This book is based on NCERT syllabus prescribed by the Central Board of Secondary Education (CBSE) for Class IX

Science for Ninth Class

(Part–3)

Biology

As per NCERT/CBSE Syllabus

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VALUE BASED QUESTIONS (WITH ANSWERS)

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A Division of S. Chand And Company Limited
(An ISO 9001 : 2008 Company)
7361, Ram Nagar, Qutab Road, New Delhi-110055
Phone: 23672080-81-82, 9899107446, 9911310888; Fax: 91-11-23677446
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First Published in 1980
Revised Edition 2014, 2016, 2017
This Edition 2018
Reprints 1981, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2015, 2016, 2017

ISBN : 978-93-528-3179-1 **Product code:** SCS3LKS090BIOAD17CBY

PRINTED IN INDIA

By Vikas Publishing House Pvt. Ltd., Plot 20/4, Site-IV, Industrial Area Sahibabad, Ghaziabad-201010
and Published by S. Chand And Company Limited, 7361, Ram Nagar, New Delhi -110 055.

PREFACE TO THE REVISED EDITION

We Indians are witnessing a challenging phase of renovation and implementation of revolutionary new ideas in the development and betterment of our nation. Our National Policy makers are becoming increasingly global in their attitudes, so there is a whiff of freshness in every walk of life be it Information Technology, Finance, Education, Health, Sports, Biotechnology or Agriculture. It appears as though we have awakened from a deep slumber, have recognised our worth and confidently taking forward steps towards progress and development of the India. Modern India is marching ahead with new hopes for the masses and downtroddens. Indeed science has become a channel to provide food, fabric, medicines, bioenergy, healthy environs and new lease of life to wild biota and protecting abiotic resources of the biosphere. Manoj Prasad recently reported in the Indian Express (December 3, 2010) on how a septagenarian tribal Mr. Simon Oranon saved rainwater and jungles with three dams, five ponds for year-round irrigation of crop fields and planted about 30,000 trees of sal, jackfruit, jamun and mango (to check the soil erosion). His ingenious social work has changed the lives of people in six villages of Chottanagpur (Ranchi), Jharkhand State (*i.e.*, Bero, Hariharpur, Jamtoli, Kaxitoli, Baitoli and Bhasanda villages). The present revised and enlarged multicolour edition of our book **"Science for Ninth Class (Part - 3) Biology"** is based on the latest CBSE Syllabus. The text part of the book is strictly according to the N.C.E.R.T Textbook. Present revised pruned edition of the book includes the following new features :

1. Text is thoroughly checked, corrected, revised and made tailor-made according to specific needs of our students.
2. Exercise of each chapter is updated according to needs of our readers. In chapter 5, adequate new ideas for activities, topics for seminars and modus operandi of holding a group discussion, all have been suggested.
3. A variety of questions, MCQs, etc. have been formulated to cover each chapter more exhaustively.
4. Almost 60 per cent questions of the book have been answered.
5. Chapter 4 of the book, is a bit bloated in volume since it carries entirely renewed Question Bank of practical related questions.

An attempt has also been made to include questions from the sample papers issued by CBSE Board.

Value Based Questions have been added at the end of each chapter. These questions are based on the application of Biology in our daily life. Value based questions are meant for inculcating social values amongst our young students.

Despite of all the major changes introduced in the present edition, we have maintained simplicity and modernity of the text so as to cater to all types of students including brilliant and outstanding ones.

Thanks and blessings to Ms Anubha Agarwal for painstaking editing and critical review of this book.

Our sincere thanks are extended to the management, editorial and DTP team of S. Chand And Company Limited. Their tireless efforts remained quite crucial in timely release of this book.

Hope, our this endeavour will help IX class students of India and fire their imagination to learn more and more about the nature.

We welcome constructive criticism and healthy suggestions from our readers for the betterment of the book.

Meerut (U.P.) **AUTHORS**

CONTENTS

CHAPTER

1

Improvements in Food Resources

For their existence, all living organisms essentially require food. Early human beings started hunting animals and collecting fruits, flowers and roots of forest plants to meet their food requirements. Food is required for growth, development and body repair. It also protects the body from diseases and provides energy for doing all life functions. For example, food supplies proteins, carbohydrates and fats (lipids), vitamins, minerals and water to our body.

Among all the living organisms, only green plants are **autotrophs**, *i.e.*, they make their own food. In fact, green plants perform a basic metabolic activity, called **photosynthesis**. In photosynthesis by using the energy of sunlight, green plants combine carbon dioxide (CO_2) and water (H_2O) to produce carbohydrates (Food). In contrast to green plants, animals and human beings are **heterotrophs**, *i.e.*, they depend on plants and other animals for food. Since time immemorial, human beings have been doing farming and rearing animals to meet their food requirements.

Plants as food are gift of nature to humans and most animals. In fact, different parts of plants, such as root, stem, leaf, flower and fruit, are consumed by humans in the form of cereals, vegetables, spices and fruits. Animals produce milk, egg, meat, etc., which also supplement our food requirements.

1.1. SUSTAINABLE AGRICULTURE AND ORGANIC FARMING

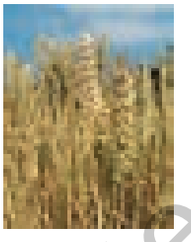
With 1.04 billion people, our country ranks second in population growth around the world. According to an estimate, by the year 2020, Indian population would rise to 1.343 billion. To feed such a huge population, we will require at least 241 million tonnes of grain production per annum. Therefore, it is necessary to increase production of both, plants and animals. Even in the past, to meet the demands of growing Indian population, our scientists (such as Swaminathan, Kurein) adapted methods to increase food production. This resulted in a variety of 'revolutions', which helped India become self- reliant. These revolutions include: **green revolution** (high production of food grains), **blue revolution** (enhanced fish production), **white revolution** (increased milk production) and **yellow revolution** (increased oil production). Our scientists are continuously making efforts to increase the pulse production, *i.e.* to spread the golden revolution.


Green Revolution.


Blue Revolution.


White Revolution.


Yellow Revolution.


Golden Revolution.

1. Sustainable Agriculture

Sustainable agriculture can be defined as the adoption of various farming and production management techniques to maximize agricultural yield. Implementing such practices would help in (i) conserving natural resources, (ii) maintaining environmental balance and (iii) coping with changing human needs (Box 1.1) Hence, to assure sustained livelihood of Indian farmers and related persons, it is necessary to adopt sustainable agricultural practices such as **mixed farming, crop rotation, intercropping** and **integrated farming** (also known as **integrated agriculture**).

Box 1.1

1. Farming. It is the process the harnessing solar energy from plants and animals in the form of economic produce.

2. Conservation. It means careful utilization, preservation or restoration of the natural environment and resources.

Integrated agriculture implies a combination of agriculture with other forms of culture such as pisciculture (fish culture), aquaculture, apiculture (bee- keeping), sericulture (silk worm culture), poultry farming, piggery, livestock production (animal husbandry), etc.

Box 1.2

Why sustainable agriculture?

With increasing human population of our country, the natural resources such as land, soil, water, fossil fuels, etc., are being overexploited for food, shelter and urbanisation. All these human activities have degraded our environment and have caused following problems: **soil erosion**, **salinization of soils, desertification, silting of rivers, floods, droughts, eutrophication, ozone depletion, deforestation, wild life extinction, pollution of air, water and land, biomagnification of toxic substances,** etc., to name a few. Thus, it has become far more important that we should increase food production without degrading our environment and disturbing the natural balance.

In recent years a concept of sustainable agriculture is developed in order to ensure that the agro-ecosystems are stabilized and sustained crop yields are assured on long term basis.

Sustainable agriculture refers to agriculture - where the agro-ecosystems function on self sustaining basis of nutrient supply and crop protection in order to stabilize the crop yields.

Sustainable agriculture involves practices such as organic farming, biological and natural control of pests, emphasis on watershed approach to conserve the soil and water, buildup of microflora in close harmony with beneficial soil - inhabitants and complete desisting the use of synthetic chemicals. It is sustainable agriculture which ensures, pollution free food production and continuation of agriculture with least damage to ecosystem.

Advantages of Sustainable agriculture. Sustainable agriculture is an agricultural production and distribution system that

- Achieves the integration of natural biological cycles and controls.

- Protects and renews soil fertility and the natural resource base.
- Optimizes the management and use of farm resources.
- Reduces the use of non-renewable resources and purchased production inputs.
- Provides an adequate and dependable form of income.
- Promotes opportunity in family farming and farm communities.


Sustainable agriculture.

Organic Farming

It is the practice of raising crops which have not been polluted with the use of manures, biofertilizers and biopesticides. Instead healthy cropping systems that provide optimum nutrients to plants and keep the pests as well as weeds under control are used. In organic farming there is little or no use of chemical fertilizers, pesticides and herbicides. Therefore, there is no toxicity due to pollution of crop plants, soil, water or air. Organic wastes are recycled in the form of manure. Biofertilizers include the nitrogen fixing organisms (bacteria and blue green algae) and mineral solubilizing bacteria. Biopesticides are organisms or their extracts which repel or kill weeds, insects and other pests, *e.g.*, azardirachtin (Morgosa or Neem), pyrethrum (chrysanthemum), thurioside (bacterium *Bacillus thurigiensis).* Neem leaves are often used in grain storage as biopesticides. Healthy cropping includes mixed cropping, intercropping and crop rotation. These cropping systems help in controlling insects, pests and weeds.


Organic farming.

Advantages of Organic Farming

1. It prevents pollution of any component of our environment.
2. Farm wastes are recycled.
3. The foods obtained from organic farming are free from pesticides and toxic chemicals.
4. Organic farming maintains the soil health.
5. The cropping system of organic farming keeps insect pests and weeds under check.

1.2. IMPROVEMENT OF CROP YIELDS

Agriculture is the science and practice of farming, which mainly involves rearing of livestock, cultivating land, raising crops, harvesting and marketing the produce. It is further subdivided into many categories (Box 1.3).

Box 1.3

1. Agronomy. The branch of agricultural science dealing with production of field crops and management of the soil.

2. Horticulture. Branch of agriculture that deal in growth and management of fruit and flowering plants in orchards and gardens.

3. Olericulture. Refers to growing and managing of vegetables.

4. Aquaculture. The farming and harvesting of plants and animals in bodies of water for economical purpose.

Agronomist. An agronomist studies crop disease, selective breeding, crop rotation and climatic factors, tests the soil, investigates the causes of soil erosion and designs land reclamation and irrigation schemes.

Types of Crops

Crops are plants which are cultivated by humans for food, fodder, fiber, flowers, timber, etc. There are about 2000 plant species which are cultivated for eating purposes. Following parts of the plants are eaten as food.

1. Seeds. Not all seeds of plants are edible. For example, large seeds such as those from a lemon pose a choking hazard, whereas seeds from apple and cherries contain poison cyanide. Edible seeds include cereals, pulses, oil seeds and nuts (dry fruits).

(*a*) **Cereals.** They include crops such as wheat, rice, maize, barley, sorghum, etc. They are a rich source of carbohydrates.

(*b*) **Pulses.** They include legumes such as chicken pea gram, (chana), pea (matar), black gram (urad), green gram (moong), pigeon pea (arhar), cow pea (lobia) and lentil (masoor). They are excellent source of proteins.

