REPRODUCTION
9th Book
Unit 20 – Organ system in Animals

Introduction

- Living organisms are evolved from the simplest form to complex level of organization. Cells are the basic fundamental units of an organism. These are grouped to form tissues, the tissues into organs and the organs form the organ systems forming an entire organism. The different organs and organ systems of an organism function by depending on one another with harmonious coordination. When we ride a bicycle, our muscular system and skeletal system work together to move our arms for steering and legs for pedalling. Our nervous system directs our arms and legs to work. Simultaneously, respiratory, digestive and circulatory systems work to provide energy to the muscles. All the systems work together in coordination to maintain the body in a homeostatic condition of an organism.

- Organ and organ systems have appeared first in the Phylum platyhelminthes and continues till mammals. Similar groups of cells form tissues like muscle tissue, nervous tissue, etc. Tissues are organised to form organs like heart, brain, etc. Two or more organs together form organ systems and perform common functions like digestion, circulation, nerve impulse transmission in co-ordination via digestive system, circulatory system, nervous system respectively. Division of labour is found among the various organ systems.

Organs Systems	Organs	Functions
Integumentary system	Skin and Skin glands	Protection, Excretion etc.
Skeleton System	Skull, Vertebral column, Sternum, Girdles and Limbs	Give Support, shape and form to the body
Muscular System	Muscle fibres	Contraction and relaxation resulting movement.
Nervous System	Brain, Spinal cord and nerves.	Conduction of nerve impulse
Circulatory System	Heart, blood and blood Vessels	Transportation of respiratory gases, nutritive substances and waste products.
Respiratory System	Respiratory tract and Lungs	Breathing
Digestive System	Digestive tract and digestive glands	Digestion, Absorption, Egestion
Excretory System	Kidneys, Ureters, Urinary bladder and Urethra	Elimination of nitrogenous waste products.
Reproductive System	Testes and Ovary	Gamete formation and development of secondary sexual characters.
Sensory System	Eyes, nose, ears, tongue and skin	Sight, smell, hearing, taste and touch
Endocrine System	Pituitary, Thyroid, Parathyroid, Adrenals, Pancreas, Pineal body, Thymus, Reproductive glands, etc.	Co – ordinates the functions of all organ systems

Human Digestive System

- The food we eat contain not only simple substances like vitamins and minerals but also complex substances such as carbohydrates, proteins and

fats. The body cannot use these complex substances unless they are converted into simple substances. The five stages of nutrition process include ingestion, digestion, absorption, assimilation and egestion.

- The process of nutrition begins with intake of food, called ingestion. The breakdown of large complex insoluble food molecules into small, simpler soluble and diffusible particles by the action of digestive enzymes is called digestion. Parts of the body concerned with the digestion of food form the digestive system.

- The digestive system consists of two sets of organs. They are as follows:

Alimentary canal (digestive tract/gastro-intestinal tract): It is a passage starting from the mouth and ending with the anus.

Digestive glands: Glands associated with the alimentary canal are the salivary glands, gastric glands, pancreas, liver and intestinal glands.

Structure of the Alimentary Canal

- Alimentary canal is a muscular coiled, tubular structure. It consists of mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine (consisting of duodenum, jejunum and ileum), large intestine (consisting of caecum, colon and rectum) and anus.

Mouth: The mouth leads into the buccal cavity. It is bound by two soft, movable upper and lower lips. The buccal cavity is a large space bound above by the palate (which separates the wind pipe and food tube), below by the throat and on the sides by the jaws. The jaws bear teeth.

Teeth: Teeth are hard structures meant for holding, cutting, grinding and crushing the food. In human beings two sets of teeth (Diphyodont) are developed in their life time. The first appearing set of 20 teeth called temporary or milk teeth are replaced by the second set of thirty two permanent teeth, sixteen in each jaw. Each tooth has a root fitted in the gum (Theocodont). Permanent teeth are of four types (Heterodont), according to their structure and function namely incisors, canines, premolars and molars.

- Dental formula represents the number of different type of teeth present in each half of a jaw (upper and lower jaw). The types of teeth are denoted as incisors (i), canine (c), premolars (pm) and molars (m).

For Milk teeth in each half of upper and lower jaw:

$$\frac{2, 1, 2}{2, 1, 2} = 10 \times 2 = 20$$

For Permanent teeth in each half of upper and lower jaw:

$$\frac{2, 1, 2, 3}{2, 1, 2, 3} = 16 \times 2 = 32$$

Types of teeth	Number of teeth	Functions
Incisors	8	Cutting and biting
Canines	4	Tearing and Piercing
Premolars	8	Crushing and grinding
Molars	12	Crushing, grinding and mastication.

Salivary glands: Three pairs of salivary glands are present in the mouth cavity. They are: parotid glands, sublingual glands and submaxillary or submandibular glands

Parotid glands are the largest salivary glands, which lie in the cheeks in front of the ears (in Greek Par - near ; otid - ear).

Sublingual glands are the smallest glands and lie beneath the tongue.
Submaxillary or Submandibular glands lie at the angles of the lower jaw.

- The salivary glands secrete a viscous fluid called saliva, approximately 1.5 liters per day. It digests starch by the action of the enzyme ptyalin (amylase) in the saliva which converts starch (polysaccharide) into maltose (disaccharide). Saliva also contain an antibacterial enzyme called lysozyme.

- ✓ **Tongue:** The tongue is a muscular, sensory organ which helps in mixing the food with the saliva. The taste buds on the tongue help to recognize the taste of food. The masticated food in the buccal cavity becomes a bolus which is rolled by the tongue and passed through pharynx into the oesophagus by swallowing. During swallowing, the epiglottis (a muscular flap-like structure at the tip of the glottis, beginning of trachea) closes and prevents the food from entering into trachea (wind pipe).

- ✓ **Pharynx:** The pharynx is a membrane lined cavity behind the nose and mouth, connecting them to the oesophagus. It serves as a pathway for the movement of food from mouth to oesophagus.

- ✓ **Oesophagus:** Oesophagus or the food pipe is a muscular-membranous canal about 22 cm in length. It conducts food from pharynx to the stomach by peristalsis (wave-like movement) produced by the rhythmic contraction and relaxation of the muscular walls of alimentary canal.

- ✓ **Stomach:** The stomach is a wide J-shaped muscular organ located between oesophagus and the small intestine. The gastric glands present in the inner walls of the stomach secrete gastric juice. The gastric juice is colourless, highly acidic, containing mucus, hydrochloric acid and enzymes rennin (in infants) and pepsin.

- Inactive pepsinogen is converted to active pepsin which acts on the proteins in the ingested food. Hydrochloric acid kills the bacteria swallowed along with food and makes the medium acidic while the mucus protects the wall of the stomach. The action of the gastric juice and churning of food in the stomach convert the bolus into a semi-digested food called chyme. The chyme moves to the intestine slowly through the pylorus.

  - ✓ **Small intestine:** The small intestine is the longest part of the alimentary canal, which is a long coiled tube measuring about 5 – 7 m. It comprises three parts- duodenum, jejunum and ileum.

  - ✓ **Duodenum** is C-shaped and receives the bile duct (from liver) and pancreatic duct (from pancreas).

- ✓ **Jejunum** is the middle part of the small intestine. It is a short region of the small intestine. The secretion of the small intestine is intestinal juice which contains the enzymes like sucrase, maltase, lactase and lipase.

- ✓ **Ileum** forms the lower part of the small intestine and opens into the large intestine. Ileum is the longest part of the small intestine. It contains minute finger like projections called villi (one millimeter in length) where absorption of food takes place. They are approximately 4 million in number. Internally, each villus contains fine blood capillaries and lacteal tubes.

- The small intestine serves both for digestion and absorption. It receives the bile from liver and the pancreatic juice from pancreas in the duodenum. The intestinal glands secrete the intestinal juices.

William Beaumont (1785-1853)

William Beaumont was a surgeon who was known as the 'Father of Gastric Physiology'. Based on his observations he concluded that the stomach's strong hydrochloric acid played a key role in digestion.

- ✓ **Liver:** It is the largest digestive gland of the body which is reddish brown in colour. It is divided into two main lobes, right and left lobes. The right lobe is larger than the left lobe. On the under surface of the liver, gall bladder is present. The liver cells secrete bile which is temporarily stored in the gall bladder. Bile is released into small intestine when food enters in it. It has bile salts (sodium glycolate and sodium tauraglycolate) and bile pigments (bilirubin and biliviridin). Bile salts help in the digestion of fats by bringing about their emulsification (conversion of large fat droplets into small ones).

Functions of Liver

- ➢ Controls blood sugar and amino acid levels.
- ➢ Synthesizes foetal red blood cells.
- ➢ Produces fibrinogen and prothrombin, used for clotting of blood.
- ➢ Destroys red blood cells.
- ➢ Stores iron, copper, vitamins A and D.
- ➢ Produces heparin (an anticoagulant).
- ➢ Excretes toxic and metallic poisons.
- ➢ Detoxifies substances including drugs and alcohol.

- ✓ **Pancreas:** It is a lobed, leaf shaped gland situated between the stomach and duodenum. Pancreas acts both as an exocrine gland and as an endocrine gland. The exocrine part of the pancreatic gland secretes pancreatic juice which contains three enzymes- lipase, trypsin and amylase which acts on fats, proteins and starch respectively. The gland's upper surface bears the islets of Langerhans which have endocrine cells and secrete hormones in which α (alpha) cells secrete glucagon and β (beta) cells secrete insulin.

- The intestinal glands secrete intestinal juice called succus entericus which contains enzymes like maltase, lactase, sucrase and lipase which act in an alkaline medium. From the duodenum the food is slowly moved down to ileum, where the digested food gets absorbed

- **Absorption of food:** Absorption is the process by which nutrients obtained after digestion are absorbed by villi and circulated throughout the body by blood and lymph and supplied to all body cells according to their requirements.

- **Assimilation of food:** Assimilation means the incorporation of the absorbed food materials into the tissue cells as their internal and homogenous component. The final products of fat digestion (fatty acids and glycerol) are again converted into fats and excess fats are stored in adipose tissue. The excess sugars are converted into a complex polysaccharide, glycogen in the liver. The amino acids are utilized to synthesize different proteins required for the body.

The small intestine is about 5 m long and is the longest part of the digestive system. The large intestine is a thicker tube, but is about 1.5 m long.

Large intestine: The unabsorbed and undigested food is passed into the large intestine. It extends from the ileum to the anus. It is about 1.5 meters in length. It has three parts- caecum, colon and rectum.

- The caecum is a small blind pouch like structure situated at the junction of the small and large intestine. From its blind end a finger – like structure

called vermiform appendix arises. It is a vestigeal (functionless) organ in human beings.

- The colon is much broader than ileum. It passes up the abdomen on the right (ascending colon), crosses to the left just below the stomach (transverse colon) and down on the left side (descending colon). The rectum is the last part which opens into the anus. It is kept closed by a ring of muscles called anal sphincter which opens when passing stools.

- The undigested or unassimilated portion of the ingested food material is thrown out from the body through the anal aperture as faecal matter. This is known as egestion or defaecation.

Digestive Glands	**Enzymes**	**Substrate (nutrient)**	**Products of digestion**
Salivary glands	Ptyalin (Salivary amylase)	Starch	Maltose
Gastric glands	Pepsin	Proteins	Peptones
	Rennin (in infants)	Milk protein or caseinogen	Curdles milk to produce casein protein
Pancreas	Pancreatic amylase	Starch	Maltose
	Trypsin	Proteins and peptones	Peptides and amino acids
	Chymotrypsin	Protein	Proteoses, peptones, Polypeptide, tri and dipepetides
	Pancreatic lipase	Emulsified fats	Fatty acids and Glycerol
Intestinal Glands	Maltase	Maltose	Glucose and Glucose
	Lactase	Lactose	Glucose and Galactose
	Sucrase	Sucrose	Glucose and Fructose
	Lipase	Fats	Fatty acids and Glycerol

Human Excretory System

- Metabolic activities continuously take place in living cells. All metabolic products produced by the biochemical reactions are not utilized by the body because certain nitrogenous toxic waste substances are also produced. They are called excretory products. In human beings urea is the major excretory product. The tissues and organs associated with the removal of waste products constitute the excretory system.

- The human excretory system consists of a pair of kidney, which produce the urine, a pair of ureters which conduct the urine from kidneys to the urinary bladder, where urine is stored temporarily and urethra through which the urine is voided by bladder contractions.

- If the waste products are accumulated and not eliminated, they become harmful and poisonous to the body. Hence, excretion plays an important role in maintaining the homeostatic condition of the body.

- Some of the excretory organs other than kidneys are skin (removes small amounts of water, urea and salts in the form of sweat) and lungs (eliminate carbon-dioxide and water vapour through exhaling).

Skin

- Skin is the outer most covering of the body. It stretches all over the body in the form of a layer. It accounts for 15% of an adult's human body weight. There are many structures and glands derived from the skin. It eliminates metabolic wastes through perspiration.

- The human body functions normally at a temperature of about 37 0C. When it gets hot sweat glands start secreting sweat, which contains water with small amounts of other chemicals like ammonia, urea, lactic acid and salts (mainly sodium chloride). The sweat passes through the pores in the skin and gets evaporated.

Kidneys

- Kidneys are bean-shaped organs reddish brown in colour. The kidneys lie on either side of the vertebral column in the abdominal cavity attached to

the dorsal body wall. The right kidney is placed lower than the left kidney as the liver takes up much space on the right side. Each kidney is about 11 cm long, 5 cm wide and 3 cm thick. The kidney is covered by a layer of fibrous connective tissue, the renal capsules, adipose capsule and a fibrous membrane.

- Internally the kidney consists of an outer dark region, the cortex and an inner lighter region, the medulla. Both of these regions contain uriniferous tubules or nephrons. The medulla consists of multitubular conical masses called the medullary pyramids or renal pyramids whose bases are adjacent to cortex. On the inner concave side of each kidney, a notch called hilum is present through which blood vessels and nerves enter in and the urine leaves out.

✓ **Ureters:** Ureters are thin muscular tubes emerging out from the hilum. Urine enters the ureter from the renal pelvis and is conducted along the ureter by peristaltic movements of its walls. The ureters carry urine from kidney to urinary bladder.

✓ **Urinary bladder:** Urinary bladder is a sac-like structure, which lies in the pelvic cavity of the abdomen. It stores urine temporarily.

✓ **Urethra:** Urethra is a membranous tube, which conducts urine to the exterior. The urethral sphincters keep the urethra closed and opens only at the time of micturition (urination).

Functions of kidney

- Maintains the fluid and electrolytes balance in our body.
- Regulates acid-base balance of blood.
- Maintains the osmotic pressure in blood and tissues.
- Helps to retain the important plasma constituents like glucose and amino acids

Structure of Nephron

- Each kidney consists of more than one million nephrons. Nephrons or uriniferous tubules are structural and functional units of the kidneys. Each nephron consists of Renal corpuscle or Malphigian corpuscle and renal tubule. The renal corpuscle consists of a cup-shaped structure called Bowman's capsule containing a bunch of

capillaries called glomerulus. Blood enters the glomerular capillaries through afferent arterioles and leaves out through efferent arterioles. The Bowman's capsule continues as the renal tubule which consists of three regions proximal convoluted tubule, U-shaped hair pin loop, the loop of Henle and the distal convoluted tubule. The distal convoluted tubule opens into the collecting tubule. The nitrogenous wastes are drained into renal pelvis which leads to ureters and stored in the urinary bladder. Urine is expelled out through the urethra.

