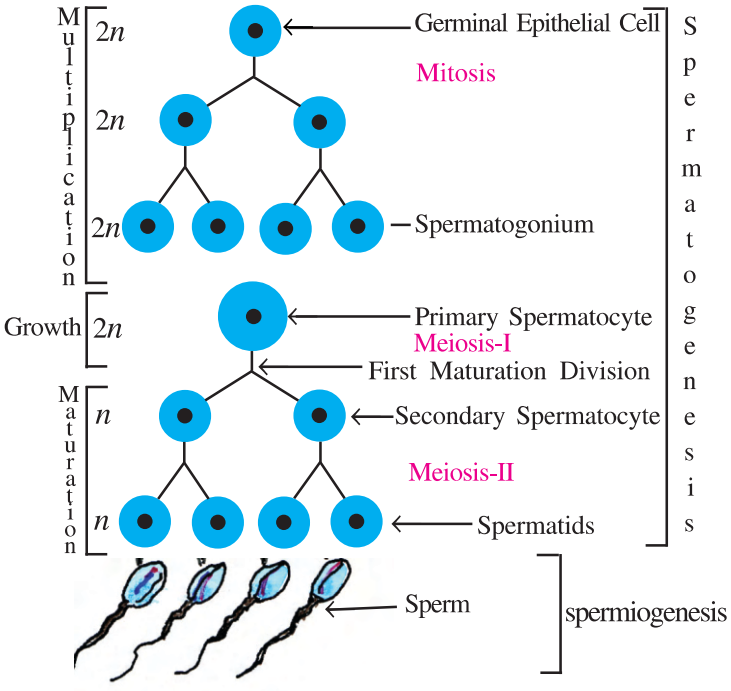
(1) Formation of spermatids (2) Spermiogenesis

(1) Formation of spermatids : The male germinal cells which produce the sperms are known as primary germinal cells. These primary germinal cells pass through the following three phases for the formation of spermatids.

(i) Multiplication phase : The undifferentiated germ cells or primary germina cells contain large sized and chromatin rich nuclei. These cells multiply by mitotic division and produce spermatogonia. Each spermatogonium is diploid.

(ii) The growth phase : In the growth phase the spermatogonia accumulate large amount of nutrient and chromatin material. Now each spermatogonium is known as the primary spermatocytes.

(iii) The maturation phase : Now primary spermatocytes are ready for first meiotic or maturation division. By this, two secondary spermatocytes are formed. Each secondary spermatocyte is haploid. Each secondary spermatocyte passes through the second meiotic or maturation division and produces two spermatids. Thus, by a meiotic or maturation division a diploid spermatogonium produces four haploid spermatids. These spermatids cannot act directly as the gametes, so they have to pass through spermiogenesis.

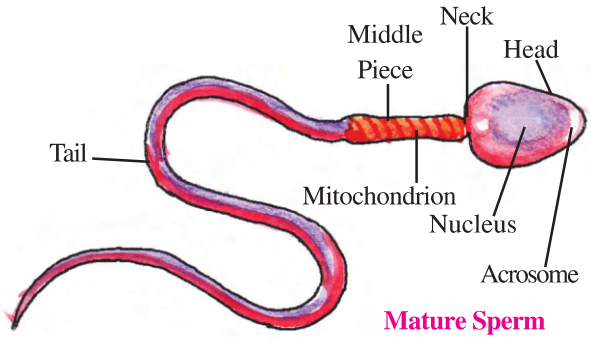


Spermatogenesis

(2) Spermiogenesis : The metamorphosis or differentiation of the spermatids into the sperms is known as spermiogenesis. In it following changes occurs in the spermatids :

(i) Changes in the nucleus : The nucleus loses water, shrinks and assumes ovoid and laterally flattened shape. The RNA and the nucleolus are greatly reduced. The DNA become more concentrated.

(ii) Acrosome Formation : The acrosome occurs at the anterior side of the sperm and contains the protease enzyme hyaluronidase which helps it to penetrate itto in the ovum. The acrosome is formed by the Golgi complex. It is concentrated near the anterior end of the sperm nucleus. One or two vacuoles of the Golgi complex become large and occupy the place between the tubes of Golgi complex. Soon after, a dense granule known as proacrosomal granule develops in the vacuole. The proacrosomal granule attaches with the anterior end of the nucleus and enlarges, which is now known as acrosome.

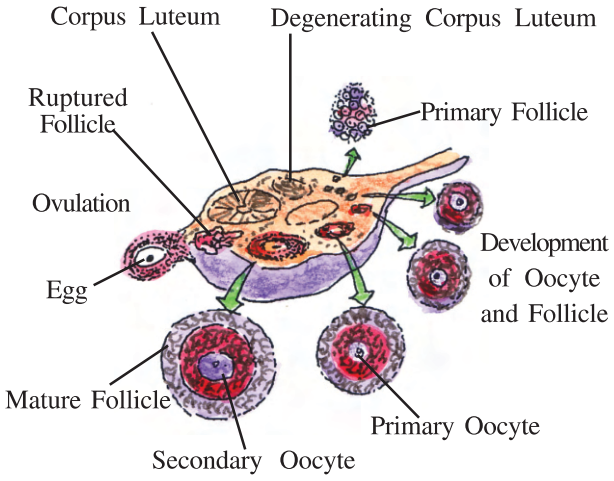


Mature Sperm

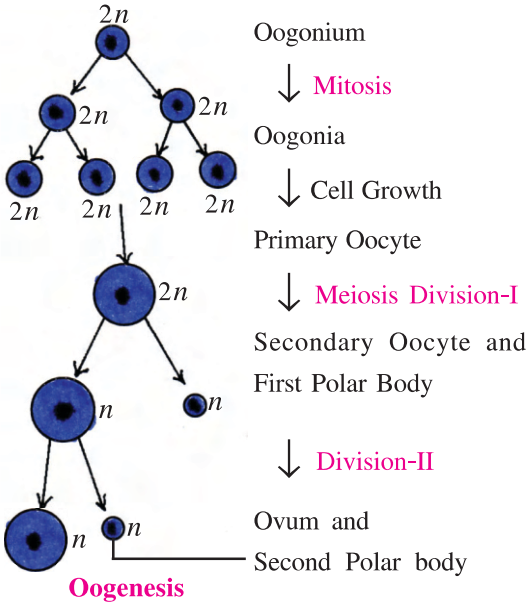
(iii) Centrioles : The two centrioles of the spermatids become arranged one after the other behind the nucleus. The anterior one is known as the proximal centriole and the posterior one is known as the distal centriole. The distal centriole changes into the basal bodies and form axial filament of the sperm. The mitochondria fuse together and twist spirally arround the axial filament. These form a middle piece of the sperm.

Oogenesis

The process of oogenesis occurs in the cells of the germinal epithelium of the ovary. The oogenesis is completed in following three successive phases :



T.S. of Ovary



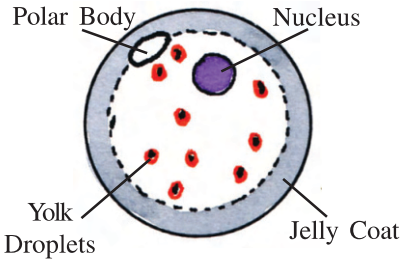
Oogenesis

(1) Multiplication phase : The germinal cells divide repeatedly to form the oogonia. The oogonia multiply by mitotic divisions and form the primary oocytes which enters in the growth phase.