(*c*) **Oil seed crops.** They include cotton seed, niger (Ramtil), safflower, soybean, flax (linseed oil), rapeseed, groundnut, sesame, mustard, sunflower, olive, etc. They are source of oil, fats and fatty acids. These seeds are typically high in unsaturated fats and when consumed in moderation are regarded as healthy foods. Coconut oil and palm oil are cheap sources of cooking medium.

(**Note.** Castor oil is not edible oil. It is mainly used as a lubricant or purgative, in the manufacturing of transparent soaps, inks, paints, phenyls, hair fixers, etc.).

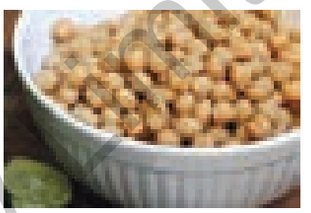
(*d*) **Nuts or Dry fruits.** Nuts are rich in proteins and fatty acids, so are considered energetic food items. Examples include almond, walnut, cashew nut, pistachio, fig, raisin (or currant), dried apricot, coconut, peanut, date, etc.


Wheat.


Maize.

Cereal Crops.


Pea.


Chicken pea.

Pulse Crops.


Soyabean.

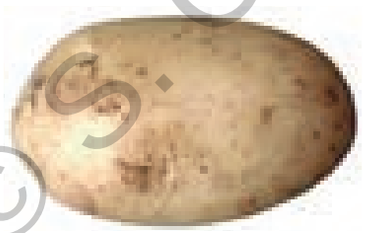

Ground nut.

Oil seed Crops.

2. Fruits. They include apple, orange, mango, banana, pineapple, guava, papaya, watermelon, muskmelon, pomegranate, pear, peach, apricot, grapes, dates, custard apple, etc. Essentially fruits are ripened ovaries of plants and are a good source of vitamins, minerals, roughage, proteins, carbohydrates and fats.

3. Vegetables. They are the edible parts of the herbaceous plants. They are eaten in raw or cooked form. Vegetables are of following types:

(a) **Roots.** Roots of some plants such as carrot, radish, turnip, sweet potato and beet root are eaten as vegetables.


Potato.

(Modified underground stem)


Carrot.

Root vegetables.


Spinach.


Lettuce.

Leaf vegetables.

(*b*) **Stems.** Stems of some plants such as mustard, bamboo, banana, asparagus, etc., are used as vegetables. Certain plants have modified underground stems that are eaten, *e.g.*, potato, onion, garlic, ginger, etc. Stems of sugarcane are used for making of cane juice and jaggery.

(*c*) **Leafy vegetables.** They include leaves of spinach, lettuce, cabbage, turnip, radish, mustard, methi, bathua (pigweed) and curry-leaf tree.

(*d*) **Inflorescence vegetables.** They include broccoli, cauliflower, etc., of vegetables.

Flowers of banana, fennel, gourd and saffron are also good examples of vegetables.

(*e*) **Fruit vegetables.** They include tomato, pumpkin, brinjal (egg plant), jack fruit, bitter gourd, bottle gourd, ridged gourd, cluster bean, cucumber, lady's finger, pumpkin (sitaphal), capsicum, lablab bean, vegetable sponge (ghia torai), faraz bean, tamarind, carmbola (kamrakh), etc.

4. Spices. Certain parts of some plants (*e.g.*, leaves, stems, flowers, fruits and seeds) are used to enhance the palatability of food. They include chilly, turmeric, black pepper, cumin, fenugreek, cardamom, fennel, nutmeg, lovage, sesame, cinnamon, dried ginger (sounth), etc .

5. Fodder crops. They provide green fodder to the cattle, *e.g.*, berseem, oat, sudan grass, sorghum, etc.

6. Other crops. Crop plants also yield fibres (*e.g.*, cotton), tobacco, tea, coffee, chocolate, peppermint, etc.

Crop Seasons

Different crop requires different climatic conditions, temperature and photoperiod for their growth and maturity. Sunlight is required for photosynthesis — the process of manufacturing food by green plants. **Photoperiods** are duration of sunlight that influences plants in their growth, flowering, formation of storage organs, leaf fall, etc. In India, there are two main seasons of crop growth: Kharif and Rabi.

1. **Kharif crops.** These crops grow during rainy season (June to October). They are also called **summer season crops.** The chief kharif crops (cereals and pulses) are paddy (rice), maize, millet, groundnut, soybean, arhar, black gram (urad), green gram (moong) cotton and jute. Vegetables of kharif crops are spinach, gourd, garlic, lady finger, pumpkin and brinjal. Fruits of kharif crops are watermelon, muskmelon, mango, litchi, plum, peach, etc.

2. **Rabi crops.** These crops grow from November to April. Rabi crops are also called **winter crops**. The important rabi crops (cereals and pulses) are wheat, barley, gram, mustard, pea and linseeds. Vegetables of rabi crops are cabbage, cauliflower, carrot, radish, turnip, beans, etc. Fruits of rabi crops are apple, pomegranate, orange, etc.

Table 1.1. Differences between Kharif and Rabi crops.

Kharif crops	*Rabi crops*
1. They are monsoon or rainy season crops	1. They are non-monsoon season crops.
2. The crops grow in hot and wet conditions.	2. The crops grow in cold and nearly dry conditons.
3. These crops are sown in the begining of rainy season in June - July.	3. These crops are sown in October-November when monsoon is retreated.
4. These crops are harvested during September - October at the end of Monsoon.	4. These crops are harvested in March-April before the advent of hot season.
5. **Examples.** Rice, Maize, Groundnut, Soybean, Green gram, Cotton, Black gram.	5. **Examples.** Wheat, Barley, Gram, Mustard, Linseed, Pea.

Improvement in Yields

Following *three* scientific approaches are adopted in India to obtain high yields from our agriculture farms :

1. Crop production management
2. Crop variety improvement
3. Crop protection management

Crop Production Management

India is an agriculture based country. In this country, agriculture sector engages about 70% of its population and accounts for 40% of the Gross National Product (GNP). Farming practices being followed depend upon size of land holding, education and financial conditions of the farmers. The production practices include "no cost" production, "low cost" production and "high cost" production. High cost production is based on improved high yield varieties, improved farming practices, modern technology, latest agricultural machines and implements. **Crop production management** refers to controlling the various aspects of crop production, to obtain the maximum and best yield. It has the following three components: 1. nutrient management; 2. irrigation and 3. cropping pattern.

Box 1.4

India is a large country with an enormous area under cultivation. India is blessed with continuous growing seasons which means that crops can be grown throughout the year. This is due to the subtropical climate, plenty of sunshine and lack of frost in most part of the country.

Nutrient Management

Nutrient management means controlling the **selection, timing** and **amount** of nutrient supply to the crops. Like other living organisms, plants also require inorganic elements for building their structure and maintaining their metabolic processes. These inorganic elements are called **nutrients**. Nutrients are supplied to the plants by air, water and soil. There are about 40 elements found in the plant ash, but only 16 of those elements are essential for plant growth and development. Hence, these 16 elements are called **essential elements** or **essential plant nutrients**.

Out of 16 essential elements, two elements, carbon and oxygen are obtained from air and hydrogen from water. Remaining 13 elements are supplied by the soil. These 13 elements are minerals. A mineral is a substance which is obtained by mining.

Table 1.2. 16 essential nutrients of plants their sources, types and examples.

Source	*Nutrients*	*Type*
1. Air	Carbon (C), Oxygen (O)	Macronutrients (= 2)
2. Water	Hydrogen (H)	Macronutrient (= 1)
3. Soil	● Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Sulphur (S)	Macronutrients (= 6)
	● Iron (Fe), Manganese (Mn), Boron (B), Zinc (Zn), Copper (Cu), Molybdenum (Mo), Chlorine (Cl)	Macronutrients (= 7)

Types of Essential Nutrients

Maze (1915) divided essential plant nutrients into two categories, macronutrients and micronutrients.

(i) **Macronutrients (Macroelements).** They are those essential elements which are present in plants in easily detectable quantities, more than 1ppm of plant body (1 mg per gm of dry weight). Macronutrients take part in synthesis of organic molecules and development of osmotic potential (Box 1.5). Carbon (from air), oxygen (from air) and hydrogen (from water), are non-mineral micronutrients. Out of 13 essential mineral elements, six are macronutrients, *i.e.*, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur (Table 1.2).

Box 1.5

Osmosis. The diffusion of a solvent, such as water, through a semipermeable membrane, which separates two solutions of different concenterations. The flow of the solvent is from the more ditute to the more concentrated solution, owing to the thermodynamic tendency of the solution to equalize the concentrations of solutes on the two sides of the membrane. A better way of defining osmosis is to say that it is net movement of water through a semipermeable membrane from a solution of higher water potential to a solution of lower water potential

Osmosis was studied by **Thomas Graham,** who coined this term in 1858. Osmosis is important in dialysis and in water transport in living tissue.

(*ii*) **Micronutrients (Microelements).** They are those essential elements which are present in plants in small quantities, less than 1ppm or 1 mg/gram of dry matter. All of them are mineral elements. Micronutrients are mostly involved in the functioning of enzymes. Out of 13 essential mineral elements, seven are micronutrients, *i.e.*, iron, manganese, boron, zinc, copper, molybdenum and chlorine.

Table 1.3. Differences between Macronutrients and Micronutrients.

Macronutrients	*Micronutrients*
1. They are required in large quantities.	1. They are required in very small amounts.
2. Concentration of each macronutrient in plants is more than 1mg/gm of dry matter.	2. Concentration of micronutrients is quite below 1 mg/gm of dry matter.
3. They take part in building plant body and different protoplasmic structures.	3. They have no such functions.
4. They have no significant role in enzyme activity and electron transport.	4. They are involved in enzyme activity and electron transport.
Examples. Nitrogen, Phosphorous, Potassium, Calcium, Magnesium, Sulphur.	6. **Examples.** Iron, Manganese, Boron, Zinc, Copper, Molybdenum, Chlorine.

Mineral Replenishment

Soil is the most important reservoir of plant nutrients. Crop plants regularly withdraw minerals (in the form of nutrients) from the soil. Unless and until minerals are replenished at regular intervals, the crop plants will develop disorders in structure, growth, reproduction, functioning and susceptibility to diseases. Mineral replenishment is done through the addition of manures and fertilizers to the crop fields.

MANURES AND FERTILIZERS

The deficiency of plant nutrients and organic matter in the soil is made up by adding manures and fertilizers to the soil of crop-fields. Both manures and fertilizers are major sources of nutrients of plants, so they are used in crop production.

A. Manures

Manures are natural fertilizers. They are bulky sources of organic matter which supply nutrients in small quantities, and organic matter in large quantities. Manures are prepared by the decomposed animal excreta and plant waste. Manures include farmyard manure (FYM), compost, green manures, vermicompost, etc.


Manure.

Advantages of manures. Manures affect the soil in following three ways :

(*i*) Manures enrich the soil with nutrients. They replenish the general deficiency of nutrients in the soil. Since manures contain less nutrients they need to be used in large quantities.

(*ii*) Manures add organic matter (called **humus**) to the soil which restores the soil texture, for better retention of water and aeration of soil. For example, organic matter present in the manures increases the water holding capacity in sandy soils and drainage in clayey soil. They also prevent water logging in clay soils.