Mechanism of Urine Formation

The process of urine formation includes the following three stages.

- Glomerular filtration
- Tubular reabsorption
- Tubular secretion

Glomerular filtration: Urine formation begins with the filtration of blood through epithelial walls of the glomerulus and Bowman's capsule. The filtrate is called as the glomerular filtrate. Both essential and non-essential substances present in the blood are filtered.

Tubular reabsorption: The filtrate in the proximal tubule consists of essential substances such as glucose, amino acids, vitamins, sodium, potassium, bicarbonates and water that are reabsorbed into the blood by a process of selective reabsorption.

Tubular secretion: Substances such as H+ or K+ ions are secreted into the tubule. This tubular filtrate is finally known as urine, which is hypertonic in man. Finally the urine passes into collecting ducts to the pelvis and through the ureter into the urinary bladder. When the urinary bladder is full the urine is expelled out through the urethra. This process is called micturition. A healthy person excretes one to two litres of urine per day.

Two healthy kidneys contain a total of about 2 million nephrons, which filter about 1700-1800 litres of blood. The kidneys reabsorb and redistribute 99% of the blood volume and only 1% of the blood filtered becomes urine.

Dialysis or Artificial kidney: When kidneys lose their filtering efficiency, excessive amount of fluid and toxic waste accumulate in the body. This condition is known as kidney (renal) failure. For this, an artificial kidney is used to filter the blood of the patient. The patient is said to be put on dialysis

and the process of purifying blood by an artificial kidney is called haemodialysis. When renal failure cannot be treated by drug or dialysis, the patients are advised for kidney transplantation.

First kidney transplant

In 1954, Joseph E.Murray and his colleagues at Peter Bent Brigham Hospital in Boston, USA performed first succesful kidney transplant between Ronald and Richard Herrick who were identical twins. The recepient Richard Herrick died after 8 years of transplantation

Human Reproductive System

- The capacity to reproduce is one of the most important characteristics of living beings. There is a distinct sexual dimorphism in human beings i.e., males are visibly different from females in physical build up, external genital organs and secondary sexual characters.

- The reproductive systems of male and female consist of many organs which are distinguished as primary and secondary sex organs. The primary sex organs are gonads, which produce gametes (sex cells) and secrete sex hormones. The secondary sex organs include the genital ducts and glands which help in the transportation of gametes and enable the reproductive process.

- The reproductive organs become functional after attaining sexual maturity. In males, sexual maturity is attained at the age of 13-14 years. In females, it is attained at the age of 11-13 years. This age is known as the age of puberty. During sexual maturity, hormonal changes take place in males and females and secondary sexual characters are developed under the influence of these hormones.

Male Reproductive System

- Human male reproductive system consists of testes (primary sex organs), scrotum, vas deferens, urethra, penis and accessory glands.

Testis: A pair of testes lies outside the abdominal cavity of the male. These testes are the male gonads, which produce male gametes (sperms) and male sex hormone (Testosterone). Along the inner side of each testis lies a mass of

coiled tubules called epididymis. The Sertoli cells of the testes provide nourishment to the developing sperms.

Scrotum: The scrotum is a loose pouch-like sac of skin which is divided internally into right and left scrotal sacs by muscular partition. The two testes lie in the respective scrotal sacs. It also contains many nerves and blood vessels. The scrotum acts as a thermoregulator organ and provides an optimum temperature for the formation of sperms. The sperms develop at a temperature of 1-3^0 C lower than the normal body temperature.

Vas deferens: It is a straight tube which carries the sperms to the seminal vesicles. The sperms are stored in the seminal plasma of seminal vesicle, which is rich in fructose, calcium and enzymes. Fructose is a source of energy for the sperm. The vas deferens along with seminal vesicles opens into ejaculatory duct which expels the sperm and its secretions from seminal vesicles into the urethra.

Urethra: It is contained inside the penis and conveys the sperms from the vas deferens which pass through the urethral opening. The accessory glands associated with the male reproductive system consist of seminal vesicles, prostate gland and Cowper's glands. The secretions of these glands form seminal fluid and mixes with the sperm to form semen. This fluid provides nutrition and helps in the transport of sperms.

The sperm is the smallest cell in the male body. A normal male produces more than 500 billion sperm cells in his life time. The process of formation of sperms is known as spermatogenesis.

Female Reproductive System

- The female reproductive system consists of ovaries (primary sex organs), oviducts, uterus and vagina.

Ovaries: A pair of almond-shaped ovaries is located in the lower part of abdominal cavity near the kidneys in female. The ovaries are the female gonads, which produce female gametes (eggs or ova) and secrete female sex hormones (Oestrogen and Progesterone).A mature ovary contains a large number of ova in different stages of development.

Fallopian tubes (Oviducts): These are paired tubes originating from uterus, one on either side. The terminal part of fallopian tube is funnel-shaped with finger-like projections called fimbriae lying near the ovary. The fimbriae pick up the ovum released from ovary and push it into the fallopian tube.

Uterus: Uterus is a pear-shaped muscular, hollow structure present in the pelvic cavity. It lies between urinary bladder and rectum.
Development of foetus occurs inside the uterus. The narrower lower part of uterus is called cervix, which leads into vagina.

Vagina: The uterus narrows down into a hollow muscular tube called vagina. It connects cervix and the external genitalia. It receives the sperms, acts as birth canal during child birth (parturition).

10th std

Unit 13 – Structural Organization of Animals

Introduction

- The variety in nature and habits of animals in the biosphere are quite amazing and interesting. What we see around us may be just few, but there are innumerable species living in this world. You have learnt in lower classes about the classification of animal kingdom. We will recall here that 'Kingdom Animalia' is divided into two groups, Invertebrates and Chordates.

- There occurs a great diversity in the habit, habitat, structural organisation and mode of reproduction between the animals existing on earth. In this chapter, you will understand the structural morphology and anatomy of an Invertebrate (Leech) and a Vertebrate (Rabbit).

- The scientific name of the Indian cattle leech is Hirudinaria granulosa which belongs to Phylum Annelida. Annelids are metamerically segmented worms with well developed organ systems.

- The scientific name of the common rabbit is Oryctolagus cuniculus. It is represents Phylum Chordata and Class Mammalia. Mammals occupy the highest group in the animal kingdom and show advancement over the other groups of animals. They are warm blooded and possess covering of hair on the body. Mammary gland in females is the most striking feature of a mammal.

Respiratory System

- Respiration takes place through the skin in leech. Dense network of tiny blood vessels called as capillaries containing the haemocoelic fluid extend in between the cells of the epidermis. The exchange of respiratory gases takes place by diffusion. Oxygen dissolved in water diffuses through the skin into haemocoelic fluid, while carbon dioxide diffuses out. The skin is

kept moist and slimy due to secretion of mucus which also prevents it from drying.

Circulatory System

- In leech, circulation is brought about by haemocoelic system. There are no true blood vessels. The blood vessels are replaced by channels called haemocoelic channels or canals filled with blood like fluid. The coelomic fluid contains haemoglobin.

- There are four longitudinal channels. One channel lies above (dorsal) the alimentary canal, one below (ventral) the alimentary canal. The other two channels lie on either (lateral) side of the alimentary canal which serve as heart and have inner valves. All the four channels are connected together posteriorly in the 26th segment.

Nervous System

- The central nervous system of leech consists of a nerve ring and a paired ventral nerve cord. The nerve ring surrounds the pharynx and is formed of suprapharyngeal ganglion (brain), circumpharyngeal connective and subpharyngeal ganglion. The subpharyngeal ganglion lies below the pharynx and is formed by the fusion of four pairs of ganglia.

Excretory System

- In leech, excretion takes place by segmentally arranged paired tubules called nephridia. There are 17 pairs of nephridia which open out by nephridiopores from 6th to 22nd segments.

Reproductive System

- Leech is hermaphrodite because both the male and female reproductive organs are present in the same animal.

Male Reproductive System

- There are eleven pairs of testes, one pair in each segment from 12 to 22 segments. They are in the form of spherical sacs called testes sacs. From each testis arises a short duct called vas efferens, which join with the vas

deferens. The vas deferens becomes convoluted to form the epididymis or sperm vesicle, to store spermatozoa.

- The epididymis leads to a short duct called ejaculatory duct. The ejaculatory ducts on both sides join to form the genital atrium. The atrium consists of two regions, the coiled prostate glands and the penial sac consisting of penis that opens through the male genital pore.

Female Reproductive System

- It consists of ovaries, oviducts and vagina. There is a single pair of ovary in the 11th segment on the ventral side. Each ovary is a coiled ribbon-shaped structure.
- The ova are budded off from the ovary. From each ovary runs a short oviduct. The oviducts of the two sides joins together, to form a common oviduct. The common oviduct opens into a pear-shaped vagina which lies mid-ventrally in the posterior part of the 11th segment.

Development

- Internal fertilization takes place. This is followed by cocoon formation. Cocoon is also known as egg case which is formed around the 9_{th}, 10_{th} and 11_{th} segments.

- Development is direct and proceeds in cocoon which contain one to 24 embryos.

- Young leech resembling the adult emerges.

Parasitic Adaptations of Leech

- Leeches lead a parasitic mode of life by sucking the blood of vertebrates and show several important adaptations in their structure.

- Blood is sucked by pharynx.
- Anterior and posterior ends of the body are provided with suckers by which the animal attaches itself to the body of the host.
- The three jaws inside the mouth, causes a painless Y-shaped wound in the skin of the host.

- The salivary glands produce hirudin which does not allow the blood to coagulate. Thus, a continuous supply of the blood is maintained.
- Parapodia and setae are completely absent
- Blood is stored in the crop. It gives nourishment to the leech for several months. Due to this reason there is no elaborate secretion of the digestive juices and enzymes

Blood letting is a technique of bleeding in a patient to remove toxic impurities from the body

Habit and Habitat

- Rabbits are gentle and timid animals. They show leaping movement and live in burrows.

- They are distributed throughout the world. They are herbivorous animals feeding on grass and vegetables like turnips, carrots and lettuce. Rabbits are gregarious (moving in groups) animals.

The pygmy rabbit was listed as a threatened species in Washington in 1990, because of decline in its population size and distribution due to habitat loss. In March 2003, the Columbia Basin Pygmy Rabbit was federally listed as an endangered species

Shape, Size and Colouration: It has an elongated and cylindrical body. Males and females are of the same size. They grow about 45 cm in length and weigh about 2.25 kg as adult. The colour varies from white to black and white. Body is covered with fur which serves to keep it warm.

Body-division: The body of the rabbit is divisible into the head, neck, trunk and tail.

Head: Head is ovoid, flattened and bears a truncate snout. It contains mouth, external nares, eyes, ears and vibrissae. The mouth is a transverse slit-like bounded by upper lip and lower lip. Just above the mouth are two oblique openings called nostrils. From each side of the upper lip tactile hairs or vibrissae (whiskers) project outwards. A pair of large, movable external ear or pinnae is situated at the top of the head.

Neck: The neck connects the head with the trunk. It helps to turn the head.

Trunk: The trunk is divisible into an anterior thorax and a posterior abdomen. In females, four or five teats or nipples are present on the ventral surface between the thorax and abdomen.

- The trunk bears two pairs of pentadactyl limbs. The forelimbs are shorter than the hind limbs. All the digits bear claws.

- The anus is present at the posterior end of the abdomen at the base of tail. In females on the ventral side a slit like vulva is present. In males penis is present in the ventral side of anus. The male has a pair of testes enclosed by scrotal sacs.

Tail: The tail is short. It is used to give signals to other rabbits in the event of danger.

Integument (Skin): The integument forms the outer covering of the body. The structures which are derived from it are hairs, claws, nails and glands like sweat glands, sebaceous glands and mammary glands.

- Mammary glands are modified glands of the skin. They secrete milk and help in nourishing young ones. The sweat glands and sebaceous glands embedded in the skin regulate the body temperature.

Coelom (Body cavity)

- Rabbit is a coelomate animal. The body is divisible into thoracic cavity and abdominal cavity separated by transverse partition called diaphragm. Diaphragm is the characteristic feature of mammals. Breathing movements are brought by the movement of the diaphragm.

- Lungs and heart lie in the thoracic cavity, whereas, abdominal cavity encloses digestive and urinogenital system.

Digestive System

- The digestive system includes the alimentary canal and the associated digestive glands. The alimentary canal consists of mouth, buccal cavity,

pharynx, oesophagus, stomach, small intestine, caecum, large intestine and anus.

- Mouth is a transverse slit bounded by upper and lower lips. It leads into the buccal cavity. The floor of the buccal cavity is occupied by a muscular tongue. Jaws bear teeth.

- The buccal cavity leads into the oesophagus through the pharynx. Oesophagus opens into the stomach followed by small intestine. Caecum is a thin walled sac present at the junction of small intestine and large intestine. It contains bacteria that helps in digestion of cellulose. The small intestine opens into the large intestine which has colon and rectum. The rectum finally opens outside by the anus.

Digestive glands

- The digestive glands are salivary glands, gastric glands, liver, pancreas and intestinal glands. The secretions of digestive glands help in digestion of food in the alimentary canal.

Dentition in Rabbit

- Teeth are hard bone-like structures used to cut, tear and grind the food materials. The two sets of teeth in the life of an animal is called diphyodont dentition. The two types of teeth are milk teeth (young ones) and permanent teeth (in adults).

- In rabbit the teeth are of different types. Hence, the dentition is called heterodont. There are four kinds of teeth in mammals viz. the incisors (I), canines (C), premolars (PM) and molars (M). This is expressed in the form of a dental formula.

- Dental formula is the simple method of representing the teeth of a mammal. The number of each kind of tooth in the upper and the lower jaws on one side is counted.

the lower jaws on one side is counted.

Dental formula is $(I\ \frac{2}{1}, C\ \frac{0}{0}, PM.\ \frac{3}{2}, M\ \frac{3}{3}.)$ in rabbit which is written as $\frac{2033}{1023}$. Canines

- Canines are absent. The gap between the incisors and premolar is called diastema. It helps in mastication and chewing of food in herbivorous animals.

Respiratory System

- Respiration takes place by a pair of lungs, which are light spongy tissues enclosed in the thoracic cavity. The thoracic cavity is bound dorsally by the vertebral column and ventrally by the sternum, laterally by the ribs. On the lower side of the thoracic cavity is the dome shaped diaphragm.

- Each lung is enclosed by a double membranous pleura. Atmospheric air passes through the external nostril and nasal passages into the pharynx. From the pharynx it passes through the glottis into the wind pipe.

- The anterior part of the wind pipe is enlarged to form the larynx or voice box with its wall supported by four cartilaginous plates. Inside the larynx lies the vocal cord and its vibrations result in the production of sound. The larynx leads into trachea or wind pipe.

- Tracheal walls are supported by rings of cartilage which help in the free passage of air. The epiglottis prevents the entry of food into the trachea through the glottis. The trachea divides into two branches called the bronchi one entering into each lung and dividing into further branches called bronchioles which end in alveoli.

