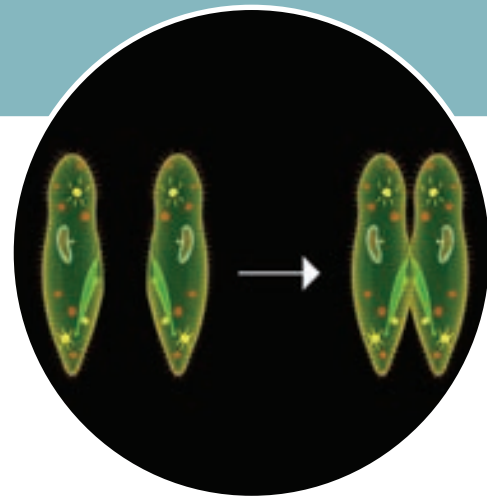


1

CHAPTER

UNIT - I

Reproduction in Organisms



Paramecium are capable of both sexual and asexual reproduction.

Chapter Outline

- 1.1. Modes of reproduction
- 1.2. Asexual reproduction
- 1.3. Sexual reproduction



Learning Objectives

- *Learns the modes of asexual reproduction in organisms.*
- *Understands the significance of asexual reproduction.*
- *Comprehends the different modes of sexual reproduction.*
- *Realizes the significance and advantage of sexual reproduction and its role in evolution.*



Living organisms show a life cycle involving birth, growth, development, maturation, reproduction and death. Reproduction is the fundamental feature of all living organisms. It is a biological process by which organisms produce their young ones. The young ones grow and mature to repeat the process. Thus reproduction results

in continuation of species and introduces variations in organisms, which are essential for adaptation and evolution of their own kind.

1.1. 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**.

1.2. Asexual reproduction

Asexual reproduction is wide spread among different organisms. It is common in members of Protista, Bacteria, Archaea and

Summary

Reproduction is a process by which the living beings propagate or duplicate their own kind. Reproduction can be broadly classified into asexual reproduction and sexual reproduction. In asexual reproduction fusion of gametes are not involved, but in sexual reproduction the formation and fusion of gametes occur. Different modes of asexual reproduction are fission, budding, fragmentation and regeneration. Fission is further divided into binary fission, multiple fission, sporulation and strobilation. According to the plane of fission different kinds of binary fission have been identified in different organisms. They are simple irregular binary fission, transverse binary fission, longitudinal binary fission and oblique binary fission. Multiple fission is the division of the parent into many small daughter cells simultaneously. Budding is another mode of asexual reproduction. The parent body produces one or more buds; each bud grows into a young one and may separate from the parent to lead a normal life. When many buds are formed on the outer surface of the parent, it is known as exogenous budding. Hundreds of buds are formed inside the cytoplasm and remain within the body of the parent, this process is called endogenous budding. Fragmentation is another mode of asexual reproduction. In fragmentation the body of the parent breaks into fragments (pieces). Each fragment has the potential to develop into a new individual. Regeneration is the development of the whole body of an organism from a small fragment. It is of two types namely restorative regeneration and reparative regeneration.

Various modes of sexual reproduction is seen in animals. In syngamy the fusion of two haploid gametes takes place to produce a zygote. The following kinds of syngamy is prevalent among the living organism. They are autogamy, exogamy, hologamy, paedogamy, merogamy, isogamy, anisogamy

and conjugation. Parthenogenesis is the special type of sexual reproduction seen in animals. It is of two main types namely natural parthenogenesis and artificial parthenogenesis.

Evaluation

- In which type of parthenogenesis are only males produced?
a) **Arrhenotoky**
b) Thelytoky
c) Amphitoky d) Both a and b
- The mode of reproduction in bacteria is by
a) Formation of gametes
b) Endospore formation
c) **Conjugation**
d) Zoospore formation
- In which mode of reproduction variations are seen
a) Asexual b) Parthenogenesis
c) **Sexual** d) Both a and b
- Assertion and reasoning questions:
In each of the following questions there are two statements. One is assertion (A) and other is reasoning (R). Mark the correct answer as
A. If both A and R are true and R is correct explanation for A
B. If both A and R are true but R is not the correct explanation for A
C. If A is true but R is false
D. If both A and R are false.
I. Assertion: In bee society, all the members are diploid except drones.
Reason: Drones are produced by parthenogenesis.
A B C D



2

CHAPTER

UNIT - I

Human Reproduction



In every child who is born, the potentiality of the human race is born again

- James Agee

Chapter Outline

- 2.1 Human reproductive system
- 2.2 Gametogenesis
- 2.3 Menstrual cycle
- 2.4 Fertilization and implantation
- 2.5 Maintenance of pregnancy and embryonic development
- 2.6 Parturition and lactation

Learning Objectives

- *Creates an awareness towards a healthy reproductive life in adolescents.*
- *Understands the structure of the male and female reproductive systems.*
- *Explains the functions of the structures associated with the male and female reproductive system.*
- *Compares the process of spermatogenesis and oogenesis.*
- *Discusses the changes in a female body during and after Fertilization.*
- *Appraises the role of hormones in the process of reproduction.*
- *Understands the events in pregnancy and foetal development.*



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 namely sperms 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.
- **Fertilization:** Fusion of male and female gametes to form zygote, called Fertilization.
- **Cleavage:** Rapid mitotic divisions of the zygote which convert the single celled

CAESAREAN 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 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.

Summary

Reproduction is a process which helps in the continuity and maintenance of a species. Human beings are sexually reproducing and viviparous. The reproductive events include gametogenesis, insemination, Fertilization, cleavage, implantation, placentation, gastrulation, organogenesis and parturition.

The female reproductive system consists of a pair of ovaries, a pair of oviducts, uterus, cervix, vagina and external genitalia. The male reproductive system consists of a pair of testes, a pair of duct system, accessory glands and external genitalia called penis.

The process of formation of gametes in the male is called spermatogenesis and in the female is called oogenesis. The reproductive cycle in females is called menstrual cycle and it is initiated at puberty. The ovum released during the menstrual cycle is fertilized by the sperm and the zygote is formed.

Zygote undergoes repeated mitotic division and the blastocyst is implanted on the walls of the uterus. It takes about 280 days or 40 weeks for the entire development of the human foetus and it is delivered out through the process of child birth or parturition. The new born baby is breast fed by the mother.



World Breast feeding week (WBW) August 1st week

WBW is organized and promoted world wide by WABA (World Alliance for Breast feeding Action), WHO (World Health Organization) and UNICEF (United Nations International Children's Emergency Fund) to stress the importance of breast feeding during the first six months of baby's life and a supplemented breast feeding for two years in order to encourage new mothers for the healthy growth and development of their children, to guard them from lethal health problems and diseases including neonatal jaundice, pneumonia, cholera, etc., The Government of Tamil Nadu has also initiated various projects like Mother's Milk Bank, Feeding rooms in bus terminals and also organizes awareness campaigns during the first week of August to highlight the importance of breast feeding to infants.

3

CHAPTER

UNIT - I

Reproductive Health



Safe motherhood begins before conception with healthy lifestyle and proper nutrition.

Chapter outline

- 3.1. Need for reproductive health problems and strategies
- 3.2. Amniocentesis and its statutory ban
- 3.3. Social impact of sex ratio, female foeticide and infanticide
- 3.4. Population explosion and birth control
- 3.5. Medical termination of pregnancy (MTP)
- 3.6. Sexually transmitted diseases (STD)
- 3.7. Infertility
- 3.8. Assisted reproductive technology (ART)
- 3.9. Detection of foetal disorders during early pregnancy



Learning objectives

- Understands the importance of sex education and reproductive health.
- Learns the importance of amniocentesis as a pre-natal diagnosis.
- Evaluates the effects of maternal and infant mortality.
- Identifies, compares and explains different types of contraceptive devices.
- Discusses the medical necessity and social consequences of MTP.
- Explains the reasons of transmission and prevention of STDs.
- Highlights the reasons of infertility.
- Develops a positive and healthy attitude towards reproductive life.



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.

3.1. 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 the available birth control methods and family planning norms.

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

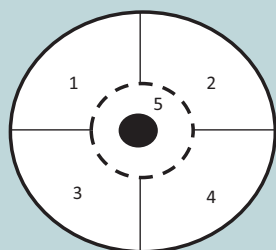
Foetoscope is used to monitor the foetal heart rate and other functions during late pregnancy and labour. The average foetal heart rate is between 120 and 160 beats per minute. An abnormal foetal heart rate or pattern may mean that the foetus is not getting enough oxygen and it indicates other problems.

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.

BREAST SELF EXAMINATION AND EARLY DIAGNOSIS OF CANCER

1. Breast is divided into 4 quadrants and the center (Nipple) which is the 5th quadrant.
2. Each quadrant of the breast is felt for lumps using the palm of the opposite hand.
3. 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.

Summary

Reproductive health refers to a total well-being in all aspects of reproduction. Providing medical facilities and care to the problems like menstrual irregularities, pregnancy related aspects, medical termination of pregnancy, STI, birth control, infertility, post natal child and maternal management are the important aspect of the Reproductive and Child Health Care programmes.

An overall improvement in reproductive health has taken place in our country as indicated by reduced maternal and infant mortality rates, assistance to infertile couples, etc. Improved health facilities and better living conditions promote an explosive growth of population. Such a growth necessitated intense propagation of contraceptive methods. Various contraceptive options are available now such as natural, traditional, barrier, IUDs, pills, injectables, implants and surgical methods. Though contraceptives are not regular

requirements for reproductive health, one is advised to use them to avoid pregnancy or to delay or space pregnancy.

