Teacher Text

Zoology

Class - XII

Government of Kerala
DEPARTMENT OF EDUCATION

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Dear Teacher,

We have introduced activity based, learner-centered, process oriented pedagogy in Higher Secondary classes as part of the continuation of curriculum revision at school level.

As per the rules of the RTE Act, the idea of learning outcomes was introduced in the Kerala school curriculum 2013. Knowledge of learning outcomes is essential to plan the teaching learning process and assessment in a precise and practical manner.

As you know, the process of transacting the curriculum is challenging as it demands higher level of proficiency and dedication on the part of the teacher who plays a pivotal role.

For effective learning, learning experiences should be based on specific objectives and focussed on learning outcomes. Our teachers are quite resourceful and can easily come up with much more compelling and innovative ideas and strategies than the ones suggested in this book. You are always welcome to do so to make teaching-learning process an enjoyable experience.

The Teacher Text in Zoology for second year Higher Secondary Course offers a few guidelines which aim at familiarising the practising teachers with the changed strategies to be adopted in the classroom.

Suggestions for improvement are most welcome.

With regards,

Director
SCERT, Kerala
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It can be said that Science is the sum of all experiences gained by humans hitherto. Such experiences are interpreted in the light of earlier experiences. Our surroundings come live to our experiences through sight, hearing, taste, touch and smell. The proper analysis of the experiences on the basis of earlier knowledge leads us to the construction of new knowledge. Every piece of knowledge thus constructed is a window for further enquiry. Logical thinking is rendered effective through asking logical questions, collecting relevant information and conducting comprehensive analysis. This is the method of science learning. There will be no superstitious beliefs and wrong ideas in a society that follows this method. Such a society will never suffer exploitation or deceit. The method of science is to be applied to all fields of life and therefore Science study should not be limited to a mere assortment of data about energy, substances and living things. Science study has broader objectives beyond this.

**Objectives of Science Learning**

- nourishing wonder, curiosity and observation skills.
- scientifically explain surroundings
- strive for improvement
- assimilating and executing the method of science.
- investigating constantly and drawing conclusions after analysing this data.
- analysing natural phenomenon
- eliminating superstitious beliefs and evil practices
- preventing the misuse of science
- developing a scientific perspective
- cultivating an eco-friendly attitude
- identifying mutual interdependence in nature
- using the assimilated knowledge for the welfare of all creatures
extending the concept of sustainable development
relating study to day to day life
helping to acquire physical-mental-social health by observing personal hygiene and social hygiene.
cultivating a scientific consciousness based on humanity
appreciate the achievements of science
using the achievements of science for social welfare.
respecting those who offered lives for science.

Science Education - Approach

To achieve the above said aims, we have to keep constantly improving the approach we adopt in Science Education. The traditional view that science education is the process of imparting the knowledge assimilated through the years about the universe had changed around forty years ago. It was after that the view that the process of science is as important as the content, came into the realm of science education. However, today, the approach that certain other facts beyond content and process are also to be considered, has gained significance. Discussing Mc Vormack and Yager's 'Taxonomy for Science Education' becomes relevant in this context. According to this, there are five domains that science education must lay emphasis on.

1. Knowledge domain

Science students are expected to know scientific principles and available scientific facts. It is through science study that a clear idea about universal phenomena, the relation between them and their explanations are gained. The following are primarily included in this domain:

- facts
- concepts
- rules
- temporary inferences and laws used by scientists currently
- science and social issues
An understanding of this area can be created through experiments and observations, discussions, debates, project activities and references.

2. Process domain

Process is a chain of procedures used with the purpose of a particular result or to achieve a particular aim. Process skills are skills that enable identifying concepts and evidences, and after collecting them, analysing and drawing conclusions.

Concept formation is an essential factor of not only science study, but the study of all subjects. It is on gaining the concept 'life', that a creature, not seen before, can be identified as a living thing. Similarly it is the result of comprehending the concept 'dissolving' that it can be concluded that an unknown substance that disappears in water, does not vanish but gets dissolved in water. Concept formation regarding science facts is very important. The concept created through experiments and observations, collecting evidences and analysis, become the student's. This concept can be developed and used in required instances. This substantiates the fact that study should be process-based.

A few important process skills
- observing
- collecting and recording data
- classifying
- measuring and preparing chart
- explaining and analysing data
- engaging in experiments
- identifying and controlling variables
- raising questions
- arriving at generalisation
- identifying solutions of problems
- formulating hypothesis and examining it
- arriving at conclusions
- taking decisions
- communicating and understanding communication of others
• foretelling and assuming
• handling apparatus
• using number relationship
• using space-time relationship
• predicting
• inferring
• making operational definition
• interpreting data

**Observing**

Observation is the process of acquiring knowledge through the five senses. Learning experiences which provide the opportunity to use all the five senses may be used.

**Classifying**

The process of grouping information gained through observation, based on salient features is called classifying. The ability to classify will vary according to the age, maturity and cognitive level of the student.

**Using number relationships**

This involves the analysis of available data, consolidation and meaningful explanation using the language of mathematics. Learning experiences may provide the opportunity to develop the skills of counting, addition, subtraction, multiplication, division and finding averages.

**Measuring & Charting**

As part of data collection, the student will have to measure quantities such as length, time, mass, temperature, force and density. What instruments are required for this? How can these instruments be used? What is the level of accuracy expected in measurements? How to record the data? All these are to be considered.

**Using Space-time relationships**

An in-depth enquiry relating to shape, distance, movement, speed, accuracy, direction and time comes under this area. It begins from
identifying the shape, speed, direction and other such features of objects.

**Communicating and understanding communication**

It is essential that knowledge developed is expressed in different ways - oral and written. The students need opportunities to communicate through tables, graphs, pictures, models, short write-ups, descriptions and lectures and also to take part in debates and discussions. Clarifying doubts by asking appropriate questions is another skill in this area.

**Predicting**

An inquisitive person attempts to answer the question "if......... then?" and proceeds to try out the guessed answer. A answer to this question is important in science. The teacher expects the student to predict the outcome of various events and experiments. Students need to develop the skill of predicting by drawing on the knowledge gained through experiments and observations.

**Inferring**

A proper inference can be drawn only if the student has good skills of analysis. The defects in analysis of data will affect the quality of inference.

**Making operational definitions**

The meaning of ideas need to be stated precisely and clearly to make them useful. This helps in communication. Operational definitions may be incomplete and temporary. But in given situations they can be logical and practical.

**Formulating hypothesis**

A hypothesis is a temporary conclusion drawn using insight. A problem can have a number of casual factors and solutions. Based on knowledge and experiences related to the problem, the causes and solutions can be guessed. Such a guess is a hypothesis and need to be tested out and rejected if disproved. Hypotheses which are proved right become conclusions.
Interpreting data

Interpretation of collected data may lead to new ideas and generalizations. Opportunities may be provided for interpreting data and formation of new ideas.

Controlling variables

Variables influence the result of experiments. For the experiment to be accurate and scientific the variables are to be effectively controlled.

Experimenting

An experiment is a planned activity to test the validity of hypotheses drawn. Experimentation contains the process skills in an integrated way. It is the main method used by scientists. Formulating methods to test the hypothesis, conducting experiments, recording, interpretation of data and drawing conclusions are included in it.

The duty of the teacher is to help the learner acquire the method of science in a natural way through learning activities based on simple and complex process skills starting from observation. The students are to be given learning experiences that are learner-centred, process oriented, and environment based and not the conventional content/product oriented experiences. When this approach is followed along with process skills the student acquires knowledge, facts, ideas, concepts and principles.

In the new approach of the curriculum, the student forms ideas and conclusions through processes. Project activities, seminar presentations and experiments enable the student to employ more than one process skill.

3. Creativity domain

Science education is considered today as a process enabling the student only in achieving certain scientific information. This is a point of view that totally ignores the student's creativity and imagination. It is essential that the student is able to deviate from the conventional path and think differently.
A few skills pertaining to this domain is given below-
• visualizing, formulating experiments
• relating objects and concepts in new ways
• identifying alternative/ not usual uses for objects
• finding solution for problems and puzzles
• fantasizing
• designing instruments and machines
• dreaming
• different thinking

4. Attitudinal domain

One of the main aims of Science Education is the desirable change in attitudes and value teaching. It cannot be said that there is any benefit in daily life by science education if there is no substantial change in perspective of life and in the stand towards social or individual problems, even if concepts and process skills are attained. It is commonly seen in our country that even people who possess higher degrees in science adopt unscientific stands in day-to-day issues. Therefore science education should examine the problem of skill development in areas like attitudes, values, decision-taking etc, more closely.

factors that may be included in this domain -
• faith in one’s abilities
• ability to understand human feelings and respect them
• expressing one’s emotions and thoughts creatively
• thinking rationally about individual values and taking decisions accordingly.

5. Application domain

The concepts, processes and values become meaningless if the student cannot implement them in daily life. Similarly, pure scientific principles and concepts divorced from technology, will not have much relevance in daily life. Scientific information is seen to be irrelevant for the student if it is not related to daily life.
These are some factors in the Application domain:

• observing instances of science concepts in day-to-day life
• use the concepts and skills gained to solve problems related to life.
• create an idea of science concepts related to household appliances.
• ability to evaluate events and developments related to science
• take scientific decision on matters of food, health, life style etc.
• relating science to other subjects

**Method of Science Learning**

These objectives can be realized only when the scientific method is adopted for science learning. Science learning should be process-based. Activities that ensure the development of skills like collecting information appropriate for problem-solving, analysing the information, arriving at proper conclusions, examining the conclusions, using them in new contexts etc, are to be conducted in the classroom. Science learning should not be restricted to the classroom. Hence outdoor learning also should be emphasized.

While saying that science learning should become process-based, it does not mean that it is merely conducting activities. Each activity must have an objectives. It should be ensured that the student has reached the objectives. Conducting activities and not consolidating may not help acquiring the result. The student must be able to identify what he/she has achieved when a study process is completed. This will help him/her for further studies.

Conclusions are made on the basis of the evidences obtained from learning activities. The evidences and the conclusions made therein have to be evaluated critically. While subjecting the method followed and the activities to evaluation again, the opportunity to identify errors, if any, and rectifying them opens up. The derived concepts are accepted or rejected only after subjecting them to criticism with high standards of academic discipline. This is possible only in classrooms that function in a democratic way where there is room for free and fearless interaction.
Concept formation occurs during interaction with the teacher, interaction with friends, observation activities or engaging in experiments. Hence the student gets various kind of experiences.

**Teaching Learning Strategies**

The explosion of knowledge has resulted in a new vision of knowledge. Earlier, it was thought that the most effective method was the transmission of knowledge by teacher to the student. However, the modern view is that the student has the responsibility and the right to construct knowledge. The teacher of modern times, hence, has to use instructional strategies that motivate the student to construct knowledge on his own.

Instructional strategies should be viewed as a social skill which is part of the educational environment and not as a technique to be mastered. They are to be considered as important components of teacher-student interaction and not as teacher activities alone. While instructional methods are planned the social and psychological aspects of the learner need to be taken into consideration.

Let us examine here some instructional strategies helpful in bringing out the curriculum objectives of Botany.

**Project**

Project is one of the most suitable methods of instruction for science. It is a method of self instruction using the method of science and useful in the development of a number of process skills and hence it is essential to use projects in science education.

**What is a project?**

When a problem is felt, data regarding the problem is collected. The collected information is summarised and analysed. The conclusions that are obtained from analysis are used to solve the problem - these steps reflect the essentials of a project. By doing projects the students are given the opportunity to train in the method of science. In doing so, the student acquires problem solving ability which helps to tide over problematic situations in life and progress in life.
Projects help to develop scientific temper, scientific attitude and interest in learning science and to ensure active participation of the student in learning activities.

Stages of a project

I. Feeling the problem

The project topic should not be arbitrarily created. It should reflect a felt problem in the learning situation and which requires a solution to proceed further.

Project topics arise when discussions relating to lessons are held in the class. It is important that the student has an internal urge to find out a solution to the particular problem. When the topic is presented the teacher must ensure this.

II. Defining the aim

If the student is to tackle the problem in a way suitable to his/her abilities, thinking skills and available facilities, the aim of the project need to be defined precisely. To state the aims of the project simply and clearly, the student needs the help of the teacher.

III. Planning

a. Hypothesizing

Drawing temporary conclusions on the basis of information available at the time is known as hypothesising.

b. Methods and instruments

Study methods and instruments are to be selected based on aims of the project and the hypothesis drawn. The nature of the topic, instruments used and the scientific approach followed should be correlated. Some methods and instruments are listed below.

Survey

Once survey method is selected, where, when and how to conduct the survey must be decided. What will be the sample and who are to be contacted for data will also be considered. Questionnaires and survey forms are to be drawn up. During the planning phase all these are to be discussed in detail. Teacher must interact with the students, give suggestions and ensure that the instructions are
suitable and effective.

**Experimentation**

When the experimental method is to be used, it must be ensured whether necessary equipment is available. If not, can these be improvised? How can materials and instruments be made available? These questions must be considered.

**C. Tabulation of data**
- What information is to be collected?
- What method can be used for collecting information?
- When should observations be made?
- How to tabulate data?
- Are pictures, samples, and working models required?
- Are checklists, rating scales and score cards needed?
- The method of analysis should be decided in advance. Keeping to schedules, honest collection of data, accuracy of data and precision are important.

Entering the necessary data like mass, time for 20 oscillation, period, etc. in respective tabular columns.

**D. Analysis**

The collected and tabulated data can be analysed to examine the validity of the hypothesis. The collected data need to be classified and compared. Comparison with standard information may also be required. Graphics and similar representation will make the analysis easier.

**E. Conclusion**

Based on similarities, differences and relationships evident from analysis of data, the validity of hypothesis may be examined. Those found invalid are rejected and others are accepted as conclusions.

**IV. Execution of the project**

An outline of the project based on the components discussed above may be drawn up. The project activities may be carried out according to this plan with necessary modifications at the appropriate stages. Difficulties faced during the execution of the
project, data obtained and information collected, are to be entered in the activity log. This will be helpful during report writing.

Visits made during the conduct of the project, experiments, arranging equipment, recording data and analysis should be supervised by the teacher. Teacher must take care to conduct discussions, with students frequently to evaluate the progress of the project.

Application

The suggestions that arise from the project must be used for problem solving wherever applicable.

V. Project report

Report is to be prepared by the students themselves. The structure of the report should be finalised through discussion with the students. It must be ensured that it is not too complex and hinders activities.

• The cover page may show title of the project, name of the student/members of the group, and school address.

• The report may contain
  1. Title
  2. Introduction
  3. Hypothesis/ Aims
  4. Method of study
  5. Collected data
  6. Analysis and Conclusions
  7. Suggestions (if any)
  8. Reference (if any)
  9. Appendix (questionnaire, observation schedule, checklist etc.)

The activity log should be made use of to prepare the project report. The aims and method of study of the project would be recorded in the activity log during the time of doing the project. The credibility of the project and data can be established with the help of activity log.
VI. Project Presentation

The project can be evaluated and the work done may be assessed when the project is presented. Ideas can be communicated and shared with others through presentation of the project.

The project can be presented in
- Class room
- Science club meeting
- Science fairs
- School annual day meeting
- PTA meeting
- Ayalkootam
- Other selected forums

The project method helps to train students to familiarise them with self study habits and to find solutions for local problems. We must take care to cultivate this as an important method of study in our schools.

II. Seminar

Reporting is a core component of learning science. In a seminar, data relating to a specific topic is collected, analysed and presented as paper for the benefit of others. It helps the learner to improve his/ her communication skills and provides opportunities for collection of secondary data and for drawing conclusions. It is useful in cultivating interests and attitude in science topics and in personality development. Topics chosen for seminars may be contemporary and should have social relevance.

Organization of seminar
- Topic presentation
- Finding out sub topics or different areas
- Group formation
- Assigning sub topics to different members of the group groups. Each group prepare paper on all the sub topics.
- Discussion by each group on the sub-topics.
(books, magazines, institutions, place and person)

• Organising ideas
• Paper writing
• Seeking the opinion of the teacher.
• Presentation
• Discussion
• Summarising
• The teacher may provide reference materials and give directions at all stages.
• Writing of report
• The report of may include new information gained through data collection, conclusion and findings.
• The information collected by all the members may be included.
• Tables, charts, books and other resource materials may be included.

Teacher may examine the paper at different stages and provide guidelines. The activities and participation of each student in the group may be assessed.

**Paper presentation**

• Teacher may function as the moderator during the initial stages, but it is better to assign this role to students themselves.
• All the group members must be present in the dias during presentation and must actively participate in the discussion after presentation by the leader.
• Questions from the audience are to be answered by group members taking turns.
• Teacher may intervene when necessary to provide instructions and help.
• When sub topics are presented, after all the presentations are over general discussion may be held. Teacher may summarise the discussion.
• A summarised version of the report may be recorded in the Botany activity log.
Seminar papers and reports may be kept in the information corner.

III Discussion

Discussion is a natural part of the transaction between teacher and student. In the process approach it has a significant role. Discussions are essential for the student to share new findings, ideas and conclusions at each stage of learning with fellow students and teachers and to assess progress.

Group discussion is an ideal method to inculcate social consciousness, co-operation, democratic attitude, friendliness, open mindedness and compromising attitude which are the ultimate aims of education. It helps the development of communication skill, hypothesis formulation, designing of experiments and analytical skills.

General discussion is a method where discussion proceeds based on the thought provoking questions raised by the teacher addressing the whole class. Based on the random responses, teacher and students move ahead with the development of concepts. Then teacher consolidates the concepts/ideas discussed in the class.

In a learner centred classroom, the following points must be borne in mind while conducting a discussion.

Discussion points may be provided to guide the progress of the discussion. This will help the students to reach the proper conclusion. Discussion points may be in the form of questions.

- During group discussion the teacher may observe each group and if needed help them to channel the discussion towards the common objective.
- All students may be given opportunity to take part and express their ideas.
- It must be ensured that time limits are observed.
- The conclusion reached may be entered by each student in the Botany activity log and a group representative must present these during consolidation.
- The teacher may correct or add to the conclusions and ensure that all the relevant ideas have been covered.
Students may be instructed to enter the consolidated ideas in the activity log.

IV Debate

After presenting a controversial topic, arguments in favour and against are put forward and a detailed analysis of facts is done by both sides in a debate.

Relevance of debate

- To develop the skill of presenting one's views logically and argue convincingly
- To develop the ability to compare others' views with one's own view and to understand relevant aspects of ideas of others
- To develop leadership quality, democratic attitude, unity, and communication skills.

Conducting a debate

The selection of the debate topic must be done very carefully. A controversial topic (one which can be viewed from two different standpoints) is suitable for debate. Both viewpoints must help in cultivating certain positive attitudes in students.

The teacher must not take a stand favouring one group. An objective approach is to be maintained while presenting the topic.

Only then the students will prepare to debate both aspects. The processes in the debate are:

- Topic presentation
- Preliminary discussion - students are grouped into two.
- The two groups discuss the arguments they are going to present.
- Responsibilities assigned for presenting different viewpoints & arguments.
- Either the teacher or a student functions as the moderator.
- Each group presents their arguments.
- Moderator presents an analysis of the ideas and consolidate the points.
Moderator presents an analysis of the ideas and consolidate the points. Moderator may present the consolidation in tune with the method of science. The consolidated information is recorded in the activity log.

Responsibilities of the moderator

- Introductory presentation
- Guiding the discussion
- Ensuring that the discussions are on right track
- Ensuring the time limits
- Consolidation of arguments

A model for planning

Stage 1

- Introductory presentation of the topic
- Grouping of students
- Group discussion
- Collection of information within groups
- Assigning responsibilities
- Fixing date and time of debate.

Stage 2 - Debate

- Seating arrangements
- Introductory remarks
- Presentation of arguments from two sides
- Discussion
- Consolidation

The moderator's main responsibility is consolidation. It must be unbiased, analytical and efficient as the role of a judge in weighing the merits of a legal point.

Stage - 3

- Preparing report on the debate.
- Entering the details of the debate in the activity log.

Experiments

Experiments familiarise the students with the method of science and
develops the process skills. It serves the following aims.

• Development of process skills.
• Ability to handle science equipments
• Development of interest in science, sense of responsibility, aptitude and attitude.
• Providing direct experience

Planning

• Must be related to curriculum objective.
• Introductory discussions must help the students to understand the need and aims of experiments. The students should develop an idea of what variables are to be controlled. Similarly they should decide on what to observe. They are also to be instructed on the manner of recording and the safe handling of equipments and materials must be demonstrated to them.
• Experiments must be suitable to the age and maturity level of students.
• Must be interesting to the student.

Points to note:

• If only limited number of apparatus is available students may work in groups.
• Each group must be given appropriate instruction
• Experiments must proceed according to instructions given.
• It must be ensured that measurements are accurate.
• Observations must be recorded
• Time limits must be maintained.

Teachers must be present during all stages of the experiment to provide necessary instructions.

VI Outdoor learning

Direct observation is essential for the development of ideas in a process based learning. It may be difficult to provide opportunities for this in all classrooms. Hence learning science within the confines of the class room is not advisable. Outdoor learning provides
experience in the natural settings that cannot be provided through a classroom situation or laboratory.

**Relevance**
- Learning becomes environment based
- Direct learning experiences are gained
- Learning is linked to real life and practical situations.
- Helps to share experiences with people who apply science in real situations.
- Develops values, attitudes and interests
- Helps to develop personal qualities
- Helps to evaluate the development of emotional domain.

**Planning**
- Lesson / unit - Objectives intended
- What are to be observed? to be enquired? to be collected?
- How to record?
- What services of local community are needed?
- Place, travel facilities, expected expenses, materials needed.

**Assessment**
- Recordings in the activity log and report.
- Participation of students
- Sharing of experiences and explanations given on questions raised
- Punctuality

**VII Information Communication Technology**

During a time of information explosion, comprehensive study of Botany cannot be limited to books alone. Information technology is a medium which can help one to collect and exchange new knowledge that is created by the minute. It helps us to study and understand phenomena which are not amenable to direct observation, new developments, habitats, and physiological activities. A contemporary mode of Botany teaching requires the help of it to a great extend.
VIII Assignments

Assignments are learning activities helping to achieve the curriculum objectives and also lead the pupil from the present level to a higher level of learning.

Assignments may be of the types - writings, drawings, construction of models etc. In assignments involving construction of models, a note on methods used in construction may also be submitted.

The discussion and planning may be carried out in classroom to complete the assignments in time. Clarifications may be given about the sources. Teacher may provide the sources if needed.

IX Problem Solving

General Steps

- Analysis and data entry
- Selection of suitable equation
- Substitution and calculation
- Final answer with unit

For a class of 50 pupils, 5 groups can be formed. Problems are given in groups. Each student should go through the problem. They should follow the above criteria for solving the problem. After individual attempt, let them start group discussion. With the clarification, let them finish the problem and present the method of solving. After re-arranging the groups, they share the findings of each group.

X Activity log

The student carries out a number of activities as part of learning. Observations, collections, data organisations in tables, analysis, consolidation and reports are some of these. The activity log is a record of all activities that the student carries out in process based learning - problems faced, methods adopted to solve them and conclusions drawn. It is useful to the student as well as to others who want to evaluate the students work and progress.

The student must record all the information about activities. The activity log must help to record data systematically to analyse the
collected data and to consolidate the ideas so as to share it with others.

In short, the activity log is expected to be a comprehensive record of learning of a year. It is a record of all the learning experiences in the subject that a student has undergone during a year.

**XI School laboratory**

Science learning should be laboratory-oriented also while it is environment-oriented. It goes without saying how important a systematic laboratory in school is! The laboratory can be developed including the models and instruments constructed by students. The role of students during experiments activities is not that of a spectator. The students should learn to handle apparatus and chemicals without harm. For this, apparatus specimens and models should be available to the required number and quantity. The students should get the opportunity to choose and handle apparatus. All science teachers should be able to freely use the laboratory. Apparatus and other specimens should be classified and kept labelled. The classroom should become a laboratory and the laboratory a classroom.

**XII Science Library**

The Science library is as important as the laboratory. The school library is mostly used for language study. A lot of books related to the field of science are available now. Collect books that are beneficial for science learning and include them in the school library as a separate category. Besides extra-reading materials, magazines and reading notes pertaining each lesson can be arranged in the class-reading corner. The students reading have to expand to greater knowledge domains.

**XIII Science Club**

The Science club should start functioning in June itself and must prepare a years’ action plan. A science exhibition can be held to exhibit the products of students at the end of the year. There are many opportunities for the science club like observing important days related to science learning, classes of experts on special topics, seminars etc. Activities
• Simple projects, experiments, improvisations, building of models.
• Conduct discussions, debate and seminar on articles in Botany and contemporary developments in science.
• Celebrations of days relating to Botany, community camps.
• Quizz programmes, speech and writing competitions, short study tours, video-film shows, interviews, classes by experts.
• Collection and preservation of materials and objects for study of Botany. Exhibitions of these objects and materials.
• Manuscript magazines
• Linking the activities of Botany club with activities of other clubs in school.

XIV Teacher Text

The teacher text should be one that helps the teacher in daily planning, provides instructions adequate to carry out the activities in the textbook, persuades the teacher to seek for more information and provides the additional information needed for the teacher. The relevance of the teacher text is that the teacher must be provided with deeper insight of the activities in the textbook, additional activities, samples of assessment and transactional strategies. Hence the following are included in the teacher text.

Introduction

An introduction is provided for each chapter. The main concepts aimed in the chapter, the values and attitudes to be inculcated and the social significance of the topic are indicated in the introduction. This part is a window to each lesson.

Unit Frame

Each unit frame is prepared in relation to important concepts. A unit frame has 3 parts. The first part includes details regarding the concepts that the student should know, the process skills to be developed etc for achieving the results of study. The next part indicates the learning activities with assessment. The last part includes the main learning outcomes that the student must achieve.
The approximate time needed for each chapter is mentioned. The teacher can prepare teacher planner according to the unit frame.

