

***Teacher Text***

**BOTANY**

**Class - XII**



**Government of Kerala**  
**DEPARTMENT OF EDUCATION**

State Council of Educational Research and Training (SCERT), Kerala  
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## Preface

*Dear Teacher,*

*We have introduced activity based, learner-centred, 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 Botany 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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## SCIENCE LEARNING APPROACH

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.
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### **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 Vornack 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. 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 then 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 where ever 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 ones views logically and argue convincingly
- To develop the ability to compare others views with ones 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.

## **V 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 class room 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 extent.

## **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 50pupils, 5groups can be formed. Problems are given in groups. Each students should go through the problem. They should follow the above crieteria 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 groups.

## **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 bend concepts based on the questions provided by the teacher.

## SYLLABUS - BOTANY

### Class XII- Theory (Total Periods - 90)

#### **VI. Reproduction (Periods 23)**

Reproduction in organisms: Reproduction, a characteristic feature of all organisms for continuation of species; Modes of reproduction – Asexual and sexual; Asexual reproduction; Modes- Binary fission, sporulation, budding, gemmule, fragmentation; vegetative propagation in plants.

Sexual reproduction in flowering plants: Flower structure; Development of male and female gametophytes; Pollination–types, agencies and examples; Outbreedings devices; Pollen-Pistil interaction; Double fertilization; Post fertilization events– Development of endosperm and embryo, Development of seed and formation of fruit; Special modes– apomixis, parthenocarpy, polyembryony; Significance of seed and fruit formation.

#### **VIII. Biology and Human Welfare (Periods 12)**

Improvement in food production: Plant breeding, tissue culture, single cell protein, Biofortification; Apiculture and Animal husbandry

#### **IX. Biotechnology and Its Applications (Periods 23)**

Principles and process of Biotechnology: Genetic engineering (Recombinant DNA technology).

Application of Biotechnology in health and agriculture: Human insulin and vaccine production, gene therapy; Genetically modified organisms- Bt crops; Transgenic Animals; Biosafety issues– Bio piracy and patents.

#### **X Ecology and environment (Periods 32)**

Organisms and environment: Habitat and niche; Population and ecological adaptations; Population interactions–mutualism, competition, predation, parasitism; Population attributes–growth, birth rate and death rate, age distribution.

Ecosystems: Patterns, components; productivity and decomposition; Energy flow; Pyramids of number, biomass, energy; Nutrient cycling (carbon and phosphorous); Ecological succession; Ecological Services– Carbon fixation, pollination, oxygen release.

Environmental issues: Air pollution and its control; Water pollution and its control; Agrochemicals and their effects; Solid waste management; Radioactive waste management; Greenhouse effect and global warming; Ozone depletion; Deforestation; Any three case studies as success stories addressing environmental issues.

## Practical (Total Periods - 30)

### SCHEME OF PRACTICAL EXAMINATION

#### 1. A. Dicot stem, Monocot stem, Dicot root, Monocot root

Preparations-2, Diagram -1, Labelling-  $\frac{1}{2}$  (at least two main parts), Identification-  $\frac{1}{2}$ , Reason-1 (two features for stem/root and other two for dicot/monocot).

#### 2. B. Vegetative propagules

Bulb, Offset, Rhizome, Runner, Sucker, Tuber (any five propagules should be provided) Name of propagule -  $\frac{1}{2}$ , which part modified -  $\frac{1}{2}$ , Labelling- 1 (at least two parts).

**3. C. Microscopic slides** (Oscillatoria, Rhizopus, Spirogyra, Moss-protonema, Fern-prothallus) Macroscopic specimens (Agaricus, Sargassum, Funaria-gametophyte with sporophyte, Nephrolepis-sporophyte, Pinus male cone and Female cone), Any three microscopic and macroscopic specimen should be provided. Name of specimen and its specified part -  $\frac{1}{2}$  any one reason for its identification-  $\frac{1}{2}$ .

**D. Photograph** of Bioreactor, Bt cotton, Cloning vector (identification-  $\frac{1}{2}$ , any one reason for its identification-  $\frac{1}{2}$ ).

**4. E. Identification** of any one stage of mitosis from the permanent slide mounting (use pointer eye piece) (Identification of given stage  $\frac{1}{2}$  any one reason for its identification-  $\frac{1}{2}$ ).

**5. F. Physiological experiments** (as per syllabus) (at least five experiments should be provided) Aim of experiment-  $\frac{1}{2}$ , diagram-  $\frac{1}{2}$ , labelling-  $\frac{1}{2}$ .

**6. G. Single flower and LS of flower** (should be mounted on dissection microscope) belongs to fabaceae, solanaceae and liliaceae should be provided for each batch to construct the floral formula-  $1\frac{1}{2}$ .

**7. H.** Lichen ,Cuscuta/Loranthus,Epiphyte( identification of interaction-1 description-1).

**8. I.** Anther should be provided to take C.S.

Section- ½, diagram-1( diagrammatic sketch of four lobed anther CS/ cellular diagram of a single lobe) labelling-½( any two parts).

**9.** Ask simple questions informally related to the physiological experiments done-1.

**10. Practical diary-2.**

\* Issue individual materials for Q.no.1A and 8.I

\* Give separate answer sheet for answering spot at sight ,the material C, D, E (mitosis )and collect the answer sheet immediately after answering.

**HIGHER SECONDARY PRACTICAL EXAMINATION  
BOTANY**

**HSE-II****Time: 1½ Hrs****Total score: 20**

1. Prepare a T.S of the given specimen **A** and identify giving reasons. Draw the ground plan and label the parts. Leave the preparation for valuation. Score 5

Preparation	- 2
Labelled diagram	- 1½
Identification	- 1½
Reason	- 1
  
2. Observe the given specimen **B**. Score 2
  - (a) Name the vegetative propagule - ½
  - (b) Which plant part is modified - ½
  - (c) Draw a neat labelled diagram - 1
  
3. Identify the material **C** and **D** at sight by giving reasons. Score 2

Identification	- ½ x 2 = 1
Reason	- ½ x 2 = 1
  
4. Identify the given stage **E** of mitosis and give reasons. Score 1

Identification	- ½
Reason	- ½
  
5. Write the aim of the experiment **F**. Draw and label the parts. Score 1½

Aim	- ½
Labelled diagram	- 1

6. Construct the floral formula of the given flower **G**  
*Score 1½*
7. Write down the ecological interaction of the specimen **H**  
*Score 2*
8. Prepare a C.S. of the given specimen **I** . Draw diagram and label any two parts. Leave the preparation for valuation.  
*Score 2*
- Section - ½  
Labelled diagram - 1½
9. Ascertaining the awareness of concepts related to the experiment  
*Score 1*
10. **Practical diary** *Score 2*



## LEARNING OUTCOMES

### 1. Reproduction in Organisms

*The learner*

- 1.1 compares the asexual reproductive methods in lower organisms.
- 1.2 identifies different kinds of vegetative propagules and explains vegetative propagation.
- 1.3 explains the features of sexually reproducing organisms and evaluates the merit of sexual reproduction.
- 1.4 explains the pre-fertilisation events.
- 1.5 identifies the significance of fertilization and differentiates external and internal fertilisation.
- 1.6 explains the post-fertilisation events and evaluates its merits.

### 2. Sexual Reproduction in Flowering Plants

- 2.1 identifies the different parts of a flower.
- 2.2 explains microsporogenesis and evaluates the role of each parts.
- 2.3 compares the structure and function of pollen grain.
- 2.4 differentiates the various parts of carpel.
- 2.5 locates the parts of ovule.
- 2.6 analyses the various stages of megasporogenesis and explains it.
- 2.7 identifies the different pollinating agents and lists the floral peculiarities.
- 2.8 explains outbreeding devices and pollen - pistil interaction.
- 2.9 states the processes involved in double fertilisation and their significance.
- 2.10 explains endosperm development.
- 2.11 explains seed formation and compares different types of fruits.
- 2.12 differentiates special types of reproduction.

### **3. Strategies for Enhancement in Food Production**

- 3.1 identifies the importance of animal husbandry with special reference to dairy farm and poultry farm management.
- 3.2 lists the importance of animal breeding and classifies animal breeding methods.
- 3.3 analyses the importance of bee-keeping, fisheries and aquaculture.
- 3.4 compares blue revolution and green revolution.
- 3.5 explains the steps in plant breeding and the methods of production of plants with desirable quantities and qualities.
- 3.6 examines the application of plant breeding in the production of disease resistant and insect/pest resistant plants.
- 3.7 evaluates the application of plant breeding in biofortification and analyses the significance of SCP.
- 3.8 explains tissue culture and somatic hybridisation.

### **4. Biotechnology: Principles and Processes**

- 4.1 identifies the development of biotechnology and the major terminologies used in it.
- 4.2 analyses the nature of restriction enzymes and DNA ligases and compares them.
- 4.3 identifies the principle of separation of DNA fragments during agarose gel electrophoresis.
- 4.4 analyses the types of cloning vectors and the uses of plasmid vector in rDNA technology and identifies the vectors for cloning genes in plants and animals.
- 4.5 evaluates competency and explains various methods of gene transfer.
- 4.6 identifies and compares the methods to extract DNA from different groups of organisms.
- 4.7 identifies the method and process of gene amplification.
- 4.8 recommends the use of bioreactors and identifies the importance of downstream processing.

## 5. Biotechnology and its Applications

- 5.1 analyses the application of biotechnology in agriculture.
- 5.2 evaluates the development of Bt cotton by genetic engineering.
- 5.3 analyses the application of RNAi in the production of pest resistant plants.
- 5.4 identifies the production of genetically engineered insulin and sketches the structure of insulin molecule.
- 5.5 identifies gene therapy and compares it with other types of treatment methods.
- 5.6 compares and recommends various types of molecular diagnostic methods.
- 5.7 analyses and categorises the various uses of transgenic animals.
- 5.8 evaluates the ethical issues of genetic engineering and judges the various aspects of patent and biopiracy.

## 6. Organisms and Populations

- 6.1 identifies the levels of organisation and major biomes.
- 6.2 lists various abiotic factors of habitats.
- 6.3 identifies the response of organisms to abiotic factors.
- 6.4 identifies and differentiates various types of adaptations shown by plants and animals.
- 6.5 lists various attributes of population and population growth.
- 6.6 differentiates the population growth models and identifies their characteristics.
- 6.7 analyses the significances of population interaction and classifies them.
- 6.8 identifies predation and evaluates the significance of predation.
- 6.9 explains competition and evaluates its merits and demerits .
- 6.10 lists the importance of parasitism and identifies different types of parasites.
- 6.11 explains commensalism with examples.
- 6.12 evaluates the significance of mutualism and co-evolution with suitable examples.

## **7. Ecosystem**

- 7.1 recognises the structure and functions of ecosystem and identifies the different components of the ecosystem.
- 7.2 differentiates primary and secondary productivity.
- 7.3 compares and explains the different stages of decomposition.
- 7.4 analyses the energy flow through various trophic levels.
- 7.5 differentiates and constructs different types of ecological pyramids .
- 7.6 analyses ecological succession and identifies different stages of xerarch.
- 7.7 identifies different stages of hydrarch succession.
- 7.8 analyses nutrient cycling and differentiates gaseous and sedimentary cycles.
- 7.9 evaluates the services provided by ecosystems.

## **8. Environmental Issues**

- 8.1 evaluates the various causes of air and noise pollution and their control measures.
- 8.2 classifies and compares various causes of water pollution and suggests remedies for control.
- 8.3 predicts the ill effects of solid wastes and e-wastes and recommends their control.
- 8.4 identifies the problems of agrochemical wastes, radioactive wastes and their control.
- 8.5 analyses the effect of greenhouse gases and global warming and suggests its control measures.
- 8.6 analyses the effect of ozone depletion in the stratosphere.
- 8.7 evaluates the degradation of natural resources and predicts the effect of deforestation.

## SAMPLE TEACHER PLANNER

Name of chapter	: Reproduction in Organisms
Date	: June 2
Expected time	: 1 Period
Learning outcomes	: Compares the asexual reproductive methods in lower organisms.
Concepts	: Life span, Reproduction - asexual, sexual, Clone, Budding, Binary fission, sporulation, Asexual reproductive structures - zoospore, conidia, Buds, Gemmules.
Skills	: Observing, comparing, analysing, inferring
Learning materials	: Video clip that shows reproduction in lower organisms, permanent slides, Animation
Expected products	: Completed figure (1.1), prepared notes, completed assignment.

Process	Assessment
<p><b>Chapter Introduction</b></p> <p>Exhibition of video showing the relevance of reproduction.</p> <p>Asks simple questions to elicit the previous knowledge.</p> <ul style="list-style-type: none"> <li>• Why do organisms reproduce?</li> <li>• What are the phases in the life of human beings?</li> </ul> <p>Asks about life span.</p> <p>Leads a general discussion.</p> <ul style="list-style-type: none"> <li>• Is the life span of all organisms the same?</li> </ul> <p>Asks to observe fig. 1.1 in the TB. Give necessary instructions to fill in the blank spaces in the figure.</p>	<p><b>Class -A<sub>Z</sub></b></p> <p>37 students - <i>Very good performance</i> 20 students - <i>Need improvement</i></p> <p><b>Roll Nos.</b></p> <p>1, 2, 3, 4, 7, 15, 23, 32, 33, 40, 42, 44, 46, 50, 52, 53, 55, 56, 57, 60</p> <p>Below average performance - Poornima, Anu, Amal.</p>

Process	Assessment
<p>Provides discussion points</p> <ul style="list-style-type: none"> <li>• What are the two types of reproduction?</li> <li>• What are the differences between the two types?</li> <li>• What is clone?</li> </ul> <p>Provides necessary help. Asks to refer TB.</p> <p>Prepare notes in the activity log.</p> <p>Shows videos on budding of yeast.</p> <p>Asks to observe it.</p> <p>Then asks to observe figure 1.2.</p> <p>Shows a video on binary fission.</p> <p>Asks to observe figure 1.2 (b)</p> <ul style="list-style-type: none"> <li>• What are the steps in binary fission?</li> <li>• How many daughter cells are formed through binary fission?</li> </ul> <p>Then shows the video on sporulation. Learners observe it.</p> <p>Leads a discussion.</p> <p><b>Discussion Points</b></p> <ul style="list-style-type: none"> <li>• What is a cyst?</li> <li>• What is encystation?</li> <li>• What is pseudopodiospores?</li> <li>• What is sporulation?</li> </ul> <p>Asks to refer TB.</p> <p>Provides necessary help.</p> <p>Then asks to observe and identify organisms in fig. 1.3 in the TB.</p> <p>Shows slides through the microscope. (conidia, gemmule)</p> <p>Asks to observe them.</p> <p>Give necessary explanations.</p>	

**Consolidation**

- Life span
- Reproduction
  - relevance
  - types
- Clone
- Budding in yeast, hydra
- Reproduction in amoeba
- Asexual reproductive structures in chlamydomonas, penicillium, sponge

**Assignment**

Provides a table and asks to complete it.

Name of organism	Asexual reproductive structure
<ul style="list-style-type: none"> <li>• Hydra</li> <li>• Penicillium</li> <li>• Chlamydomonas</li> <li>• Sponge</li> </ul>	

**CE****Process assessment**

- Participation
- Observation
- Preparation of notes

**Portfolio assessment**

- Prepared notes
- Completed assignment

**Reflections**

- For 20 students I have to prepare some worksheets to make them aware of the concepts.
- Three students need more care and attention to attain the LO

## SCHEME OF WORK

Unit	Chapter	Month	Periods	Score weight
<b>Term - 1</b>				
VI	1. Reproduction in Organisms	June	8	2
VI	2. Reproduction in Flowering Plants	June-July	15	5
VIII	3. Strategies for Enhancement in Food Production	July-August	12	3
IX	4. Biotechnology : Principles and Processes (upto Page 197)	August	4	4
<b>Term - 2</b>				
IX	4. Biotechnology : Principles and Processes-continued	September	9	
IX	5. Biotechnology and its Applications	October	10	4
X	6. Organisms and Populations	October - November	12	4
X	7. Ecosystem	November - December	10	4
<b>Term - 3</b>				
X	8. Environmental Issues	December - January	10	4
			<b>90</b>	<b>30</b>
	<b>Practical</b>		<b>30</b>	<b>20</b>
	<b>Total</b>		<b>120</b>	<b>50</b>



# Unit VI

# Reproduction

## Chapter 1 - Reproduction in Organisms

### *Introduction*

*Reproduction is the production of new generation of individuals of the same species. It is one of the fundamental characteristics of living organisms. Reproduction helps to continue populations generation after generation. Population size will vary according to the balance between rate of reproduction and rate of death of individuals. A new individual normally has to go through a period of growth and development before it reaches the stage at which it can reproduce. Duration of these stages may vary from species to species.*

*Organisms reproduce through asexual and sexual methods. Different types of asexual reproductive methods can be seen in lower forms of organisms. The most common form of asexual reproduction in plants is vegetative propagation. Specialised organs of propagation often develop in several aquatic and terrestrial species of angiosperms. Plants possessing them can therefore survive from one year to the next.*

*Reproduction is a process that helps to continue life. Organisms follow a number of different reproductive strategies, all with certain advantages and disadvantages. Learners have acquired some basic concepts regarding reproduction in their lower classes.*

### Values and Attitudes

- Develops an attitude to protect plants.
- Respects elders realising the greatness of parentage.

**Time : 8 Periods**

## Unit Frame

Concepts/Ideas and process skills	Process/Activity with assessment	Learning outcomes
<ul style="list-style-type: none"> <li>• Life span</li> <li>• Reproduction</li> <li>• Asexual reproduction-types</li> <li>- Observing</li> <li>- Comparing</li> <li>- Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• Picture reading(fig 1.1 in the T.B) and its completion</li> <li>• Observation of chart/animation of asexual reproduction</li> <li>• Discussion</li> <li>• Completion of tables</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Compares the asexual reproductive methods in lower organisms.</li> </ul>
<ul style="list-style-type: none"> <li>• Vegetative propagation</li> <li>• Various kinds of vegetative propagules</li> <li>- Observing</li> <li>- Comparing</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• Collection of vegetative propagules mentioned in the TB</li> <li>• Observation of collected vegetative propagules (P.E)</li> <li>• Discussion</li> <li>• Picture reading</li> <li>• Preparation of notes and drawings in the practical log</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies different kinds of vegetative propagules and explains vegetative propagation.</li> </ul>
<ul style="list-style-type: none"> <li>• Sexual reproduction</li> <li>- Significance</li> <li>• Features of sexually reproducing organisms</li> <li>- Observing</li> <li>- Classifying</li> <li>- Differentiating</li> </ul>	<ul style="list-style-type: none"> <li>• Discussion</li> <li>• Table completion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Explains the features of sexually reproducing organisms and evaluates the merit of sexual reproduction.</li> </ul>
<ul style="list-style-type: none"> <li>• Sexual reproduction-main events</li> <li>• Pre-fertilisation events</li> <li>- Observing</li> <li>- Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• Picture reading(fig 1.5, 1.6) in the T.B</li> <li>• Observation of chart/photos of various types of gametes Table 1.1 completion</li> <li>• Observation of animation/video showing gamete transfer mechanism in lower organisms and plants</li> <li>• General discussion</li> <li>• Table completion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>Explains the pre-fertilisation events.</li> </ul>

<b>Concepts/Ideas and process skills</b>	<b>Process/Activity with assessment</b>	<b>Learning outcomes</b>
<ul style="list-style-type: none"> <li>• Fertilisation -types</li> <li>- Observing</li> <li>- Collecting</li> <li>- Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Observation of animation / video of external fertilization in frogs</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the significance of fertilisation and differentiates external and internal fertilisation.</li> </ul>
<ul style="list-style-type: none"> <li>• Post-fertilisation events</li> <li>- Observing</li> <li>- Evaluating</li> <li>- Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• Discussion</li> <li>• Picture reading</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Explains the post - fertilisation events and evaluates its merits.</li> </ul>

## *Towards the chapter*

### CONCEPTS

- ❖ Life span, reproduction, asexual reproduction , clone

### **Suggested Activities** : Discussion, picture reading

The mentor introduces the topic and then asks simple questions to elicit the previous knowledge about life span.

- What is life span?
- Is life span of all organisms the same?
- 

Random responses of the learners are collected. Asks them to observe Fig1.1 in the T.B. The mentor provides necessary help to complete the blank spaces in the figure. Then the mentor asks some questions about reproduction. The learners discuss with one another and prepare notes in the activity log.

### **Discussion points**

- What is reproduction?
- Why is reproduction essential for organisms ?
- What are the main types of reproduction?
- Why is the offspring formed by asexual reproduction referred to as clone?
- 

Then provides the table given below and asks to complete it .

Asexual reproduction	Sexual reproduction

### **Consolidation**

- ◆ Life span of various organisms
- ◆ Reproduction- Definition-types,significance
- ◆

**CONCEPTS**

- ❖ Asexual reproduction, different methods- Yeast- Amoeba- Hydra - Chlamydomonas - Penicillium - Sponge

**Suggested Activities :** Observation of video/animation, general discussion, picture reading

The mentor exhibits the video/animation of different asexual reproductive methods given in the T.B. The learners observe them. Provides discussion points.

**Discussion points**

- How does budding in yeast occur?
- How will you differentiate binary fission and sporulation in Amoeba?
- What are the two methods in which Hydra reproduce asexually?
- How do Penicillium reproduce asexually?
- What are gemmules?
- 

The learners refer the figures in the T.B and prepare notes in the activity log. Asks them to complete the table given below.

Method of asexual reproduction	Organism
Sporulation .....	..... Yeast
Fragmentation .....	..... Paramecium
Zoospore formation	.....