(2) Growth phase : This phase is comparatively longer than the spermatogenesis. In this phase, the size of the primary oocyte increases enormously. In the primary oocyte, fats and proteins present in the form of yolk. The cytoplasm becomes rich in RNA, DNA, ATP and enzymes, moreover, mitochondria golgi complex, ribosomes etc. are also concentrated in it. During this phase, changes also occurs in the nucleus of the primary oocyte and it becomes large due to the increased amount of the nucleoplasm. When the growth of the cytoplasm and nucleus of the primary oocyte is completed, it becomes ready for the maturation phase.

(3) Maturation Phase : The maturation phase is accompanied by the maturation division or meiod (meotic) division (meiosis). This division is quite different from the meiotic division of spermatocyte. Here, after the first division primary oocyte divides unequally to form one large sized haploid secondary oocyte and one small sized haploid first polar body.

Ovulation takes place at the secondary oocyte stage only and enters into oviduct. When sperm penetrates into secondary oocyte it undergoes unequal second meiotic division and produces second polar body and an ovum. In the same way the first polar body undergoes equal second meiotic division and produces two second polar bodies. However, if the sperm does not penetrate into the secondary oocytes, it simply deteriorates without completing meiosis to form the ovum. The mature ovum has a cell like structure.



Secondary oocyte

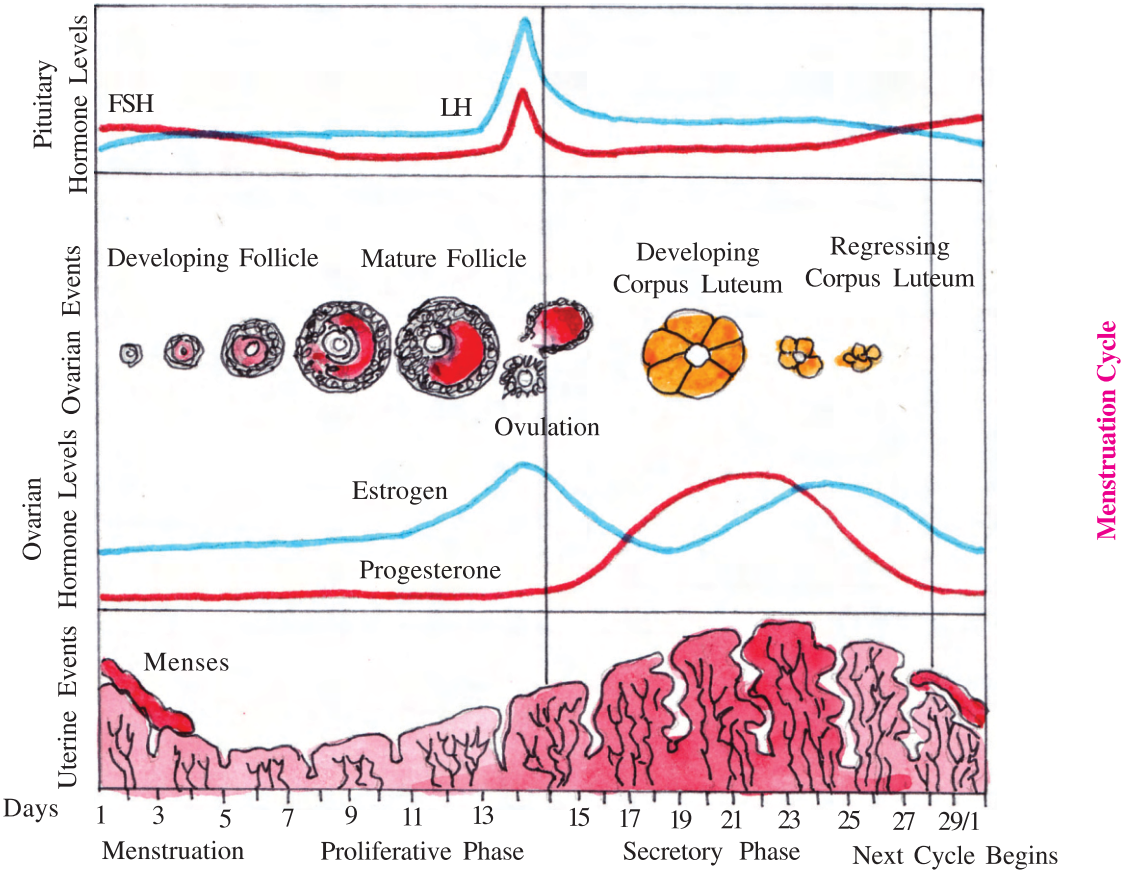
Menstrual Cycle

The events of the menstrual or uterine cycle are the cyclic changes in the endometrium, which occur in cyclic form every month. This is due to the change in the levels of female sex hormones like estrogen and progesterone, in the blood. The events in this cycle can be divided into 28 days.

Days 1-5 : Due to lower concentration of female sex hormones in the blood, the endometrium disintegrates and blood vessels within it break up. Due to this, secretion of blood through vagina takes place It lasts for 3 to 5 days. During this period about 50ml to 150ml blood is lost. This phase is known as a menstrual phase.

Days 6-14 : This phase of the cycle is known as a proliferative phase. This phase is stimulated by rising estrogen levels which is produced by the growing follicles. The endometrium becomes glandular, vascularized and thick. At the end of this phase (on 14th day) ovulation occurs.

Days 15-28 : Rising levels of progesterone produced by the corpus luteum induces development of endometrium and increases its blood supply. Now endometrium is ready for implantation of embryo. If fertilization does not occur, the corpus luteum degenerates. This phase is known as secretory phase. At this juncture, menstruation begins.

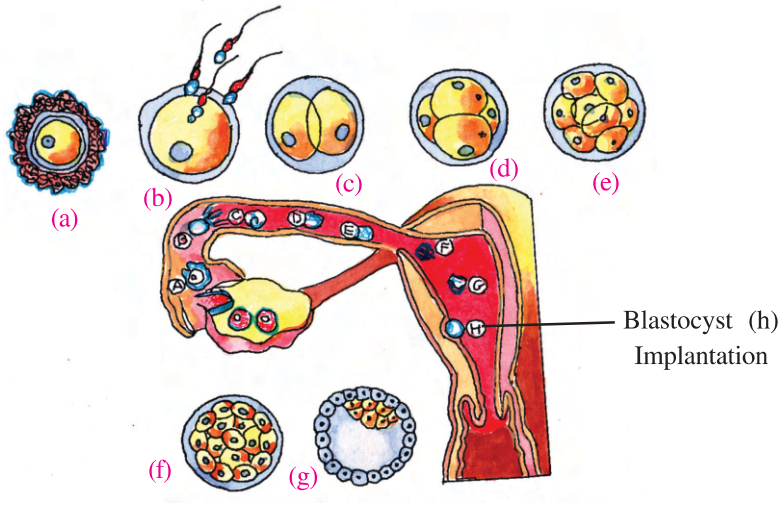


Menstruation Cycle

Fertilization and Implantation

During the act of copulation, male individual deposits semen in the female vagina through the penis. The amount of semen is nearly 3 to 4 ml. It contains billions of sperms.