Diseases or infections transmitted through coitus are called Sexually transmitted infections (STIs). Pelvic inflammatory diseases (PIDs), still birth, infertility are some of the complications of STDs. Early detection facilitates better cure of these diseases. Avoiding coitus with unknown/multiple partners, use of condoms during coitus are some of the simple precautions to avoid contracting STIs.

Inability to conceive or produce children even after unprotected sexual cohabitation is called infertility. Various methods are now available to help such couples. *In vitro* fertilization followed by transfer of embryo into the female genital tract is one such method.

Evaluation



- Which of the following is correct regarding HIV, hepatitis B, gonorrhoea and trichomoniasis?
 - Gonorrhoea is a STD whereas others are not.
 - Trichomoniasis is a viral disease whereas others are bacterial.
 - HIV is a pathogen whereas others are diseases.**
 - Hepatitis B is eradicated completely whereas others are not.
- Which one of the following groups includes sexually transmitted diseases caused by bacteria only?
 - Syphilis, gonorrhoea and candidiasis
 - Syphilis, chlamydia and gonorrhoea**
 - Syphilis, gonorrhoea and trichomoniasis
 - Syphilis, trichomoniasis and pediculosis

- Identify the correct statements from the following
 - Chlamydia is a viral disease.
 - Gonorrhoea is caused by a spirochaete bacterium, *Treponema palladium*.
 - The incubation period for syphilis is 2 to 14 days in males and 7 to 21 days in females.
 - Both syphilis and gonorrhoea are easily cured with antibiotics.**
- A contraceptive pill prevents ovulation by
 - blocking fallopian tube
 - inhibiting release of FSH and LH**
 - stimulating release of FSH and LH
 - causing immediate degeneration of released ovum
- The approach which does not give the defined action of contraceptive is

(a) Hormonal contraceptive	Prevents entry of sperms, prevent ovulation and fertilization
(b) Vasectomy	Prevents spermatogenesis
(c) Barrier method	Prevents fertilization
(d) Intra uterine device	Increases phagocytosis of sperms, suppresses sperm motility and fertilizing capacity of sperms

- Read the given statements and select the correct option.

Statement 1: Diaphragms, cervical caps and vaults are made of rubber and are inserted into the female reproductive tract to cover the cervix before coitus.

Statement 2: They are chemical barriers of conception and are reusable.

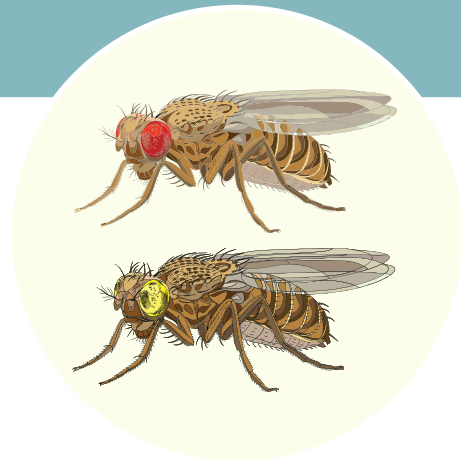
- Both statements 1 and 2 are correct and statement 2 is the correct explanation of statement 1.

4

CHAPTER

UNIT - II

Principles of Inheritance and Variation



Drosophila are ideal for the study of genetics and development

Chapter outline

- 4.1 Multiple alleles
- 4.2 Human blood groups
- 4.3 Genetic control of Rh factor
- 4.4 Sex determination
- 4.5 Sex linked inheritance
- 4.6 Karyotyping
- 4.7 Pedigree analysis
- 4.8 Mendelian disorders
- 4.9 Chromosomal abnormalities



Learning objectives

- *Learns the inheritance of multiple alleles with reference to human blood groups.*
- *Understands the mechanism of sex determination in human beings, insects and birds.*
- *Learns about sex linked (X and Y) inherited diseases in human beings.*
- *Understands the Mendelian disorders and diseases associated with chromosomal abnormalities.*



Genetics is a branch of biology that deals with the study of heredity and variations. It describes how characteristics and features pass on from the parents to their offsprings in each successive generation. The unit of heredity is known as the gene. Gene is the inherited factor that determines the biological character of an organism. A variation is the degree by which the progeny differs from their parents.

In this chapter, we are going to learn about multiple alleles with reference to the human blood groups, sex determination in man, insects and birds, sex linked inherited traits and genetic disorders.

4.1 Multiple alleles

The genetic segregations in Mendelian inheritance reveal that all genes have two alternative forms – dominant and recessive alleles e.g. tall versus dwarf (T and t). The former is the normal allele or wild allele and the latter the mutant allele. A gene can mutate several times producing several alternative forms. When three or more alleles of a gene that control a particular trait occupy the same locus on the homologous chromosome of an organism, they are called multiple alleles and their inheritance is called **multiple allelism**.

1. Down's Syndrome/Trisomy – 21

Trisomic condition of chromosome - 21 results in Down's syndrome. It is characterized by severe mental retardation, defective development of the central nervous system, increased separation between the eyes, flattened nose, ears are malformed, mouth is constantly open and the tongue protrudes.

2. Patau's Syndrome/Trisomy-13

Trisomic condition of chromosome 13 results in Patau's syndrome. Meiotic non disjunction is thought to be the cause for this chromosomal abnormality. It is characterized by multiple and severe body malformations as well as profound mental deficiency. Small head with small eyes, cleft palate, malformation of the brain and internal organs are some of the symptoms of this syndrome.

b. Allosomal abnormalities in human beings

Mitotic or meiotic non-disjunction of sex chromosomes causes allosomal abnormalities. Several sex chromosomal abnormalities have been detected. Eg. Klinefelter's syndrome and Turner's syndrome.

1. Klinefelter's Syndrome (XXY Males)

This genetic disorder is due to the presence of an additional copy of the X chromosome resulting in a karyotype of 47,XXY. Persons with this syndrome have 47 chromosomes (44AA+XXY). They are usually sterile males, tall, obese, with long limbs, high pitched voice, under developed genitalia and have feeble breast (gynaecomastia) development.

2. Turner's Syndrome (XO Females)

This genetic disorder is due to the loss of a X chromosome resulting in a karyotype of 45,X. Persons with this syndrome have 45 chromosomes (44 autosomes and one X chromosome) (44AA+XO) and are sterile females. Low stature, webbed neck, under developed breast, rudimentary gonads lack of menstrual cycle during puberty, are the main symptoms of this syndrome.

Summary

Genetics is a branch of biology that deals with the study of heredity and variation. It describes how characteristics and features pass on from the parents to their offsprings in successive generations. Variation is the degree by which progeny differ from their parents. A set of three or more alleles of the same gene occupying the same locus in a given pair of homologous chromosomes controlling a particular trait is called Multiple allele. ABO blood grouping in man is a good example for multiple allelism. Apart from A and B antigens, the RBC's of humans contain a special type of antigen called Rh antigen/Rh factors. Erythroblastosis foetalis, also called haemolytic disease of the newborn, in which the red blood cells of a foetus are destroyed due to maternal immune reaction resulting from a blood group incompatibility between the foetus and the mother.

The mechanism of determination of male and female individuals in a species is called sex determination. The chromosomes are different in two sexes and referred to as allosomes; the remaining chromosomes are named autosomes. The inheritance of a trait that is determined by a gene located on one of the sex chromosomes is called sex linked inheritance. Haemophilia, colourblindness, muscular dystrophy are some examples for X linked inheritance in human beings.

Pedigree analysis is the study of traits as they have appeared in a given family line for several generations. The genetic disorders are of two types- Mendelian and chromosomal. Alternations or mutation in single gene causes Mendelian disorders like, thalassemia, albinism, phenylketonuria, and Huntington's chorea. Chromosomal abnormalities arise due to chromosomal non-disjunction, translocation, deletion, duplication and inversion. Down's syndrome, Klinefelter's syndrome, Turner's syndrome and Patau's syndrome are some of the chromosomal disorders. Down's syndrome is due to trisomy of chromosome 21. Presence of trisomic condition of chromosome 13 results in

Patau's syndrome. In Turner's syndrome the sex chromosome is XO and in Klinefelter's syndrome the condition is XXY. An idiogram refers to a diagrammatic representation of chromosomes.