The respiratory events consist of inspiration (breathing in) and expiration (breathing out) allowing exchange of gases (oxygen and carbon dioxide). Inspiration is an active process while expiration is a passive process.

Circulatory System

- The circulatory system is formed of blood, blood vessels and heart. The heart is pear shaped and lies in the thoracic cavity in between the lungs. It is enclosed by pericardium, a double layered membrane.

- The heart is four chambered with two auricles and two ventricles. The right and left auricles are separated by interauricular septum, similarly right and left ventricles are separated by interventricular septum.

- The right auricle opens into the right ventricle by right auriculoventricular aperture, guarded by a tricuspid valve. The left auricle opens into the left ventricle by left auriculoventricular aperture guarded by a bicuspid valve or mitral valve. The opening of the pulmonary artery and aorta are guarded by three semilunar valves.

- The right auricle receives deoxygenated blood through two precaval (superior vena cava) and one postcaval (inferior vena cava) veins from all parts of the body. The left auricle receives oxygenated blood from the pulmonary veins from the lungs. From the right ventricle arises pulmonary trunk which carries the deoxygenated blood to the lungs and from the left ventricle arises the systemic arch (aorta) which supplies oxygenated blood to all parts of the body.

Nervous System

- The nervous system in rabbit is formed of the central nervous system (CNS), peripheral nervous system (PNS) and autonomic nervous system (ANS).

- CNS consists of brain and spinal cord. PNS is formed of 12 pairs of cranial nerves and 37 pairs of spinal nerves. ANS comprises sympathetic and parasympathetic nerves.

- Brain is situated in the cranial cavity and covered by three membranes called an outer duramater, an inner piamater and a middle arachnoid membrane. The brain is divided into forebrain (prosencephalon), midbrain (mesencephalon) and hindbrain (rhombencephalon).

- Forebrain consists of a pair of olfactory lobes, cerebral hemispheres and diencephalon. The right and left cerebral hemispheres are connected by transverse band of nerve tissue called corpus callosum.

- The midbrain includes the optic lobes. The hindbrain consists of the cerebellum, pons varolii and medulla oblongata.

Urinogenital System

- It comprises the urinary or excretory system and the genital or reproductive system. Therefore, they are usually described as urinogenital system in vertebrates.

Excretory system

- Each kidney is made of several nephrons. It separates the nitrogenous wastes from blood and excretes it in the form of urea. Kidneys are dark red, bean shaped organs situated in the abdominal cavity. From each kidney arises the ureters which open posteriorly into the urinary bladder and leads into a thick walled muscular duct called urethra.

Reproductive System

- Sexual dimorphism is exhibited in rabbits. The male and female sexes are separate and are morphologically different.

Male Reproductive system

- The male reproductive system of rabbit consists of a pair of testes which are ovoid in shape. Testes are enclosed by scrotal sacs in the abdominal cavity. Each testis consists of numerous fine tubules called seminiferous tubules. This network of tubules lead into a coiled tubule called epididymis, which lead into the sperm duct called vas deferens. The vas deferens join in the urethra just below the urinary bladder. The urethra runs backward and passes into the penis.

- There are three accessory glands namely prostate gland, cowper's gland and perineal gland. Their secretions are involved in reproduction.

Female reproductive system

- The female reproductive system of rabbit consists of a pair of ovaries which are small ovoid structures. They are located behind the kidneys in the abdominal cavity.

- A pair of oviducts opens into the body cavity by a funnel shaped opening from each side of the ovary. The anterior part of the oviduct is the fallopian tube. It leads into a wider tube called the uterus. The uterus join together to form a median tube called vagina. The common tube is formed by the union of urinary bladder and the vagina and is called the urinogenital canal or vestibule. It runs backwards and opens to the exterior by a slit-like aperture called vulva.

- A pair of Cowper's gland and perineal gland are the accessory glands present in the female reproductive system.

10th std
Unit 16 – Plant Animal Harmones

Human Endocrine Glands

- Endocrine glands in animals possess a versatile communication system to coordinate biological functions. Exocrine glands and endocrine glands are two kinds of glands found in animals. Endocrine glands are found in different regions of the body of animals as well as human beings. These glands are called ductless glands. Their secretions are called hormones which are produced in minute quantities. The secretions diff use into the blood stream and are carried to the distant parts of the body. They act on specific organs which are referred as target organs.

The branch of biology which deals with the study of the endocrine glands and its physiology is known as 'Endocrinology'. Thomas Addison is known as Father of Endocrinology. English physiologists W. M. Bayliss and E. H. Starling introduced the term hormone in 1909. They first discovered the hormone secretin

- Exocrine glands have specific ducts to carry their secretions e.g. salivary glands, mammary glands, sweat glands.

Endocrine glands present in human and other vertebrates are

- Pituitary gland
- Thyroid gland
- Parathyroid gland
- Pancreas (Islets of Langerhans)
- Adrenal gland (Adrenal cortex and Adrenal medulla)
- Gonads(Testes and Ovary)
- Thymus gland

Pituitary Gland

- The pituitary gland or hypophysis is a pea shaped compact mass of cells located at the base of the midbrain attached to the hypothalamus by a pituitary stalk. The pituitary gland is anatomically composed of two lobes and perform different functions. They are the anterior lobe

(adenohypophysis) and the posterior lobe (neurohypophysis). The intermediate lobe is non-existent in humans.

- The pituitary gland forms the major endocrine gland in most vertebrates. It regulates and controls other endocrine glands and so is called as the "Master gland".

- Hormones secreted by the anterior lobe (Adenohypophysis) of pituitary

- The anterior pituitary is composed of different types of cells and secrete hormones which stimulates the production of hormones by other endocrine glands. The hormones secreted by anterior pituitary are

- Growth Hormone
- Thyroid stimulating Hormone
- Adrenocorticotropic Hormone
- Gonadotropic Hormone which comprises the Follicle Stimulating Hormone and Luteinizing Hormone
- Prolactin

Growth hormone (GH)

- GH promotes the development and enlargement of all tissues of the body. It stimulates the growth of muscles, cartilage and long bones. It controls the cell metabolism.

- The improper secretion of this hormone leads to the following conditions.

Dwarfism: It is caused by decreased secretion of growth hormone in children. The characteristic features are stunted growth, delayed skeletal formation and mental disability.

Gigantism: Oversecretion of growth hormone leads to gigantism in children. It is characterised by overgrowth of all body tissues and organs. Individuals attain abnormal increase in height.

Acromegaly: Excess secretion of growth hormone in adults may lead to abnormal enlargement of head, face, hands and feet.

Thyroid stimulating hormone (TSH)

- TSH controls the growth of thyroid gland, coordinates its activities and hormone secretion.

Adrenocorticotropic hormone (ACTH)

- ACTH stimulates adrenal cortex of the adrenal gland for the production of its hormones. It also influences protein synthesis in the adrenal cortex.

Gonadotropic hormones (GTH)

- The gonadotropic hormones are follicle stimulating hormone and luteinizing hormone which are essential for the normal development of gonads.

Follicle stimulating hormone (FSH)

- In male, it stimulates the germinal epithelium of testes for formation of sperms. In female it initiates the growth of ovarian follicles and its development in ovary.

Luteinizing hormone (LH)

- In male, it promotes the Leydig cells of the testes to secrete male sex hormone testosterone. In female, it causes ovulation (rupture of mature graafian follicle), responsible for the development of corpus luteum and production of female sex hormones estrogen and progesterone.

Prolactin (PRL)

- PRL is also called lactogenic hormone. This hormone initiates development of mammary glands during pregnancy and stimulates the production of milk after child birth.

Hormones secreted by the posterior lobe (Neurohypophysis) of pituitary

The hormones secreted by the posterior pituitary are

- Vasopressin or Antidiuretic hormone

- Oxytocin

Vasopressin or Antidiuretic hormone (ADH)

- In kidney tubules it increases reabsorption of water. It reduces loss of water through urine and hence the name antidiuretic hormone.

- Deficiency of ADH reduces reabsorption of water and causes an increase in urine output (polyuria). This deficiency disorder is called Diabetes insipidus.

Oxytocin

- It helps in the contraction of the smooth muscles of uterus at the time of child birth and milk ejection from the mammary gland after child birth.

Thyroid Gland

- The thyroid gland is composed of two distinct lobes lying one on either side of the trachea. The two lobes are connected by means of a narrow band of tissue known as the isthmus. This gland is composed of glandular follicles and lined by cuboidal epithelium.The follicles are filled with colloid material called thyroglobulin.

An amino acid tyrosine and iodine are involved in the formation of thyroid hormone. The hormones secreted by the thyroid gland are

- Triiodothyronine (T3)
- Tetraiodothyronine or Thyroxine (T4)

Functions of thyroid hormones

The functions of thyroid hormones are

- Production of energy by maintaining the Basal Metabolic Rate (BMR) of the body.
- Helps to maintain normal body temperature.
- Influences the activity of central nervous system.
- Controls growth of the body and bone formation.
- Essential for normal physical, mental and personality development .

- It is also known as personality hormone.
- Regulates cell metabolism.

Thyroid Dysfunction

- When the thyroid gland fails to secrete the normal level of hormones, the condition is called thyroid dysfunction. It leads to the following conditions

Hypothyroidism

- It is caused due to the decreased secretion of the thyroid hormones. The abnormal conditions are simple goitre, cretinism and myxoedema.

Goitre

- It is caused due to the inadequate supply of iodine in our diet. This is commonly prevalent in Himalayan regions due to low level of iodine content in the soil. It leads to the enlargement of thyroid gland which protrudes as a marked swelling in the neck and is called as goitre.

Cretinism

- It is caused due to decreased secretion of the thyroid hormones in children. The conditions are stunted growth, mental defect, lack of skeletal development and deformed bones. They are called as cretins.

Myxoedema

- It is caused by deficiency of thyroid hormones in adults. They are mentally sluggish, increase in body weight, puffiness of the face and hand, oedematous appearance.

Hyperthyroidism

- It is caused due to the excess secretion of the thyroid hormones which leads to Grave's disease. The symptoms are protrusion of the eyeballs (Exopthalmia), increased metabolic rate, high body temperature, profuse sweating, loss of body weight and nervousness.

Parathyroid Gland

- The parathyroid glands are four small oval bodies that are situated on the posterior surface of the thyroid lobes. The chief cells of the gland are mainly concerned with secretion of parathormone.

Functions of Parathormone

- The parathormone regulates calcium and phosphorus metabolism in the body.They act on bone, kidney and intestine to maintain blood calcium levels.

Parthyroid Dysfunction

- The secretion of parathyroid hormone can be altered due to the following conditions.

Removal of parathyroid glands during thyroidectomy (removal of thyroid) causes decreased secretion of parathormone. The conditions are

- Muscle spasm known as Tetany (sustained contraction of muscles in face, larynx, hands and feet).
- Painful cramps of the limb muscles

Pancreas (Islets of Langerhans)

- Pancreas is an elongated, yellowish gland situated in the loop of stomach and duodenum. It is exocrine and endocrine in nature. The exocrine pancreas secretes pancreatic juice which plays a role in digestion while, the endocrine portion is made up of Islets of Langerhans

- The Islets of Langerhans consists of two types of cells namely alpha cells and beta cells. The alpha cells secrete glucagon and beta cells secrete insulin.

Functions of Pancreatic hormones

- A balance between insulin and glucagon production is necessary to maintain blood glucose concentration.

Insulin

- Insulin helps in the conversion of glucose into glycogen which is stored in liver and skeletal muscles.
- It promotes the transport of glucose into the cells.
- It decreases the concentration of glucose in blood.

Glucagon

- Glucagon helps in the breakdown of glycogen to glucose in the liver.
- It increases blood glucose levels.

Diabetes mellitus

The deficiency of insulin causes Diabetes mellitus. It is characterised by
- Increase in blood sugar level (Hyperglycemia).
- Excretion of excess glucose in the urine (Glycosuria).
- Frequent urination (Polyuria).
- Increased thirst (Polydipsia).
- Increase in appetite (Polyphagia).

Human insulin was first discovered by Fredrick Banting, Charles Best and MacLeod in 1921. Insulin was first used in treatment of diabetes on 11th January 1922.

Adrenal Gland

- The adrenal glands are located above each kidney. They are also called supra renal glands.
- The outer part is the adrenal cortex and the inner part is the adrenal medulla. The two distinct parts are structurally and functionally different.

Adrenal Cortex

- The adrenal cortex consists of three layers of cells. They are zona glomerulosa, zona fasciculata and zona reticularis

Hormones of Adrenal Cortex

The hormones secreted by the adrenal cortex are corticosteroids. They are classified into

- Glucocorticoids
- Mineralocorticoids

Functions of adrenocortical hormones

Glucocorticoids

- The glucocorticoids secreted by the zona fasciculata are cortisol and corticosterone

- They regulate cell metabolism.
- It stimulates the formation of glucose from glycogen in the liver.
- It is an anti-inflammatory and anti-allergic agent.

Mineralocorticoids

- The mineralocorticoids secreted by zona glomerulosa is aldosterone

- It helps to reabsorb sodium ions from the renal tubules.
- It causes increased excretion of potassium ions.
- It regulates electrolyte balance, body fluid volume, osmotic pressure and blood pressure.

Adrenal Medulla

- The adrenal medulla is composed of chromaffin cells. They are richly supplied with sympathetic and parasympathetic nerves.

Hormones of Adrenal Medulla

It secretes two hormones namely

- Epinephrine (Adrenaline)
- Norepinephrine (Noradrenaline)

- They are together called as "Emergency hormones". It is produced during conditions of stress and emotion. Hence it is also referred as "flight, fright and fight hormone".

Functions of adrenal medullary hormones

Epinephrine (Adrenaline)

- It promotes the conversion of glycogen to glucose in liver and muscles.
- It increases heart beat and blood pressure.
- It increases the rate of respiration by dilation of bronchi and trachea.
- It causes dilation of the pupil in eye.
- It decreases blood flow through the skin.

Norepinephrine (Noradrenalin)

- Most of its actions are similar to those of epinephrine.

Reproductive Glands (Gonads)

- The sex glands are of two types the testes and the ovaries. The testes are present in male, while the ovaries are present in female.

Testes

- Testes are the reproductive glands of the males. They are composed of seminiferous tubules, Leydig cells and Sertoli cells. Leydig cells form the endocrine part of the testes. They secrete the male sex hormone called testosterone.

Functions of testosterone

- It influences the process of spermatogenesis.
- It stimulates protein synthesis and controls muscular growth.
- It is responsible for the development of secondary sexual characters (distribution of hair on body and face, deep voice pattern, etc).

Ovary

- The ovaries are the female gonads located in the pelvic cavity of the abdomen. They secrete the female sex hormones

- Estrogen
- Progesterone

- Estrogen is produced by the Graafian follicles of the ovary and progesterone from the corpus luteum that is formed in the ovary from the ruptured follicle during ovulation.

Functions of estrogens

- It brings about the changes that occur during puberty.
- It initiates the process of oogenesis.
- It stimulates the maturation of ovarian follicles in the ovary.
- It promotes the development of secondary sexual characters (breast development, high pitched voice etc).

Functions of progesterone

- It is responsible for the premenstrual changes of the uterus.
- It prepares the uterus for the implantation of the embryo.
- It maintains pregnancy.
- It is essential for the formation of placenta

Thymus Gland

- Thymus is partly an endocrine gland and partly a lymphoid gland. It is located in the upper part of the chest covering the lower end of trachea. Thymosin is the hormone secreted by thymus.