**Towards the Chapter**

This part includes the details of the suggested activities and necessary instructions. The teacher can follow these suggested activities or make use of other suitable activities based on his/her own requirement. Areas for PE also mentioned, possibilities of CE is also discussed. Certain samples of tables, flow charts, concept maps are provided when and where necessary. Teacher can modify or make use of them as tools for self assessment or peer assessment.

**Assessment**

It needs no emphasis to state the importance of assessment for effectively conducting learning activities. The teacher has to prepare on his/her own worksheets for continuous evaluation, self-assessment tools and peer assessment tools. Some samples are given in the teacher text. Certain sample TE questions with scoring key are also given at the end of each chapter. Teachers can refer them and prepare more questions to equip the students to appear for the public examination.

**Concept map or mind map**

This is a tool to relate different concepts in a continuous and logical manner in a schematic way.

**Open Book Assessment**

This can be adopted as one of the methods of unit-based assessment. This helps the learners to read and comprehend concepts based on the questions provided by the teacher.
1. **HUMAN REPRODUCTION (Periods 10)**
   Human Reproduction: Male and female reproductive systems; Microscopic anatomy of testis and ovary; Gametogenesis-spermatogenesis & oogenesis; Menstrual cycle; Fertilisation, embryo development upto blastocyst formation, implantation; Pregnancy and placenta formation (Elementary idea); Parturition (Elementary idea); Lactation (Elementary idea).

2. **REPRODUCTIVE HEALTH (Periods 7)**
   Reproductive health: Need for reproductive health and prevention of sexually transmitted diseases (STD); Birth control- Need and Methods, Contraception and Medical Termination of Pregnancy (MTP); Amniocentesis; Infertility and assisted reproductive technologies - IVF, ZIFT, GIFT (Elementary idea for general awareness).

3. **PRINCIPLES OF INHERITANCE AND VARIATION (Periods 15)**
   Heredity and variation: Mendelian Inheritance; Deviations from Mendelism- Incomplete dominance, Co-dominance, Multiple alleles and Inheritance of blood groups, Pleiotropy; Elementary idea of polygenic inheritance; Chromosome theory of inheritance; Chromosomes and genes; Sex determination– In humans, birds, honey bee; Linkage and crossing over; Sex
linked inheritance- Haemophilia, Colour blindness; Mendelian disorders in humans- Thalassemia; Chromosomal disorders in humans; Down’s syndrome, Turner’s and Klinefelter’s syndromes.

4. MOLECULAR BASIS OF INHERITANCE (Periods 17)
Molecular Basis of Inheritance: Search for genetic material and DNA as genetic material; Structure of DNA and RNA; DNA packaging; DNA replication; Central dogma; Transcription, genetic code, translation; Gene expression and regulation– Lac Operon; Genome and human genome project; DNA fingerprinting.

5. EVOLUTION (Periods 13)
Evolution: Origin of life; Biological evolution and evidences for biological evolution (Paleontological, comparative anatomy, embryology and molecular evidence); Darwin’s contribution, Modern Synthetic theory of Evolution; Mechanism of evolution– Variation (Mutation and Recombination) and Natural Selection with examples, types of natural selection; Gene flow and genetic drift; Hardy Weinberg’s principle; Adaptive Radiation; Human evolution.

6. HUMAN HEALTH AND DISEASE (Periods 9)
Health and Disease: Pathogens; parasites causing human diseases (Malaria, Filariasis, Ascariasis, Typhoid, Pneumonia, common cold, amoebiasis, ring worm); Basic concepts of immunology– vaccines; Cancer, HIV and AIDS; Adolescence, drug and alcohol abuse.
7. MICROBES IN HUMAN WELFARE (Periods 7)

Microbes in human welfare: In household food processing, industrial production, sewage treatment, energy generation and as biocontrol agents and biofertilizers.

8. BIODIVERSITY AND CONSERVATION (Periods 10)

Biodiversity and its conservation: Concept of Biodiversity; Patterns of Biodiversity; Importance of Biodiversity; Loss of Biodiversity; Biodiversity conservation; Hotspots, endangered organisms, extinction, Red Data Book, biosphere reserves, National parks and sanctuaries.

(Practicals - Total Periods - 30)
LEARNING OUTCOMES

1. HUMAN REPRODUCTION

1.1 identifies and explains the structure of male reproductive system.
1.2 compares the functions of various cells in the process of spermatogenesis.
1.3 identifies and explains the structure of female gonads and their associated parts.
1.4 compares the functions of various structures of female reproductive system.
1.5 explains and compares the process of spermiogenesis and oogenesis.
1.6 identifies and compares structure of sperm and ovum.
1.7 appraises the role of hormones in gametogenesis.
1.8 identifies and explains major phases of menstrual cycle.
1.9 compares the role of hormones in different phases of oogenesis.
1.10 appraises the natural phenomenon of menstrual cycle.
1.11 identifies and explains the importance of gametes in fertilization.
1.12 infers the future of fertilized ovum.
1.13 appraises the natural phenomenon of fertilisation and implantation.
1.14 identifies explains and analyse the events during pregnancy and embryonic development.
1.15 compares the role of hormones during pregnancy.
1.16 identifies the importance of colostrum.
1.17 explains the process of parturition.
2. REPRODUCTIVE HEALTH

2.1 identifies and explains the importance of sex education and reproductive health.
2.2 identifies the importance of amniocentesis as a pre-natal diagnosis.
2.3 evaluates the effects of maternal and infant mortality.
2.4 identifies, compares and explains different types of contraceptive devices.
2.5 evaluates the rate of reliability in birth control by natural, temporary and permanent methods.
2.6 judges the medical necessity and social consequences of MTP.
2.7 identifies various STDs.
2.8 explains the reasons of transmission and prevention of STDs.
2.9 identifies the reasons of infertility.
2.10 compares, assesses and recommends the importance of Assisted Reproductive Technologies (ART) to overcome infertility.

3. PRINCIPLES OF HERIDITY AND VARIATION

3.1 explains the hybridisation experiments in pea plants.
3.2 explains law of dominance and law of segregation.
3.3 formulates ratio of F1 and F2 in Monohybrid cross.
3.4 designs different types of hybridisation experiments.
3.5 differentiates Mendelian inheritance and other type of inheritance.
3.6 explains law of independent assortment.
3.7 formulates ratio of F1 and F2 in Dihybrid cross.
3.8 designs different types of hybridisation experiments using 2 characters.
3.9 differentiates types of linkage and recombination.
3.10 explains types of sex determination in human and other animals.
3.11 compares and explains types of mutations.
3.12 assesses pedigree of human disorders.
3.13 explains and differentiates Mendelian and chromosomal disorders.

4. MOLECULAR BASIS OF INHERITANCE

4.1 explains and constructs the structure of Nucleosome and DNA
4.2 identifies the importance of DNA as a genetic material.
4.3 differentiates DNA and RNA as a genetic material.
4.4 identifies and explains the features of RNA.
4.5 identifies and explains the mode of replication in DNA.
4.6 constructs the models of DNA replication.
4.7 identifies and explains transcription unit.
4.8 explains the role of enzymes involved in transcription.
4.9 constructs models of transcription unit.
4.10 identifies and explains the features of genetic code.
4.11 differentiates codons in genetic code.
4.12 explains translation.
4.13 identifies and explains the role of enzymes involved in translation.
4.14 constructs model showing process of translation.
4.15 explains the process of gene regulation and expression in prokaryotes.
4.16 explains Human Genome Project.
4.17 evaluates the importance of Human Genome Project.
4.18 criticises the ethical aspects of HGP.
4.19 explains the importance of DNA finger printing.
4.20 appraises the genetic uniqueness and hereditary pattern of organisms.

5. EVOLUTION

5.1 identifies, compares and judges various views on the origin of earth and life.
5.2 designs and constructs the experimental setup of chemical origin of life.
5.3 analyses and justifies chemical origin as the most favourable view on evolution
5.4 analyses and justifies Charles Darwin’s and Alfred Wallace’s views on evolution of life forms.
5.5 identifies, compares and analyses morphological, anatomical and palentological evidences on evolution.
5.6 differentiates convergent and divergent evolution.
5.7 evaluates and reports effect of anthropogenic action on evolution.
5.8 identifies the role of adaptive radiation in evolution.
5.9 analyses and justifies evolution of Darwin’s finches, Australian marsupials and certain other placental mammals of Australia.
5.10 compares and analyses biological evolution of microbes.
5.11 appraises the importance of natural selection in biological evolution.
5.12 analyses different views on the origin of variation and speciation.
5.13 analyses and justifies Hardy Weinberg principle.
5.14 identifies and compares factors affecting Hardy Weinberg equilibrium.
5.15 identifies evolutionary history of organisms through geological periods.
5.16 evaluates the correlation of geological history and biological origin of life.
5.17 identifies stages in the evolution of man.
5.18 appraises various components of human evolution.

6. HUMAN HEALTH AND DISEASE
6.1 identifies the importance of keeping healthy lifestyle.
6.2 differentiates various types of diseases and their pathogens.
6.3 judges and concludes the mode of transmission of diseases.
6.4 recommends the preventive measures of diseases.
6.5 differentiates various types of immunity.
6.6 judges and concludes the importance of vaccination and immunisation.
6.7 explains different allergens.
6.8 recommends various measures to overcome allergies.
6.9 identifies and explains the causes and control measures of AIDS.
6.10 identifies and explains the causes and symptoms of cancer.
6.11 recommends the various diagnostic techniques and treatment of cancer.
6.12 categorizes and compares useful and abusable drugs.
6.13 identifies and judges the negative effects of alcohol, tobacco and drugs.
6.14 decides to say ‘no’ to drugs tobacco and alcohol.

7. MICROBES IN HUMAN WELFARE
7.1 identifies and describes the importance of various microbes in household products such as curd, cheese, toddy etc.
7.2 identifies and explains the importance of various microbes in industrial products.
7.3 appraises the role of microbes in production of antibiotics and bio-active molecules.
7.4 explains and appraises the importance of microbes in sewage treatment and waste water management.
7.5 constructs an improvised model of sewage treatment plant.
7.6 identifies, explains and appraises the importance of microbes in production of biogas.
7.7 constructs an improvised model of biogas plant.
7.8 describes and concludes the importance of microbes as biocontrol agents.
7.9 explains and concludes the importance of microbes as biofertilisers and compares it with chemical fertilisers.
8. BIODIVERSITY AND CONSERVATION

8.1 identifies heterogeneity in the organisms of biosphere.
8.2 compares and differentiates levels of biodiversity.
8.3 estimates and compares global and Indian biodiversity.
8.4 judges and appraises India as one of the 12 megadiversity countries of the world.
8.5 identifies the role of latitudinal gradients in the patterns of biodiversity.
8.6 hypothesizes the reasons for greater biodiversity of tropics.
8.7 analyses the graphical representation of species - area relationship.
8.8 assesses the significance of “Z” value in species - area relationship.
8.9 examines the relation between species diversity, Biomass and Productivity.
8.10 assesses and appraises importance of species diversity to ecosystem.
8.11 identifies 'Evil Quartets' as the cause of biodiversity loss.
8.12 analyses the effects of biodiversity loss.
8.13 criticises the uncivilised attitudes which leads to biodiversity loss.
8.14 appraises earth's rich biodiversity which is vital for the very survival of mankind.
8.15 justifies the need of biodiversity conservation.
8.16 identifies and compares various strategies for conserving biodiversity.
8.17 appraises various plans, designs and rules for conserving biodiversity.
TEACHER PLANNER

Name of chapter : HUMAN REPRODUCTION
Date : ..............................
Expected time : 40 minutes
Learning Outcomes :
1. Identifies and explains the structure of male reproductive system.
2. Compares the functions of various cells in the process of spermatogenesis.

Concepts : Male reproductive system
Process Skill : Observing, Identifying, Comparing, Inferring, Charting, Communicating
Values and attitudes : Develops a positive attitude to maintain healthy and hygienic reproductive system.
Learning materials : Stethoscope, Sphygmomanometer
Teacher Materials : ICT presentation and charts

<table>
<thead>
<tr>
<th>Process</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Introduction (5 minutes)</td>
<td>Class -1a</td>
</tr>
<tr>
<td>• Slide /video/chart presentation (10 Minutes)</td>
<td>40 students - Very good observation, participation, completed flow chart.</td>
</tr>
<tr>
<td>Points to be discussed</td>
<td>10 students - Sruthy, Jyothika, Preethy, Kiran, Anoop, Bharath, Ajmal, Husna, Reshma, Jayakrishnan - Needs improvement</td>
</tr>
<tr>
<td>• Mention the importance of position of testis.</td>
<td>5 students - Nandu, Kannan, Renjith, Poomima, Amina</td>
</tr>
<tr>
<td>• What is the structure of testis</td>
<td>Below average performance</td>
</tr>
<tr>
<td>• Mention the difference between male germ cells and sertoli cells</td>
<td></td>
</tr>
<tr>
<td>• What are the parts of male sex accessory ducts</td>
<td></td>
</tr>
<tr>
<td>• What are accessory glands of male reproductive system</td>
<td></td>
</tr>
</tbody>
</table>

Class -1a
• Mention the structures/parts of seminiferous tubule with function
• Mention the importance of the products of accessory glands of male reproductive system
• General Discussion with discussion points (15 minutes)

**Consolidation (5 minutes)**
• Maintains ideal temperature for sperm development as it is placed outside the body in scrotum.
• Composed of testicular lobules, seminiferous tubule, leydig cells, sertoli cells
• Germ cells produces gametes, sertoli cells provide nutrition to germ cells
• Epifiedymis, rete testis, vasa efferentia, vas deferens
• Seminal vesicles, Prostate gland and bulbourethral gland
• Composed of testicular lobules, seminiferous tubule, sertoli cells and germ cells
• Helps in lubrication, rich in fructose, calcium and enzymes

**Self assessment, peer assessment**
• Question-Answering-Interaction

**Assigned activity**
• Chart preparation of male reproductive system.
• Draw diagrammatic representation of sectional view of seminiferous tubule.
### Feedback
- Out of 60 students, 40 students observe and participate in the class very effectively. 16 students need more attention due to lack of concentration (personal problems). After giving remedial teaching, 20 students improved and attained the LO. For the remaining four students, LO attained by giving special care and attention and repeated remedial coaching. Constructs the data

### Process
- Participation
- Leadership quality
- Self confidence
- Inspiration and motivation skill
- Communication skill

**Product assessment**
**Portfolio:**
Activity log contains
- discussion points
- lecture notes
- prepared notes
- prepared question answers
- chart and diagram

### Reflections
- For 20 students, work sheets and table should be prepared to make them more aware of concepts.
- 4 learners need more attention and remedial, coaching to attain the LOs
## Scheme of Work

<table>
<thead>
<tr>
<th>Unit</th>
<th>Chapter</th>
<th>Month</th>
<th>Periods</th>
<th>Score weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Term - 1</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>VI</td>
<td>Human Reproduction</td>
<td>June</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>VI</td>
<td>Reproductive Health</td>
<td>June-July</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>VII</td>
<td>Principles of Heridity and Variation</td>
<td>July</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td><strong>Term - 2</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>VII</td>
<td>Molecular basis of Inheritance</td>
<td>August-September</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>VII</td>
<td>Evolution</td>
<td>September</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>VIII</td>
<td>Human Health and Diseases</td>
<td>October-November</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td><strong>Term - 3</strong></td>
<td></td>
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<tr>
<td>VIII</td>
<td>Microbes in Human Welfare</td>
<td>December</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>X</td>
<td>Biodiversity and Conservation</td>
<td>January</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td><strong>Practical</strong></td>
<td></td>
<td></td>
<td>90</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>120</td>
<td>50</td>
</tr>
</tbody>
</table>
Introduction

The survival of each species of organisms requires individual members multiply to replace lost ones. This multiplication is achieved by the process of reproduction which is the production of new generation of individuals of same species. Population sizes will vary according to the balance between the rate of reproduction and rate of death of individuals.

This chapter deals with the structure and function of human reproductive system.

Values and attitudes

After completing this chapter the learner...

- Develops a positive attitude to maintain healthy and hygienic reproductive system.
- Develops positive attitude against misconception regarding virginity.
<table>
<thead>
<tr>
<th>Concepts/ Ideas</th>
<th>Process/Activity with assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
</table>
| **The Male Reproductive System**  
- Observing  
- Charting  
- Classifying  
- Communicating |  
**Assessment**  
General discussion using Chart/animated videos/slides  
Prepared charts, diagrams, flow chart and works in activity log |  
- Identifies and explains the structure of male reproductive system.  
- Compares the functions of various cells in the process of spermatogenesis. |
| **The Female Reproductive System**  
- Observing  
- Identifying  
- Comparing  
- Inferring  
- Charting  
- Communicating |  
**Assessment**  
General discussion using Chart/Slides/animated videos.  
Prepared charts, schematic representations, flow charts and works in activity log. |  
- Identifies and explains the structure of female gonads and their associated parts.  
- Compares the functions of various structures of female reproductive system. |
| **Gametogenesis**  
- Observing  
- Identifying  
- Comparing  
- Inferring  
- Charting  
- Constructing  
- Communicating |  
**Assessment**  
General discussion using Chart/slides/3D models followed by group discussion  
Prepared charts, constructed models and notes in activity log. |  
- Explains and compares the process of spermatogenesis and oogenesis.  
- Identifies and compares the structure of sperm and ovum.  
- Appraises the role of hormones in gametogenesis. |
| **Menstrual Cycle**  
- Observing  
- Identifying  
- Comparing  
- Inferring  
- Charting  
- Communicating |  
**Assessment**  
General discussion using Chart/animated videos  
Prepared charts, graphs and notes in the activity log. |  
- Identifies and explains major phases of menstrual cycle.  
- Compares the role of hormones in different phases of oogenesis.  
- Appraises the natural phenomenon of menstrual cycle. |
| **Fertilisation and Implantation**  
- Observing  
- Identifying  
- Comparing |  
**Assessment**  
General discussion using Chart/animations/models/slides  
Prepared charts, constructed models and notes in activity log. |  
- Identifies and explains the importance of gametes in fertilization.  
- Infers the future of fertilized ovum. |
<table>
<thead>
<tr>
<th>Concepts/ Ideas</th>
<th>Process/Activity with assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inferring</td>
<td></td>
<td>- Appraises the natural phenomenon of fertilisation and implantation.</td>
</tr>
<tr>
<td>Charting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constructing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communicating</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pregnancy and Embryonic Development</strong></td>
<td>General discussion using Chart/slides/videos</td>
<td>- Identifies, explains and analyses the events during pregnancy and embryonic development.</td>
</tr>
<tr>
<td>Observing</td>
<td>Assessment Prepared charts works in activity log and report of field visit.</td>
<td>- Compares the role of hormones during pregnancy.</td>
</tr>
<tr>
<td>Identifying</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inferring</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Parturition and Lactation</strong></td>
<td>General discussion using slides/videos and visit to the Embryology Department.</td>
<td>- Identifies the importance of colostrum.</td>
</tr>
<tr>
<td>Observing</td>
<td>Assessment Prepared chart, table and works in the activity log.</td>
<td>- Explains the process of parturition.</td>
</tr>
<tr>
<td>Identifying</td>
<td></td>
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<tr>
<td>Comparing</td>
<td></td>
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<tr>
<td>Inferring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communicating</td>
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</tr>
</tbody>
</table>
Through the Chapter....

The mentor introduces the chapter showing a video clip of birth of an animal and discusses the importance of a well-developed reproductive system in higher organisms.

CONCEPT : Male reproductive system

Suggested Activities: Mentor initiates a General discussion using Chart/ Videos/slides

Points to be discussed
- Mention the importance of position of testis?
- What is the structure of testis?
- Mention the difference between male germ cells and sertoli cells.
- What are the parts of male sex accessory ducts?
- What are accessory glands of male reproductive system?
- Mention the structures/parts of seminiferous tubule with function?
- Mention the importance of the products of accessory glands of male reproductive system.

Consolidation
- Maintains low temperature (2-2.5°C lower than normal body temp) for sperm development as it is placed outside the body in scrotum.
- Composed of testicular lobules, seminiferous tubules, Leydig cells, Sertoli cells.
- Germ cells produce gametes, Sertoli cells provide nutrition to germ cells.
- Epididymis, Rete testis, Vasa efferentia, Vas deferens
- Seminal vesicles, Prostate gland and bulbourethral gland
- Germ cells, testicular lobules, seminiferous tubule, sertoli cells.
- Helps in lubrication, rich in fructose, calcium and enzymes

Assigned activity
- Chart preparation of male reproductive system.
- Draw diagramatic representation of sectional view of seminiferous tubule
Complete the chart

<table>
<thead>
<tr>
<th><strong>Seminiferous tubules</strong></th>
<th>?</th>
<th>?</th>
<th>Epididymis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urethra</td>
<td>Ejaculatory duct</td>
<td>?</td>
<td></td>
</tr>
</tbody>
</table>

**Assessment**
- Prepared charts diagrams, schematic representation and notes in activity log.

**PROSTATITIS**
An infection or inflammation of the prostate gland. Symptoms are urinary tract infection with increased urinary frequency and urgency, pain in the pelvis and genital area, burning sensation while urinating, in extreme cases, completely blocked urine flow.

**MALE CLIMACTERIC**
Like all women who go through menopause between the ages of 45 to 50, some men also experience comparable physiological changes in their sexual life. Male climacteric is also known as andropause or male menopause. Here, there is deficiency of testosterone resulting in decreased physical, mental and sexual activity.

**SEMEN**
A viscous whitish secretion produced in the male reproductive organs, containing spermatozoa and secretions of the testes, seminal vesicles, prostate, and bulbourethral glands. It is also called seminal fluid. Major portion is contributed by the seminal vesicles and is viscous and fructose rich which is an energy source. The prostatatic fluid gives milky appearance and includes acid phosphatase and proteolytic enzymes that lead to coagulation and subsequent liquefaction of semen. The prostate also contains most of the IgA found in semen.

**INGUINAL HERNIA**
It is a protrusion of abdominal-cavity contents through the inguinal canal. Symptoms may include bulges in the groin area, pain or discomfort especially in the groin with coughing, exercise, or going to the toilet and swelling of the scrotum in men. In men the testes descend through the inguinal canal just before birth.
CONCEPT : Female reproductive system

Suggested activity : General discussion is conducted using Chart/Videos/slides.

Points to be discussed
- What are the parts of female reproductive system?
- What is the role of hymen in the persistence of virginity?
- What are the components of mammary glands?
- Write the structure of ovary?
- What are the parts of fallopian tube?
- Which layers are present in uterine wall?
- What are the parts of external genitalia of human female?

Consolidation
- Ovary, fallopian tubes, uterus, cervix, vagina, external genitalia etc.
- Absence of hymen is not reliable indicator of virginity
- Contains glandular tissue and fat
- Stroma, cortex and medulla, Germ cells, follicle cells
- Infundibulum, isthmus and ampulla
- Perimetrium, myometrium and endometrium
- Mons pubis, Labia majora, Labia minora, Clitoris

Assigned activity
- Chart preparation of Female reproductive system.
- Draw diagrammatic representation of sectional view of ovary.
Prepare a schematic representation of passage of ovum from oviducal funnel to uterus.

Prepare a flow chart showing the path of flow of milk in mammary glands.

Assessment

- Prepared charts, diagrams, flow charts and notes in activity log

**HYSTERECTOMY**

The surgical removal of the uterus. It may also involve removal of the cervix, ovaries, fallopian tubes and other associated structures.

**Subtotal hysterectomy**: Removal of main body of the womb and leaving the cervix in place.

**Total hysterectomy**: Removal of womb and cervix. It is usually preferred over a subtotal hysterectomy because removing the cervix means that there is no risk of developing cervical cancer later.

**Radical hysterectomy**: The body of womb and cervix will be removed, along with fallopian tubes, part of vagina, ovaries, lymph glands and fatty tissue. Usually carried out to remove and treat cancer when other treatments aren’t suitable or haven’t worked.

**Total hysterectomy with bilateral salpingo oophorectomy**: Removal of the fallopian tubes (salpingectomy) and ovaries (oophorectomy).

The National Institute for Health and Care Excellence (NICE) recommends that the ovaries should only be removed if there is a significant risk of further problems – e.g., a history of ovarian cancer.

**CONCEPT : Gametogenesis**

Suggested activity: Mentor initiates a general discussion using Chart/slides/models followed by group discussion. By using appropriate grouping technique mentor groups the learners and asks to discuss the details of gametogenesis. After discussion the group leaders present their views and the mentor consolidates.

Points to be discussed

- What are the stages of spermatogenesis?
- Mention the process of cell divisions during spermatogenesis and oogenesis?
- Mention the hormones involved spermatogenesis?
- What is the structure of a spermatozoan?
• Mention the difference between spermatogenesis and spermiogenesis?
• Mention the components of semen?
• What are the stages of oogenesis?
• What is the structure of ovum/egg?
• How primary follicle differs from secondary and graffian follicle?
• What is the change that occur in chromosome number during the cell division in gametogenesis?

Consolidation
• Formation of spermatagonia, primary spermatocyte, secondary spermatocyte, spermatids and sperm.
• Mitosis and Meiosis
• GnRH, FSH, LH.
• Head, Neck, Middle piece and Tail.
• Formation of spermatozoan, conversion of spermatid into sperm.
• Seminal plasma along with sperm.
• Formation of oogonia, primary oocyte, secondary oocyte, ovum.
• Ovum consist of three layers- vitelline membrane, zona pellucida and corona radiata around egg membrane.
• Primary oocyte surrounded by granulosa cells - primary follicle, which is surrounded by more layers of follicle cells, mature nutrient filled group of follicle cells.
• Diploid number of chromosomes becomes haploid number.

Assigned activity
☐ Prepare an improvised models of gametogenesis.
☐ Prepare a comparative table of spermatognesis and oogenesis, structure of sperm and ovum.
☐ Prepare a flowchart of spermatogenesis and oogenesis.

Practical Evaluation: Observation of Permanent slide of T.S of Testis and Ovary

Assessment
• Prepared charts, flowchart, constructed models, comparative tables and works in activity log.
WORK SHEET

Complete the representation by filling the hexagons (A to G) with the functions of each hormone in gametogenesis.