The sperms, emptied in the vagina, start moving towards oviducts through the uterus. In their locomotion, contractions of vaginal passage and uterine wall are helpful. The slimy secretion of oviduct wall also help in this process. This process takes about 5 to 6 hrs.



(a) Secondary oocyte
(b) Fertilization
(c) & (d) cleavage
(e) Morula
(f) 16 cells stage
(g) Blastocyst
(h) Blastocyst Implantation

Transport of Ovum in Fallopian Tube and Implantation

The secondary oocyte is surrounded by numerous sperms. Oocyte is surrounded by egg membrane and a layer of jelly. Various enzymes are located in the acrosome of sperms, one of which is hyaluronidase which makes the entry of sperm into oocyte possible. The head and middle part of sperm enters the secondary oocyte. The nucleus present in the head of sperm is now known as male pronucleus.

The entry of sperm induces some immediate changes into oocytes. The egg membrane becomes slighty separated from protoplasm. Now it is known as fertilization membrane. This membrane prevents entry of other sperms. Entry of sperm induces completion of maturation of secondary oocyte and forms a female pronucleus. Thus one sperm and one ovum become involved in fertilization. A diploid zygote nucleus is formed through the fusion of male and female pronucleus. Now fertilized ovum is called zygote. During movement of zygote into oviduct, the division of zygote starts, called cleavage. It forms 2, 4, 8, 16 daughter cells called blastomeres. The embryo with 16 cells is called morula. The morula stage continues to divide and transforms into blastocyst as it moves further into uterus. All these changes take place in a period of one week. The fluid within the blastocyst is formed by the cells of trophoblast. Now, the process of implantation of embryo in the uterine wall takes place. The jelly like layer around the embryo is removed. The enzymes secreted from trophoblast cells digest some tissues and blood vessels of uterine wall and make implantation possible. The inner wall of uterus develops and partially envelops the embryo. This process is called implantation of embryo.

Pregnancy and Embryonic Development

The period of development of young one in the female reproductive system is known as pregnancy. In humans the normal period of pregnancy is approximately 266 days to 280 days (40 weeks) from last menstruation from ovulation. However, many babies are born 1 to 2 weeks earlier or later. The fertilized ovum during the first 12 weeks is called embryo and thereafter it known as foetus.

After implantation, the trophoblast part of the blastocyst develops elaborate projections, called chorionic villi, which cooperate with the tissues of the mother's uterus to form the placenta. The placenta functions to deliver nutrients and oxygen to embryo and remove wastes from the embroynic blood. The placenta is connected to the embryo through an umbilical cord; placenta also acts as an endocrine tissue and produces many hormones like human chorionic gonadotropin(hcG), human placental lactogen (hpL), estrogens and progesterone. In the later stage of pregnancy, hormone relaxin is produced from ovary. The hormones like hCG, hPL and relaxin are produced only during pregnancy.

These hormones help in fetal growth, metabolic changes in the mother and maintenance of pregnancy.

The embryonic development is a continues process which is sumarized as under :

Embryo Development

Period	Changes
Embryo Development	
First week	• Zygote undergoes cleavage
	• The blastocyst implants in the uterus.
	• Begins to receive nutrients from the mother.
Second week	• Implantation of blastocyst becomes deep in the endometrium
	• The embryonic disc and amniotic cavity develop.
	• The mesoderm is spreading between ectoderm and endoderm.
Third week	• The embryonic disc broadens.
	• Primitive heart is formed but it is not yet beating.
Fourth week	• The embryo is protected and suspended in amniotic fluid.
	• The primary brain, eyes, stomach, kidneys and heart develop.
	• Heart starts beating, approximately 60 times per minute.
	• The primitive umbilical cord is formed.
	• In this stage, the embryo length is less than 4 cm.
Second month	• The embryo is now looks like a human.
	• The main organs of the body develop and begin their function.
	• In this stage, head is larger compared to the body.
	• It is 2.5 cm long.
Foetus Development	
Third month	• Now embryo called foetus, means `Young one'
	• Foetus reaches 7.5 cm height and about 14 g weight.
	• Body has grown, but head is larger than body.
	• The limbs becomes longer.
	• The external genitalia appear, but it is difficult to identify sex.
	• Some movements of limbs and body occurs.

Fourth Month	• Body is bright red in colour because the blood vessels grow through its transparent skin.
	• The muscles become active.
Fifth month	• Skin is now less transparent and covered with hair.
	• From this stage onwards, the growth of the placenta slows down.
Sixth Month	• The skin is wrinkled because it lacks fat.
	• Two eyelids are separated but a membrane covers the pupils.
	• The foetus measures about 32 cm and weighs about 650 g.
Seventh Month	• The foetus moves round vigorously within the uterus.
	• It can open its eyes.
	• If born at this stage it can now breath but with difficulty.
Eighth Month	• In this stage, foetus is about 42 cm long and its weight is about 1800 g.
	• Development of lungs can now support life.
	• At this stage, if baby is born, it is necessary to provide expert care.
Ninth Month	• At the end of this month, foetus measures about 46 cm.
Tenth Month	• In this stage mother awaits the birth of her child.
	• Generally the child is about 50 cm long and weighs 3300 g. There are wide variations in the weight of the child at birth.

Toward the later part of pregnancy, the human foetus normally assumes a position with its head directed downward, ie. at the time of birth.

Parturition and Lactation

Parturition is also called childbirth. It is the culmination of pregnancy. It usually occurs within 15 days of the calculated due date. The series of events that expel the infant from the uterus are collectively referred to as labour.

Parturition is induced by a complex neuroendocrin mechanism. The signals for parturition originate from the fully developed foetus and the placenta which induce mild uterine contractions called foetal ejection reflex.

At the time of birth, two chemical signals co-operate to creat real labour pain. Some cells of the foetus begin to produce oxytocin, which stimulates the placenta to release prostaglandins. Both hormones stimulate more frequent and powerful contractions of the uterus. At this point, signals for the release of oxytocin is sent by the posterior pituitary. The combined effects of rising levels of oxytocin and prostaglandins initiate true labour. Stronger contractions cause the release of more oxytocin, which causes even more vigorous contractions, forcing the baby even deeper into the mother's pelvis. This leads the baby out of the uterus. Soon after the infant is delivered.

The mammary glands of the female undergo differentiation during pregnancy and start producing milk after delivery; this process is called lactation. Mother feeds this to her new born baby. Milk secreted during initial days of lactation is known as colostrum, which contains antibodies.