**Consolidation**

- ◆ Asexual reproduction-methods and structures
- ◆

**Assignment**

- ◆ Collection of vegetative propagules

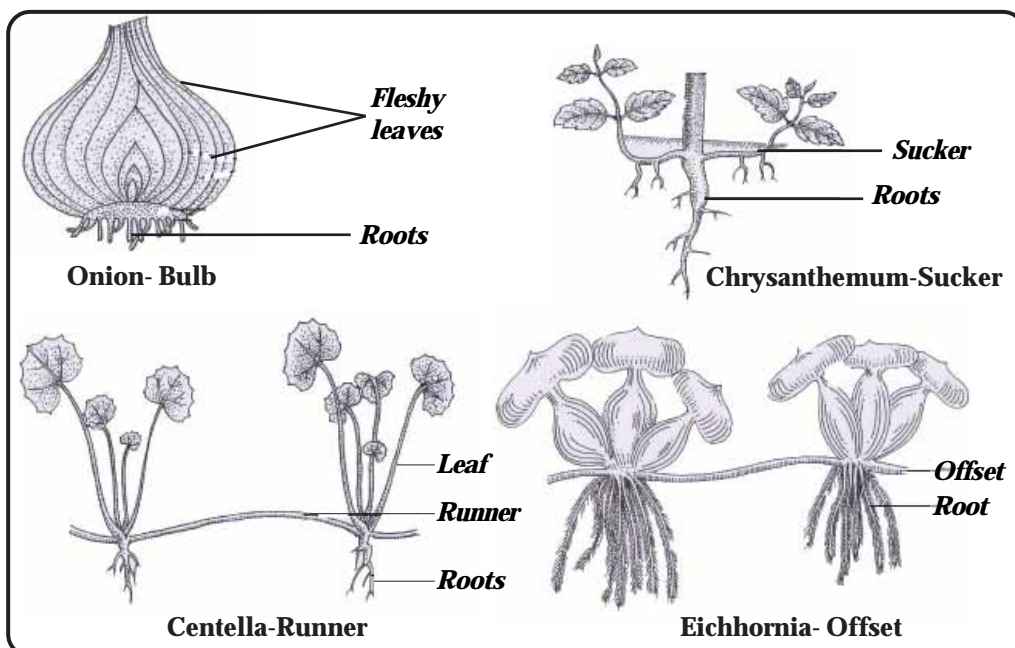
## CONCEPTS

- ❖ Vegetative propagation- relevance, vegetative propagules

**Suggested Activities:** Collection, observation of vegetative propagules (lab work), picture reading, discussion.

The mentor asks the learners to exhibit the vegetative propagules they have collected. Compare them with the figures in the TB. Draw the figures and prepare notes in the activity log and practical log.

### Vegetative propagules



### Discussion points

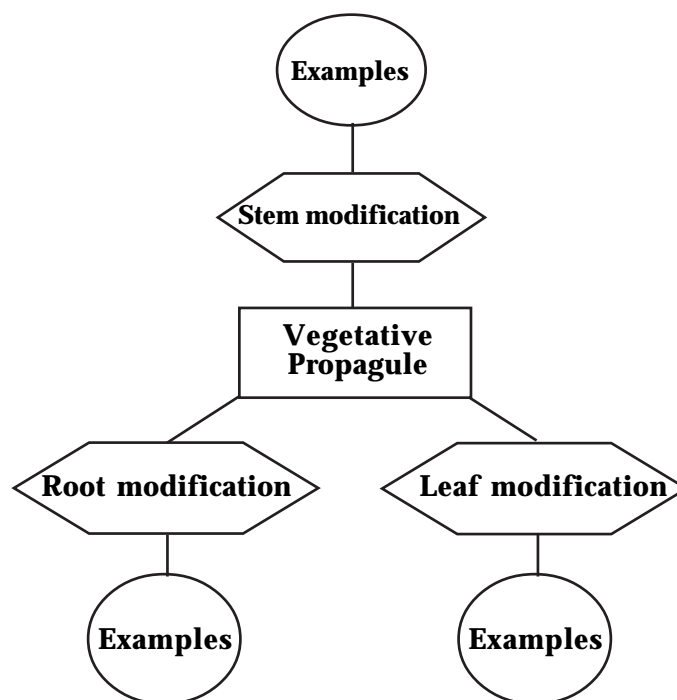
- What are vegetative propagules?
- Why is vegetative propagation called asexual reproduction?
- What kind of vegetative propagules are formed from underground stem modification?
- How do Agave, Bryophyllum and water hyacinth reproduce?
- What is a runner?
- How are plants like sugarcane, banana and dahlia cultivated?
- 

### Consolidation

- ◆ Vegetative propagules

- ◆ Stem modification
- ◆ Leaf modification
- ◆ Root modification
- ◆ Flower bud modification
- ◆

Then the learners are asked to complete the concept map given below.



### CONCEPTS

- ❖ Sexual reproduction- significance, phases of growth, flowering pattern, reproductive pattern in animals

### **Suggested Activities : Discussion**

Mentor asks some simple questions about reproduction .

- Are all organisms reproduce at the same age?
- When does an organism start reproducing?

Random responses. Then the mentor organises a discussion.

### **Discussion points**

- What are the phases of growth in plants?
- What are the phases of growth in animals?

- How will you differentiate annual, biennial and perennial plants?
- What peculiarities can be observed in the flowering nature of bamboo and neelakurinji?
- How will you differentiate oestrus cycle and menstrual cycle?
- Why organisms are classified as seasonal breeders and continuous breeders?
- What are the peculiarities of senescence or old age?
- 

### **Consolidation**

- ◆ Sexual reproduction - significance
- ◆ Phases of growth
- ◆ Annual, biennial and perennial plants
- ◆ Oestrus cycle
- ◆ Menstrual cycle
- ◆ Seasonal breeders
- ◆ Continuous breeders
- ◆ Old age - significance

### **CONCEPTS**

- ❖ Sexual reproduction, pre-fertilisation events- gametogenesis - types of gametes- gamete transfer

**Suggested Activities :** Observation of photos/animation, discussion, picture reading

The mentor exhibits photograph/animation of gametes mentioned in the TB. The learners observe it and discuss, refer TB and prepare notes.

### **Discussion points**

- What is gametogenesis?
- How many types of gametes are produced by sexually reproducing organisms?
- What peculiarities can you observe in the gametes of cladophora, fucus and human beings ?
- How will you classify fungi and plants based on the presence of male and female reproductive structures?



➤ What is a hermaphrodite?

➤

Then the mentor shows the animation of meiosis and asks them about meiosis.

- Where do meiosis occur?
- What is its significance?
- 

Then asks the learner to complete table 1.1 in the TB.

The mentor shows the video/animation of gamete transfer mechanisms in lower plants, fungi and higher plants.

### Consolidation

Events in sexual reproduction

- ◆ Gametogenesis
- ◆ Homogametes
- ◆ Heterogametes
- ◆ Sexuality in organisms
- ◆ Chromosome number in meiocytes and gametes
- ◆ Gamete transfer mechanisms
- ◆

### CONCEPTS

❖ Fertilisation - definition, types, significance

**Suggested Activities :** Observation of video/animation and general discussion

The mentor shows the video/animation of fertilisation.

### Discussion points

- Why fertilisation is called the most vital event in sexual reproduction?
- What is parthenogenesis?
- What is external fertilisation? What is its disadvantage?
- What are the advantages of internal fertilisation?
-

The learners are asked to complete the table given below.

Types of Fertilisation	Definition	Advantage	Disadvantage	Example
External				
Internal				

### Consolidation

- ◆ Fertilisation- External and internal
- ◆ Advantages and disadvantages
- ◆ Parthenogenesis
- ◆

### CONCEPTS

- ❖ Post-fertilisation events, embryogenesis, oviparous organisms, viviparous organisms

**Suggested Activities :** Discussion

### Discussion points

- How do sexual reproduction enable algae and fungi to overcome adverse condition?
- Zygote is considered as a vital link between organisms of one generation to the next. Why?
- What is embryogenesis?
- How do zygote development in viviparous and oviparous organisms occur?
- What changes occur in flowering plants after the formation of zygote inside the ovule?
- 

### Consolidation

- ◆ Development of zygote
  - in algae and fungi

- in animals
- in flowering plants



### Repository of CE

Process assessment	Portfolio assessment	Unit assessment
Participation Collection Preparation of notes  Completion of concept map and tables	Collected specimens Prepared notes in the activity log and practical log Completed concept map and table	Checklist completion

### Unit assessment (Checklist)

Read the following statements and put (✓) mark in the appropriate box.

	Yes	No
1. The chromosome number of meiocyte is haploid.	<input type="checkbox"/>	<input type="checkbox"/>
2. Hydra asexually reproduce through fragmentation.	<input type="checkbox"/>	<input type="checkbox"/>
3. Chara is a monoecious plant.	<input type="checkbox"/>	<input type="checkbox"/>
4. The ploidy of zygote is 'n'.	<input type="checkbox"/>	<input type="checkbox"/>
5. The offspring formed through asexual reproduction is called clone.	<input type="checkbox"/>	<input type="checkbox"/>
6. Parthenogenesis can be seen in frog.	<input type="checkbox"/>	<input type="checkbox"/>
7. The chromosome number in the gamete of maize is 10.	<input type="checkbox"/>	<input type="checkbox"/>
8. Leech is a hermaphrodite.	<input type="checkbox"/>	<input type="checkbox"/>
9. Bulbil is the vegetative propagule in bryophyllum.	<input type="checkbox"/>	<input type="checkbox"/>
10. Conidia is the asexual reproductive structure of Chlamydomonas.	<input type="checkbox"/>	<input type="checkbox"/>

## SAMPLE TE QUESTIONS

### I. Multiple choice questions

- Choose the correct matching from the options.

a. Ginger	1. Offset	
b. Potato	2. Rhizome	
c. Water hyacinth	3. Bulbil	
d. Agave	4. Tuber	(Score 1)

A. a-4,b-2,c-1,d-3      B. a-2,b-4,c-1,d-3  
C. a-3,b-1,c-2,d-4      D. a-2,b-1,c-4,d-3
- Choose the wrong statement.
  - Earthworm is bisexual.
  - Cladophora produces heterogametes.
  - The chromosome number in the meiocyte of fruit fly is eight.

A. b and c      B. a only      C. c only      D. b only      (Score-1)
- Binary fission can be seen in  
A. Penicillium    B. Hydra    C. Paramecium    D. Sponge  
(Score-1)
- Vegetative propagation in Bryophyllum occurs through  
A. Gemmules    B. Runners    C. Tubers    D. Leaf buds  
(Score-1)
- A post- fertilisation event is  
A. Gametogenesis    B. Embryogenesis    C. Pollination  
D. Parthenogenesis      (Score-1)

### II. Short answer type questions

- Differentiate between binary fission and multiple fission.  
(Score-2)

7. Write the chromosome number in the meiocyte and gamete of potato. (Score-2)
8. Compare internal fertilisation and external fertilisation. (Score-2)

**III. Essay type questions**

9. Write a comparative note on monoecious and dioecious plants. Write examples for each. (Score-3)
10. Explain the three phases in the life cycle of plants. (Score-3)

**TE Questions : Scoring Key**

<b>Q. No.</b>	<b>Scoring indicator</b>	<b>Splitted Score</b>	<b>Total Score</b>
1	B	1	1
2.	D	1	1
3.	C	1	1
4.	D	1	1
5.	B	1	1
6.	Binary fission-Organism divides into two Multiple fission- Organism divides into more than two.	1 1	2
7.	Meiocyte:- 48 gamete-24	1+1	2
8.	Internal fertilization- Takes place inside the body of the female parent. External fertilization:- Takes place outside the body	1 1	2
9.	Monoecious- Male and female flowers are seen on the same plant eg: any one plant given in the TB Dioecious-male and female flowers are seen on two plants eg: any one plant given in the TB	1 ½ 1 ½	3
10.	Vegetative /juvenile phase-vegetative growth Reproductive phase- process of reproduction Senescence phase - Aging	1+1+1	3

# Unit VI

# Reproduction

## Chapter 2 - Sexual Reproduction in Flowering Plants

### **Introduction**

*The remarkable evolutionary success of flowering plants can be linked to their reproductive strategies. Flower is the reproductive organ in angiosperms. Plants most often gain competence to respond external or internal signals regulating flowering. Once plants are competent to reproduce, a combination of factors including light, temperature, and both promotive and inhibitory internal signals determine when a flower is to be produced.*

*The complex and elegant process that gives rise to the reproductive structure called flower is often compared with metamorphosis in animals. It is the shift from mitosis to meiosis in the sporogenous cell leading to the development of a haploid gamete producing gametophyte is perhaps even more critical. Pollen matures within the anthers and is transported often by wind, insects, water or birds to the stigma of another flower.*

*Successful pollination leads to fertilisation in the embryo sac. Once fertilisation is complete the embryo develops. It results in formation of the seed. The seed in turn is enclosed in the fruit. These typical angiosperm structures evolved in response to the need for seed to be dispersed over a long distance to ensure genetic variability. The learners have already learnt about the parts of flower and their functions. In this chapter we explore reproductive strategies in the angiosperms and how their unique features have contributed to their success.*

### **Values and Attitudes**

- Develops an attitude to protect flowers identifying their significance in reproduction.
- Appreciates seed and fruit diversity among angiosperms.

**Time : 15 Periods**

## Unit Frame

Concepts/Ideas and process skills	Process/Activity with assessment	Learning outcomes
<ul style="list-style-type: none"> <li>• Parts of flower</li> <li>• Stamen -parts</li> <li>• Anther-types</li> <li>- Observing</li> <li>- Comparing</li> <li>- Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• Collection of flowers</li> <li>• Flower dissection</li> <li>• Picture reading</li> <li>• Drawing</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the different parts of a flower.</li> </ul>
<ul style="list-style-type: none"> <li>• Microsporogenesis- Stages</li> <li>• Pollen grain -parts</li> <li>- Functions</li> <li>- Observing</li> <li>- Experimenting</li> <li>- Communicating</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• Slide preparation - Anther (P.E)</li> <li>• Drawing</li> <li>• Picture reading</li> <li>• Observation of video/photos of pollen grain</li> <li>• Preparation of notes and drawings in the activity log and practical log, assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Explains microsporogenesis and evaluates the role of each parts.</li> <li>• Compares the structure and function of pollen grain.</li> </ul>
<ul style="list-style-type: none"> <li>• Carpel -Parts</li> <li>• Different types of carpels</li> <li>- Observing</li> <li>- Classifying</li> <li>- Differentiating</li> </ul>	<ul style="list-style-type: none"> <li>• Flower dissection</li> <li>• Observation of floral parts</li> <li>• Picture reading</li> <li>• Observation of chart</li> </ul>	<ul style="list-style-type: none"> <li>• Differentiates the various parts of carpel.</li> </ul>
<ul style="list-style-type: none"> <li>• Ovule - Parts</li> <li>• Functions</li> <li>- Observing</li> <li>- Communicating</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Preparation of chart, diagram</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Locates the parts of ovule.</li> </ul>
<ul style="list-style-type: none"> <li>• Megasporogenesis process</li> <li>- Embryosac</li> <li>- Parts</li> <li>- Function</li> <li>- Observing</li> <li>- Collecting</li> <li>- Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of animation/video/photos of embryosac development</li> <li>• Picture reading</li> <li>• Preparation of notes</li> <li>• Drawings</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses the various stages of megasporogenesis and explains it.</li> </ul>



<b>Concepts/Ideas and process skills</b>	<b>Process/Activity with assessment</b>	<b>Learning outcomes</b>
<ul style="list-style-type: none"> <li>• Pollination</li> <li>- agents and types</li> <li>- Observing</li> <li>- Evaluating</li> <li>- Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of video</li> <li>• General discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the different pollinating agents and lists the floral peculiarities.</li> </ul>
<ul style="list-style-type: none"> <li>• Outbreeding devices</li> <li>• Pollen - pistil interaction</li> <li>- Observing</li> <li>- Analysing</li> <li>- Inferring</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Observation of video/animation</li> <li>• Preparation of notes</li> <li>• Assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Explains outbreeding devices and pollen - pistil interaction.</li> </ul>
<ul style="list-style-type: none"> <li>• Double fertilisation- Events</li> <li>- Significance</li> <li>• Observing</li> <li>• Analysing</li> <li>• Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of animation and chart</li> <li>• Picture reading</li> <li>• Preparation of notes, drawings</li> </ul>	<ul style="list-style-type: none"> <li>• States the processes involved in double fertilisation and their significance.</li> </ul>
<ul style="list-style-type: none"> <li>• Development of endosperm- Three types</li> <li>• Embryogeny</li> <li>- Observing</li> <li>- Communicating</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Preparation of notes</li> <li>• Assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Explains endosperm development.</li> </ul>
<ul style="list-style-type: none"> <li>• Seed-Formation and types</li> <li>• Fruits-types</li> <li>• Seed -advantages</li> <li>• Dormancy</li> <li>• Special types of reproduction</li> <li>- Observing</li> <li>- Communicating</li> <li>- Interpreting data</li> </ul>	<ul style="list-style-type: none"> <li>• Seed collection</li> <li>• Observation of collected seeds</li> <li>• Observation of video and collected fruits</li> <li>• Preparation of notes</li> <li>• Assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Explains seed formation and compares different types of fruits.</li> <li>• Differentiates special types of reproduction.</li> </ul>

## *Towards the chapter*

### CONCEPTS

- ❖ Flower- significance - parts, stamen - parts, structure of microsporangium, microsporogenesis

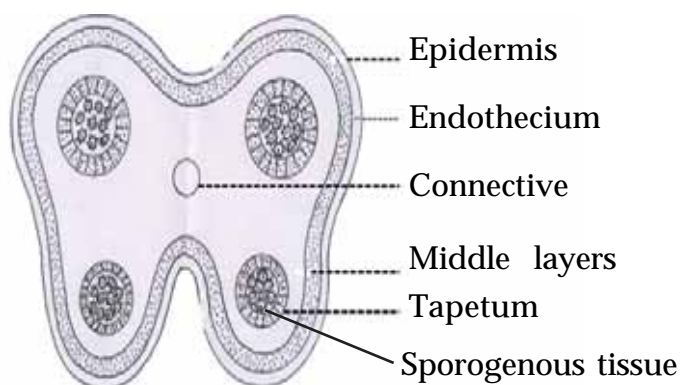
**Suggested Activities :** General discussion, collection, dissection, lab work.

The mentor asks the learners to dissect the collected flowers and to identify each parts. Asks to compare the parts with the diagram given in TB. Then organises a discussion.

### **Discussion Points**

- What are the uses of flowers?
- What is floriculture?
- Which are the parts of a flower?
- What is the unit of androecium?
- Which are the parts of a stamen ?
- What is a dithecous anther?
- 

The mentor makes necessary arrangements to take the transverse section of anther. The learner takes the T.S and observe it through the microscope. Draw labelled diagram in the practical log(PE).



The mentor exhibits a chart showing the T.S of young anther. Then organises a general discussion. The learners refer figure 2.3 in the T.B.

### Discussion Points

- How many microsporangia are located at each lobe?
- How does a pollen sac develop?
- How many wall layers are seen in a microsporangium?
- Which are the layers ? What are their functions?
- What is the fate of sporogenous tissue?
- What is the ploidy of microspore tetrad?
- What is microsporogenesis?
- How microspore tetrads develop into pollen grains?
- 

### Consolidation

- ◆ Parts of stamen
- ◆ Dithecous anther
- ◆ Pollen sac, microsporangia
- ◆ Four wall layers-Functions
- ◆ Sporogenous tissue
- ◆ Microsporogenesis
- ◆

### CONCEPTS

- ❖ Pollen grain- parts, functions, significance.

**Suggested Activities :** Observation of video/photo of pollen grains, collection, general discussion

The mentor exhibits the video/photos of various kinds of pollen grains and pollen tetrad, then shows a chart showing the different stages of development of microspore into a mature pollen. The learners are asked to observe the pollen grains they have collected through a hand lens.

### Discussion points

- Which is the outer layer of pollen grain?
- What are the distinguishing features of the outer layer and inner layer?
- Which are the two cells seen in the microspore?

- What is the fate of each cell?
- How many cells are present in pollen at the time of shedding?
- Why some pollen grains are considered dangerous?
- What are the uses of pollen grains?
- What is pollen viability?
- How can we store pollen grains in pollen banks?
- 

### Consolidation

- ◆ Pollen grain-layers- structure and function
- ◆ Sporopollenin
- ◆ Vegetative and generative cell
- ◆ Useful and harmful effects of pollen grain
- ◆ Pollen viability and preservation
- ◆

### Assignment

- ◆ Complete the table, writing the differences between the two

Exine	Intine

### CONCEPTS

- ❖ Pistil - parts-types , ovule - structure, embryo sac, megasporogenesis

**Suggested Activities :** Collection ,observation of animation/chart, general discussion

The learners dissect flowers, observe and write notes on monocarpellary, multicarpellary, syncarpus and apocarpous condition. The mentor exhibits a chart showing the structure of ovule.

### Discussion points

- What is funicle?
- Which part is seen in between the ovule and funicle?

- What are integuments?
- How will you differentiate chalaza and micropyle?
- What is nucellus?
- Which is the female gametophyte of angiosperms?

Then, the mentor shows the animation of embryo sac development. The learners observe it, refer TB and prepare notes and sketches.

- What is megasporogenesis?
- What are the changes that occur in the megaspore mother cell?
- How 8 nuclei are formed in the embryo sac?
- How the embryo sac becomes seven celled?
- Which are the cells in egg apparatus?
- What is the function of filiform apparatus?
- What is megasporogenesis?
- 

### Consolidation

- ◆ Ovule - structure and function
- ◆ Megasporogenesis
- ◆ Formation of 8 nuclei
- ◆ Formation of 7 cells
- ◆

### Assignment

- ◆ Draw the L.S of ovule and label the parts.
- ◆ Draw and label a mature embryo sac.

### CONCEPTS

- ❖ Pollination- Types, pollinating agents, floral structures, mechanism

**Suggested Activities:** Observation of video/specimens, picture reading  
The mentor shows a video of wind pollination, water pollination and insect pollination. Provides cleistogamous flowers and chasmogamous flowers in groups. The learners observe them and discuss.

### Discussion points

- What is pollination?
- What are the main types of pollination?

- What is the difference between cleistogamous and chasmogamous flowers?
- What are the peculiarities of wind pollinated flowers?
- How does pollination in *Vallisneria* take place?
- What are the peculiarities of insect pollinated plants?
- How can you explain mutualism among *Yucca* and moth?
- 

### Assignment

- ◆ Complete the table given below.

Name of pollinating agent	Nature of pollinating agent	Floral features	Examples
1. Wind	Abiotic	.....	.....
2.....	.....	.....	.....
3.....	.....		

### Consolidation

- ◆ Pollination
  - Autogamy
  - Geitonogamy
  - Xenogamy
- ◆ Wind pollination
- ◆ Water pollination
- ◆ Insect pollination
- ◆

### CONCEPTS

- ❖ Outbreeding devices-types, pollen - pistil interaction, artificial hybridisation- steps and significance

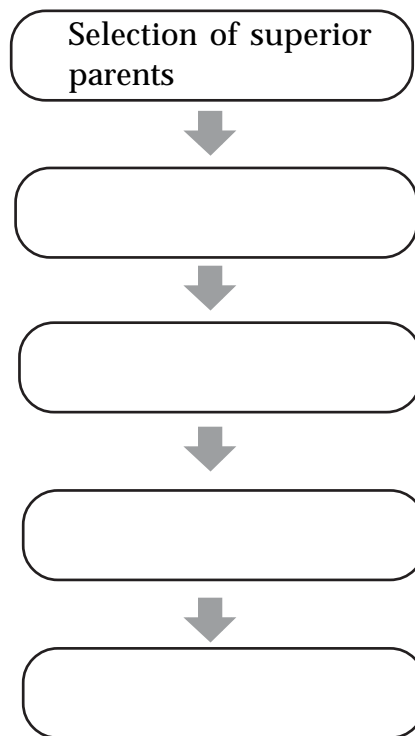
**Suggested Activities :** Picture reading, slide/animation/video observation, experiment.