CONCEPT: Menstrual cycle

Suggested activity: General discussion using Chart/animated videos/slides

Points to be discussed

• What is menstrual cycle?
• What are stages of menstrual cycle?
• Which are the hormones that take part in the process of menstrual cycle?
• How pregnancy influences menstrual cycle?

Consolidation

• Cycle of events starting from one menstruation to the next one.
• Menstrual phase, follicular phase and luteal phase.
• FSH, LH, Oestrogen, Progesterone
• All events of menstrual cycle stops

Assigned activity

- Preparation of chart or graphical representation of hormone levels in menstrual cycle.
- Preparation of cyclic representation of various phases of menstrual cycle.
Assessment

• Prepared charts, cyclic, graphical representation and works in activity log.

Amenorrhea:
The absence of a menstrual period in women of reproductive age. It is a normal feature in prepubertal, pregnant, and postmenopausal females. Amenorrhoea is divided into two categories:

Primary amenorrhea:
The failure of menses to occur by age 16 years. It may occur with or without other signs of puberty. Most girls begin menstruating between ages 9 and 18, with an average of around 12 years old. If by age 13 menses has not occurred and the onset of puberty, such as breast development, is absent, a workup for primary amenorrhea should start.

Secondary amenorrhea:
The cessation of menstruation for at least 6 months sometime after menarche has occurred. Secondary amenorrhea’s most common and most easily diagnosable causes are pregnancy, thyroid disease, and hyperprolactinemia.

Oligomenorrhea:
Infrequent menstruation occurring at intervals longer than 35 days apart.

Polymenorrhea:
A condition in which a woman has abnormally frequent menstrual cycles with intervals usually less than 21 days apart.

Dysmenorrhea:
It refers to "difficult or painful periods". There are two types of dysmenorrhea; primary and secondary.

• Primary dysmenorrhea is the most common kind of dysmenorrhea. It is characterised by cramping pain in the lower abdomen (belly) which may start from 1-2 days before the beginning of the period and can last 2-4 days.

• Secondary dysmenorrhea is usually the result of some kind of disorder such as endometriosis of the reproductive system. The pain is usually more intense and lasts long.

Menorrhagia:
The occurrence of excessive bleeding (with respect to quantity or duration) during periods.

CONCEPT : Fertilization and Implantation

Suggested activity : General discussion is conducted using charts/animations/slides showing the process of fertilization and implantation of zygote.
Points to be discussed

- Where does fertilization take place in human female?
- What is the role of chromosomes (X&Y) in sex determination?
- How does implantation take place in humans?
- How pregnancy is maintained in humans?
- Which are the stages in the development of zygote?

Consolidation

- Ampullary - isthmic junction of oviducts
- XX will be female and XY will be male
- Trophoblast layer attaches to endometrium, uterine wall divides and covers the blastocyst. Embedding of blastocyst in the endometrium of uterus
- Pregnancy is maintained with hormones like progesterone initially, then with placenta and placental hormones.
- Cleavage (Blastomeres), implantation, embryonic development etc

Fertilization Membrane

After fertilization, vittelline membrane lifts from egg surface, thickens and the perivittelline space is filled with secretions from cortical granules. It helps in preventing further entry of sperms into ova.
Fertilizin & Antifertilizin

The process of fertilization is species specific. The type specificity of male and female gamete is achieved by the help of certain chemicals compounds. The egg contains a chemical substance known as Fertilizin. Fertilizin is a glycoprotein composed of different types of aminoacids and monosaccharides (glucose, fructose, and galactose) according to the species. The surface layer of sperm contains another protein called Antifertilizin. It is a protein composed of acidic aminoacids. It is found that fertilizins of the egg are supposed to attract the sperm which contain antifertilizins of the same species. Fertilizins of a species react efficiently with the sperm antifertilizins of the same species to cause clumping of sperms around ovum.

Assigned activity
- Prepare a model showing various stages of embryonic development from zygote to blastocyst.
- Prepare a flow chart showing the events of fertilization and implantation.

Assessment
- Prepared flow charts, constructed models and notes in activity log.

Practical Evaluation: Observation and drawing of permanent slides of TS of Blastocyst

CONCEPT: Pregnancy and Embryonic Development

Suggested activity: Mentor initiates a general discussion after a brief introduction using Chart/slides/videos. After completion of topic a visit to the Embryology Department of a Medical College can be arranged.

Points to be discussed
- What is the role of chorionic villi and placenta in embryonic duct?
- Name the hormones produced from the placenta during pregnancy?
- From which layers of embryo do the organs develop in man?
- What are the features of embryonic development at various months of pregnancy in humans?

Consolidation
- Chorionic villi changes to placenta, Placenta makes vital connection between mother and foetus
- hCG, hPL, Oestrogen, Progestogens, Relaxin etc
- From ectoderm, endoderm and mesoderm
- Complete the table
### Chapter 1 - Human Reproduction

#### Assigned activity
- Preparation of table showing various features of embryonic development at various months of pregnancy.
- Preparation of table showing placental hormones and functions.
- Visit to an Embryology Department of a Medical college.

#### Assessment
- Prepared charts, tables, report of visit and notes in activity log.

#### Ectopic Pregnancy

An ectopic pregnancy (EP) is a condition in which a fertilized egg settles and grows in any location other than the inner lining of the uterus. Majority of ectopic pregnancies occur in the Fallopian tube (tubular pregnancy). The major health risk of ectopic pregnancy is rupture leading to internal bleeding. Ectopic pregnancy remains the leading cause of pregnancy-related death in the first trimester of pregnancy.

<table>
<thead>
<tr>
<th>Types of Placenta</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epithelio-chorial</td>
<td>Pig, Mare</td>
</tr>
<tr>
<td>Syndesmochorial</td>
<td>Cows, buffalos</td>
</tr>
<tr>
<td>Endotheliochorial</td>
<td>Dog, Cat,</td>
</tr>
<tr>
<td>Haemochorial</td>
<td>Man</td>
</tr>
<tr>
<td>Haemoendothelial</td>
<td>Rats, Rabbits</td>
</tr>
</tbody>
</table>

#### CONCEPT: Parturition and Lactation

**Suggested activity**: General discussion using slides and videos

**Points to be discussed**
- What is parturition?
- Which hormones help in parturition and lactation?
- What is colostrum?
Consolidation

- Delivery of foetus.
- Oxytocin and Relaxin
- Initial milk which contains antibodies for resistance of infants.

Assigned activity
- Preparation of table showing gestation periods of common mammals.

Assessment
- Prepared charts, table and works in activity log

**MILK EJECTION**

Milk ejection is by a neuro-endocrine reflex called milk ejection reflex or milk let down reflex. The phenomenon occurs due to the hypothalamic stimulation. When baby suckles, the sensory impulses are transmitted to the hypothalamus, that causes the oxytocin secretion along with prolactin. Oxytocin reaches the breast and causes myoepithelial cells to contract which exert pressure on alveoli causing milk ejection.

<table>
<thead>
<tr>
<th>Mammal</th>
<th>Gestation period</th>
<th>Mammal</th>
<th>Gestation period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>259-280</td>
<td>Gorilla</td>
<td>255-260</td>
</tr>
<tr>
<td>Tiger</td>
<td>105-113</td>
<td>Giraffe</td>
<td>420-450</td>
</tr>
<tr>
<td>Squirrel(gray)</td>
<td>30-40</td>
<td>Elephant(Asian)</td>
<td>617</td>
</tr>
<tr>
<td>Sheep (domestic)</td>
<td>144-151</td>
<td>Elephant(African)</td>
<td>645</td>
</tr>
<tr>
<td>Rat</td>
<td>21-23</td>
<td>Dog (domestic)</td>
<td>58-65</td>
</tr>
<tr>
<td>Rabbit (domestic)</td>
<td>28-35</td>
<td>Cow</td>
<td>279-292</td>
</tr>
<tr>
<td>Pig (domestic)</td>
<td>144-151</td>
<td>Chimpanzee</td>
<td>230-250</td>
</tr>
<tr>
<td>Monkey (rhesus)</td>
<td>164</td>
<td>Cat (Domestic)</td>
<td>58-67</td>
</tr>
<tr>
<td>Kangaroo</td>
<td>42</td>
<td>Guinea pig</td>
<td>56-74</td>
</tr>
</tbody>
</table>

**Additional activity : A discussion with a medical practioner**

**CLEAVAGE**

The repeated mitotic division of the zygote into smaller cellular units called blastomeres, which later differentiate into several types of body cells. During cleavage there is no appreciable growth and the size and volume of the embryo remain almost same. In microlecithal eggs cleavage results in a
compact mass of cells called morula. Later, it gets transformed into a blastula. While the wall of the blastula is called blastoderm, the central cavity is called blastocoels. The blastocoel is filled with a thick blastocoel jelly.

**PLANES OF CLEAVAGE**

An egg can be divided from different planes during cleavage. Depending on the position of the cleavage furrow the planes of cleavage are named.

1. **Meridional plane:**
   The plane of cleavage lies on the animal vegetal axis. It bisects both the poles and the egg is divided into two equal halves.

2. **Vertical plane:**
   The cleavage furrows pass from animal to vegetal pole and lie parallel to and on either side of the meridional plane. Produce unequal sized blastomeres.

3. **Equatorial plane:**
   This cleavage plane bisects the egg at right angles to the main axis. It lies on the equatorial plane. It divides the egg into two halves.

4. **Latitudinal plane:**
   It is similar to the equatorial plane, but it lies either above or below the equator. It is also called as transverse or horizontal cleavage. Produce unequal sized blastomeres.

**TYPES OF CLEAVAGE:**

Cleavage has been classified variously

Influence of yolk on cleavage

Yolk is needed for embryonic development. However the amount of the yolk and its distribution affect the process of cleavage. Accordingly several cleavage patterns have been recognised.

1. **Total or holoblastic cleavage**
   In this type the cleavage furrow bisects the entire egg. Such a cleavage may be either equal or unequal.
(a) Equal holoblastic cleavage: In microlecithal and isolecithal eggs, cleavage leads to the formation of blastomeres of equal size. E.g.: Amphioxus and placental mammals.

(b) Unequal holoblastic cleavage: In mesolecithal and macrolecithal eggs, cleavage leads to the formation of blastomeres of unequal size - small sized micromeres and large sized macromeres.

2. Meroblastic cleavage
Also known as partial or incomplete cleavage. In this type the cleavage furrows are restricted to the active cytoplasm found either at the animal pole (macrolecithal egg) or superficially surrounding the egg (centrolecithal egg). Meroblastic cleavage may be of two types.

a) Discoidal cleavage: In macrolecithal and highly telolecithal eggs the cleavage furrows are formed only in the small disc shaped yolkless cytoplasm (blastodisc) present at the animal pole. Such a cleavage is called discoidal meroblastic cleavage. E.g: birds and reptiles.

(b) Superficial cleavage: In centrolecithal eggs, the cleavage is restricted to the peripheral cytoplasm of the egg. E.g: eggs of insects and birds.

PATTERN OF CLEAVAGE
On the basis of arrangement of blastomere cleavage is of four types-

Radial cleavage
A type of holoblastic cleavage where each cleavage division occurs at right angle to the earlier one. So the blastomeres of the upper tier lie directly over those of the lower tier resulting in radial symmetry around the polar axis of the embryo. E.g.: Echinoderms

Spiral cleavage
A type of holoblastic cleavage where the cleavage planes are oblique. Hence the blastomeres are shifted either clockwise or anticlockwise. Due to this shifting the blastomeres of the upper tier lie directly over the cell junctions of those of the lower tier so that the blastomeres appear to spiral around the polar axis of the embryo. If the blastomere rotates clock wise than cleavage is called as dextral spiral cleavage. E.g. Molluscs. If the blastomeres rotate anti-clock wise then cleavage is called as sinistral spiral cleavage. E.g. Helminthes (Aschelminthes and platyhelminthes), Annelids.

Bilateral cleavage
Due to unequal holoblastic cleavage blastomeres are arranged in a bilateral symmetrical pattern. Blastomeres of one lateral side are smaller in size than the blastomeres of the other side. E.g. Ascidians
Rotational cleavage

Due to the extreme asynchrony in cleavage the blastomeres do not divide at the same time. Thus the multiplication of cells does not occur in a geometric pattern; instead show an arithmetic progression. The cleavage furrows and blastomeres are arranged in a clockwise pattern. Such a cleavage is called rotational cleavage. E.g.: Mammals

CLASSIFICATION OF CLEAVAGE ON THE BASIS OF FATE OF BLASTOMERES

It is of 2 types - (a) Determinate and (b) Indeterminate

(a) Determinate cleavage - (Mosaic development): Here cleavage results in the formation of qualitatively different blastomeres. The fate of each blastomere is fixed and thus a specific blastomere forms a specific part of embryo. In this cleavage if any blastomere of embryo is removed or destroyed than the related part of embryo will not form. E.g. Annelida, Mollosca, Platyhelminthes, Nematoda.

(b) Indeterminate cleavage - (Regulative development): Here cleavage results in the formation of qualitatively identical blastomeres. The fate of blastomeres is not fixed. Each blastomere has capacity to form the complete embryo. There will be no effect on embryo formation if any blastomere or part is removed from embryo e.g. Deuterostomes (Echinoderms, chordates).

Maternal and Foetal connection through Placenta
1. Select the correct path of sperm movement in male reproductive system.
   a) Seminiferous tubule, Vas deferens, Urethra, Vasa efferentia, Rete testis, Epididymis.
   b) Vas deferens, Vasa efferentia, Seminiferous tubule, Rete testis, epididymis, Urethra
   c) Seminiferous tubule, Rete testis, Vasa efferentia, Epididymis, Vas deferens, Urethra.
   d) Seminiferous tubule, Vas deferens, Urethra, Vasa efferentia, Epididymis, Rete testis

2) Observe the diagram

   I) Name a and b
   II) write the function of Sertoli cells

3. Observe the diagram and label A, B, C and D

4) Categorize the following parts of reproductive system and give proper heading.
   (Ovary, Vas deferens, Seminal vesicle, Uterus, Penis, Oviduct)
5) Select the odd man out and write the common feature of others.
(Seminal vesicle, Sertoli cells, Bulbourethral gland cells, Prostate gland)

6) Name the hormone which induces ovulation, what happens to remnants of graffian follicle after ovulation?

7) Observe the diagram and label A and B

8) Male gamete is released after completion of meiosis but female gamete is not. Justify.

9) How many number of sperms and ova are produced from one primary spermatocyte and primary oocyte respectively?

10) Prepare a table showing embryonic development in various months of pregnancy?

Open Book Assessment
Spermatogenesis is continuous but Oogenesis is discontinuous. Give reasons?

- **Process Assessment**
  - Group discussion on male & female reproductive system, gametogenesis, menstrual cycle, fertilization, pregnancy and lactation.
  - Prepared notes in the activity log.
  - Preparation of models and charts.
  - Preparation of tables and flow charts.

- **Portfolio Assessment**
  - Constructed models
  - Charts
  - Prepared tables
  - Activity log

- **Unit Assessment**
  - Unit test
  - Quiz programme
  - Oral test
  - Open book assessment
### SCORING INDICATORS

<table>
<thead>
<tr>
<th>Qn. No.</th>
<th>Value Points</th>
<th>Split score</th>
<th>Total score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>a - Spermatozoa    b - Primary spermatocyte II) Sertoli cells - supply nutrients</td>
<td>1/2 x 2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>a. Endometrium, b - Ovary, c - fallopian tube, d - vagina</td>
<td>1/2 x 4</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Seminal vesicle, penis, Vas deferens (male)Ovary, Uterus, Oviduct (Female)</td>
<td>1/2 x 6</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Sertoli cells, Others are accessory reproductive glands</td>
<td>1/2 x 2</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>LH Remnants of graffian follicles changes to corpus luteum</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>a - Trophectoderm, b - Inner cell mass</td>
<td>1/2 x 2</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Female gamete is released from ovary in secondary oocyte stage which undergo further division after fertilisation</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>From a single primary spermatocyte four sperms are produced while from a single primary oocyte only one ova is produced</td>
<td>1/2 x 4</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>1 month - heart , End of second month-limbs and digits, 3rd month-major organ systems, 6th month- body covers with hair 9th month- embryo fully develops</td>
<td>6x1</td>
<td>2</td>
</tr>
</tbody>
</table>
Introduction

Reproductive health is defined as a state of physical, mental, and social well-being in all matters relating to the reproduction, at all stages of life. Good reproductive health implies that people are able to have a satisfying and safe sexual life, the capability to reproduce and the freedom to decide if, when, and how to do so. Men and women should be informed about and have access to safe, effective, affordable, and acceptable methods of family planning of their choice, and the right to appropriate health-care services that enable women to safely go through pregnancy and childbirth. Reproductive health should be looked at through a lifecycle approach as it affects both men and women from infancy to old age. According to UNFPA, reproductive health at any age profoundly affects health later in life. The life cycle approach incorporates the challenges people face at different times in their lives such as family planning, services to prevent sexually transmitted diseases and early diagnosis and treatment of reproductive health illnesses. Health and education systems need to be more strengthened and availability of essential health supplies such as contraceptives and medicines must be supported.

This chapter deals with the effects of population explosion, Methods of population control and assisted reproductive technologies.

Values and attitudes

After completing this chapter the learner...

- Develops a positive and healthy attitude towards reproductive life.
- Develops positive attitude to overcome the impacts of population explosion.
<table>
<thead>
<tr>
<th>Concepts/Ideas</th>
<th>Process/Activity with assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
</table>
| **Reproductive Health - Problems and Strategies** | - Data collection and General discussion  
- Group discussion & Interview with a clinical expert.  
**Assessment**  
- Collected data.  
- Questionnaire.  
- Works in activity log. | - Identifies and explains the importance of sex education and reproductive health.  
- Identifies importance of amniocentesis as a prenatal diagnosis. |
| **Population Explosion and Birth Control**       | - General discussion using Charts/Videos/slides.  
**Assessment**  
- Picture album of contraceptive devices, comparative table, charts and notes in the activity log. | - Evaluates the effects of maternal and infant mortality.  
- Identifies, compares and explains different types of contraceptive devices.  
- Evaluates the rate of reliability in birth control by natural, temporary and permanent methods. |
| **Medical Termination of Pregnancy (MTP)**       | - Group discussion and debate after a brief introduction.  
**Assessment**  
- Prepared report on debate and notes in activity log. | - Judges the medical necessity and social consequences of MTP. |
| **Sexually Transmitted Diseases (STDs)**         | - General discussion using slides/diagrams followed by group discussion  
**Assessment**  
- Report of awareness programme, table and notes in activity log | - Identifies various STDs  
- Explains the reasons of transmission and prevention of STDs. |
<table>
<thead>
<tr>
<th>Concepts/ Ideas</th>
<th>Process/Activity with assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infertility</strong></td>
<td>✅ General discussion using Chart/slides. ✅ Interview with a clinical expert. <strong>Assessment</strong> Notes and interview report in activity log.</td>
<td>- Identifies the reasons of infertility. - Compares, assesses and recommends the importance of Assisted Reproductive Technologies (ART) to overcome infertility</td>
</tr>
</tbody>
</table>
Through the Chapter....
The mentor introduces the chapter showing a video on impacts of population explosion and initiates a general discussion.

CONCEPT : Reproductive health-Problems and Strategies

Suggested Activities Data collection and General discussion followed by Group discussion and Interview with a clinical expert

Points to be discussed
- Mention the action plan organised by the Government to attain total reproductive health?
- Which are the strategies to be implemented to attain total reproductive health?
- What is amniocentesis?
- Why amniocentesis needs statutory ban?

Consolidation
- Family planning initiated in 1951, Reproductive and child health programme(RCH).
- Introduction of sex education, Proper information about reproductive organs, adolescence and related changes, safe and hygenic sexual practices, STDs and AIDS, Giving awareness about problems due to uncontrolled population growth, social evils like sex abuse and sex related crimes.
- Foetal sex determination test based on the chromosomal pattern in amniotic fluid.
- In order to check increasing female foeticides, massive child immunisation.

Assigned activity
- Data collection on other pre-natal diagnostic tests.
- Preparation of questionnaire

Assessment
- Collected data, questionnaire and works in activity log.
Family Planning in India

- Launched a nationwide Family Planning Programme in 1951, a first of its kind in the developing countries.
- This covered initially birth control programmes and later included mother and child health, nutrition and family welfare.
- In 1966, the ministry of health created a separate department of family planning. Government in 1977 developed a new population policy, which was to be accepted not by compulsion but voluntarily.
- It also changed the name of Family Planning Department to Family Welfare Programme.

The Reproductive and Child Health (RCH)

- Programme was launched in October 1997
- The main aim of the programme is to reduce infant, child and maternal mortality rates.
- Other objective of the programme is to improve the effectiveness of existing Family Welfare services.

CONCEPT: Population explosion and birth control

Suggested activity: General discussion is conducted using chart, videos, slide presentation. Preparation of picture album of various contraceptive methods.

Points to be discussed

- What are the reasons of population explosion in India?
- What are the consequences of population explosion in India?
- What are the measures taken by the government to control population explosion in India?
- What are the features of an ideal contraceptive?

Consolidation

- Rapid decline in death rate, maternal mortality rate and infant mortality rate
- Absolute scarcity of basic requirements like food, shelter, clothing etc.
- Statutory rising of marriagiable age of female to 18 years, male to 21 years, incentives given to couple with small families and family planning programme.
- User friendly, easily available, effective and reversible with no or least side effects.
Assigned activity

- Completion of table.
- Prepare a picture album showing various contraceptive methods.
- Prepare a graphical representation on population explosion of last 50 years

Mentor asks the learners to complete the table

<table>
<thead>
<tr>
<th>Contraceptive Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
</tr>
<tr>
<td>---------</td>
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<td>--------</td>
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<tr>
<td>--------</td>
</tr>
</tbody>
</table>

Assessment

- Table, Graphical representation, Picture album and Notes in activity log.

Extension activity

- A debate on “Population control in present scenario”

Copper IUDs

Copper wire or copper sleeves are put on the plastic frame (polyethylene frame). The various types of Copper IUDs differ from each other by the amount of copper. The initial Copper IUDs were wound with 200-250 mm² wire. The modern copper-containing devices contain more copper and a part of copper in the form of solid tubal sleeves rather than wire. This increases the efficacy and lifespan. This shape is chosen as it fits the area around the uterus, allowing for the Copper T to sit in place for years without moving around.

Cu-7

It is made by Monsanto subsidiary G. D. Searle. It was in use from 1974-1986 and caused many problems as well. It was linked to ectopic pregnancy, perforation of the uterus, and pelvic inflammation.

CuT 380A

It is a T shaped device with a polyethylene frame holding 380 mm² of exposed surface area of copper. The IUD frame contains barium sulfate thus making it radio-opaque.
Multiload 375
It has 375 mm² of copper wire wound around its stem. The flexible arms are designed to minimize expulsions. The multiload 375 and Cu T -380 A are similar in their efficacy and performance.

Hormone Releasing IUDs
Progestasert
It is a T shaped IUD made of ethylene and vinyl acetate copolymer containing titanium dioxide. The vertical stem contains a reservoir of 38 mg progesterone together with barium sulfate dispersed in silicone fluid. The progesterone is released at the rate of 65 µg per day.

LNG - 20
This T shape & device has a collar attached to vertical arm containing 52 mg of levonorgestrel dispersed in poly dimethyl siloxane. It releases levonorgestrel per day in vivo and is effective for 7-10 years.

COMBINATION PILLS
Mala D and Mala N are combination hormonal oral contraceptive pills supplied free or at subsidized price under the Contraceptive Social Marketing Program of the government. The pills come in packets of 28 pills in which 21 white coloured pills are for contraception and 7 brown coloured pills are for Iron supplementation. Each contraceptive tablet contains levonorgestrel 0.15 mg and ethinyloestradiol 0.03mg and each brown tablet contains ferrous fumerate 60mg equivalent to ferrous iron 19.5mg. 100% effective if taken correctly.

Mechanism of Action:
- Combination hormonal contraceptives inhibit ovulation.
- Makes sperm penetration difficult by making the cervical mucus thick.
- Prevents implantation by keeping the uterine endometrium thin.
**CONCEPT : Medical Termination of Pregnancy**

**Suggested activity** : A brief introduction using slide presentation followed by group discussion and debate on positive and negatives aspects of MTP.

**Points to be discussed**
- What are the medical necessity and social consequences of MTP?
- 

**Consolidation**
- To avoid unwanted pregnancy or a pregnancy harmful / fatal either to mother or the foetus or both. Emotional, ethical, religious and social issues.
- 

**Assigned activity**
- Debate on positive and negative aspects of MTP

**Assessment**
- Report on debate and notes in activity log

**CONCEPT : Sexually Transmitted Diseases (STDs)**

**Suggested activity** : General discussion, using slides/diagrams followed by group discussion
Points to be discussed

- Which are the major STDs and what are the symptoms?
- How STDs are transmitted?
- What are the preventive measures of STDs?

Consolidation

- AIDS, Hepatitis, Gonorrhoea, Syphilis, Genital Herpes, Genital warts, Trichomoniasis, Chlamydia.
- Sharing injection needles, surgical instruments with infected persons, transfusion of blood or from an infected mother to foetus, through sexual contact with infected persons.
- Avoid sex with unknown partners/multiple partners, always use condoms during coitus, early detection and treatment.

Assigned activity

- Preparation of table showing major STDs and symptoms.
- Organise an awareness programme on STDs.