SUMMARY

The human is unisexual and viviparous. Reproduction is the mechanism by which continuation of generation is sustained. Like all other vertebrates, humans also exhibits sexual dimorphism. The male and female reproductive systems are organized by several types of organs. The organs of the male reproductive system are, one pair of testes, one pair of epididymis, one pair of vas deferens, one pair of seminal vesicles, prostate gland, bulbourethral gland, urethra and penis. Female reproductive system consists of one pair of ovaries, the uterine tubes, uterus, vagina, external genitalia and mammary glands.

To produce gametes, gametogenesis occurs in both male and female. The male gamete is known as sperm and female gamete is known as ovum. The process of sperm production is known as spermatogenesis and ovum production is known as oogenesis.

Menstrual cycle is the events of the cyclic changes in the endometrium, which it goes through month after month as it responds to change in the levels of female sex hormones in the blood.

The one sperm and one ovum become involved in fertilization. A diploid zygote nucleus is formed through the fusion of male and female pronucleus. Now, fertilized ovum is called zygote. During movement of zygote into oviduct, cleavage occurs. The embryo with 16 cells is called morula. Now, the process of implantation of embryo take place.

The period of development of young one in female reproductive system is known as pregnancy. It takes approximately 266 to 280 days. The process of child birth is called parturition. The mammary glands of the mother undergo differentiation during pregnancy and start producing milk after delivery, this process is called lactation.

EXERCISES

1. Put dark colour in a given circle for the correct answer :

(1) With reference to sex, human is which type of animal ?

(a) Unisexual and Oviparous ◯ (b) Unisexual and Viviparous ◯

(c) Bisexual and Oviparous ◯ (d) Bisexual and Viviparous ◯

(2) From which gland is testosterone hormone released ?

(a) Ovary ◯ (b) Adrenal Gland ◯

(c) Testes ◯ (d) Pituitary Gland ◯

(3) The temperature of scrotal sac is ..... lower than the normal body temperature.

(a) 1 °C ◯ (b) 2 °C ◯ (c) 3 °C ◯ (d) 4 °C ◯

(4) Vas deferens is about ..... long tube.

(a) 45 cm ◯ (b) 40 cm ◯ (c) 30 cm ◯ (d) 35 cm ◯

(5) The fluid containing sperm is known as ..... .

(a) Sperm Fluid ◯ (b) Semen ◯

(c) Reproductive Fluid ◯ (d) Fertilization Fluid ◯

(6) Out of the following which is a part of female reproductive system ?

(a) Uterus ◯ (b) Penis ◯

(c) Bulbourethral Gland ◯ (d) Urinary Bladder ◯

(7) Sixteen celled embryo is called .....

(a) Foetus ◯ (b) Zygote ◯ (c) Morula ◯ (d) Blastocyte ◯

(8) Menstrual cycle takes how many days ?

(a) 26 ◯ (b) 28 ◯ (c) 30 ◯ (d) 24 ◯

(9) How much blood is lost during menstrual cycle ?

(a) 50 ml to 150 ml ◯ (b) 50 ml to 250 ml ◯

(c) 10 ml to 100 ml ◯ (d) 10 ml to 50 ml ◯

(10) The normal period of pregnancy in humans is ..... .

(a) 300 weeks ◯ (b) 40 weeks ◯

(c) 35 weeks ◯ (d) 50 weeks ◯

2. Answer the following questions in short :

(1) Name the reproductive organs of man.

(2) Mention the location of testis.

(3) Write the function of leydig's cell.

(4) Mention the location of prostate gland.

(5) Which layer covers the ovary ?

(6) Which glandular body is formed after ovulation ?

(7) What is spermatogenesis ?

(8) What is fertilization ?

(9) What is pregnancy ?

(10) What is lactation ?

3. Do as directed :

(1) Describe : Sexual dimorphism in human.

(2) Explain : Accessory male reproductive organs.

(3) Describe : Female reproductive system with diagram.

(4) Write note on : Spermatogenesis.

(5) Write note on : Oogenesis.

(6) Explain : Menstrual cycle.

(7) Write note on : Implantation.

(8) Explain : Embryonic development in human.

(9) Explain the changes during foetus development.

(10) Describe : Parturition.

(11) Draw a labeled diagram of : (i) Male reproductive system (ii) Female reproductive system.

7

Reproductive Health

We have already studied human reproductive system and its functions in the previous chapter. Now, let us learn about reproductive health. The normal functions of reproductive system is referred to as reproductive health. According to the World Health Organization (WHO), reproductive health means a total well-being in all aspects of reproduction, i.e., physical, emotional, behavioural and social. Therefore, a society with people having physically and functionally normal reproductive organs and normal emotional and behavioural interactions among them in all sex-related apsects might be called reproductively healthy. Why is it significant to maintain reproductive health ? Let us see.

Reproductive Health-Problems and Strategies

India was the first country in the world to kick off action plans and programmes at a national level to get total reproductive health as a social goal. These programmes are called 'family planning' and were initiated in 1952 and were periodically assessed over the past decades. Improved programmes covering wider reproduction-related areas are currently in operation under the popular name 'Reproductive and Child Health Care (RCH) programmes'. Creating awareness among people about various reproduction related aspects and providing facilities and support for building up a reproductively healthy society are the major tasks under these programmes. With the help of audio-visual and the print-media, governmental and non-governmental agencies have taken various steps to create awareness among the people about reproductive health. Parents, other close relatives, teachers and friends, also have a major role in the dissemination of the above information. Introduction of sex education in schools should also be encouraged to provide right information to the young so as to discourage children from believing in myths and having misconceptions about sex related aspects. Proper information about reproductive organs, adolescence and related changes, safe and hygienic sexual practices, sexually transmitted diseases (STD), AIDS, etc., would help people, especially those of adolescent age. Educating people, especially couples and those in marriageable age group, about available birth control options, care of pregnant mothers, post-natal care of the mother and child, importance of breast feeding, equal opportunities for the male and the female child, etc., will make society healthy. Awareness of problems like uncontrolled population growth and of social evils like sex-abuse and sex-related crimes, etc., needs to be created to take up necessary steps to prevent them and thereby build up a socially responsible and healthy society.

The successful implementation of various action plans for reproductive health requires strong infrastructural facilities, professional expertise and material support. It is essential to provide medical assistance and care to people in reproduction-related problems like pregnancy, delivery, STDs, abortions, contraception, menstrual problems, infertility, etc. Implementation of better techniques and new strategies from time to time is required to provide more efficient care and assistance to people. Research on various reproduction-related areas is encouraged and supported by governmental and non-governmental agencies.

Population Explosion and Necessity and Patterns of Birth Control

Population explosion is an advantage or a nuisance ? In the developed European countries like Spain and Italy, where the population is decreasing, this might be considered as an advantage. however, for the developing countries like India, population explosion is a nuisance and causes damage to the development of the country and its society. The developing countries are already facing a lack of resources, and with the rapidly increasing population, the resources available per person are reduced further, leading to increased poverty, malnutrition, and other large population-related problems.

India is the second most populous country in the world after China. India supports 16.87 percent of the world's population on its meager 2.4 percent world surface area. At the time of independence, the country's population was 342 million. The country's population size had grown from 361 million in 1951 to around 846 million in 1991 and 1027 millon in 2001. The population of India almost tripled during the period of 1951-2001. The phenomenal increase in the population during the last fifty years has led to rapid industrialization and high rate of urbanization which have created tremendous pressure on natural resources like land, air and water.