The mentor shows specimens, video/photos of various adaptations of flowers to prevent self pollination. After this the mentor prepares a slide of pollen germination. The learners observe it. The mentor explains outbreeding devices.

**Discussion points**

- What are the different types of outbreeding devices?
- What is self incompatibility?
- What is dioecy?
- How does pollen germination occur?
- What do you mean by pollen-pistil interaction?
- 

Then the mentor shows the video/animation of hybridisation. After observing it, the mentor asks to complete the flow chart.

**Discussion points**

- What is emasculation and what is its significance?
- Why bagging is very important in hybridisation?
- 

**Consolidation**

- ◆ Outbreeding devices
- ◆ Pollen - pistil interaction

- ◆ Pollen growth
- ◆ Artificial hybridisation - steps, importance of each step.

### CONCEPTS

- ❖ Double fertilisation, syngamy, triple fusion,

**Suggested Activities :** Observation of chart/animation, general discussion

The mentor exhibits the animation/chart of events in fertilisation and explains it. Learners draw the diagram and prepare notes.

### **Discussion points**

- Where are the male gametes from the pollen tube released?
- What is the fate of male gamete?
- Why fertilisation in angiosperms is called double fertilisation?
- What are the products of syngamy and triple fusion?
- 

### **Consolidation**

- ◆ Double fertilisation- events, products
- ◆

### CONCEPTS

- ❖ Post-fertilisation events, endosperm development, embryo development- parts of embryo, structure of dicot and monocot embryo

**Suggested Activities :** General discussion

The mentor shows a chart of various kinds of endosperm development and development of the embryo. Asks to observe figure 2.13 in the T.B.

### **Discussion points**

- Endosperm development proceeds embryo development. Why?
- How can you explain endosperm formation in coconut?
- How do endosperm formation occur?
- What do you mean by embryogeny?
- What is proembryo?



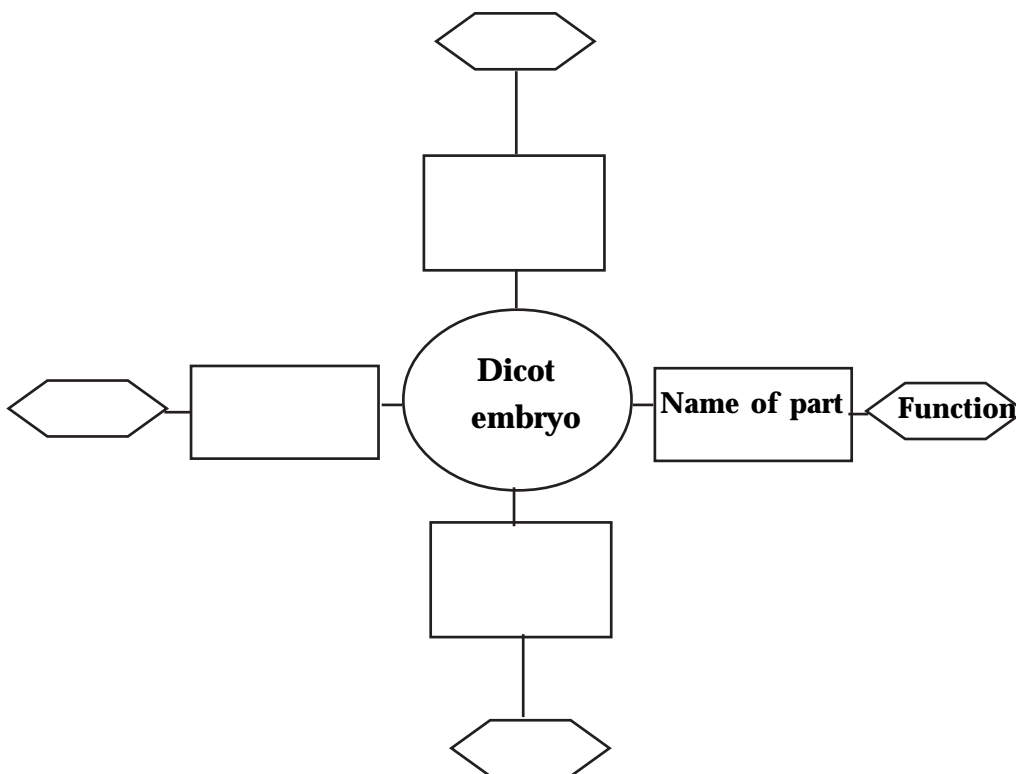
- How does a proembryo develop into a mature embryo?
- What are the parts of a dicot embryo?
- What are the parts of a monocot embryo?
- What are the differences between dicot embryo and monocot embryo?
- How can you differentiate coleoptile from coleorrhiza?
- 

**Consolidation**

- ◆ Endosperm development - types
- Embryo development - structure, types
- ◆

**Assignment**

1. Complete the concept map.



- ◆ 2. Complete the table given below.

Dicot embryo	Monocot embryo

### CONCEPTS

- ❖ Seed, fruit, apomixis, polyembryony

**Suggested Activities :** Collection, observation of specimens, discussion

The mentor provides some seeds in groups. Asks them to classify the seeds into albuminous seeds and non-albuminous seeds.

### Discussion points

- Which floral part is modified into a seed?
- Which are the parts of a seed?
- What is the difference between albuminous and non-albuminous seeds?
- What is perisperm?
- What is seed dormancy?
- What is pericarp?
- What is the difference between true fruit and false fruit?
- What is parthenocarpy?
- How long do the seeds remain alive after they are dispersed?
- What is apomixis?
- What is polyembryony?
- What is the importance of apomixis in agriculture?
- 

### Assignment

1. Draw and label the parts of monocot seed and dicot seed.
2. Compare the parts of ovule and seed filling the table given below.

Parts of ovule	Parts of seed	Function

Then asks to observe the fruits they collected and classify them as dry and fleshy fruits.

Nature of fruit	Peculiarities	Examples
Dry fruits		
Fleshy fruits		

Then asks to observe figure 2.15 in the text book and to complete the table given below.

Types of fruit	Peculiarities	Examples

### Consolidation

- ◆ Seed
- ◆ Albuminous and non - albuminous seed
- ◆ Perisperm
- ◆ Seed dormancy
- ◆ Pericarp
- ◆ Types of fruit
- ◆ Parthenocarpy
- ◆ Seed viability
- ◆ Apomixis and polyembryony
- ◆

### Assignment

- ◆ Prepare a note describing the advantages of angiosperms for wide dispersal citing suitable examples.

## Repository of CE

Process assessment	Portfolio assessment	Unit assessment
Collection Lab work Assignment Table completion Conceptmap completion	Completed assignments Prepared notes and sketches in the activity log and practical log Completed tables and concept map	Written test/Quiz

**SAMPLE TE QUESTIONS****I. Multiple choice questions**

1. Choose the correct statement.
  - a. Filiform apparatus plays an important role in guiding the pollen tube into synergids.
  - b. Intine is made up of sporopollenin
  - c. The stalk of the ovule is called funicle
 A. b only B. a only C. a and c D. a and b (Score - 1)
2. Egg apparatus consists of
  - A. Two egg cells and one synergid
  - B. One egg cell and one synergid
  - C. One egg cell and two antipodals
  - D. One egg cell and two synergids
 (Score - 1)
3. A parthenocarpic fruit is
  - A. Apple B. Strawberry C. Banana D. Cashew nut
 (Score - 1)
4. Select the correct sequence of hybridisation.
  - A. Selection of parents, pollination, bagging, emasculation
  - B. Selection of parents, emsculation, bagging, pollination
  - C. Bagging, selection of parents, pollination, emasculation
  - D. Bagging, emasculation, pollination, selection of parents
 (Score - 1)
5. Remnants of nucellus is called-----
  - A. Scutellum B. Perisperm C. Pericarp D. Coleoptile
 (Score - 1)

**II. Short answer type questions**

6. Write the name of any four parts of an ovule. (Score - 2)
7. Write any four features of wind pollinated flowers. (Score - 2)
8. Differentiate between coleoptile and coleorrhiza. (Score - 2)

**III. Essay type questions**

9. Plants use abiotic and biotic agents to achieve pollination.
  - a. Name the agents of pollination in Vallisneria.
  - b. Write any four features of insect pollinated flowers. (Score - 3)
10. Explain the structure of pollen grain. (Score - 3)

**TE Questions : Scoring Key**

<b>Q. No.</b>	<b>Scoring indicator</b>	<b>Splitted Score</b>	<b>Total Score</b>
1	C	1	1
2.	D	1	1
3.	C	1	1
4.	B	1	1
5.	B	1	1
6.	Hilum, funicle, chalaza, nucellus, embryo sac, micropyle, integuments (any four parts)	$\frac{1}{2} \times 4$	2
7.	Pollen grains are light, non sticky, well exposed stamens, large feathery stigma, large ovule, numerous flowers packed as inflorescence ( any four)	$\frac{1}{2} \times 4$	2
8.	Coleoptile- undifferentiated sheath enclosing the radicle Coleorrhiza- foliar structure enclosing the shoot apex	1 1	2
9.	a. Water B. Large flowers, sticky stamens, attractive colour, presence of honey, fragrance (any four)	1 $\frac{1}{2} \times 2$	3
10	Pollen grain has two layered wall, -outer exine and inner intine, Exine is hard made up of sporopollenin, exine has prominent apertures called germ pore. Intine is thin made up of cellulose and pectin. Pollen grain contains two cells -large vegetative cell, small generative cell (any six responses).	$\frac{1}{2} \times 6$	3

# Unit VIII

## Biology in Human Welfare

### Chapter 3 - Strategies for Enhancement in Food Production

#### **Introduction**

*The human being has utilised animals and plants for many years and at times has improved and domesticated them. At the present time our food, clothing, shelter, furniture and raw materials needed for many industries are obtained either directly or indirectly by making use of biological principles. Agriculture depends on the knowledge of the structure, function and development of domesticated plants and animals. Biological studies have contributed a great deal to each of these phases and the state of present day agriculture is the result of judicious application of the knowledge from various disciplines of biology.*

*Over the past decades the world's population has been increasing at a tremendous rate without an adequate supply of food resulting in food shortage in many parts of the world today. There is a need for improved varieties of plants and animals to sustain the economy.*

*The ever increasing demand of food from plants and animals both in terms of quality and quantity has been met by good plant breeding and animal husbandry practices. The animal husbandry practice includes management of farm and farm animals and animal breeding. Plant breeding may be used to create varieties which are resistant to pathogens and to insects / pests. In India, several varieties of different crop plants have been produced. The learners have already learnt about some superior varieties of plants and animals.*

#### **Values and Attitudes**

- Develops a positive attitude to cultivate plants and rear cattle for the sake of food security.
- Appreciates the gift of nature for the well being of its inhabitants in the form of various food resources.
- Constructs a kitchen garden with high yielding varieties of plants.

**Time : 12 Periods**

## Unit Frame

Concepts/Ideas and process skills	Process/Activity with assessment	Learning outcomes
<ul style="list-style-type: none"> <li>• Animal husbandry</li> <li>• Dairy farm management</li> <li>• Poultry farm management</li> <li>- Observing</li> <li>- Comparing</li> <li>- Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of video and picture</li> <li>• Discussion</li> <li>• Preparation of chart</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the importance of animal husbandry with special reference to dairy farm and poultry farm management.</li> </ul>
<ul style="list-style-type: none"> <li>• Animal breeding methods</li> <li>- Inbreeding</li> <li>- Outbreeding</li> <li>- Artificial insemination</li> <li>- MOET</li> <li>- Observing</li> <li>- Comparing</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of video and pictures</li> <li>• Discussion</li> <li>• Concept mapping</li> <li>• Preparation of notes</li> <li>• Assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Lists the importance of animal breeding and classifies animal breeding methods.</li> </ul>
<ul style="list-style-type: none"> <li>• Bee-keeping</li> <li>• Fisheries</li> <li>• Pisciculture</li> <li>• Aquaculture</li> <li>• Blue revolution</li> <li>• Green revolution</li> <li>- Observing</li> <li>- Classifying</li> <li>- Comparing</li> <li>- Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of video and picture</li> <li>• Discussion</li> <li>• Concept mapping</li> <li>• Preparation of notes</li> <li>• Assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses the importance of bee-keeping, fisheries and aquaculture.</li> <li>• Compares blue revolution and green revolution.</li> </ul>
<ul style="list-style-type: none"> <li>• Plant breeding -</li> <li>• Objectives</li> <li>• Steps</li> <li>• Plant varieties</li> <li>• Observing</li> <li>• Classifying</li> <li>• Differentiating</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of pictures</li> <li>• Discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Explains the steps in plant breeding and the methods of production of plants with desirable quantities and qualities.</li> </ul>



<b>Concepts/Ideas and process skills</b>	<b>Process/Activity with assessment</b>	<b>Learning outcomes</b>
<ul style="list-style-type: none"> <li>• Plant breeding for</li> <li>- disease resistant plants</li> <li>- insect/pest resistant plants</li> <li>- mutation breeding</li> <li>- Observing</li> <li>- Communicating</li> <li>- Comparing</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• Discussion</li> <li>• Table completion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Examines the application of plant breeding in the production of disease resistant and insect/pest resistant plants.</li> </ul>
<ul style="list-style-type: none"> <li>• Biofortification- objectives, examples</li> <li>• SCP Examples</li> <li>- Observing</li> <li>- Comparing</li> <li>- Communicating</li> <li>- Classifying</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of pictures</li> <li>• Discussion</li> <li>• Preparation of a list of biofortified plants and SCP</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Evaluates the application of plant breeding in biofortification and analyses the significance of SCP.</li> </ul>
<ul style="list-style-type: none"> <li>• Tissue culture</li> <li>• Explant</li> <li>• Totipotency</li> <li>• Micropropagation</li> <li>• Somaclones</li> <li>• Somatic hybridisation</li> <li>- Observing</li> <li>- Analysing</li> <li>- Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of video and photographs</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Explains tissue culture and somatic hybridisation.</li> </ul>

## *Towards the chapter*

### CONCEPTS

- ❖ Animal husbandry , dairy farm management, poultry farm management, animal breeding

**Suggested Activities** : Observation of video, discussion

The mentor shows a video clip of an ideal dairy farm and poultry farm and elicits the previous knowledge. Then leads a discussion.

### **Discussion points**

- What is animal husbandry?
- Which are the different areas in animal husbandry?
- What is dairying ?
- Which are the measures to be practiced for increasing yield and improving quality of milk?
- What is poultry? What are its important components?
- How can we prevent the spread of the bird flu?
- 

### **Consolidation**

- ◆ Animal husbandry-areas and scope
- ◆ Dairy farm management-success components
- ◆ Poultry farm management-components
- ◆ Bird flu
- ◆

### **Assignment**

- ◆ Prepare a list of good breeds of cattle and chicken.

### CONCEPTS

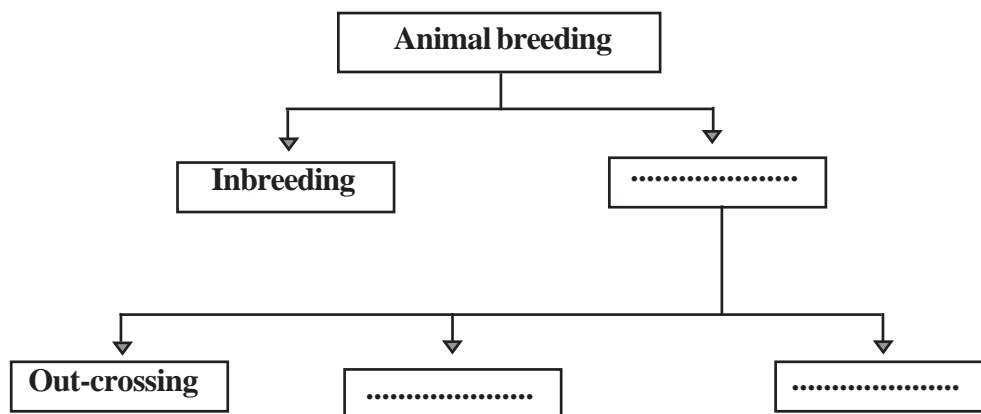
- ❖ Animal breeding- different methods, controlled breeding experiments- artificial insemination, MOET

**Suggested Activities** : Discussion based on photographs and video clips.

### Discussion points

- What is animal breeding?
- What is the difference between inbreeding and out-breeding?
- What are the demerits of inbreeding?
- How can we overcome homozygosity and inbreeding depression?
- How can you differentiate out-crossing and cross-breeding?
- What is Hisardale?
- Name the cross leads to the production of mule?
- What is artificial insemination?
- What are the main steps in MOET?
- How can you produce high quality breeds to increase herd size in a short time?
- 

The learner is directed to fill the concept map in the activity log.



### Consolidation

- ◆ Animal breeding-techniques and examples
- ◆ Inbreeding and out-breeding -merits and demerits
- ◆ Interspecific hybridisation
- ◆ Controlled breeding experiments-types, protocol
- ◆

### Assignment

- ◆ Collection of pictures of cross bred animals.

## CONCEPTS

- ❖ Bee-keeping, fisheries, pisciculture, aquaculture, blue revolution.

**Suggested Activities :** Observation, collection, discussion

The learners are asked to observe the video of various kinds of fish and ask them to identify them. The mentor provides the given table to classify the fish.

Fresh water fish	Marine fish
<ul style="list-style-type: none"><li>• Catla</li><li>•</li></ul>	<ul style="list-style-type: none"><li>• Hilsa</li><li>•</li></ul>

Then provides discussion points and asks to prepare notes in the activity log.

### Discussion points

- What is apiculture?
- Which are the major products of apiculture?
- What are the importance of honey and other bee products?
- Which is the most common species of honey bee ?
- Which are the points to be considered for successful bee-keeping?
- What is fisheries?
- What is the difference between pisciculture and aquaculture?
- What is blue revolution?
- 

### Consolidation

- ◆ Bee-keeping-significance, components
- ◆ Bee products
- ◆ Fisheries -examples
- ◆ Pisciculture
- ◆ Aquaculture
- ◆ Blue revolution
- ◆

### Assignment

- ◆ Table completion

Bee products	Uses
1 .....	1 .....
.....	.....

### CONCEPTS

- ❖ Green revolution, steps of plant breeding, varieties of wheat and rice, varieties of sugarcane, varieties of millets

**Suggested Activities :** Observation , discussion

The mentor elicits previous knowledge of hybridisation in flowering plants by asking simple questions.

- What is hybridisation?
- What is green revolution?
- What are the advantages of hybrids?
- 

The mentor exhibits photographs of some hybrid plants and provide discussion points.

### Discussion points

- What is plant breeding?
- Which are the main steps in plant breeding?
- Which are the common high yielding varieties of wheat and rice?
- How can hybridisation in sugarcane help to improve quality?
- Which millets are successfully developed in India?

### Consolidation

- ◆ Plant breeding-objectives
- ◆ Green revolution-significance
- ◆ Steps of plant breeding
- ◆ High yielding varieties of wheat and rice
- ◆ Hybridisation in sugarcane
- ◆ Millets
- ◆

## CONCEPTS

- ❖ Plant breeding for disease resistance- mutation breeding - insect pest resistance

**Suggested Activities:** General discussion, table completion

The mentor asks the learners to write some reasons of crop loss in their activity log. Prepare notes based on discussion.

### Discussion points

- Which are the main plant pathogens?
- Which are the major plant diseases?
- What is mutation breeding?
- What is the advantage of mutation breeding over conventional breeding?
- Which are the common examples for plant varieties developed by mutation breeding?
- How does plant breeding help in developing plants which are resistant to insect pests?
- 

The learners copy the tables and complete them.

Crop	Variety	Resistance to disease
Wheat	.....	.....
.....	Pusa swarnim	.....
Cauliflower	.....	.....
.....	.....	Bacterial blight
Chilli	.....	.....

Crop	Variety	Insect pest
Brassica	.....	Aphids
.....	Pusa sem 2	.....
.....	Pusa sem 3	.....
Okra	.....	.....

**Consolidation**

- ◆ Plant breeding for disease resistance
- ◆ Mutation breeding
- ◆ Plant breeding for insect/pest resistance
- ◆

**CONCEPTS**

❖ Biofortification, single cell protein.

**Suggested Activities :** Observation of pictures/video, discussion

The mentor shows a video of people suffering with poverty. Then asks simple questions related to this and introduce hidden hunger.

**Discussion points**

- How can we improve nutritional quality of plant products?
- What is biofortification?
- Which are the objectives of biofortification?
- Which are the common examples of fortified plants?
- What is SCP?
- What are the advantages of SCP?
- What are the common examples of SCP?
- 

**Consolidation**

- ◆ Biofortification -significance, aim, examples
- ◆ SCP-definition, significance
- ◆

**CONCEPTS**

❖ Tissue culture- protocol, micropropagation, totipotency, somaclones, meristem culture, somatic hybridisation

**Suggested Activities :** Observation of video on tissue culture and photograph of pomato.

The mentor exhibits a video clip of tissue culture in banana. The learner observes and write brief notes on steps of tissue culture in the activity log. Provides discussion points.

### Discussion points

- What is tissue culture?
- What is explant?
- What is totipotency?
- Why does tissue culture known as 'micropropagation'?
- What is somaclone?
- What is the significance of meristem culture?
- How can you produce a somatic hybrid?
- Which plant is a typical example for somatic hybridisation?
- 

### Consolidation

- ◆ Tissue culture - definition
- ◆ Explant
- ◆ Totipotency
- ◆ Micropropagation
- ◆ Somaclones
- ◆ Meristem culture
- ◆ Somatic hybridisation
- ◆

### Repository of CE

Process assessment	Portfolio assessment	Unit assessment
Collection	Collected materials	Work sheet/ Completion
Discussion	Prepared notes and completed tables in the	Written test
Assignment	Activity log	



**UNIT ASSESSMENT(WORK SHEET)**

Instruction: Answer all questions in the space provided below

1. What is the difference between out-crossing and cross-breeding?  
.....  
.....
2. How can we produce a pureline of an animal?  
.....  
.....
3. What is inbreeding depression?  
.....  
.....
4. What cross led to the production of mule?  
.....  
.....
5. Expand MOET.  
.....  
.....
6. Find out the difference between pisciculture and aquaculture?  
.....  
.....
7. Who is the Father of Indian green revolution?  
.....
8. Which are the major semi-dwarf varieties of rice and wheat?  
.....  
.....
9. How does mutation breeding help to produce disease resistant plants?  
.....  
.....
10. How pomato is produced?  
.....  
.....