Assessment

- Prepared table, report of awareness programme and notes in activity log

Complete the Table

<table>
<thead>
<tr>
<th>STDs</th>
<th>Symptoms</th>
<th>STDs</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIDS,</td>
<td></td>
<td>Genital Herpes</td>
<td></td>
</tr>
<tr>
<td>Hepatitis</td>
<td></td>
<td>Genital warts</td>
<td></td>
</tr>
<tr>
<td>Gonorrhoea</td>
<td></td>
<td>Trichomoniasis</td>
<td></td>
</tr>
<tr>
<td>Syphilis</td>
<td></td>
<td>Chlamydia</td>
<td></td>
</tr>
</tbody>
</table>

Hepatitis B is a liver infection caused by the Hepatitis B virus (HBV). It is transmitted when blood, semen, or another body fluid from a person infected with the Hepatitis B virus enters the body of someone who is not infected. This can happen through sexual contact; sharing needles, syringes, or other drug-injection equipment; or from mother to baby at birth. Chronic Hepatitis B can lead to serious health issues, like cirrhosis or liver cancer. The best way to prevent Hepatitis B is by getting vaccinated.
• There is no specific treatment for acute hepatitis B. Therefore, care is aimed at maintaining comfort and adequate nutritional balance, including replacement of fluids lost from vomiting and diarrhoea.
• Chronic hepatitis B infection can be treated with drugs, including oral antiviral agents. Treatment can slow the progression of cirrhosis, reduce incidence of liver cancer and improve long term survival.

Syphilis: Caused by the spirochete Treponema pallidum. Trans parental infection of the foetus can occur.

1. Early Syphilis
   • **Primary syphilis**: Incubation period is between 14 and 28 with a range of 9-90 days. Primary lesion or chancre (SHAN - KUR) develops at genital area. A dull red macule develops, become papular and then erodes to form indurated ulcer (chancre). Without treatment it will resolve (within 2-6 weeks) to leave an atrophic scar.
   • **Secondary syphilis**: Occurs 6-8 weeks after development of chancre. Mild fever, malaise, and headache are common. Rash on the trunk and limbs occur. Without treatment, the rash may last for up to 12 weeks. The clinical manifestations of secondary will resolve with out treatment but relapse may occur, within the first year of infection. There after the disease enters the phase of latency.
   • **Latent syphilis**: Characterised by the presence of positive syphilis serology or cerebrospinal fluid abnormal qualities of neurosyphilis.

2. Late syphilis
   Respiratory tract or skin infections, benign teritory syphilis, cardiovascular syphilis, neurosyphilis etc.
<table>
<thead>
<tr>
<th>Disease</th>
<th>Pathogen</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonorrhoea</td>
<td>Neisseria gonorrhoeae (Bacteria)</td>
<td>• Burning or frequent urination.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A yellowish discharge from the penis or vagina.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Redness and swelling of the genitals.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A burning or itching of the vaginal area.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lower abdominal or pelvic pain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Painful or swollen testicles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Swelling of the vulva (vulvitis)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Bleeding between periods</td>
</tr>
<tr>
<td>Genital Herpes-Simplex</td>
<td>Herpes simplex virus Type 1.(HSV-1) Type 2(HSV-2)</td>
<td>• Problems in urinating</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pain and itching</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Appearance of small red bumps or tiny white blisters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ulcers that form when the blisters rupture and ooze or bleed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Scabs that form as the ulcers heal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Flu-like symptoms</td>
</tr>
<tr>
<td>Chlamydiasis</td>
<td>Chlamydia trachomatis. Bacterium</td>
<td>• Men have a discharge from their urethra or a burning sensation while urinating, itching over the head of the penis, testicular swelling with pain.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Women have abnormal vaginal discharge or a burning sensation while urinating, lower abdominal discomfort, lower back pain, pain during sexual intercourse, and bleeding in between menstrual periods.</td>
</tr>
<tr>
<td>Genital warts</td>
<td>Human papilloma - Viruses (HPVs)</td>
<td>• Flesh coloured, soft -to-the-touch bumps on the skin. They often grow in more than one place and may cluster in large masses.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In males lesions apper on penis.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In female lesions on the cervix, vaginal wall or anus.</td>
</tr>
<tr>
<td>Trichomoniasis</td>
<td>Protozoan parasite Trichomonas vaginalis</td>
<td>• Site of infection is urethra and the vagina.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Symptoms include pain, burning or itching in the penis, urethra (urethritis), or vagina (vaginitis), discomfort for both sexes may increase during intercourse and urination.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In women there may yellowgreen, itchy, frothy, foulsmelling, vaginal discharge.</td>
</tr>
</tbody>
</table>
CONCEPT: Infertility

Suggested activity: General discussion and interview with clinical expert.

Points to be discussed
- What are the methods used to assist infertile couple to have children?

Consolidation
- Complete the branching chart

Assisted Reproductive Technologies (ART)

Assigned activity
- Expand the abbreviations used in branching chart.

Assessment
- Completed branching chart, expanded abbreviations and notes in activity log.

Process Assessment
- Participation in general discussion on reproductive health, birth control, MTP, STDs and Infertility
- Group discussion on reproductive health, MTP and STDs
- Debate on MTP
- Interview with clinical expert

Portfolio Assessment
- Report on group discussion and debate
- Charts and tables
- Graphical representations
- Prepared questionnaire
- Collected data
- Works in the activity log

Unit Assessment
- Unit test
- Quiz programme
- Oral test
- Open book assessment
Questions

1. The figures A and B are given
   a) Identify and Name the methods of birth control in diagram A and B.
   b) Write the merit and demerit of the above methods.

   ![Diagram A and B]

2. What is amniocentesis? Why a satutory ban is imposed on this technique?

3. Name two programmes launched by Govt of India in order to attain reproductive health.

4. Select the correct term from the bracket and complete the given branching tree
   (Barriers, Lactational ammonorrhoea, CuT, Tubectomy)

   ![Branching Tree Image]
5. What is meant by STDs? Give eg. What are the preventive methods to avoid transmission of STDs?

6. Correct the following statements
   a) Transfer of an ovum collected from donor into the fallopian tube is called ZIFT.
   b) Transfering of an embryo with more than 8 blastomeres into uterus is called GIFT.
   c) Multiload 375 is a hormone releasing IUD.

7. Maternal mortality rate (MMR) and Infant mortality rate (IMR) are inversely proportional to population growth. Justify?

8. Which method do you suggest the couple to have a baby, If the male partner fail to inseminate the female or due to very low sperm count in the ejaculate?

9. Implants or injections for birthcontrol under the skin consists of .........................

10. Expand the following a) ZIFT  b) ICSI

Open Book Assessment

‘Healthy reproduction, legaly checked birth control measures and proper family planing programmes are essesential for the survival of man kind’ Justify.
### SCORING KEY

<table>
<thead>
<tr>
<th>Qn. No.</th>
<th>Value Points</th>
<th>Split score</th>
<th>Total score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>a.) A - Vasectomy B - Tubectomy b) Highly effective, Reversibility is poor</td>
<td>1 x 2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 x 2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>a) A foetal sex determination test based on chromosomal pattern b) Check increasing female foeticide</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Family Planning, Reproductive and Child Health Care (RCH)</td>
<td>1/2 x 2</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>A - lactational ammenorrhoea B - barriers C - Tubectomy D - CuT</td>
<td>1/2 x 4</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Sexually transmitted diseases/VD/RTI a) Avoid sex with Unknown partner b) Use condoms c) Early detection</td>
<td>1/2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 x 3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>a) Transfer of ovum from a donor to fallopian tube is GIFT b) ZIFT</td>
<td>1 +1</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>MMR and IMR reduces population growth directly</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Artificial Insemination</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Oestrogen or combination of Oestrogen and Progesterone</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>a) Zygote Intra Fallopian Transfer b) Intra Cytoplasmic Sperm Injection</td>
<td>1/2 x 2</td>
<td>1</td>
</tr>
</tbody>
</table>
Introduction

Genetics may be claimed to be one of the most important branches of biology. “Like begets like” as says the proverb all organisms show all sort of characteristics and their offsprings show many of these too. Genetics is the study of heredit of characteristics or traits from one generations to another. Modern genetics is concerned with the study of genes. Geneticists investigate how these genes are transferred from one generation to the next, what their structure is and how they function to determine the characteristics of a living organism.

This chapter deals with the patterns of inheritance in organisms, sex determination in animals and genetic disorders.

Values and attitudes

After completing this chapter the learner...

- Develops a positive attitude regarding the ancestral heritage.
- Develops an empathy towards the people with genetic disorders.
- Develops a positive attitude against the mis-conceptions of hereditary transmission.
<table>
<thead>
<tr>
<th>Concepts/ Ideas</th>
<th>Process/Activity with assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mendel’s Law of Inheritance</strong>&lt;br&gt;- Observing&lt;br&gt;- Identifying&lt;br&gt;- Comparing&lt;br&gt;- Charting&lt;br&gt;- Inferring&lt;br&gt;- Communicating&lt;br&gt;- Experimenting</td>
<td>General discussion using Chart/slides followed by group discussion&lt;br&gt;<strong>Assessment</strong>&lt;br&gt;Prepared charts, performance of experiment and works in activity log</td>
<td>- Explains the hybridisation experiments in pea plants.</td>
</tr>
<tr>
<td><strong>Inheritance of One Gene</strong>&lt;br&gt;- Law of dominance&lt;br&gt;- Law of segregation&lt;br&gt;- Incomplete dominance&lt;br&gt;- Co-dominance&lt;br&gt;- Observing&lt;br&gt;- Identifying&lt;br&gt;- Comparing&lt;br&gt;- Charting&lt;br&gt;- Inferring&lt;br&gt;- Communicating&lt;br&gt;- Experimenting</td>
<td>General discussion using Chart/slides. Experimentation using pea plants&lt;br&gt;<strong>Assessment</strong>&lt;br&gt;Prepared charts, tables, works in activity log</td>
<td>- Explains law of dominance and law of segregation.&lt;br&gt;- Formulates ratio of F1 and F2 in Monohybrid cross.&lt;br&gt;- Designs different types of hybridisation experiments.&lt;br&gt;- Differentiates mendelian inheritance and other type of inheritance.</td>
</tr>
<tr>
<td><strong>Inheritance of Two Genes</strong>&lt;br&gt;- Law of independent assortment&lt;br&gt;- Chromosomal theory of inheritance&lt;br&gt;- Linkage and recombination&lt;br&gt;- Observing&lt;br&gt;- Identifying&lt;br&gt;- Charting&lt;br&gt;- Inferring&lt;br&gt;- Communicating</td>
<td>General discussion using Chart/slides&lt;br&gt;<strong>Assessment</strong>&lt;br&gt;Works in activity log</td>
<td>- Explains law of independent assortment.&lt;br&gt;- Formulates ratio of F1 and F2 in Dihybrid cross.&lt;br&gt;- Designs different types of hybridisation experiments using two characters.&lt;br&gt;- Differentiates types of linkage and recombination.</td>
</tr>
<tr>
<td>Concepts/ Ideas</td>
<td>Process/Activity with assessment</td>
<td>Learning outcome</td>
</tr>
<tr>
<td>---------------------------------</td>
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<td>فشله التفاعل باستخدام الرسومات والصور/الفيديوهات المتحركة</td>
<td>- يشرح أنواع التكاثر في الإنسان والآله الأخرى.</td>
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<td>- Sex determination in Humans</td>
<td>فشله التفاعل باستخدام الرسومات والصور/الفيديوهات المتحركة</td>
<td>- يشرح أنواع التكاثر في الإنسان والآله الأخرى.</td>
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<tr>
<td>- Observing</td>
<td>Notes in activity log and charts**</td>
<td>- تقيس أصول الإنسان.</td>
</tr>
<tr>
<td>- Identifying</td>
<td>Prepared charts and works in activity log**</td>
<td>- يشرح والتقيس أنواع التكاثر.</td>
</tr>
<tr>
<td>- Comparing</td>
<td>Prepared charts and works in activity log**</td>
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<tr>
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<td>- Inferring</td>
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<td>- يشرح والتقيس أنواع التكاثر.</td>
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<td>- Observing</td>
<td>ڤنة التفاعل باستخدام الرسومات والصور/الفيديوهات المتحركة</td>
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<td>- Identifying</td>
<td>ڤنة التفاعل باستخدام الرسومات والصور/الفيديوهات المتحركة</td>
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<tr>
<td>- Comparing</td>
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<tr>
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<td><strong>Genetic Disorders</strong></td>
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<td>- يشرح التكاثر في الإنسان والآله الأخرى.</td>
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<td>- Pedigree Analysis</td>
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<tr>
<td>- Mendelian disorders</td>
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<td>- يشرح التكاثر في الإنسان والآله الأخرى.</td>
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<td>- Down’s syndrome</td>
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<td>- Klinefelter’s syndrome</td>
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<td>- Turner’s syndrome</td>
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<tr>
<td>- Observing</td>
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<tr>
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<tr>
<td>- Comparing</td>
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<tr>
<td>- Charting</td>
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<tr>
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<td>- يشرح التكاثر في الإنسان والآله الأخرى.</td>
</tr>
</tbody>
</table>
**Through the Chapter....**

Mentor introduces the topic showing different colours of flowers of same species and explains the difference in traits.

**CONCEPT : Mendels laws of inheritance**

**Suggested Activities**  
General discussion followed by group discussion using chart/ slides. Collection of contrasting characters.

**Points to be discussed**
- Which are the contrasting traits studied by Mendel in pea plant?

**Consolidation**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Characters</th>
<th>Contrasting traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stem height</td>
<td>Tall/dwarf</td>
</tr>
<tr>
<td>2</td>
<td>Flower colour</td>
<td>Violet/White</td>
</tr>
<tr>
<td>3</td>
<td>Flower position</td>
<td>Axial/Terminal</td>
</tr>
<tr>
<td>4</td>
<td>Pod shape</td>
<td>Inflated/ Constricted</td>
</tr>
<tr>
<td>5</td>
<td>Pod colour</td>
<td>Green/Yellow</td>
</tr>
<tr>
<td>6</td>
<td>Seed shape</td>
<td>Round/Wrinkled</td>
</tr>
<tr>
<td>7</td>
<td>Seed colour</td>
<td>Yellow/Green</td>
</tr>
</tbody>
</table>

**Assigned activity**
- Collect leaves/ flowers/ seeds/ pods of locally available plants with contrasting characters

**Assessment**
- Works in the activity log, performance of experiment and Observation table of experiment.
Pre Mendelian genetics

The ideas or theories to explain the phenomenon of inheritance before Mendelian period

1) Vapour theories:
   - Pythagoras proposed that (9500 BC) every organ of body gives some types of vapours, these vapours unite to form a new individual.
   - Hippocrates (400 BC) believed that reproductive material is handed over from all parts of the body of an individual.
   - Aristotle (350BC) believed that father contributes some kind of non material guiding principle - ‘soul or entelechy’ - through semen and mother contributes the material foundation - ‘catamenia’. He was not aware of egg.

2) Preformation theories
   - Leonardo da Vinci (1452-1519) proposed that male and female parents contribute equally to the heridity of offspring
   - W. Harvey (1578-1657) speculated that all animals arise from egg and semen only plays vitalizing role
   - R. de. Graaf (1641-1673) observed that progeny would have characters of both father and mother and concluded that both parents should contribute to the heridity.

CONCEPT: Inheritance of one gene

Law of Dominance

- Law of Segregation
  - Incomplete Dominance
  - Co-Dominance

Suggested activity: General discussion using chart/slides. Tables and Experimentation.

Points to be discussed

- How Mendel experimented and proved inheritance of one gene?
- Which are the exceptional inheritance pattern in one gene inheritance?

Consolidation

- Mono hybrid cross
  - Alleles - Alternative forms of a gene.
  - Homozygous, Heterozygous, Dominant trait, Recessive trait
  - Phenotypic ratio: 3 Tall : 1 Dwarf,
Genotypic ratio: 1 TT : 2Tt : 1 tt

Law of dominance: Expression of only one of the parental characters (alleles) in F1 of monohybrid cross

Law of segregation (law of purity of gametes): Alleles stay together but do not show any blending or mixing and enters into two separate gametes. (purity of gametes)

- Exceptional inheritance: Incomplete dominance and Co-dominance

**Assigned activity**
- Find the F1 and F2, genotypes, phenotypes and their ratio of other six characters of pea plant selected by Mendel

**Assessment**
- Prepared charts, tables and notes in activity log.

**Extension activity**
- Conduct monohybrid cross in pea plants.

**CO - DOMINANCE**

- In co-dominance two alleles are fully expressed at the same time side by side in a heterozygote.

- Eg:- coat colour seen in cattle.
  - The cross between a red homozygous cattle and a white homozygous cattle results in a heterozygous offspring with a roan coat. This roan coat consists of a mixture of red and white hairs - where each individual hair is either all white or all red; never a blend.

- Pleiotropism: The multiple phenotypic effect of a single gene is called pleiotropism.

  I) The allele ‘Ay’ in mice has two phenotypic effects. Controlling lethality and controlling yellow coat colour.

  II) In human beings, Marfan’s syndrome, characterized by long limbs, slender body, hypermobility of joints, lens dislocation and...
susceptibility to cardiac diseases are caused by single pleiotropic gene.

III) Sickle cell disease It is a genetically transmitted haemolytic disease. Homozygotes have two copies of abnormal gene leading to formation of crescent or sickle shaped RBC with defective haemoglobin (Hbs). In heterozygotes (having one abnormal copy and one normal copy), there is an advantage called heterozygote advantage. These heterozygotes are protected against malaria.

**Example of Incomplete Dominance**

<table>
<thead>
<tr>
<th>Characters</th>
<th>Phenotypes of Parent I</th>
<th>Phenotypes of Parent II</th>
<th>Phenotypes of Heterozygous offspring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coat colour in rabbit</td>
<td>Red</td>
<td>White</td>
<td>Brown</td>
</tr>
<tr>
<td>Type of hair in man</td>
<td>Curly</td>
<td>Straight</td>
<td>Wavy</td>
</tr>
<tr>
<td>Feather colour in Andalusian Fowl</td>
<td>Black</td>
<td>White</td>
<td>Blue</td>
</tr>
<tr>
<td>Body colour in sheep</td>
<td>Black</td>
<td>White</td>
<td>Grey</td>
</tr>
<tr>
<td>Coat colour in cat</td>
<td>White</td>
<td>Brown</td>
<td>Orange</td>
</tr>
<tr>
<td>Height in horse</td>
<td>Tall</td>
<td>Short</td>
<td>Medium</td>
</tr>
<tr>
<td>Flower colour in tulip</td>
<td>Red</td>
<td>White</td>
<td>Pink</td>
</tr>
</tbody>
</table>

Tay-Sachs disease is an example of the result of incomplete dominance because the gene that makes the antibodies only creates half of the necessary antibodies which creates a vulnerability in the individual to get Tay-Sachs.

**CONCEPT : Inheritance of two genes**

- Law of independent Assortment
- Chromosomal theory of inheritance
- Linkage and Recombination

**Suggested activity**: General discussion using chart/slide presentation. Preparation of punnet square of dihybrid crosses

**Points to be discussed**

- How Mendel experimented and proved inheritance of two genes?
- What is Law of Independent assortment?
- What is chromosomal theory of inheritance and who proposed it?
• Who experimentally proved chromosomal theory of inheritance and in which organism?
• What is linkage and recombination?

Consolidation

Phenotypic ratio: - 9:3:3:1
Genotypic ratio: - 1:2:1:2:4:2:1:2:1

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Genotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tall Red</td>
<td>TTRR</td>
</tr>
<tr>
<td>Tall Red</td>
<td>TTRr</td>
</tr>
<tr>
<td>Tall Red</td>
<td>TtRR</td>
</tr>
<tr>
<td>Dwarf red</td>
<td>ttRr</td>
</tr>
<tr>
<td>Tall white</td>
<td>Ttrr</td>
</tr>
<tr>
<td>Tall Dwarf</td>
<td>Trr</td>
</tr>
<tr>
<td>Tall White</td>
<td>ttR</td>
</tr>
<tr>
<td>Dwarf red</td>
<td>ttR</td>
</tr>
<tr>
<td>Dwarf White</td>
<td>ttR</td>
</tr>
</tbody>
</table>

- Dihybrid crosses - when inheritance of two genes are considered.
- Law of independent assortment - when the alleles of two different characters come in an individual during gamete formation each of these alleles separate or segregate and assort independently.
- Chromosome theory of inheritance is proposed by Walter Sutton and Theodre Boveri in 1902. It states that the chromosomes, which are located in the nucleus of cells, are the carriers of the genes, and are responsible for passing genetic information from one generation to the next.
- Thomas Hunt Morgan, Drosophila melanogaster. Linkage is the tendency of genes inherit together from one generation to another. Recombination is the tendency of genes to separate and to combine independently to form non-parental types.

Assigned activity
- Find the phenotype and genotype of F1 and F2 of the following cross - Pea plant with Axial flower and Yellow seed (AAYY) with plant with Terminal flower and Green seed (aayy) using Punnet square.

Find the phenotype and genotype of F1 and F2 of the following cross - Pea plant with Axial flower and Yellow seed (AAYY) with plant with Terminal flower and Green seed (aayy) using Punnet square.
Assessment

- Solved cross and notes in the activity log.

Genetic linkage is the tendency of alleles that are located close together on a chromosome to be inherited together during meiosis.

- It first discovered by the British geneticists William Bateson, Edith Rebecca Saunders and Reginald Punnett.
- T H Morgan’s observation led to the idea that crossover frequency might indicate the distance separating genes on the chromosome.
- Alfred Sturtevant, first developed linkage maps. By working out the number of recombinants it is possible to obtain a measure for the distance between the genes. This distance is expressed in terms of a genetic map unit (m.u.), or a centimorgan. A recombinant frequency (RF) of 1% is equivalent to 1 m.u.

Types of Linkage: Complete and Incomplete.

- Complete Linkage: The genes closely located on the same chromosome do not separate and are inherited together over the generations due to the absence of crossing over. During inbreeding of F1 individuals, recombinant types are absent. Usually this will produce an approximate ratio of 1:1 test ratio is never achieved because total linkage is rare.
- Incomplete Linkage: Genes present in the same chromosome have a tendency to separate due to crossing over and hence produce recombinant progeny besides the parental type. The number of recombinant individuals is usually less than the number expected in independent assortment. It does not usually yield the ratio of 1:1:1:1. Only 9.3% recombinant types were observed, which is different from 50% recombinants in case of independent assortment. This shows that in the gametes of the F1 generation only some of the chromatids undergo cross-over while the majority is preserved intact. This produces 90.7% parental types in the progeny.

CONCEPT : Sex determination

- Sex Determination in Humans

Suggested activity: A general discussion is conducted using charts/slides/animated videos. Preparation of chart.
Points to be discussed

• Who was the scientist who paved the way to identify ‘X’ Chromosome?
• How sex is determined in insects and birds?
• In human, male is responsible for the determination of sex. How?

Consolidation

• Henking in 1891 (termed it as X - Body)
• Insects - 2 types of sex determination
  XX - XO type (grass hopper) male with only one X chromosome female with 2 X chromosome (male heterogamety and female homogamety)
  XX - XY type (Drosopilla) male with one X and one Y chromosome female with 2 X chromosome (Male heterogamety and female homogamety)
• Birds - ZZ - ZW type (male possesses two Z chromosome and female one Z chromosome and one W chromosome) male homogamety and female heterogamety
• Humans - XX - XY type (male possesses one X chromosome and one Y chromosome and female 2 X chromosome male heterogamety and female homogamety. Because male is heterogametic

Assigned activity

☐ Preparation of chart showing sex determination in animals.

Assessment

• Notes in the activity log and chart showing sex determination in animals.

CONCEPT : Mutation

Suggested activity : General discussion using slide presentation

Points to be discussed

• What is mutation?
• What are mutagens?
• How mutation affects inheritance?
Consolidation

- Phenomenon which results in the alteration of DNA sequences and results in changes in the genotype and phenotype of an organism. (sudden heritable changes occurring in the genetic makeup of an organism)
- Mutagens are chemical and physical factors which induce mutation. Eg UV radiations.
- Changes in genetic constitution may lead to change in characters and cause genetic disorders.

**Physical mutagens:**

High energy, penetrating radiations such as X-rays and ultraviolet light are powerful physical mutagens. It can penetrate organisms and are capable of producing mutations.

**Chemical mutagens:**

Nitrous acid, formaldehyde, ethylethane, sulphonate, etc., produce mutations by the addition or subtraction of whole nucleotides.

Assigned activity

- Preparation of chart showing diagrammatic representation of mutation.

Assessment

- Prepared charts and notes in the activity log.

**CONCEPT: Genetic disorders**

**Suggested activity:** Mentor initiates a general discussion using slides showing a pedigree chart.

**Points to be discussed**

- What is pedigree analysis? Which are the symbols commonly used in pedigree analysis?
- Which are the common mendelian disorders?
- Name three chromosomal disorders and how it occurs.
Consolidation

- Family tree showing history about inheritance of characters over generations

Complete the table

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Genotype</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Down’s syndrome</td>
<td>?</td>
<td>Trisomy 21, Short statured with round face, furrowed tongue, partially opened mouth, palm crease</td>
</tr>
<tr>
<td></td>
<td>44AA + XXY = 47</td>
<td>?</td>
</tr>
<tr>
<td>Turner’s syndrome</td>
<td>44AA + XO = 46</td>
<td>?</td>
</tr>
</tbody>
</table>

Assigned activity

- Complete a table showing symptoms and genotype of 3 chromosomal disorders.

Assessment

- Notes in the activity log and completed table.

Construct circles denoting chromosomal disorders using genotypes and symptoms/features given in frames.
**Process Assessment**
- General discussion on Inheritance, Mendel’s laws, Sex determination, Mutation and genetic disorders.
- Group discussion on Mendel’s laws.
- Preparation of charts, completion of tables etc.
- Experimentation on inheritance and Mendel’s laws.
- Preparation tables and flow charts.

**Portfolio Assessment**
- Report on group discussion
- Charts
- Prepared tables
- Activity log
- Observation and inference of experiment.

**Unit Assessment**
- Unit test
- Quiz programme
- Oral test
- Open book assessment
• **Thalassemia** is an inherited autosomal recessive blood disorder in which the body makes an abnormal form of haemoglobin. The disorder results in large numbers of red blood cells being destroyed, which leads to anemia. Haemoglobin is made of a proteins called globin consisting of two alpha globin chain and two beta chains. Thalassemia occurs when there is a defect in the gene that helps control production of one of these polypeptide chains. The genes coding for alpha and beta chains are found on chromosomes 16 and 11 respectively.