Decline in death rate and increase in birth rate are the main factors affecting population growth. Increased health facilities along with better living conditions also had impact on the growth of population. Such alarming growth rate could lead us to a scarcity of the basic requirements, i.e., food, shelter and clothing.

The government of India has been organizing several programs for controlling the population increase and has been spending millions of rupees on controlling the birth rate. One of the programmes has been successful, and the rate of increase has also reduced, but has still to reach the sustainable rate. Our main goal to control population growth is decreasing the birth rate. Several government-funded agencies like the Family Planning Association of India spend billion of rupees on promoting family planning. These organizations aim to promote family planning as a basic human right. The family planning methods provided by the family planning programme are vasectomy, tubectomy, IUD (Intra Uterine Devices Copper-T, conventional contraceptives (Condoms, Diaphragms etc.) and oral pills.

Barrier Method

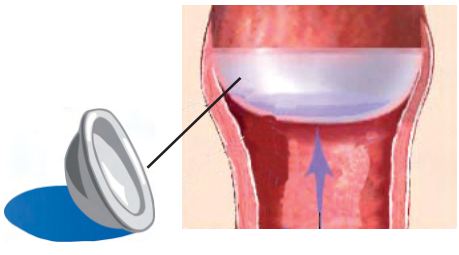
A variety of barrier methods, suitable for both men and women are available. The aim of these methods is to prevent live sperm from meeting the ovum. Barrier methods have increased in popularity due to the absence of side effects and some protection from sexually transmitted diseases.

(i) Physical Methods : In this method condoms are used. It is made of thin rubber and used to cover the penis in the male or vagina and cervix in the female just before coitus so that the ejaculated semen does not enter into the female reproductive tract.

Diaphragm is a vaginal barrier made of synthetic rubber or plastic material and inserted into the female reproductive tract to cover the cervix during coitus. Variations of diaphragm include the conical cap, vault cap and the vinule cap.

Condom for Male

Condom for Female



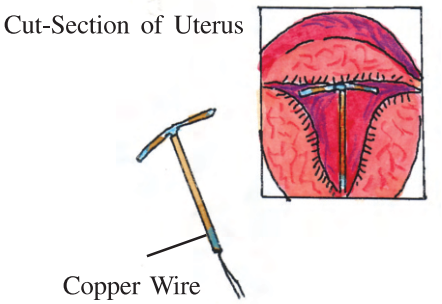
Diaphragm

(ii) Chemical Methods : Spermicides are in the form of foams and creams which attach themselves to sperm and inhibit oxygen uptake and kill sperms.

Intrauterine Devices (IUDS)

Intrauterine devices contraception could also be achieved by introducing a foreign body into the uterus of the female. Such devices are known as Intra Uterine Devices (IUDs)

The non-medicated or inert IUDs are often referred to as first generation IUDs. The copper IUDs comprise the second generation IUDs which release metal ions which have strong anti-fertility effect. The third generation IUDs release hormones (progestasert) which have a direct local effect on the uterine lining.



Copper–T

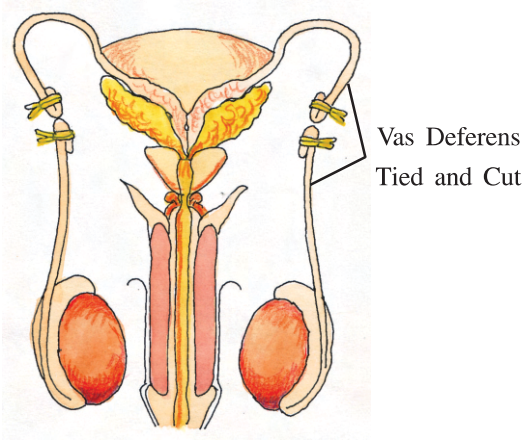
Hormonal Methods

Hormonal contraceptives when properly used are the most effective spacing methods of contraception. Oral administration of small doses of progestogens or progestogen-setrogen combination in the form of tablets which are known as the pills. The pill is given orally for 21 consecutive days beginning on the 5th day of the menstrual cycle followed by a break of 7 days during which period menstruation occurs. They are used prevent the release of ovum from the ovary and also render the cervical mucus thick and scanty and thereby, inhibit sperm penetration.

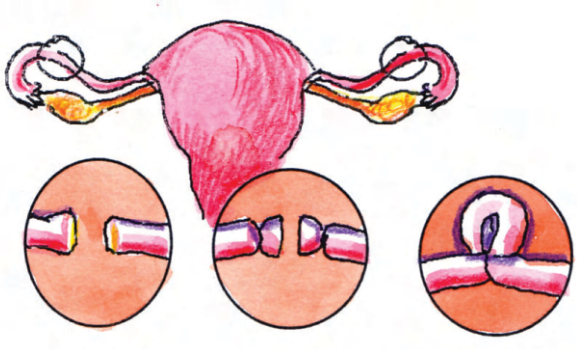
"Saheli", the new oral contraceptive for female contains a non-steroidal preparation. It was developed at Central Drug Research Institute (CDRI) in Lucknow, India It is a "once a week" pill with few side effects and high contraceptive value.

Sterilization

Sterilization is generally advised for the male/female partner as a terminal method to prevent any more pregnancies. Surgical intervention blocks gamete transport and thereby prevents conception. Sterilization procedure in the male (men) is called 'vasectomy' and that in the female (women), 'tubectomy'. In vasectomy, a small part of the vas deferens is removed or tied up through a small incision in the scrotum whereas in tubectomy, a small part of the fallopian tube is removed or tied up through a small incision in the abdomen or through vagina. These techniques are highly effective but their reversibility is very poor. It needs to be emphasised that the selection of a suitable contraceptive method and its use should always be undertaken in consultation with qualified medical practitioner.



Vasectomy



Tubectomy

Natural Methods

Other than above mentioned methods, natural methods are also used which work on the principle of avoiding chances of the meeting of ovum and sperms. Periodic abstinence is one such method in which the couples avoid or abstain from coitus from day 10 to 17 of the menstrual cycle when ovulation could be expected, because chances of fertilization are very high during this period. Therefore, by avoiding intercourse during this period, conception can be prevented. Withdrawal or interruption-coitus interruptus is another method in which the male partner withdraws his penis from the vagina just before ejaculation. In the lactational amenorrhea (absence of menstruation) method, menstruation cycle does not occur during the period of intense lactation following parturition. Therefore, as long as the mother breast-feeds the child fully, chances of conception are almost nil. However, this method has been reported to be effective only upto a maximum period of six months following parturition. As no medicines or devices are used in these methods, side effects are almost nil.

Medical Termination of Pregnancy (MTP)

Voluntary termination of pregnancy before foetus becomes viable is called medical termination of pregnancy (MTP) or induced abortion. Nearly 45 to 50 million MTPs are performed in a year all over the world. Whether to accept / legalize MTP or not is a subject debated in many countries due to emotional, ethical, religious and social issues involved in it.