## SAMPLE TE QUESTIONS

### I. Multiple choice questions

1. Select the group that contains marine fish only.  
(a) Hilsa, Pomfret, Rohu      (b) Pomfret, Catla, Common carp  
(c) Hilsa, Sardine, Mackerel      (d) Pomfret, Rohu, Catla  
(Score -1)
2. Which of the following is a freshwater fish  
(A) Rohu      (B) Hilsa  
(C) Sardine      (D) Pomfret  
(Score -1)
3. A semi-dwarf variety of wheat?  
(A) Ratna      (B) Taichung native-I  
(C) IR-8      (D) Sonalika  
(Score -1)
4. Which plant part is used for the production of virus - free plants through tissue culture?  
(Score -1)
5. What is meant by the term breed ?  
(Score -1)
6. What is explant?  
(Score -1)
7. What is germplasm collection?  
(Score -1)
8. .... is a wheat variety having high protein content and it is a good example for a fortified plant variety.  
(Score -1)
9. Two species of sugarcane were successfully crossed to get sugarcane varieties with high yeild.Which are the species of sugarcane used for crossing?  
(Score -2)
10. How can we produce a somatic hybrid?  
(Score -2)
11. What is inbreeding depression? How can we overcome it ? (Score -2)
12. What is plant breeding ?Which are the main steps of plant breeding?  
(Score -3)
13. What is biofortification?Briefly explain the objectives of biofortification  
(Score -3)

<b>TE Questions : Scoring Key</b>			
<b>Q. No.</b>	<b>Scoring indicator</b>	<b>Splitted Score</b>	<b>Total Score</b>
1	C. Hilsa, Sardine, Mackerel	1	1
2	A. Rohu	1	1
3	D. Sonalika	1	1
4	Meristem	1	1
5	A group of animals related by descent and similar in most characters	1	1
6.	Any plant part used for tissue culture	1	1
7.	The entire collection of plant /seeds having all the diverse alleles for all genes in a given crop is called germplasm collection	1	1
8.	Atlas 66	1	1
9.	Saccharum officinarum and Saccharum barberi	1 1	2
10.	Isolated protoplasts from two different varieties of plants each having a desirable character can be fused to get hybrid protoplasts. These protoplasts can be grown into somatic hybrid	1 1	2
11.	Continued inbreeding reduces fertility and productivity. It can be overcome by outbreeding	1 1	2
12	Plant breeding - definition 5 steps (½ x 5)	½ 2½	3
13.	Biofortification -definition 4 objectives (4 x ½)	1 2	3

### *More to know*

Hissardale : Hissardale was evolved at the Government Livestock Farm, Hissar, through crossbreeding Australian Merino rams with Bikaneri (Magra) ewes and stabilizing the exotic inheritance at about 75 per cent. There is a small flock of this breed at the Government Livestock Farm, Hissar. The rams of this breed were earlier distributed in the hilly regions of Kullu, Kangra etc.

Ref: ICAR -Central Sheep and Wool Research Institute  
Avikanagar(PO) Malpura, tonk(dist), Rajasthan

Tenualosa ilisha (ilish, hilsa, hilsa herring or hilsa shad) is a species of fish in the herring family (Clupeidae), and a popular food fish in South Asia. It is also the national fish of Bangladesh. The national fish of Bangladesh contributes about 12% of the total fish production and about 1% of GDP. About 450,000 people are directly involved with the catching for livelihood; around four to five million people are indirectly involved with the trade.

The millets are considered to have been cultivated in India from pre-historic times. Their importance as an article of human food can be realized from the fact that about 30 million acres in India fall under millets.

Millets are generally grown as mixed crops in regions of low rainfall, the other crop grown with them being usually one of the legumes. Most of the millets grown in our country are of short duration, taking, three to four months from sowing to harvesting. Some of India are sorghum pearl millet and finger millet.

E.g. Sorghum, Pear Millet, Oat, Rye, Gorgon Nut

# Unit IX

## Biotechnology

### Chapter 4 - Biotechnology : Principles and Processes

#### **Introduction**

*In a simple way biotechnology refers to any application of biology for human welfare. In this sense practice of biotechnology is ancient including plant and animal breeding by early civilisations, use of yeasts in food and beverage preparations etc. The term biotechnology was first used by Hungarian engineer Karoly Ereky in 1919 to describe the industrial production of pigs by feeding them sugar beets as an inexpensive source of nutrients.*

*The development of biotechnology as a branch of science from its early form of cultural practices is through a number of theoretical, methodological and conceptual changes in the study of life and life processes. Today the science of biotechnology is an integration of biology, chemistry, physics, mathematics and computer science. It is a product oriented science to benefit humans in areas like agriculture, industry and medicine.*

*Most scientific terms have clear definitions. But the term biotechnology was interpreted to mean different by different people/organisations. For example according to United Nations Convention on Biological Diversity 'biotechnology is technology based on biology, especially when used in agriculture, food science and medicine'. In the view of American Association for the Advancement of Science biotechnology is the use of living things to make products and the European Federation of Biotechnology defines biotechnology as the integration of natural science and organisms, cells, parts there of and molecular analogues for products and services. This chapter deals with the tools and processes of biotechnology.*

#### **Values and Attitudes**

- Appreciates scientists who tailored biomolecules for human welfare.
- Develops an attitude to engage in biotechnological experiments.

**Time : 9 Periods**

## Unit Frame

Concepts/Ideas and process skills	Process/Activity with assessment	Learning outcomes
<ul style="list-style-type: none"> <li>• Biotechnology-Principles</li> <li>• Genetic engineering rDNA</li> <li>Gene cloning</li> <li>Gene transfer</li> <li>- Observing</li> <li>- Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• Slide/video observation,</li> <li>• General discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the development of biotechnology and the major terminologies used in it.</li> </ul>
<ul style="list-style-type: none"> <li>• Tools of rDNA technology</li> <li>- Restriction enzymes</li> <li>- Palindromic sequences</li> <li>- DNA ligases</li> <li>- Observing</li> <li>- Comparing</li> <li>- Communicating</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• Slide/chart observation</li> <li>• Discussion</li> <li>• Preparation of table</li> <li>• Preparation of notes</li> <li>• Assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses the nature of restriction enzymes and DNA ligases and compares them.</li> </ul>
<ul style="list-style-type: none"> <li>• Separation and isolation of DNA fragments</li> <li>• Gel electrophoresis-steps</li> <li>- Observing</li> <li>- Communicating</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of video on gel electrophoresis</li> <li>• Discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the principle of separation of DNA fragments during agarose gel electrophoresis.</li> </ul>
<ul style="list-style-type: none"> <li>• Cloning vectors</li> <li>- features</li> <li>• Insertional inactivation</li> <li>• Competent host</li> <li>• Heat shock</li> <li>• Microinjection</li> <li>- Observing</li> <li>- Communicating</li> <li>- Analysing</li> <li>• Vectors for plant and animals</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of slides</li> <li>• Discussion</li> <li>• Drawings in practical log (PE)</li> <li>• Preparation of notes</li> <li>• Assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses the types of cloning vectors and the uses of plasmid vector in rDNA technology and identifies the vectors for cloning genes in plants and animals.</li> </ul>

<b>Concepts/Ideas and process skills</b>	<b>Process/Activity with assessment</b>	<b>Learning outcomes</b>
<ul style="list-style-type: none"> <li>• Biolistics</li> <li>• Disarmed pathogen</li> <li>- Observing</li> <li>- Communicating</li> <li>- Comparing</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of slides/video</li> <li>• Discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Evaluates competency and explains various methods of gene transfer.</li> </ul>
<ul style="list-style-type: none"> <li>• Process of rDNA technology</li> <li>• Isolation of DNA</li> <li>• Cutting of DNA at specific locations</li> <li>- Observing</li> <li>- Comparing</li> <li>- Communicating</li> <li>- Interpreting data</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of slides</li> <li>• Discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies and compares the methods to extract DNA from different groups of organisms.</li> </ul>
<ul style="list-style-type: none"> <li>• Gene amplification by PCR</li> <li>• Insertion of rDNA into host organism</li> <li>• Observing</li> <li>• Interpreting data</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of slides/ video</li> <li>• Discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the method and process of gene amplification.</li> </ul>
<ul style="list-style-type: none"> <li>• Obtaining the foreign gene product</li> <li>• Bioreactors</li> <li>• Downstream processing</li> <li>• Observing</li> <li>• Inferring</li> </ul>	<ul style="list-style-type: none"> <li>• Drawing diagram in practical log (P.E). Preparation of notes</li> <li>• Discussion</li> </ul>	<ul style="list-style-type: none"> <li>• Recommends the use of bioreactors and identifies the importance of downstream processing.</li> </ul>

## *Towards the chapter*

### **CONCEPTS**

- ❖ Biotechnology, principle, genetic engineering, rDNA, gene cloning, plasmid

**Suggested Activities** : Slide/video observation, discussion

The mentor asks few questions to introduce the content.

- Have you heard about Bt cotton and Bt brinjal? What are their specialities and how they are produced?
- How human insulin used in the treatment of diabetes is produced?
- 

The mentor shows slides on the work of Stanley Cohen and Herbert Boyer and conducts a discussion on the development of rDNA technology.

### **Discussion points**

- What is the definition of biotechnology given by EFB?
- What are the principles of biotechnology ?
- What is a plasmid?
- What is meant by vector?
- What are restriction enzymes?
- What is meant by origin of replication?
- What is cloning?
- Which was the first rDNA experiment?
- Which are the basic steps of genetic engineering?
- 

### **Consolidation**

- ◆ Biotechnology -Definition by EFB
- ◆ Gene cloning
- ◆ Gene transfer
- ◆ Plasmid
- ◆



## CONCEPTS

- ❖ Restriction enzymes, palindromic sequences, DNA ligases

**Suggested Activities** : Observation of slide/chart, assignment, discussion

The mentor exhibits slides on the nature and types of restriction enzymes and the way they are named.

- How restriction enzymes are classified?
- How restriction enzymes are named?
- 

The mentor asks the learners to complete the following table.

Genus name	Species name	Strain	Order of discovery	Name of restriction enzymes
<i>Escherichia</i>	<i>coli</i>	RY13	I	EcoRI
<i>Proteus</i>	<i>vulgaris</i>		I	
<i>Providencia</i>	<i>stuartii</i>		I	
<i>Haemophilus</i>	<i>influenzae</i>	d	III	
<i>Caryophanon</i>	<i>latum</i>			
<i>Streptomyces</i>	<i>albus</i>			
<i>Bacillus</i>	<i>amyloliquefaciens</i>	H		

The mentor presents a chart of palindromic sequences.

## Discussion points

- What is meant by palindromic sequences ?
- How do restriction endonuclease act?
- What is the function of DNA ligase?
-

## Consolidation

- ◆ Restriction enzymes
- ◆ Exonuclease and endonuclease
- ◆ Naming protocol of restriction enzyme
- ◆ Palindromic sequence
- ◆ Sticky ends
- ◆ DNA ligases
- ◆

## Assignment

1. Prepare 5 palindromic sequences.

After consolidation ask to draw the steps in the formation of rDNA by the action of restriction endonuclease.

## CONCEPTS

- ❖ Separation and isolation of DNA fragments- Gel electrophoresis

**Suggested Activities :** Slide/video observation of agarose gel electrophoresis, discussion

The mentor exhibits a video on agarose gel electrophoresis and leads a discussion.

## Discussion points

- What is the charge of DNA?
- How DNA molecule can be cut?
- How we can separate DNA fragments?
- How DNA is visualised after electrophoresis?
- What is elution?
- 

## Consolidation

- ◆ Gel electrophoresis- steps, medium
- ◆ Elution of DNA
- ◆

## CONCEPTS

- ❖ Cloning vectors - features, examples, vectors for plant and animal cells.

**Suggested Activities :** Slide presentation, picture reading (P.E), discussion

The mentor presents slides on different types of cloning vectors and the detailed structure of plasmid vector. The mentor asks the learners to draw the structure of plasmid vector pBR322 in their practical log (P.E). Then the mentor exhibits slides on how selectable markers and insertional inactivation help in the identification of recombinant cells/organisms. Also exhibits slides on the vectors of plant and animal cells.

## Discussion points

- What is meant by a cloning vector?
- What are the major cloning vectors used in rDNA technology?
- What are the main components of a plasmid vector?
- What is meant by ori?
- What is the use of selectable marker?
- What are the major marker genes used in rDNA technology?
- What is meant by a cloning site?
- How cloning site and recognition site are related?
- What happens to the antibiotic resistant gene in the cloning site after ligation?
- How silencing of antibiotic resistant gene becomes helpful in the identification of recombinants?
- What is the disadvantage of using two antibiotic resistant genes as markers for the identification of recombinants?
- How insertional inactivation of an enzymatic marker gene tunes helpful in the easy identification of recombinants?
- How can we use *Agrobacterium tumifaciens* for transforming plants?
- How retroviruses become useful in transforming animal cells?

## Consolidation

- ◆ Cloning vector - features
- ◆ pBR322

- ◆ Insertional inactivation
- ◆ Ti plasmid
- ◆ Retroviruses
- ◆

### Assignment

- ◆ Expand the names of restriction enzymes seen in pBR322.

### CONCEPTS

- ❖ Competent host, micro-injection, biolistics

**Suggested Activities:** Slide/video observation, discussion

The mentor exhibits slides/video on various methods of gene transfer.

### Discussion points

- How bacterial cells can be made competent to take up DNA?
- How micro-injection is practiced in rDNA technology?
- What are the uses of biolistics/gene gun in rDNA technology?
- 

### Consolidation

- ◆ Bacterial competency to take up DNA
- ◆ Competence
- ◆ Micro-injection, Biolistics, disarmed pathogen
- ◆

### CONCEPTS

- ❖ Process of recombinant DNA technology- isolation of DNA, cutting of DNA at specific locations

**Suggested Activities :** Slide /video observation, discussion

The mentor shows slides on extraction of DNA from various organisms.

### Discussion points

- Which is the genetic material in organisms?
- Where is DNA located in prokaryotic and eukaryotic organisms?
- How DNA can be isolated from bacteria, plant cells, fungi and animal cells using enzymes?

- How DNA can be purified and precipitated out?
- How DNA can be cut at specific locations?
- How DNA fragments can be separated out?
- How DNA fragments can be joined?
- 

### Consolidation

- ◆ Lysozyme, cellulase, chitinase
- ◆ Purification
- ◆ DNA precipitation
- ◆ Cutting of DNA at specific locations
- ◆

### CONCEPTS

- ❖ Amplification of gene of interest by PCR, insertion of rDNA into the host cell/organism.

**Suggested Activities :** Slide/video observation, assignment, discussion

The mentor presents slide/video of PCR and discusses the various molecules and steps involved in it. The mentor asks the learners to prepare a chart showing PCR.

### Discussion points

- What is the full form of PCR?
- What are the various biomolecules required for PCR?
- What are the different steps involved in PCR?
- Why Taq polymerase is used in PCR?
- What are the different methods to introduce rDNA into the host cell/organisms?
- How can we identify recombinant cells/organisms from non-recombinant ones?
- 

### Consolidation

- ◆ Polymerase Chain Reaction -steps
- ◆ Taq polymerase

- ◆ *Thermus aquaticus*
- ◆

## CONCEPTS

- ❖ Bioreactors , downstream processing

**Suggested Activities:** Slide/video observation, visit to industries, picture reading of bioreactor (P.E), discussion

The mentor presents slides/video on commercial production of foreign gene products and their purification. The mentor organises a visit to food/ pharmaceutical industry. After that organises a discussion and asks to refer TB figure 11.7.

### **Discussion points**

- How recombinant proteins are produced in large scale?
- How bioreactors provide optimal conditions for achieving desired product?
- What are the advantages of stirred tank bioreactors?
- What is meant by downstream processing?
- 

### **Consolidation**

- ◆ Bioreactors - types - peculiarities
- ◆ Downstream processing
- ◆

### **Repository of CE**

Process assessment	Portfolio assessment	Unit assessment
Table completion Lab work Participation Assignment	Prepared notes and sketches in the activity log and practical log Completed tables and assignment	Unit test

## SAMPLE TEST QUESTIONS

- Which of the following is a palindromic sequence? (Score-1)
 

a. CGTATG	b. CGAATG	c. GAATTC	d. GACTAC
GCATAC	CGAATG	CTTAAGx	TAGCAC
- Gene amplification using primers can be done by (Score-1)
 

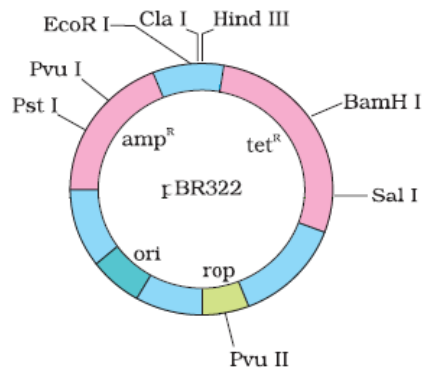
a. Micro-injection	b. ELISA	c. Gene gun	d. PCR
--------------------	----------	-------------	--------
- Which of the following is correctly matched (Score-1)
 

a. Agrobacterium-tumour	b. Thermus aquaticus - Bt gene
c. pBR322- $\text{ori}$ enzyme	d. Ligase- molecular scissors
- Match column I with column II (a) (Score-2)
 

Column I	Column II
a. Selectable marker	(i) DNA staining
b. Ethium bromide	(ii) Stirring type
c. Bioreactor	(iii) DNA replication
d. Ori	(iv) ampR
- Complete the given passage with appropriate words or phrases. (Score-2)
 

The first restriction endonuclease discovered was ..... and the convention for naming these RE are as follows. The first letter refers to the.....(b).....of the bacterial cell and the second two letters refer to its .....(c)..... from which it has been isolated, followed by the name of the .....(d)..... and the Roman numerals ,at the end indicates the order in which that RE was isolated.
- What are palindromes? What is the use of palindromic sequences in recombinant DNA technology? (Score-2)
- Write two methods of direct gene transfer (Score-2)
- Briefly explain gel electrophoresis. (Score-2)

9. What is insertional inactivation? How does insertional inactivation helps in the identification of recombinants. (Score-3)
10. Observe the diagram and answer the following questions.



- (a) Write one selectable marker
- (b) Write any two cloning sites (Score-3)



<b>TE Questions : Scoring Key</b>			
<b>Q. No.</b>	<b>Scoring indicator</b>	<b>Splitted Score</b>	<b>Total Score</b>
1	c. GAATTC CTTAAG	1	1
2.	(d) PCR	1	1
3.	(a) Agrobacterium- tumour	1	1
4.	a. Selectable marker - ampR b. Ethium bromide - DNA staining c. Bioreactor - Stirring type d. Ori - DNA replication	$\frac{1}{2} \times 4$	2
5.	a. Hind II b. Genus c. Species d. Strain	$\frac{1}{2} \times 4$	2
6.	It is a sequence of base pairs that reads same on the two strands when orientation of reading is kept same RE cut the strands of DNA a little away from the centre of palindrome site	1 1	2
7.	Micro- injection Biolistics /Gene gun	1 1	2
8.	Brief explanation of the separation and isolation of DNA fragments	2	2
9.	When a recombinant DNA is inserted within the coding sequence of an enzyme, the enzyme is inactivated. It is called insertional inactivation Insertional inactivation of the beta galactosidase results the bacterial colonies do not produce any colour, while other colonies produce blue colour. So recombinant colonies can be easily identified.	1 1 1	3
10.	a) Anyone selectable marker b) Any two cloning site	1 2	3

## *More to know*

### ISOLATION OF DNA

To obtain DNA in a relatively purified form which can be used for further investigations, i.e. PCR, sequencing, etc

#### PROTOCOL:

- Most DNA extraction protocols consist of two parts
  1. A technique to lyse the cells gently and solubilize the DNA
  2. Enzymatic or chemical methods to remove contaminating proteins, RNA, or macromolecules
- In plants, the nucleus is protected within a nuclear membrane which is surrounded by a cell membrane and a cell wall. Four steps are used to remove and purify the DNA from the rest of the cell.
  1. Lysis: grind in Liquid N<sub>2</sub> and use detergent
  2. Precipitation Part I: phenol/chloroform extraction to get rid of proteins
  3. Precipitation Part II: addition of salts to interrupt hydrogen bonding between water and phosphates on the DNA
  4. Precipitation Part III: addition of ethanol to pull DNA out of solution
  5. Wash and resuspend: DNA is washed in ethanol, dried, and resuspended in H<sub>2</sub>O or TE buffer.

**Lysis:** The cell wall (made of cellulose) is disrupted by mechanical force (for example, grinding the leaves) .Then the addition of a detergent in the which breaks down the cell membranes

Detergents are able to disrupt membranes due to the amphipathic (having both hydrophilic and hydrophobic regions) nature of both cellular membranes and detergent molecules. The detergent molecules are able to pull apart the membranes

The end result of LYSIS is that the contents of the plant cells are distributed in solution.

#### Precipitation Part I

The second part of DNA precipitation is the addition of salts. The salts interrupt the hydrogen bonds between the water and DNA molecules.

#### Precipitation Part II

The DNA is then precipitated from the protein in a subsequent step with isopropanol or ethanol. In the presence of cations, ethanol induces a structural change in DNA molecules that causes them to aggregate and precipitate out of solution. The DNA is pelleted by spinning with a centrifuge and the supernatant removed

**Washing:** The precipitated DNA is laden with acetate salts. It is “washed” with a 70% ethanol solution to remove salts and other water soluble impurities but not resuspend the DNA.

**Resuspension:** The clean DNA is now resuspended in a buffer to ensure stability and long term storage. The most commonly used buffer for resuspension is called 1xTE

Overview of DNA isolation

Checking the Quality of isolated DNA

- The product of your DNA extraction will be used in subsequent experiments
- Poor quality DNA will not perform well in PCR

### **POLYMERASE CHAIN REACTIO(PCR)**

- Polymerase Chain Reaction—first described in 1971 by Kleppe and Khorana, re-described and first successful use in 1985
- Allows massive amplification of specific sequences that have defined endpoints

#### **Requirements:**

1. Template DNA that contains the “target sequence”
2. Primers: short oligonucleotides that define the ends of the target sequence
3. Thermostable DNA polymerase
4. Buffer, dNTPs
5. A thermal cycler

**Denaturation:** denature template strands (94°C for 2-5 minutes), can also add your DNA polymerase at this temp. for a “hot start” (adding DNA pol to a hot tube can prevent false priming in the initial round of DNA replication)

**Annealing:** The default is usually 55°C. This temperature variable is the most critical one for getting a successful PCR reaction. This is the best variable to start with when trying to optimize a PCR reaction for a specific set of primers. Annealing temperatures can be dropped as low as 40-45°C, but non-specific annealing can be a problem

**Extension:** generally 72°C, this is the operating temperature for many thermostable DNA polymerases.

**Number of cycles:** Depends on the number of copies of template DNA and the desired amount of PCR product. Generally 20-30 cycles is sufficient.