• There are two main types of thalassemia: **Alpha thalassemia** and **beta thalassemia**. Alpha thalassemia occurs when the gene coding for the alpha chains missing or changed (mutated). Beta thalassemia occurs when similar gene defects affect production of the beta globin protein.

• Both alpha and beta thalassemia include the following two forms: Thalassemia major and Thalassemia minor. Thalassemia minor develops when the person is a carrier. On the other hand Thalassemia major develops when the individual is homozygous for the defective gene.

• Beta thalassemia major is also called Cooley’s anemia.

• The most severe form of alpha thalassemia major causes stillbirth. Children born with thalassemia major (Cooley’s anemia) are normal at birth, but develop severe anemia during the first year of life. Other symptoms can include: Facial bone deformities, Fatigue, Growth failure, Shortness of breath, Yellow skin (jaundice), etc. Persons with the minor form of alpha and beta thalassemia have small red blood cells but no symptoms.

---

**Eugenics**, meaning “well born,” was introduced in the 1880s by Sir Francis Galton, a cousin of Charles Darwin and the father of modern statistics. Galton pioneered the use of pedigrees, twin studies, and statistical correlation for the purpose of using that knowledge to improve “the breed of man.” “It is the study of or belief in the possibility of improving the qualities of the human species or a human population, especially by such means as discouraging reproduction by persons having genetic defects or presumed to have inheritable undesirable traits (negative eugenics) or encouraging reproduction by persons presumed to have inheritable desirable traits (positive eugenics). Eugenics, the social movement claiming to improve the genetic features of human populations through selective breeding and sterilization, based on the idea that it is possible to distinguish between superior and inferior elements of society.”
Wilson's disease is a rare inherited disorder that causes too much copper to accumulate in your liver, brain and other vital organs. Copper plays a key role in the development of healthy nerves, bones, collagen and the skin pigment melanin. Normally, copper is absorbed from your food, and any excess is excreted through bile. But in people with Wilson's disease, copper isn't eliminated properly and instead accumulates, possibly to a life-threatening level (by causing irreversible organ damage). The disease is named after Samuel Alexander Wilson (1878-1937), the British neurologist who first described the condition in 1912.

The condition is due to recessive mutations in the Wilson disease protein (ATP7B: ATPase Cu2+ transporting polypeptide) gene located on chromosome 13. Heterozygotes for the affected gene are carriers whereas homozygotes develop the disease. Wilson's disease occurs in 1 to 4 per 100,000 people. Symptoms usually appear between the ages of 6 and 23 years. Carriers do not develop any symptoms. Wilson's disease manifests as neurological or psychiatric symptoms and liver disease. It is treated with medication that reduces copper absorption or removes the excess copper from the body.

Lethal genes
Genes which when expressed result in the death of the bearer are called lethal genes. Lethal genes arise occasionally by mutation. In homozygous condition lethal genes cause 100% mortality. Therefore individuals carrying lethal genes in homozygous condition are removed from the population in the same generation in which they emerge.

Lethalism is of two types: dominant lethalism and recessive lethalism. In dominant lethalism the dominant allele of the lethal gene in homozygous condition results in the death of the carrier while in recessive lethalism the recessive allele of the lethal gene in homozygous condition causes the death of the carrier.

Cystic fibrosis is a life threatening disorder that causes severe damage to the lungs and digestive system. It affects the cells that produce mucus, sweat and digestive juices. These secreted fluids are normally thin and slippery. But in cystic fibrosis, a defective gene causes the secretions to become thick and sticky. Instead of acting as a lubricant, the secretions plug up tubes, ducts and passages, especially in the lungs and pancreas. Cystic fibrosis is caused by a genetic mutation; specifically a mutation in a gene called CFTR (Cistic Fibrosis Transmembrane conductance Regulator). If the CFTR gene is defective, it results in a buildup of thick,
sticky mucus in the body’s tubes and passages. Symptoms usually start in early childhood and include: persistent cough, recurring chest and lung infections, poor weight gain. An early sign is that an affected child’s sweat is unusually salty.

<table>
<thead>
<tr>
<th>Euploidy</th>
<th>Increase in number of complete sets of chromosome occurs frequently in plants but rarely in animals can lead to formation of new species, eg. triploid (3n), tetraploid (4n) odd numbers are usually sterile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aneuploidy</td>
<td>Variation in the number of a particular chromosome within a set generally leads to an abnormal condition because it leads to an imbalance in amount of gene products (too much or too little) eg. trisomy (2n + 1), monosomy (2n -1)</td>
</tr>
<tr>
<td>Mosaicism</td>
<td>Part of the organism contains cells that are genetically different from other parts. eg: Drosophila egg that is XX and loses an X in first mitotic division. it results in half of body being male and other half being female (gynandromorphs)</td>
</tr>
<tr>
<td>Auto polyploidy</td>
<td>Having two or more sets of chromosomes derived from the same species. complete nondisjunction occurs which results in an individual with one or more sets of chromosomes. 2n gamete self fertilized by another 2n gamete = 4n</td>
</tr>
</tbody>
</table>

**Human phenotypes**

1. Shape of the face.: Oval shape is dominant. Square shape is recessive
2. Cleft in the Chin: Absence of a cleft is dominant The presence of a cleft is recessive 3. Hair Curl: Curliness of hair is probably polygenic. To simplify we will assume it is the product of incomplete dominance of alleles of a single gene. Curly is homoygous. Wavy is heterozygous. Straight is homozygous. 4. Hairline:A slight dip in the center of the hairline is called a widow’s peak. A widow’s peak is dominant A straight hairline is recessive. 5. Eyebrow Size: Broad eyebrows are dominant. Slender eyebrows are recessive.
6. Eyebrow Shape: Eyebrows that are separated by a bare patch of skin is dominant Eyebrows that are joined by a line of hairs is recessive 7. Eyelash Length: Long eyelashes are dominant Short eyelashes are recessive 8. Dimples: Dimples are dominant Absence of dimples is
9. Size of Nose: Nose size is probably polygenic. To simplify, we will assume it is the result of incomplete dominance of two alleles of a single gene. Large is more than 38% of face length and homozygous. Medium is about 33% of face length and heterozygous. Small is less than 31% of face length and homozygous.

10. Size of Ears: Ear size is probably polygenic. We will assume it is the result of incomplete dominance of one pair of alleles of a single gene. Large ears are 38% or more of the face length and homozygous. Medium sized ears are about 33% of the face length and heterozygous. Small ears are 31% or less of face length and homozygous.

11. Earlobes: Definite free earlobes are dominant. Attached earlobes are recessive.

12. Width of Mouth: Several factors govern mouth width, but we will assume it is the product of the incomplete dominance of a pair of alleles of a single gene. A wide mouth is 95% or more of interpupillary distance and is homozygous. A medium mouth is 70%-90% of interpupillary distance and is heterozygous. A small mouth is 65% or less of interpupillary distance and is homozygous. Try not to smile when being measured.

13. Eye Spacing: Eyes are considered close together if the distance between them is less than the eye width, corner to corner. We will assume that close eye spacing is homozygous. Medium spacing is defined as being equal to the eye width and is heterozygous. Wide eye spacing is defined as being greater than the eye width and is homozygous.

14. Freckles on Cheeks: Freckles are dominant. Lack of freckles is recessive.

15. Tongue Rolling: The ability to roll the tongue, side edges up, is a dominant trait. The inability to roll the tongue is recessive.

16. Tongue Folding: The ability to fold the tip of the tongue backwards, without touching the roof of the mouth, is recessive. The inability to fold the tongue as described is dominant.

17. Mid-digital Hair: The presence of hair on the back of the middle joint of the fingers is dominant. The absence of hair on the back of the middle joint of the fingers is recessive.

18. Hitch-hiker’s Thumb: A thumb that is straight when fully bent back is dominant. A thumb in which the distal segment (furthest from the hand) forms an angle with the proximal segment is recessive.

19. Bent Little Finger: In the dominant condition the center line of the distal segment of the little finger bends slightly towards the ring finger. A perfectly straight little finger is recessive.

20. Hair on the Back of the Hand: Hair on the back of the hand is dominant. Hairless hands are recessive.

21. Taste Testing: The ability to detect certain chemicals is determined genetically and is a dominant trait. The inability to taste the chemicals is recessive. The chemicals being tested here are P.T.C (Phenyl Thio Carbamide), sodium benzoate and thiourea.
Chapter 3 - Principles of Inheritance and Variation

Questions

1. In dogs black coat colour (B) is dominant over white color (b). What coloured dog will you choose to breed a given black dog in order to find its genotype. What is this type of cross known as?

2. Match the table

<table>
<thead>
<tr>
<th>Type</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Monohybrid Phenotypic ratio</td>
<td>1:2:1</td>
</tr>
<tr>
<td>2. Dihybrid phenotypic ratio</td>
<td>3:1</td>
</tr>
<tr>
<td>3. Incomplete dominance</td>
<td>9:3:3:1</td>
</tr>
</tbody>
</table>

3. In pea plants genes (B & b) controlling starch synthesis has more than one effect (seed shape and size of starch grains) What happens in seed shape and size when the genotype becomes.
   a) BB     b) bb    c) Bb

4. Names of three scientists and their contributions are given below. Arrange their names against contribution.
   (Henking, T H Morgan, Longdon Down, Linkage in Drosophilla, X - Body, Downs Syndrome,)


6. What are mutagens? Give example

7. Identify the following symbols used in pedigree analysis

A B C D
8. A wealthy couple died together in an accident. Soon a man comes to claim their property saying that he is their only son. Hospital records of the died couple shows that their blood group is AB and O respectively. The person has blood group O. Explain whether the person claiming their property is really their son.

9. A baby has palmcrease, broad flat face and congenital heart disease. Identify the disease and write the genottype.

10. Study the following representation. Which one of the following condition/disease could be an example of this pattern in humans.

(A) Phenylketonuria  
(B) Sickle celled anemia  
(C) Thalasseemia  
(D) Haemophilia.

Open Book Assessment

‘Incomplete dominance, co-dominance and linkage are the deviations of the Mendalian laws of inheritance’

Do you agree with this statement? Give reason?
### SCORING KEY

<table>
<thead>
<tr>
<th>Qn No.</th>
<th>Value Points</th>
<th>Split Score</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>White(bb), Test cross</td>
<td>1 x 2</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>1 - b , 2 - c , 3 - a</td>
<td>( \frac{1}{2} \times 3 )</td>
<td>1 ½</td>
</tr>
<tr>
<td>3.</td>
<td>BB - Round, Large starch grain, Bb - Round, Intermediate, bb - Wrinkled, smaller starch grain</td>
<td>1 x 3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Henking X - body, T H Morgan Linkage in Drossophilla, Longdon Down Downs Syndrome</td>
<td>1 x 3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>Man --- XX - XY ( Male), Grasshopper XX - XO ( Male )</td>
<td>1 x 2</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>Chemical or physical factor which cause mutation eg. UV Rays</td>
<td>1 x 2</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>A. Sex unspecified B. Consanginous marriage C. Normal Female D. Parents with diseased male</td>
<td>( \frac{1}{2} \times 4 )</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>No, If any one of the parent is having AB Blood group O group child cannot be formed</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

![Blood Group Table](image)

<table>
<thead>
<tr>
<th>AB Blood Group</th>
<th>O Blood Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>I^a I^b</td>
<td>i i</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>I^a</th>
<th>I^b</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>i(^i) A group</td>
<td>i(^i) B group</td>
</tr>
<tr>
<td>i</td>
<td>i(^i) A group</td>
<td>i(^i) B group</td>
</tr>
</tbody>
</table>

9. Downs Syndrome, 45 AA + XX or XY | 1+1 | 2 |

10. D. Haemophilia | 1 | 1 |
Introduction

Living matter is made up of biochemicals hence genetic materials is also biochemical in nature. Genetic material may be DNA or RNA, which is made up of several thousand of genes. In most cases DNA is the genetic material but in some viruses RNA perform the same role. Both DNA and RNA are made up of nucleotides. Their arrangement and sequence nature of nucleotides etc. control the transmission and expression of the genetic material. Identification of uniqueness in DNA is helpful in all aspects. The first genetic material is generally believed to have been RNA but the modern cells use RNA mainly for the building of proteins from DNA instructions in the form of mRNA, rRNA and tRNA.

This chapter deals with the structure of DNA, its replication, process of making RNA from DNA, genetic code, protein synthesis and elementary basis of their regulation.

Values and attitudes

After completing this chapter the learner...

- Appraises the uniqueness of the genetic material of living organisms and its mechanism of action.
- Develops positive attitude towards the significance and scope of DNA fingerprinting and Human Genome Project.
### Chapter 4 - Molecular Basis of Inheritance

<table>
<thead>
<tr>
<th>Concepts/ Ideas</th>
<th>Process/Activity with assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The DNA</strong></td>
<td>- General discussion after a brief introduction using chart, videos, models, slides.</td>
<td>- Explains and constructs the structure of Nucleosome and DNA.</td>
</tr>
<tr>
<td>- Structure of poly-nucleotide chain</td>
<td>- Construction of models of nucleosome and DNA</td>
<td></td>
</tr>
<tr>
<td>- Packing of DNA helix</td>
<td>- Observing - Identifying - Comparing - Charting - Inferring - Communicating</td>
<td></td>
</tr>
<tr>
<td><strong>The search of Genetic material.</strong></td>
<td>- General discussion using Chart/Videos/slides.</td>
<td>- Identifies the importance of DNA as a genetic material.</td>
</tr>
<tr>
<td>- The genetic material is DNA.</td>
<td>- Collection of brief history of scientists, charts and works in activity log.</td>
<td>- Differentiates DNA and RNA as a genetic material.</td>
</tr>
<tr>
<td>- Properties of genetic material (DNA versus RNA)</td>
<td>- Observing - Identifying - Comparing - Charting - Inferring - Communicating</td>
<td></td>
</tr>
<tr>
<td><strong>RNA world</strong></td>
<td>- General discussion using Chart/slides/models.</td>
<td>- Identifies and explains the features of RNA.</td>
</tr>
<tr>
<td>- Observing - Identifying - Charting - Constructing - Inferring - Communicating</td>
<td>- Constructed models and notes in activity log.</td>
<td></td>
</tr>
<tr>
<td><strong>Replication</strong></td>
<td>- General discussion using Chart/animations/models/slides followed by group discussion.</td>
<td>- Identifies and explains the mode of replication in DNA.</td>
</tr>
<tr>
<td>- The experimental proof.</td>
<td>- Model preparation - Constructed model, prepared table and notes in activity log</td>
<td>- Constructs the models of DNA replication.</td>
</tr>
<tr>
<td>- The machinery and enzymes</td>
<td>- Observing - Identifying - Comparing - Charting - Constructing - Inferring - Communicating</td>
<td></td>
</tr>
</tbody>
</table>

Assessment

- Constructed models and notes in activity log.
<table>
<thead>
<tr>
<th>Concepts/ Ideas</th>
<th>Process/Activity with assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
</table>
| **Transcription**  
- Transcription unit.  
- Transcription unit and the gene.  
- Types of RNA and the process of transcription  
  - Observing  
  - Identifying  
  - Comparing  
  - Charting  
  - Constructing  
  - Inferring  
  - Communicating | ➥ General discussion after a brief introduction using chart/animated videos/3D models/slides followed by group discussion  
**Assessment**  
Constructed models and notes in activity log | - Identifies and Explains transcription unit.  
- Explains the role of enzymes involved in transcription.  
- Constructs models of transcription unit. |
| **Genetic code**  
- Mutations and genetic code.  
- RNA The adaptor molecule  
  - Observing  
  - Identifying  
  - Comparing  
  - Charting  
  - Inferring  
  - Communicating | ➥ General discussion using chart/slides.  
**Assessment**  
Preparation of model of mRNA.  
 **General discussion using chart/slides.**  
**Preparation of model of mRNA.** | - Identifies and Explains the features of genetic code.  
- Differentiates codons in genetic code. |
| **Translation**  
- Observing  
- Identifying  
- Comparing  
- Charting  
- Constructing  
- Inferring  
- Communicating | ➥ General discussion using chart/videos followed by group discussion  
**Assessment**  
Schematic representation and works in activity log. | - Explains translation  
Identifies and explains the role enzymes involved in translation.  
- Constructs model showing process of translation. |
| **Regulation of gene expression**  
- Lac operon  
- Observing  
- Identifying  
- Comparing  
- Charting  
- Inferring  
- Communicating | ➥ General discussion using chart/animations slides.  
**Assessment**  
Prepared concept map, table and works in the activity log. | - Explains the process of gene regulation and expression in prokaryotes. |
# Chapter 4 - Molecular Basis of Inheritance

<table>
<thead>
<tr>
<th>Concepts/Ideas</th>
<th>Process/Activity with assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
</table>
| **Human Genome Project**  
- Salient features of human genome.  
- Applications and future challenges  
  - Observing  
  - Identifying  
  - Comparing  
  - Charting  
  - Inferring  
  - Communicating | ✉️ General discussion after a brief introduction using chart, videos, models, slides.  
✎ General discussion using Chart/slides followed by group discussion.  
**Assessment**  
Collected notes and works in activity log. | - Explains Human genome project.  
- Evaluates the importance of Human genome project.  
- Critizes the ethical aspects of HGP. |
| **DNA Fingerprinting**  
- Observing  
- Identifying  
- Comparing  
- Charting  
- Inferring  
- Communicating | ✉️ General discussion using Chart/animations/slides.  
**Assessment**  
Completed flow charts, notes in activity log. | - Explains the importance of DNA fingerprinting.  
- Appraises the genetic uniqueness and hereditary pattern of organisms. |
Mentor introduces the chapter showing a videocliping of Genome of an animal and initiates a brief discussion regarding the same.

**CONCEPT : The DNA**

**Suggested Activities** A general discussion is conducted using slides and videos etc., Construction of model of DNA.

**Points to be discussed**
- Mention the monomer unit and its components of DNA
- Identify the no of nucleotides in $\Phi$ x 174, Lamda phage, E coli and man
- What are the differences between DNA and RNA?
- List out the contributers in the study of DNA
- Mention the contribution of Erwin Chargaff in explaining the structure of ds DNA
- What are the salient features of double helical structure of DNA?
- What is central dogma of molecular biology and who proposed it.
- Calculate the length of DNA in man and E coli
- How the DNA is packed in organisms?
- How can we differentiate Euchromatin and Heterochromatin?

**Consolidation**
- Nucleotide( Pentose sugar, Nitrogen bases and phosphoric acid)
- $\Phi$ x 174 - 5386 bp, Lamda phage- 48502 bp, E coli - 4.6 x 10^6 bp, man - 3.3 x 10^9 bp

<table>
<thead>
<tr>
<th>DNA</th>
<th>RNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deoxyribose</td>
<td>Ribose</td>
</tr>
<tr>
<td>Stable</td>
<td>Unstable</td>
</tr>
</tbody>
</table>
• Frederic Meischer - 1869 - identified DNA, in nucleus and named as nuclein Maurice Wilkins and Rosalind Franklin produced X ray diffraction data of DNA James Watson and Francis crick in 1953 explained the structure of DNA.

• Erwin Chargaff proposed that ratio between Purines and Pyrimidines are constant.

• DNA is made up of two polynucleotide chains where back bone is sugar - phosphate and bases projected inside. Two chains have antiparallel polarity. The bases in two chains are paired through hydrogen bonds - $A = T, G \equiv C$

• Proposed by Francis crick

- In man $0.34 \times 10^9 \times 6.6 \times 10^9$ and in Ecoli $0.34 \times 10^6 \times 4.6 \times 10^6$

- In prokaryotes DNA is packed with the help of non histone proteins while in Eukaryotes it is packed as nucleosomes with histone proteins.

- Euchromatin is loosely packed and transcriptionally active while heterochromatin is densely packed and transcriptionally inactive.

Assigned activity
- Preparation of improvised model of Nucleosome and double helical structure of DNA

Assessment
- Notes in activity log and models
**CONCEPT:** The search of genetic material

**Suggested activity:** General discussion using charts / slides.

**Points to be discussed**

- “Transforming principle was the first step in search of genetic material”. How and by whom it is conducted?
- Who experimentally proved the biochemical nature of transforming principle? How?
- Who conducted experiments to prove that the genetic material is DNA and how?
- What are the basic qualities of a molecule to act as a genetic material?

**Consolidation**

- In 1928 Frederick Griffith conducted transforming principle, he conducted the except by using Streptococcus bacteria and Mice.
- Oswald Avery, Colin Macleod, Maclyn Mc Carthy proved transforming principle, by using purified chemicals (DNA, Protein, RNA) from heat killed S Cells, find that DNA can convert R bacteria to S bacteria. (S = smooth, R = Rough)
WORK SHEET

Few Scientists, Their works and related concepts/ materials are given below. Select appropriate items related to each scientist and arrange them. Write brief notes also.

- Double Helix
- Operons
- E - coli & N_{14} - N_{15} Medium
- Bacteriophages
- Streptococcus pneumonia
- Transformation
- Viral genetic material
- Structure of DNA
- DNA Replication Semiconservative experimental proof
- Lactose Utilizing System

Mathew Meselson & Franklin Stahl
James Watson and Francis Crick
Frederick Griffith
Alfred Harshey & Martha Chase
Francois Jacob & Jacque Monad
Hershey and Chase conducted the experiment by using E.coli, and T2 phage. Should be able to generate its replica. Genetic material should be stable, less mutable. Should be able to express itself in the form of Mendelian characters.

**Assigned activity**
- Prepare a chart showing various steps of the experiments in search of genetic materials.
- Collection of brief history of the scientists who conducted experiments in search of genetic materials.

**Assessment**
- Prepared chart, collected data, completed worksheet and notes in activity log.

**CONCEPT : RNA world**

**Suggested activity :** General discussion using chart /slide/ video / models.

**Points to be discussed**
- Which is the first genetic material in living world and why it is not considered as a most stable genetic material?

**Consolidation**
- RNA because it can act as a catalyst, unstable compound.

**Assigned activity**
- Prepare a table showing types of RNA and its features.

**Assessment**
- Notes in activity log and table showing types of RNA.

**CONCEPT : Replication**

- The experimental proof
- The machinery and the enzymes

**Suggested activity :** Mentor initiates a general discussion showing slides, models or animations regarding replication of DNA. After the discussion learners are advisd to prepare a model of DNA replication.
Points to be discussed

• Why DNA replication is semiconservative?
• What contribution does Mathew Meselson and Franklin Stahl provided in the history of DNA replication?
• Name the scientists who conducted replication experiments in Vicia faba?
• What are the enzymes and steps in the mechanism of DNA replication?
• Is DNA replication continuous in one strand and discontinuous in the other?

Consolidation

• After completion of replication, DNA molecule would have one parental and one newly synthesized strand.
• They gave experimental proof to semiconservative mode of replication with the help of Ecoli.
• Taylor and colleagues in 1958.
• DNA polymerase, DNA Ligase
• DNA helix forms replication fork.

DNA dependent DNA Polymerase catalyses polymerisation in one direction 5’¾ 3’ in one strand it is continuous while the other it is discontinuous. Finally DNA ligase joins fragments of discontinuous strand. In one strand the process of replication is continuous because the template has a polarity 3’¾5’ while the other has 5’¾3’ polarity.

Assigned activity

☐ Preparation of improvised model of DNA replication
☐ Prepare a table showing various activities on leading and lagging strand during DNA replication

Assessment

• Notes in activity log and model

CONCEPT: Transcription

• Transcription unit
• Transcription unit and the gene
• Types of RNA and the process of transcription
Suggested activity: General discussion using Chart/animations/slides followed by group discussion. Mentor groups the learners using appropriate grouping strategies and assigns separate topics. Each group presents their views and mentor consolidates the same.

Points to be discussed

• What is transcription and identify the components of a transcription unit specifying the function of each?
• What is the difference between monocistronic and polycistronic condition?
• What are exons and intron?
• What are the steps in the process of transcription?
• Name enzymes and protein factors in transcription and how they involved in the process of transcription?
• What are the additional complexities/steps in the eukaryotic transcription?

Consolidation

• Process of copying genetic information from one strand of DNA into RNA. Transcription unit has 3 components - a promoter, structural gene, a terminator.
  When RNA polymerase binds to promoter initiates transcription, codes the genetic information, Terminator stops the transcription.
• Monocistronic gene has interrupted coding sequences all present in eukaryotes while polycistronic genes are non interrupted, present in prokaryotes.
• The coding or expressed sequences are exons while intrones or intervening sequences do not appear in mature RNA.
• Initiation, Elongation and Termination.
• The major enzyme is RNA polymerase Sigma factor and Rho factor. Sigma factor helps in initiation while Rho factor terminates the transcription.
• Presence of different types of RNA polymerases, splicing, capping and tailing

Assigned activity

☑ Preparation of improvised model of primary transcript, splicing, caping and tailing.
Assessment

- Notes in activity log and models

CONCEPT: Genetic code

- Mutations and Genetic code
- tRNA the adaptor molecule

Suggested activity: General discussion using slide presentation on genetic code.

Points to be discussed

- Who first introduced the code of genetic transmission and how?
- What are the contribution of Marshall Nirenberg, Severo Ochoa and Har Govind Khorana in the construction / cracking of genetic code?
- What are the salient features of genetic code?
- What is mutation? In what way mutations affect transcription? Give examples?
- Which RNA is called adaptor molecule?
- Write the structure and function of tRNA?

Consolidation

- George Gamow who argued that there are only four bases which they have to code 20 aminoacids
- Marshal Neirenberg - cell free system for protein synthesis, Severo Ochoa - enzymatic synthesis of RNA, Khorana - Instrumental synthesis of RNA
- Codon is triplet, 61 codons for Amino Acids and 3 codons for stop signals. One codon code only one amino acid hence it is unambiguous and specific.

Some aminoacids are coded by more than one codon hence it is degenerate.

Genetic code is universal, AUG has dual function act as initiator codon. Codes for Amino acid methionine

- Effect in the segment of DNA which is inheritable, Point mutation - Sickle cell anemia - Frame shift mutation.
- tRNA / Soluble RNA.
- Has a clover leaf shape in secondary structure, L shape in actual structure posses anti-codon loop, amino acid acceptor end.
Assigned activity

- Sketch an mRNA segment containing codons of all the 20 amino acids.
- Prepare a chart of Genetic code.