Evaluation



- Haemophilia is more common in males because it is a
 - Recessive character carried by Y-chromosome
 - Dominant character carried by Y-chromosome
 - Dominant trait carried by X-chromosome
 - Recessive trait carried by X-chromosome**
- ABO blood group in man is controlled by
 - Multiple alleles**
 - Lethal genes
 - Sex linked genes
 - Y-linked genes
- Three children of a family have blood groups A, AB and B. What could be the genotypes of their parents?
 - $I^A I^B$ and $I^O I^O$
 - $I^A I^O$ and $I^B I^O$**
 - $I^B I^B$ and $I^A I^A$
 - $I^A I^A$ and $I^O I^O$
- Which of the following is not correct?
 - Three or more alleles of a trait in the population are called multiple alleles.
 - A normal gene undergoes mutations to form many alleles.
 - Multiple alleles map at different loci of a chromosome.**
 - A diploid organism has only two alleles out of many in the population.
- Which of the following phenotypes in the progeny are possible from the parental combination AxB?
 - A and B only
 - A,B and AB only
 - AB only
 - A,B,AB and O**
- Which of the following phenotypes is not possible in the progeny of the parental genotypic combination $I^A I^O \times I^A I^B$?
 - AB
 - O**
 - A
 - B
- Which of the following is true about Rh factor in the offspring of a parental combination DdxDd (both Rh positive)?
 - All will be Rh positive
 - Half will be Rh positive
 - About $\frac{3}{4}$ will be Rh negative
 - About one fourth will be Rh negative**
- What can be the blood group of offspring when both parents have AB blood group?
 - AB only
 - A, B and AB**
 - A, B, AB and O
 - A and B only
- If the child's blood group is 'O' and father's blood group is 'A' and mother's blood group is 'B' the genotype of the parents will be
 - $I^A I^A$ and $I^B I^O$
 - $I^A I^O$ and $I^B I^O$**
 - $I^A I^O$ and $I^O I^O$
 - $I^O I^O$ and $I^B I^B$
- XO type of sex determination and XY type of sex determination are examples of
 - Male heterogamety**
 - Female heterogamety
 - Male homogamety
 - Both (b) and (c)
- In an accident there is great loss of blood and there is no time to analyse the blood group which blood can be safely transferred?
 - O and Rh negative**
 - O and Rh positive
 - B and Rh negative
 - AB and Rh positive
- Father of a child is colourblind and mother is carrier for colourblindness, the probability of the child being colourblind is
 - 25%
 - 50%**
 - 100%
 - 75%

5

CHAPTER

UNIT - II

Molecular Genetics



New life for Woolly Mammoth DNA-researchers can now re-create the genes of mammoth and study the proteins they encoded

Chapter Outline

- 5.1 Gene as the functional unit of inheritance
- 5.2 In search of the genetic material
- 5.3 DNA is the genetic material
- 5.4 Chemistry of nucleic acids
- 5.5 RNA world
- 5.6 Properties of genetic material
- 5.7 Packaging of DNA helix
- 5.8 DNA Replication
- 5.9 Transcription
- 5.10 Genetic code
- 5.11 tRNA – the adapter molecule
- 5.12 Translation
- 5.13 Regulation of Gene expression
- 5.14 Human Genome Project (HGP)
- 5.15 DNA finger printing technique

Learning Objectives

- *Identifies DNA as the genetic material.*
- *Understands the organization of prokaryotic and eukaryotic genome.*
- *Learns to differentiate the nucleotides of DNA and RNA.*
- *Understands gene expression - Replication, Transcription and Translation.*
- *Learns about codons and the salient features of genetic code.*
- *Understands the gene regulation through Lac operon model.*
- *Realizes the importance of Human Genome Project.*
- *Illustrates the applications of DNA finger printing technique.*



Mendel's theory dispelled the mystery of why traits seemed to appear and disappear magically from one generation to the next. Mendel's work reveals the patterns of heredity and reflect the transmission of evolved information from parents to offspring. This information is located on the chromosomes. One of the most advanced realizations of human knowledge was that our unique characteristics are encoded within molecules of DNA. The discovery that DNA is the genetic material left several questions unanswered. How is the information in DNA used? Scientists now know that DNA directs the construction of proteins. Proteins determine the shapes of cells and the rate of chemical reactions, such as those that occur during metabolism and photosynthesis. The hereditary nature of every living organism is defined by its genome, which consists of a long sequence of nucleic acids that provide the information needed to construct the organism. The genome contains the complete set of hereditary information for any organism. The genome may be divided into a number of different nucleic acid molecules. Each of the nucleic acid molecule may contain large number of genes. Each gene is a sequence within the nucleic acid that represents a single protein. In this chapter we will discuss the



4. Separation of DNA by electrophoresis

During electrophoresis in an agarose gel, the DNA fragments are separated into bands of different sizes. The bands of separated DNA are sieved out of the gel using a nylon membrane (treated with chemicals that allow for it to break the hydrogen bonds of DNA so there are single strands).

5. Denaturing DNA

The DNA on gels is denatured by using alkaline chemicals or by heating.

6. Blotting

The DNA band pattern in the gel is transferred to a thin nylon membrane placed over the 'size fractionated DNA strand' by **Southern blotting**.

7. Using probes to identify specific DNA

A radioactive probe (DNA labeled with a radioactive substance) is added to the DNA bands. The probe attaches by base pairing to those restriction fragments that are complementary to its sequence. The probes can also be prepared by using either 'fluorescent substance' or 'radioactive isotopes'.

8. Hybridization with probe

After the probe hybridizes and the excess probe washed off, a photographic film is placed on the membrane containing 'DNA hybrids'.

9. Exposure on film to make a genetic/DNA Fingerprint

The radioactive label exposes the film to form an image (image of bands) corresponding to specific DNA bands. The thick and thin dark bands form a pattern of **bars** which constitutes a genetic fingerprint.

Application of DNA finger printing

- **Forensic analysis** - It can be used in the identification of a person involved in criminal activities, for settling paternity or maternity disputes, and in determining relationships for immigration purposes.

- **Pedigree analysis** – inheritance pattern of genes through generations and for detecting inherited diseases.

- **Conservation of wild life** – protection of endangered species. By maintaining DNA records for identification of tissues of the dead endangered organisms.

- **Anthropological studies**–It is useful in determining the origin and migration of human populations and genetic diversities.

Summary

In the twentieth century, one of the landmark discovery in biology was the identification of DNA, as genetic material of living organisms. Gene may be defined as a segment of DNA which is responsible for inheritance and expression of a particular character.

In 1953, James Watson and Francis Crick proposed DNA structure based on X-ray crystallographic studies provided by Maurice Wilkins and Rosalind Franklin. Nucleotides are the structural units of nucleic acids. Each nucleotide has three components, i) pentose sugar ii) nitrogenous base and iii) phosphate. DNA and RNA are polynucleotides. DNA has double stranded helical structure while RNA is a single stranded structure. DNA acts as genetic material of almost all the living organism except few viruses.

The non genetic RNAs are of three types; m-RNA, r-RNA and t-RNA. They help in protein synthesis. DNA has capacity of replication, while the three types of RNA are transcribed on DNA. Meselson and Stahl (1958) proved experimentally the semi-conservative nature of DNA replication using heavy isotope of nitrogen N^{15} in *E.coli*.

In 1958 Crick proposed that DNA determines the sequence of amino acids in a polypeptide (protein) through mRNA, and proposed the central dogma of protein synthesis which involves transcription and translation. The process of copying genetic information from one strand of DNA into RNA is termed transcription. The DNA transcribed RNA molecules serve as a template for the synthesis of polypeptides by a process termed translation. Each amino acid in

a polypeptide chain is represented by a sequence of three nucleotides in the RNA known as the genetic code. RNA transfers genetic message from nucleus to the cytoplasm. DNA is always present in the nucleus and synthesis is also confined to the nucleus

Jacob and Monod proposed the classical model of *Lac* operon to explain gene expression and regulation in *E. coli*. In *lac* operon a polycistronic structural gene is regulated by a common promoter and regulator. It is an example of negative control of transcription initiation.

Human genome project, a mega project was aimed to sequence every gene in the human genome. Polymerase chain reaction is an *in vitro* method of synthesis of nucleic acids wherein, a specific DNA segment is amplified rapidly without concomitant replication of the rest of the DNA molecule. DNA fingerprinting is a technique to identify variations in individuals of a population at the DNA level. It has immense applications in the field of forensic analysis, pedigree analysis, anthropological studies, and conservation of wild life.

Evaluation

- Hershey and Chase experiment with bacteriophage showed that
 - Protein gets into the bacterial cells
 - DNA is the genetic material**
 - DNA contains radioactive sulphur
 - Viruses undergo transformation
- DNA and RNA are similar with respect to
 - Thymine as a nitrogen base
 - A single-stranded helix shape
 - Nucleotide containing sugars, nitrogen bases and phosphates**
 - The same sequence of nucleotides for the amino acid phenyl alanine



- A mRNA molecule is produced by
 - Replication
 - Transcription**
 - Duplication
 - Translation
- The total number of nitrogenous bases in human genome is estimated to be about
 - 3.5 million
 - 35000
 - 35 million
 - 3.1 billion**
- E. coli* cell grown on ^{15}N medium are transferred to ^{14}N medium and allowed to grow for two generations. DNA extracted from these cells is ultracentrifuged in a cesium chloride density gradient. What density distribution of DNA would you expect in this experiment?
 - One high and one low density band.
 - One intermediate density band.
 - One high and one intermediate density band.
 - One low and one intermediate density band.**
- What is the basis for the difference in the synthesis of the leading and lagging strand of DNA molecules?
 - Origin of replication occurs only at the 5' end of the molecules.
 - DNA ligase works only in the 3' \rightarrow 5' direction.
 - DNA polymerase can join new nucleotides only to the 3' end of the growing stand.**
 - Helicases and single-strand binding proteins that work at the 5' end.
- Which of the following is the correct sequence of event with reference to the central dogma?
 - Transcription, Translation, Replication
 - Transcription, Replication, Translation
 - Duplication, Translation, Transcription
 - Replication, Transcription, Translation**

6

CHAPTER

UNIT - II

Evolution



"Each has his own tree of ancestors, but at the top of all sits probably arboreal"

Chapter Outline

- 6.1 Origin of life - Evolution of life forms
- 6.2 Geological time scale
- 6.3 Biological evolution
- 6.4 Evidences for biological evolution
- 6.5 Theories of biological evolution
- 6.6 Mechanism of evolution
- 6.7 Hardy Weinberg principle
- 6.8 Origin and evolution of man

Learning Objectives

- Understands the evolution of life on earth.
- Gains knowledge on theories of evolution.
- Interprets evidences (anatomical, embryological and geological) of evolution.
- Learns the principles of biological evolution.
- Understands the importance of gene frequencies in a population.
- Studies the geological time scale.