## AGAROSE GEL ELECTROPHORESIS

- Electrophoresis is a method of separating substances based on the rate of movement while under the influence of an electric field.
- Agarose is a polysaccharide purified from seaweed. An agarose gel is created by suspending dry agarose in a buffer solution, boiling until the solution becomes clear, and then pouring it into a casting tray and allowing it to cool. The result is a flexible gelatin-like slab.
- During electrophoresis, the gel is submerged in a chamber containing a buffer solution and a positive and negative electrode.
- The DNA to be analyzed is forced through the pores of the gel by the electrical current. Under an electrical field, DNA will move to the positive electrode (red) and away from the negative electrode (black).
- Several factors influence how fast the DNA moves, including; the strength of the electrical field, the concentration of agarose in the gel and most importantly, the size of the DNA molecules. Smaller DNA molecules move through the agarose faster than larger molecules. DNA itself is not visible within an agarose gel.
- The DNA will be visualized by the use of a dye that binds to DNA.

Purpose: To determine the presence or absence of PCR products and quantify the size (length of the DNA molecule) of the product.

Materials needed: Agarose, TAE Buffer, 6X Sample Loading Buffer, DNA ladder standard, Electrophoresis chamber, Power supply, Gel casting tray and combs, DNA stain, Staining tray, Gloves, Pipette and tips

Recipes: TAE Buffer, 4.84 g Tris Base, 1.14 ml Glacial Acetic Acid, 2 ml 0.5M EDTA (pH 8.0), - bring the total volume up to 1L with water

Add Tris base to ~900 ml H<sub>2</sub>O. Add acetic acid and EDTA to solution and mix. Pour mixture into 1 L graduated cylinder and add H<sub>2</sub>O to a total volume of 1 L.

Note - for convenience a concentrated stock of TAE buffer (either 10X or 50X) is often made ahead of time and diluted with water to 1X concentration prior to use.

### 6X Sample Loading Buffer

1 ml sterile H<sub>2</sub>O

1 ml Glycerol

enough bromophenol blue to make the buffer deep blue (~ 0.05 mg)

-for long term storage, keep sample loading buffer frozen.

### QUIKView DNA Stain

25 ml WARDS QUIKView DNA Stain

475 ml warm water (50-55° C)

Preparing the agarose gel

- Measure 1.25 g Agarose powder and add it to a 500 ml flask
- Add 125 ml TAE Buffer to the flask. (the total gel volume will vary depending on the size of the casting tray)
- Melt the agarose in a microwave or hot water bath until the solution becomes clear. (if using a microwave, heat the solution for several short intervals - do not let the solution boil for long periods as it may boil out of the flask).
- Let the solution cool to about 50-55°C, swirling the flask occasionally to cool evenly.
- Seal the ends of the casting tray with two layers of tape.
- Place the combs in the gel casting tray.
- Pour the melted agarose solution into the casting tray and let cool until it is solid (it should appear milky white).
- Carefully pull out the combs and remove the tape.
- Place the gel in the electrophoresis chamber.
- Add enough TAE Buffer so that there is about 2-3 mm of buffer over the gel.

Note – gels can be made several days prior to use and sealed in plastic wrap (without combs). If the gel becomes excessively dry, allow it to rehydrate in the buffer within the gel box for a few minutes prior to loading samples.

**Loading the gel**

- Add 6 ml of 6X Sample Loading Buffer to each 25 ml PCR reaction
- Record the order each sample will be loaded on the gel, including who prepared the sample, the DNA template - what organism the DNA came from, controls and ladder.
- Carefully pipette 20 ml of each sample/Sample Loading Buffer mixture into separate wells in the gel.
- Pipette 10 ml of the DNA ladder standard into at least one well of each row on the gel.

Note – if you are running multiple gels, avoid later confusion by loading the DNA ladder in different lanes on each gel.

**Running the gel**

- Place the lid on the gel box, connecting the electrodes.

- Connect the electrode wires to the power supply, making sure the positive (red) and negative (black) are correctly connected. (Remember – “Run to Red”)
- Turn on the power supply to about 100 volts. Maximum allowed voltage will vary depending on the size of the electrophoresis chamber – it should not exceed 5 volts/ cm between electrodes! .
- Check to make sure the current is running through the buffer by looking for bubbles forming on each electrode.
- Check to make sure that the current is running in the correct direction by observing the movement of the blue loading dye – this will take a couple of minutes (it will run in the same direction as the DNA).
- Let the power run until the blue dye approaches the end of the gel.
- Turn off the power.
- Disconnect the wires from the power supply.
- Remove the lid of the electrophoresis chamber.
- Using gloves, carefully remove the tray and gel.

#### **Gel Staining**

- Using gloves, remove the gel from the casting tray and place into the staining dish.
- Add warmed (50-55°) staining mix.
- Allow gel to stain for at least 25-30 minutes (the entire gel will become dark blue).
- Pour off the stain (the stain can be saved for future use).
- Rinse the gel and staining tray with water to remove residual stain.
- Fill the tray with warm tap water (50-55°). Change the water several times as it turns blue. Gradually the gel will become lighter, leaving only dark blue DNA bands. Destain completely overnight for best results.
- View the gel against a white light box or bright surface.
- Record the data while the gel is fresh, very light bands may be difficult to see with time.

Note – Gels stained with blue stains are stable for long periods. When destaining is complete, remove gel from water and allow the gel to dehydrate. Dark bands can be seen for in a dried gel for weeks or months.

## Unit IX

# Biotechnology

## Chapter 5 - Biotechnology and its Applications

### **Introduction**

*Contrary to its name, biotechnology is not a single technology, rather it is a group of technologies that share two (common) characteristics — working with living cells and their molecules and having a wide range of practice uses that can improve our lives.*

*The applications of biotechnology are so broad, and the advantages so compelling, that virtually every industry is using this technology. Developments are under way in areas as diverse as pharmaceuticals, diagnostics, textiles, aquaculture, forestry, chemicals, household products, environmental clean-up, food processing and forensics to name a few. Biotechnology is enabling these industries to make new or better products, often with greater speed, efficiency and flexibility. Biotechnology is at a crossroads in terms of public acceptance. The future of the world food supply depends upon how well scientists, government, and the food industry are able to communicate with consumers about the benefits and safety of the technology.*

*Biotechnology, in the form of genetic engineering, is a facet of science that has the potential to provide important benefits if used carefully and ethically. Through genetic engineering, genetically modified crops or organisms are formed. These GM crops or GMOs are used to produce biotech-derived foods. In this chapter we discuss the biotechnological applications in agriculture, medicine and uses of transgenic animals.*

### **Values and Attitudes**

- Appreciates the biotechnological applications for the service of human welfare.
- Develops an interest to produce and protect various biotechnological products.

**Time : 10 Periods**

## Unit Frame

Concepts/Ideas and process skills	Process/Activity with assessment	Learning outcomes
<ul style="list-style-type: none"> <li>• Types of agriculture</li> <li>• Uses of GM plants</li> <li>- Observing</li> <li>- Comparing</li> <li>- Communicating</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• Slide observation</li> <li>• General discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses the application of biotechnology in agriculture.</li> </ul>
<ul style="list-style-type: none"> <li>• Bt cotton</li> <li>• Bt toxin</li> <li>• Insecticidal protein</li> <li>• Cry genes</li> <li>- Observing</li> <li>- Comparing</li> <li>- Interpreting data</li> <li>- Evaluating</li> </ul>	<ul style="list-style-type: none"> <li>• Video/slide observation</li> <li>• Discussion</li> <li>• Picture reading (P.E)</li> <li>• Preparation of notes and drawings in the activity log and practical log</li> </ul>	<ul style="list-style-type: none"> <li>• Evaluates the development of Bt cotton by genetic engineering .</li> </ul>
<ul style="list-style-type: none"> <li>• Pest resistant plants</li> <li>• RNA interference</li> <li>• Double stranded RNA</li> <li>- Nematode worms</li> <li>- Observing</li> <li>- Communicating</li> <li>- Evaluating</li> </ul>	<ul style="list-style-type: none"> <li>• Slide/video observation</li> <li>• Discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses the application of RNAi in the production of pest resistant plants.</li> </ul>
<ul style="list-style-type: none"> <li>• Biotechnological application in medicine</li> <li>• Genetically engineered insulin</li> <li>- Observing</li> <li>- Comparing</li> <li>- Communicating</li> <li>- Inferring</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Slide/video observation</li> <li>• Picture reading</li> <li>• Preparation of notes</li> <li>• Assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the production of genetically engineered insulin and sketches the structure of insulin molecule.</li> </ul>



Concepts/Ideas and process skills	Process/Activity with assessment	Learning outcomes
<ul style="list-style-type: none"> <li>• Gene therapy</li> <li>- ADA deficiency</li> <li>- Treatment-types</li> <li>- retroviral vector</li> <li>- Observing</li> <li>- Analysing</li> <li>- Inferring</li> </ul>	Slide observation Discussion Preparation of notes	<ul style="list-style-type: none"> <li>• Identifies gene therapy and compares it with other types of treatment methods.</li> </ul>
<ul style="list-style-type: none"> <li>• Molecular diagnosis</li> <li>• Conventional methods</li> <li>• PCR</li> <li>• rDNA technology</li> <li>• ELISA</li> <li>• Autoradiography</li> <li>- Observing</li> <li>- Communicating</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• Slide/video observation</li> <li>• Discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Compares and recommends various types of molecular diagnostic methods.</li> </ul>
<ul style="list-style-type: none"> <li>• Transgenic animals</li> <li>- Normal physiology and development</li> <li>- Study of diseases</li> <li>- Biological products</li> <li>- Vaccine safety</li> <li>- Chemical safety testing</li> <li>• Ethical issues</li> <li>• GEAC</li> <li>• Patent</li> <li>• Biopiracy</li> <li>- Communicating</li> <li>- Analysing</li> <li>- Inferring</li> </ul>	<ul style="list-style-type: none"> <li>• Seminar</li> <li>• General discussion</li> <li>• Slide/video observation</li> <li>• Preparation of notes</li> <li>• Assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses and categorises the various uses of transgenic animals.</li> <li>• Evaluates the ethical issues of genetic engineering and judges the various aspects of patent and biopiracy.</li> </ul>

## *Towards the chapter*

### **CONCEPTS**

- ❖ Research areas of biotechnology, types of agriculture, green revolution, Genetically Modified Organisms - uses, Bt cotton, Bt toxin, insecticidal proteins, cry genes

**Suggested Activities** : Discussion video/slide observation, lab work

The mentor shows a video of various kinds of agriculture and genetically engineered crops. Asks simple questions.

- Which are the different kinds of agriculture?
- What is green revolution ?
- Which are the different research areas of biotechnology?

Then asks about GMO.

- What is GMO?
- Which are the uses of GMO?
- 

The mentor exhibits the video of Bt cotton, asks to observe and compare Figure 12.1 (PE) and then provides discussion points.

- What does Bt stand for?
- Which kind of protein is produced by the bacterium?
- What are the peculiarities of this protein?
- Why Bt toxins are referred as insect specific?
- Which are the common insects that can be controlled by Bt toxin?
- What do you mean by cry genes? give examples.
- 

### **Consolidation**

- ◆ Research areas of biotechnology
- ◆ Different types of agriculture
- ◆ Green revolution
- ◆ Uses of GMO
- ◆ *Bacillus thuringiensis* - Bt toxin
- ◆ Insecticidal proteins

- ◆ Cry genes
- ◆

### CONCEPTS

- ❖ Pest resistant plants, RNA interference, double stranded RNA, nematode worms

**Suggested Activities :** General discussion, observation of animation/video and pictures

### **Discussion points**

- What are pests ?
- What is RNAi ?
- How does the mechanism of RNAi help in the production of pest resistant tobacco plants?
- Which pest can be controlled by this method ?
- Which vector is used in RNAi ?
- What is the role of double stranded RNA in mRNA silencing ?
- 

### **Consolidation**

- ◆ RNA interference - Protocol
- ◆ *Meloidegyne incognita*
- ◆ Cellular defense mechanism
- ◆

### CONCEPTS

- ❖ Biotechnological application in medicine, genetically engineered insulin

**Suggested Activities :** Slide/video observation, picture reading, general discussion.

The mentor shows a video/animation on the structure and formation of insulin. Organises a general discussion on the production of insulin through genetic engineering. Asks to observe figure 12.3.

### Discussion points

- How many recombinant therapeutics are approved for human use all over the world?
- What is the structure of human insulin?
- What is the demerit of insulin produced from the pancreas of slaughtered animals?
- Which are the polypeptide chains present in proinsulin?
- How does active insulin molecule develop from proinsulin?
- How does Eli Lilly company prepare human insulin by genetic engineering?
- 

### Consolidation

- ◆ Recombinant therapeutics
- ◆ Insulin prepared from animals
- ◆ Insulin- structure, maturation
- ◆ Preparation of genetically engineered insulin
- ◆

### Assignment

- ◆ Draw the diagram of maturation of proinsulin into insulin.

### CONCEPTS

- ❖ Gene therapy, ADA deficiency - treatment methods.

**Suggested Activities :** Slide observation, discussion.

The mentor shows slides of gene therapy and provides discussion points.

### Discussion points

- What is gene therapy?
- Which was the first gene therapy? When was it done?
- What is ADA?
- How does ADA deficiency affect man?
- Which were the early methods used for the treatment of ADA deficiency?
- How can we overcome ADA deficiency through gene therapy?
- What is ADA cDNA?
-

**Consolidation**

- ◆ Gene therapy
- ◆ Adenosine Deaminase Deficiency (ADA)
- ◆ Bone marrow transplantation
- ◆ Enzyme replacement therapy
- ◆ cDNA
- ◆ Gene therapy in bone marrow cells
- ◆

**CONCEPTS**

- ❖ Molecular diagnosis, conventional methods, PCR, rDNA technology, ELISA, autoradiography

**Suggested Activities:** Slide/video clip observation, discussion

The mentor exhibits a video/slide showing molecular diagnostic methods and provides discussion points.

**Discussion points**

- Why does early diagnosis useful in pathophysiology?
- What are the drawbacks of conventional methods of diagnosis?
- What is ELISA?
- What is the principle of ELISA?
- How is PCR useful in molecular diagnosis?
- What is autoradiography?
- 

**Consolidation**

- ◆ Conventional methods of diagnosis
- ◆ Molecular diagnostic methods
- ◆ ELISA
- ◆ PCR
- ◆ Autoradiography
- ◆

**CONCEPTS**

- ❖ Transgenic animals- uses, ethical issues, GEAC, patent, biopiracy

**Suggested Activities :** Slide/video observation , seminar and discussion

These concepts can be transacted through a seminar. Three sub-topics can be selected.

1. Uses of transgenic animals
2. Ethical issues
3. Patent and biopiracy

Group the learners into five and assign the three sub topics to the five groups, then give necessary instructions. (Refer TeacherText of XI for details of seminar.)

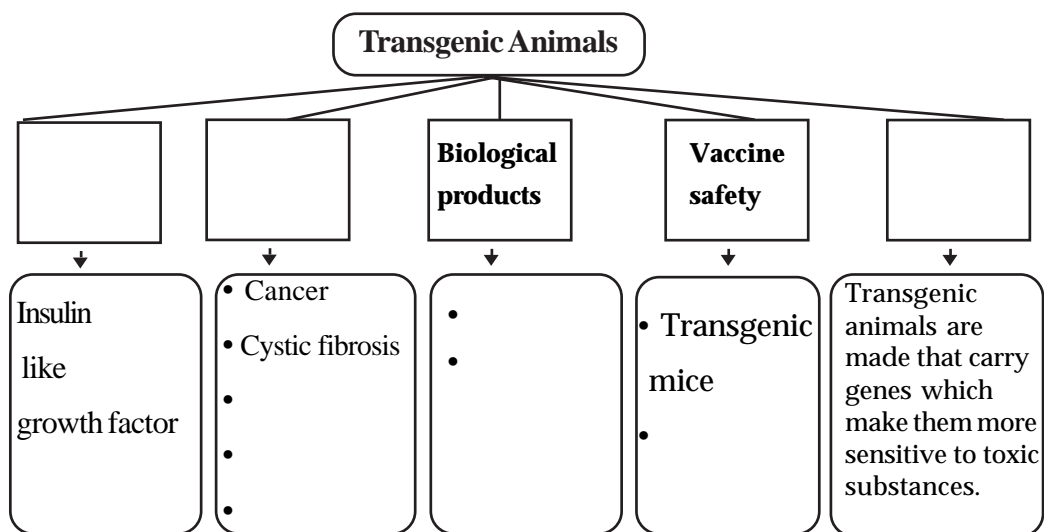
- Group discussion - Organise a group discussion to give necessary instructions.
- Data collection - Provide enough time for collection of various data regarding the topic.
- Finalisation in the group - Interact in the groups for modification and finalisation of the paper.
- Seminar paper preparation - Prepare the paper and fix date and time.
- Presentation
- Report writing

### Consolidation

- ◆ Transgenic organisms-Uses
- ◆ GEAC-significance
- ◆ Patent-merits and demerits
- ◆ Biopiracy
- ◆

### Assignment

1. Prepare a concept map in the activity log



2. Prepare a list of transgenic animals and their uses.

### Repository of CE

Process assessment	Portfolio assessment	Unit assessment
Lab work Seminar Assignment	Seminar report Preparation of notes in the activity log and practical log	Check list completion

### Unit assessment (Checklist)

Read the following statements and put (✓) mark in the appropriate box.

	True	False
1. Bt toxins are insect group specific.	<input type="checkbox"/>	<input type="checkbox"/>
2. Bt toxin gene Cry IAc controls corn borer.	<input type="checkbox"/>	<input type="checkbox"/>
3. <i>Meloidegyne incognitia</i> can be controlled through RNAi.	<input type="checkbox"/>	<input type="checkbox"/>
4. Genetically engineered insulin is prepared by a German company Eli Lilly.	<input type="checkbox"/>	<input type="checkbox"/>
5. PCR is based on the principle of antigen - antibody interaction.	<input type="checkbox"/>	<input type="checkbox"/>
6. Alpha -I antitrypsin is used to treat ADA deficiency.	<input type="checkbox"/>	<input type="checkbox"/>
7. The first transgenic cow was produced in 1997.	<input type="checkbox"/>	<input type="checkbox"/>
8. GEAC is genetic engineering approval centre.	<input type="checkbox"/>	<input type="checkbox"/>
9. In proinsulin C peptide is absent.	<input type="checkbox"/>	<input type="checkbox"/>
10. Cry I Ab controls the cotton bollworm.	<input type="checkbox"/>	<input type="checkbox"/>

## SAMPLE TE QUESTIONS

1. ELISA is based on the principle of -----  
(a) Gene amplification                      (b) Antigen-antibody interaction  
(b) Radioactive hybridisation              (d) Serum analysis              (Score -1)
2. A nematode that infects the roots of tobacco plants is  
(a) Lepidopterans                      (b) *Agrobacterium*  
(c) *Meloidegryne incognitia*              (d) Coleopteran                      (Score -1)
3. Rosie produced ----- enriched milk?  
(a) Growth factor                      (b) Alpha 1- antitrypsin  
(c) Alpha lactalbumin              (d) Insulin like growth factor              (Score -1)
4. Which peptide is absent in mature insulin?  
(a) A peptide                      (b) C peptide  
(c) D peptide                      (d) B peptide                      (Score-1)
5. What does Bt stand for in Bt cotton ?  
(a) Biotechnology                      (b) Best type  
(c) *Bacillus tomentosa*                      (d) *Bacillus thuringiensis*              (Score-1)
6. Write any two molecular diagnostic methods.              (Score -2)
7. Name two bio-pirated plants in India.              (Score-2)
8. The gene which produce Bt toxin is called Cry gene.  
(a) Name three cry genes.  
(b) Name the gene that controls corn borer.              (Score-2)
9. Write the steps in the treatment of ADA deficiency through gene therapy.              (Score-3)
10. What is RNAi? How it is used to transform tobacco plant to a pest resistant plant ?              (Score-3)



TE Questions : Scoring Key			
Q. No.	Scoring indicator	Splitted Score	Total Score
1	b. Antigen - antibody interaction	1	1
2	c. <i>Meloidegyne incognitia</i>	1	1
3	c. Alpha lactalbumin	1	1
4	b. C peptide	1	1
5	d. <i>Bacillus thuringiensis</i>	1	1
6.	PCR, rDNA technology, ELISA(Any two)	1+1	2
7	Basmati, Neem, Turmeric (Any two)	1+1	2
8.	a) Cry I Ac Cry II Ab Cry I Ab b) Cry I Ab	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	2
9.	Lymphocytes from the patient are grown in the culture Introduce ADA cDNA into the lymphocyte Transformed lymphocytes are introduced into the patient	1 1 1	3
10.	This is a method which involves the silencing of mRNA due to a complementary dsRNA Introduce nematode specific genes into the tobacco plant. It produces both sense and antisense RNA in host plant. It produced RNA and initiateRNAi	1  2	3

### ***More to know***

Host-generated double stranded RNA induces RNAi in plant-parasitic nematodes and protects the host from infection

Bindhya Chal Yadav a, Karuppanan Veluthambi b, Kuppuswamy Subramaniam a

Several species of nematodes parasitize a wide variety of plants and animals, including human. Human parasites such as the gut worm *Ascaris lumbricoides*, hook worms *Ancylostoma duodenale* and *Necator americanus*, and the causative agents of the lymphatic filariasis *Wuchereria bancrofti* and *Brugia malayi* infect and severely affect the health of about half the world's

population. Similarly, gastrointestinal nematodes (*Ostertagia ostertagi*) and liver fluke (*Fasciola hepatica*) infect livestock leading to considerable yield loss in animal husbandary. The plant parasites such as the root-knot (*Meloidogyne* spp.) and cyst (*Heterodera* and *Globodera* spp.) nematodes cause significant damage to important crop plants such as legumes, vegetables and cereals in most parts of the world. Annual crop loss due to plant-parasitic nematodes is estimated to be over \$ 125 billion. Despite this enormous impact on world-wide agriculture, currently there is no effective and environmentally safe method available to prevent or treat plant nematode infections. One of the main reasons for this is our limited understanding of the functions of nematode's genes. Since these organisms require a suitable host for their growth and proliferation, it is nearly impossible to culture them in the laboratory. Because of this, it has not been possible to use the traditional genetic tools, which are widely used to determine gene function in the free-living model organisms, for the functional characterization of parasitic nematode genes.