Functions of Thymosin

- It has a stimulatory effect on the immune function.
- It stimulates the production and differentiation of lymphocytes.

10th Full book

Unit 17 – Reproduction in Animals

Sexual Reproduction in Human

- In human beings the male and female reproductive organs differ anatomically and physiologically. New individuals develop by the fusion of gametes. Sexual reproduction involves the fusion of two haploid gametes (male and the female gametes) to form a diploid individual (zygote).

- Organs of the reproductive system are divided into primary and secondary (accessory) sex organs.

➢ Primary reproductive organs include the gonads (Testes in male and Ovaries in female).

➢ **Accessory sex organs**

➢ **Male:** Vas deferens, epididymis, seminal vesicle, prostate gland and penis.

➢ **Female:** Fallopian tubes, uterus, cervix and vagina.

The secondary (accessory) sex organs include those structures which are involved in the

➢ Process of ovulation
➢ Fusion of the male and female gametes (fertilization)
➢ Division of the fertilized egg upto the formation of embryo
➢ Pregnancy
➢ Development of foetus
➢ Child birth.

Male Reproductive Organ - Structure of Testes

- Testes are the reproductive glands of the male that are oval shaped organs which lie outside the abdominal cavity of a man in a sac like structure

called scrotum. Now we shall study the various cells which are present in the testes.

- Each testes is covered with a layer of fibrous tissue called tunica albuginea. Many septa from this layer divide the testes into pyramidal lobules, in which lie seminiferous tubules, cells of Sertoli, and the Leydig cells (interstitial cells).

- The process of spermatogenesis takes place in the seminiferous tubules. The Sertoli cells are the supporting cells and provide nutrients to the developing sperms. The Leydig cells are polyhedral in shape and lie between the seminiferous tubules and secrete testosterone. It initiates the process of spermatogenesis.

Female Reproductive Organ - Structure of Ovary

- The ovaries are located on either side of the lower abdomen composed of two almond shaped bodies, each lying near the lateral end of fallopian tube. Each ovary is a compact structure consisting of an outer cortex and an inner medulla. The cortex is composed of a network of connective tissue called as stroma and is lined by the germinal epithelium. The epithelial cells called the granulosa cells surround each ovum in the ovary together forming the primary follicle. As the egg grows larger, the follicle also enlarges and gets filled with the fluid and is called the Graafian follicle.

Gametogenesis

- The formation of the sperm in male and the ovum in female is called gametogenesis. It involves spermatogenesis (formation of spermatozoa) and oogenesis (the formation of ova). Gametes with haploid cells are produced through gametogenesis.

Structure of Human Sperm

- The spermatozoan consists of head, a middle piece and tail. The sperm head is elongated and formed by the condensation of nucleus. The anterior portion has a cap like structure called acrosome. It contains hyaluronidase an enzyme that helps the sperm to enter the ovum during

fertilization. A short neck connects the head and middle piece which comprises the centrioles.The middle piece contains the mitochondria which provides energy for the movement of tail. It brings about sperm motility which is essential for fertilization.

Structure of Ovum

- The mature ovum or egg is spherical in shape.The ovum is almost free of yolk. It contains abundant cytoplasm and the nucleus. The ovum is surrounded by three membranes. The plasma membrane is surrounded by inner thin zona pellucida and an outer thick corona radiata. The corona radiata is formed of follicle cells. The membrane forming the surface layer of the ovum is called vitelline membrane. The fluid-filled space between zona pellucida and the surface of the egg is called perivitelline space.

Puberty

- The reproductive system in both males and females becomes functional and an increase in sex hormone production resulting in puberty. This phenomenon tends to start earlier in females than in males. Generally boys attain puberty between the age of 13 to 14 years, while girls reach puberty between 11 to 13 years. In male, the onset of puberty is triggered by the secretion of the hormone testosterone in the testes, in female the secretion of estrogens and progesterone from the ovary. The secretion of both male and female hormones are under the control of the pituitary gonadotropins luteinizing hormone (LH) and follicle stimulating hormone (FSH).

Menstrual Cycle-Process of Ovulation

- The cyclic events that take place in a rhythmic fashion during the reproductive period of a woman's life is called menstrual cycle. In human females the menstrual cycle starts at the age of 11-13 years which marks the onset of puberty and is called menarche, and ceases around 48-50 years of age and this stage is termed menopause. The reproductive period is marked by characteristic events repeated almost every month in physiologically normal women (28 days with minor variation) in the form of a menstrual flow. The menstrual cycle consists of 4 phases.

- Menstrual or Destructive Phase
- Follicular or Proliferative Phase
- Ovulatory Phase
- Luteal or Secretory Phase

- These phases show simultaneous synchrony of events in both ovary and uterus. Changes in the ovary and the uterus are induced by the pituitary hormones (LH and FSH) and ovarian hormones (estrogen and progesterone).

Phase	**Days**	**Changes in Ovary**	**Changes in Uterus**	**Hormonal Changes**
Menstrual Phase	4-5 days	Development of Primary Follicles	Breakdown of Uterine endometrial lining leads to bleeding	Decrease in Progesterone and Oestrogen
Follicular phase	6^{th} – 13^{th} days	Primary follicles grow to become a fully mature Graafian follicle	Endometrium regenerates through Poliferation	FSH and Oestrogen increase
Ovulatory phase	14^{th} day	The Graafian follicle ruptures, and releases the Ovum (Egg)	Increase in endometrial thickness	LH Peak
Luteal Phase	15^{th} – 28^{th} days	Emptied Graafian follicle develops into corpus luteum	Endometrium is prepared for implantation if fertilization of egg takes place, if fertilization does not occur corpus luteum degenerates,	LHS and FSH Decrease, corpus luteum Produces progesterone and its level increases followed by a decline, if menstrual bleeding

			Uterine wall ruptures, bleeding starts and unfertilized egg is expelled	occurs.

Fertilization to Foetal Development

Fertilization

- Fertilization in human is internal and occurs in the oviduct of the female genital tract. It takes place usually in the ampulla of the fallopian tube. An oocyte is alive for about 24 hours after it is released from the follicle. Fertilisation must take place within 24 hours. The sperm enters into the ovum and fuses with it, resulting in the formation of a 'zygote'. This process is called fertilization. The zygote is a fertilized ovum.

Cleavage and Formation of Blastula

- The first cleavage takes place about 30 hours after fertilization. Cleavage is a series of rapid mitotic divisions of the zygote to form many celled blastula (Blastocyst) which comprises an outer layer of smaller cells and inner mass of larger cells.

Implantation

- The blastocyst (fertilized egg) reaches the uterus and gets implanted in the uterus. The process of attachment of the blastocyst to the uterine wall (endometrium) is called implantation. The fertilized egg becomes implanted in about 6 to 7 days after fertilization

Gastrulation

- The transformation of blastula into gastrula and the formation of primary germ layers (ectoderm, mesoderm and endoderm) by rearrangement of the cells is called gastrulation. This takes place after the process of implantation.

Organogenesis

- The establishment of the germ layers namely ectoderm, mesoderm and endoderm initiates the final phase of embryonic development. During organogenesis the various organs of the foetus are established from the different germ layers attaining a functional state.

Formation of Placenta

- The placenta is a disc shaped structure attached to the uterine wall and is a temporary association between the developing embryo and maternal tissues. It allows the exchange of food materials, diffusion of oxygen, excretion of nitrogenous wastes and elimination of carbon dioxide. A cord containing blood vessels that connects the placenta with the foetus is called the umbilical cord.

Pregnancy (Gestation)

- It is the time period during which the embryo attains its development in the uterus. Normally gestation period of human last for about 280 days. During pregnancy the uterus expands upto 500 times of its normal size.

Parturition (Child Birth)

- Parturition is the expulsion of young one from the mother's uterus at the end of gestation. Oxytocin from the posterior pituitary stimulates the uterine contractions and provides force to expel the baby from the uterus, causing birth.

Sometimes ovaries releases two eggs and each is fertilised by a different sperm, resulting in Non-Identical Twins (Fraternal Twins). If single egg is fertilised and then divides into two foetus, Identical Twins develop.

Lactation

- The process of milk production after child birth from mammary glands of the mother is called lactation. The first fluid which is released from the mammary gland after child birth is called as colostrum. Milk production from alveoli of mammary glands is stimulated by prolactin secreted from the anterior pituitary.

- The ejection of milk is stimulated by posterior pituitary hormone oxytocin.

Reproductive Health

- According to World Health Organization (WHO) reproductive health means a total well being in all aspects of reproduction, ability to reproduce and regulate fertility, women's ability to undergo pregnancy and safe child birth, maternal and infant survival and well being.

- Several measures were undertaken by the government to improve the reproductive health of the people by launching National Health Programmes such as the

- Family Welfare Programme
- Reproductive and Child Health Care (RCH) Programme

Family welfare programme: The National Family Welfare Programme is a comprehensive scheme which includes:

- Maternal and child health care (MCH)
- Immunization of mothers, infants and children.
- Nutritional supplement to pregnant women and children.
- Contraception with health education, to motivate couples to accept contraceptive methods and to have small family norms, which improve economic status, living status and the quality of life.

Reproductive and Child Health Care (RCH) Programme: It has integrated all services which include

- Pregnancy and child birth
- Postnatal care of the mother and child
- Importance of breast feeding
- Prevention of reproductive tract infections and sexually transmitted diseases.

Population Explosion and Family Planning

- Population explosion defined as the sudden and rapid rise in the size of population, especially human population. Realizing the dangers inherent

in population growth, the Government of India has taken several measures to check population growth and introduced family planning. India has been one of the first country in the world to launch the nation wide family planning programme in 1952.

- Family planning is a way of living that is adopted voluntarily by couples on the basis of knowledge and responsible decisions to promote the health and welfare of the family group and society. The WHO (World Health Organisation) has also stressed the importance of family planning as global strategy health for all.

The inverted red triangle is a symbol of family planning in India for family welfare. It is displayed prominently at all hospitals, primary health clinics and family welfare centres where any help or advice about family planning is available free of cost. The symbol is displayed along with a slogan Small Family, Happy Family.

Contraception

- Contraception is one of the best birth control measures. A number of techniques or methods have been developed to prevent pregnancies in women. The devices used for contraception are called contraceptive devices. Common contraceptive methods used to prevent pregnancy are discussed here

- Barrier methods
- Hormonal methods
- Intra-Uterine Devices (IUDs)
- Surgical methods

Barrier Methods

- This method prevents sperms from meeting the ovum. Its entry into the female reproductive tract is prevented by barrier.

Condom: Condom prevents deposition of sperms in the vagina. Condoms are made of thin rubber or latex sheath. Condom also protect against sexually transmitted diseases (STD) like syphilis, AIDS.

Diaphragm (Cervical cap): Vaginal diaphragm fitting into the vagina or a cervical cap fitting over the cervix. This prevents the entry of sperms into the uterus.

Hormonal Methods

- Hormonal preparations are in the form of pills or tablets (contraceptive pills). These hormones stop (interfere with ovulation) the release of egg from the ovary.

Intra-Uterine Devices (IUDs)

- The intrauterine device (IUD)are contraceptive devices inserted into the uterus. There are two synthetic devices commonly used in India are Lippe's Loop and Copper-T made of copper and plastic (non irritant). This can remain for a period of 3 years. This reduces the sperm fertilizing capacity and prevents implantation. This also helps to give adequate time interval between pregnancies.

Surgical Methods

- Surgical contraception or sterilization techniques are terminal methods to prevent any pregnancy. This procedure in males is vasectomy (ligation of vas deferens) and in females it is tubectomy (ligation of fallopian tube). These are methods of permanent birth control.

Urinary Tract Infection (UTI)

- Many diseases affect both women and men, but a few diseases occur at a higher frequency in woman. Woman are susceptible to UTI from the bacteria that are present on skin, rectum or vagina. This will enter the urethra, before moving upwards. The types of UTI are:

Cystitis or Bladder infection

- Bacteria lodged in the urinary bladder thrive and multiply leading to inflammation. It is most common in the age group of 20 to 50.

Kidney Infection

- The bacteria can travel from the urinary bladder and upward to ureter and affect one or both the kidneys. It also infects the blood stream and leads to serious life-threatening complications.

Asymptomatic Bacteriuria

- The bacteria present in the urinary bladder which may not show any symptoms.

Personal Hygiene

- Hygiene is the practice of healthy living and personal cleanliness. Personal hygiene is caring of one's own body and health. Social hygiene is proper care of the surrounding environment. The main aspect of hygiene are body hygiene, food hygiene, sanitary hygiene and hygienic environment.

Body Hygiene

- Washing is vital to all age group of people which maintains our personal hygiene. A daily bath regularly keeps skin clean and free of germs. Hair should be kept clean by frequent washing. Mouth wash should be done after every meal. We should wash our hands many times during the day.

- Cloth towels used to dry our hands or body should be dried after each use and laundered regularly. Clothes, handkerchief, undergarments and socks should be washed daily. Washing prevents body odour, infections and skin irritation.

Toilet Hygiene

- The toilet has a lot to do with personal hygiene and general health as it is a place that cannot be avoided and used regularly. Parents should guide and practice their children on how to use the toilets at home, in schools and other public places so that it will protect the children from various contagious infections and diseases. The following measures can ensure toilet hygiene

➢ The floors of the toilet should be maintained clean and dry. This helps to reduce the bad odour and also infection.

- Toilet flush handles, door knobs, faucets, paper towel dispensers, light switches and walls should be cleaned with disinfectants to kill harmful germs and bacteria.

- Hands should be washed thoroughly with soap before and after toilet use.

Menstrual and Napkin Hygiene

- Women's health depends upon the level of cleanliness to keep them free from skin and genitourinary tract infection.

Menstrual hygiene

- Maintaining menstrual hygiene is important for the overall health of women. The basic menstrual hygiene ways are

- Sanitary pads should be changed regularly, to avoid infections due to microbes from vagina and sweat from genitals.

- Use of warm water to clean genitals helps to get rid of menstrual cramps

Wearing loose clothing rather than tight fitting clothes will ensure the airflow around the genitals and prevent sweating.

12th Zoology

Chapter 1- Reproduction in Organisms

Modes of reproduction

- All modes of reproduction have some basic features such as synthesis of RNA and proteins, replication of DNA, cell division and growth, formation of reproductive units and their fertilization to form new individuals. Organisms exhibit two major modes of reproduction namely asexual and sexual reproduction. Reproduction by a single parent without the involvement of gamete formation is asexual reproduction and the offspring produced are genetically identical. Asexual reproduction is usually by amitotic or mitotic division of the somatic (body) cells, hence is also known as somatogenic or blastogenic reproduction. When two parents participate in the reproductive process involving two types of gametes (ova and sperm), it is called sexual reproduction.

Asexual reproduction

- Asexual reproduction is wide spread among different organisms. It is common in members of Protista, Bacteria, Archaea and in multicellular organisms with relatively simple organisation. The offsprings show "uniparental inheritance" without any genetic variation. The different modes of asexual reproduction seen in animals are fission, sporulation, budding, gemmule formation, fragmentation and regeneration.

- Fission is the division of the parent body into two or more identical daughter individuals. Four types of fission are seen in animals. They are binary fission, multiple fission, sporulation and strobilation.