The term evolution is used to describe heritable changes in one or more characteristics of a population of species from one generation to the other. The present state of mankind on earth is the outcome of three kinds of evolution - chemical, organic and social or cultural evolution.

Radiometric dating of meteorites yields an estimated age for the solar system and for earth as around 4.5 – 4.6 billion years. The new born earth remained inhospitable for at least few hundred millions years. At first it was too hot. This is because the collisions of the planetesimals that coalesced to form earth released much heat to melt the entire planet. Eventually outer surface of the earth cooled and solidified to form a crust. Water vapour released from the planet's interior cooled and condensed to form oceans. Hence origin of life can be reconstructed using indirect evidences. Consequently, biologists have turned to gather disparate bits of information and filling them together like pieces of jig saw puzzle. Many theories have been proposed to explain the origin of life. Few have been discussed in this chapter.

fire and buried their dead. They did not practice agriculture and animal domestication.

Cro-Magnon was one of the most talked forms of modern human found from the rocks of Cro-Magnon, France and is considered as the ancestor of modern Europeans. They were not only adapted to various environmental conditions, but were also known for their cave paintings, figures on floors and walls.

Homo sapiens or modern human arose in Africa some 25,000 years ago and moved to other continents and developed into distinct races. They had a brain capacity of 1300 – 1600 cc. They started cultivating crops and domesticating animals.

Summary

Evolutionary Biology is the study of history of life forms on Earth which originated on Earth millions of years ago. How Earth originated, how life originated, what is the place of man in the universe are all general questions. This chapter deals with several theories to explain the life on Earth. Evidence from the fossil record and many other areas of biology like embryology, anatomy and molecular biology indicates a common ancestry.

The theories advanced by Lamarck, Darwin, Hugo de Vries explained the intricate evolutionary process. Geological time scale with different eras, periods and epochs gives an idea about the dominant species in those days. The mathematical distribution of gene and genotype frequencies remains constant in a small population was contributed by Hardy and Weinberg in 1908. Natural Selection and gene pool are the important factors those affect Hardy Weinberg equilibrium.

Human evolution states that humans developed from primates or ape like ancestors. The emergence of *Homo sapiens* as a distinct species from apes and placental mammals in brain size, eating habit and other behavior proves that 'Ontogeny recapitulates Phylogeny'.

Evaluation

- 1) The first life on earth originated
 - a) in air
 - b) on land
 - c) in water**
 - d) on mountain
- 2) Who published the book "Origin of species by Natural Selection" in 1859?
 - a) Charles Darwin**
 - b) Lamarck
 - c) Weismann
 - d) Hugo de Vries
- 3) Which of the following was the contribution of Hugo de Vries?
 - a) Theory of mutation**
 - b) Theory of natural Selection
 - c) Theory of inheritance of acquired characters
 - d) Germplasm theory
- 4) The wings of birds and butterflies is an example of
 - a) Adaptive radiation
 - b) convergent evolution**
 - c) divergent evolution
 - d) variation
- 5) The phenomenon of "Industrial Melanism" demonstrates
 - a) Natural selection**
 - b) induced mutation
 - c) reproductive isolation
 - d) geographical isolation
- 6) Darwin's finches are an excellent example of
 - a) connecting links
 - b) seasonal migration
 - c) adaptive radiation**
 - d) parasitism
- 7) Who proposed the Germplasm theory?
 - a) Darwin
 - b) August Weismann**
 - c) Lamarck
 - d) Alfred Wallace
- 8) The age of fossils can be determined by
 - a) electron microscope
 - b) weighing the fossils
 - c) carbon dating**
 - d) analysis of bones



- 9) Fossils are generally found in
 a) igneous rocks b) metamorphic rocks
 c) volcanic rocks **d) sedimentary rocks**
- 10) Evolutionary history of an organism is called
 a) ancestry b) ontogeny
c) phylogeny d) paleontology
- 11) The golden age of reptiles was
a) Mesozoic era b) Cenozoic era
 c) Paleozoic era d) Proterozoic era
- 12) Which period was called “Age of fishes”?
 a) Permian b) Triassic
c) Devonian d) Ordovician
- 13) Modern man belongs to which period?
a) Quaternary b) Cretaceous
 c) Silurian d) Cambrian
- 14) The Neanderthal man had the brain capacity of
 a) 650 – 800cc b) 1200cc
 c) 900cc **d) 1400cc**
- 15) According to Darwin, the organic evolution is due to
 a) Intraspecific competition
 b) Interspecific competition
 c) Competition within closely related species.
 d) Reduced feeding efficiency in one species due to the presence of interfering species.
- 16) A population will not exist in Hardy-Weinberg equilibrium if
 a) Individuals mate selectively
 b) There are no mutations
 c) There is no migration
 d) The population is large
- 17) List out the major gases seems to be found in the primitive earth.
- 18) Explain the three major categories in which fossilization occur?
- 19) Differentiate between divergent evolution and convergent evolution with one example for each.
- 20) How does Hardy-Weinberg’s expression ($p^2+2pq+q^2=1$) explain that genetic equilibrium is maintained in a population? List any four factors that can disturb the genetic equilibrium.
- 21) Explain how mutations, natural selection and genetic drift affect Hardy Weinberg equilibrium.
- 22) How did Darwin explain fitness of organisms?
- 23) Mention the main objections to Darwinism.
- 24) Taking the example of Peppered moth, explain the action of natural selection. What do you call the above phenomenon?
- 25) Darwin's finches and Australian marsupials are suitable examples of adaptive radiation – Justify the statement.
- 26) Who disproved Lamarck’s Theory of acquired characters? How?
- 27) How does Mutation theory of De Vries differ from Lamarck and Darwin’s view in the origin of new species.
- 28) Explain stabilizing, directional and disruptive selection with examples.
- 29) Rearrange the descent in human evolution
Australopithecus → *Homo erectus* → *Homo sapiens* → *Ramapithecus* → *Homo habilis*.
- 30) How does Neanderthal man differ from the modern man in appearance?

7

CHAPTER

UNIT - III

Human Health and Diseases



Sneezing spreads diseases through the droplets of mucus

Chapter outline

- 7.1 Common diseases in human beings
- 7.2 Maintenance of personal and public hygiene
- 7.3 Basic concepts of immunology
- 7.4 Immunodeficiency diseases
- 7.5 Autoimmune diseases
- 7.6 Adolescence – Drug and alcohol abuse
- 7.7 Mental health – Depression

Learning Objectives

- *Learns about various bacterial, viral, fungal, protozoan and helminth diseases.*
- *Understands the life cycle of malarial parasite.*
- *Understands the basic concepts of immunology.*
- *Differentiates between innate immunity and acquired immunity, primary immune response and secondary immune response, active and passive immunity.*



- *Realizes the importance of immunization.*
- *Learns to comprehend the concept of hypersensitivity.*
- *Learns the ill effects of drugs and alcohol.*
- *Realizes the responsibility for their behaviour, health care and life styles.*
- *Understands the importance of mental health.*

The World Health Organization [WHO] defines health as ‘a state of complete physical, mental and social wellbeing and not merely absence of diseases’. We can also say “HEALTH IS WEALTH”, when people are healthy they are more efficient at work. Health increases longevity of people and reduces infant and adult mortality. Personal hygiene, regular exercise and balanced diet are very important to maintain good health.

7.1 Common diseases in human beings

Disease can be defined as a disorder or malfunction of the mind or body. It involves morphological, physiological and psychological disturbances which may be due to environmental

7.7 Mental health – Depression

Mental health is a state of well being of the mind, with self esteem. Self esteem means liking yourself and being able to stand up for what you believe is right. Positive mental health is an important part of wellness. A mentally healthy person reflects a good personality. Activities of mentally healthy people are always appreciated and rewarded by the society as these persons are creative as well as cooperative with others. Mental health improves the quality of life.

Depression is a common mental disorder that causes people to experience depressed mood, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep poor appetite, low energy and poor concentration.

Signs and symptoms of mental depression

- Loss of self confidence and self esteem
- Anxiety
- Not being able to enjoy things that are usually pleasurable or interesting

Lifestyle changes like exercise, meditation, yoga and healthy food habits can help to be relieved from depression. Exercise stimulates the body to produce **serotonin** and **endorphins**, which are neurotransmitters that suppress depression. Practicing exercise in daily life creates a positive attitude .

Participating in an exercise programme can:

- Increase self-esteem
- Boost self-confidence
- Create a sense of empowerment
- Enhance social connections and relationships

Brain is one of the most metabolically active part of the body and needs a steady stream of nutrients to function. A poor diet may not provide the nutrients for a healthy body and may provoke symptoms of anxiety and depression.