Assessment

- Prepared chart, mRNA segment and notes in activity log

CONCEPT : Translation

Suggested activity: Mentor presents a slide show and initiates a general discussion using chart/slides/animations followed by group discussion.

Points to be discussed

- How a polypeptide chain is formed from mRNA?

Consolidation

- Translation - polymerisation of amino acids to form polypeptide chain.

Assigned activity

- Sketch the process of translation with mRNA having 10 codons.

Assessment

- Sketches and notes in activity log.

CONCEPT : Regulation of Gene Expression

Suggested activity: General discussion using chart/slides/animations, Table completion and preparation of diagrammatic representation.

Points to be discussed

- Name the stages in which gene expression is regulated
- Which is the predominant mechanism for the control of gene expression in prokaryotes
- How expression of gene is regulated in prokaryotes
- Identify the components of lac operon and how it is controlled negatively and positively

Consolidation

- Transcriptional level, Processing level Transport of mRNA from
nucleus to cytoplasm, Translational level, Control of rate of transcriptional initiation.

- It is through Operons, Eg. Lac Operon
- When lactose is present in the medium which induces the operon positively, while lactose is absent repressor protein binds on Operator gene.
- Complete the figure

<table>
<thead>
<tr>
<th>p</th>
<th>i</th>
<th>p</th>
<th>o</th>
<th>z</th>
<th>y</th>
<th>a</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Repressor mRNA → Inactive Repressor

mRNA

**Assigned activity**

☐ Prepare a diagrammatic representation to show positive and negative regulation of lac operon.

**Assessment**

- Completed diagramatic representation and notes in activity log.
Jacques Monod and François Jacob did much to elucidate how genes regulate cell metabolism by directing the biosynthesis of enzymes. The pair shared, along with André Lwoff, the Nobel Prize for Physiology or Medicine in 1965. In 1961 Jacob and Monod proposed the existence of a messenger ribonucleic acid (mRNA), a substance whose base sequence is complementary to that of deoxyribonucleic acid (DNA) in the cell. They postulated that the messenger carries the “information” encoded in the base sequence to ribosomes, the sites of protein synthesis; here the base sequence of the messenger RNA is translated into the amino acid sequence of a proteinaceous enzyme (biological catalyst). In advancing the concept of gene complexes that they called operons, Jacob and Monod postulated the existence of a class of genes that regulate the function of other genes by affecting the synthesis of messenger RNA. For this work they were awarded a Nobel Prize.

**Inducible versus repressible operons**

a. Inducible operons are turned on in response to a metabolite (a small molecule undergoing metabolism) that regulates the operon. E.g. the lac operon is induced in the presence of lactose (through the action of a metabolic by-product allolactose).

b. Repressible operons are switched off in response to a small regulatory molecule. E.g., the trp operon (tryptophan operon) is repressed in the presence of tryptophan.

**TRYPTOPHAN OPERON**

In the presence of tryptophan, repressor binds with operator and mRNA synthesis is suppressed.

In the absence of tryptophan, repressor dissociates from the operator and mRNA synthesis begins.
CONCEPT : Human Genome Project

Suggested activity: Mentor initiates a general discussion using slide presentation, A group discussion is also conducted on various issues of Human Genome Project. Using appropriate grouping technique the learners are grouped. the various aspects of HGP is discussed and the points are presented and the mentor consolidates the discussion.

Points to be discussed

- What is Human Genome Project and when was it launched?
- Why it is called mega project?
- What are the goals of HGP?
- What are the two approaches in the methodologies in Human Genome project?
- What are the salient features of Human Genome and when it was completed?

Consolidation

- HGP is sequencing human genome launched in 1990.
- It is a megaproject because it requires US 0.3 bp. As human genome has 3.3 x 10^9 bp total estimated cost was 9 billion US dollars. If it is written in books it requires 3300 books with 1000 pages. Requires high speed computational devices for data storage and retrieval.
- Identify the all 20000 - 25000 genes of human DNA, Determine the sequences of 3 million chemical base pairs, Store the information in data bases, Improve tools for data analysis, Transfer the related technologies to other sectors, such as industries, Address the ethical legal and social issues (ELSI).
- Expressed sequence tags (ESTs), Sequencing the whole genome. (Sequence annotation)
- Genome contains 3164.7 million nucleotides, Average gene consists of 3000 bases, Total no. of genes is 30,000, 9.9% of bases are same in all, Functions are unknown for 50%, less than 2% codes for proteins, Repeated sequence constitute large portion, chromosome 1 has maximum gene and Y has least, About 1.4 million locations with SNPs are identified. Completed in 2003

Assigned activity

- Collect details of present developments in HGP.

Assessment

- Details of HGP and other notes in activity log.
CONCEPT : DNA Fingerprinting

Suggested activity : Mentor initiates a general discussion using slide presentation of various steps involved in DNA Fingerprinting.

Points to be discussed
• What is DNA Fingerprinting ?
• What is the genetic principle behind DNA fingerprinting and what are its applications?
• What are the steps in DNA Fingerprinting ?

Consolidation
• Identifying the difference in some specific regions of DNA sequence called repetitive DNA
• Identification of polymorphism, useful in forensic applications, paternity dispute etc.

Complete the flowchart of the steps in DNA fingerprinting

Isolation of DNA

?.................................

Seperation of DNA fragments by electrophoresis

?.................................

?.................................

?.................................

Detection of hybridised DNA fragments by autoradiography
Assigned activity
• Preparation of short notes on satellite DNA

Assessment
• Notes, completed flowchart and short notes on satellite DNA in activity log

Lalji Singh (born 5 July 1947) is an Indian scientist who has worked in the field of DNA fingerprinting technology in India. Singh has also worked in the areas of molecular basis of sex determination, Wildlife conservation forensics and evolution and migration of humans. Dr Lalji Singh and his colleagues in the CCMB, at Hyderabad, developed a probe called Bkm-derived probe for DNA fingerprinting, as a fall out of their earlier internationally well known work on the mechanisms of determination of sex. Their probe is being extensively used for forensic investigation, paternity determination and seed stock verification. In recognition of this contribution, Dr Singh and his group have been awarded the CSIR Technology Award for the year 1992. In 2004, he received the Padmasree in recognition of his contribution to Indian science and technology.
Complete the crossword puzzle

Towards Right
1. A chemical substance which can initiate (ON) the working of operon. (6) (INDUCER)

4. Self regulating mechanism consist of a segment of DNA which consists of Promoter, Structural gene etc (6) (OPERON)

5. Triplet for stop codon (3) (UAA)

6. Smaller nuclear RNAs (6) (SN RNAs)

8. Initiation factor during transcription (11) (SIGMA FACTOR)

12. Three letter format developed by George Gamov, which is 64 in number. (7) (TRIPLET)

13. The RNA molecule which plays structural and catalytic role during translation (4) (R RNA)

Downwards
1. Non coding sequences in primary transcript. (7) (INTRONS)

2. Un Translated Region (3) (UTR)

3. Coding sequence in primary transcript (5) (EXONS)

5. A nitrogen base which is present only in RNA (6) (URACIL)

7. An enzyme which seal the gap between fragments of DNA or between lagging strands. (6) (LIGASE)

9. RNA in which genetic information is coded in the form of triplets (4) (M RNA)

10. Made up of Poly A, at the 3' end of mRNA (4) (TAIL)

11. Origin of replication (3) (ORI)
Questions

1. Prepare the correct sequence of central dogma of molecular biology by using hints given below in brackets.
   (Translation, RNA, Transcription, Replication, DNA, mRNA, Reverse transcription, Protein synthesis)

2. Match the table

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>a DNA Ligase</td>
<td>1 Polymerisation of nucleotide in DNA</td>
</tr>
<tr>
<td>b RNA Polymerase</td>
<td>2 Digestion of DNA</td>
</tr>
<tr>
<td>c Restriction endonuclease</td>
<td>3 Joining DNA strands</td>
</tr>
<tr>
<td>d DNA Polymerase</td>
<td>4 Transcription</td>
</tr>
<tr>
<td></td>
<td>5 Translation</td>
</tr>
</tbody>
</table>

3. Observe the given diagram and answer.

   ![Diagram of DNA strand with promoter and terminator]

   a) Identify the diagram
   b) Name A and B
   c) Write the function of A

4. Write the contributions of the following scientists
   a) George Gamow
   b) Jacob &Monad
   c) Alec Jeffreys

5) Transforming principle was the first step in search of genetic material
   a) Who conducted the transforming principle experiment?
   b) Name the experimental organisms in this experiment?
   c) Who conducted the continuation of this experiment?

6) In a DNA molecule Adenine is 15%. what would be the % of other nitrogen bases
7) Select the wrong statement
   a. AUG is coded for Tryptophan
   b. AUG is start codon and codes for Methionine
   c. UAA is stop codon
   d. DNA dependent RNA polymerase catalyse polymerisation of nucleotides in DNA.
      1) a only  2) b & c  3) a & d  4) a, b & c

8. Observe the given diagram and answer

   p     i     p     o     z     y     a

   Repressor mRNA
   Inactive Repressor

   mRNA
   mRNA
   mRNA

   A
   B
   Transacetylase

   a) What A and B denotes

9. Study the mRNA segment given below which is ready to be translated into a polypeptide chain

   5'  X  U  U  G  G  G  U  U  A  Y  3'

   a) What X and Y denotes
   b) Write the triplet code for X and Y

10) read the following statements and select the true statement or statement
    a) 23s RNA act as a catalyst/ enzyme in prokaryotes
    b) In prokaryotes the DNA is Monocistronic
    c) Francis Crick first proposed central dogma of molecular biology
    d) In eukaryotes there are 3 different types of RNA polymerase are present
       1) a and b only  2) a, c and d  3) a and d  4) a and c
## SCORING KEY

<table>
<thead>
<tr>
<th>Qn No.</th>
<th>Value Points</th>
<th>Split Score</th>
<th>Total Score</th>
</tr>
</thead>
</table>
| 1.     | Transcription - Translation  
DNA → RNA → Protein  
Reverse transcription | 1/2 x 6 | 3 |
| 2      | a-3, b-5, c-2 , d-1 | 1/2 x 4 | 2 |
| 3      | a -Transcription unit  
b - Structural gene / Template coding strand  
c - From which RNAis formed | 1 x 3 | 3 |
| 4      | a) George Gamow- Genetic code,  
b) Jacob and Monad -Lac operon  
c) Alec Jeffreys- DNA Fingerprinting | 1/2 x 6 | 3 |
| 5      | a . G.F Griffith  
b. Streptococcus and mice  
c. Oswald Avery, Colin Mac Leod, Maclyn Mc Carty | 1 x 3 | 3 |
| 6      | As per Chargaff  
A=T , C=G Then A is 15%, and T is also 15%  
Hence Cis 30%, and G is also 30% i.e 100% | 1x2 | 2 |
| 7      | a and d | 1 | 1 |
| 8      | A- Betagalactosidase, B - Permease | 2 | 2 |
| 9.     | A ) X - Start codon  
Y - Stop codon  
B) X - AUG  
Y - UAA, UGA, UAG | 1/2 x 6 | 3 |
| 10.    | 2 - a,c and d | 1 | 1 |
Introduction

The word evolution means change over a period of time. More precisely it is the orderly change of an entity in the course of time from simple to complex state. Formation of earth and life on earth is considered as an interesting phenomenon. Among the stories of evolution of individual species the evolution of modern man is the most amazing and appears to parallel evolution of human brain and language. The study of evolution provides a focus for investigation into the nature of life itself, the origin of life, the great diversity of living things and the underlying similarities in structure and functions which they have.

A brief outline of main theories concerning origin of life, evidences for these theories and human evolution are discussed in this chapter.

Values and attitudes

After completing this chapter the learner...

- Develops a positive attitude towards unity in diversity by understanding the principles of common ancestry for all present day organisms.
- Appreciates the process of evolution of Modern man
<table>
<thead>
<tr>
<th>Concepts/ Ideas</th>
<th>Process/Activity with assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ORIGIN OF LIFE</strong>&lt;br&gt;- Observing&lt;br&gt;- Identifying&lt;br&gt;- Comparing&lt;br&gt;- Charting&lt;br&gt;- Judging&lt;br&gt;- Inferring&lt;br&gt;- Constructing&lt;br&gt;- Communicating</td>
<td>通用讨论使用动画/图片/幻灯片</td>
<td>- 识别，比较并判断各种关于地球和生命的起源的观点。&lt;br&gt;- 设计和制作化学起源的实验装置。&lt;br&gt;- 分析并验证化学起源是关于生物进化的最有利的观点。</td>
</tr>
<tr>
<td><strong>EVOLUTION OF LIFE FORMS - A THEORY</strong>&lt;br&gt;- Observing&lt;br&gt;- Identifying&lt;br&gt;- Inferring&lt;br&gt;- Comparing&lt;br&gt;- Communicating</td>
<td>小组讨论使用图片/图表</td>
<td>- 分析和验证查尔斯·达尔文和阿尔弗雷德·华莱士关于生物进化形式的理论。</td>
</tr>
<tr>
<td><strong>WHAT ARE THE EVIDENCES FOR EVOLUTION</strong>&lt;br&gt;- Observing&lt;br&gt;- Identifying&lt;br&gt;- Comparing&lt;br&gt;- Analysing&lt;br&gt;- Evaluating&lt;br&gt;- Inferring&lt;br&gt;- Charting&lt;br&gt;- Communicating</td>
<td>小组讨论使用图表/幻灯片/3D模型/图片</td>
<td>- 识别，比较和分析形态学，解剖学和古生物学的证据。&lt;br&gt;- 区分趋同进化和分歧进化。</td>
</tr>
<tr>
<td><strong>WHAT IS ADAPTIVE RADIATION</strong>&lt;br&gt;- Observing&lt;br&gt;- Identifying&lt;br&gt;- Analysing&lt;br&gt;- Comparing&lt;br&gt;- Inferring&lt;br&gt;- Charting&lt;br&gt;- Communicating</td>
<td>通用讨论使用动画/图片</td>
<td>- 识别，比较和分析达尔文金丝雀，澳大利亚袋鼠和其他澳大利亚的哺乳动物的进化。</td>
</tr>
<tr>
<td>Concepts/ Ideas</td>
<td>Process/Activity with assessment</td>
<td>Learning outcome</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| **BIOLOGICAL EVOLUTION**       | - Observing  
- Identifying  
- Comparing  
- Inferring  
- Charting  
- Communicating  
  **Assessment**  
  Prepared table, chart and works in the activity log | - Compares and analyses biological evolution of microbes.  
- Appraises the importance of natural selection in biological evolution |
| **MECHANISM OF EVOLUTION**     | - Observing  
- Identifying  
- Comparing  
- Inferring  
- Communicating  
  **Assessment**  
  Notes in the activity log. | - Analyses different views on the origin of variation and speciation. |
| **HARDY - WEINBERG PRINCIPLE** | - Observing  
- Identifying  
- Comparing  
- Inferring  
- Communicating  
  **Assessment**  
  Prepared table and notes in the activity log  
  **Notes**  | - Analyses and justifies Hardy Weinberg principle.  
- Identifies and compares factors affecting Hardy Weinberg equilibrium. |
| **A BRIEF ACCOUNT OF EVOLUTION** | - Observing  
- Identifying  
- Comparing  
- Inferring  
- Charting  
- Communicating  
  **Assessment**  
  Prepared table, chart and notes in the activity log. | - Identifies evolutionary history of organisms through geological periods.  
- Evaluates the correlation of geological history and biological origin of life. |
| **ORIGIN AND EVOLUTION OF MAN** | - Observing  
- Identifying  
- Comparing  
- Inferring  
- Charting  
- Constructing  
- Communicating  
  **Assessment**  
  Prepared flow chart, table constructed model, picture album and notes in the activity log. | - Identifies stages in the evolution of man.  
- Appraises various components of human evolution. |
Through the Chapter....

Mentor introduces the chapter by showing a video on Big Bang theory of formation of earth.

CONCEPT : Origin of life

Suggested Activities 1 A general discussion is to be conducted on origin of earth and life using slide presentation. After general discussion the learners are asked to prepare an improvised model of Urey-Miller’s apparatus and comparative table of various theories of origin life.

Points to be discussed

• Why origin of earth and origin of life are considered as unique events in the history of universe?
• What are the major theories to explain origin of life?
• What are the findings of Louis Pasteur in the evolution of life on earth?
• What are the conditions of primitive atmosphere?
• Name the scientists who proposed the chemical origin of life and how?
• Who experimentally proved chemical origin of life and how?

Consolidation

• Universe is vast, old, formation of universe (Big Bang), formation of earth, primitive atmosphere, formation of life on earth, earth is formed 4.5 billion years back, life originated 500 million years back.
• Panspermia, spontaneous generation, special creation, chemical evolution etc.
• Louis Pasteur Experimentally proved that life comes only from pre-existing life and disapproved spontaneous generation.
• High temperature, presence of water vapour, methane, carbon dioxide, ammonia, UV rays, reducing atmosphere, volcanic storms etc.
• Oparin and Haldane, chemical evolution, combination of chemicals and formation of diverse organic molecules from inorganic constituents under the energy of high temperature, UV rays, thunder, lightning etc.
• Stanley Miller created similar conditions of primitive atmosphere and electrical discharge in a closed flask with CH4, NH3, H2 and water vapour and observed the formation of sugar, nitrogenous bases, pigments and fats.
Assigned activity
- Prepare a comparative table of various theories of origin of life.
- Prepare an improvised model/chart of Urey Miller experimental set up.

Assessment
- Comparative table, constructed model/chart and notes in activity log

Work sheet
The mentor asks the learners to complete the table on various views on the origin of life on earth

<table>
<thead>
<tr>
<th>Theory of special creation</th>
<th>Theory of Panspermia</th>
<th>Theory of spontaneous generation</th>
<th>Chemical origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>----------------------------</td>
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</tr>
</tbody>
</table>

The Oparin-Haldane Hypothesis
Aleksandr Ivanovich Oparin and John Haldane independently suggested that if the primitive atmosphere was reducing (absence of oxygen), and if there was an appropriate supply of energy (lightning, ultraviolet light etc.), a wide range of organic compounds might be synthesised.

Oparin suggested that the organic compounds have undergone a series of reactions leading to the formation of more and more complex molecules. He proposed that the molecules formed are colloid aggregates, or ‘coacervates’, in an aqueous environment.
- The coacervates were able to absorb and assimilate organic compounds from the environment.
- The coacervates would have taken part in evolutionary processes, eventually leading to the first life forms.

Haldane’s ideas about the origin of life were very similar to Oparin’s. Haldane proposed that the primordial sea served as a vast chemical laboratory powered by solar energy. The atmosphere was oxygen free, and the combination of chemical molecules gave rise to a host of organic compounds. The sea became a ‘hot dilute soup’ containing large populations of organic monomers and polymers. Haldane envisaged that groups of monomers and polymers acquired lipid membranes, and that further developments led to formation of first living cells.
- Haldane coined the term ‘prebiotic soup’, and this became a powerful symbol of the Oparin - Haldane view of the origin of life.
CONCEPT : Evolution of life forms - A theory

Suggested activity : Group discussion using slide presentation, Locating of Galapagos islands and Malayan Archipelago

After a brief introduction mentor groups the learners using appropriate grouping strategies. Each groups are given separate topics regarding the theory of evolution of life forms. Each group presents their views and the same is consolidated by mentor. Mentor asks to prepare a brief history of Charles Darwin and Alfred Wallace and to Galapagos islands and Malayan Archipelago.

Points to be discussed
• What are the major observations/hypothesis/theories/regarding the present day life forms?

Consolidation
• Natural selection theory of Darwin and his voyage in a sail ship HMS Beagle and observation of Alfred Wallace and his works at Malay Archipelago.

Assigned activity
☐ Prepare a brief history of Charles Darwin and Alfred Wallace.
☐ Find the geographical location of Galapagos islands and Malayan Archipelago

Assessment
• Prepared notes and geographical location in the activity log.

Alfred Russel Wallace
Born on January 8, 1823 in Wales, UK. His fields were exploration, evolutionary biology, biogeography and social reforms. He became well known for his co-discovery on natural selection, pioneering works on biogeography (Wallace effect and Wallace line)
• The Wallace Line is a faunal boundary line drawn in 1859 by Alfred Russel Wallace that separates the ecozones of Asia and Wallacea, a transitional zone between Asia and Australia. West of the line are found organisms related to Asiatic species; to the east, a mixture of species of Asian and Australian origin)

CONCEPT : What are the evidences for evolution

Suggested activity : Group discussion, Picture album preparation, Seminar.

After a brief introduction, using chart/slide presentation followed by group discussion. Each groups are given various topics to discuss and their views are presented and consolidation is done by mentor. Preparation of a picture album of palaeontological, anatomical and morphological evidences of evolution, a table of artificially selected animals and plants of human use.
Points to be discussed

- Which are the major evidences of evolution?
- What are homologous and analogous organs? give examples.
- What is convergent evolution?
- What is divergent evolution?
- Why white winged moths dominated black winged before industrialisation and reversed after industrialisation?
- What are the other examples of evolution by anthropogenic action?

Consolidation

- Evidences from Paleoantology, Morphology and Comparative Anatomy.
- Homologous organs - Organs which are anatomically similar and morphologically or functionally dissimilar. Eg. Forelimbs of vertebrates. Analogous organs - Anatomically different and functionally similar organs. Eg. Wings of birds and butterflies
- Convergent evolution - Different structures evolving for the same function.
- Divergent evolution - Same structure evolving for different function.
- Natural selection.
- Resistance of microbes against antibiotics.

Assigned activity

- Prepare a picture album of palaeontological, anatomical and morphological evidences of evolution.
- Prepare a table of artificially selected animals and plants of human use.
- Conduct a seminar on ‘Positive and negative aspects of evolution by anthropogenic action.’
- With the help of the mentor the learners organizes a seminar on the above topic. They presents their views on positive and negative aspects, the moderator consolidates the views.

Assessment

- Collected pictures and data, prepared table, seminar report and notes in the activity log.

CONCEPT : What is adaptive radiation

Suggested activity : General discussion, Table preparation.

General discussion is conducted using animated videos/pictures of Darwin's finches and Australian marsupials. Preparation of chart showing adaptive radiation of Darwin's finches and Australian marsupials.
Points to be discussed
- What is adaptive radiation and what is its significance in evolution?

Consolidation
- Process of evolution of different species in a given geographical area starting from a point and radiating to other geographical areas. It helps in divergent evolution eg. Marsupial radiation, Darwin's finches

Work Sheet
Arrange the given Homologous and Analogous organs into 2 columns
A) Fore limb of man, bat, cheetah and whale
B) Vertebrate heart
C) Vertebrate brain
D) Thorn of bougainvillea and tendril of cucurbita
E) Flippers of penguin and dolphin
F) Sweet potato and potato
G) Wing of bird, bat and butterfly

<table>
<thead>
<tr>
<th>Homologous organs</th>
<th>Analogous organs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Assigned activity
- Prepare chart showing adaptive radiation of Darwin's finches and Australian marsupials.

Assessment
- Prepared chart and notes in the activity log

CONCEPT: Biological evolution

Suggested activity: Group discussion, Chart preparation.

Group discussion is conducted after a brief introduction on Darwin's and Lamarck's theory on evolution with videos/slide presentation. Preparation of comparative table of Darwin's and Lamarck's theory on evolution, Prepartion of chart to show various examples of natural selection.
Points to be discussed

- What Lamarck said on evolution of life forms? Give example.
- What is Darwin’s theory of evolution?
- How does the change in growing medium affect bacterial culture and how is it linked to Darwin’s theory on natural selection?
- What are two key concepts of Darwin’s theory?
- What Thomas Malthus commented on population explosion?
- How does Malthusian theory on population influenced Darwin?

BRANCHING DESCENT

The process by which new species originate from a single common ancestor. A tree of life where two new organisms’ branch out from a single common ancestor, further branching keeps on taking place. When these new organisms formed from a common ancestor, becomes geographically isolated and becomes a lot different from each other and becomes adapted to a particular kind of environment, it results in the formation of a new species.

Consolidation

- Use and disuse of organs leads to evolution. Eg. Neck of giraffe.
- Natural selection.
- Change in medium leads the selection of new population which can survive under new condition - survival of the fittest.
- Branching descent and Natural selection (Stabilizing selection, directional selection and disruptive selection).
- Population increases by geometric proportion while resources increases by arithmetic proportion.
- When resources are scarce and population increases continuously there occurs struggle for existence and survival of the fittest which lead to variation and origin of new species.

Assigned activity

- Prepare a comparative table of Darwin’s and Lamarck’s theory on evolution.
- Preparation of chart to show various examples of natural selection.
**Assessment**
- Prepared table, chart and notes in the activity log.

**CONCEPT: Mechanism of evolution**

**Suggested activity:** General discussion using slide presentation.

**Points to be discussed**
- What is the basic mechanism underlying evolution?
- What are the opinions of Hugo deVries and Darwin on speciation (evolution)?
- How mutation differs from Darwinian variation?
- What is saltation?
- What is founder effect?

**Consolidation**
- Variation
- According to De Vries a new species is caused by mutation (sudden and drastic changes), in a single step; but according to Darwin speciation is a slow process and it results from the gradual accumulation of large number of small variations.
- Mutations are sudden, random and directionless whereas Darwinian variations are small and directional.
- Saltation – Single step large mutation

**Assigned activity**
- Prepare a brief account of mutation experiments of Hugo de Vries.

**Assessment**
- Prepared notes in the activity log.

**CONCEPT: Hardy-Weinberg Principle**

**Suggested activity:** General discussion using slide/chart. Preparation of table showing various factors affecting Hardy-Wienberg principle.

**Points to be discussed**
- What is Hardy-Wienberg principle?
- Write the Evolutionary significance of this principle?
- Which are the factors affecting Hardy-Wienberg principle?