The MTP Act was passed by Indian Government in 1971 and it came into force from April 1, 1972. It is a health care measure, which helps to reduce maternal mortality resulting from illegal abortion. MTP is required to terminate pregnancy in the following cases :

- Continuation of pregnancy might endanger the mother's life.
- There is substantial risk of the child being born with serious handicaps.
- Where the pregnancy is the result of rape.
- Where the pregnancy is unwanted resulting from failure of any contraceptive device.

MTP can be performed only by registered doctors and it can be done only up to 20 weeks of pregnancy only.

Sexually Transmitted Diseases (STDs)

Diseases or infection which are transmitted through sexual intercourse are collectively called sexually transmitted diseases (STDs). It is caused by bacteria, virus, protozoan and fungi. STDs are becoming a major health problem in India. More than 20 pathogens have been found to be spread by sexual contact. The highest cases are observed in the 20-24 age group; it is followed by the 25-29 age group and the 15-19 age group. Some of these diseases are summarized below :

Summary of STDs

Name of Disease	Name of Pathogens	Major Symptoms
(1) Gonorrhoea	Neisseria gonorrhoeae (Bacteria)	• Pain during passing urine • Pain in lower abdomen
(2) Syphilis	Treponema pallidium (Bacteria)	• A painless rush • Flu-like illness, tiredness. • White patches on the tongue or roof of the buccal cavity. • Patchy hair loss.

(3) Genital herpes	*Herpes simplex virus*	• Many people will not have any visible signs and symptoms. • If person do get signs and symptoms they are : feeling of uneasiness. • Symptoms such as fever, tiredness, headache, itching in the genital or anal area etc. are seen. • Pain while passing urine. • Small, fluid-filled blisters anywhere in the genital or anal area.
(4) Hepatitis B	Hepatitis B virus	• Symptoms like fever, joint pain, fatigue, loss of appetite, jaundice, pain in upper right abdomen etc. are seen
(5) AIDS	Human immunodeficiency virus (HIV)	• Person loses immunity so all diseases are dominated. • No specific symptoms are seen, but some symptoms like, fever for over months, diarrhoea, rapid weight loss, a cough that won't go away, short term memory loss etc. are seen.
(6) Trichomoniasis	*Trichomonas vaginalis* (Protozoan)	• Soreness, inflammation and itching in and around vagina. • Pain or a burning sensation while passing urine.

The diagnosis of these diseases is based on causative organism and the symptoms. The medical examination and symptoms reveal their STD nature. Certain diagnostic tests for these diseases includes culture of the pathogenic organism. Through culturing, microorganisms can be isolated, observed and identified, by microscopic examination using special stains. ELISA (Enzyme Linked Immuno Absorbent Test) test is used for identification of antigen-antibody. In ELISA method, antibodies against HIV antigen are searched out from the patient's blood. This helps in establishing the identification of the pathogenic organisms. DNA–hybridization : In DNA–Hybridization, a short polynucleotide chain of the genetic material of the pathogenic organism is utilized. Polymerase Chain Reaction (PCR) : In the PCR method, the specific section of a gene of the pathogenic organism is multiplied with the help of a suitable primer.

Someone has said "Prevention is the better than cure"; thus prevention of STDs is in your hands. You could be free of these infections if you follow the simple principles given below :

- Avoid sex with unknown partners.
- Always use condoms during coitus.
- In case of doubt, consult a doctor and get treatment if the disease is diagnosed.

INFERTILITY

Amniocentesis

Amniocentesis is also known as amniotic fluid test or AFT. It is a medical procedure used in prenatal diagnosis of chromosomal abnormalities, in which a small amount of amniotic fluid is sampled from the amnion surrounding a developing foetus, and its DNA is examined for genetic abnormalities. Using this process the gender of the foetus can also be determined and hence this procedure has been legally restricted for sex determination in India.

A number of couples all over the world including India are facing infertility, i.e., they are unable to produce children. In India, mostly female is blamed for this, but it is not always true; the problem can lie both in the male or female partner. Infertility clinic could help in diagnosing and curing these disorders and helping these types of couples to have children. The couples could be assisted to have children through certain special techniques commonly known as assisted reproductive technologies (ART). Assisted reproductive technology (ART) is a general term referring to methods used to achieve pregnancy by artificial or partially artificial means. Common methods of ART are *In vitro* fertilization (IVF), Zygote intrafallopian transfer (ZIFT) and Gamete intrafallopian transfer (GIFT).

***In Vitro* Fertilization (IVF) :** It means fertilization outside of the body. IVF is the most effective ART. It is often used when a woman's fallopian tubes are blocked or when a man produces very few sperms. Doctors treat the woman with a drug that causes the ovaries to produce multiple eggs. Once mature, the eggs are removed from the woman. They are kept in a dish in the lab along with the man's sperm for fertilization. After 3 to 5 days, healthy embryos are implanted in the woman's uterus.

Zygote Intrafallopian Transfer (ZIFT) or Tubal Embryo Transfer : It is similar to IVF. Fertilization occurs in the laboratory. Then the very young embryo is transferred to the Fallopian tube instead of the uterus.

Gamete Intrafallopian Transfer (GIFT) : It involves transferring eggs and sperm into the woman's Fallopian tube. So fertilization occurs in the woman's body.

ART procedures sometimes involve the use of donor eggs (eggs from another woman), donor sperm, or previously frozen embryos. Donor eggs are sometimes used for women who can not produce eggs. Also, donor eggs or donor sperm are sometimes used when the woman or man has a genetic disease that can be passed on to the baby. An infertile woman or couple may also use donor embryos. These are embryos that were either created by couples in infertility treatment or were created from donor sperm and donor eggs. The donated embryo is transferred to the uterus. The child will not be genetically related to either parent.

SUMMARY

The normal functions of reproductive system are refered as reproductive health. India was the first country in the world to kick off action plans and programmes at a national level to get total reproductive health as a social goal. These programmes called 'family planning' were initiated in 1952 and were periodically assessed over the past decades.

Proper information about reproductive organs, adolescence and related changes, safe and hygienic sexual practices, sexually transmitted diseases (STD), AIDS, etc., would help people, especially those in the adolescent age group. Educating people, especially couples and those in marriageable age group about available birth control options, care of pregnant mothers, post-natal care of the mother and child, importance of breast feeding, equal opportunities for the male and the female child, etc., can make society healthy.

India is the second most populous country in the world after China. India supports 16.87 percent of the world's population on its meager 2.4 percent world surface area. At the time of independence the country's population was 342 million. The country's population size had grown from 361 million in 1951 to around 846 million in 1991 and 1027 million in 2001. Our main goal is to control population growth by decreasing the birth rate. Several government-funded agencies like the Family Planning Association of India spend billons of rupees on promotion of family planning. The family planning methods provided by the family planning programme are vasectomy, tubectomy, IUD, conventional contraceptives (Condoms, Diaphragms etc.) and oral pills.

Voluntary termination of pregnancy before foetus becomes viable is called induced abortion or MTP.