Summary

Health is a state of complete physical and psychological well being. Many other extended factors like microbes may cause illness to human body. Protozoans like *Entamoeba*, *Plasmodium* and *Leishmania* cause diseases such as amoebic dysentery, malaria and kala-azar respectively. Personal cleanliness and hygiene, proper disposal of waste, safe drinking water and immunization are very useful in preventing diseases. Drug and alcohol abuse of young and adolescent is another cause of concern. Addiction to drugs and alcohol is happening due to peer pressure, examination-related and competition-related stresses. The addicted person should receive proper counselling, education and professional medical help to liberate themselves from all forms of addiction.

Immunology deals with a study of the immune system. The immune system recognises and eliminates the invaders, and the ability of the body to overcome the pathogen is called immunity. Immunity is classified into innate immunity and acquired immunity. Acquired immunity is further classified into cell mediated immunity and antibody mediated immunity as its components. Acquired immunity may be active or passive immunity. Immune response is the body's response to pathogens and it may be primary or secondary. The organs involved in the origin, maturation and proliferation of lymphocytes are called lymphoid organs. Thymus, bone marrow are primary lymphoid organs. The secondary lymphoid organs are lymph node, MALT, GALT and BALT.

The malfunctioning of immune system leads to hypersensitivity, immunodeficiency or autoimmune diseases. A tumour or neoplasm is a group of cells whose growth has gone unchecked. The best results in the treatment of cancer is achieved by an integrated approach to therapy, surgery, radiotherapy, chemotherapy and immunotherapy.



INTERESTING FACTS

- Freezing does not kill bacteria; it only arrests their growth.
- Antibiotics not only kill harmful bacteria, but also kill beneficial bacteria of our body.
- UTI- Urinary Tract Infection is one of the most common bacterial infections affecting 150 million people each year worldwide.
- World malaria day is on 25th April .
- Iceland and the Faroe islands are the only countries in the world, where there are “No mosquitoes” (Mosquito free countries).
- VCRC- Vector Control Research Center is situated in Puduchery. WHO is collaborating with the Centre for Research and Training in Lymphatic Filariasis and

Integrated Methods of Vector Control.

- Sterile insect technique (SIT)



The screw-worm fly was the first pest successfully eliminated from an area through the sterile insect technique, by the use of an integrated area-wide approach.

- Zika virus* could become a surgical weapon against brain cancer.

Evaluation

- A 30 year old woman has bloody diarrhoea for the past 14 hours, which one of the following organisms is likely to cause this illness?



- Streptococcus pyogenes*
 - Clostridium difficile*
 - Shigella dysenteriae***
 - Salmonella enteritidis*
- Exo-erythrocytic schizogony of *Plasmodium* takes place in -----
 - RBC
 - Leucocytes
 - Stomach
 - Liver**

- The sporozoites of *Plasmodium vivax* are formed from -----
 - Gametocytes
 - Sporoblasts
 - Oocysts**
 - Spores
- Amphetamines are stimulants of the CNS, whereas barbiturates are ----
 - CNS stimulant
 - both a and b
 - hallucinogenic
 - CNS depressants**
- Choose the correctly match pair.

a) Amphetamines	-	Stimulant
b) LSD	-	Narcotic
c) Heroin	-	Psychotropic
d) Benzodiazepine	-	Pain killer

8

CHAPTER

UNIT - III

Microbes in Human Welfare



Saccharomyces cerevisiae, a species of yeast used in baking and brewing industry.

Chapter outline

- 8.1 Microbes in household products
- 8.2 Microbes in industrial products
- 8.3 Microbes in sewage treatment and energy generation
- 8.4 Microbes in the production of biogas
- 8.5 Bioremediation

Learning objectives

- Differentiates probiotics from pathogens.
- Understands the use of microbes in household products.
- Learns about antibiotic production and fermented beverages.
- Realizes the importance of microbes in sewage treatment and energy generation.
- Realizes the applications of microbes in bio-remediation.



Microbes such as bacteria, fungi, protozoa, certain algae, viruses, viroids and prions are some of the major components of the biological system on Earth. Several microorganisms are beneficial and contribute to human welfare. Microbes are present everywhere – in soil, water, air and within bodies of animals and plants. Microbes like bacteria and fungi can be grown on nutritive media to form colonies which can be visibly seen. Some of the microbes useful to human welfare are discussed here.

8.1 Microbes in household products

In every day life, microbes and their products are used in the preparation of idli, dosa, cheese, curd, yogurt, dough, bread, vinegar, etc., Bacteria like *Lactobacillus acidophilus*, *L. lactis* and *Streptococcus lactis* commonly called **lactic acid bacteria** (LAB) are probiotics which check the growth of pathogenic microbes in the stomach and other parts of the digestive tract.

The LAB bacteria grows in milk and convert it into curd, thereby digesting the milk protein casein. A small amount of curd added to fresh milk as a starter or inoculum contains millions of *Lactobacilli*, which under suitable

called bioremediation. Bioremediation is less expensive and more sustainable than other remediations available. It is grouped into *in situ* bioremediation (treatment of contaminated soil or water in the site) and *ex situ* bioremediation (treatment of contaminated soil or water that is removed from the site and treated).

8.5.1 Microorganisms involved in bioremediation

Aerobic microbes degrade the pollutants in the presence of oxygen. They mainly degrade pesticides and hydrocarbons. *Pseudomonas putida* is a genetically engineered microorganism (GEM). Ananda Mohan Chakrabarty obtained patent for this recombinant bacterial strain. It is multi-plasmid hydrocarbon-degrading bacterium which can digest the hydrocarbons in the oil spills (Fig. 8.4).

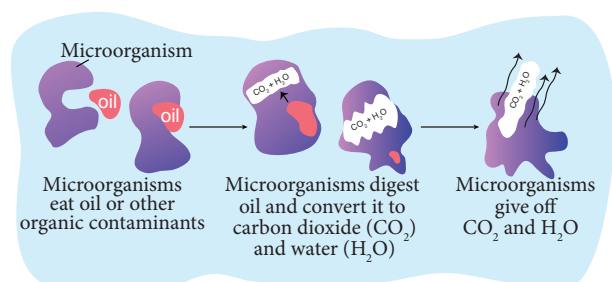


Fig. 8.4 The process of bioremediation

Nitrosomonas europaea is also capable of degrading benzene and a variety of halogenated organic compounds including trichloroethylene and vinyl chloride. *Ideonella sakaiensis* is currently tried for recycling of PET plastics (Fig. 8.5). These bacteria use PETase and MHETase enzymes to breakdown PET plastic into terephthalic acid and ethylene glycol.

Anaerobic microbes degrade the pollutants in the absence of oxygen. *Dechloromonas aromatica* has the ability to degrade benzene anaerobically and to oxidize toluene and xylene. *Phanerochaete chrysosporium* an anaerobic fungus exhibits strong potential for bioremediation of pesticides, polyaromatic hydrocarbons,

dyes, trinitrotoluene, cyanides, carbon tetrachloride, etc., *Dehalococcoides* species are responsible for anaerobic bioremediation of toxic trichloroethene to non-toxic ethane. *Pestalotiopsis microspora* is a species of endophytic fungus capable of breaking down and digesting polyurethane. This makes the fungus a potential candidate for bioremediation projects involving large quantities of plastics.

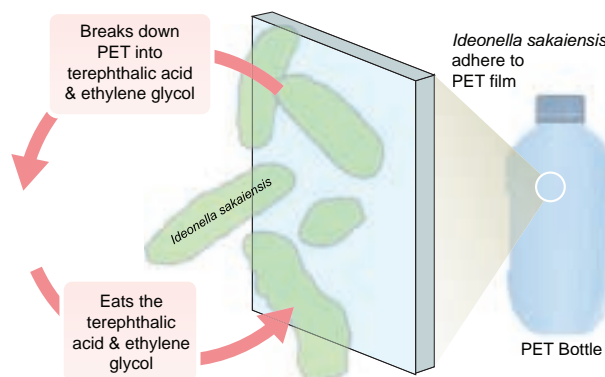


Fig. 8.5 Actions of *Ideonella sakaiensis*

Summary

All microbes are not pathogenic, many of them are beneficial to human beings. We use microbes and their derived products almost every day. Lactic acid bacteria convert milk into curd. *Saccharomyces cerevisiae* (yeast) is used in bread making. Idly and dosa are made from dough fermented by microbes. Bacteria and fungi are used in cheese making. Industrial products like lactic acid, acetic acid and alcohol are produced by microbes. Antibiotics are produced from useful microbes to kill the disease causing harmful microbes. For more than a hundred years, microbes are being used to treat sewage by the process of activated sludge formation. Bio-gas produced by microbes is used as a source of energy in rural areas. In bio-remediation naturally occurring or genetically engineered microorganisms are used to reduce or degrade pollutants.