**Consolidation**
- Allele frequencies in a population are stable and constant from generation to generation if it is not influenced by factors ($p^2 + 2pq + q^2 = 1$).
• Change of frequency of an allele in a population results in evolution (Disturbances in Hardy-Weingberg equilibrium).
• Migration (Gene flow), Mutation, Genetic recombination, Natural selection and genetic drift

**Work sheet**

**Describe the following branching representation**

![Diagram showing the branching representation of evolution](image)

**Genetic drift**

Genetic drift (or allelic drift) is the change in the frequency of a gene variant (allele) in a population due to random or chance events. Genetic drift may cause gene variants to disappear completely and thereby reduce genetic variation. The smaller the population, the greater will be the impact of genetic drift. This is because there are fewer individuals and the gene pool is smaller.
Bottleneck Effect

A population bottleneck (or genetic bottleneck) is a sharp reduction in the size of a population (as a result of death) due to environmental events (such as earthquakes, floods, fires, disease, or droughts) or human activities (such as genocide). When the size of the population is reduced so quickly, many alleles are lost and the genetic diversity of the population decreases drastically. The bottleneck is completely independent of selection. After the catastrophe, the smaller population (of animals/people) with a correspondingly smaller genetic diversity remains to pass on genes to future generations of offspring through sexual reproduction.

Assigned activity

- Prepare a table showing various factors affecting Hardy - Winberg principle and their features.

Assessment

- Prepared table and notes in the activity log.

CONCEPT: Brief account of evolution

Suggested activity: General discussion with videos/pictures/slides of geological time scale of plants and animals. Preparation of chart to show dominating animals of each period of geological time scale.

Points to be discussed

- What are the stages in the evolutionary history of Earth? Name the animals predominant in each stage?

Consolidation

- Paleozoic era (Silurian, Devonian, Carboniferous, Permian periods), Mesozoic (Triassic, Jurassic, Cretaceous periods), Cenozoic (Tertiary, Quaternary periods). About 500 million years ago invertebrate were formed and active jaw less fishes evolved around 350 million years ago.

Mentor asks the students to observe figures 7.9 and 7.10 and to prepare a table showing various stages of earth's history and animals dominant during each stage.
**CONCEPT : Origin and evolution of man**

*Suggested activity :* A general discussion is conducted with the help of chart/videos and slides of human evolution.

**Points to be discussed**
- What are the evolutionary stages of man?

**Consolidation**
- Dryopithecus (more ape like) - Ramapithecus (more man like), Australopithecines, Homo habilis (brain size: 650-800cc), Homo erectus (brain size: 900cc), Neanderthal man, (brain size: 1400cc), Homo sapiens (During ice age between 75000-10000 years).

**Assigned activity**
- Prepare a flow chart of human evolution.
- Prepare a table to show the components/features of human evolution.
- Prepare a picture album of evolution of man.

**Assessment**
- Prepared flow chart, table, notes, completed puzzle in the activity log.

---

**Assigned activity**
- Draw chart to show dominating animals of each period of geological time scale.

**Assessment**
- Prepared chart, completed table and works notes in the activity log.

---

<table>
<thead>
<tr>
<th>Eras</th>
<th>Periods</th>
<th>Dominant plants</th>
<th>Dominant animals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
Observe the puzzle carefully, find out the stages of human evolution and arrange them in the sequential order of evolution to man

B C V E V Y S F R A E V Y S A G I H
C D A H O M O H A B I L I S P H K O
M B V A S D H Y M G E G R E H K Y M
N Z T U I L P J A T A S D H R L H D
A U S T R A L O P I T H E C I N E S
M B V A S D H Y I V G R H K Q J A
A H D R Y T I K T U T R E B V J I P
V D R Y O P I T H E C U S A O P K I
T M C F S V H G E F E F R E R T H L E
S O Q D E G T B C T A V B N G R I N
H W M X E E C A U S S Q E R T G M S
D A W R E Q F T S W S S S S S S S S S
D B Q E R T Y U D V G H J K L U N V
A I X G T R H M H K H H P K Q R H E
A L N E A N D E R T H A L M A N S D
A I G B N E N T J T G K T Q S T D G C
H O M O E R E C T U S O J L A D G F

■ Process Assessment
- Participation in discussion on origin of life, adaptive radiation, mechanism of evolution, Hardy Weinberg principle, Human evolution
- Group discussion on theories and evidences of evolution and biological evolution.
- Construction of improvised model.
- Seminar on evidences of evolution.
- Table preparation, chart and flow chart, picture album and collection of data on evidences of evolution.

■ Portfolio Assessment
- Report of group discussion
- Charts
- Prepared tables
- Activity log
- Seminar report
- Prepared album

■ Unit Assessment
- Puzzle
- Unit test
- Quiz
- Open book assessment
Questions

1. Diagramatic representation of an experiment in evolution is given

[Diagram of experiment]

A) Name the experiment?
B) For what purpose the experiment was conducted?

2. Match the following

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Evolution by anthropogenic action</td>
<td>a Speciation</td>
</tr>
<tr>
<td>2 Aaptive radiation</td>
<td>b Darwin Finches</td>
</tr>
<tr>
<td>3 Convergent Evolution</td>
<td>c Resistance against antibiotics</td>
</tr>
<tr>
<td>4 Saltation</td>
<td>d Analogous organs</td>
</tr>
</tbody>
</table>

3. Write any two vertebrate body parts that are homologous to human forelimbs.

4. Name the type of natural selection operated in the following
   A) More individuals acquire mean character value.
   B) More individuals acquire value other than mean character value.
   C) More individuals peripheral character value at both ends of the distribution curve.
5. Select the wrong statement from the following.
   A) Homo sapiens evolved during the ice age between 75000 - 10000 years ago
   B) Homo erectus evolved about 1.5 mya (Million years ago)
   C) Dryopithicus evolved about 3-4 mya
   D) Australopithicines was evolved about 10 mya

6. Names of geological periods are given in disorder, arrange them in chronological order from ancient to modern.
   (Tertiary, Jurassic, Permian, Cretaceous, Triassic, Carboniferous)
   ......................... and natural selection are the key concepts of Darwinian theory

8. Match the correct brain capacities given in column B with the primates given in column A

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Homo erectus</td>
<td>i) 650 - 800 cc</td>
</tr>
<tr>
<td>b) Neanderthal man</td>
<td>ii) 900 cc</td>
</tr>
<tr>
<td>c) Homo habilis</td>
<td>iii) 1400 cc</td>
</tr>
<tr>
<td>d) Australopithecus</td>
<td>iv) 600 cc</td>
</tr>
</tbody>
</table>

9. Give the composition of gases in the Millers experiment. In what form had Miller supplied energy in the experiment?

10. a) How did Hardy-Weinberg explained that alleleic frequencies in a population stable and constant from generation to generation?

Open Book Assessment

1. Why homology and analogy are considered as the basis of divergent and convergent evolution respectively?
2. How does the geographical history of earth correlates with the evolutionary history of life?
## SCORING KEY

<table>
<thead>
<tr>
<th>Qn. No.</th>
<th>Value Points</th>
<th>Split score</th>
<th>Total score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A) Miller`s experiment</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>B) In order to prove chemical evolution</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1 - c, 2 - b, 3 - d, 4 - a</td>
<td>1/2 x 4</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Fore limbs of cheetah, Wings of bat</td>
<td>1 x 2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>A. Stabilizing natural selection</td>
<td>1 x 3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>B. Directional natural selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. Disruptive natural selection</td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>D</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Carboniferous - Permian - Triassic - Jurassic - Cretaceous - Tertiary</td>
<td>1/2 x 6</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Branching descent</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>a - II, b - III, c - I, d - IV</td>
<td>1/2 x 4</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>CH&lt;sub&gt;4&lt;/sub&gt;, NH&lt;sub&gt;3&lt;/sub&gt;, H&lt;sub&gt;2&lt;/sub&gt;O and H&lt;sub&gt;2&lt;/sub&gt;</td>
<td>1/2 x 4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Spark discharge</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>p&lt;sup&gt;2&lt;/sup&gt; + 2 pq + q&lt;sup&gt;2&lt;/sup&gt; = 1</td>
<td>1/2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Gene flow, Genetic drift, Mutation, Genetic recombination and Natural selection</td>
<td>1/2 x 5</td>
<td></td>
</tr>
</tbody>
</table>
Introduction

Health is considered as a steady state of body and mind. Biology states that mind influences the health through neural system, endocrine system and immune system. Thus mind and mental state can affect our health. HEALTH could be defined as a state of complete physical, mental and social wellbeing. Balanced diet, personal hygiene and regular exercise are very important to maintain good health. When the functioning of one or more organs or systems of the body is adversely affected, characterised by various signs and symptoms, we will become unhealthy and become diseased. Drug and alcohol abuse also affect health.

This chapter deals with details of human health, various diseases and other factors which affect human health.

Values and attitudes

After completing this chapter the learner...

- Develops a positive attitude in keeping a healthy lifestyle.
- Develops a positive attitude to say no to drugs, tobacco and alcohol.
<table>
<thead>
<tr>
<th>Concepts/ Ideas</th>
<th>Process/Activity with assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td>General discussion after a brief introduction using Chart/ followed by group discussion.</td>
<td>- Identifies the importance of keeping healthy life style.</td>
</tr>
<tr>
<td>Health</td>
<td>General discussion using Chart/ Videos/Slides, Interview with a medical practitioner.</td>
<td>- Differentiates various types of diseases and their pathogens. - Judges and concludes the mode of transmission of various diseases. - Recommends the preventive measures of various diseases.</td>
</tr>
<tr>
<td>Immunity</td>
<td>General discussion using Charts/slides/Videos followed by group discussion.</td>
<td>- Differentiates various types of immunity. - Judges and concludes the importance of vaccination and immunisation. - Explains different allergens. - Recommends various measures to overcome allergies.</td>
</tr>
<tr>
<td>Concepts/ Ideas</td>
<td>Process/Activity with assessment</td>
<td>Learning outcome</td>
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<tr>
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<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| **AIDS**                       | Г General discussion after a brief introduction using Chart/ Videos/ Slides followed by group discussion. Picture completion  
**Assessment**        | Completed work sheet and notes in activity log. |
| - Observing                    |                                                                                                                                                                                                                                 | - Identifies and explains the causes and control measures of AIDS.                                                                                                                                               |
| - Identifying                  |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Comparing                    |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Inferring                    |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Charting                     |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Constructing                 |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Communicating                |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| **Cancer**                     | Г General discussion using Charts, slides, Videos.  
**Assessment**        | Picture album, prepared table and notes in activity log. |
| - Observing                    |                                                                                                                                                                                                                                 | - Identifies and explains the causes and symptoms of cancer.                                                                                                                                                   |
| - Identifying                  |                                                                                                                                                                                                                                 | - Recommends the various diagnostic techniques and treatment of Cancer.                                                                                                                                          |
| - Comparing                    |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Inferring                    |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Charting                     |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Communicating                |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| **Drugs and Alcohol Abuse**    | Г General discussion after a brief introduction using Chart/slides, Videos etc.  
**Assessment**        | Charts, tables and notes in activity log. |
| - Adolescence and drug/alcohol abuse |                                                                                                                                                                                                                                 | - Categorizes and compares useful and abusable drugs.                                                                                                                                                           |
| - Addiction and dependence     |                                                                                                                                                                                                                                 | - Identifies and Judges the negative effects of alcohol, tobacco and drugs.                                                                                                                                      |
| - Effect of drug/alcohol abuse |                                                                                                                                                                                                                                 | - Decides to say no to drugs, tobacco and alcohol.                                                                                                                                                              |
| - Prevention and control       |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Observing                    |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Identifying                  |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Comparing                    |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Charting                     |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Inferring                    |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
| - Communicating                |                                                                                                                                                                                                                                 |                                                                                                                                                                                                             |
Through the Chapter....

The mentor introduces the chapter using a video clipping regarding health and hygiene.

CONCEPT : Health

Suggested Activities 1 General discussion followed by group discussion each group is asked to discuss various aspects of health and factors affecting health. Each group presents their views and the mentor consolidates. Preparation of table showing factors which affect health.

Points to be discussed

• What is health and what are the factors which affect health?
• Mention the factors which are helpful in maintaining good health?
• Mention the types of diseases?

Consolidation

• Health- state of complete physical, mental and social well-being. Genetic disorders, infections and lifestyle.
• Balanced diet, personal hygiene, regular exercise, awareness about diseases, vaccination, proper disposal of waste, control of vectors, maintenance of hygienic food and water resource.
• Infectious and non-infectious disease.

Assigned activity

☐ Table showing factors which affect health.

Assessment

• Table and notes in activity log.

CONCEPT : Common diseases in Humans


Points to be discussed

• Which are the common diseases in Humans and what are its causative organisms?
• How various diseases can be identified using their symptoms?
• How can the common diseases be prevented?
Most common anti malarial drugs
Chloroquine (Aralen), Quinine sulfate (Qualaquin)
Hydroxychloroquine (Plaquenil), Mefloquine etc.

Consolidation
- Mentor asks the learners to complete the worksheet.

<table>
<thead>
<tr>
<th>Type of pathogen</th>
<th>Disease</th>
<th>Causative organism</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Common cold</td>
<td>Rhino virus</td>
</tr>
<tr>
<td></td>
<td>Typhoid</td>
<td>?</td>
</tr>
<tr>
<td>Bacteria</td>
<td></td>
<td>?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strepococcus pneumoniae, Haemophilus influenzae</td>
</tr>
<tr>
<td>Protozoans</td>
<td>Amoebiasis</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Ring worm disease</td>
<td>Epidermophyton, Trichophyton, Microsporum</td>
</tr>
<tr>
<td></td>
<td>Ascariasis</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Filariasis (Elephantiasis)</td>
<td>Wuchereria bancroftii, W.malayi</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disease</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common cold</td>
<td>Nasal congestion and discharge etc.</td>
</tr>
<tr>
<td>Typhoid</td>
<td>Sustained high fever (39-40°C), weakness, headache etc.</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Fever, chills, cough, lips and nails turns grey to blue etc.</td>
</tr>
<tr>
<td>Amoebiasis</td>
<td>Constipation, abdominal pain, stools with blood and mucus etc.</td>
</tr>
<tr>
<td>Ring worm disease</td>
<td>Dry scaly skin, nails and scalp etc.</td>
</tr>
<tr>
<td>Ascariasis</td>
<td>Internal bleeding, muscular pain, blockage of intestinal passage etc.</td>
</tr>
<tr>
<td>Filariasis (Elephantiasis)</td>
<td>Chronic inflammation to organs resulting in deformity etc.</td>
</tr>
</tbody>
</table>
• Keeping personal and public hygiene, close contact with infected person or their belongings should be avoided. Control or elimination of insect vectors and their breeding places. Use of mosquito nets, larvicidal fishes like Gambusia, spraying of insecticides.

**Assigned activity**

- Prepare a table showing common human disease and symptoms.
- Complete the the blank spaces A, B and C. By observing the given diagram prepare a flow chart showing life cycle of plasmodium.

**Assessment**

- Prepared table, flow chart and works in the activity log

**Extension activity**

- With the help of a voluntary organisation (like NSS, Red cross etc) conduct a seminar in the school about common human diseases and its prevention.
- Organise an awareness programme on common infectious diseases.

**Practical Evaluation**

Identify the pathogen and write the symptoms of following diseases by using permanent slides/pictures

1) Malaria 2) Ascariasis 3) Ring worm disease 4) Amoebiasis
Type of Plasmodium species

• **P. falciparum**, is found in tropical and subtropical areas. Causes severe malaria. Infected parasites can clog small blood vessels. When it occurs in the brain, cerebral malaria results, a complication that can be fatal.

• **P. vivax** is found mostly in Asia, Latin America, and in some parts of Africa. **P. vivax** has dormant liver stages ("hypnozoites") that can activate and invade the blood ("relapse") several months or years after the infecting mosquito bite.

• **P. ovale** is found mostly in Africa (especially West Africa) and the islands of the western Pacific. Can infect individuals who are negative for the Duffy blood group (due to presence of Duffy antigen/chemokine receptor (DARC) also known as Fy glycoproteins)

• **P. malariae**, found worldwide, is the only human malaria parasite species that has a quartan cycle (72 hours). (Other species have a tertian, 48 hours.) If untreated, **P. malariae** causes a long-lasting, chronic infection that in some cases can last a lifetime. **P. malariae** can cause serious complications such as the nephrotic syndrome in some cases.

• **P. knowlesi** is found throughout Southeast Asia as a natural pathogen of long-tailed and pig-tailed macaques. It has recently been shown to be a significant cause of zoonotic malaria in that region.

**CONCEPT:** Immunity

**Suggested activity:** Group discussion is conducted after a brief introduction using slides/charts.

Data collection on autoimmune disorders. Table preparation of a table of Primary and Secondary lymphoid organs.

**Points to be discussed**

• What are the types of immunity and differentiate them?
• What are the barriers which help in innate immunity? Site examples
• Which are the two responses in acquired immunity?
• Why mothers milk is very essential for the infants?
• How vaccines help in developing immunity in human?
• How allergy is caused?
• How the symptoms of allergy is reduced?
• What is autoimmunity and auto-immune diseases?
• Which are the primary and secondary lymphoid organs in man?
• Expand MALT?
Consolidation

- Innate immunity and Acquired immunity.
  
  Innate immunity - present at the time of birth.
  Acquired immunity - Acquired after birth
  
  Active immunity - immunity produced by antibodies of host
  Passive immunity - immunity produced from ready made antibodies

- Physical barriers - skin and mucus membrane, Physiological barriers - acid in stomach saliva in mouth, Cellular barriers - WBC, Cytokine barriers - interferons.

- Humoral immunity and Cell mediated immunity.

- Mothers milk is abundant in antibody A or IgA.

- Vaccines act as antigens which causes production of antibodies that neutralize the pathogenic agents, generate memmory B and T cells.

- The exagerated response of immune system to certain antigens causes allergy.

- Using drugs like anti-histamine, adrenaline and steroids.

- Ability to differentiate foreign organisms from self cells, sometimes due to genetic or some other unknown reasons body attack self cells.

- Primary lymphoid organs - Bone marrow and Thymus, Secondary lymphoid organs - spleen, lymph nodes, tonsils, Peyer’s patches of small intestine.

- Mucosal Associated Lymphoid Tissues.

---

**Complete the worksheet**

<table>
<thead>
<tr>
<th>Eg. Interferons</th>
<th>Physical barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(D)</td>
<td>(A)</td>
</tr>
</tbody>
</table>

**INNATE IMMUNITY**

- Cellular barriers

- HCL in stomach

---

( A )

( B )

( C )

( D )
Assigned activity

- Collect the details of autoimmune disorders.
- Prepare a table of Primary and Secondary lymphoid organs.

Assessment

- Prepared chart, completed worksheet, table of lymphoid organs and details of auto immune disorders in activity log.

Extension activity

- Prepare an immunisation chart.

<table>
<thead>
<tr>
<th>Classes of Immunoglobulins</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class</strong></td>
</tr>
</tbody>
</table>
| IgA | Dimeric and Monomeric | Alpha heavy chains | - Found in gastro-intestinal, respiratory and urinogenital tract mucosal, saliva, tears and milk  
- Prevents colonization by pathogen. |
| IgD | Monomeric | Delta heavy chains | - Membrane immunoglobulin.  
- Part of the membrane receptor of native B lymphocytes. |
| IgE | Monomeric | Gamma heavy chains | - Involved in allergic and parasitic process.  
- Interaction with basophil and mast cells cause histamin release. |
| IgG | Monomeric | Epsilon heavy chains | - Main immunoglobulin of acquired immunity and has the capacity to cross placental barrier. |
| IgM | Monomeric Pentameric | Mu heavy chains | - Part of the membrane receptor of naive B lymphocytes.  
- Form found in the serum, secreted early in acquired immune response |

Mucosa Associated Lymphoid Tissue

The mucosa associated lymphoid tissue (MALT) is a lymphoid tissue found in the gastrointestinal tract, thyroid, breast, lung, salivary glands, eye, and skin. MALT is populated by T cells, B cells, plasma cells and macrophages.

The components of MALT are

1. GALT (gut associated lymphoid tissue),
2. BALT (bronchus associated lymphoid tissue),
3. NALT (nasal associated lymphoid tissue),
4. CALT (conjunctival associated lymphoid tissue),
5. OMALT (organized mucosa associated lymphatic tissue),
6. LALT (larynx associated lymphoid tissue),
7. SALT (skin associated lymphoid tissue).
CONCEPT: AIDS

Suggested activity: General discussion using slides and video presentation.

Points to be discussed

- What is the expansion of AIDS?
- When was AIDS first reported?
- How AIDS is transmitted?
- What are the control measures to prevent AIDS?
- How retrovirus replicates?

Consolidation

- Acquired Immuno Deficiency Syndrome.
- In 1981.
- Through sexual contact with infected person, through contaminated blood and blood products, by sharing infected needles, from infected mother to foetus through placenta.
- Avoid sexual relation with multiple and unknown partners, making blood safe from HIV, use disposable needles and syringes, control drug abuse, use condoms.....
- The mentor ask the learners to complete the picture using the text.

![Retrovirus Replication Diagram]

Work Sheet - Replication of Retrovirus

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Virus can infect other cells</td>
<td>Acquired Immuno Deficiency Syndrome.</td>
<td>In 1981.</td>
<td>Through sexual contact with infected person, through contaminated blood and blood products, by sharing infected needles, from infected mother to foetus through placenta.</td>
<td>Avoid sexual relation with multiple and unknown partners, making blood safe from HIV, use disposable needles and syringes, control drug abuse, use condoms.</td>
</tr>
</tbody>
</table>
Assigned activity
   □ Completion of work sheet

Assessment
   • Completed worksheet and notes in the activity log

Extension activity
   □ AIDS awareness campaign on December 1

CONCEPT: Cancer

Suggested activity: The Mentor conducts a general discussion after a video presentation on Cancer

Preparation of photo album and table of types of Cancer.

Points to be discussed
   • Which are the 2 types of tumours?
   • What are the causes of cancer?
   • How cancer can be detected?
   • What are the treatments for cancer?

Consolidation
   • Benign and Malignant tumour.
   • Carcinogens - physical and chemical, Oncoviruses, X rays, Gama rays.
   • Biopsy and histopathological studies of tissue, blood and bone marrow. Technique like X ray, CT and MRI scanning.
   • Surgery, Radiation therapy, Immunotherapy (Interferon), Chemotherapy.

Interferons
   • Interferons were discovered by British bacteriologist Alick Isaacs and Swiss microbiologist Jean Lindermann.
   • They are proteins produced by the body’s cells as a defensive response to viruses. It was named for its ability to interfere with viral proliferation, combat bacterial and parasitic infections, inhibit cell division, and promote or impede the differentiation of cells.
   • Interferons are categorized as cytokines, small proteins that are involved in intercellular signaling.
   • It stimulates the infected cells and those nearby to produce proteins that prevent the virus from replicating within them.
Assigned activity
- Preparation of photo album on various types of Cancer.
- Preparation of a table showing different types of Cancer.

Assessment
- Prepared album, table, notes in the activity log.

Extension activity
- With the help of Oncology department of a hospital organise an awareness programme and medical camp to detect cancer.

CONCEPT: Drug and alcohol abuse


Points to be discussed
- Which are the commonly abused drugs?
- What are opioids?
- What are cannabinoids?
- What are cocains?
- How drug and alcohol abuse happens in adolescence?
- What is addiction and dependence?
- What are the effects of drug/alcohol abuse?
- List out the prevention and control of alcohol and drug abuse?

Consolidation
- Opioids, cannabinoids and Cocca alkaloids
- Opioids binds to specific receptors of CNS and Gastrointestinal tract eg. Heroin
- Cannabinoids - interact with cannabinoid receptors present in brain. Eg. marijuana, hashish, Ganja, Charas.
- Cocains - chemicals interfere with the transport of neurotransmitter like dopamine.
- Due to curiosity, need for adventure, excitement and experimentation.
- Addiction - psychological attachment to certain effects such as Euphoria and temporary feeling of well being due to drugs and alcohol, Dependence - tendency of body to manifest and unpleasant
withdrawal syndrome if regular dose of drugs/ alcohol is abruptly discontinued which is characterized by anxiety, shakiness, nausea and sweating.

- Physical effect, Psychological effect, Physiological effect, social effect and ethical effect
- Avoid undue peer pressure, Education and counselling, Seeking help from parents and peers, Looking for danger signs and Seeking professional and medical help.

**Complete the table**

<table>
<thead>
<tr>
<th>Group of drugs</th>
<th>Source plant</th>
<th>Effect on human body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opioids</td>
<td>?</td>
<td>On CNS and gastrointestinal tract, act as depressant</td>
</tr>
<tr>
<td>?</td>
<td>Cannabis sativa</td>
<td>?</td>
</tr>
<tr>
<td>?</td>
<td>Erythroxylum cocca</td>
<td>?</td>
</tr>
</tbody>
</table>

**Assigned activity**
- Preparation of charts and table.

**Assessment**
- Prepared charts, tables and works in the activity log

**Extension activity**
- Awareness programme on drug and alcohol abuse with the help of Excise department
- Organise an anti-drug campaign in school.