In many organisms, including the free-living nematode *Caenorhabditis elegans*, introduction of double stranded RNA (dsRNA) has been observed to deplete the endogenous mRNA that shares a high degree of sequence identity with the introduced dsRNA. In *C. elegans*, dsRNA can be introduced by microinjection, soaking or feeding bacteria that express the dsRNA. However, these approaches could not be used in the case of parasitic nematodes – successful recovery of microinjected juveniles is technically difficult and the juveniles of parasitic nematodes do not take up much orally from solutions. Urwin et al. overcame this problem by treating juveniles with octopamine which induced oral uptake. Since then a few groups have successfully employed this approach to elicit RNAi response in plant-parasitic nematodes. Soaking eggs in the dsRNA solution has also been reported to induce RNAi. While these approaches are useful to study gene function, they cannot be adopted directly as a control method. In addition, probably due to inefficient uptake of the dsRNA, the near null phenotype seen for many *C. elegans* genes following RNAi has not been observed in the case of parasitic nematodes.

The intermediate steps of RNAi mechanism include the cleavage of dsRNA into smaller fragments called short interfering RNA (siRNA) and, in some species, amplification of the original signal. We reasoned that the delivery of parasite's dsRNA through the host – many hosts possess the basic RNAi machinery and elicit RNAi in response to dsRNA – may benefit from these features of host's RNAi machinery and be more effective. Moreover, this approach may directly serve as a tool to control parasite infection. Here we demonstrate that the dsRNA delivered through tobacco plants not only leads to almost total depletion of the target mRNA in the plant-parasitic nematode *Meloidogyne incognita*, but also provides the host effective resistance against the parasite.

We selected the target genes for RNAi based on the following criteria: (a) their *C. elegans* orthologs should be essential genes and RNAi for them should work robustly in *C. elegans*. (b) Their functions should be conserved in diverse organisms, so the chance that their functions have been conserved in the parasitic nematodes is very high. (c) Their sequences should be dissimilar enough that the RNAi is nematode-specific. Two genes – one coding for splicing factor and the other coding for integrase – of the root-knot nematode *M. incognita* met all the above criteria. We amplified the cDNAs of these two genes from *M. incognita* juveniles by

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Table 1

Effect of dsRNA expression in the host plant on *M. incognita* infection

dsRNA	Number of knots/plant	Number of females/knot	Number of egg masses/plant	Number of eggs hatching/egg mass
No dsRNA	130 (12)	9 (10)	840 (5)	97 (70)
Splicing factor	3.5a (25)	4b (50)	2.5 (25)	0.25 (20)
Integrase	1 2.6a (19)	6b (50)	9.8 (19)	0.75 (20)

The number of plants, knots or egg masses examined in each case are shown in parentheses.

a Knot size was considerably smaller than the control (see Fig. 1A and B).

b Color and shape of these worms were very different from the control (see Fig. 1C and D). Reverse transcription-polymerase chain reaction (RT-PCR) and cloned them in a plant expression vector that expresses both sense and anti-sense strands such that the resultant transcript forms a hair pin-shaped dsRNA (see Fig. 1 legend for methods). These constructs were then introduced into tobacco plants with the help of *Agrobacterium*.

To determine whether transgenic plants carrying the above constructs resist nematode infection, we inoculated them with *M.*

*incognita* juveniles. While all the control plants ( $n = 12$ ) developed several large root knots, only a few of the transgenic plants (2 out of 25) expressing the splicing factor dsRNA formed root knots. These knots were significantly smaller in size as well as number when compared with those of the control

plants (Fig. 1 and Table 1). Rest of the transgenic plants tested (23 out of 25) did not produce any visible knots. Similar results were obtained with the transgenic plants expressing integrase dsRNA: 6 out of 19 produced fewer root knots that were smaller and 13 out of 19 did not form any root knots. We conclude that the plants that express dsRNA of essential genes of *M. incognita* are protected against infection by this parasite.

Fig. 1. Host plant-generated dsRNA triggers RNAi in parasitic nematodes. (A) Roots of a typical control and (B) transgenic plant 45 days after inoculation with 2500 *Meloidogyne incognita* juveniles. Scale bar: 1 cm. Arrows point to knot-like structures formed due to infection by the parasite. Inset shows a single knot at a higher magnification. Scale bar for the inset: 2 mm. (C) Female nematodes isolated from the knots of control and (D) dsRNA-expressing transgenic roots. Scale bar: 300  $\mu$ m. The females of the control plants appear saccate and dark, whereas the ones from transgenic plants are elongated and transparent. For the expression of dsRNA in transgenic plants, we used two vectors based on a published plant RNAi vector [15] and pBI121 (Clontech). The CaMV 35S promoter (pBC6) or a tobacco root-specific promoter [16] (pBC7) are placed upstream of the intron of the Arabidopsis MADS-box gene (Y12776) flanked by two multiple cloning sites. For RT-PCR, total RNA from *M. incognita* was isolated using Trizol (Invitrogen). First strand cDNA was synthesised [17] with RevertAid M-MuLV reverse transcriptase (Fermentas), 1 g of total RNA, and oligo (dT)18 primer. PCR settings were 95  $\text{^\circ}$ C, 2 min; 35 cycles of 15 s at 95  $\text{^\circ}$ C, 20s at 55 $\text{^\circ}$ C and 1 min at 72  $\text{^\circ}$ C, and 10 min at 72  $\text{^\circ}$ C using Taq polymerase (Bangalore Genei). A 349-bp splicing factor sequence (AW828516) was amplified in sense and anti-sense directions using KS1098: TCTGG ATCCCTGCT CTTTTCGTTGCACGT, KS1099: TCTCTCGAGTGTGT-GAGAAATTGACGTCC, KS1100: TCTGAGC TCCTGCTCTTTTCGTTGCACGT and KS1101: TCTGGTACCTGTGT GAGAAATTGACGTCC and primers KS1094: TCTGGATC CATGTCA AA GGCAACGTATGGA, KS1095: TCTCTCGAGTTCAGC-AATCATT TCAGGGG, KS1096: TCTGAGCTCATGTCAAAGGCAACGTATGGA and KS1097: TCTGGTACCTTC AGCAATCATTTCAGGGG were used for cloning a 624-bp fragment of the integrase cDNA (AW871671). The dsRNA constructs were transferred into LBA4404 *Agrobacterium tumefaciens* through tri-parental mating using pRK2013 as mobilization helper [18], then introduced into tobacco plants by co-cultivation of *Agrobacterium* with tobacco leaf discs [19]. At least 20 independent lines of transgenic plants (confirmed by PCR) were generated per construct. All plant infection experiments were performed in a green house. *M. incognita* from a local field was maintained on tomato plants and eggs were hatched on moist filter paper. Approximately 2500 freshly hatched juveniles were transferred to the soil close to roots, which were examined for infection 45 days later.

Next, we wanted to test whether the parasite could develop normally in the few root knots that formed on the transgenic plants. For this, we dissected

the root knots and examined the nematodes using a dissecting stereomicroscope. In control plants, several females were found in all the root knots. These worms were saccate (tear drop-shaped) and dark – both characteristic of *M. incognita* (Fig. 1C). In contrast, only a small fraction of the root knots of the transgenic plants had worms. Even in these few root knots, only one or two worms were found (Table 1). These worms were fusiform (elongated) and transparent (Fig. 1D). Since the dark color of healthy females is due to the dark granules of intestinal cells, the transparent body of nematodes in the transgenic knots probably indicates a lack of gut granules. These results indicate that the expression of dsRNA in host plants interferes with the normal development of the nematode.

To determine whether the inability of nematodes to infect transgenic roots is a result of RNAi of the targeted genes, we checked for the presence of target mRNAs in the worms of transgenic root knots by RT-PCR. Even after 45 cycles of amplification, we failed to amplify the splicing factor cDNA from the RNA isolated from worms of transgenic plants that express splicing factor dsRNA. However, we were able to amplify the cDNAs of actin and integrase from the same RNA preparations. Similarly, the actin and splicing factor cDNAs, and not the integrase cDNA, could be amplified from the worms of integrase transgenic plants. In contrast, all three cDNAs could be amplified from the worms of control plants (Fig. 2). From these results, we conclude that our failure to amplify cDNAs of target mRNAs was most likely due to the absence of these mRNAs in the respective worms and not due to their recalcitrance for RT-PCR amplification or due to general RNA degradation. Specific absence of the target mRNAs, which is a hallmark of RNAi response, indicates that the host plant-generated dsRNA can trigger RNAi in the parasitic nematode.

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Fig. 2. RT-PCR amplification of actin (Accession# CF099470), splicing factor (S) and integrase (I) cDNAs of the worms isolated from control, transgenic plant producing splicing factor dsRNA and integrase dsRNA. In all cases, the control plants carry the expression vector without any insert. The number of PCR cycles is indicated above the lanes. RNA isolation and RT-PCR were carried out as described in Fig. 1 legend. The primers used for actin amplification were KS1406:

CATCGCAATGGTCGAAGAAG and KS1407: CAACATAGCAAAGCTTCTCC. Lane M: DNA molecular size markers.

Our results provide strong support for the hypothesis that the production of dsRNA in hosts could be an effective strategy to control parasitic diseases. In addition, our method has the potential as a powerful tool to characterize the functions of parasite genes. Owing to their parasitic nature, these organisms have been particularly recalcitrant to traditional genetic manipulations. As a consequence, only a limited number of their genes have been functionally characterized. Since many hosts, especially plants,

themselves respond to RNAi, their RNAi machinery most likely aids in eliciting RNAi response in the targeted parasites by the amplification and production of siRNAs. The siRNAs generated by the hosts may more readily pass through the feeding tubes of parasites like *M. incognita*. Thus, the production of dsRNA in the hosts may be a more effective way of delivering dsRNA (or siRNA) to the parasites than other methods.

### **cDNA (Complementary DNA)**

Complementary DNA (cDNA) is double-stranded DNA synthesized from a messenger RNA (mRNA) template in a reaction catalysed by the enzyme reverse transcriptase. cDNA is often used to clone eukaryotic genes in prokaryotes. When scientists want to express a specific protein in a cell that does not normally express that protein (i.e., heterologous expression), they will transfer the cDNA that codes for the protein to the recipient cell. cDNA is also produced naturally by retroviruses (such as HIV-1, HIV-2, Simian Immunodeficiency Virus, etc.) and then integrated into the host's genome where it creates a provirus.

The term cDNA is also used, typically in a bioinformatics context, to refer to an mRNA transcript's sequence, expressed as DNA bases (GCAT) rather than RNA bases (GCAU).

From Wikipedia, the free encyclopedia

### **First Gene Therapy Patients Attend IDF 2013 National Conference**

Date: 02 Oct 2013

Ashanthi DeSilva and Cindy Kisik were born with ADA-SCID, a type of Severe Combined Immune Deficiency (SCID) with mutations in a gene that encodes an enzyme called adenosine deaminase (ADA). On September 14, 1990, Ashanthi, only 4 years old, underwent the first human gene therapy, and four months later 10-year-old Cindy's identical treatment followed. IDF Medical Director R. Michael Blaese, MD was part of the team of physicians who pioneered gene therapy and worked with the girls and their families. Now adults, Ashanthi and Cindy attended the IDF 2013 National Conference and enjoyed a reunion with Dr. Blaese. Dr. Blaese said, "It was wonderful to see 'my girls' happy and healthy nearly 23 years after helping pioneer the use of genes as medicines for serious inherited diseases. The contributions of the girls and their parents were critical to the initial steps in bringing this new technology to clinical practice which is now helping patients with a range of disorders beyond primary immunodeficiency including metabolic problems, cancer and blindness. During the coming decades gene therapy will become increasingly common thanks to their willingness to participate in the clinical trial that started it all."

# Unit X

# Ecology

## Chapter 6 - Organisms and Populations

### *Introduction*

*Ecology is mainly concerned with four levels of biological organisations-organisms, populations, communities, and biomes. The relationship of living organisms with the physico-chemical factors (abiotic factors) and biotic factors are also considered. Evolutionary changes usually take place at the population level and hence population ecology is an important area of ecology. Ecological effects of any factors on a population are generally reflected in its size, which may be expressed in different ways like numbers, biomass etc. In nature, populations of different species in a habitat do not live in isolation but interact in many ways.*

*The learner already learnt some concepts like food chain and food web in their lower classes. This chapter mainly aims at the transaction of characteristics of population and various abiotic factors and the response of organisms to that. This chapter also tells about the species interactions.*

### Values and Attitudes

- Realises the importance of abiotic factors that sustain life on earth.
- Appreciates the aesthetics of nature by maintaining interactions among various organisms.

**Time : 12 Periods**

## Unit Frame

Concepts/Ideas and process skills	Process/Activity with assessment	Learning outcomes
<ul style="list-style-type: none"> <li>• Levels of organisation</li> <li>• Major biomes</li> <li>• Biotic and abiotic factors</li> <li>• Observing</li> <li>• Classifying</li> <li>• Analysing</li> <li>• Interpreting data</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of video clip discussion</li> <li>• Concept mapping</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the levels of organisation and major biomes.</li> </ul>
<ul style="list-style-type: none"> <li>• Major abiotic factors</li> <li>• Temperature</li> <li>• Water</li> <li>• Light</li> <li>• Soil</li> <li>- Observing</li> <li>- Analysing</li> <li>- Communicating</li> <li>- Listing</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Lists various abiotic factors of habitats.</li> </ul>
<ul style="list-style-type: none"> <li>• Response to abiotic factors</li> <li>• regulate</li> <li>• confirm</li> <li>• migrate</li> <li>• suspend</li> <li>- Observing</li> <li>- Communicating</li> <li>- Inferring</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of graph</li> <li>• General discussion</li> <li>• Concept mapping</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the response of organisms to abiotic factors.</li> </ul>
<ul style="list-style-type: none"> <li>• Adaptations - morphological</li> <li>• physiological</li> <li>• behavioural</li> <li>- Observing</li> <li>- Communicating</li> <li>- Classifying</li> <li>- Inferring</li> </ul>	<ul style="list-style-type: none"> <li>• Project</li> <li>• Observation of collected specimens, video clips</li> <li>• General discussion</li> <li>• Preparation of tables and notes</li> <li>• Assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies and differentiates various types of adaptations shown by plants and animals.</li> </ul>



<b>Concepts/Ideas and process skills</b>	<b>Process/Activity with assessment</b>	<b>Learning outcomes</b>
<ul style="list-style-type: none"> <li>• Population attributes</li> <li>• Birth rate, death rate</li> <li>• Sex ratio</li> <li>• Age pyramid</li> <li>• Population density</li> <li>• Population growth               <ul style="list-style-type: none"> <li>- Observing</li> <li>- Communicating</li> <li>- Identifying</li> <li>- Differentiating</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Observation of figures, flow chart.</li> <li>• Discussion</li> <li>• Preparation of table, flow chart</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Lists various attributes of population and population growth.</li> </ul>
<ul style="list-style-type: none"> <li>• Population growth models</li> <li>• Exponential growth</li> <li>• Logistic growth</li> <li>• Life history variations               <ul style="list-style-type: none"> <li>- Observing</li> <li>- Communicating</li> <li>- Comparing</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Graph reading, discussion</li> <li>• Preparation of graph</li> <li>• Formulation of equations</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Differentiates the population growth models and identifies their characteristics.</li> </ul>
<ul style="list-style-type: none"> <li>• Population interaction</li> <li>• Beneficial interaction</li> <li>• Detrimental interaction</li> <li>• Neutral interaction               <ul style="list-style-type: none"> <li>- Observing</li> <li>- Communicating</li> <li>- Comparing</li> <li>- Interpreting data</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Observation of table</li> <li>• Discussion</li> <li>• Preparation of table</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses the significances of population interaction and classifies them.</li> </ul>
<ul style="list-style-type: none"> <li>• Predation</li> <li>• Biological control</li> <li>• Defense mechanism               <ul style="list-style-type: none"> <li>- Observing</li> <li>- Communicating</li> <li>- Comparing</li> <li>- Inferring</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Observation of plant specimens, photograph, video clip</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies predation and evaluates the significance of predation.</li> </ul>

<b>Concepts/Ideas and process skills</b>	<b>Process/Activity with assessment</b>	<b>Learning outcomes</b>
<ul style="list-style-type: none"> <li>• Competition</li> <li>- Competitive release</li> <li>- Competitive exclusion principle</li> <li>• Resource partitioning</li> <li>- Observing</li> <li>- Communicating</li> <li>- Comparing</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• Preparation of notes</li> <li>• Observation of video</li> <li>• General discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Explains competition and evaluates its merits and demerits .</li> </ul>
<ul style="list-style-type: none"> <li>• Parasitism</li> <li>- Endoparasite</li> <li>- Ectoparasite</li> <li>• Brood parasitism</li> <li>• Observing</li> <li>• Communicating</li> <li>• Comparing</li> <li>• Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of specimens, photographs</li> <li>• Discussion</li> <li>• Preparation of notes(PE)</li> <li>• Preparation of concept map</li> </ul>	<ul style="list-style-type: none"> <li>• Lists the importance of parasitism and identifies different types of parasites.</li> </ul>
<ul style="list-style-type: none"> <li>• Commensalism</li> <li>• Mutualism</li> <li>• Sexual deceit</li> <li>• Co-Evolution</li> <li>- Observing</li> <li>- Communicating</li> <li>- Comparing</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• Observation of specimens, photographs, discussion</li> <li>• Preparation of notes (PE)</li> <li>• Assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Explains commensalism with examples.</li> <li>• Evaluates the significance of mutualism and co-evolution with suitable examples.</li> </ul>

*Towards the chapter***CONCEPTS**

- ❖ Levels of biological organisation, major biomes, biotic and abiotic factors, elements lead to variation in habitats

**Suggested Activities** : General discussion, observation of video clip

The mentor introduces the concept of ecology by asking some simple questions.

- What is ecology ?
- What are the various levels of organisation ?
- Which are the biotic and abiotic factors in a habitat?

By answering the questions the learner recalls a general idea of ecology and its importance.

The learners observe the video clip showing different biomes. Analysis of the picture in the text book (Fig. 13.1) and discuss.

**Discussion points**

- What is a biome ?
- Which are the major biomes ?
- Why does each biome lead to the formation of a wide variety of habitats?
- What are the key elements that lead variations in different habitats?
- 

**Consolidation**

- ◆ Levels of organisation
- ◆ Major biomes - peculiarities, examples
- ◆ Physico - chemical factors
- ◆ Biotic components
- ◆

## Assignment

- ◆ Complete the following table.

Biome	Mean annual precipitation(cm)	Mean annual temperature(°c)

## CONCEPTS

- ❖ Major abiotic factors, temperature, water, light, soil

**Suggested Activities :** General discussion

### Discussion points

- Which are the major abiotic factors ?
- How does temperature affect the metabolism of organisms ?
- How can we classify organisms based on temperature tolerance?
- How does water influence the distribution of organisms?
- How can we classify organisms based on salinity tolerance ?
- What is the significance of light in habitat ?
- Which are the major characteristics of soil?
- 

### Consolidation

- ◆ Abiotic factors - temperature, water, light and soil
- ◆ Eurythermal, stenothermal organisms
- ◆ Euryhaline, stenohaline organisms
- ◆ Light - significance
- ◆ Characteristics of soil
- ◆

## CONCEPTS

- ❖ Response to abiotic factors - regulate, conform, migrate, suspend

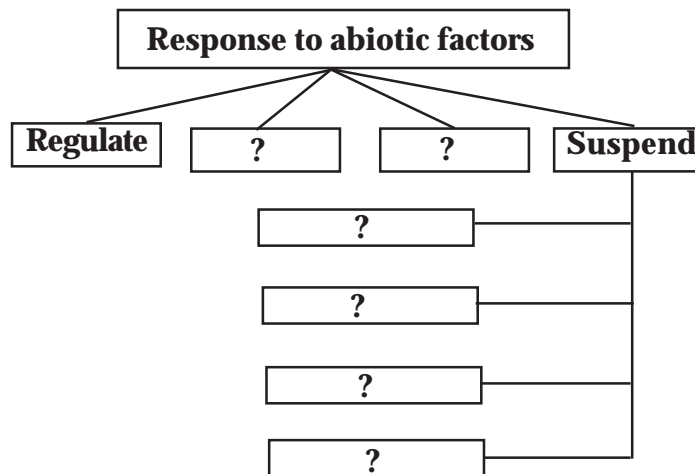
**Suggested Activities:** Observation of graph (fig 13.2), general discussion

### Discussion points

- How do the organisms live in different habitats cope up with stressful conditions?

- What is homeostasis ?
- What are regulators?
- Which are the two types of internal regulations?
- How can you explain regulation in man with a suitable example?
- What are conformers?
- What is migration?
- Why do organisms suspend their body metabolism?
- What is the difference between hibernation and aestivation?
- What is diapause ?
- 

The learners complete the flow chart in the activity log



**Consolidation**

- ◆ Homeostasis
- ◆ Regulate
- ◆ Conform
- ◆ Migrate
- ◆ Suspend
- ◆

**CONCEPTS**

- ❖ Adaptations-importance,morphological adaptations, physiological adaptations,behavioural adaptations.

**Suggested Activities :** Project, discussion, observation of collected specimen of Opuntia, photographs of some animals and video clips.

These concepts can be transacted through a project.

### Steps

1. Feeling the problem : Are the organisms living in desert, polar regions and high attitude have same kind of adaptations?
2. Defining the aim
3. Planning
4. Survey, collection
5. Analysis
6. Conclusion
7. Project report writing
8. Project presentation

(For more details refer Teacher text XI-Pages 63-67)

**Assignment :** Complete the table

Morphological adaptation	Physiological adaptation	Behavioural adaptation
eg:-	eg:-	eg:-

### Consolidation

- ◆ Adaptations
- ◆ Morphological adaptations with examples
- ◆ Physiological adaptations with examples
- ◆ Behavioural adaptations with examples
- ◆

### CONCEPTS

- ❖ Population attributes, birth rate, death rate, sex ratio, age pyramid, population density, population growth.

**Suggested Activities :** Observation of figure 13.4 ,flow chart in the text book, discussion

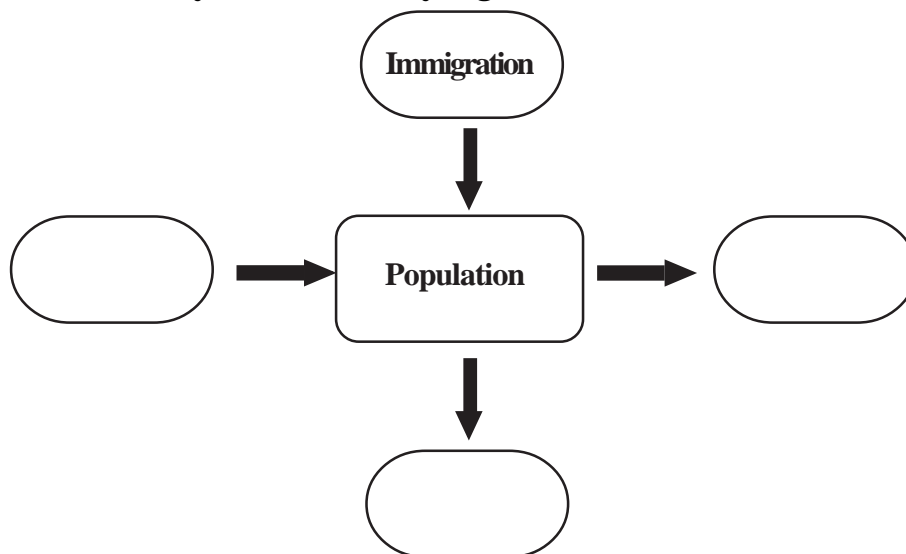
**Discussion points**

- Which are the major attributes of population?
- What is age pyramid?
- Which are the three types of age pyramids?
- How can you measure population density?
- Which are the factors that affect population growth?
- 

Learners draw 3 types of age pyramids in the activity log and write their characteristics in the table provided.