Diseases or infections which are transmitted through sexual intercourse are collectively called sexually transmitted diseases (STDs). The highest cases of it are observed in the 20-24 age group, it is followed by the 25-29 age group and the 15-19 age group. Amniocentensis is also known as aminotic fluid test or AFT. It is a medical procedure used in prenatal diagnosis of chromosomal abnormalities.

A number of couples all over the world including India are facing infertility, i.e., they are unable to produce children. The couples could be assisted to have children through certain special techniques commonly known as assisted reproductive technologies (ART). Common methods of ART are *In vitro* fertilization (IVF), Zygote intrafallopian transfer (ZIFT) and Gamete intrafallopian transfer (GIFT).

EXERCISES

1. Put dark colour in a given circle for the correct answer :

(1) The normal functions of reproductive system is referred to ..... .

(a) Reproductive health ◯ (b) Reproductive care ◯

(c) None ◯ (d) a and b both ◯

(2) Which country was the first in the world to kick off action plans and programmes at a national level for family health ?

(a) India ◯ (b) USA ◯ (c) UK ◯ (d) China ◯

(3) India occupies which place in the world according to population ?

(a) Second ◯ (b) First ◯ (c) Fourth ◯ (d) Third ◯

(4) India supports ..... percent of the world's population.

(a) 16.21 ◯ (b) 16.00 ◯ (c) 16.87 ◯ (d) 17.87 ◯

(5) Sterilization procedure in the male (men) is called...

(a) Sterilization ◯ (b) Tubectomy ◯

(c) vasectomy ◯ (d) All of the above ◯

(6) Sterilization procedure in the female (women) is called...

(a) Sterilization ◯ (b) Tubectomy ◯

(c) Vasectomy ◯ (d) All of the above ◯

(7) How many pathogens have been found to spread by sexual contact ?

(a) 21 ◯ (b) 20 ◯ (c) 18 ◯ (d) 19 ◯

2. Answer the following questions in short :

(1) What is reproductive health ?

(2) Give full name of RCH.

(3) Mention the names of barrier methods for family planning.

(4) What is IUD ?

(5) What is meant by MTP ?

(6) Define vasectomy.

(7) Which disease is caused by *Neisseria gonorrhoeae.*

(8) Which disease is caused by *Trichomonas vaginalis.*

(9) Which disease is caused by *Treponema palladium.*

(10) What is IVF ?

(11) What is GIFT ?

(12) Give full name of ELISA :

3. Do as directed :

(1) Describe strategies for reproductive health.

(2) Describe natural method for family planning.

(3) Describe barrier methods of family planning.

(4) Describe hormonal method of family planning.

(5) Explain MTP.

(6) Write a short note on diagnosis of STDs.

(7) Write a short note on ART methods.

8

Heredity and Variation

INTRODUCTION

You may have pondered over such questions as, why do hen's egg always hatch into chicken and not sparrow ? Why do children in a family resemble one another but are not exactly alike ? Why do they only partly resemble their parents ? The answers to these and many more similar questions come from an important branch of biology, called Genetics, the study of heredity. It means there is a continuity of features from one generation to the next. Its information is present in the zygote. The term genetics was first coined by William Bateson in 1906. The word genetics is derived from the Greek term gen which means 'to become'. According to Webster's dictionary, Genetics is the branch of Biology which deals with heredity and variation among related organisms.

There are two main components of this discipline. The first is heredity or the study of factors responsible for the resemblance between the parents and their offspring. Thus, heredity can be defined as the "Transmission of characters from parents to offsprings". The second, called variation is concerned with the forces or influences due to which no two organisms are exactly alike. Thus the occurrence of differences among the individuals of the same species is known as variation.

In the earlier chapter, you have studied about sexual reproduction. Due to this capacity every organism reproduces new generation of offspring that resembles the parental generation. Thus heredity and variation within a progeny is the result of sexual reproduction. But, each species has its own individuality, e.g. each species is recognizable by certain specific characteristics. Thus, by the process of gradual and continuous change, living organisms have evolved to exhibit a wide diversity.

Historical Background of Heredity

The concept of heredity is not new. Selective breeding of horses, donkeys and date palm was also done during the ancient civilization of Babylon and Assyria nearly 6000 years ago. Ancient Chinese writing mentions creating better varieties of paddy nearly 5000 years ago. Hippocrates (400 B.C.) believed that characteristic are inherited from parents because reproductive material is handed over from all parts of the body of an individual. The science of heredity and variation, the scientific principle of the science of genetics originated in 1900 with the re-discovery of a scientific article published in 1866 by Gregor Johann Mendel. Mendel's 'factors', the carriers of heredity information, are known as 'genes', a term coined by Johansen in 1909.

Gregor Mendel–The Father of Genetics

The contribution of Mendel to Genetics is called Mendelism. Mendel is called the father of Genetics.

Gregor Johann Mendel (1822-1884)

Christien Johann Mendel was born in 1822. He came to the monastery at Brunn and was appointed as priest in 1848. In 1856, he began to collect and observe the numerous varieties of the garden pea. These varieties differed in seed, pod, flower and a number of other characteristics. He grew each variety in different plots, so that any variation from the listed characteristics could be easily spotted. He carried out experiments for seven years (1856–1863) in the monastery gardens. He presented the results of his study of hybridizations together with generalisations at the Natural History Society of Brunn in 1865. No one at that time read Mendel's research papers. They lay neglected until 1900 when they were discovered almost simultaneously and independently by Karl currens, Hugo de varies and von Tschermark. He died in 1884. When Mendel's work was recognized and appreciated, he was no more.

Mendel's Work

Mendel did his work on garden pea (*Pisum sativum L.*). The following were the reasons for the success of Mendel :

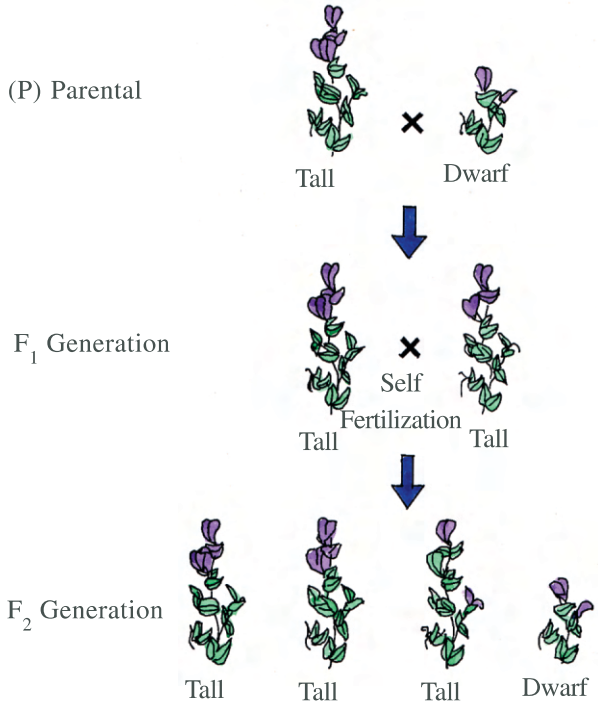
- It is very easy to cultivate the pea plants in open ground.
- The flowers of pea plants are normally self-fertilized.
- The pea plant shows a number of contrasting characters.
- The hybrid of garden pea are perfectly fertile.
- Cross pollination is not very difficult in pea plant.
- Artificial fertilization was almost successful.
- He studied the inheritance of only one character at a time in most of the experiments.
- He maintained statistical records of his results. It helped Mendel to drive numerical ratios of significance.