Evaluation

- Which of the following microorganism is used for production of citric acid in industries?
a) *Lactobacillus bulgaris*
b) *Penicillium citrinum*
c) ***Aspergillus niger*** d) *Rhizopus nigricans*
- Which of the following pair is correctly matched for the product produced by them?
a) *Acetobacter aceti* - Antibiotics
b) *Methanobacterium* - Lactic acid
c) *Penicillium notatum* - Acetic acid
d) ***Saccharomyces cerevisiae* - Ethanol**
- The most common substrate used in distilleries for the production of ethanol is _____
a) Soyameal b) Groundgram
c) **Molasses** d) Corn meal
- Cyclosporin – A is an immunosuppressive drug produced from _____
a) *Aspergillus niger*
b) *Manascus purpureus*
c) *Penicillium notatum*
d) ***Trichoderma polysporum***
- CO₂ is not released during
a) Alcoholic fermentation
b) **Lactate fermentation**
c) Aerobic respiration in animals
d) Aerobic respiration in plants



- The purpose of biological treatment of waste water is to _____
a) **Reduce BOD** b) Increase BOD
c) Reduce sedimentation
d) Increase sedimentation
- The gases produced in anaerobic sludge digesters are
a) Methane, oxygen and hydrogen sulphide.
b) Hydrogen sulphide, methane and sulphur dioxide.
c) Hydrogen sulphide, nitrogen and methane.
d) **Methane, hydrogen sulphide and CO₂.**
- How is milk converted into curd? Explain the process of curd formation.
- Give any two bioactive molecules produced by microbes and state their uses.
- Define the following terms:
a) Antibiotics b) Zymology
c) Superbug
- Write short notes on the following.
a) Brewer's yeast b) *Ideonella sakaiensis*
c) Microbial fuel cells
- List the advantages of biogas plants in rural areas.
- When does antibiotic resistance develop?
- What is referred to as industrial alcohol? Briefly describe its preparation.
- What is bioremediation?

9

CHAPTER

UNIT - IV

Applications of Biotechnology



"Our world is built on biology"

Chapter outline

- 9.1 Applications in Medicine
- 9.2 Gene therapy
- 9.3 Stem Cell Therapy
- 9.4 Molecular Diagnostics
- 9.5 Transgenic Animals
- 9.6 Biological products and their uses
- 9.7 Animal cloning
- 9.8 Ethical issues



Learning objectives

- Understand the applications of rDNA technology in the field of medicine.
- Analyse the role of diagnostic tools in Molecular diagnosis.
- Learn animal cloning and its applications.
- Create awareness on the ethical issues involved in biotechnology.



Before we start this chapter, it will be helpful if you revise the structure of DNA, Protein synthesis and genetic engineering. Genetic engineering involves the manipulation of DNA and naturally occurring processes such as protein synthesis for a wide range of applications including the production of therapeutically important proteins. This also involves extracting a gene from one organism and transferring it to the DNA of another organism, of the same or another species. The DNA produced in this way is referred to as recombinant DNA (rDNA) and this technique as recombinant DNA technology. All these are part of the broad field biotechnology which can be defined as the applications of scientific and engineering principles to the processing of material by biological agents to provide goods and services.

Biotechnology is an umbrella term that covers various techniques for using the properties of living things to make products or provide services. The term biotechnology was first used before 20th century for such traditional activities as making idli, dosa, dairy products, bread or wine, but none of these would be considered biotechnology in the modern sense.

In this chapter we will study the applications of bio-technology in various fields including the field of Medicine. Recombinant DNA technology has led to the large scale production of various hormones and proteins of therapeutic use.

ewe which served as a surrogate mother. Five months later Dolly was born. Dolly was the first animal to be cloned from a differentiated somatic cell taken from an adult animal without the process of fertilization (**Fig. 9.8**).



Ian Wilmut and Campbell removed 277 cells from the udder of an adult sheep and fused those cells with 277 unfertilised egg cells from which the nuclear material was removed. After culturing the resulting embryos for 6 days, they implanted 29 embryos into the surrogate mother's womb and only one Dolly was produced.

Advantages and Disadvantages Of Cloning Animals

- Offers benefits for clinical trials and medical research. It can help in the production of proteins and drugs in the field of medicine.
- Aids stem cell research.
- Animal cloning could help to save endangered species.
- Animal and human activists see it as a threat to biodiversity saying that this alters evolution which will have an impact on populations and the ecosystem.
- The process is tedious and very expensive.
- It can cause animals to suffer.
- Reports show that animal surrogates were manifesting adverse outcomes and cloned animals were affected with disease and have high mortality rate.
- It might compromise human health through consumption of cloned animal meat.
- Cloned animals age faster than normal animals and are less healthy than the parent organism as discovered in Dolly.
- Cloning can lead to occurrence of genetic disorders in animals.
- More than 90% of cloning attempts fail to produce a viable offspring.

A gene 'knock out' is a genetically engineered organism that carries one or more genes in its chromosomes that have been made inoperative.

9.8 Ethical Issues

Biotechnology has given to the society cheap drugs, better fruits and vegetables, pest resistant crops, indigenous cure to diseases and lot of controversy. This is mainly because the major part of the modern biotechnology deals with genetic manipulations. People fear that these genetic manipulations may lead to unknown consequences. The major apprehension of recombinant DNA technology is that unique microorganisms either inadvertently or deliberately for the purpose of war may be developed that could cause epidemics or environmental catastrophies. Although many are concerned about the possible risk of genetic engineering, the risks are in fact slight and the potential benefits are substantial.

Summary

Biotechnology is defined as "any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use". In 1919, Hungarian agricultural engineer Karl Ereky coined the term Biotechnology. Biotechnology includes two major technologies, Genetic engineering and Chemical engineering.

Biotechnology has application in four major industrial areas, including health care (medical) agriculture, industrial and environment. Biotechnology techniques are used in the field of medicine for diagnosis, prevention and treatment of different diseases. Production of recombinant hormones, and recombinant interferons have helped in the treatment of diseases. Recombinant vaccines have been used to prevent various diseases. The recombinant vaccines are of three types- subunit recombinant vaccines, attenuated recombinant vaccines and gene recombinant vaccines.

Genetic defects could be corrected by a process called Gene therapy. It is of two types somatic cell gene therapy and germline gene therapy.

Stem cells are undifferentiated cells found in multicellular organisms. These cells are of two types -Embryonic stem cells and adult stem cells. Stem cells have the ability to regenerate damaged and diseased organs. Recombinant DNA technology, Polymerase chain reaction and Enzyme Linked Immunosorbent Assay are techniques that are reliable and help in early diagnosis.

Transgenesis is the process of introduction of a foreign gene into the genome of animals to create and maintain stable heritable characters.

A biological product is a substance derived from a living organism and used for the prevention or treatment of diseases.

Cloning is the process of producing genetically identical individuals of an organism either naturally or artificially.

Advances in Biotechnology and their applications are most frequently associated with controversies, ethical issues and concerns.

Evaluation

- The first clinical gene therapy was done for the treatment of
 - AIDS
 - Cancer
 - Cystic fibrosis
 - SCID**
- Dolly, the sheep was obtained by a technique known as
 - Cloning by gene transfer
 - Cloning without the help of gametes
 - Cloning by tissue culture of somatic cells
 - Cloning by nuclear transfer**
- The genetic defect adenosine deaminase deficiency may be cured permanently by
 - Enzyme replacement therapy
 - Periodic infusion of genetically engineered lymphocytes having ADA cDNA
 - Administering adenosine deaminase activators
 - Introducing bone marrow cells producing ADA into embryo at an early stage of development**



- How many amino acids are arranged in the two chains of Insulin?
 - Chain A has 12 and Chain B has 13
 - Chain A has 21 and Chain B has 30 amino acids**
 - Chain A has 20 and chain B has 30 amino acids
 - Chain A has 12 and chain B has 20 amino acids.
- PCR proceeds in three distinct steps governed by temperature, they are in order of
 - Denaturation, Annealing, Synthesis**
 - Synthesis, Annealing, Denaturation
 - Annealing, Synthesis, Denaturation
 - Denaturation, Synthesis, Annealing
- Which one of the following statements is true regarding DNA polymerase used in PCR?
 - It is used to ligate introduced DNA in recipient cells
 - It serves as a selectable marker
 - It is isolated from a Virus
 - It remains active at a high temperature**
- ELISA is mainly used for
 - Detection of mutations
 - Detection of pathogens**
 - Selecting animals having desired traits
 - Selecting plants having desired traits
- Transgenic animals are those which have
 - Foreign DNA in some of their cells
 - Foreign DNA in all their cells**
 - Foreign RNA in some of their cells
 - Foreign RNA in all their cells
- Vaccines that use components of a pathogenic organism rather than the whole organism are called
 - Subunit recombinant vaccines**
 - attenuated recombinant vaccines
 - DNA vaccines
 - conventional vaccines
- Mention the number of primers required in each cycle of PCR. Write the role of primers and DNA polymerase in PCR. Name the source organism of the DNA polymerase used in PCR.

10

CHAPTER

UNIT - V

Organisms and Populations



Save nature – save our future

Chapter Outline

- 10.1. Organism and its Environment
- 10.2. Habitat
- 10.3. Major Abiotic Components or Factors
- 10.4. Concept of Biome and their Distribution
- 10.5. Responses to abiotic factors
- 10.6. Adaptations
- 10.7. Populations
- 10.8. Population attributes
- 10.9. Population age distribution
- 10.10. Growth models / Curves
- 10.11. Population regulation
- 10.12. Population interaction

Learning Objectives

To gain knowledge / insight about:

- *The local and geographical distribution - abundance of organisms.*
- *Temporal changes in the occurrence, abundance and activities.*
- *Interrelationship between organism in population and communities.*
- *Structural adaptation and functional adjustment of organisms to their physical environment.*
- *The evolutionary development of all these interrelations.*
- *Population growth, models, regulation.*
- *Animal associations – intraspecific, interspecific.*



The word 'ecology' is derived from the Greek term 'oikos', meaning 'house' and 'logos', meaning 'study'. Thus, the study of the environmental 'house' includes all the organisms in it and all the functional processes that make the house habitable.