Expanding	Stable	Declining

The learner fills up the flow chart showing the factors which influence population density in their activity log.



Learners construct a mathematical formula for the calculation of population density in their activity log.

**Consolidation**

- ◆ Population attributes
- ◆ Birth rate, death rate

- ◆ Sex ratio
- ◆ Age pyramids
- ◆ Population density
- ◆ Population growth
- ◆

### CONCEPTS

- ❖ Population growth models, exponential growth, logistic growth, life history variations

**Suggested Activities :** Observation of graph in figure 13.5 and discussion

### **Discussion points**

- Which are the population growth models?
- What is exponential growth?
- Which is the exponential growth equation?
- Which is the logistic growth equation?
- How do organisms show variation in reproduction?
- 

The learner draws population growth curve in the activity log and writes equation for exponential and logistic growth.

### **Consolidation**

- ◆ Population growth models
- ◆ Exponential growth-graph and equation
- ◆ Logistic growth-graph and equation
- ◆ Life history variations
- ◆

### CONCEPTS

- ❖ Population interactions-beneficial, detrimental, neutral interactions

**Suggested Activities :** Observation of table 13.1, discussion

### **Discussion points**

- What is population interaction?



- Why do interactions are essential in populations?
- What are beneficial interactions?
- What is the difference between detrimental and neutral interactions?
- What are the common examples of population interactions?
- 

### Consolidation

- ◆ Population interaction - significance, effects
- ◆

### CONCEPTS

- ❖ Predation, biological control, defense mechanism

**Suggested Activities :** Observation of plant specimens, photograph / video clips, discussion.

The mentor shows video on the significance of predation. Elicits previous knowledge.

### Discussion points

- What is predation?
- What is biological control?
- How does predation help in maintaining species diversity?
- Why do the predators in nature are prudent?
- How do frog and monarch butterfly escape from their predators?
- How do plants escape from their natural predators?
- 

Learners write notes on predation in the activity log based on discussion, observed specimens and video .

### Consolidation

- ◆ Predation-relevance
- ◆ Biological control
- ◆ Maintaining species diversity
- ◆ Defense mechanism
- ◆

## CONCEPTS

- ❖ Competition, competitive release, competitive exclusion principle, resource partitioning

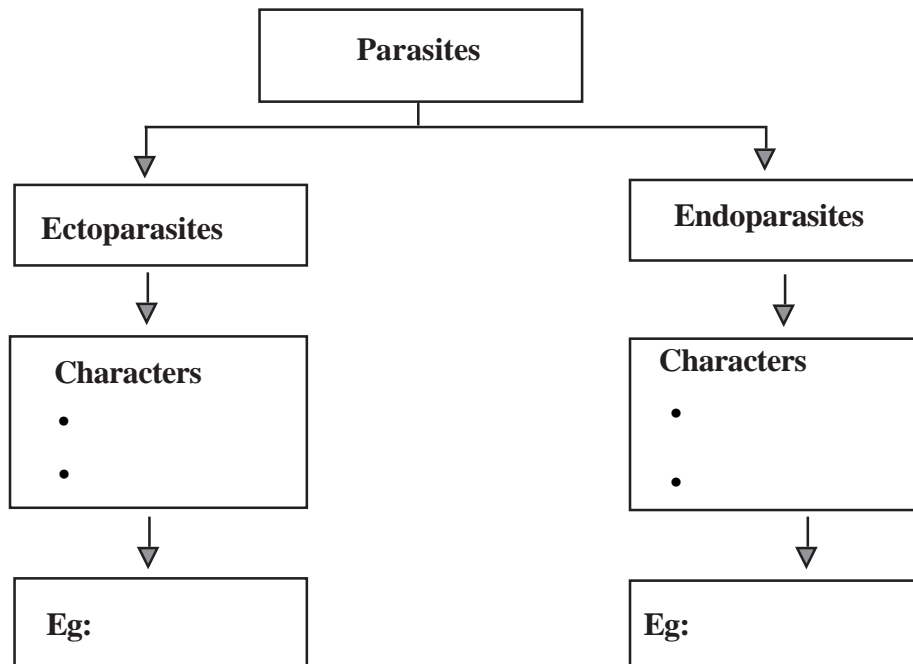
**Suggested Activities :** Observation of video , discussion

Learners observe the video clip showing competition between organisms like Abington tortoise and goat, balanus and chathamalus etc., and write down the importance of competition in their activity log based on the discussion.

### Discussion points

- How does competition occur among organisms?
- What is interference competition?
- Define competition in terms of its 'intrinsic rate of natural increase'?
- What is competitive release?
- What is competitive exclusion principle?
- What is resource partitioning?

Learners prepare notes in their activity log based on discussion. Copy the concept map and fill in the blanks.



**Consolidation**

- ◆ Parasitism
- ◆ Co-evolution
- ◆ Adaptations of parasites
- ◆ Endoparasites
- ◆ Ectoparasites
- ◆ Brood parasitism
- ◆

**CONCEPTS**

- ❖ Commensalism, mutualism, co-evolution, sexual deceit

**Suggested Activities :** Observation of plant specimens, video, discussion

The mentor shows vanda, orchid and fruits of ficus and photographs of egrets, cattle, sea anemone, clown fish, shark and sucker fish. Then asks the benefit attained by each organisms.

**Discussion points**

- What is commensalism?
- What are epiphytes?
- What is mutualism?
- How can you explain co-evolution on the basis of mutualism between wasp and fig tree?
- What is mycorrhizae?
- What is sexual deceit?
- 

**Consolidation**

- ◆ Commensalism
- ◆ Mutualism
- ◆ Co-evolution
- ◆ Mycorrhiza
- ◆ Sexual deceit
- ◆

## Assignment

Prepare a note on characteristic features of vanda and orchids which show commensalism (**PE**).

## Repository of CE

<b>Process assessment</b>	<b>Portfolio assessment</b>	<b>Unit assessment</b>
Lab work Project Collection Discussion Assignment	Collected specimen Project report Prepared notes and Diagrams in the activity log and practical log	Written test

## SAMPLE TEST QUESTIONS

- A terrestrial mammal who seldom drinks water.
  - Hippopotamus
  - Rhinoceros
  - Kangaroo rat
  - Camel
 (Score -1)
- What is wrong about xerophytes?
  - Sunken stomata
  - Small spiny leaves
  - Thick cuticle
  - Large number of stomata
 (Score -1)
- Animals have shorter and smaller ears and limbs in colder areas. It is
  - Allen's rule
  - Cope's rule
  - Dollo's rule
  - Bergman's rule
 (Score -1)
- Find the odd one and give reasons.  
Loranthus, Cuscuta, Vanda  
(Score -2)
- People who have visited very high altitudes experienced 'high altitude sickness'. How did their body solve this problem? (Score -2)
- What is the difference between hibernation and aestivation? (Score -2)
- Predation helps to maintain species diversity in a community. Justify? (Score -2)
- Briefly explain co-evolution among organisms which show mutualism. Give a suitable example (Score -3)
- Define 'Competitive Exclusion principle' with a suitable example. (Score -3)
- Fill up the blanks suitably.

Species A	Species B	Name of Interaction
+	+	(a) .....
-	-	(b) .....
+	-	(c) .....
+	-	(d) .....
+	0	(e) .....
-	0	(f) .....

(Score-3)

**TE Questions : Scoring Key**

<b>Q. No.</b>	<b>Scoring indicator</b>	<b>Splitted Score</b>	<b>Total Score</b>
1	c. Kangaroo rat	1	1
2	d. Large number of stomata	1	1
3	a. Allen's rule	1	1
4	Vanda It is a commensal other two are parasites	1 1	2
5	The body compensate low oxygen availability by increasing red blood cell production, decreasing the binding affinity of haemoglobin and by increasing breathing rate	1+1	2
6.	Hibernation- Remain in a suspended state to overcome winter related problems. Aestivation-Remain in a suspended state to overcome summer related problems	1 1	2
7.	Predation helps in maintaining species diversity in a community by reducing the intensity of competition among competing prey species	2	2
8.	Evolution of two organisms are tightly linked with one another eg:fig tree and wasp and its explanation	1 2	3
9.	Two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated eventually. eg;any one	2 1	3
10.	a) Mutualism b) Competition c) Predation d) Parasitism e) Commensalism f) Ammensalism	½ ½ ½ ½ ½ ½	3

Unit

X

# Ecology

## Chapter 7- Ecosystem

### **Introduction**

*An ecosystem is a community of living organisms(plants, animals and microbes)in connection with the non-living components of their environment(things like air, water and mineral soil)interacting as a system. There are many examples of ecosystems — a pond, a forest, an estuary, grassland etc. In an ecosystem each organism has its own niche or role to play. The ecosystem is a core concept in biology and ecology serving as the levels of biological organisation in which organisms interact simultaneously with each other and with their environment.*

*The study of ecosystems mainly consists of the study of certain processes that link the living or biotic components to the non-living or abiotic components. Energy transformation and biogeochemical cycling are the main processes that comprise the field of ecosystem ecology. Ecosystems have no particular size. An ecosystem can be as large as a desert or a lake or as small as a tree or a puddle. If you have an aquarium, that is an artificial ecosystem where the water, temperature, plants, animals, air, light and soil all work together. Ecosystems have lots of different living organisms that interact with each other. The living organisms in an ecosystem can be divided into three categories: producers, consumers and decomposers. They are all important parts of an ecosystem. The learner already has knowledge of ecosystem and components of ecosystem. This chapter deals with structural organisation and various functions of ecosystem.*

### **Values and Attitudes**

- Develops an attitude to protect plants as they produce energy to whole organisms.
- Appreciates the role of various living and non -living organisms in the ecosystem.

**Time : 10 Periods**

### Unit Frame

Concepts/Ideas and process skills	Process/Activity with assessment	Learning outcomes
<ul style="list-style-type: none"> <li>• Ecosystem</li> <li>• Definition</li> <li>• Structure</li> <li>• Functions</li> <li>- Observing</li> <li>- Communicating</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Picture reading</li> <li>• Slide/video observation</li> <li>• Field visit</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Recognises the structure and functions of ecosystem and identifies the different components of the ecosystem.</li> </ul>
<ul style="list-style-type: none"> <li>• Productivity - Primary and secondary</li> <li>• Gross and net productivity</li> <li>- Observing</li> <li>- Communicating</li> <li>- Differentiating</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Slide observation</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Differentiates primary and secondary productivity.</li> </ul>
<ul style="list-style-type: none"> <li>• Decomposition - Stages</li> <li>• Factors</li> <li>- Observing</li> <li>- Communicating</li> <li>- Identifying</li> <li>- Comparing</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Picture reading (fig 14.1 of T.B)</li> <li>• Slide observation</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Compares and explains the different stages of decomposition.</li> </ul>
<ul style="list-style-type: none"> <li>• Energy flow</li> <li>• Food chain</li> <li>• Food web</li> <li>• Trophic levels</li> <li>• Ecological pyramids</li> <li>- Observing</li> <li>- Communicating</li> <li>- Identifying</li> <li>- Analysing</li> <li>- Illustrating</li> </ul>	<ul style="list-style-type: none"> <li>• Video/slide observation</li> <li>• General discussion</li> <li>• Picture reading</li> <li>• Concept mapping</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses the energy flow through various trophic levels.</li> <li>• Differentiates and constructs different types of ecological pyramids .</li> </ul>



<b>Concepts/Ideas and process skills</b>	<b>Process/Activity with assessment</b>	<b>Learning outcomes</b>
<ul style="list-style-type: none"> <li>• Ecological succession               <ul style="list-style-type: none"> <li>• types</li> <li>• xeral stages</li> <li>• xerarch</li> </ul> </li> <li>- Observing</li> <li>- Communicating</li> <li>- Differentiating</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Slide observation</li> <li>• Preparation of notes and</li> <li>• Illustrations</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses ecological succession and identifies different stages of xerarch.</li> </ul>
<ul style="list-style-type: none"> <li>• Hydrarch</li> <li>• Different stages</li> <li>- Observing</li> <li>- Communicatinng</li> <li>- Differentiating</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Slide observation</li> <li>• Picture reading</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies different stages of hydrarch succession.</li> </ul>
<ul style="list-style-type: none"> <li>• Nutrient cycling</li> <li>• Carbon cycle</li>   <li>• Phosphorus cycle</li> <li>- Comparing</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Slide observation</li> <li>• Concept mapping</li> <li>• Picture reading</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses nutrient cycling and differentiates gaseous and sedimentary cycles.</li> </ul>
<ul style="list-style-type: none"> <li>• Ecosystem services</li> <li>• Observing</li> <li>• Communicating</li> <li>• Interpreting data</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Evaluates the services provided by ecosystems.</li> </ul>

## *Towards the chapter*

### CONCEPTS

- ❖ Ecosystem - types, structure and functions of ecosystem, pond ecosystem

**Suggested Activities** : General discussion, slide observation, picture reading, field trip

The mentor elicits the previous knowledge of the learner regarding the ecosystem by asking some questions.

- What are the components of ecosystem?
- Give some examples of ecosystem?

The mentor conducts a field trip to the near by pond for studying the pond ecosystem. The learners are grouped into four or five and assigns duty to each group for identifying living and non-living components. Then asks to complete the table.

Biotic components	Abiotic components

Then asks to prepare notes.

### **Discussion points**

- What is stratification?
- What are the functions of ecosystem?
- 

### **Consolidation**

- ◆ Ecosystem -types
- ◆ Ecosystem -structure
- ◆ Components of ecosystem
- ◆ Pond ecosystem
- ◆

**CONCEPTS**

- ❖ Productivity- types, significance

**Suggested Activities** : General discussion, slide observation

The mentor exhibits the slide showing productivity and conducts a general discussion.

**Discussion points**

- From where plants get energy?
- Name the process in which the plant utilizes this energy?
- How plants utilize this energy ?
- What is the source of energy for animals ?
- 

**Consolidation**

- ◆ Primary productivity
- ◆ Gross productivity
- ◆  $NPP = GPP - R$
- ◆ Secondary productivity
- ◆

**CONCEPTS**

- ❖ Decomposition-definition, steps, factors

**Suggested Activities** : General discussion, picture reading, slide/video observation.

Learners observe the (fig 14.1) in the text book. The mentor exhibits the slide showing various stages of decomposition and conducts a general discussion.

**Discussion points**

- What happens to plants and animals after death ?
- What are the organisms that help in decomposition?
- What are the steps in decomposition?
- What do you mean by humus?

- Why the humus contain soil is highly fertile?
- Who help for the formation of humus?
- How minerals are formed from humus?
- What are the factors that affect the rate of decomposition?
- 

### **Consolidation**

- ◆ Decomposition
- ◆ Detritus, detritivores
- ◆ Fragmentation
- ◆ Leaching
- ◆ Catabolism
- ◆ Humification
- ◆ Mineralisation
- ◆

### **CONCEPTS**

- ❖ Energy flow, food chain-types, food web, trophic levels

**Suggested Activities :** General discussion, slide observation, picture reading, concept mapping

The mentor asks the learner to observe the diagram of energy flow in the text book .Then present the slides regarding energy flow and conduct a general discussion.Analyse figure 14.2 in the T.B.

### **Discussion points**

- What do you mean by PAR?
- How will you substantiate that energy flow in the ecosystem takes place according to first and second law of thermodynamics?
- What are producers and consumers?
- What are primary carnivores ?
- How will you differentiate grazing and detritus food chain?
- What is trophic level?
- 

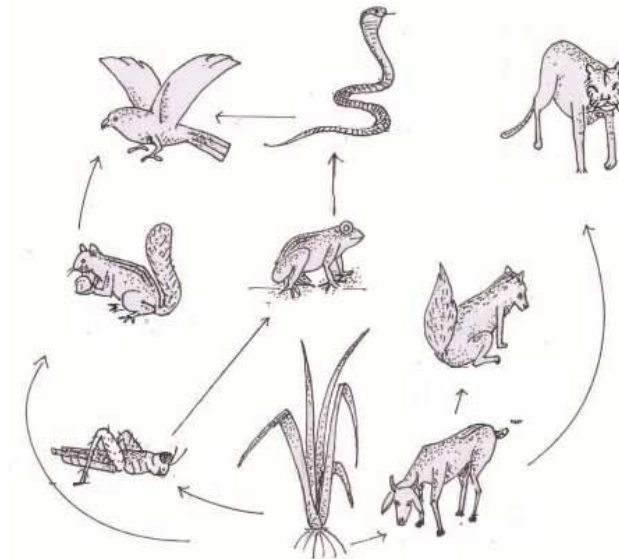
### **Consolidation**

- ◆ Photosynthetically Active Radiation(PAR)
- ◆ Laws of thermodynamics

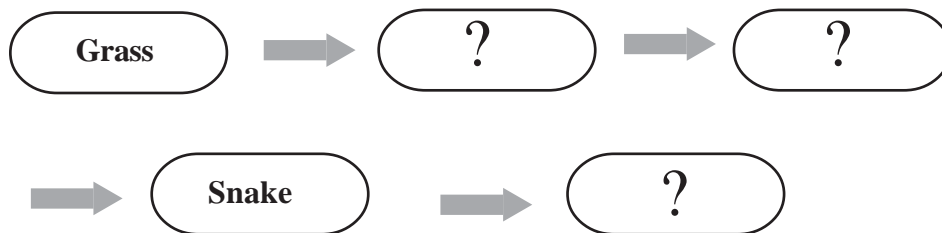
- ◆ Producers
- ◆ Consumers
- ◆ Food chain
- ◆ Detritus food chain
- ◆ Grazing food chain
- ◆ Food web
- ◆ Standing crop
- ◆ 10% law
- ◆

**Assignment**

1. Draw as many as food chains from the given food web.



2. Complete the flow chart.



3. Construct any three food chains from figure 14.2 given in the T.B.

## CONCEPTS

- ❖ Ecological pyramid - relevance, types

**Suggested Activities:** Discussion, picture reading, slide observation, concept mapping

The mentor asks the learner to observe the diagram showing various ecological pyramids in the text book. The mentor conducts a discussion and asks the learners to complete the pyramids in the activity log.

### Discussion points

- What are the different types of ecological pyramids ?
- Who occupies the base of the pyramid?
- What are upright pyramids?
- What do you mean by inverted pyramids?
- 

The mentor asks the learner to complete the pyramids.



### Consolidation

- ◆ Pyramid of number
- ◆ Pyramid of biomass
- ◆ Pyramid of energy
- ◆

## CONCEPTS

- ❖ Ecological succession-primary and secondary, hydrarch succession, xerarch succession

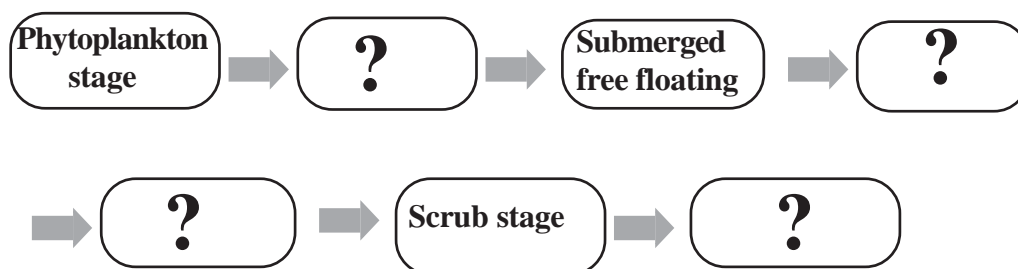
**Suggested Activities :** Discussion, picture reading, slide/video observation

The mentor shows the slides of xerarch succession and also shows a video presentation and organises a discussion.

### Discussion points

- What is the first appeared species in xerarch succession?
- What are the successive plant groups following the pioneer species in xerarch succession?
- What is the climax community in xerarch succession?
- 

The mentor asks the learner to observe figure 14.5 in the text book and also show the slides. Then asks the learners to complete the flow chart in the activity log.



### Consolidation

- ◆ Biological succession
- ◆ Primary and secondary succession
- ◆ Xerarch succession- seral stages
- ◆ Hydrarch succession- seral stages
- ◆

### CONCEPTS

- ❖ Nutrient cycling-carbon cycle (gaseous cycle), phosphorus cycle (sedimentary cycle), standing state, ecosystem services.

**Suggested Activities :** Picture reading, slide observation, general discussion, concept mapping

The mentor asks the learners to observe the fig.14.6 in the T.B and organises a discussion.

### Discussion points

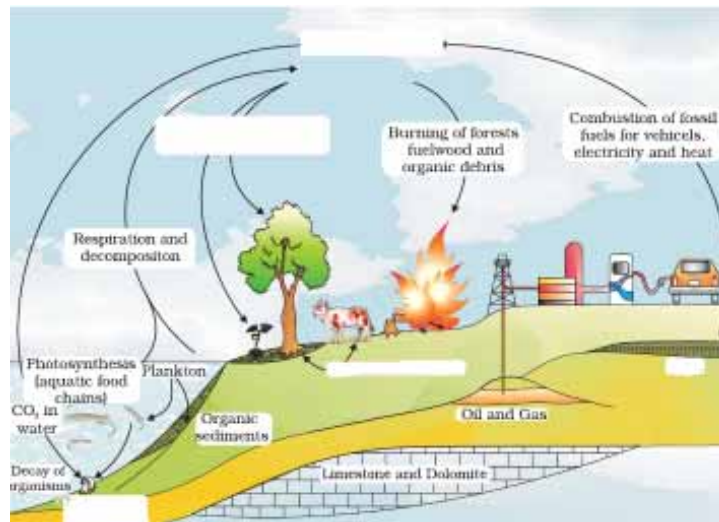
- What is the reservoir of CO<sub>2</sub>?
- Which process absorbs CO<sub>2</sub> from the atmosphere?
- What are the sources of CO<sub>2</sub> which enters the atmosphere?
- How much amount of CO<sub>2</sub> is fixed in the atmosphere annually?
- How human activity influence carbon cycle?

### Consolidation

- ◆ Carbon cycle - processes

### Assignment

1. Complete the carbon cycle in the activity log.



### Phosphorus cycle

### Discussion points

- What is the source of phosphorus in the earth?
- How plants get phosphorus?
- How do phosphorus cycle operate?