(*iii*) The organic matter in manures provides food for the soil organisms, (decomposers such as bacteria, fungi, etc.) which help in providing nutrients to plants.

Thus, organic manures help to improve the physical properties of soil, reduce soil erosion, increase the moisture holding capacity of soil and are low cost nutrient carriers. Using biological waste material is a way of re-cycling the farm waste. Manures protect our environment from synthetic chemicals (*i.e.*, fertilizers).

Disadvantages of manures. Manures are bulky with low nutrient content. The nutrients get released slowly, unable to fulfill the high and rapid demand of nutrients required by improved high-yielding hybrid varieties of crops. Being bulky and voluminous, they are inconvenient to handle, store and transport. Moreover, manures are not nutrient specific and, hence, are not much useful when a particular nutrient is required in the soil for a particular crop.

Types of manures. 1. Farmyard manure (FYM). FYM is the decomposed mixture of cattle excreta, (dung), urine, litter (*i.e.,* bedding material used in night under cattles) and left over organic matter such as roughage, or fodder. These waste materials are collected daily from the cattle shed and stored in a pit for decomposition by the microorganisms (bacteria, fungi, etc.). FYM contains nitrogen, phosphorus and potassium. A well decomposed farmyard manure contains about 0.5 per cent nitrogen (N), 0.2 per cent phosphorus pentaoxide (P_2O_5) and 0.5 per cent potassium monoxide (K_2O).

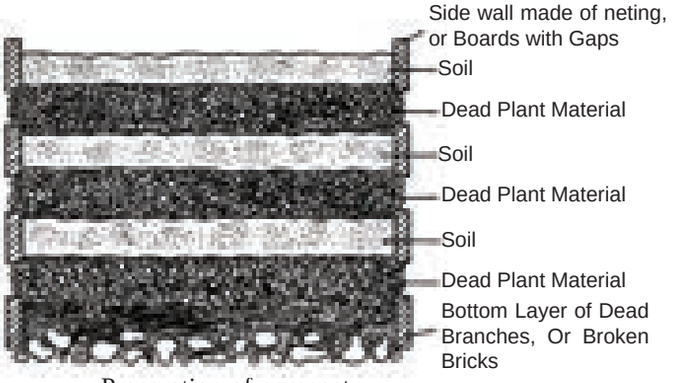
2. Compost. Compost is prepared from farm and town refuge such as vegetable and animal refuse (*e.g.,* excreta of domestic animals such as cattle, goat, sheep, horse, donkey, camel, dogs, cats, etc.), faecal matter of human beings, sewage waste (Box 1.6), weeds, crop stubble, straw, rice hulls, forest litter, etc. **Composting** is a biological process in which both **aerobic** (organisms requiring the presence of oxygen for the respiration) and **anaerobic** (organisms, in which respiration takes place in the absence of oxygen) microorganisms decompose the organic matter. It takes about 3 to 6 months for decomposition of organic refuse. The nutrient contents of town compost are about 1.4 per cent nitrogen (N), 1.0 per cent phosphorus pentaoxide (P_2O_5) and 1.4 per cent potassium monoxide (K_2O).

Box 1.6

Sewage

In modern system of sanitation, water is used for removal of human excreta and other wastes. Sewage consists of two components: (*i*) The solid part, called the **sludge** and (*ii*) the liquid part, called **effluent** or **sewage water**. The dried sludge may be used as soil conditioner in lawns and flower gardens. Sewage water is quite rich in many nutrients of plants so can be used for fertilizing and irrigating the soil.

Method of preparing compost. For preparing compost, a trench of suitable size, *i.e.*, 4 to 5 m long, 1.5 to 1.8 m broad and 1.0 to 1.8 m deep is dug. A layer of well-mixed refuse of about 30 cm thickness is spread in the trench. This layer is well moistened by slurry (water paste) of cattle dung and water or earth and water. A second layer of mixed refuse is spread in trench till the heap rises to a height of 45 to 60 cm above ground level. The top of this heap is then covered with a thin layer of moist earth. After



Preparation of compost.

three months, the partially decomposed biomass is taken out of the trench and collected in conical heap. This heap is moistened if necessary and covered with earth. After another one or two months, the compost is ready for use in the field.

Box 1.7

Vermicomposting

The degradation of organic waste through the consumption by the earthworms is called **vermicomposting**. An earthworm is physically an aerator, crusher and mixer, chemically a degrader and biologically a stimulator of decomposition. In India, following species of earthworms are used in vermicomposting: *Dichogaster bolani*, *Drawida willsi*, *Perionyx excavatus* (Indian species) and *Eisenia foetida, Eudrilus eugeniae* (Exotic species).

3. Green manure. The practice of green manuring includes growing, mulching by ploughing and mixing of green crops with soil, to improve physical structure and soil fertility. A green manure crop supplies: (*i*) nitrogen and phosphorus; (*ii*) organic matter for improving hydration, aeration and crumb structure of the soil. It tends to provide protection against erosion and leaching.

Green manures are generally quick growing leguminous and non-leguminous plants. Some examples of green manure plants are 1. Dhaincha (*Sesbania aculeata);* 2. Sunn Hemp (*Crotalaria juncea);* 3. Cluster bean or guar (*Cyamopsis tetragonoloba*); 4. Cow pea or Lobia (*Vigna sinensis);* 5. Lentil or Masur (*Lens culinaris*); 6. Egyptian clover or Berseem (*Trifolium alexandrium),* 7. Horse gram (*Dolichos uniflorus*).

The green manure crops are grown in the field for about 6 to 8 weeks and are overturned when in tender stage, *i.e.,* at flowering stage. These crops remain buried for about one to two months. During this period, plants should be completely decomposed before sowing of next crop. Generally the crops which require high nutrient input, are raised in a green manured field. Such crops are rice, maize, sugarcane, cotton, wheat, etc.

B. Fertilizers

Fertilizers provide plant nutrients, commercially manufactured using chemicals. Fertilizers supply Nitrogen, Phosphorus and Potassium (NPK). They are used for good vegetative growth (*i.e.*, growth of leaves, branches and flowers), giving rise to healthy plants. Fertilizers are one of the major components for obtaining higher yields specially in expensive farming practices. Fertilizers contain much higher amount of nutrients in comparison to the manures and are, therefore, used in very small quantities. A **Complete fertilizer** is one which contains all the three **critical elements** or **minerals,** nitrogen, phosphorus and potassium.These fertilizers may supply one or more nutrients. Chemically they may be **inorganic compounds** (*e.g.,* ammonium sulphate) or **organic compounds** (*e.g.,* urea). On the basis of the availability of nutrients from them, fertilizers are divided into following *four* groups:

1. Nitrogenous fertilizers. These fertilizers supply the macronutrient nitrogen. Examples of nitrogenous fertilizers are: (*i*) Urea, $CO(NH_2)_2$; (*ii*) Ammonium sulphate, $(NH_4)_2SO_4$; (*iii*) Calcium ammonium nitrate; (*iv*) Sodium nitrate, $NaNO_3$; (*v*) Ammonium nitrate, NH_4NO_3.

2. Phosphatic fertilizers. They are the source of the macronutrient phosphorus. Examples of phosphatic fertilizers are : (*i*) Single superphosphate; (*ii*) Triple super phosphate; (*iii*) Dicalcium phosphate.

3. Potassic fertilizers. These fertilizers supply potassium which is one of the essential macronutrient of the plants. Examples of potassic fertilizers are : (*i*) Muriate of potash or potassium chloride, KCl ; (*ii*) Potassium sulphate, K_2SO_4; (*iii*) Potassium nitrate, KNO_3.

4. Complex fertilizers. When a fertilizer contains at least two or more nutrients (N, P_2O_5 and K_2O), it is called **complex fertilizer**. Examples of complex fertilizers are : (*i*) Nitrophosphate; (*ii*) Ammonium phosphate; (*iii*) Urea ammonium phosphate.

Fertilizers should be applied scientifically, in terms of proper dose, time, pre-and post-application precautions for their complete utilisation. For example, sometimes due to excessive water, fertilizer gets washed away and do not get fully absorbed by the plants. Fertilizers generally get washed off through irrigation, rainfall as drainage, and pollute rivers, lakes, streams (causing toxicity, algal bloom and

eutrophication) and disturbing the ecosystem. The water of these water bodies becomes unfit for human consumption and even kills the aquatic animals such as fishes. So chemical fertilizers must be used carefully and judiciously.

Differences between manure and fertilizer have been discussed in Table 1.4.

Table 1.4. Comparison of manure and fertilizer.

Manure	*Fertilizer*
1. A manure is a natural substance. It is obtained by the decomposition of animal wastes such as dung (gobar) of cattle and buffaloes and plant residues.	1. A fertilizer is a human-made substance. It is an inorganic salt or an organic compound.
2. A manure contains small amounts of essential plant nutrients such as nitrogen, phosphorus and potassium.	2. Fertilizers are very rich in plant nutrients such as nitrogen, phosphorus and potassium.
3. A manure adds a great amount of organic matter in the form of humus in the soil.	3. A fertilizer does not add any humus to the soil.
4. Nutrients present in the manure are absorbed slowly by the crop plants, since manure is not soluble in water. Nutrients exist locked inside the organic compounds of humus.	4. Being soluble in water, a fertilizer is readily absorbed by the crop plants.
5. A manure is not nutrient specific and it tends to remove the general deficiency from the soil.	5. A fertilizer is nutrient specific. It can specifically provide nutrients such as nitrogen, phosphorus and potassium to the soil according to the need.
6. A manure is voluminous and bulky so it is inconvenient to store, transport, handle and apply to the crop.	6. A fertilizer is compact and concentrated so it is easy to store, transport and apply to the crop.
7. A manure is cheap and is prepared in rural homes or fields.	7. A fertilizer is costly and is prepared in factories.

5. Biofertilizers. Organisms which enrich the soil with nutrients are called **biofertilizers**. Biofertilizers are used for the specific crop plants such as pulses, legumes, oil seeds and rice. Biofertilizers are renewable and non-pollutant sources of plant nutrients such as nitrogen. They are not alternatives to chemical fertilizers but can play a supplementary role is supplying *nitrogen* to specific crops under specific soil conditions. Nitrogen fixing microorganisms, *i.e.*, non-symbiotic and symbiotic cyanobacteria and phosphate-solubilising microorganism, are the main type of biofertilizers that are being used in India. Recently, two biofertilizers, namely *Rhizobium* cultures and blue green algae (such as *Anabaena* and *Nostoc*) have gained popularity amongst farmers cultivating pulses, legumes, oil seeds and wet-land rice.

6. Mycorrhiza. Mycorrhiza is a symbiotic (mutualistic) association of certain fungi with roots of higher plants. Mycorrhiza increases water and nutrient uptake by plants and increase growth, vigour and yield of the plants.