The study of ecology encompasses different levels-organism, population, community, ecosystem, etc., In ecology, the term population, originally coined to denote a group of people is broadened to include groups of individuals of any one kind of organism. Community in the ecological sense (designated as 'biotic community') includes all the populations occupying a given area. The community (Biotic) and the non-living environment (Abiotic) function together as an ecological system (or) ecosystem. Biome is a term in wide use for a large regional or sub continental system characterized by a major vegetation type. The largest and most nearly self-sufficient biological system is often designated as the Ecosphere, which includes all the living organisms of the Earth, interacting with the physical environment to regulate their distribution, abundance, production and evolution.

Table 10.3 Analysis of two species population interactions

S. NO.	TYPES OF INTERACTION	SPECIES 1	SPECIES 2	GENERAL NATURE OF INTERACTION	EXAMPLES
1	Amensalism	–	0	The most powerful animal or large organisms inhibits the growth of other lower organisms	Cat and Rat
2	Mutualism	+	+	Interaction favorable to both and obligatory	Between crocodile and bird
3	Commensalism	+	0	Population 1, the commensal benefits, while 2 the host is not affected	Sucker fish on shark
4	Competition	–	–	Direct inhibition of each species by the other	Birds compete with squirrels for nuts and seeds
5	Parasitism	+	–	Population 1, the parasite, generally smaller than 2, the host	<i>Ascaris</i> and tapeworm in human digestive tract
6	Predation	+	–	Population 1, the predator, generally larger than 2, the prey	Lion predatory on deer

Summary

Ecology is the study of the relationships of living organisms with the abiotic and biotic components of their environment. Temperature, Light, Water, Soil, Humidity, Wind and Topographic factors are the important physical components of the environment to which the organisms are adapted in various ways. Maintenance of a constant internal environment by the organisms contributes to optimal performance, but only some organisms (regulators) are capable of homeostasis in the fact of changing external environment. Others simply conform. Many species have evolved adaptations to avoid unfavourable conditions in space or in time.

Population ecology is an important area of ecology. A population is a group of individuals of a given species sharing or competing for similar resources in a defined geographical area. Populations have attributes that individual organisms do not, such as natality and mortality,

sex ratio and age distribution. The proportion of different age groups of males and females in a population is often presented graphically as age pyramid, its shape indicated whether a population is stationary, growing or declining.

Ecological effects of any factors on a population are generally reflected in population density. Population grow through births and immigration and decline through deaths and emigration. When resources are unlimited, the growth is usually exponential but when resources become progressively limiting the growth pattern turns logistic. In either case, growth is ultimately limited by the carrying capacity of the environment. The intrinsic rate of natural increase is a measure of the inherent potential of a population to grow.

Population of the same or different species in a habitat do not live in isolation but interact in many ways. These interactions may be intra specific or interspecific. They may be positive, negative or neutral in nature.

Evaluation:

1. All populations in a given physical area are defined as

- a) **Biome**
- b) Ecosystem
- c) Territory
- d) Biotic factors



2. Organisms which can survive a wide range of temperature are called

- a) Ectotherms **b) Eurytherms**
- c) Endotherms d) Stenotherms

3. The interaction in nature, where one gets benefit on the expense of other is...

- a) Predation b) Mutualism
- c) Amensalism **d) Commensalism**

4. Predation and parasitism are which type of interactions?

- a) (+,+) b) (+, 0)
- c) (-, -) **d) (+, -)**

5. Competition between species leads to

- a) Extinction** b) Mutation
- c) Amensalism d) Symbiosis

6. Which of the following is an r-species

- a) Human **b) Insects**
- c) Rhinoceros d) Whale

7. Match the following and choose the correct combination from the options given below.

Column I

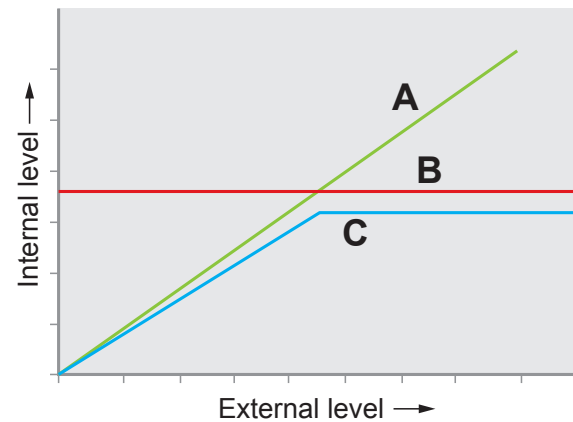
Column II

- | | |
|-----------------|--|
| A. Mutualism | 1. Lion and deer |
| B. Commensalism | 2. Round worm and man |
| C. Parasitism | 3. Birds compete with squirrels for nuts |
| D. Competition | 4. Sea anemone on hermit crab |
| E. Predation | 5. Barnacles attached to Whales. |

Dispersal

- a) **A- 4, B-5, C-2, D -3, E-1**
- b) A- 3, B-1, C-4, D - 2, E-5
- c) A- 2, B-3, C-1, D - 5, E-4
- d) A- 5, B-4, C-2, D - 3, E-1

8. The figure given below is a diagrammatic representation of response of organisms to abiotic factors. What do A, B and C represent respectively.



S. No.	A	B	C
a.	Conformer	Regulator	Partial Regulator
b.	Regulator	Partial Regulator	Conformer
c.	Partial Regulator	Regulator	Conformer
d.	Regulator	Conformer	Partial Regulator

9. The relationship between sucker fish and shark is.....

- a) Competition **b) Commensalism**
- c) Predation d) Parasitism.

10. Which of the following is correct for r-selected species

- a) Large number of progeny with small size**
- b) large number of progeny with large size
- c) small number of progeny with small size
- d) small number of progeny with large size

11

CHAPTER

UNIT - V

Biodiversity and its Conservation



Nilgiri tahr is an endangered species in the IUCN Red List of Threatened Species due to hunting and poaching

Chapter outline

- 11.1 Biodiversity
- 11.2 Importance of biodiversity – Global and India
- 11.3 Biogeographical regions of India
- 11.4 Threats to biodiversity
- 11.5 Causes of Biodiversity Loss
- 11.6 IUCN
- 11.7 Biodiversity and its conservation



Learning objectives

- *Acquire knowledge about concept, level and patterns of biodiversity.*
- *Appreciate the magnitude of India's biodiversity.*
- *Understand biogeographical regions and resources of India.*
- *Gain insight into the threats to biodiversity.*
- *Understand the reasons/causes and effects of extinction.*



A wide variety of living organisms including plants, animals and micro-organisms with whom we share this planet earth makes the world a beautiful place to live in. Living organisms exist almost everywhere from mountain peaks to the ocean depths; from deserts to the rainforests. They vary in their habit and behaviour, shape, size and colour. The remarkable diversity of living organisms forms an inseparable and significant part of our planet, however, the ever increasing human population is posing serious threats to bio-diversity. In this chapter, we shall discuss biodiversity – concepts, levels, magnitude and patterns, importance of biodiversity, biogeographical regions of India, threats to biodiversity, causes of biodiversity loss, extinction, and biodiversity conservation.

11.1 Biodiversity

The 1992 UN Earth Summit defined **Biodiversity** as the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes diversity within species, between species and ecosystems of a region. It reflects the number of different organisms and their relative frequencies in an ecological system and constitutes the most important functional component of a natural ecosystem.

Agasthyamalai (Karnataka - Tamil Nadu - Kerala), Nilgiri (Tamil Nadu - Kerala), Gulf of Mannar (Tamil Nadu) are the BRs notified in Tamil Nadu.

Sacred Groves

A sacred grove or sacred woods are any grove of trees that are of special religious importance to a particular culture. Sacred groves feature in various cultures throughout the world.

11.7.2 Ex-Situ Conservation

It is conservation of selected rare plants/ animals in places outside their natural homes. It includes offsite collections and gene banks.

Offsite Collections

They are live collections of wild and domesticated species in Botanical gardens, Zoological parks, Wildlife safari parks, Arborata (gardens with trees and shrubs). The organisms are well maintained for captive breeding programmes. As a result, many animals which have become extinct in the world continue to be maintained in Zoological Parks. As the number increases in captive breeding, the individuals are selectively released in the wild. In this way the Indian crocodile and gangetic dolphin have been saved from extinction.

Gene Banks

Gene banks are a type of biorepository which preserve genetic materials. Seeds of different genetic strains of commercially important plants can be stored in long periods in seed banks, gametes of threatened species can be preserved in viable and fertile condition for long periods using cryopreservation techniques.

However, it is not economically feasible to conserve all biological wealth and all the ecosystems. The number of species required to be saved from extinction far exceeds the conservation efforts.

Table 11.4 Difference between Insitu and Exsitu Conservation

<i>Insitu</i> Conservation	<i>Exsitu</i> Conservation
It is the on-site conservation or the conservation of genetic resources in natural populations of plant or animal species.	This is a conservation strategy which involves placing of threatened animals and plants in special care locations for their protection.
It is the process of protecting an endangered plant or animal species in its natural habitat, either by protecting or restoring the habitat itself, or by defending the species from predators.	It helps in recovering populations or preventing their extinction under simulated conditions that closely resemble their natural habitats.
National Parks, Biosphere Reserve, Wild Life Sanctuaries form <i>insitu</i> conservation strategies.	Zoological parks and Botanical gardens are common <i>exsitu</i> conservation programs.