The mentor asks to differentiate carbon and phosphorus cycle in the table given below.

Carbon cycle	Phosphorus cycle

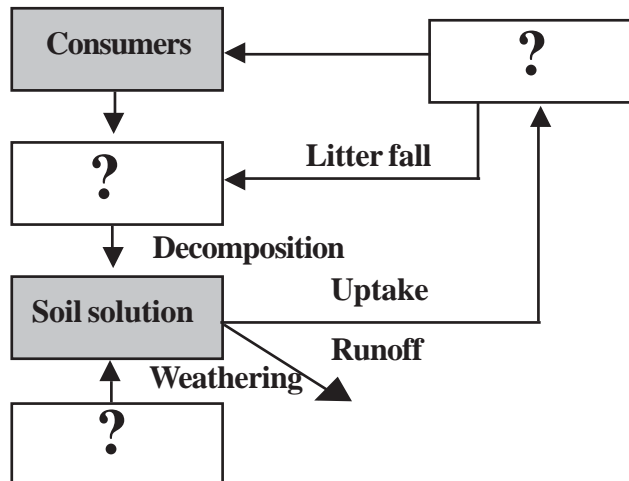


**Consolidation**

- ◆ Phosphorus cycle
- ◆

**Assignment**

Complete the phosphorus cycle in the activity log.

**CONCEPTS**

- ❖ Ecosystem services

**Suggested Activities :** General discussion

The mentor conducts a general discussion on ecological services.

**Discussion points**

- What is ecosystem services?
- What are the services provided by the forest ecosystem?
- What are the prices given to various services by Robert Constanza and his colleagues?

**Consolidation**

- ◆ Importance of ecosystem services
- ◆

**Repository of CE**

Process assessment	Portfolio assessment	Unit assessment
Discussion Table completion Assignment	Prepared notes Completed tables, flow chart	Written test

## SAMPLE TE QUESTIONS

- The pioneer community in the hydrarch succession  
(a) Lichen (b) Moss  
(c) Phytoplankton (d) Zooplankton (Score -1)
- The second trophic level in lake is  
(a) Benthos (b) Phytoplankton  
(c) Birds (d) Zooplankton (Score -1)
- The amount of nutrients in the soil at any given time is -----  
(a) Standing crop (b) Standing state  
(c) Trophic level (d) Stratification (Score -1)
- The process by which the bacteria and fungal enzymes degrade detritus into simpler inorganic substances.  
(a) Fragmentation (b) Leaching  
(c) Catabolism (d) Humification (Score -1)
- Plants can capture only-----% of PAR  
(a) 2-10% (b) 3-15%  
(c) 2-10% (d) 2-15% (Score -1)
- The ecological pyramid is always upright in  
(a) Pyramid of biomass (b) Pyramid of number  
(c) Pyramid of energy (d) None of the above (Score -1)
- Pond is a self sustainable unit. Some organisms in the pond are given below.  
Tadpole, fish, waterplants, kingfisher  
a) Construct a food chain with the listed organisms.  
b) Explain trophic level. (Score-2)
- Differentiate standing state and standing crop in the ecosystem. (Score-2)
- Explain phosphorus cycle. (Score-2)
- How will you differentiate grazing and detritus food chain? (Score-2)
- Define ecological succession? What are the seral stages in hydrarch succession? (Score -3)
- Write any two reservoir of carbon cycle and write any four processes that add CO<sub>2</sub> to the reservoir. (Score-3)

TE Questions : Scoring Key			
Q. No.	Scoring indicator	Splitted Score	Total Score
1	c. Phytoplankton	1	1
2	d. Zooplankton	1	1
3	b. Standing state	1	1
4	c. Catabolism	1	1
5	a. 2 -10 %	1	1
6.	c. Pyramid of energy	1	1
7.	a. water plants- tadpole- fish- kingfisher b. specific place in food chain	1 1	2
8.	Mass of living material- standing crop Amount of nutrient in soil-standing state	1x 2	2
9.	Schematic representation/explanation	2	2
10.	Grazing food chain start with green plants detritus food chain starts with dead organic matter	1x 2	2
11.	Definition Phytoplakton-submerged-submerged Free floating -Reed swamp-marsh meadow Scrub stage- Forest	1 2	3
12.	Reservoir - Atmosphere, Ocean/fossil fuel (any two) Processes - Decomposition, burning of wood, forest fire combustion of organic matter/fossil fuel, deforestation, forest fire (any four)	$\frac{1}{2} + \frac{1}{2}$ $\frac{1}{2} \times 4$	1 2

# Unit 10

# Environmental Issues

## Chapter 8

### **Introduction**

*One of the greatest problems that the world is facing today is that of environmental pollution, increasing with every passing year and causing grave and irreparable damage to the earth. Environmental pollution is causing a lot of distress not only to humans but also to the animals, driving many animal species to endangerment and even extinction. Environmental pollution consists of four basic types of pollution, namely, air, water, soil and light. Environmental pollution is a problem both in developed and developing countries. Factors such as population growth and urbanization invariably place greater demands on the planet and stretch the use of natural resources to the maximum. We need to preserve our wetlands, our rainforests, our farmlands and Arctic zones. And we need to save the endangered species.*

*Our environment is constantly changing. Our planet is poised at the brink of severe environmental crisis. Environmental issues are the effects of harmful human activity on the biological environment. Environmental issues are one of the primary causes of disease, health issues and long term livelihood. Current environmental problems make us vulnerable to disasters and tragedies now and in the future. We are in a state of planetary emergency with environmental problems piling up high around us. In this chapter we discuss various environmental issues like air pollution, water pollution, global warming, deforestation etc.*

### **Values and Attitudes**

- Develops an attitude towards the awareness of conservation of nature.
- Appreciates the activity of various organizations in protecting environment and engages in such conservation activities.
- Stay away from activities that pollute nature.

**Time : 10 Periods**

### Unit Frame

Concepts/Ideas and process skills	Process/Activity with assessment	Learning outcomes
<ul style="list-style-type: none"> <li>• Air pollution,</li> <li>• Noise pollution</li> <li>- Causes</li> <li>- Control measures</li> <li>- Case study</li> <li>.. Observing</li> <li>.. Communicating</li> <li>- Analysing</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Picture reading</li> <li>• Slide/Video observation</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Evaluates the various causes of air and noise pollution and their control measures.</li> </ul>
<ul style="list-style-type: none"> <li>• Water pollution</li> <li>- Causes</li> <li>- Algal bloom</li> <li>- Eutrophication</li> <li>- Biomagnification</li> <li>- Control measures</li> <li>- Observing</li> <li>- Communicating</li> <li>- Comparing</li> <li>- Inferring</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Slide observation</li> <li>• Picture reading</li> <li>• Concept mapping</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Classifies and compares various causes of water pollution and suggests remedies.</li> </ul>
<ul style="list-style-type: none"> <li>• Solid wastes- effects</li> <li>- Disposal measures</li> <li>• Electronic wastes</li> <li>- Observing</li> <li>- Communicating</li> <li>- Identifying</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Video/slide observation</li> <li>• Brain storming</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Predicts the ill effects of solid wastes and e-wastes and recommends their control .</li> </ul>
<ul style="list-style-type: none"> <li>• Agrochemical wastes and their effects</li> <li>- Case study of organic farming</li> <li>• Radio active wastes</li> <li>• Observing</li> <li>• Communicating</li> <li>• Interpreting data</li> </ul>	<ul style="list-style-type: none"> <li>• Video/slide observation</li> <li>• General discussion</li> <li>• Field visit to a farm</li> <li>• Concept mapping</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the problems of agrochemical wastes, radioactive wastes and their control.</li> </ul>

<b>Concepts/Ideas and process skills</b>	<b>Process/Activity with assessment</b>	<b>Learning outcomes</b>
<ul style="list-style-type: none"> <li>• Greenhouse effect</li> <li>• Global warming               <ul style="list-style-type: none"> <li>- Observing</li> <li>- Analysing</li> </ul> </li> <li>• Inferring</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Slide observation</li> <li>• Picture reading</li> <li>• Preparation of notes, Illustrations</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses the effect of greenhouse gases and global warming and suggests its control measures.</li> </ul>
<ul style="list-style-type: none"> <li>• Ozone depletion               <ul style="list-style-type: none"> <li>- Causes</li> <li>- Effects</li> <li>- Montreal Protocol</li> <li>- Observing</li> <li>- Communicating</li> <li>- Analysing</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• General discussion</li> <li>• Slide/video observation</li> <li>• Picture reading</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Analyses the effect of ozone depletion in the stratosphere.</li> </ul>
<ul style="list-style-type: none"> <li>• Improper uses of resources</li> <li>• Deforestation</li> <li>• Jhum cultivation</li> <li>• Reforestation               <ul style="list-style-type: none"> <li>- Observing</li> <li>- Communicating</li> <li>- Analysing</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Slide observation</li> <li>• General discussion</li> <li>• Picture reading</li> <li>• Preparation of notes</li> </ul>	<ul style="list-style-type: none"> <li>• Evaluates the degradation of natural resources and predicts the effect of deforestation.</li> </ul>

*Towards the chapter***CONCEPTS**

- ❖ Air pollution - reasons, control measures, noise pollution-reasons and control measures, case study.

**Suggested Activities** : General discussion, slide/video observation, picture reading(Fig 16.1 of T.B)

The mentor elicits the previous knowledge of the learner by asking some questions.

- How the air gets polluted?
- What are the effects of air pollution?
- How can you define pollution?

The mentor consolidates pollution and causes of air pollution.

The mentor presents the slide/video which shows various causes of air pollution. Also asks the learners to observe the diagram (16.1 of T.B) and conducts a discussion.

**Discussion points**

- What are the sources of air pollution?
- How can we classify air pollutants?
- How these pollutants affect humans and other organisms?
- What are the main parts of the electrostatic precipitator?
- How do scrubber work?
- How can we reduce vehicular pollution?
- 

The mentor shows a video on noise pollution and elicits the danger of noise pollution by asking some questions.

- What are the sources of noise pollution?
- How does noise pollution affect humans ?
- How can we reduce noise pollution?
- 

**Consolidation**

- ◆ Causes of air pollution
- ◆ Electrostatic precipitator

- ◆ Scrubber
- ◆ Central pollution control board
- ◆ Catalytic converter
- ◆ Air (prevention and control of pollution) act 1981
- ◆ Noise pollution
- ◆

The mentor asks one of the learners to read aloud the case study of Delhi and organise a general discussion on the control measures.

### Discussion points

- What is the main reason for air pollution in Delhi?
- What are the measures taken by the government of Delhi to control vehicular air pollution?
- What are the advantages of CNG ?
- Why do we use unleaded petrol?
- 

### Consolidation

- ◆ Control measures advantages
- ◆ CNG
- ◆ New auto fuel policy of India
- ◆ Mass Emission Standards
- ◆

### Assignment

Analyse table 16.1 in the T.B and prepare a note on the Mass Emission Standards in India.

### CONCEPTS

- ❖ Water pollution - causes, algal bloom, biomagnification, case study, control measures

**Suggested Activities:** General discussion, picture reading, slide/video observation, concept mapping, seminar

The mentor shows the video on the various ways by which the water get polluted and also asks the learner to observe the diagrams 16.2 and 16.3 of T.B and to write the notes in the activity log.



The mentor exhibits the slide/video showing algal bloom and conducts a discussion.

### **Discussion points**

- How does water get polluted?
- What happens when nutrients get enriched in water?
- What are the adverse effects of algal bloom?
- What are the diseases spread through polluted water?
- Name the industries which cause water pollution?
- 

### **Consolidation**

- ◆ Water pollution - causes
- ◆ Industrial effluents - effects
- ◆ Biological Oxygen Demand
- ◆ Algal bloom- causes, effects
- ◆

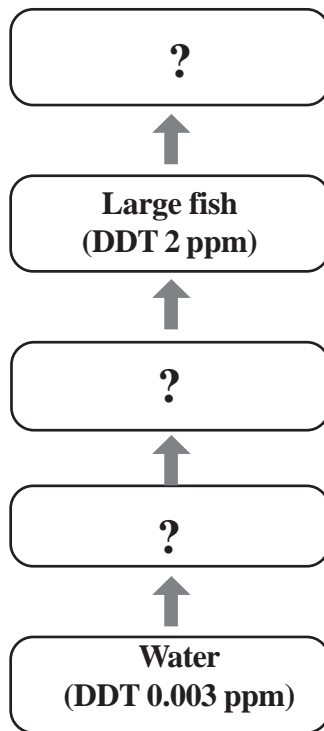
The mentor shows a video of biomagnification and eutrophication. Then asks the learners to prepare notes based on discussion points and to analyse figure 16.5 in the T.B. Then provides assignment.

### **Discussion points**

- What is biomagnification?
- How does DDT affects the life of birds?
- How does nutrient enrichment affect the water bodies?
- How do thermal plants affect water?
- What do you mean by accelerated eutrophication?
- 

### **Assignment**

The learners are asked to complete the flow chart.



The mentor asks to read the case study of Integrated Waste Water Treatment and conducts a general discussion.

### Discussion points

- What are the processes conducted in Arcata to clean water?
- What is FOAM?
- How can human excreta be disposed without using water?
- What is ecological sanitation?
- What do you mean by EcoSan toilet?
- 

### Consolidation

- ◆ Biomagnification
- ◆ Eutrophication
- ◆ Accelerated eutrophication
- ◆ Integrated Waste Water Treatment
- ◆ Ecological sanitation
- ◆

**CONCEPTS**

- ❖ Solid wastes, electronic wastes, case study

**Suggested Activities :** General discussion, picture reading, brain storming, video observation.

The mentor asks the learners to read the narration on solid wastes in T.B. Then asks the following questions to the learners. The responses of the learners are noted on the black/white board. After this the mentor consolidates and asks to prepare notes.

- How wastes can be categorized ?
- How biodegradable wastes can be disposed?
- What do you mean by electronic wastes?
- How can we dispose e- wastes properly?
- Name the metals that can be recycled from e-wastes?
- 

**Consolidation**

- ◆ Solid wastes - categorisation
- ◆ Electronic wastes (e-wastes) - disposal measures
- ◆

**Assignment**

Prepare a note based on following questions.

- How did Ahmed Khan collect plastic wastes?
- How did he use the collected waste?
- Which are the agencies that helped Ahmed Khan?

**CONCEPTS**

- ❖ Agrochemical wastes and their effects, case study of organic farming, radioactive wastes.

**Suggested Activities :** Slide/video observation, field visit, group discussion.

The mentor exhibits the video on the impact of inorganic fertilizers and pesticides. He/she can also conduct a field trip to a nearby organic farm. Then asks to read the case study of organic farming.

### **Consolidation**

- ◆ Organic farming-significance
- ◆ Haryana Kisan Welfare Club
- ◆

The mentor conducts a general discussion on radioactive wastes.

### **Discussion points**

- What are the uses of nuclear energy?
- Where did the accidental leakage of nuclear energy occur?
- How nuclear wastes can be disposed?

### **Consolidation**

- ◆ Radioactive wastes-problems
- ◆ Disposal measures
- ◆

### **CONCEPTS**

- ❖ Greenhouse effect, global warming

**Suggested Activities :** General discussion, picture reading, slide observation.

The mentor asks the learner to observe the diagrams 16.6 and 16.7 of the text book and asks them to analyse the two. Then conducts a discussion.

### **Discussion points**

- Which are the major greenhouse gases?
- What do you mean by greenhouse effect?
- What is the state of earth if greenhouse effect is absent?
- What do you mean by global warming?
- What are the effects of global warming?
- How global warming can be controlled?
- 

### **Consolidation**

- ◆ Greenhouse effect
- ◆ Greenhouse gases

- ◆ Global warming-effects
- ◆ Control of global warming
- ◆

### CONCEPTS

- ❖ Ozone depletion in the stratosphere

**Suggested Activities :** General discussion, picture reading, slide observation.

The mentor exhibits the slide on the effect of ozone depletion and formation of ozone and asks the learner to write the points in the activity log. Then starts a discussion.

### **Discussion points**

- What are bad and good ozone?
- Which unit is used to measure ozone?
- Which gas mainly depletes ozone?
- Name the layer of atmosphere in which the ozone is seen?
- What do you mean by ozone hole?
- Which type of UV rays cause snow blindness?
- What is Montreal Protocol?

### **Consolidation**

- ◆ Ozone -significance
- ◆ Dobson unit
- ◆ Formation of ozone
- ◆ Ozone degradation - reasons
- ◆ Ozone hole - effects
- ◆ UV-B- harmful effects
- ◆ Montreal Protocol
- ◆

### CONCEPTS

- ❖ Degradation by improper resource utilization, deforestation

**Suggested Activities :** General discussion, video/slide observation

The mentor conducts a discussion on degradation by improper resource utilization.

### **Discussion points**

- How does soil erosion occur?
- What are the results of soil erosion?
- How does irrigation affect the soil salinity?
- How does waterlogging affect agriculture?
- How does desertification occur?

The mentor then exhibits a video showing deforestation and also conducts a general discussion.

### **Discussion points**

- What is the present percent of forest area in India?
- What is jhum cultivation?
- What are the consequences of deforestation?
- What do you mean by reforestation?
- How did Amrita Devi object king's men from cutting down the trees?
- Name the movement conducted in India for the protection of forest.
- What is JFM?

### **Consolidation**

- ◆ Soil erosion
- ◆ Desertification
- ◆ Soil salinity
- ◆ Deforestation
- ◆ Jhum cultivation
- ◆ Reforestation
- ◆ Amrita Devi Bishnoi Wildlife Protection Award
- ◆ Chipko movement
- ◆ Joint forest management
- ◆

**Repository of CE**

Process assessment	Portfolio assessment	Unit assessment
Discussion Field trip Assignment	Prepared notes in the activity log Completed assignments	Quiz/Unit test

Teacher gives an assignment to learners to prepare maximum number of one - word questions including picture type questions with answers. Provide them enough time to prepare questions. After this, collect questions and answers from the students.

Teacher should select twenty questions from the collected questions. Fix the date and time of quiz programme after discussing with students. Group them into two. Select 10 students each from a group as participants. Select a student as scorer. Keep the remaining students as audience. Give one question to each student of each group. The first group asks questions to the second group and vice versa. If any group does not answer the questions the chance will be given to the audience. Teacher is the moderator.

## SAMPLE TE QUESTIONS

1. The metal used to prepare catalytic converter  
(a) Rhodium (b) Calcium (b) Gold (d) Magnesium  
(Score -1)
2. The unit used to measure ozone is  
(a) decibel (b) dobson unit  
(c) Parts per million (d) gm/cm<sup>3</sup> (Score -1)
3. The disease cholera, typhoid and jaundice are due to the pollution of.....  
(a) Air (b) Water (c) Food items (d) Soil (Score -1)
4. A river with high BOD value is  
(a) Highly polluted  
(b) Highly productive  
(c) Highly clean  
(d) None of the above (Score -1)
5. Which gas is responsible for the depletion of ozone layer?  
(a) Nitrogen (b) Carbon dioxide  
(c) Chloro fluorocarbon (d) Nitrogen oxide (Score -1)
6. CNG is preferred for vehicles than petrol or diesel. Why?  
(Score -1)
7. The concentration of DDT adversely affect bird's population. Substantiate your answer. (Score -2)
8. Match the following

A	B
1. Scrubber	a. Deforestation
2. Montreal Protocol	b. Air pollution
3. Thinning of eggs	c. Ozone depletion
4. Chipko movement	d. Biomagnification

(Score -2)



9. Global warming cause so many hazards to the nature.  
(a) Suggest two methods to reduce global warming.  
(b) Write the major greenhouse gases which causes global warming.  
(Score -3)
10. How is ozone produced and destroyed? (Score -3)
11. Deforestation is highly dangerous to our environment. Why?  
(Score -3)

**TE Questions : Scoring Key**

<b>Q. No.</b>	<b>Scoring indicator</b>	<b>Splitted Score</b>	<b>Total Score</b>
1	a. Rhodium	1	1
2	b. Dobson unit	1	1
3	b. Water	1	1
4	a. Highly polluted	1	1
5.	c. Chlorofluorocarbon	1	1
6	CNG burns most effectively and is cheaper Biomagnification	1	1
7	Thinning of eggs Calcium metabolism failure (any two)	1 1	2
8.	1 - b 2 - c 3 - d 4 - a	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	2
9.	a. Plant trees Reduce the use of fossil fuels Reduce deforestation Reduce the emission of greenhouse gases (any two) b. CO <sub>2</sub> , Methane, CFC, N <sub>2</sub> O	1 2	3
10.	Ozone is formed by the action of UV rays on molecular oxygen Ozone is depleted by the action of chlorine released by CFCs	1 2	3
11.	Increase in CO <sub>2</sub> concentration Loss of biodiversity due to habitat loss Soil erosion Global warming (any three)	1 1 1	3

***More to know*****ECOSAN TOILET****(The 'ECOSAN compost pit latrine')**

The ECOSAN toilet is a very advanced and modern way of constructing a toilet.

The main objectives are:

1. To avoid contamination of ground water.
2. To avoid pollution of air, water, and soil.
3. To recover nutrients from human excreta and safely recycle them back to the environment as fertilizers,

This toilet will be constructed only above the ground level.

It consists of two chambers, which are used in turn for defecation, and an outlet for urine. In this way urine and feces is going separately.

When the first chamber is filled up with feces, it is closed for 6 months. In the meantime the second chamber is filled up.

**Important features**

The important features of the ECOSAN toilet are:

- It is not polluting water or soil, because the faeces are kept in the watertight chambers. Even if the ground around the toilet is flooded, feces will not get in connection with the water.
- It is improving environmental sanitation by converting feces to manure.
- It uses less water than other toilets.  
2-3 liters of water per day are enough. The standard toilet requires 10 – 12 liters per day. A person can save up to 7000 liters of water per year. This is a big advantage when water is becoming scarce at various times of the year.
- Urine is separated at the time of defecation and will be mixed with the water from washing. All the water will be diverted to a soakage pit, to the kitchen garden or collected and used as urea for agriculture.
- The human waste is safely disposed of by the user of the toilet.
- There is no odour.
- The toilet is easy to clean.

During six months the feces in the first chamber will decompose.

Then the chamber can be opened and the compost taken out and used as manure in garden or field.

It is important that no water is running down in the chambers where feces are collected.

Therefore the toilet has to be cleaned by use of ash, and ash has to be strewn in the chamber after use. Water for cleaning has to be used above the urine outlet.

How to use the toilet

- Remove the cover lid of the pit
- Sit properly on the seat so that feces will go directly in to the pit.
- After defecation spread some ash or sand
- Close the pit with the cover lid.
- Clean anus, wash hands with ash, soap, mud or water.
- Ensure that the cleaning water does not leak into the pit

We cordially thanks the organizations BLESS, Palmyra and Eco-Pro for giving training and instructions to our staff in use and construction of ECOSAN toilets.