Irrigation

Crop plants get water from soil. Soil obtains water from rain. However, sufficient rain is not always available. Therefore, soil is not able to supply sufficient water to crops. The extra water required by crops is met through irrigation. ***The process of supplying water to crop plants by means of canals, wells, reservoirs, tube-wells, etc., is known as irrigation.***

In our country, there are 12 major river basins and 8 composite river basins. Ground water also contributes significantly to our total water resources. This is replenished by rainfall. However, only 55% of our cropped area is either partly irrigated (about 25%) or is under assured irrigation (about 30%). Remaining about 45% of cropped area is unirrigated and is dependent on rain for the cultivation of crops. It is called ***rainfed agriculture.*** The success of rainfed agriculture depends upon timely and sufficient rain during most of the growing season. Scarcity and irregular distribution of rain can cause **drought (*sookha*).** Drought prone areas generally have light soil (sand-rich soil) which is unable to retain water for long. They

are, therefore, more affected by drought. Poor monsoons or rains tend to result in crop failure. However, agriculture scientists have developed some crop varieties which can grow in rain fed areas and survive drought conditions. **Water management** is arranging and supplying required water to crops without harming soil aeration, change of water table or causing water-logging and soil salinity.

Advantages of Irrigation

In agriculture irrigation fulfil the following goals :

1. Crop plants are irrigated with freshwater to supply two essential elements to them, hydrogen and oxygen. Both of these elements are present in water molecules and are necessary for growth and development of crop plants.
2. Irrigation of crop fields is necessary to provide sufficient moisture for the germination of seeds, as seeds do not germinate in dry soils.
3. Irrigation of crop plants is essential for the growth and elongation of the roots of the crop plants. This is because roots of crop plants fail to develop and elongate in dry soil.
4. Irrigation is necessary to increase the number of aerial branches (called **tillers**) in crop plants so as to get a good crop yield.
5. Irrigation is essential for the absorption of nutrient elements by the crop plants from the soil. The irrigation water tends to dissolve the nutrients present in the soil of a crop field to form a solution. This solution of nutrients is then absorbed by the roots of crops for the development of the plants.

Some other Advantages of Irrigation

Irrigation has many other advantages compared to natural rain water supplies.

(*i*) The supply of water by irrigation is regular and reliable, where as rainfall is often seasonal or unpredictable.

(*ii*) Irrigation water supplied by rivers in flood often carries silt which adds to soil of the fields, enhancing fertility and crop yield.

(*iii*) With irrigation, cultivation can be done round the year and not during the rainy season only.

(*iv*) In desert areas, the constant flow of irrigation water through the soil helps to reduce the salinity of the soil. However, if the water is allowed to evaporate in the fields, salt content of soil will increase.

(*v*) Modern multipurpose dams not only provide water for irrigation but also help to control floods, generate hydroelectric power and improve the navigability of the rivers.

Factors Controlling Irrigation

The irrigation or water requirements of crop plants depends on the following two factors:

1. Irrigation dependent on the nature of the crop plants (*i.e.*, crop-based irrigation).
2. Irrigation dependent on the nature of soil of the crop fields (*i.e.*, soil-based irrigation).

1. Crop-based irrigation. Water requirements of different crops are different during the various stages of their growth and maturation (ripening). Some crop plants require more water, while others need less water. For example, paddy crop (rice crop) is **transplanted** in standing water (wet lands) and requires continuous water supply, whereas, other crops such as wheat, gram and cotton requires less water. For cereals such as wheat, irrigation is required before ploughing the field (*i.e.,* before tilling), at the time of flowering and at the time of development of the grain.

2. Soil based irrigation. Irrigation also depends on the nature of the soil in which crop is grown. The crops grown in a **sandy soil** need irrigation more frequently, whereas the frequency of irrigation is comparatively less for crops grown in a **clayey soil**. Let us find out why this occurs ! Sandy soil is highly porous, and has

high permeability. When the crop plants standing in a sandy soil are irrigated, water quickly percolates down the soil and the crop plants are not able to absorb adequate amounts of water. So, due to the poor water retaining capacity of the sandy soil, the crops cultivated in sandy soil need more frequent irrigation. In contrast to sandy soil, clayey soil is much less permeable, so it can retain water for a much longer time. So, when the crops grown in a clayey soil are irrigated, the water persists in the soil for a longer time and as a consequence plants grown in clayey soil can absorb this water in adequate amount. Thus, due to good water retaining capacity of the clayey soil, the crops cultivated in clayey soil need irrigation less frequently.

Irrigation Systems

Our country is blessed with large water and land resources with varied climatic conditions. Under such circumstances, various types of irrigation systems have been adopted to supply water to the agricultural lands. Some most commonly used irrigation systems are the following:

1. Canal system. In canal system, the human-made canals receive water from one or two reservoirs or from rivers. This is usually an elaborate and extensive irrigation system. Thus, **main canal** is distributed into **branch canals** and branch canals further have **distributaries** or **field channels**. These unlined field channels may serve individual fields or a group of fields. Under the canal irrigated areas, the rotation system is followed. Rotation system is known as **water bandhi** or **intermittent water delivery method**. This provides adequate irrigation to all the fields, when the water supply is short. Each field or group of fields are given water by rotation.

2. Tanks. Tanks are small storage reservoirs, which catch and store the runoff of smaller catchment areas. Small dams are built below the higher elevations of the catchment areas. In the tanks, outflows are controlled according to the availability of water. Otherwise it causes an uneven distribution of water. The main drawback of uneven distribution of irrigation water is that it causes shortage of water at tail end and excessive use at the top.

3. Wells. Wells are constructed wherever exploitable ground water is present. Wells are of two types:

(*i*) Dug wells. In the dug wells, the water is collected from water bearing strata. These dug wells have their base below the ground water table. The water from the shallow strata slowly accumulates in the pit. From these wells, water is lifted by mechanical means, *e.g.*, bullock operated devices.

(*ii*) Tube wells. A tube well (Fig. 1.1) can tap water from the deeper strata. From these wells, water is lifted by diesel or electricity run pumps. Deep bore tube well can supply water continuously for many years.

Box 1.8

1. Wells and tube wells are successful in those areas where underground water is not saline, in areas where underground water is saline, canal water is used for irrigation.

2. Excessive irrigation causes water logging and increases surface salinity. In water logged soil plant, roots do not get proper aeration.

4. River lift system. River lift system is more useful in those areas where canal flow is insufficient or irregular due to inadequate water release. In this system, water is directly drawn from the rivers for supplement irrigation.

5. River valley system. Certain parts of the country such as Karnataka and Kerala which lie along the Western Ghats, use water that is discharged into the steep and narrow riverine valleys, during the raining season. In these parts of India, the rainfall is heavy but concentrated in four or five months period of the year. This is followed by drying up during the *rabi* season. On the slopes of these valleys and in the valleys perennial plants (= crops) such as coconuts, areca nuts (supari), coffee, rubber and tapioca are cultivated. The bottom flat lands of the valleys are used for growing a single rice crop.

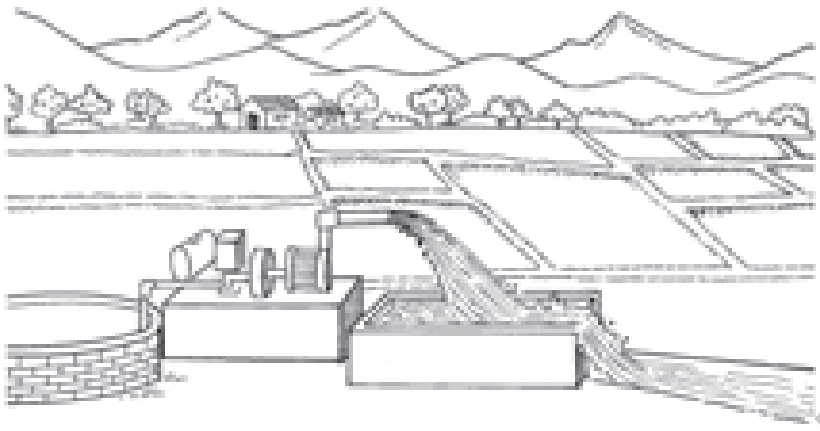


Figure 1.1. Tube well.

Box 1.9

1. Sprinkler irrigation system is being introduced in canal irrigated areas of Haryana, Rajasthan and Madhya Pradesh. 2. **Drip irrigation system** is being encouraged in Maharashtra, Karnataka, Andhra Pradesh, Orissa and Tamil Nadu for fruit crops. **Fertigation** is an innovation of applying fertilizer through drip irrigation to maximise farm productivity with available water.

6. Drip and sprinkler system. Overhead pipes for spraying water and sprinkler system save a lot of water and are more natural. They however, require a pumping system. These methods are very common in U.S.A., Britain, Europe and parts of India (Box 1.9).

Sprinkle irrigation.

Water Augmentation

Water availability for irrigation can be assured by augmenting ground water. It is carried out by following two methods.

1. Rain water harvesting. Rain water is not allowed to go waste. It is collected and used for recharging ground water by sinking deep drain pipes. It can also be poured into wells or used to recharge ground water by digging up wells.

2. Water shed management. Small check dams are built up in water shed areas to increase percolation of water into ground, reduce flow of rain water and prevent soil erosion.

CROPPING PATTERNS

These are models of raising crops which help in obtaining maximum benefit from the same piece of land, reduce risk of crop failure, disease and infestation. Three common types of cropping patterns are mixed cropping, intercropping and crop rotation.

(i) Mixed Cropping

Farming is an agricultural process of harnessing solar energy in the form of economic produce of plants and animals. The Indian farmers depend a great deal on the monsoon rain for water. Monsoons sometimes bring very heavy rain and cause **floods**. Sometimes there are dry spells which lead to **drought** conditions. Also, the amount of rainfall in a particular season is not dependable. Therefore, the small and marginal farmers, particularly in the rain-fed regions cannot take

Mixed cropping.

the risk of growing specialized crops. They prefer a farming system, called **mixed cropping** *which is the practice of growing of two or more crops simultaneously in the same piece of land*. It is an age-old practice in our country. Indian farmers used to mix the seeds of two crops and sow in the field.

1. Objective of mixed cropping. The basic objective in mixed cropping is to minimise the risk and insure against the crop failure due to abnormal weather conditions.

2. Crop-combination used in mixed cropping. In India, the following combinations of the crops are used by farmers in mixed cropping :

(*i*) Maize + Urad bean (*ii*) Cotton + Moong bean (*iii*) Groundnut + Sunflower
(*iv*) Sorghum + Pigeon pea (*v*) Wheat + Chick pea (*vi*) Barley + Chick pea
(*vii*) Wheat + Mustard.

3. Criteria for the selection of the crops for mixed cropping. While selection of the crop is made for the mixed cropping, the following criteria are maintained :

(*i*) The different crops to be grown together are so selected that the products and waste materials from one crop stimulates the growth of the other crop. For example, if a cereal crop such as wheat is grown along with a leguminous crop such as pulse (*e.g.*, gram) , then the uptake of nitrogen from the soil by the cereal is compensated by the nitrogen-fixing legume. This has two advantages : the fertility of the soil is increased and ultimately yield of the crop too is improved.

(*ii*) Care is taken to select crops that do not compete with each other for light, nutrients and water. For example:

(*a*) One crop is of long duration and other crop is of short duration. Thus, if one crop fails due to shortage of moisture or nutrients, the other crop can cover the risk of complete failure.

(*b*) One crop is tall growing and other is short growing. Thus, component crops used in mixed cropping have different **canopy**. The *crop canopy* means the structure of leaves, stems and flowers found above ground.