Mendel crossed two plants differing in two characters, such as flower position and height of the stem. The plants involved in the above crosses are called parent plants. It was marked by P. The first Hybrid generation resulting from a cross between parental plants is called the first filial generation and is marked as F_1. The second generation of hybrids arising from the self or cross-fertilization of F_1 hybrid generation is called the second filial generation and is marked as F_2.

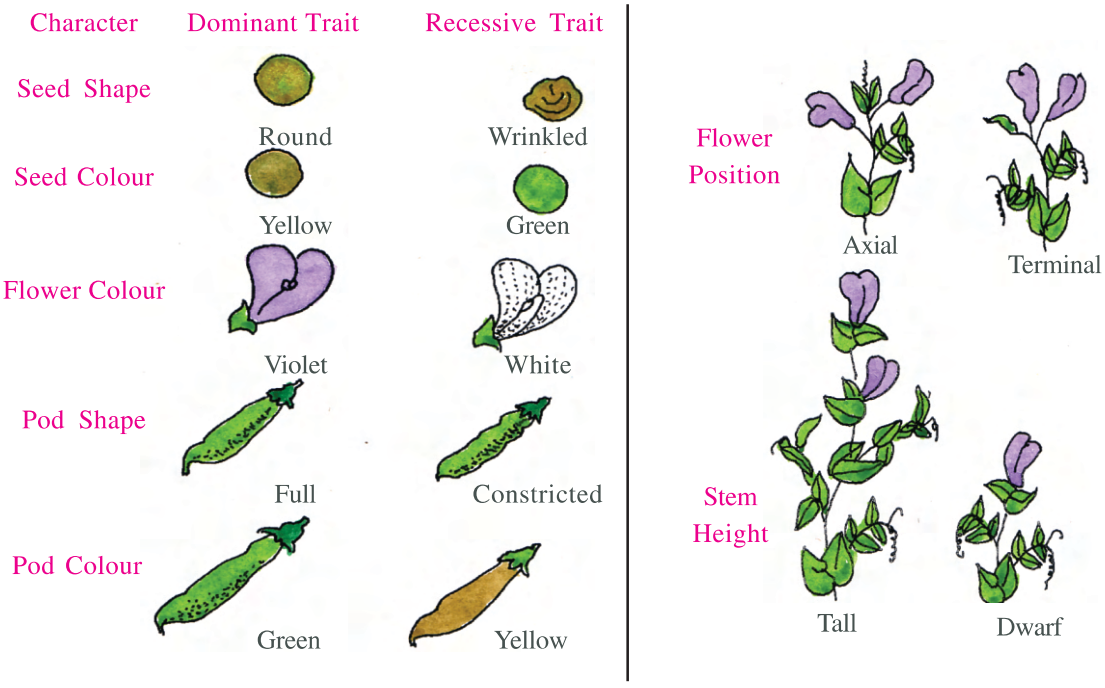
Monohybrid Cross Experiments (Single Gene Inheritance)

The experiments considering the inheritance of any one character are called monohybridization experiment. Mendel selected two pea plants, one with a tall stem and the other with a dwarf or short stem. These plants were considered as parental plants (P) and were pure breeding. This was done by first removing the anther of an immature flower of tall plants. This flower was than covered with a small plastic bag when this flower matured, the pistil was dusted with pollen received from the dwarf plant. Seeds were collected from this plant. These seeds were sown and a group of plants were raised. These plants represent F_1 generation.

In Mendel's above referred experiment, all plants in F_1 generation were tall. They were as tall as their parents in P generation. The F_1 plants were inbreed. The seeds were collected and the next generation F_2 was raised. In the F_2 generation two type of plants were found. They were tall and dwarf. Mendel counted the number of tall and dwarf plants of the 1064 plants of F_2 generation, 787 plants were tall and 277 plants were dwarf. This ratio is approximately (3 : 1). Mendel carried out similar experiments, involving seven different characters. Each time he obtained similar results.



Diagrammatic Representation of Monohybrid Experiment



Seven Pairs of Contrasting Traits in Pea Plant Studied by Mendel

Contrasting Traits Studied by Mendel in Pea

No.	Characters	Alternative	
		Dominant	Recessive
(1)	The length of the stem	Tall	Dwarf
(2)	The position of the flower	Axial	Terminal
(3)	The colour of the pod	Green	Yellow
(4)	The shape of the pod	Inflated	Constricted
(5)	The shape of the seed	Round	Wrinkled
(6)	The colour of flower	Violet	White
(7)	The colour of the seed	Yellow	Green

Each character that Mendel followed had two alternative appearance or 'Traits', i.e., tall or short stems, round or wrinkled seed, etc. Mendel's differentating characters have been variously called 'factors' or 'genes'. Bateson proposed the name 'Alleomorph' or 'Allele' for them.

Based on his observations on monohybrid crosses, Mendel proposed two general rules to consolidate his understanding of inheritance in monohybrid crosses. Today these rules are called the Principles or Laws of inheritance. The First Law or Law of Dominance and the Second Law or Law of Segregation.

Laws of Dominance

When two different alleles for a character occur in an organism, only one of the two alleles expresses itself. The other allele remains unexpressed. The allele which is expressed is called dominant gene and the allele which is not expressed is called recessive gene.

Let us now examine results obtained from self-fertilization amongst F_1 individuals. All F_1 plants are tall and have Tt genotype. As a male parent, they will produce two types of gamets (T and t gametes), as a female parent also they will produce two types of gamets (T and t) – two types of gamets can fertilize two types of gametes in four possible ways (TT, Tt, Tt, tt). Of these, three kinds will be tall (TT, Tt, Tt) and one kind will be dwarf (tt). Thus in F_2 generation 3/4 of the total offsprings obtained exhibit dominant expression and 1/4 of them exhibit recessive expression. Thus, the ratio of 3:1 is obtained. Based as such results, Mendel derived the law.

Law of Segregation

When a pair of contrasting traits are brought together in a hybrid, the two factors (alleles) remain together without mixing. When the gametes are formed from each other, only one enters each gamete. Thus any gamete contains only one gene for an expression of a character, this is also called Law of Purity of gametes. An organism can be homozygous or heterozygous for a character, but its gametes will always be pure for a particular expression of that character.

Test Cross

A cross, arranged for deciding whether an organism is homozygous or heterozygous is called test cross. Selected cross breed of pea may be homozygous tall or heterozygous tall. If we cross a tall plant with a dwarf plant, two outcomes are possible. This will depend on the genotype of tall plant. If homozygous tall (TT) is cross with dwarf plant (tt) all offspring will be tall. If it is heterozygous tall (Tt) 50 % will be tall and 50 % will be dwarf. Thus, through such a cross, genotype of the plant can be determined. Hence, it is called test cross. The ratio obtained is 1 : 1.