- In binary fission, the parent organism divides into two halves and each half forms a daughter individual. The nucleus divides first amitotically or mitotically (karyokinesis), followed by the division of the cytoplasm (cytokinesis). The resultant offsprings are genetically identical to the parent. Depending on the plane of fission, binary fission is of the following types

- Simple irregular binary fission
- Transverse binary fission
- Longitudinal binary fission
- Oblique binary fission

- Simple binary fission is seen in Amoeba like irregular shaped organisms, where the plane of division is hard to observe. The contractile vacuoles cease to function and disappear. The nucleoli disintegrate and the nucleus divides mitotically. The cell then constricts in the middle, so the cytoplasm divides and forms two daughter cells.

- In transverse binary fission, the plane of the division runs along the transverse axis of the individual. e.g. Paramecium and Planaria. In Paramecium the macronucleus divides by amitosis and the micronucleus divides by mitosis.

- In longitudinal binary fission, the nucleus and the cytoplasm divides in the longitudinal axis of the organism. In flagellates, the flagellum is retained usually by one daughter cell.

- The basal granule is divided into two and the new basal granule forms a flagellum in the other daughter individual. e.g. Vorticella and Euglena.

- In oblique binary fission the plane of division is oblique. It is seen in dinoflagellates. e.g. Ceratium

- In multiple fission the parent body divides into many similar daughter cells simultaneously. First, the nucleus divides repeatedly without the division of the cytoplasm, later the cytoplasm divides into as many parts as that of nuclei. Each cytoplasmic part encircles one daughter nucleus. This results in the formation of many smaller individuals from a single parent organism. If multiple fission produces four or many daughter individuals by equal cell division and the young ones do not separate until the process is complete, then this division is called repeated fission e.g. Vorticella.

- In Plasmodium, multiple fission occurs in the schizont and in the oocyte stages. When multiple fission occurs in the schizont, the process is called schizogony and the daughter individuals are called merozoites. When

multiple fission occurs in the oocyte, it is called sporogony and the daughter individuals are called sporozoites.

- During unfavorable conditions (increase or decrease in temperature, scarcity of food) Amoeba withdraws its pseudopodia and secretes a three-layered, protective, chitinous cyst wall around it and becomes inactive. This phenomenon is called encystment. When conditions become favourable, the encysted Amoeba divides by multiple fission and produces many minute amoebae called pseudopodiospore or amoebulae. The cyst wall absorbs water and breaks off liberating the young pseudopodiospores, each with a fine pseudopodia. They feed and grow rapidly to lead an independent life.

- In some metazoan animals, a special type of transverse fission called strobilation occurs. In the process of strobilation, several transverse fissions occur simultaneously giving rise to a number of individuals which often do not separate immediately from each other e.g. Aurelia. Plasmotomy is the division of multinucleated parent into many multinucleate daughter individuals with the division of nuclei. Nuclear division occurs later to maintain normal number of nuclei. Plasmotomy occurs in Opalina and Pelomyxa (Giant Amoeba).

- During unfavourable conditions Amoeba multiplies by sporulation without encystment. Nucleus breaks into several small fragments or chromatin blocks. Each fragment develops a nuclear membrane, becomes surrounded by cytoplasm and develops a spore-case around it. When conditions become favourable, the parent body disintegrates and the spores are liberated, each hatching into a young amoeba.

- In budding, the parent body produces one or more buds and each bud grows into a young one. The buds separate from the parent to lead a normal life. In sponges, the buds constrict and detach from the parent body and the bud develops into a new sponge.

- When buds are formed on the outer surface of the parent body, it is known as exogenous budding e.g. Hydra. In Hydra when food is plenty, the ectoderm cells increase and form a small elevation on the body surface. Ectoderm and endoderm are pushed out to form the bud. The bud contains an interior lumen in continuation with parent's gastro-vascular

cavity. The bud enlarges, develops a mouth and a circle of tentacles at its free end. When fully grown, the bud constricts at the base and finally separates from the parent body and leads an independent life.

- In Noctiluca, hundreds of buds are formed inside the cytoplasm and many remain within the body of the parent. This is called endogenous budding. In freshwater sponges and in some marine sponges a regular and peculiar mode of asexual reproduction occurs by internal buds called gemmules is seen. A completely grown gemmule is a hard ball, consisting of an internal mass of food-laden archaeocytes. During unfavourable conditions, the sponge disintegrates but the gemmule can withstand adverse conditions. When conditions become favourable, the gemmules begin to hatch.

- In fragmentation, the parent body breaks into fragments (pieces) and each of the fragment has the potential to develop into a new individual. Fragmentation or pedal laceration occurs in many genera of sea anemones. Lobes are constricted off from the pedal disc and each of the lobe grows mesenteries and tentacles to form a new sea anemone.

- In the tapeworm, Taenia solium the gravid (ripe) proglottids are the oldest at the posterior end of the strobila . The gravid proglottids are regularly cut off either singly or in groups from the posterior end by a process called apolysis. This is very significant since it helps in transferring the developed embryos from the primary host (man) to find a secondary host (pig).

- Regeneration is regrowth in the injured region. Regeneration was first studied in Hydra by Abraham Trembley in 1740. Regeneration is of two types, morphallaxis and epimorphosis. In morphallaxis the whole body grows from a small fragment e.g. Hydra and Planaria. When Hydra is accidentally cut into several pieces, each piece can regenerate the lost parts and develop into a whole new individual. The parts usually retain their original polarity, with oral ends, by developing tentacles and aboral ends, by producing basal discs. Epimorphosis is the replacement of lost body parts. It is of two types, namely reparative and restorative regeneration. In reparative regeneration, only certain damaged tissue can be regenerated, whereas in restorative regeneration severed body parts can develop. e.g. star fish, tail of wall lizard.

Power of Regeneration

Sponge when macerated and squeezed through fine silk cloth, the cluster of cells pass through, and these can regenerate new sponges. This technique is used for cultivation of sponges.

Sexual reproduction

- Sexual reproduction involves the fusion of male and female gametes to form a diploid zygote, which develops into a new organism. It leads to genetic variation. The types of sexual reproduction seen in animals are syngamy (fertilization) and conjugation. In syngamy, the fusion of two haploid gametes takes place to produce a diploid zygote. Depending upon the place where the fertilization takes place, it is of two types. In external fertilization, the fusion of male and female gametes takes place outside the body of female organisms in the water medium. e.g. sponges, fishes and amphibians. In internal fertilization, the fusion of male and female gametes takes place within the body of female organisms. e.g. reptiles, aves and mammals.

- Different kinds of syngamy (fertilization) are prevalent among living organisms. In autogamy, the male and female gametes are produced by the same cell or same organism and both the gametes fuse together to form a zygote e.g. Actinosphaerium and Paramecium. In exogamy, the male and female gametes are produced by different parents and they fuse to form a zygote. So it is biparental. e.g. Human – dioecious or unisexual animal.

- In lower organisms, sometimes the entire mature organisms do not form gametes but they themselves behave as gametes and the fusion of such mature individuals is known as hologamy e.g. Trichonympha. Paedogamy is the sexual union of young individuals produced immediately after the division of the adult parent cell by mitosis. In merogamy, the fusion of small sized and morphologically different gametes (merogametes) takes place. The fusion of morphological and physiological identical gametes (isogametes) is called isogamy.

- e.g. Monocystis, whereas the fusion of dissimilar gametes is called anisogamy (Gr. An-without; iso-equal; gam-marriage). Anisogamy occurs

in higher animals but it is customary to use the term fertilization instead of anisogamy or syngamy. e.g. higher invertebrates and all vertebrates.

- Conjugation is the temporary union of the two individuals of the same species. During their union both individuals, called the conjugants exchange certain amount of nuclear material (DNA) and then get separated. Conjugation is common among ciliates, e.g. Paramecium, Vorticella and bacteria (Prokaryotes).

- **Phases of life cycle:** Organisms have three phases – Juvenile phase, reproductive phase and senescent phase. Juvenile phase/ vegetative phase is the period of growth between the birth of the individual upto reproductive maturity. During reproductive phase/ maturity phase the organisms reproduce and their offsprings reach maturity period. On the basis of time, breeding animals are of two types: seasonal breeders and continuous breeders. Seasonal breeders reproduce at particular period of the year such as frogs, lizards, most birds, deers etc., Continuous breeders continue to breed throughout their sexual maturity e.g. honey bees, poultry, rabbit etc., Senescent phase begins at the end of reproductive phase when degeneration sets in the structure and functioning of the body.

PARTHENOGENESIS
(Gr. Parthenos – virgin, Genesis-produce)

- Development of an egg into a complete individual without fertilization is known as parthenogenesis. It was first discovered by Charles Bonnet in 1745. Parthenogenesis is of two main types namely, Natural Parthenogenesis and Artificial Parthenogenesis. In certain animals, parthenogenesis occurs regularly, constantly and naturally in their life cycle and is known as natural parthenogenesis.

Natural parthenogenesis are of different types:
Arrhenotoky: In this type only males are produced by parthenogenesis. eg: honey bees
Thelytoky: In this type of parthenogenesis only females are produced by parthenogenesis.eg: Solenobia
Amphitoky: In this type parthenogenetic egg may develop into individuals of any sex. Eg: Aphis

- Natural parthenogenesis may be of two types, viz., complete and incomplete. Complete parthenogenesis is the only form of reproduction in certain animals and there is no biparental sexual reproduction. These are no male organisms and so, such individuals are represented by females only. Incomplete parthenogenesis is found in some animals in which both sexual reproduction and parthenogenesis occurs. e.g. In honeybees; fertilized eggs (zygotes) develop into queen and workers, whereas unfertilized eggs develop into drones (male). In paedogenetic parthenogenesis (paedogenesis) the larvae produce a new generation of larvae by parthenogenesis. It occurs in the sporocysts and Redia larvae of liver fluke. It is also seen in the larvae of some insects. e.g. Gall fly. In artificial parthenogenesis, the unfertilized egg (ovum) is induced to develop into a complete individual by physical or chemical stimuli. e.g., Annelid and seaurchin eggs

- Animals are classified mainly into three groups namely – Oviparous, Viviparous and Ovoviviparous depends on the site of development of embryo and whether they lay eggs (unfertilized or fertilized) or give birth to young ones. In Oviparous (L., Ovum-egg-, Parere- to produce) animals (egg laying animals), the young hatch from eggs laid outside the mother's body. e.g. reptiles and birds (their eggs are covered by hard calcareous shells), invertebrates, fishes and amphibians (eggs are not covered by hard calcareous shells but covered by a membrane). Viviparous (L., Vivus - alive, Parere - to produce) animals give rise to young ones.

- Viviparity is a type of development in which the young ones are born alive after being nourished in the uterus through the placenta. Majority of mammals including human beings are viviparous. In Ovoviviparous animals, the embryo develops inside the egg and remains in the mother's body until they are ready to hatch. This method of reproduction is similar to viviparity but the embryos have no placental connection with the mother and receive their nourishment from the egg yolk. Ovoviviparity is seen in fishes like shark.

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Chapter 2 – Human Reproduction

- Every organ system in the human body works continuously to maintain homeostasis for the survival of the individual. The human reproductive system is essential for the survival of the species. An individual may live a long healthy life without producing an offspring, but reproduction is inevitable for the existence of a species.

The reproductive system has four main functions namely,
- to produce the gametes namelysperms and ova
- to transport and sustain these gametes
- to nurture the developing offspring
- to produce hormones

The major reproductive events in human beings are as follows:

- **Gametogenesis:** Formation of gametes by spermatogenesis and oogenesis.
- **Insemination:** Transfer of sperms by the male into the female genital tract.
- **Fertilisation:** Fusion of male and female gametes to form zygote, called fertilisation.
- **Cleavage:** Rapid mitotic divisions ofthe zygote which convert the single celled zygote into a multicellular structure called blastocyst.
- **Implantation:** Attachment of blastocyst to the uterine wall.
- **Placentation:** Formation of placenta which is the intimate connection between foetus and uterine wall of the mother for exchange of nutrients.
- **Gastrulation:** Process by which blastocyst is changed into a gastrula with three primary germ layers
- **Organogenesis:** Formation of specific tissues, organs and organ systems from three germ layers.
- **Parturition:** Expulsion of the foetus from the mother's womb.

- These functions are carried out by the primary and accessory reproductive organs. The primary reproductive organs namely the ovary and testis are responsible for producing the ova and sperms respectively. Hormones secreted by the pituitary gland and the gonads help in the development of the secondary sexual characteristics, maturation of the reproductive

system and regulation of normal functioning of the reproductive system. The accessory organs help in transport and to sustain the gametes and to nurture the developing offspring.

Human reproductive system

- The male reproductive system comprises of a pair of testes, accessory ducts, glands and external genitalia

- Testes are the primary male sex organs. They are a pair of ovoid bodies lying in the scrotum.The scrotum is a sac of skin that hangs outside the abdominal cavity. Since viable sperms cannot be produced at normal body temperature, the scrotum is placed outside the abdominal cavity to provide a temperature 2-3oC lower than the normal internal body temperature. Thus, the scrotum acts as a thermoregulator for spermatogenesis.

- Each testis is covered by an outermost fibrous tunica albuginea and is divided by septa into about 200 - 250 lobules each containing 2-4 highly coiled testicular tubules or seminiferous tubules. These highly convoluted tubules which form 80 percent of the testicular substance are the sites for sperm production.

- The stratified epithelium of the seminiferous tubule is made of two types of cells namely sertoli cells or nurse cells and spermatogonic cells or male germ cells. Sertoli cells are elongated and pyramidal and provide nourishment to the sperms till maturation. They also secrete inhibin, a hormone which is involved in the negative feedback control of sperm production. Spermatogonic cells divide meiotically and differentiate to produce spermatozoa.

- Interstitial cells or Leydig cells are embedded in the soft connective tissue surrounding the seminiferous tubules. These cells are endocrine in nature and secrete androgens namely the testosterone hormone which initiates the process of spermatogenesis. These cells are endocrine in nature and are characteristic features of the testes of mammals. Other immunologically competent cells are also present.

- The accessory ducts associated with the male reproductive system include rete testis, vasa efferentia, epididymis and vas deferens. The seminiferous tubules of each lobule converge to form a tubulus rectus that conveys the sperms into the rete testis. The rete testis is a tubular network on the posterior side of the testis. The sperms leave the rete testis and enter the epididymis through the vasa efferentia. The epididymis is a single highly coiled tube that temporarily stores the spermatozoa and they undergo physiological maturation and acquire increased motility and fertilizing capacity. The epididymis leads to the vas deferens and joins the duct of the seminal vesicle to form the ejaculatory duct which passes through the prostate and opens into the urethra. The urethra is the terminal portion of the male reproductive system and is used to convey both urine and semen at different times. It originates from the urinary bladder and extends through the penis by an external opening called urethral meatus.