(*c*) If one crop is deep rooted, the other has shallow roots.

(*d*) One crop needs comparatively lesser water and nutrients than the other.

Box 1.10

In mixed cropping :

1. Seeds of two crops are mixed before sowing and there is no definite pattern for sowing the seeds.
2. Same fertilizers and pesticides are used for all crops.
3. Products of different crops are harvested, threshed, marketed and consumed in mixed form.

Advantages of Mixed Cropping

1. The risk of total crop failure due to uncertain monsoon is reduced.
2. Farmers tend to harvest a variety of produce such as cereal, pulses or vegetables or fodder to meet the various requirements of family or of an agricultural farm.
3. Due to complementary effect of component crops, yield of both crops is increased, *e.g.*, wheat and gram.
4. Fertility of the soil is improved by growing two crops simultaneously.
5. Chances of pest infestation are greatly reduced.

(ii) Intercropping

Intercropping is a practice of growing two or more crops simultaneously in a same field in definite row patterns with the objective of increasing productivity per unit area. The practice of intercropping is adopted by small farmers and where farmers have least access to irrigation. Intercropping is an improved version of mixed cropping. All the crop combinations in mixed cropping can also be practiced in intercropping. But row patterns are definite, *i.e.*, 1 : 1, 1 : 2 or 1 : 3. It means after one row of main crop, one, two, or three rows of intercrops can be grown.

Intercropping.

Advantages of Intercropping

1. It makes better use of the natural resources of sunlight, land and water.
2. Soil erosion is effectively arrested.
3. Since the seeds of the two crops are not mixed before sowing, fertilizers can be added as per the need of the crops.
4. Since the seed maturity period of these crops vary, the different crops can be harvested and threshed separately.
5. The produce of each crop can be marketed and consumed separately.

The comparison between mixed cropping and intercropping has been tabulated in Table 1.5.

Table 1.5. Comparison between mixed cropping and intercropping.

Mixed cropping	*Intercropping*
1. It aims to minimise risk of crop failure.	1. It aims to increase productivity per unit area.
2. Seeds of two crops are mixed before sowing.	2. Seeds of two crops are not mixed.
3. It involves no set pattern of rows of crops.	3. It involves set patterns of rows of crops.
4. In this method there is a difficulty of fertilizer application to individual crops.	4. In intercropping fertilizer can be placed as per need of the crops.
5. Spraying for pest control to individual crop is difficult.	5. Pesticides can be easily applied to individual crop.
6. Harvesting and threshing of crops separately not possible.	6. Both crops can be easily harvested and threshed separately.
7. Marketing and consumption of only mixed produce is possible.	7. Product of each crop can be marketed and consumed separately.

(iii) Crop Rotation

If we grow a crop continuously in the same field for many years, it results into various problems such as (*i*) depletion (deficiency) of same types of nutrients and (ii) build up of diseases and insect-pests. This demands for the requirement of the practice of crop rotation. **Crop rotation** can be defined as *the practice of growing of different crops on a piece of land in a preplanned succession*. Depending upon the duration crop rotation may be of following three types (Table 1.6).

Crop rotation.

Table 1.6. Types of crop rotation

Type of crop rotation	*Component crops involved in rotation*
1. One year rotation	1. Maize - Mustard 2. Rice - Wheat
2. Two years rotation	1. Maize - Mustard–Sugarcane - Fenugreek (Methi) 2. Maize - Potato - Sugarcane - Peas
3. Three years rotation	1. Rice - Wheat - Moong - Mustard - Sugarcane - Berseem 2. Cotton - Oat–Sugarcane - Peas - Maize - Wheat

Selection of Crops for Rotation

Most commonly, legumes are included in the crop rotation programme. They are used to increase soil fertility. Those crops which require high fertility level (*e.g.*, wheat) may be grown after growing legumes (*e.g.*, pea). Thus, *high input crops* such as sugarcane, potato, maize, wheat and rice may be grown before low

input required crops. This is necessary for maintaining the soil fertility that, crops of same family should not be repeatedly grown in the same field. This practice will promote build up of diseases and insect pests and decrease the similar nutrients from the soil. Thus, while making selection of crops for crop rotation, the following points should be considered :

(*i*) Availability of moisture through rain or irrigation;

(*ii*) Status of nutrients in the soil;

(*iii*) Availability of inputs such as fertilizers, pesticides, human power and machine power;

(*iv*) Duration of crop–short or long;

(*v*) Marketing and processing facilities.

Box 1.11

The Norflok Rotation

This is one of the best known crop rotation technique. It involves the growing of four crops in a given field over a period of four years. These crops are wheat (cereal), clover or bean (legume), barley (another cereal) and turnip or sugar beet (a root crop).

Advantages of Crop Rotation

1. It controls pests and weeds. Most pathogens survive on crop residue, but only for a limited time, and most pathogens do not infect multiple crops. By naturally breaking the cycles of weeds, insects and diseases, the application and cost of insecticides may be reduced.
2. Crop rotation reduces the need of fertilizers. For example, nitrogen supply is maintained in the crop field when leguminous crops are alternated with others.

[**Note :** Nitrogen fixers (*e.g., Rhizobium meliloti* of root-nodules of soybean plant (*Glycine max*) work hardest when the nitrogen supply in their environment is low, adding nitrogen fertilizer to a legume crop shuts down biofixation (nitrogen-fixation)].

3. Several crops may be grown in succession with only one soil preparation (ploughing). For example, land is ploughed for maize and the maize stubbles (which retain nutrients) is left on the land for wheat.
4. By alternation between deep and shallow rooted crops, the soil may be utilised more completely.

ACTIVITY 1.1.

Sow seeds of wheat, paddy, vegetables in different pots with and without manuring and fertilizer application. Record observations given below and note on each crop with special emphasis on the following aspects :

1. Percentage of seed germination.
2. Flowering and maturity time.

(2) Crop Variety Improvement

The art of recognising valuable traits and incorporating them into future generation is very important in plant breeding. Breeders search for individual plants that exhibit desirable traits. The two most desirable qualities of food plants are **high yield** and **natural resistance to disease**. Such traits occasionally arise spontaneously through a process called **mutation**, but the natural rate of mutation is too slow and unreliable to produce all the plants that breeders would like to see.

Plant breeders select plant varieties with desired characters and cross them. The developed offsprings combine the attributes of both parents. These varieties are multiplied and supplied to farmers.

(i) Need for Higher Crop Yield

1. **Higher yield.** The main aim of crop improvement is to improve the productivity of economic produce, *e.g.*, grain, vegetables and fodder. Quality seeds of improved varieties are used for their commercial production.
2. **Improved quality.** Quality considerations of crop products varies from crop to crop, *e.g.*, baking quality in wheat, protein quality in pulses, oil quality in oil seeds and preserving quality of fruits and vegetables.
3. **Biotic and abiotic resistance.** Under different situations crop suffers due to **biotic stresses** (such as diseases, insects and nematodes) and **abiotic stresses** (such as drought , salinity, water logging, heat, cold and frost). If we develop crop varieties which are resistant to these stresses, then we can improve significantly the crop production. For example, **MUW 318** is a HYV (high yielding variety) of wheat which is released for cultivation in non-tradional areas as Nilgiri and Palni hills and resistant to all the rusts.

Box 1.12

Green Revolution in India

The bumper increase in the yield of food grains (especially the wheat crop) as during the 1970s, is often termed as **green revolution**. The 1970 Nobel laureate, American scientist **Dr.N.E. Borlaug** was the person behind triple dwarf Mexican wheat varieties. Their colour was changed to Indian liking through gamma irradiation **(by M.S.Swaminathan, Father of Green Revolution in India)**.

Green revolution has made our country self-sufficient in food, increased the buffer stock of food grains and improved the economic conditions of Indian farmers as well as provided employment avenues to large number of people.

M.S. Swaminathan

4. **Changes in maturity duration.** In some of the short duration crops, early maturing varieties can make the crop fit into double and multiple cropping system. This will also reduce the crop's cost of production. Uniform maturity will make the harvesting process easy and reduce the loss of produce during harvesting.
5. **Photo-insensitivity and thermo-insensitivity.** Most of the plants are sensitive to certain abiotic factors as light and temperature. Development of photo-insensitive and thermo-insensitive crop varieties will help in crossing the cultivation boundaries, *e.g.*, a HYV of wheat , **MACS 2469** can tolerate high temperature.
6. **Desirable agronomic traits.** If we develop those varieties of crops which contain desired agronomic traits then it will help in setting higher production. Thus, tallness, high tillering and profuse branching are desirable characters for the fodder crops. Whereas, dwarfness is desired in cereals as dwarf varieties provide protection from lodging. For example, breeding for resistance to **red rot** has led to sugarcane varieties such as **Co 975** and **Co 62399** which increase cane production in problem areas. Likewise new varieties of chicken pea as **BG 244** and **ICC 34** grow erect, have many branches and pods from base to tip.
7. **Wider adaptability.** If we develop those varieties of crops which have wider adaptability, then it will help in stabilizing the crop production under different environmental conditions. For example, **ICPH 8** is a hybrid pigeon pea plant which takes a short duration to mature, escapes diseases such as **fusarium wilt** and **sterility mosaic** and yields 30 to 40 per cent more than the popular breed. It performs well under drought as well as high-moisture conditions.

Mechanism

Crop variety improvement is manipulation of crop plants for increasing their yield, improving quality, suitability to varied conditions and resistance to biotic and abiotic stresses. **Genetic manipulation** is incorporation of new genes for various traits from other genotypes into the crop variety so as to bring about desired changes. It is carried out through hybridization, mutation, breeding, polyploidy and DNA recombination technology.

The plant breeding means *production of new varieties or strains by a programme of* ***artificial selection*** *spanning several generations of the organism concerned.* Plant breeding is a science as well as art of improving genetic make up of plant in relation to their economic use . Various approaches which are used for genetic improvement of crop plants are referred to as **plant breeding methods** or **techniques**. Genetic improvement of various crop plants has been done by adopting the following *three* steps : Introduction, Selection and Hybridization.

1. Introduction. This refers to transportation of crop plants from the place of their cultivation to the place where they were never grown earlier. Thus, the process of introducing new plants from their growing place to a new region with a different climate is termed as **plant introduction**. The adjustment of such plants to their new region is called **acclimatization**. It is a quick method to bring about improvement with minimum effort and cost. For example, crops such as potato, coffee, tea, tobacco, groundnut, papaya, etc., have been introduced in India from the other parts of the world.

2. Selection. This process involves selection of the most desirable offspring of a variety of plant for controlled propagation. Selection favours the survival and further propagation of some plants having more desirable characters (related to yield and quality) than others. There are following *two* patterns of selection:

(a) Mass selection. Seeds from a number of similar plants having the desired traits are mixed and sown to raise the new offspring. Offsprings with the undesirable traits are eliminated and the process is continued with the remaining progeny in the same manner until the desired improvement is achieved. Grapes, apples, pear, watermelon, radish, onion and maize have been improved by this method.

(b) Pure-line selection. Seeds from a single plant having the desirable trait is sown in separate rows to produce the offspring. Desired plants are again selected from the progeny and the process is continued for several generations. The inferior varieties are eliminated in each generation. Wheat varieties such as Kalyan Sona-227 and PV-18 have been developed by this method.