Summary:

Biodiversity is the variety of all life on Earth, encompassing genetic, species and ecosystem diversity. Today's biodiversity is the fruit of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans. To date, about two million species have been identified on Earth.

Biodiversity supplies a large number of goods and services that sustain human life, including the provision of food, fuel and building materials; purification of air and water; stabilization and moderation of the earth's climate; moderation of floods, droughts, temperature extremes and wind forces; generation and renewal of soil health; maintenance of genetic resources as inputs to crop varieties and livestock breeds, medicines, and other products; and cultural, recreational and aesthetic benefits.

Over the past few hundred years, biodiversity has faced major challenges, including a growing demand for biological resources caused by population growth and increased consumption. This increased exploitation of biological resources has resulted in the loss of species at levels currently estimated to be 100 times faster than the natural rate of loss prior to significant human intervention. Though many species were lost and new ones formed, it is likely we will lose all this natural wealth in less than two centuries, if the present rate of biodiversity losses persist.

The biodiversity and its conservation is the important global issue of international concern. Recognition of this problem has made scientists and policy makers to work and develop mechanisms to document, conserve and sustainably use biodiversity.

The younger generation should be made to realize the critical state of biodiversity today and volunteer to protect and conserve it, so as to enable the future generations get to enjoy the benefits of Nature.

Evaluation

- Which of the following region has maximum biodiversity
 - Taiga
 - Tropical forest**
 - Temperate rain forest
 - Mangroves
- Conservation of biodiversity within their natural habitat is
 - Insitu conservation**
 - Exsitu conservation
 - In vivo conservation
 - In vitro conservation
- Which one of the following is not coming under insitu conservation
 - Sanctuaries
 - Natural parks
 - Zoological park**
 - Biosphere reserve



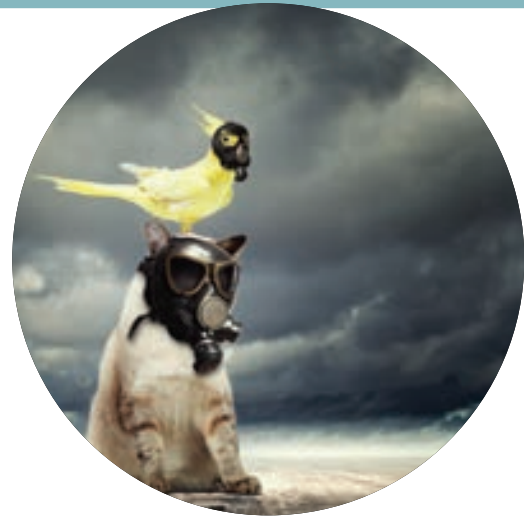
- Which of the following is considered a hotspots of biodiversity in India
 - Western ghats
 - Indo-gangetic plain
 - Eastern Himalayas
 - A and C**
- The organization which published the red list of species is
 - WWF
 - IUCN**
 - ZSI
 - UNEP
- Who introduced the term biodiversity?
 - Edward Wilson
 - Walter Rosen**
 - Norman Myers
 - Alice Norman
- Which of the following forests is known as the lungs of the planet earth?
 - Tundra forest
 - Rain forest of north east India
 - Taiga forest
 - Amazon rain forest**
- Which one of the following are at high risk extinction due to habitat destruction
 - Mammals
 - Birds
 - Amphibians**
 - Echinoderms
- Assertion:** The Environmental conditions of the tropics are favourable for speciation and diversity of organisms. **Reason:** The climate seasons, temperature, humidity and photoperiod are more or less stable and congenial.
 - Both Assertion and Reason are true and Reason explains Assertion correctly.**
 - Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
 - Assertion is true , but Reason is false.
 - Both Assertion and Reason are false.
- Define endemism.
- How many hotspots are there in India? Name them.
- What are the three levels of biodiversity?
- Name the active chemical found in the medicinal plant *Rauwolfia vomitoria*. What type of diversity it belongs to?
- “Amazon forest is considered to be the lungs of the planet”-Justify this statement.
- ‘Red data book’-What do you know about it?

12

CHAPTER

UNIT - V

Environmental Issues



Environment is my prime teacher
- Masanabu Fukuoka

Chapter Outline

- 12.1 Pollution
- 12.2 Air Pollution
- 12.3 Water Pollution
- 12.4 Noise Pollution
- 12.5 Agrochemicals
- 12.6 Biomagnification
- 12.7 Eutrophication
- 12.8 Organic Farming and its Implementation
- 12.9 Solid Waste Management
- 12.10 Ecosan Toilets

Learning Objectives

- Gain knowledge about our environment and its importance.
- Get to know about the effects and after effects of human activities on climate and ecosystem.
- Know about eco-friendly practices for pollution mitigation.
- Acquire insights into solutions to environmental problems.
- Understand the need for peoples' participation in environmental protection.
- Understand the importance of clean environment.



A clean environment is very necessary to live a peaceful and healthy life. But our environment is getting dirty day by day because of our negligence. Earth is currently facing a lot of environmental concerns like air pollution, water pollution, and noise pollution, global warming, acid rain, biomagnification, eutrophication, deforestation, waste disposal, ozone layer depletion and climate change. Over the last few decades, the exploitation of our planet and degradation of our environment have gone up at an alarming rate. As our actions have not been in favour of protecting this planet, we have seen natural disasters striking us more often in the form of flash floods, tsunami and cyclones.

“Every individual should be environmentally aware, regardless of whether they work with environmental issues or not.”

12.1 Pollution

Pollution is any undesirable change in the physical, chemical and biological characteristics of the environment due to natural causes and human activities. The agents which cause pollution are called pollutants. Pollution is

and recycling of nutrients from excreta to create a valuable supply for agriculture. 'EcoSan' toilets are being used in several parts of India and Sri Lanka.

Summary

Degrading natural environments, depleting natural resources, pollution, vulnerability to large scale environmental changes and hazards are the core Environmental issues of today.

Air pollution by fossil fuel burning and other anthropological activities like industrialization is reaching alarming levels and affecting human health and testing the survival of sensitive species.

Domestic and industrial sewage, and agricultural run-off are the most common reasons for pollution of water bodies, resulting in reduced dissolved oxygen and increased Biochemical Oxygen demand of water bodies. Eutrophication and algal blooms are regular occurrences today. Industrial wastewaters are often rich in toxic chemicals, heavy metals and organic compounds which harm living organisms and may even result in death of aquatic life.

Noise pollution is a threat to human and other animals. It can affect health and disturb peaceful habitats. Agrochemicals and its usages cause many ill effects in human beings, other organisms and soil. Agrochemicals can also cause biomagnification. The solution is to revert to non-chemical farming (use of biofertilisers, biopesticides, protect pollinators) practices.

Generation of municipal wastes and their safe disposal are major issues faced by communities today. Solid wastes create environmental problems and must be disposed-off in safe ways. Disposal of solid wastes, radioactive wastes and e-wastes requires further efforts and research. Solid wastes like plastic can be combated by practicing the 4R - refuse, reduce, reuse and recycle. Ecosan toilets are some of the universally accepted eco-friendly practices.

Evaluation



1. Right to Clean Water is a fundamental right, under the Indian Constitution
 - a) Article 12
 - b) Article 21**
 - c) Article 31
 - d) Article 41
2. The 'thickness' of Stratospheric Ozone layer is measured in/on:
 - a) Sieverts units
 - b) Dobson units**
 - c) Melson units
 - d) Beaufort Scale
3. As per 2017 statistics, the highest per capita emitter of Carbon dioxide in the world is
 - a) USA
 - b) China**
 - c) Qatar
 - d) Saudi Arabia
4. The use of microorganism metabolism to remove pollutants such as oil spills in the water bodies is known as
 - a) Biomagnification
 - b) Bioremediation**
 - c) Biomethanation
 - d) Bioreduction
5. Which among the following always decreases in a Food chain across tropic levels?
 - a) Number
 - b) Accumulated chemicals
 - c) Energy**
 - d) Force
6. In the E-waste generated by the Mobile Phones, which among the following metal is most abundant?
 - a) Copper**
 - b) Silver
 - c) Palladium
 - d) Gold
7. SMOG is derived from :
 - a) Smoke
 - b) Fog
 - c) Both A and B**
 - d) Only A



8. Excess of fluoride in drinking water causes:
 - a) Lung disease
 - b) Intestinal infection
 - c) **Fluorosis**
 - d) None of the above
9. Expand (i) CFC (ii) AQI (iii) PAN
10. What is SMOG and how it is harmful for us?
11. List all the wastes that you generate, at home, school or during your trips to other places. Could you very easily reduce the generation of these wastes? Which would be difficult or rather impossible to reduce?
12. Write notes on the following:
 - a. Eutrophication
 - b. Algal Bloom
13. What effect can fertilizer runoff have on an aquatic ecosystem?
14. How can we control eutrophication?
15. Discuss the role of an individual to reduce environmental pollution.
16. How does recycling help reduce pollution?
17. Discuss briefly the following :
 - a. Catalytic converter
 - b. Ecosan toilets
18. What are some solutions to toxic dumping in our oceans?