- The accessory glands of the male reproductive system include the paired seminal vesicles and bulbourethral glands also called Cowper's gland and a single prostate gland. The seminal vesicles secrete an alkaline fluid called seminal plasma containing fructose sugar, ascorbic acid, prostaglandins and a coagulating enzyme called vesiculase which enhances sperm motility. The bulbourethral glands are inferior to the prostate and their secretions also help in the lubrication of the penis. The prostate encircles the urethra and is just below the urinary bladder and secretes a slightly acidic fluid that contains citrate, several enzymes and prostate specific antigens. Semen or seminal fluid is a milky white fluid which contains sperms and the seminal plasma (secreted from the seminal vesicles, prostate gland and the bulbourethal glands). The seminal fluid acts as a transport medium, provides nutrients, contains chemicals that protect and activate the sperms and also facilitate their movement.

- The penis is the male external genitalia functioning as a copulatory organ. It is made of a special tissue that helps in the erection of penis to facilitate insemination. The enlarged end of the penis called glans penis is covered by a loose fold of skin called foreskin or prepuce.

- The female reproductive system is far more complex than the male because in addition to gamete formation, it has to nurture the developing foetus. The female reproductive system consists of a pair of ovaries along with a pair of oviducts, uterus, cervix, vagina and the external genitalia

located in the pelvic region. These parts along with the mammary glands are integrated structurally and functionally to support the process of ovulation, fertilisation, pregnancy, child birth and child care.

- Ovaries are the primary female sex organs that produce the female gamete, ovum. The ovaries are located one on each side of the lower abdomen. The ovary is an elliptical structure about 2-4 cm long. Each ovary is covered by a thin cuboidal epithelium called the germinal epithelium which encloses the ovarian stroma. The stroma is differentiated as the outer cortex and inner medulla. Below the germinal epithelium is a dense connective tissue, the tunica albuginea. The cortex appears dense and granular due to the presence of ovarian follicles in various stages of development. The medulla is a loose connective tissue with abundant blood vessels, lymphatic vessels and nerve fibres. The ovary remains attached to the pelvic wall and the uterus by an ovarian ligamentcalled mesovarium.

- The fallopian tubes (uterine tubes or oviducts), uterus and vagina constitute the female accessory organs . Each fallopian tube extends from the periphery of each ovary to the uterus. The proximal part of the fallopian tube bears a funnel shaped infundibulum. The edges of the infundibulum have many finger like projections called fimbriae which help in collection of the ovum after ovulation.

Female uterus contains one of the strongest muscles of the human body.

- The infundibulum leads to a wider central portion called ampulla. The last part of the oviduct is the isthmus which is short and thick walled connecting the ampulla and infundibulum to the uterus.

- The uterus or womb is a hollow, thick-walled, muscular, highly vascular and inverted pear shaped structure lying in the pelvic cavity between the urinary bladder and rectum. The major portion of the uterus is the body and the rounded region superior to it, is the fundus. The uterus opens into the vagina through a narrow cervix. The cavity of the cervix called the cervical canal communicates with the vagina through the external orifice and with the uterus through the internal orifice. The cervical canal along with vagina forms the birth canal.

- The wall of the uterus has three layers of tissues. The outermost thin membranous serous layer called the perimetrium, the middle thick muscular layer called myometrium and the inner glandular layer called endometrium. The endometrium undergoes cyclic changes during the menstrual cycle while myometrium exhibits strong contractions during parturition.

- Vagina is a large fibromuscular tube that extends from the cervix to the exterior. It is the female organ of copulation. The female reproductive structures that lie external to the vagina are called as the external genitalia or vulva comprising of labia majora, labia minora, hymen and clitoris

- The Bartholin's glands (also called greater vestibular glands) are located posterior to the left and right of the opening of the vagina. They secrete mucus to lubricate the vagina and are homologous to the bulbourethral glands of the male. The Skene's glands are located on the anterior wall of the vagina and around the lower end of the urethra. They secrete a lubricating fluid and are homologous to the prostate gland of the males.

- The external opening of the vagina is partially closed by a thin ring of tissue called the hymen. The hymen is often torn during the first coitus (physical union). However in some women it remains intact. It can be stretched or torn due to a sudden fall or jolt and also during strenuous physical activities such as cycling, horseback riding, etc., and therefore cannot be considered as an indicator of a woman's virginity.

- The mammary glands are modified sweat glands present in both sexes. It is rudimentary in the males and functional in the females. A pair of mammary glands is located in the thoracic region. It contains glandular tissue and variable quantities of fat with a median nipple surrounded by a pigmented area called the areola. Several sebaceous glands called the areolar glands are found on the surface and they reduce cracking of the skin of the nipple. Internally each mammary gland consists of 2-25 lobes, separated by fat and connective tissues. Each lobe is made up of lobules which contain acini or alveoli lined by epithelial cells. Cells of the alveoli secrete milk. The alveoli open into mammary tubules. The tubules of each lobe join to form a mammary duct. Several mammary ducts join to form a wider mammary ampulla which is connected to the lactiferous duct in the nipple. Under the nipple, each lactiferous duct expands to form the

lactiferous sinus which serves as a reservoir of milk. Each lactiferous duct opens separately by a minute pore on the surface of the nipple.

- Normal development of the breast begins at puberty and progresses with changes during each menstrual cycle. In non-pregnant women, the glandular structure is largely underdeveloped and the breast size is largely due to amount of fat deposits. The size of the breast does not have an influence on the efficiency of lactation.

Gametogenesis

- Gametogenesis is the process of formation of gametes i.e., sperms and ovary from the primary sex organs in all sexually reproducing organisms. Meiosis plays the most significant role in the process of gametogenesis

Spermatogenesis

- Spermatogenesis is the sequence of events in the seminiferous tubules of the testes that produce the male gametes, the sperms. During development, the primordial germ cells migrate into the testes and become immature germ cells called sperm mother cells or spermatogonia in the inner surfaces of the seminiferous tubules. The spermatogonia begin to undergo mitotic division at puberty and continue throughout life.

- In the first stage of spermatogenesis, the spermatogonia migrate among sertoli cells towards the central lumen of the seminiferous tubule and become modified and enlarged to form primary spermatocytes which are diploid with 23 pairs i.e., 46 chromosomes.

- Some of the primary spermatocytes undergo first meiotic division to form two secondary spermatocytes which are haploid with 23 chromosomes each. The secondary spermatocytes undergo second meiotic division to produce four haploid spermatids. The spermatids are transformed into mature spermatozoa (sperms) by the process called spermiogenesis. Sperms are finally released into the cavity of seminiferous tubules by a process called spermiation. The whole process of spermatogenesis takes about 64 days. At any given time, different regions of the seminiferous tubules contain spermatocytes in different stages of development. The

sperm production remains nearly constant at a rate of about 200 million sperms per day.

- Spermatogenesis starts at the age of puberty and is initiated due to the increase in the release of Gonadotropin Releasing Hormone (GnRH) by the hypothalamus. GnRH acts on the anterior pituitary gland and stimulates the secretion of two gonadotropins namely Follicle Stimulating Hormone (FSH) and Lutenizing Hormone (LH). FSH stimulates testicular growth and enhances the production of Androgen Binding Protein (ABP) by the sertoli cells and helps in the process of spermiogenesis. LH acts on the Leydig cells and stimulates the synthesis of testosterone which in turn stimulates the process of spermatogenesis.

Structure of human spermatozoan

- The human sperm is a microscopic, flagellated and motile gamete. The whole body of the sperm is enveloped by plasma membrane and is composed of a head, neck and a tail. The head comprises of two parts namely acrosome and nucleus. Acrosome is a small cap like pointed structure present at the tip of the nucleus and is formed mainly from the Golgi body of the spermatid. It contains hyaluronidase, a proteolytic enzyme, popularly known as sperm lysin which helps to penetrate the ovum during fertilisation. The nucleus is flat and oval. The neck is very short and is present between the head and the middle piece. It contains the proximal centriole towards the nucleus which plays a role in the first division of the zygote and the distal centriole gives rise to the axial filament of the sperm. The middle piece possesses mitochondria spirally twisted around the axial filament called mitochondrial spiral or nebenkern. It produces energy in the form of ATP molecules for the movement of sperms. The tail is the longest part of the sperm and is slender and tapering. It is formed of a central axial filament or axoneme and an outer protoplasmic sheath. The lashing movements of the tail push the sperm forward. The human male ejaculates about 200 to 300 million sperms during coitus. It is estimated that around 60 percent of sperms must have normal shape of which at least 40 per cent must show vigorous motility for normal fertility.

The sperm is the smallest human cell and the ovum or egg is the largest human cell.

Oogenesis

- Oogenesis is the process of development of the female gamete or ovum or egg in the ovaries. During foetal development, certain cells in the germinal epithelium of the foetal ovary divide by mitosis and produce millions of egg mother cells or oogonia. No more oogonia are formed or added after birth. The oogonial cells start dividing and enter into Prophase I of meiotic division I to form the primary oocytes which are temporarily arrested at this stage. The primary oocytes then get surrounded by a single layer of granulosa cells to form the primordial or primary follicles. A large number of follicles degenerate during the period from birth to puberty, so at puberty only 60,000 to 80,000 follicles are left in each ovary.

- Out of the million eggs women possess during birth, only about 300 to 400 will ovulate before menopause.
- On the other hand, males produce more than 500 billion sperms in their life time

- The primary follicle gets surrounded by many layers of granulosa cells and a new theca layer to form the secondary follicle. A fluid filled space, the antrum develops in the follicle and gets transformed into a tertiary follicle. The theca layer gets organized into an inner theca interna and an outer theca externa. At this time, the primary oocyte within the tertiary follicle grows in size and completes its first meiotic division and forms the secondary oocyte. It is an unequal division resulting in the formation of a large haploid secondary oocyte and a first polar body. The first polar body disintegrates. During fertilisation, the secondary oocyte undergoes second meiotic division and produces a large cell, the ovum and a second polar body. The second polar body also degenerates. The tertiary follicle eventually becomes a mature follicle or Graafian follicle. If fertilisation does not take place, second meiotic division is never completed and the egg disintegrates. At the end of gametogenesis in females, each primary oocyte gives rise to only one haploid ovum.

Structure of ovum

- Human ovum is non-cleidoic, alecithal and microscopic in nature. Its cytoplasm called ooplasm contains a large nucleus called the germinal vesicle. The ovum is surrounded by three coverings namely an inner thin transparent vitelline membrane, middle thick zona pellucida and outer

thick coat of follicular cells called corona radiata. Between the vitelline membrane and zona pellucida is a narrow perivitelline space.

Menstural cycle

- The menstrual or ovarian cycle occurs approximately once in every 28/29 days during the reproductive life of the female from menarche (puberty) to menopause except during pregnancy. The cycle of events starting from one menstrual period till the next one is called the menstrual cycle during which cyclic changes occurs in the endometrium every month. Cyclic menstruation is an indicator of normal reproductive phase

Menstrual cycle comprises of the following phases

- Menstrual phase
- Follicular or proliferative phase
- Ovulatory phase
- Luteal or secretory phase

Menstrual phase

- The cycle starts with the menstrual phase when menstrual flow occurs and lasts for 3-5 days. Menstrual flow is due to the breakdown of endometrial lining of the uterus, and its blood vessels due to decline in the level of progesterone and oestrogen. Menstruation occurs only if the released ovum is not fertilized. Absence of menstruation may be an indicator of pregnancy. However it could also be due to stress, hormonal disorder and anaemia.

Follicular or proliferative phase

- The follicular phase extends from the 5th day of the cycle until the time of ovulation. During this phase, the primary follicle in the ovary grows to become a fully mature Graafian follicle and simultaneously, the endometrium regenerates through proliferation. These changes in the ovary and the uterus are induced by the secretion of gonadotropins like FSH and LH, which increase gradually during the follicular phase. It stimulates follicular development and secretion of oestrogen by the follicle cells.

Ovulatory phase

- Both LH and FSH attain peak level in the middle of the cycle (about the 14th day). Maximum secretion of LH during the mid cycle called LH surge induces the rupture of the Graafian follicle and the release of the ovum (secondary oocyte) from the ovary wall into the peritoneal cavity. This process is called as ovulation.

Luteal or secretory phase

- During luteal phase, the remaining part of the Graafian follicle is transformed into a transitory endocrine gland called corpus luteum. The corpus luteum secretes large amount of progesterone which is essential for the maintenance of the endometrium. If fertilisation takes place, it paves way for the implantation of the fertilized ovum. The uterine wall secretes nutritious fluid in the uterus for the foetus. So, this phase is also called as secretory phase. During pregnancy all events of menstrual cycle stop and there is no menstruation.

- In the absence of fertilisation, the corpus luteum degenerates completely and leaves a scar tissue called corpus albicans. It also initiates the disintegration of the endometrium leading to menstruation, marking the next cycle.

POLY CYSTIC OVARY SYNDROME (PCOS)

PCOS is a complex endocrine system disorder that affects women in their reproductive years. Polycystic means 'many cysts'. It refers to many partially formed follicles on the ovaries, which contain an egg each. But they do not grow to maturity or produce eggs that can be fertilized. Women with PCOS may experience irregular menstrual cycles, increased androgen levels, excessive facial or body hair growth (hirsutism), acne, obesity, reduced fertility and increased risk of diabetes. Treatment for PCOS includes a healthy lifestyle, weight loss and targeted hormone therapy.

Menstrual disorders

- Absence of menstruation is called amenorrhoea. If menarche does not appear till the age of 18, it is called primary amenorrhoea. Absence of menstruation for over three consecutive months is secondary amenorrhoea.

- Polymenorrhoea is a term used to describe a menstrual cycle that is shorter than 21 days. It may be due to hyperactivity of the anterior pituitary gland causing frequent ovulation, psychological disturbances and malnutrition. Chronic pelvic inflammation by certain sexually transmitted diseases (STD) such as chlamydiasis or gonorrhoea can cause inflammation in the uterus causing polymenorrhoea.

- Pain associated with menstruation is called dysmenorrhoea. It is the most commonly reported menstrual disorder. There are two types of dysmenorrhoea viz primary and secondary dysmenorrhoea. Primary dysmenorrhoea is pain or cramps during menstrual period and is caused by secretions of prostaglandin in the uterus. Secondary dysmenorrhoea is caused by a disorder in the reproductive system like endometriosis or uterine fibroids.

- Heavy and prolonged menstrual period that disrupts a woman's normal activities is referred to as menorrhagia. Menorrhagia may be due to

hormonal imbalance, ovarian dysfunction, uterine fibroids and may also be due to cancer of the ovary, uterus or cervix.

- Oligomenorrhoea is a condition with infrequent menstrual periods. It occurs in women of childbearing age. Some variation in menstruation is normal, but a woman who regularly goes more than 35 days without menstruating may be diagnosed with oligomenorrhoea.

Menstrual hygiene

- Menstrual hygiene is vital for good health, well-being, dignity, empowerment and productivity of women. The impact of poor menstrual hygiene on girls is increased stress levels, fear and embarrassment during menstruation. This can keep girls inactive during such periods leading to absenteeism from school.

- Clean and safe absorbable clothing materials, sanitary napkins, pads, tampons and menstrual cups have been identified as materials used to manage menstruation. Changing sanitary material 4-5 hours as per the requirement, provides comfort, cleanliness and protection from infections. It also helps in enhancing the quality of life of women during this period. Used sanitary napkins should be wrapped in paper and disposed. It should not be thrown in open areas or drain pipe of toilets. Flushing of sanitary napkins in the drain pipes causes choking of the drainage line leading to water pollution.