- OTHER DRUGS OF ABUSE: Medically used drugs that do not fall into any of the above categories. Muscle relaxants, Painkillers, Anti-histamines, prescribed for allergies Anti-emetics, Anti-depressants / anti-psychotics etc.
- VOLATILE SOLVENTS: volatile hydrocarbons, Petroleum derivatives
## Types of Drugs and its effects

<table>
<thead>
<tr>
<th>Type of drugs</th>
<th>Shot term effects</th>
<th>Long term effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NARCOTIC ANALGESICS</strong></td>
<td>Pain relievers</td>
<td></td>
</tr>
<tr>
<td>Opium – Morphine, Codeine, Heroin (brown sugar), Buprenorphine, Methadone, Pentazocine</td>
<td>Euphoria, thought process impairment, drowsiness, lack of hunger, pain not felt, overdose of heroin can cause convulsions, coma and death.</td>
<td>Mood instability, Reduced libido, Constipation and respiratory impairments</td>
</tr>
<tr>
<td><strong>STIMULANTS</strong></td>
<td>Excite or speed up the central nervous system</td>
<td></td>
</tr>
<tr>
<td>Amphetamines – oral Cocaine – snorted</td>
<td>Heightened feeling of well being, sense of super-abundant energy, increased motor and speech activity, suppression of appetite, increased wakefulness etc.</td>
<td>Chronic sleep problem, poor appetite, rapid and irregular heart beat, mood swings, 'Amphetamine psychosis'</td>
</tr>
<tr>
<td><strong>HALUCINOGENS</strong></td>
<td>Affect perception, emotions and mental processes, LSD -Lysergic acid diethylamide (oral tablets) PCP -Phencyclidine (snorted/smoked), Mescaline (oral tablets), Psilocybin (smoked)</td>
<td></td>
</tr>
<tr>
<td>Alterations of mood, distortion of the sense of direction, distance and time, Pseudo' hallucinations. Synesthesia – melding of two sensory modalities and feelings of depersonalization</td>
<td>A motivational syndrome, LSD precipitated psychosis etc.</td>
<td></td>
</tr>
<tr>
<td><strong>CANNABIS</strong></td>
<td>Ganja / Marijuana Hashish / Charas Hashish oil Bhang</td>
<td>Mild euphoria, lowering of inhibitions, reddening of eyes, sense of smell, touch and taste are often enhanced. Altered sense of time perception, impaired short-term memory etc.</td>
</tr>
<tr>
<td><strong>DEPRESSANTS</strong></td>
<td>Slow down the functions of the central nervous system Barbiturates, Benzodiazepines.</td>
<td>Relief from anxiety and tension, Euphoria, lowering of inhibitions, poor motor coordination, impaired concentration and judgement, Slurred speech and blurred vision. Sedation, sleep with larger doses etc.</td>
</tr>
</tbody>
</table>
## Assessment Questions

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Statement</th>
<th>Yes</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>HIV is a retrovirus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Interferons are example for cytokine barriers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Innate immunity is acquired after birth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Cancer is transmitted through mosquites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>PMNL is a type of cellular barrier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>In AIDS HIV kills helper T cells or $T_H$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Cannabinoids are drugs obtained from the plant <em>Cannabis sativa</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>B Lymphocytes provide humoral mediated immunity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>In malignant tumour metastasis is absent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Ascariasis is caused by helminth pathogen</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Process Assessment
- General discussion on health, human diseases, immunity, AIDS, Cancer, Drug/alcohol abuse
- Group discussion on health, immunity, AIDS
- Interview with medical practitioner
- Preparation of album showing different pathogens and Cancer
- Chart preparation of Health, diseases, immunity, cancer, drug and alcohol abuse.
- Table preparation on health, human diseases, immunity, cancer, drug and alcohol abuse.
- Works in activity log

Portfolio Assessment
- Report of group discussion
- Charts
- Prepared tables
- Activity log
- Questionnaire
- Prepared album

Unit Assessment
- Unit test
- Quiz programme
- Oral test
- Check list
Questions

1. Complete the table

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Disease</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhinovirus</td>
<td>(A)</td>
<td>(B)</td>
</tr>
<tr>
<td>(C)</td>
<td>Malaria</td>
<td>Chill and High fever</td>
</tr>
<tr>
<td>W. bancroftii</td>
<td>(D)</td>
<td>Chronic inflammation to organs especially in Limbs</td>
</tr>
<tr>
<td>(E)</td>
<td>Typhoid</td>
<td>(F)</td>
</tr>
</tbody>
</table>

2. Complete the concept map

Eg. Interferons \[\text{(D)}\] Physical barriers \[\text{(A)}\]

\[\text{INNATE IMMUNITY}\]

Cellular barriers \[\text{(C)}\] HCL in stomach \[\text{(B)}\]

3. Categorize the following organs which plays important role in immune system into two with appropriate heading. (Spleen, Bone marrow, Lymph nodes, Thymus)
4. Complete the picture.

5. Match column A with B and C

<table>
<thead>
<tr>
<th>A - Group of drugs</th>
<th>B - Source plant</th>
<th>C - Effect on human body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opioids</td>
<td>Erythroxulum cocca</td>
<td>Principally in brain, act as hallucinogen</td>
</tr>
<tr>
<td>Cannabinoids</td>
<td>Papaver somniferum</td>
<td>On CNS and gastrointestinal tract, act as depressant</td>
</tr>
<tr>
<td>Cocaine</td>
<td>Cannabis sativa</td>
<td>Interferes the transport of neurotransmitters, produces euphoria</td>
</tr>
</tbody>
</table>

6. Write any four ways for prevention or control of alcohol or drug abuse.

7. Following are the symptoms of common human diseases. Read carefully and identify disease and its pathogen

a) alveoli get filled with fluid, which leads to fever, chills, cough and head ache. In severe cases lips and fingertips becomes greyish - blue colour
b) sustained fever (39 - 400 C, weakness, stomach pain, constipation, headache and loss of appetite.

c) Internal bleeding, muscular pain, fever, blockage of intestinal passage.

8. Observe the given diagram.

![Diagram of Antigen Binding Sites]

a) Identify the diagram.

b) In acquired immunity, primary and secondary immune response mainly in the form of

1. humoral / antibody mediated Immune response

2. .................................................................

9. Identify the peculiarity of the following disease

a) Rheumatoid arthritis

b) Asthma

10. select the correct statement

a) Malignant malaria is caused by Plasmodium falciparum, which is fatal,

b) Malignant malaria is caused by Plasmodium malariae which is fatal

c) Malignant malaria is caused by all three species of plasmodium, which is not fatal

d) Malignant malariae is caused by P. vivax and P. malariae, it is not fatal
### SCORING KEY

<table>
<thead>
<tr>
<th>Qn No.</th>
<th>Value points</th>
<th>Split score</th>
<th>Total score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>A - common cold, B - Congestion in nasal canal/running nose, C - Plasmodium vivax, D - Filariasis, E Salmonella typhii, F - Sustained fever</td>
<td>1/2 x 6</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>A) Mucus coating/skin, B - Physiological barrier, C - PMNL/Monocyte, D - Cytokine barriers</td>
<td>1/2 x 4</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>Primary lymphoid organs - Bone marrow, Thymus Secondary lymphoid organs - Spleen, lymph node</td>
<td>1/2 x 6</td>
<td>3</td>
</tr>
</tbody>
</table>
| 4.     | a) Viral RNA introduces to host cell  
b) New viruses are produced                                                                                                                                                                                                  | 1 x 2       | 2           |
| 5.     | B - Source plant  
C - Effect on human body  
Papaver somniferum - On CNS and gastrointestinal tract, act as depressant  
Cannabis sativa - Interacts with receptors present principally in brain.  
Erythroxylum coca - Interfers the transport of neurotransmitters, produces euphoria                                                                                                                   | 1/2 x 6     | 3           |
| 6.     | 1) Avoid undue peer pressure, 2 - Looking for danger signs, 3 - Education and counselling, 4 - Seeking help from parents and peers                                                                                                                                           | 1/2 x 4     | 2           |
| 7.     | a) Pneumonia / Streptococcus pneumoniae,  
b) Typhoid/ salmonella typhii,  c) - Ascariasis/ Ascaris lumbricoides                                                                                                                                                 | 1/2 x 6     | 3           |
| 8.     | a) Antibody  
A) Cell mediated immunity                                                                                                                                                                                                                                           | 1 x 2       | 2           |
| 9.     | a) Auto immune Disease  
b) Allergic Disease                                                                                                                                                                                                                             | 1 x 2       | 2           |
| 10.    | a) Malignant malaria is caused by P. falciparum, which is fatal                                                                                                                                                                                                          | 1           | 1           |
**Introduction**

Microbes are small organisms which are invisible to naked eye because they have a size of 0.1 mm or less but most of them can be grown on nutritive media where they form colonies and are visible to naked eyes. They consist of a diverse group of organisms bacteria, fungi, protozoa, microscopic plants. They are present everywhere, in soil, in water, air, inside and outside body of animals and plants, in snow in thermal vents etc. while microbes are casual agents of most infectious diseases. They have also been used by man and nature in many important processes in home, in industries, agriculture and sewage treatment.

This chapter deals with uses of microbes in production of household products, Antibiotics, sewage treatment, Biogas production and importance of microbes as biopesticides and biofertilizer.

**Values and attitudes**

After completing this chapter the learner...

- Appraises the significant role played by microbes in the day to day life of human beings.
<table>
<thead>
<tr>
<th>Concepts/Ideas</th>
<th>Process/Activity with assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
</table>
| **Microbes in Household products**  
- Observing  
- Identifying  
- Comparing  
- Inferring  
- Charting  
- Communicating | **General discussion after a brief introduction using Chart/ followed by group discussion.**  
**Assessment**  
Prepared charts and works in activity log. | - Identifies and describes the importance of various microbes in household products such as curd, cheese, toddy etc. |
| **Microbes in industrial products**  
- Fermented Beverages  
- Antibiotics, Chemicals,  
- Enzymes and Other Bioactive molecules  
- Observing  
- Identifying  
- Comparing  
- Charting  
- Inferring  
- Communicating | **General discussion using Chart/Videos/slides.**  
**Assessment**  
Prepared charts, comparative table and works in activity log. | - Identifies and explains the importance of various microbes in industrial products.  
- Appraises the role of microbes in production of antibiotics and bioactive molecules. |
| **Microbes in sewage treatment**  
- Observing  
- Identifying  
- Comparing  
- Inferring  
- Charting  
- Constructing  
- Communicating | **General discussion using Chart/slides/Video clipings.**  
**A field visit to a water/sewage treatment plant.**  
**Assessment**  
Prepared charts, constructed models and notes in activity log.  
Report of field visit. | - Explains and appraises the importance of microbes in sewage treatment and waste water management.  
- Constructs an improvised model of sewage treatment plant. |
| **Microbes in production of biogas**  
- Observing  
- Identifying  
- Comparing  
- Inferring  
- Charting  
- Constructing  
- Communicating | **General discussion after a brief introduction using Chart/videos/3D models/slide followed by group discussion.**  
**Field visit to a biogas plant.**  
**Assessment**  
Prepared charts, constructed models and notes in activity log.  
Report of field visit. | - Identifies explains and appraises the importance of microbes in production of biogas.  
- Constructs an improvised model of biogas plant. |
<table>
<thead>
<tr>
<th>Concepts/ Ideas</th>
<th>Process/Activity with assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
</table>
| **Microbes as Biocontrol agents**  
- Observing  
- Identifying  
- Comparing  
- Inferring  
- Charting  
- Communicating |  
- General discussion after a brief introduction using Charts/slides.  
- Group discussion on various biocontrol agents.  
**Assessment**  
Prepared charts and works in activity log. |  
- Describes and concludes the importance of microbes as biocontrol agents. |
| **Microbes as Biofertilizers**  
- Observing  
- Identifying  
- Comparing  
- Inferring  
- Charting  
- Communicating |  
- General discussion after a brief introduction using Chart/slides/field visit.  
**Assessment**  
Prepared charts and works in activity log. |  
- Explains and concludes the importance of microbes as biofertilisers and compares it with chemical fertilisers. |
Through the Chapter....

The mentor introduces the chapter showing a video clip of sewage causing water pollution and a biogas plant and asks the students what actually happens in a biogas plant.

CONCEPT : Health

Suggested Activities: General Discussion followed by group discussion. Preparation of chart showing various microbes in household products.

Points to be discussed

- What happens when curd is added to milk?
- Why does the dough give a puffed appearance when kept overnight for the preparation of dosas?
- Which microbe is responsible for the fermentation of dough for making bread?
- Name the bacteria which is used for the production of Swiss cheese?

Consolidation

- Milk gets coagulated, because curd consists of LAB.
- Due to CO2 produced by the action of microbes.
- S. cerevisiae (Baker’s yeast)
- Propionibacterium sharmanii.

Assigned activity

- Prepare a detailed chart showing various microbes in household products.

Assessment

- Prepared chart, Notes in activity log.

CONCEPT : Microbes in Industrial Products

- Fermented beverages
- Antibiotics,
- Chemicals, Enzymes and other bioactive molecules

Suggested activity: General discussion using slides and video presentation. Preparation of a detailed table showing different microorganisms which produce industrial products and bio active molecules.
Points to be discussed

- Name the micro organism which is used for preparation of fermented beverages.
- Identify an antibiotic and the microbe from which they are produced.
- Why antibiotics are “pro life to human even though it means against life”? 
- Name the microbes which produce organic acids, cyclosporin, statins, streptokinase and butyric acid.

Consolidation

- *S. cerevisiae* (Baker’s yeast)
- Pencilin - *Pencillium notatum*
- Antibiotics are used to destroy micro organisms which is harmful to man.

Assigned activity

☐ Preparation of a detailed table showing different micro organisms which produce industrial products and bio active molecule.

Assessment

- Prepared tables and notes in activity log.

### Types of Alcoholic Beverages

<table>
<thead>
<tr>
<th>Alcoholic Beverage</th>
<th>Source</th>
<th>Approx. Alcohol Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beer (standard)</td>
<td>Cereals</td>
<td>3-4</td>
</tr>
<tr>
<td>Beer (Strong)</td>
<td>Cereals</td>
<td>8-11</td>
</tr>
<tr>
<td>Wine</td>
<td>Grapes (and other fruits)</td>
<td>8-10</td>
</tr>
<tr>
<td>Distilled Spirit</td>
<td>Fruits, cereals, sugarcane</td>
<td>40</td>
</tr>
</tbody>
</table>

**Microbes used in cheese production**

- Propionibacterium sharmanii
- Lactococcus lactis.
- Streptococcus salivarius.
- Lactobacillus delbruckii.
- Lactobacillus helveticus.
- *Penicillium camemberti*. 
- *Penicillium roqueforti*. 

**Microbes**

- Acetic acid - *Acetobacter aceti*
- Citric acid - *Aspergillus niger*
- Gluconic acid - *Aspergillus niger*
- Proteases - *Mortirella renispora*
- Amylases - *Aspergillus, Bacillus sps*
- Lactases - *S. fragilis*
- Lipases - *Candida lipolytica*
CONCEPT: Microbes in sewage treatment

Suggested activity: General discussion, Field visit and preparation of an improvised model of a sewage treatment plant

Points to be discussed

• Name the stages of sewage treatment and their differences.
• Why biological treatment is essential in the process of sewage treatment?
• Differentiate primary sludge and activated sludge.
• Why sewage treatment can be used for waste management as well as a sustainable energy source?
• Microbes play a key role in saving major rivers of India. site examples

Consolidation

• Physical and Biological treatment.
• Because at this stage BOD is reduced (10 - 15%), with the help of aerobic microbes.
• Sediment in physical treatment and sediment in biological treatment.
• Because which is used to treat sewage and at the same time biogas is produced.
• Ganga Action Plan and Yamuna action plan.

Assigned activity

☐ Preparation of an improvised model of a sewage treatment plant
☐ Collection of details of river action plans in India (Sutlej and Gomti action plan)

Assessment

• Prepared model, collected data and notes in activity log.

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Producer organism</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin</td>
<td><em>Penicillium chrysogenum</em></td>
<td>Gram positive bacteria</td>
</tr>
<tr>
<td>Erythromycin</td>
<td><em>Streptomyces erythreus</em></td>
<td>Gram positive bacteria</td>
</tr>
<tr>
<td>Neomycin</td>
<td><em>Streptomyces fradiae</em></td>
<td>Broad spectrum</td>
</tr>
<tr>
<td>Streptomycin</td>
<td><em>Streptomyces griseus</em></td>
<td>Gram negative bacteria</td>
</tr>
<tr>
<td>Gentamicin</td>
<td><em>Micromonospora purpurea</em></td>
<td>Broad spectrum</td>
</tr>
<tr>
<td>Tetracycline</td>
<td><em>Streptomyces rimosus</em></td>
<td>Broad spectrum</td>
</tr>
<tr>
<td>Polimyxin B</td>
<td><em>Bacillus polymyxa</em></td>
<td>Gram negative bacteria</td>
</tr>
</tbody>
</table>
GANGA ACTION PLAN: This plan was launched on 14 Jan. 1986 with the main objective of pollution abatement, to improve the water quality by interception, diversion and treatment of domestic sewage and present toxic and industrial chemical wastes from identified grossly polluting units entering into the river. The other objectives of the Ganga Action Plan are

- Control of non-point pollution from agricultural run off, human defecation, cattle wallowing and throwing of unburnt and half burnt bodies into the river.
- Research and Development to conserve the biotic diversity of the river to augment its productivity.
- New technology of sewage treatment like Up-flow Anaerobic Sludge Blanket (UASB) and sewage treatment through afforestation has been successfully developed.
- Rehabilitation of soft-shelled turtles for pollution abatement of river have been demonstrated and found useful.
- Resource recovery options like production of methane for energy generation and use of aquaculture for revenue generation have been demonstrated.
- To act as trend setter for taking up similar action plans in other grossly polluted stretches in other rivers.

YAMUNA ACTION PLAN: This plan envisaged protecting and preserving the River Yamuna from pollution via various schemes and plans. Yamuna Action Plan was conceived in early 1990's. Main objective of Yamuna Action Plan was conceived in early 1990's. Main objective of Yamuna Action Plan was to stop drains from dumping wastewater into the 1375-km-long-river and to intercept and divert sewage.

CONCEPT: Microbes in production of biogas

Suggested activity: General discussion, Model preparation, Field visit.

Points to be discussed
- Name the micro organism which produces bio gas?
- What are the parts of a biogas plant and how gas is produced in the plant?
- Name various institutions or agencies which popularize the usage of biogas plants?
Consolidation

- Methanogens.
- Digestor, gas holder, gas outlet, sludge outlet, dung water inlet.
- IARI, KVIC

**Production of Biogas**

- Proteins
- Fats
- Cellulose
- Hemicellulose

Soluble components / Monomers

Fermentative microbes

Organic acids

Methanogenic bacteria

Decomposer microbes

BIOGAS

Assigned activity

- Prepare an improvised model of biogas plant.

Assessment

- Prepared model, collected data and notes in activity log.

CONCEPT : Microbes as biocontrol agents

Suggested activity: Mentor initiates a general discussion using slides of various agents of biological control agents.

Points to be discussed

- What is biological control?
- Name some microbes which can be used as biological agents.
- Which microorganism is used for the production of disease resistant cotton plant?
- What is IPM?

Consolidation

- Use of biological methods for controlling plant diseases or pests.
- Bacillus thuringiensis, Nucleopolyhedrovirus, Trichoderma, Bacculovirus
• Bacillus thuringiensis
• Combination of different pest control methods (Integrated Pest Control)

Assigned activity
- Detail the advantages of biocontrol agents over chemicals in pest control.
- Prepare a detailed list of various biocontrol agents used in Integrated Pest Management.

Assessment
- Prepared charts and notes in activity log.

**Baculo viruses** are naturally occurring insect pathogens, host-specific, safe to non-target organisms and are ideal microbial insecticides in pest management.

- Baculo viruses are of two types: Nucleo Polyhedro viruses (NPVs) and Granuloviruses (GVs).
- Baculoviruses are Eco-friendly. They have been shown to have no negative impacts on plants, mammals, birds, fish, or even on non-target insects (parasites and predators). This is especially desirable when beneficial insects are being conserved to aid in an overall IPM programme, or when an ecologically sensitive area is being treated. This group of viruses is therefore considered safe and ecologically acceptable for use.
- These viruses are excellent candidates for species-specific narrow spectrum insecticidal applications.
- Baculoviruses are available as aqueous suspensions in water. The storable formulation usually does not contain any other ingredients except the filtered virus prepared from ground diseased larvae. Baculo virus formulation should be stored under cool dark conditions for prolonged storage up to 1 year to preserve efficacy and quality.

**CONCEPT: Microbes as biofertilisers**

**Suggested activity** : General discussion after a brief introduction using Chart/slides, Field visit
Points to be discussed
- Organic farming is more nature friendly why?
- Leguminous plants are most common intercrops Why?
- Name few cyanobacteria, free living bacteria and fungi used as biofertilizers?

Consolidation
- Less expensive, no harmful chemicals are used in this method
- Because their root nodules contain nitrogen fixing bacteria
- Anabaena, Nostoc, Azotobacter, Mycorrizha. help from parents and peers. Looking for danger signs and seeking professional and medical help.

Assigned activity
- Prepare a list of various biofertilisers.
- Visit to an organic farm.
- Prepare a list showing differences between organic fertilizers and chemical fertilizers.

Assessment
- Prepared lists, Report on field visit, comparative table and notes in activity log.

Process Assessment
- General discussion on microbes in household products, industrial products, sewage treatment, biogas production, bio control agents and bio fertilizers.
- Group discussion on use of microbes in house hold products, biogas production and bio control agents.
- Preparation of table and chart
- Construction of model of sewage treatment and biogas plant

Portfolio Assessment
- Report on group discussion
- Report of field visit
- Constructed model
- Prepared charts tables and works in activity log.

Unit Assessment
- Unit test
- Quiz programme
- Oral test
Integrated Pest Management (IPM)

IPM is a process which can be used to solve pest problems while minimizing risks to people and the environment. IPM can be used to manage all kinds of pests anywhere—in urban, agricultural, and wildland or natural areas. IPM focuses on long term prevention of pests or their damage by managing the ecosystem. In IPM, monitoring and correct pest identification help you decide whether management is needed. IPM programs combine management approaches for greater effectiveness by using a combination of methods that work better together than separately.

Approaches for managing pests

• **Biological control**

  Biological control is the use of natural enemies—predators, parasites, pathogens, and competitors—to control pests and their damage. Invertebrates, plant pathogens, nematodes, weeds, and vertebrates have many natural enemies.

• **Cultural control**

  Cultural controls are practices that reduce pest establishment, reproduction, dispersal, and survival. For example, changing irrigation practices can reduce pest problems, since too much water can increase root disease and weeds.

• **Mechanical and physical control**

  Mechanical and physical controls kill a pest directly or make the environment unsuitable for it. Traps for rodents are examples of mechanical control. Physical controls include mulches for weed management, steam sterilization of the soil for disease management, or barriers such as screens to keep birds or insects out.

• **Chemical control**

  Chemical control is the use of pesticides. In IPM, pesticides are used only when needed and in combination with other approaches for more effective, longterm control. Pesticides are selected and applied in a way that minimizes their possible harm to people and the environment. With IPM the most selective pesticide is to be used, that will do the job and be the safest for other organisms and for air, soil, and water quality.

• **IPM programs**

  These IPM principles and practices are combined to create IPM programs. While each situation is different, five major components are common to all IPM programs:

  1. Pest identification
  2. Monitoring and assessing pest numbers and damage
  3. Guidelines for when management action is needed
  4. Preventing pest problems
  5. Using a combination of biological, cultural, physical/mechanical and chemical management tools
Questions

1. Complete the table

<table>
<thead>
<tr>
<th>Type of Microbe</th>
<th>Scientific name</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterium</td>
<td>A</td>
<td>Convert milk to curd</td>
</tr>
<tr>
<td>B</td>
<td>Trichoderma polysporum</td>
<td>C</td>
</tr>
<tr>
<td>Bacterium</td>
<td>D</td>
<td>Butyric acid production</td>
</tr>
</tbody>
</table>

2. Complete the fourth place by observing the first pair.

Primary treatment : Physical :: Secondary treatment : .................

3. Write the uses of following microbes.
   a) Monascus purpureus
   b) Propionibacterium sharmanii
   c) Pencillium notatum
   d) Rhizobium

4. In traditional method vinegar is produced from coconut water. Identify the microbe which helps the production of vinegar.

5. Microbial products are life saving because they can remove clots in blood vessels of heart patients. Name the microbe which produces clot busters.

6. Select the correct statement or statements from the following
   a) Methanobacterium is present in rumen of cattle which can produce biogas.
   b) Secondary stage of sewage treatment is done with the help of aerobic sludge digesters.
   c) Statins are produced by bacteria named Streptococcus.
   d) Cyanobacteria are autotrophic bacteria which can fix atmospheric Nitrogen.
   1) a only 2) b and c 3) d only 4) a and d

7. Expand the following
   a) IARI  b) KVIC  c) IPM  d) LAB
8. Complete the flowchart using hints in bracket
   (Biological treatment, Primary sludge, Activated sludge)

   Sewage treatment
   ↓
   Primary treatment (Physical)
   ↓
   Supernatent or Effluent
   ↓
   Secondary Treatment
   ↓
   ...................... (BOD reduces)
   ↓
   Activated sludge
   ↓
   Releases to natural water resources like rivers streams

9) Write the chemical/Enzyme or the bioactive molecule secreted by the following microbes
   a) Monascus purpeurus
   b) Trichoderma polysporum
   c) Clostridium butyricum

10) The purpose of biological treatment of waste water is
   a) Reduce BOD  b) Increase BOD  c) Reduce sedimentation  d) Increase sedimentation

Quiz programme

Mentor gives an assignment to the learners to prepare maximum number of one word questions with answers. Provide them enough time to prepare questions. After this, mentor select 15 questions from the question pool and organise a quiz programme by grouping the students. Select two students from each group and keep remaining students of the group as audience. Mentor is the moderator.
<table>
<thead>
<tr>
<th>Q No</th>
<th>Value Points</th>
<th>Split Score</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A) LAB  B) Fungus  C) Cyclosporin  D) Clostridium butylicum</td>
<td>1/2 x 4</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Biological</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>a) Production of statins  b) Cheese production  c) Penicillin  d) Nitrogen fixing bacteria</td>
<td>1/2 x 4</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Acetobactor aceti</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Streptococcus</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>4) a and d</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>a) Indian Agricultural Resarch Institute  b) Khadi and Village Industries Commission  c) Integrated Pest Management  d) Lactic Acid Bacteria</td>
<td>1/2 x 4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>A) Primary sludge  B) Biological  C) Secondary effluent</td>
<td>1 x 3</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>a) Statins  b) Cyclosporins  c) Butyric acid</td>
<td>1 x 3</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>a - Reduce BOD</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>