Box 1.13

Selection by human beings is also called **artificial selection.** Artificial selection operating over long time spans can give rise to varieties strikingly different from starting generation. For example broccoli, cabbage, cauliflower and other varieties have been obtained through artificial selection from wild cabbage.

3. Hybridisation. The **crossing** between genetically dissimilar plants to produce a new kind (**hybrid**) is called **hybridisation**. Crossing may be between two different varieties (**intervarietal cross-breeding**), between two different species of the same genus (**interspecific cross-breeding**) and between different genera (**intergeneric cross-breeding**). This method incroporates the desired (good) characteristics of both parents in one variety. The most common type of breeding is inter varietal.

Box 1.14

Cross-breeding

Cross-breeding of two varieties of plants (one high-yielding and other having resistance to diseases) is carried out to obtain an improved variety of plants which will combine in it both the desired characteristics of the parent crop plants. For example, the new improved variety of crop plant, thus, obtained will give high yield of food grains and it will be disease resistant too. This process of cross-breeding of different plants to obtain a new improved variety of crops is called hybridisation. The new varieties of crop plants, thus, obtained are called ''hybrid varieties'' ''improved varieties'' or ''high yielding varieties'' (HYV) of crops.

In India crops are grown in diverse types of soil and different climatic conditions by poor to progressive farmers. Keeping in mind climatic factors, input application, disease and pest resistance, quality and adaptability, etc., a large number of varieties have been developed in India (Table 1.7). These varieties are high yielding and resistant to diseases and pests; they have better quality and early to late maturing time.

Table 1.7. Improved varieties or high yielding varieties (HYV) of some important crop plants.

Commodities	*Crops*	*Varieties*
1. Cereals	1. Rice	IR 8, Jaya, Heera, VL Dhan 221, C ST 7-1, Jawahar, TRC - C 10, IR 36, Pusa Basmati 1, Kasturi, Vikas, PNR - 591 - 18, Padma
	2. Wheat	MIKS 11 KML 7406, HUW 318, MACS 2496, HD 2687, HD 2285, C 306, PBW 154, HW 157, Pusa Lerma, Sharbati Sonora
	3. Maize	Ganga 5, HIM128, Shakti, Navjot, Vikram
2. Pulses	1. Chick pea (gram)	BE 244, ICC 34, K 850, H 208, Pusa 240, Pant 114
	2. Pigeon pea	ICPH 8, Pusa Ageti, UPAS 120, Pusa 84 Manak, T21
	3. Urad bean	LB G 17, ADT 3, T9 Pant 430, PS 1, CO5
	4. Moong bean	MLZ 67, CO4, PS 16, S8, T 44, K851, Aasha
3. Oil seeds	1. Groundnut	MH 2, ICGS 1, M37, GG 11, TMV 12, Kaushal, ICGS 11, ICGS 44
	2. Mustard	Pusa Bold, Kranti, Pusa Agarni, RLM 514, RH 30
	3. Soyabean	PK 262, PK 327, Pusa 24, Durga, Gaurav
	4. Sunflower	BSH 1, MSF H 8, Morden, Arun, Paras

4. Mutation breeding. Mutations are sudden inheritable variations. They are produced at random through **gamma irradiation** and a number of other physical and chemical agents called **mutagens**. Triple dwarf Mexican varieties of wheat were developed by **N.E. Borlaugh** (1963) through incorporation of mutations by selective hybridization. They were, however, red grained. The same were converted into amber grained forms (e.g., Pusa Lerma, Sharbati Sonora) through mutation carried out by gamma irradiation.

5. Polyploidy. It is increasing the chromosome number. Polyploids are generally more robust with higher yields, *e.g.,* potato.

6. DNA recombinant technology. This technology refers transfer of genes from one organism to another so as to modify the latter. They are called **genetically modified organisms (GMOs)** or **transgenic organisms**. Such transgenic food plants are called **genetically modified food** (**GMFs**). Bt cotton is a genetically modified crop which carries bacterial genes that protect plants with insects. Bt stands for the bacterium *Bacillus thuringiensis* whose genes are used by transgenic crops such as cotton, rice, mize, potato, tomato, brinjal, cauliflower, cabbage, etc., to get protection from their insect pests.

(3) Crop Protection Management

Field crops are infested with a variety of **pests**. A *pest* is any destructive organism which causes great economic loss by destroying crop plants or products obtained from them. Pests of crop plants include weeds, insects, mites, nematodes, rodents, fungi, bacteria and viruses. Field crops are infested by a large number of insect pests and diseases. If these pests are not controlled at appropriate time they can damage the crops to the extent of 50 to 70 per cent.

There are various methods by which insects and diseases can be controlled. One of the most common and effective methods is the use of **pesticides** or **biocides** which include **insecticides** (for killing the insects), **weedicides** (for killing the weeds) and **fungicides** (for killing the fungi). Thus, chemicals (poisons) used to kill pests, *e.g.,* weeds, insects, mites, rodents and fungi are called **pesticides**. These chemicals (*i.e.,* pesticides) are sprayed on crop plants or used for treating seeds and soil. However, one should try to avoid the use of these toxic chemicals (pesticides) as they cause environmental pollution. In fact, it would be far better if

we adopt the **preventive measures** rather than allowing the crops to be infested by pests and then control them by pesticides. Some of the preventive measures of pests are the following:

1. Use of resistant varieties of crop plants;
2. Selection of optimum time of sowing the crops;
3. Crop rotation and multiple cropping;
4. Clean cultivation;
5. Summer ploughing.

For example, humid and warm climate is regarded as more favourable for infestation of insect pests and diseases. That is why "*kharif*" crops (*e.g.,* maize, millet) are more prone to these pests in contrast to "*rabi*" crops (*e.g.,* wheat, gram, sugarcane, pea, etc.).

I. Weed Control

Weeds are unwanted plants in the cultivated fields. In other words, plants other than crops are the weeds. Weeds tend to compete with the crops for food (water and nutrients), space and light. In comparison of cultivated crops, the seeds of weeds, germinate easily, their seedlings grow faster, they flower early, their seed production begins after a short growth period and they produce large number of seeds. In fact, weeds take up all the nutrients and reduce the growth of crop in various ways. Therefore, removal of weed plants from cultivated field in early stage of crop is essential to harvest high input returns in terms of high yield. In **un-irrigated condition** weeds affect the water availability and in **irrigated condition** there is competition for nutrient uptake between weeds and crop plants. For example, barley or mustard plants act as weeds in a wheat field and compete with crop for nutrition. Likewise, wild sorghum grown in cultivated crop fields of sorghum (jowar) acts as a weed plant and compete with crop for water and nutrients.

Types of weeds. Infestation of weeds is more during 'kharif' season than in 'rabi' season. Based on the morphology of plants, weeds can be classified into **narrow-leaf weeds** and **broad-leaf weeds. (Fig. 1.3):**

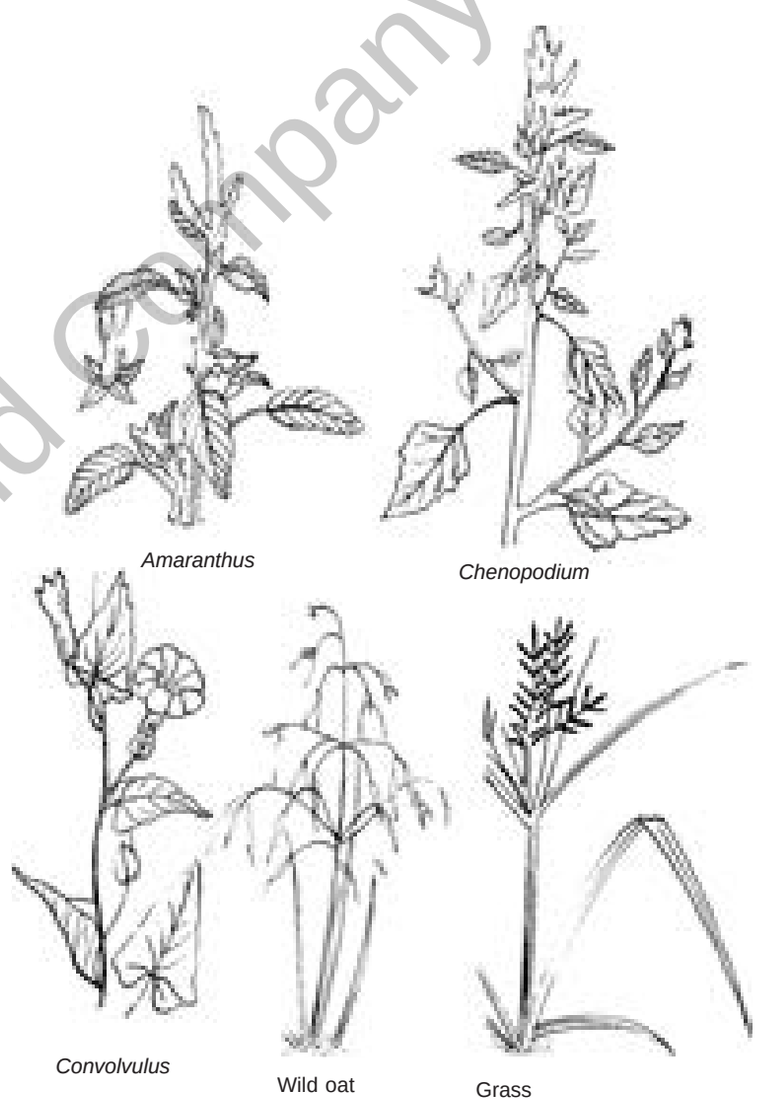


Figure 1.2. Certain common weeds.

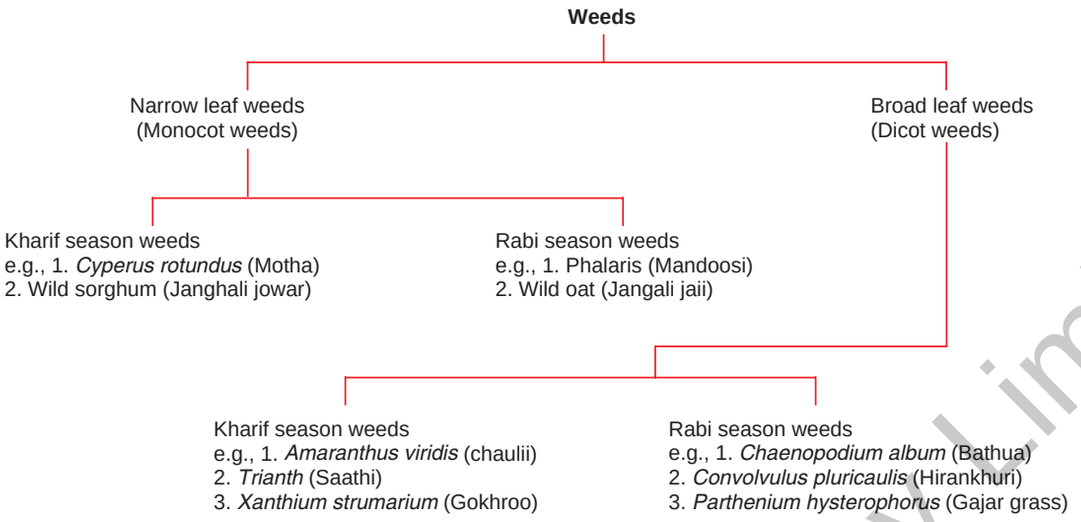


Figure 1.3. Classification of weeds.