Disposal of Napkins

The ecofriendly way to dispose menstrual waste scientifically and hygienically is to destroy the sanitary napkins using incinerators. Measures are being taken to install incinerators and napkin vending machines in washrooms of schools , colleges and public facilities

Menopause

- Menopause is the phase in a women's life when ovulation and menstruation stops. The average age of menopause is 45-50 years. It indicates the permanent cessation of the primary functions of the ovaries.

Fertilisation and implantation

- Fertilisation occurs when a haploid sperm fuses with a haploid ovum to form a fertilized egg or diploid zygote.

- The sperms deposited in the female reproductive tract undergo capacitation, which is a biochemical event that enables the sperm to penetrate and fertilise the egg. Fertilisation occurs only if the ovum and sperms are transported simultaneously to the ampullary isthmic junction of the fallopian tube.

- Before a sperm can enter the egg, it must penetrate the multiple layers of granulosa (follicular) cells which are around the ovum forming the corona radiata. The follicular cells are held together by an adhesive cementing substance called hyaluronic acid. The acrosomal membrane disintegrates releasing the proteolytic enzyme, hyaluronidase during sperm entry through the corona radiata and zona pellucida. This is called acrosomal reaction. Once fertilisation is accomplished, cortical granules from the cytoplasm of the ovum form a barrier called the fertilisation membrane around the ovum preventing further penetration of other sperms. Thus polyspermy is prevented.

- The first cleavage produces two identical cells called blastomeres. These produce 4 cells, then 8 and so on. After 72 hours of fertilisation, a loose collection of cells forms a berry shaped cluster of 16 or more cells called the morula

- Under the influence of progesterone, smooth muscles of the fallopian tube relax and the dividing embryo takes 4-5 days to move through the fallopian tube into the uterine cavity and finally gets implanted in the uterine wall. At this point the embryo consists of a fluid filled hollow ball of about 100 cells, called the blastocyst. The blastocyst is composed of a single layer of large flattened cells called trophoblast and a small cluster of 20-30 rounded cells called the inner cell mass. The inner cell mass of the blastocyst develops into the embryo and becomes embedded in the endometrium of the uterus. This process is called implantation and it results in pregnancy.

- If the fertilised ovum is implanted outside the uterus it results in ectopic pregnancy. About 95 percent of ectopic pregnancies occur in the fallopian tube. The growth of the embryo may cause internal bleeding, infection and in some cases even death due to rupture of the fallopian tube.

Twins are two offsprings produced in the same pregnancy.

- Monozygotic (Identical) twins are produced when a single fertilised egg splits into two during the first cleavage. They are of the same sex, look alike and share the same genes.

- Dizygotic (Fraternal) twins are produced when two separate eggs are fertilised by two separate sperms. The twins may be of the same sex or different sex and are non-identical.

- Siamese (United) twins are the conjoined twins who are joined during birth.

Maintenance of pregnancy and embryonic development

- The inner cell mass in the blastula is differentiated into epiblast and hypoblast immediately after implantation. The hypoblast is the embryonic endoderm and the epiblast is the ectoderm. The cells remaining in between the epiblast and the endoderm form the mesoderm. Thus the transformation of the blastocyst into a gastrula with the primary germ layers by the movement of the blastomeres is called gastrulation. Each germ layer gives rise to specific tissues, organs and organ systems during organogenesis.

- The extra embryonic membranes namely the amnion, yolk sac, allantois and chorion protect the embryo from dessication, mechanical shock and help in the absorption of nutrients and exchange of gases . The amnion is a double layered translucent membrane filled with the amniotic fluid. It provides a buoyant environment to protect the developing embryo from injury, regulates the temperature of the foetus and provides a medium in which the foetus can move. The yolk sac forms a part of the gut and is the source of the earliest blood cells and blood vessels.

- The allantois forms a small out pocketing of embryonic tissue at the caudal end of the yolk sac. It is the structural base for the umbilical cord

that links the embryo to the placenta and ultimately it becomes part of the urinary bladder. The chorion is the outermost membrane which encloses the embryo and all other membranes and also helps in the formation of the placenta.

- The trophoblast cells in the blastocyst send out several finger like projections called chorionic villi carrying foetal blood and are surrounded by sinuses that contain maternal blood. The chorionic villi and the uterine tissues form the disc-shaped placenta. Placenta is a temporary endocrine organ formed during pregnancy and it connects the foetus to the uterine wall through the umbilical cord. It is the organ by which the nutritive, respiratory and excretory functions are fulfilled. The embryo's heart develops during the fourth week of pregnancy and circulates blood through the umbilical cord and placenta as well as through its own tissues.

- The primary germ layers serve as the primitive tissues from which all body organs develop. The ectoderm gives rise to the central nervous system (brain and spinal cord), peripheral nervous system, epidermis and its derivatives and mammary glands. The connective tissue, cartilage and bone, muscles, organs of urinogenital system (kidney, ureter and gonads) arise from the mesoderm. The endodermal derivatives are epithelium of gastrointestinal and respiratory tract, liver, pancreas, thyroid and parathyroids.

- Human pregnancy lasts for about 280 days or 40 weeks and is called the gestation period. It can be divided for convenience into three trimesters of three months each. The first trimester is the main period of organogenesis, the body organs namely the heart, limbs, lungs, liver and external genital organs are well developed. By the end of the second trimester, the face is well formed with features, eyelids and eyelashes, eyes blink, body is covered with fine hair, muscle tissue develops and bones become harder. The foetus is fully developed and is ready for delivery by the end of nine months (third trimester).

- During pregnancy, the placenta acts as a temporary endocrine gland and produces large quantities of human Chorionic Gonadotropin (hCG), human Chorionic Somatomammotropin (hCS) or human Placental Lactogen (hPL), oestrogens and progesterone which are essential for a

normal pregnancy. A hormone called relaxin is also secreted during the later phase of pregnancy which helps in relaxation of the pelvic ligaments at the time of parturition. It should be noted that hCG, hPL and relaxin are produced only during pregnancy. In addition, during pregnancy the level of other hormones like oestrogen and progesterone, cortisol, prolactin, thyroxine, etc., is increased several folds in the maternal blood. These hormones are essential for supporting foetal growth.

Parturition and lactation

- Parturition is the completion of pregnancy and giving birth to the baby. The series of events that expels the infant from the uterus is collectively called "labour". Throughout pregnancy the uterus undergoes periodic episodes of weak and strong contractions. These contractions called Braxter-Hick's contractions lead to false labour. As the pregnancy progresses, increase in the oestrogen concentration promotes uterine contractions. These uterine contractions facilitate moulding of the foetus and downward movement of the foetus. The descent of the foetus causes dilation of cervix of the uterus and vaginal canal resulting in a neurohumoral reflex called Foetal ejection reflex or Ferguson reflex. This initiates the secretion of oxytocin from the neurohypophysis which in turn brings about the powerful contraction of the uterine muscles and leads to the expulsion of the baby through the birth canal. This sequence of events is called as parturition or childbirth.

- Relaxin is a hormone secreted by the placenta and also found in the corpus luteum. It promotes parturition by relaxing the pelvic joints and by dilatation of the cervix with continued powerful contractions. The amnion ruptures and the amniotic fluid flows out through the vagina, followed by the foetus. The placenta along with the remains of the umbilical cord called "after birth" is expelled out after delivery.

- Lactation is the production of milk by mammary glands. The mammary glands show changes during every menstrual cycle, during pregnancy and lactation. Increased level of oestrogens, progesterone and human Placental Lactogen (hPL) towards the end of pregnancy stimulate the hypothalamus towards prolactin – releasing factors. The anterior pituitary responds by secreting prolactin which plays a major role in lactogenesis.

- Oxytocin causes the "Let-Down" reflex- the actual ejection of milk from the alveoli of the mammary glands. During lactation, oxytocin also stimulates the recently emptied uterus to contract, helping it to return to pre - pregnancy size.

When normal vaginal delivery is not possible due to factors like position of the baby and nature of the placenta, the baby is delivered through a surgical incision in the woman's abdomen and uterus. It is also termed as abdominal delivery or Caesarean Section or 'C' Section.

Colostrum

Colostrum, a nutrient rich fluid produced by the human female immediately after giving birth, is loaded with immune, growth and tissue repair factors. It acts as a natural antimicrobial agent to actively stimulate the maturation of the infant's immune system. No artificial feed can substitute the first milk, with all its natural benefits and therefore should be definitely fed to the baby after birth.

- The mammary glands secrete a yellowish fluid called colostrum during the initial few days after parturition. It has less lactose than milk and almost no fat, but it contains more proteins, vitamin A and minerals.

- Colostrum is also rich in IgA antibodies. This helps to protect the infant's digestive tract against bacterial infection. Breast milk is the ideal food for infants as it contains all the constituents in suitable concentration and is easily digestible. It is fully sufficient till about 6 months of age and all infants must be breast fed by the mother to ensure the growth of a healthy baby.

12th book

Chapter 3 – Reproductive Health

- Reproductive health represents a society with people having physically and functionally normal reproductive organs. Healthy people have healthier babies and are able to care for their family, and contribute more to the society and community. Hence, health is a community issue. Reproductive system is a complex system controlled by the neuro-endocrine system, hence, it is important to take necessary steps to protect it from infectious diseases and injury.

Need for reproductive health-Problems and strategies

- India is amongst the first few countries in the world to initiate the 'Family planning programme' since 1951 and is periodically assessed every decade. These programmes are popularly named as 'Reproductive and Child Health Care (RCH). Major tasks carried out under these programmes are:

- Creating awareness and providing medical assistance to build a healthy society.

- Introducing sex education in schools to provide information about adolescence and adolescence related changes.

- Educating couples and those in the marriageable age groups about theavailable birth control methods and family planning norms

- Creating awareness about care for pregnant women, post-natal care of mother and child and the importance of breast feeding.

- Encouraging and supporting governmental and non-governmental agencies to identify new methods and/or to improve upon the existing methods of birth control.

Globally, about 800 women die every day of preventable causes related

to pregnancy and childbirth; 20 per cent of these women are from India. Similarly India's infant mortality rate was 44 per 1,000 live. Although, India has witnessed dramatic growth over the last two decades, maternal mortality still remains high as in comparison to many developing nations.

Health care programmes such as massive child immunization, supply of nutritional food to the pregnant women, Janani Suraksha Yojana, Janani Shishu Suraksha Karyakaram, RMNCH+A approach (an integrated approach for reproductive, maternal, new born, child and adolescent health), Pradhan Mantri Surakshit Matritva Abhiyan, etc., are taken up at the national level by the Government of India

Amniocentesis and its statutory ban

- Due to small family norms and the skewed choice for a male child, female population is decreasing at an alarming rate. Amniocentesis is a prenatal technique used to detect any chromosomal abnormalities in the foetus and it is being often misused to determine the sex of the foetus. Once the sex of the foetus is known, there may be a chance of female foeticide. Hence, a statutory ban on amniocentesis is imposed.

Social impact of sex ratio, female foeticide and infanticide

- The sex ratio is the ratio of males to the females in a population. In India, the child sex ratio has decreased over the decade from 927 to 919 female for every 1000 males. To correct this ratio, steps are needed to change the mind set and attitudes of people, especially in the young adults. Female foeticide and infanticide is the manifestation of gender discrimination in our society.

- Female foeticide refers to 'aborting the female in the mother's womb'; whereas female infanticide is 'killing the female child after her birth'. These have resulted in imbalance in sex ratio. In UNDP's GII 2018 (United nations developmental programmes gender inequality index) reflected that India was ranked at 135 out of 187 countries due to availability of very few economic opportunities to women as compared to men.

- In order to prevent female foeticide and infanticide, Government of India has taken various steps like PCPNDT Act (Preconception and Prenatal diagnostic technique act-1994) enacted to ban the identification of sex and

to prevent the use of prenatal diagnostic techniques for selective abortion. Various measures are taken by the Government to ensure survival, provision of better nutrition, education, protection and empowerment of girls by eliminating the differences in the sex ratio, infant mortality rate and improving their nutritional and educational status. POCSO Act (Prevention of children from sexual offences), Sexual harassment at workplace (Prevention, prohibition and redressal) Act and the changes in the Criminal law based on the recommendations of Justice Verma Committee, 2013 aims at creating a safe and secure environment for both females and males.

Population explosion and birth control

- Increased health facilities and better living conditions have enhanced longevity. According to a recent report from the UN, India's population has already reached 1.26 billion and is expected to become the largest country in population size, surpassing China around 2022. To overcome the problem of population explosion, birth control is the only available solution. People should be motivated to have smaller families by using various contraceptive devices. Advertisements by the Government in the media as well as posters/bills, etc., with a slogan Naam iruvar namakku iruvar (we two, ours two) and Naam iruvar namakku oruvar (we two, ours one) have also motivated to control population growth in Tamilnadu. Statutory rising of marriageable age of the female to 18 years and that of males to 21 years and incentives given to couples with small families are the other measures taken to control population growth in our country.

Birth control methods

- The voluntary use of contraceptive procedures to prevent fertilization or prevent implantation of a fertilized egg in the uterus is termed as birth control. An ideal contraceptive should be user friendly, easily available, with least side effects and should not interfere with sexual drive. The contraceptive methods are of two types – temporary and permanent. Natural, chemical, mechanical and hormonal barrier methods are the temporary birth control methods.

Natural method is used to prevent meeting of sperm with ovum. i.e., Rhythm method (safe period), coitus interruptus, continuous abstinence and lactational amenorrhoea.

Periodic abstinence/rhythm method Ovulation occurs at about the 14th day of the menstrual cycle. Ovum survives for about two days and sperm remains alive for about 72 hours in the female reproductive tract. Coitus is to be avoided during this time.

Continuous abstinence is the simplest and most reliable way to avoid pregnancy is not to have coitus for a defined period that facilitates conception.

Coitus interruptus is the oldest family planning method. The male partner withdraws his penis before ejaculation, thereby preventing deposition of semen into the vagina.

Lactational amenorrhoea Menstrual cycles resume as early as 6 to 8 weeks from parturition. However, the reappearance of normal ovarian cycles may be delayed for six months during breast-feeding. This delay in ovarian cycles is called lactational amenorrhoea. It serves as a natural, but an unreliable form of birth control. Suckling by the baby during breast-feeding stimulates the pituitary to secrete increased prolactin hormone in order to increase milk production. This high prolactin concentration in the mother's blood may prevent menstrual cycle by suppressing the release of GnRH (Gonadotropin Releasing Hormone) from hypothalamus and gonadotropin secretion from the pituitary.

Barrier methods In these methods, the ovum and sperm are prevented from meeting so that fertilization does not occur.

Chemical barrier Foaming tablets, melting suppositories, jellies and creams are used as chemical agents that inactivate the sperms in the vagina.

Mechanical barrier Condoms are a thin sheath used to cover the penis in male whereas in female it is used to cover vagina and cervix just before coitus so as to prevent the entry of ejaculated semen into the female reproductive tract. This can prevent conception. Condoms should be discarded after a single use. Condom also safeguards the user from AIDS and STDs. Condoms are made of polyurethane, latex and lambskin.

Diaphragms, cervical caps and vaults are made of rubber and are inserted into the female reproductive tract to cover the cervix before coitus in order to prevent the sperms from entering the uterus.

Hormonal barrier

- It prevents the ovaries from releasing the ova and thickens the cervical fluid which keeps the sperm away from ovum.

Oral contraceptives — Pills are used to prevent ovulation by inhibiting the secretion of FSH and LH hormones. A combined pill is the most commonly used birth control pill. It contains synthetic progesterone and estrogen hormones. Saheli, contraceptive pill by Central Drug Research Institute (CDRI) in Lucknow, India contains a non-steroidal preparation called centchroman.

Intrauterine Devices (IUDs)

- Intrauterine devices are inserted by medical experts in the uterus through the vagina. These devices are available as copper releasing IUDs, hormone releasing IUDs and non-medicated IUDs. IUDs increase phagocytosis of sperm within the uterus. IUDs are the ideal contraceptives for females who want to delay pregnancy. It is one of the popular methods of contraception in India and has a success rate of 95 to 99%.

Copper releasing IUDs differ from each other by the amount of copper. Copper IUDs such as Cu T-380 A, Nova T, Cu 7, Cu T 380 Ag, Multiload 375, etc. release free copper and copper salts into the uterus and suppress sperm motility. They can remain in the uterus for five to ten years.

Hormone-releasing IUDs such as Progestasert and LNG – 20 are often called as intrauterine systems (IUS). They increase the viscosity of the cervical mucus and thereby prevent sperms from entering the cervix.

Non-medicated IUDs are made of plastic or stainless steel. Lippes loop is a double S-shaped plastic device.

Permanent birth control methods are adopted by the individuals who do not want to have any more children.

- Surgical sterilisation methods are the permanent contraception methods advised for male and female partners to prevent any more pregnancies. It blocks the transport of the gametes and prevents conception. Tubectomy is the surgical sterilisation in women. In this procedure, a small portion of

both fallopian tubes are cut and tied up through a small incision in the abdomen or through vagina. This prevents fertilization as well as the entry of the egg into the uterus. Vasectomy is the surgical procedure for male sterilisation. In this procedure, both vas deferens are cut and tied through a small incision on the scrotum to prevent the entry of sperm into the urethra. Vasectomy prevents sperm from heading off to penis as the discharge has no sperms in it.

Medical termination of pregnancy (MTP)

- Medical method of abortion is a voluntary or intentional termination of pregnancy in a non-surgical or non-invasive way. Early medical termination is extremely safe upto 12 weeks (the first trimester) of pregnancy and generally has no impact on a women's fertility. Abortion during the second trimester is more risky as the foetus becomes intimately associated with the maternal tissue. Government of India legalized MTP in 1971 for medical necessity and social consequences with certain restrictions like sex discrimination and illegal female foeticides to avoid its misuse. MTP performed illegally by unqualified quacks is unsafe and could be fatal. MTP of the first conception may have serious psychological consequences.

Sexually transmitted diseases (STD)

- Sexually transmitted diseases (STD) or Venereal diseases (VD) or Reproductive tract infections (RTI) are called as Sexually transmitted infections (STI). Normally STI are transmitted from person to person during intimate sexual contact with an infected partner. Infections like Hepatitis-B and HIV are transmitted sexually as well as by sharing of infusion needles, surgical instruments, etc with infected people, blood transfusion or from infected mother to baby. People in the age of 15 to 24 years are prone to these infections. The bacterial STI are gonorrhoea, syphilis, chancroid, chlamydiasis and lymphogranuloma venereum. The viral STI are genital herpes, genital warts, Hepatitis-B and AIDS. Trichomoniasis is a protozoan STI, and candidiasis is a fungal STI. STI caused by bacteria, fungi and protozoa or parasites, can be treated with antibiotics or other medicines, whereas STI caused by virus cannot be treated but the symptoms can be controlled by antiviral medications. Latex condoms usage greatly reduces the risk, but does not completely eliminate the risk of transmission of STI

Prevention of STDs

- Avoid sex with unknown partner/ multiple partners
- Use condoms
- In case of doubt, consult a doctor for diagnosis and get complete treatment.

According to World Health Organization (WHO), 2017 more than one million people globally acquires a sexually transmitted infection every day. India has the third largest HIV epidemic in the world, with 2.1 million people living with HIV

TNHSP (Tamilnadu health systems project), a unit of the Health and family welfare department of the Government of Tamilnadu does free screening for cervical and breast cancer.

STD and their symptoms

Name of the Disease	**Causative agent**	**Symptom**	**Incubation Period**
	Bacterial STI		
Gonorrhoea	Neisseria gonorrhoeae	Affects the Urethra, rectum and throat and in females the cervix also get affected. Pain and pus discharge in the genital tract and burning sensation during Urination	2 to 5 days
Syphilis	Treponema palladium	**Primary Stage** Formation of painless ulcer on the external genitalia. **Secondary Stage** Skin lesions,	10 to 90 days.

		rashes, Swollen joints and fever and hair loss. **Tertiary Stage** Appearance of chronic ulcers on nose, lower legs and palate. Loss of movement, mental disorder, visual impairment, heart problems, gummas(Soft non – cancerous growths) etc.	
Chlamydiasis	Chlamydia trachomatis	Trachoma, affects the cells of the columnar epithelium in the urinogenital tract, respiratory tract and conjunctiva	
Lymphogranuloma Venereum	Chlamydia trachomatis	Cutaneous or mucosal genital damage, urethritis and endocervicitis Locally harmful ulcerations and genital elephantiasis	2 to 3 weeks or upto 6 weeks
Viral STI			
Genital herpes	Herpes simplex virus	Sores in and around the vulva, vagina, urethra in female or sores on or	2-21 days (average 6 days)

		around the penis in male. Pain during urination, bleeding between periods. Swelling in the groin nodes.	
Genital Warts	Human Papilloma virus (HPV)	Hard outgrowths (Tumour) on the external genitalia, cervix and Perianal region	1-8 months
Hepatitis - B	Hepatitis – B virus (HBV)	Fatigue, jaundice, fever, rash and stomach pain Liver cirrhosis and liver failure occur in the later stage.	30-80 days
AIDS	Human immunodeficiency virus (HIV)	Enlarged lymph nodes, prolonged fever, prolonged diarrhoea, weight reduction, night sweating.	2 to 6 weeks even more than 10 years.
Fungal STI			
Candidiasis	Candida albicans	Attacks mouth, throat, intestinal tract and vagina. Vaginal itching or soreness, abnormal	-

		vaginal discharge and pain during urination	
Protozoan STI			
Trichomoniasis	Trichomonas vaginalis	Vaginitis, greenish Yellow vaginal discharge, itching and burning sensation, urethritis, epididymitis and prostatitis	4-28 days

Cervical cancer

- Cervical cancer is caused by a sexually transmitted virus called Human Papilloma virus (HPV). HPV may cause abnormal growth of cervical cells or cervical dysplasia.

- The most common symptoms and signs of cervical cancer are pelvic pain, increased vaginal discharge and abnormal vaginal bleeding. The risk factors for cervical cancer include

- Having multiple sexual partners
- Prolonged use of contraceptive pills

- Cervical cancer can be diagnosed by a Papanicolaou smear (PAP smear) combined with an HPV test. X-Ray, CT scan, MRI and a PET scan may also be used to determine the stage of cancer. The treatment options for cervical cancer include radiation therapy, surgery and chemotherapy.

- Modern screening techniques can detect precancerous changes in the cervix. Therefore screening is recommended for women above 30 years once in a year. Cervical cancer can be prevented with vaccination. Primary prevention begins with HPV vaccination of girls aged 9 – 13 years, before they become sexually active. Modification in lifestyle can also help in

preventing cervical cancer. Healthy diet, avoiding tobacco usage, preventing early marriages, practicing monogamy and regular exercise minimize the risk of cervical cancer.

Infertility

- Inability to conceive or produce children even after unprotected sexual cohabitation is called infertility. That is, the inability of a man to produce sufficient numbers or quality of sperm to impregnate a woman or inability of a woman to become pregnant or maintain a pregnancy.

- The causes for infertility are tumours formed in the pituitary or reproductive organs, inherited mutations of genes responsible for the biosynthesis of sex hormones, malformation of the cervix or fallopian tubes and inadequate nutrition before adulthood. Long-term stress damages many aspects of health especially the menstrual cycle. Ingestion of toxins (heavy metal cadmium), heavy use of alcohol, tobacco and marijuana, injuries to the gonads and aging also cause infertility.

Other causes of infertility

- Pelvic inflammatory disease (PID), uterine fibroids and endometriosis are the most common causes of infertility in women.
- Low body fat or anorexia in women. i.e. a psychiatric eating disorder characterised by the fear of gaining weight.
- Undescended testes and swollen veins (varicocoele) in scrotum.
- Tight clothing in men may raise the temperature in the scrotum and affect sperm production.
- Under developed ovaries or testes.
- Female may develop antibodies against her partner's sperm.
- Males may develop an autoimmune response to their own sperm.

All women are born with ovaries, but some do not have functional uterus. This condition is called Mayer-Rokitansky syndrome

Assisted reproductive technology (ART)

- A collection of procedures, which includes the handling of gametes and/or embryos outside the body to achieve a pregnancy, is known as Assisted Reproductive Technology. It increases the chance of pregnancy in

infertile couples. ART includes intra-uterine insemination (IUI), in vitro fertilization, (IVF) Embryo transfer (ET), Zygote intra-fallopian transfer (ZIFT), Gamete intrafallopian transfer (GIFT), Intra-cytoplasmic sperm injection (ICSI), Preimplantation genetic diagnosis, oocyte and sperm donation and surrogacy.

Intra-uterine insemination (IUI)

- This is a procedure to treat infertile men with low sperm count. The semen is collected either from the husband or from a healthy donor and is introduced into the uterus through the vagina by a catheter after stimulating the ovaries to produce more ova. The sperms swim towards the fallopian tubes to fertilize the egg, resulting in normal pregnancy.

In vitro fertilization (IVF) or Test tube baby

- In this technique, sperm and eggs are allowed to unite outside the body in a laboratory. One or more fertilized eggs may be transferred into the woman's uterus, where they may implant in the uterine lining and develop. Excess embryos may be cryopreserved (frozen) for future use. Initially, IVF was used to treat women with blocked, damaged, or absent fallopian tubes. Today, IVF is used to treat many causes of infertility. The basic steps in an IVF treatment cycle are ovarian stimulation, egg retrieval, fertilization, embryo culture, and embryo transfer.

- Egg retrieval is done by minor surgery under general anesthesia, using ultrasound guide after 34 to 37 hours of hCG (human chorionic gonadotropin) injection. The eggs are prepared and stripped from the surrounding cells. At the same time, sperm preparation is done using a special media. After preparing the sperms, the eggs are brought together. 10,000-1,00,000 motile sperms are needed for each egg. Then the zygote is allowed to divide to form 8 celled blastomere and then transferred into the uterus for a successful pregnancy. The transfer of an embryo with more than 8 blastomeres stage into uterus is called Embryo transfer technique.

Cryopreservation (or freezing) of embryos is often used when there are more embryos than needed for a single IVF transfer. Embryo cryopreservation can provide an additional opportunity for pregnancy, through a Frozen embryo transfer (FET), without undergoing another ovarian stimulation and retrieval.

Zygote intra-fallopian transfer (ZIFT)

- As in IVF, the zygote upto 8 blastomere stage is transferred to the fallopian tube by laparoscopy. The zygote continues its natural divisions and migrates towards the uterus where it gets implanted.

Intra uterine transfer (IUT)

- Embryo with more than 8 blastomeres is inserted into uterus to complete its further development.

Gamete intra-fallopian transfer (GIFT)

- Transfer of an ovum collected from a donor into the fallopian tube. In this the eggs are collected from the ovaries and placed with the sperms in one of the fallopian tubes. The zygote travels toward the uterus and gets implanted in the inner lining of the uterus.

Intra-cytoplasmic sperm injection (ICSI)

- In this method only one sperm is injected into the focal point of the egg to fertilize. The sperm is carefully injected into the cytoplasm of the egg. Fertilization occurs in 75 - 85% of eggs injected with the sperms. The zygote is allowed to divide to form an 8 celled blastomere and then transferred to the uterus to develop a protective pregnancy.

Surrogacy

- Surrogacy is a method of assisted reproduction or agreement whereby a woman agrees to carry a pregnancy for another person, who will become the newborn child's parent after birth. Through in vitro fertilization (IVF), embryos are created in a lab and are transferred into the surrogate mother's uterus.

Male infertility prevention

- Azoospermia is defined as the absence of spermatozoa in the ejaculate semen on at least two occasions and is observed approximately in 1% of the population.

- Micro-testicular sperm extraction (TESE) Microsurgical sperm retrieval from the testicle involves a small midline incision in the scrotum, through which one or both testicles can be seen. Under the microscope, the seminiferous tubules are dilated and small amount of testicular tissue in areas of active sperm production are removed and improved for sperm yield compared to traditional biopsy techniques.

Detection of foetal disorders during early pregnancy

Ultrasound scanning

- Ultrasound has no known risks other than mild discomfort due to pressure from the transducer on the abdomen or vagina. No radiation is used during this procedure. Ultrasonography is usually performed in the first trimester for dating, determination of the number of foetuses, and for assessment of early pregnancy complications.

There are several types of ultrasound imaging techniques. As the most common type, the 2-D ultrasound provides a flat picture of one aspect of the baby. The 3-D image allows the health care provider to see the width, height and depth of the images, which can be helpful during the diagnosis. The latest technology is 4-D ultrasound, which allows the health care provider to visualize the unborn baby moving in real time with a three-dimensional image

Amniocentesis

- Amniocentesis involves taking a small sample of the amniotic fluid that surrounds the foetus to diagnose for chromosomal abnormalities.

- Amniocentesis is generally performed in a pregnant woman between the 15th and 20th weeks of pregnancy by inserting a long, thin needle through the abdomen into the amniotic sac to withdraw a small sample of amniotic fluid. The amniotic fluid contains cells shed from the foetus.

Chorionic villus sampling (CVS)

- CVS is a prenatal test that involves taking a sample of the placental tissue to test for chromosomal abnormalities.

Foetoscope

- Foetoscope is used to monitor the foetal heart rate and other functions during late pregnancy and labour. The average foetal heart rate is between 120 and 160 beats per minute. An abnormal foetal heart rate or pattern may mean that the foetus is not getting enough oxygen and it indicates other problems.

BREAST SELF EXAMINATION AND EARLY DIAGNOSIS OF CANCER

Breast is divided into 4 quadrants and the center (Nipple) which is the 5th quadrant.

Each quadrant of the breast is felt for lumps using the palm of the opposite hand.

The examination is done in both lying down and standing positions, monthly once after the 1st week of menstrual cycle.

This way if there are lumps or any deviation of the nipple to one side or any blood discharge from the nipple we can identify cancer at an early stage.

Mammograms are done for women above the age of 40 years and for young girls and women below 40 years. Ultrasound of the breast aids in early diagnosis.

- A hand-held doppler device is often used during prenatal visits to count the foetal heart rate. During labour, continuous electronic foetal monitoring is often used.

- Vitamin E is known as anti-sterility vitamin as it helps in the normal functioning of reproductive structures.
- Sex hormones were discovered by Adolf Butenandt.
- 11th July is observed as World Population Day.
- 1st December is observed as World AIDS Day.
- NACO (National AIDS Control Organisation) was established in 1992.
- Syphilis and gonorrhoea are commonly called as international diseases.