Further, during 'kharif' season, short duration (*e.g.*, maize and millet), short saturated (*e.g.*, groundnut) and slow growing (*e.g.*, pigeon pea) crops are more susceptible to weeds. Critical period of controlling weeds in these crops is 35 to 45 days.

Methods of weed control. Weeds can be controlled by following methods:

1. Mechanical methods. These include the following methods: **uprooting**, **weeding** with trowel or 'khurpi' or harrow (a comb-like implement), **hand hoeing** (scraping), **interculture**, **ploughing**, **burning** and **flooding**.

The process of removing the weeds from crop field is called **weeding**. Weeding can be done by the following methods: 1. Weeds may be pulled out with hand. Ploughing helps in removing large number of the weeds because it uproots majority of them. 2. Before sowing or transplantation, weeds are removed by using a big comb like harrow. Harrow cannot be used in standing crops because it will also uproot the crop plants. The weeds which appear during the growth of crop plants are removed manually by using a trowel (khurpa).

2. Cultural methods. They include the following methods: proper bed preparation, timely sowing of crops, intercropping and crop rotation.

3. Chemical methods. Chemical weed killers, called **herbicides** or **weedicides**, are sprayed on weeds to destroy (kill) them. This is called **chemical control of weeds**. Some common examples of weedicides are the following: (*i*) 2, 4-D (2, 4-Dichlorophenoxy acetic acid); (*ii*) Atrazine; (*iii*) Fluchloralin; (*iv*) Isoproturon.

4. Biological control. Biological control of weeds involves the deliberate use of insects or some other organisms which consume and specifically destroy the weed plants. The best Indian example of biological control is eradication of prickly-pear cactus (*Opuntia*) by using the cochineal insects in Maharashtra and Tamil Nadu. Generally, a combination of one or more of these weed control methods are employed to get good results. Aquatic weeds are controlled by the fish grass carp.

Effects of Weeds on Crop Plants

1. The growth of weeds in the crop fields is harmful because they compete with the crops of nutrients, water, space and light. Weeds are generally more efficient than crop plants. They grow quickly, absorb more nutrients and water and deprive the crop plants of essential inputs. As a result the growth of the crop is reduced.

2. The weeds spread crop pests and diseases by acting as alternate host to insects and microorganisms.

3. Some weeds may produce toxic substance which may interfere with growth of crop plants.
4. During harvesting weeds get mixed with crop's produce to downgrade its quality.

ACTIVITY 1.2.

Visit a weed infested field in the month of July or August and make a list of weeds, insect pests and diseases noticed in crops of the field.

II. Insect Pest Control

Many insects are serious pests of plants. They attack all stages, parts and products of plants. Insects attack the crop plants in the following *three* ways:

1. Chewing insects. The chewing insects destroy all sort of crop plants. They cut root, stem and leaf of crop plants by the help of their chewing mouth parts. Thus, chewing insects tear off bits of leaves, delicate branches, chew them and then swallow them, *e.g.,* locusts, grasshoppers (*Hieroglyphus*), caterpillars, grubs, etc.

2. Sucking insects. The sucking insects suck the cell sap from various parts of the plant. They include various common pests of crop plants such as aphids (*e.g., Aphis*), leaf hoppers (*Pyrilla*), plant bugs (Gundhi bug of rice, painted bug or *Bagrada* of cruciferous plants, and red cotton bug or *Dysdercus*). They possess piercing-sucking mouth parts. Sucking insects make fine punctures in the skin of the plants with their needle-like, hollow beaks and suck the sap.

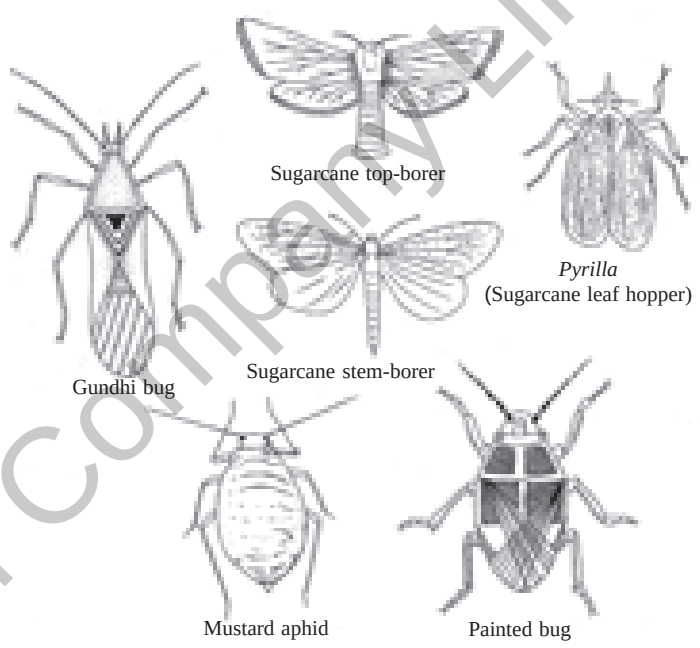


Figure 1.4. Certain common Indian insect pests of crop plants.

3. Internal feeders. The internal feeders live inside the plant parts. They are called **borers** when they live in twigs or roots as **sugarcane borers**. **Pod borer** make holes in pods of chick pea and feed on developing grain. They are called **weevils** when they attack the fruits and seeds such as **cotton-boll weevil** and **grain weevil**. The maggots of fruit-flies live inside the fruits such as guava, *ber*, *karela*, *ghia tori*, etc., and render them unfit for human consumption.

Further, **grubs** (larvae of beetle) and **termites** (*e.g., Microtermes obesi* and *Odontotermes obesus* damage sugarcane) attack the root zone of crops and then reach the aerial parts causing great damage.

Infestation of different types of insect pests can be controlled by the following methods:

(*i*) Root cutting types of insects are controlled by mixing insecticide in soil, *e.g.,* **chloropyriphos.**

(*ii*) Stem and leaf cutting and boring type of insects are controlled by dusting or spraying the contact insecticides (Table 1.8), *e.g.,* **malathion**, **lindane** and **thiodan**.

(*iii*) All sap sucking insects can be controlled by spraying systemic insecticides *e.g.,* **dimethoate** and **metasystox**. An insecticide entering the plant via the roots or shoots and passing through the tissues is called **systemic.** A systemic insecticide harmlessly penetrates the tissues of host plant and poison insects feeding on it (*e.g.*, Aphids).

III. Diseases of Crop Plants

Our environment contains a variety of pathogens. When they get favourable conditions for their growth and propagation, they spread and infest the crop plants causing diseases. Depending upon their mode of occurrence, crop diseases are of following *four* main types:

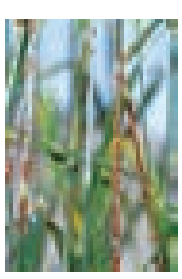
1. Seed-borne diseases. These diseases spread through seeds, *e.g.,* "ergot of bajra" or of pearl millet; ''leaf spot of rice"; "loose smut of wheat"; red rot of sugarcane; — all are caused by fungi.

2. Soil-borne diseases. These diseases spread through the soil and mostly affect roots and stems of crop plants, *e.g.,* "smut of bajra," "tikka disease of groundnut".

3. Air-borne diseases. These crop diseases are transmitted by the air, *e.g.,* "rust of wheat", "blast of rice", etc. Air-borne diseases attack all aerial parts of the plants, *e.g.,* leaf, flower, and fruits.

4. Water-borne diseases. Pathogens of these crop diseases are transmitted by the water, *e.g.,* "bacterial blight of rice".

Control of crop diseases. All the seed-borne and soil-borne diseases can be controlled by treating the seed or soil. Air-borne diseases are controlled by spraying fungicide solution on infested parts. Diseases of the major crops and their control measures have been given in Table 1.8.


Rust of wheat


Tikka Disease of Groundnut

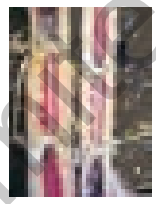

Red rot of sugar cane

Table 1.8. Diseases of major crops, their symptoms and control measures

Name of the crop	*Disease*	*Pathogen*	*Symptoms*	*Control measures*
1. Rice (paddy)	Blast	Fungus, *Pyricularis oryzae*	Brown boat-shaped lesions (spots) appear on the margins of leaves.	1. Seed treatment with **Thiram** 2.5 g/kg seed. 2. Spray **Bavistin** (1 g/*l* water) at 10 days interval.
2. Wheat	Rust	Fungus, *Puccinia graminis*	Yellow, brown or black elongated spots appear on leaves and straws.	Spray **Dithane M45** at 2 g/l water at 10 days intervals.
3. Chick pea	Wilt	Fungus	The leaves become yellow and dry up. Roots turn black and decompose.	Deep sowing at 8–10 cm depth in the light soils.
4. Pigeon pea	Stem rot	Fungus	Development of brown to dark brown lesions on the stem near soil surface. These lesions girdle the stem and plant dies.	1. Grow sorghum and pigeon pea mixed cropping. 2. Avoid water logging.
5. Mustard	1. White rust	Fungus	White or cream yellow scattered pustules appear on the lower surface of leaves.	Spray **Dithane Z.78** or **Dithane M45** at 2g/l water.
	2. Downy mildew	Fungus	Yellow irregular spots appear on leaves. In severe infection, the inflorescence is malformed, twisted and covered with white powder.	Spray the crop with 0.2% Ziram or Maneb

(4) Storage of Grain

Most crops are harvested only once a year. Thus, they are available in plenty during a selective time. For getting seasonal foods regularly throughout the year, they are stored in safe storage. Cereals or food grains are **stored** at following *three* levels: 1. at producer (farmer) level (called **rural storage**); 2. at trader's level (this is done by keeping food grains in gunny bags, Fig. 1.5); 3. at FCI (Food Corporation of India) level (This is done by storing grains in

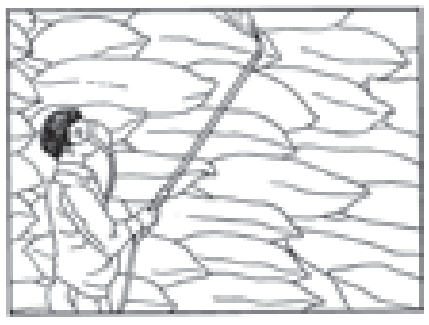


Figure 1.5. Grain storage in gunny bags (showing spraying insecticides on them).

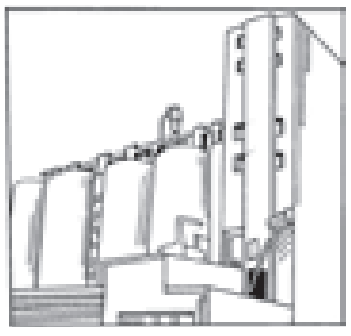


Figure 1.6. A grain-silo.

silos, Fig. 1.6.). During storage, grains and seeds are subjected to spoilage and wastage by various means. This loss has been estimated to be 9.3 per cent annually. During storage damage of grains can take place by following *two* main types of factors:

ACTIVITY 1.3

Make herbarium of cereals, pulses and oil seeds and mention their seasons of sowing and harvesting.

1. Biotic factors such as **insects** (Box 1.15; Fig. 1.7), **rodents** (*e.g.,* striped squirrel, house rat, house mouse, lesser bandicoot, etc.), **birds** (*e.g.,* parakeet, sparrow, bulbul, blue rock pigeon, crow, etc.), **mites** and **bacteria**.

Box 1.15

Some Common Insect Pests of Stored Grain

1. **Gram dhora** or **pulse beetle** (*Callosobruchus maculatus*) – Its grub damage stored gram.
2. **Rice weevil** (*Sitophilus oryza*)– Both grub and beetle (adult) damage rice.
3. **Khapra** or **wheat weevil** (*Trogoderma granarium*)– Infests stored wheat.
4. **Grain and flour moth** (*Sitotroga cerealella*)– Its caterpillars bore into grains of rice, wheat, barley, maize and jowar.
5. **Rust red flour beetle** (*Tribolium castaneum*)– Both larvae and adult damage flour and flour products.
6. **Rice moth** (*Corcyra cephalonica*)– Larvae damage rice and maize.
7. **Lesser grain borer** (*Rhizopertha dominica*)– Both grub and adult (beetle) damage the grains, reducing them to perforated shells (Fig. 1.7).

2. Abiotic factors such as moisture contents and temperature.

(*a*) Effect of temperature. The growth of insects and microorganisms in the stored food materials depends upon the fluctuation of temperature. As the maximum growth rate of the insects is at a higher temperature at 30°C to 32°C, the microorganisms and enzymes are most active at 30°C to 40°C.

Therefore, the food-grains / materials should be stored at lower temperature, *i.e.,* below 30°C, then the insects and microorganisms and enzymes will become less active and the damage of material is minimised.

(*b*) Effect of moisture. For safe-storage, the moisture content of the food-grains should be 14 per cent by weight or less. The greater amount of moisture present in food grains increases the rate of decay of food materials caused by microorganisms and enzymes and the population of insects increases rapidly. When these insects respire they release a lot of heat, so the temperature of stored food grain rises. The rise in temperature of stored food-grains due to the heat released by the respiration of a large number of insects, microorganisms (fungi such as molds, yeast, etc.) is called **dry heating of food grains.**

Another disadvantage of the presence of greater moisture is that, it increases the size of the food-grains, due to which these grains require more space.

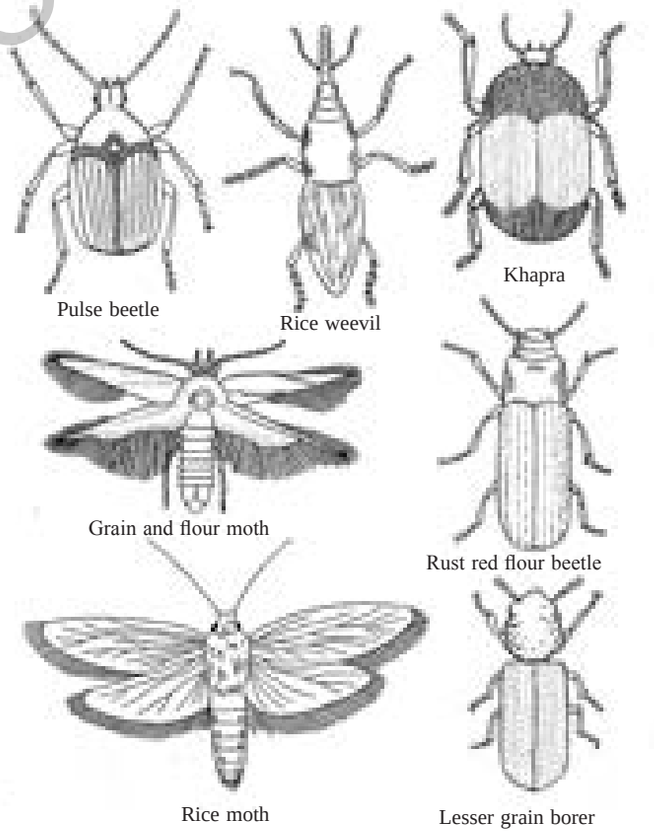


Figure 1.7. Some insect pests of stored grains.

(*c*) Effect of humidity. The moisture contents present in air is known as **humidity**. It promotes the growth of moulds (*e.g., Mucor, Penicillium*) on the stored food materials. High humidity content also initiates the germination process of stored seeds which also releases the heat. Therefore, as the moisture content of the grains increases from 14 to 18 per cent, the temperature may shoot up to 66°C. *The rise in temperature of stored food-grains due to the growth of moulds and fungi and germination of stored food-grains under high humidity conditions of air is called* **wet heating** or **damp grain heating**.

Thus, dry heating and wet heating both lowers the quality of stored food-grains and badly affect the germination of grains.

Combination of biotic and abiotic factors causes infestation of insects, degradation in quality, loss in weight, poor germinability, discolouration of produce, poor marketability and economic loss. Therefore, stored grains must be protected from all types of losses and damages.

Preventive and Control Measures

Biotic and abiotic factors which cause destruction of grains during storage can be prevented and controlled by using the following methods.

1. Drying. The proper time of **harvesting** a crop is very important, because the time of harvesting a crop determines the yield of the crop production as well as the storing qualities of the crop products.

At the time of harvesting of the crop, moisture content in grains varies from 15-35 per cent. But, for safe storage the seeds and grains should have moisture content below 14%. So the step of drying of grains is a vital preventive measure.

The harvested food grains should be dried by spreading them over plastic sheets or on cemented floor (This is done because if the grains are spread directly on the ground, they will absorb more moisture from the ground). All the sun dried food grains are allowed to cool to the room temperature before storing them.

On commercial bases, mechanical drier with hot air is used.

2. Cleaning. The grains and other agriculture produce should be properly cleaned before their storage. They should be filled in new gunny bags before keeping in godowns, warehouses or stores.

3. Safe and proper storage. Godown, warehouses and stores should be properly cleaned, dried and repaired. Pathways (alleys) should be provided between the stacks of grain-filled bags, for the periodic inspection, for spraying (Fig. 1.5) or for fumigation.

For the large scale storage of grains, the **grain silos** are used. The silos are big and tall cylindrical structures (Fig. 1.6). They store different stocks of food items at different levels. Silos are provided with outlets (chutes) at different levels to withdraw the desired stock of grains. They have built in arrangement for aeration, temperature control, protection from insects, rats, birds and mammals, for fumigation and inspection of their grain stocks.

4. Chemical control. The pesticide solution is sprayed over the gunny bags containing food grains by using manual sprayer or a mechanical sprayer. The spraying of pesticides is more suitable for disinfecting the whole godown before the arrival of the fresh stock of grains. The following pesticides can be sprayed : BHC (benzene hexa chloride), malathion and pyrethrum. Pesticides can be mixed with the grains only when they are to be used as seeds for sowing.

5. Fumigation. Those pesticides which can destroy insects by forming toxic fumes are called **fumigants** and process of their use is called **fumigation.** Fumigants may be solid, liquid or gaseous. Ultimately they volatalise or react with moisture of the air, forming poisonous fumes. Examples.

1. Aluminium phosphate (*solid fumigant)* tablets commonly known as **black poison** (3g each) can be used at the 2 tablets per tonne grain or 160 tablets per 100 cubic metre volume of grain.
2. Ethylene dichloride plus carbon tetrachloride or EDCT (*liquid fumigant*). Ethyl dibromide (*EDB*) is another liquid fumigant.
3. Methyl bromide (*gaseous fumigant).*

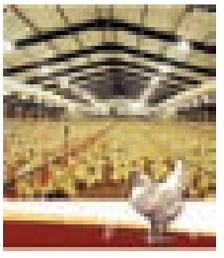
Fumigation is the most effective method of destroying insects in stored food grains.

1.3. ANIMAL HUSBANDRY

The branch of agriculture that deals with the feeding, caring and breeding of domestic animals is called **animal husbandry**. *Husbanding* means to use a resource carefully and without waste. Thus, animal farming

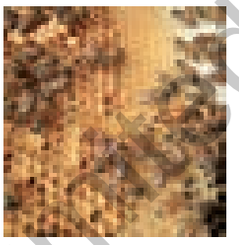
or animal husbandry requires planning for domestic animal's shelter, breeding, health, disease control and proper economic utilisation. Our domestic animals or livestock includes those animals which are raised for farm purposes, *e.g.*, cattle (cow, bull or ox), buffalo, yak, horse, ass, goat, sheep, camel, etc.

Cattle production.



Poultry.

Fish farming.



Bee keeping.

A. Cattle Farming

In India, cattle (cows and buffaloes) are next to land in use for farmers. Human beings domesticate them for milk, also for meat, leather and transportation. Thus, cattle raising is done to fulfill the specific needs for dairy, draught or dual purpose of breeds. Generic name of cow is *Bos indicus*; it is adapted for drier regions of the country such as Gujarat and Rajasthan. Buffalo is commonly called Indian water buffalo; its generic name is *Bubalus bubalis*. It is well adapted for wet areas and river beds of Kerala, Bengal, Andhra Pradesh and Tamil Nadu.

1. Breeds of Cows

Cows are classified as draught, dairy and dual purpose breeds (Table 1.9):

Table 1.9. There are 26 breeds of cows (cattle) in India. Some of the cattle breeds of India and their distribution.

	Cattle Breed	*Distribution*
		Milch Breeds
1.	Gir	Gujarat, Rajasthan
2.	Sahiwal	Punjab, Haryana, Uttrar Pradesh
3.	Red Sindhi	Andhra Pradesh
4.	Deoni	Andhra Pradesh
		Draught Breeds
5.	Malvi	Rajasthan, Madhya Pradesh
6.	Nageri	Delhi, Haryana, Uttar Pradesh
7.	Hallikar	Karnataka
8.	Kangayam	Tamil Nadu and other parts of South India
		General Utility Breeds
9.	Ongole	Andhra Pradesh
10.	Kankrej	Gujarat
11.	Tharparkar	Gujarat, Andhra Pradesh

Box 1.16

A **breed** is a group of animals of common origin within a species that has certain distinguishing characteristics not found in other members of the same species.

1. Draught breeds. Their meat is tough and they give little milk. Hence, they are used as beasts of burden in various agricultural practices such as tilling (to plough the land), irrigation (in running the water wheel or Persian wheel) and carting (to transport humans and materials from place to place). Small and marginal farmers still make use of draught breeds of cow.

2. Dairy breeds. They have large digestive systems and a spacious udder because as much as possible of the food they consume must be turned into milk.

3. Dual purpose breeds. These breeds provide milk as well as help in agricultural tasks. In India, dual-purpose breeds are favoured by farmers because in these breeds the cows are fairly good milk yielders and the bullocks(sterilized males) good for draught work.

Milk producing female population of animals is called **milch animals** or **dairy animals**. These include cow, buffalo, goat, camel and yak. Buffalo and cow, both are excellent dairy animals, as well as, their males or he-buffaloes and oxen (bullocks) are used for various draft purposes (*i.e.*, bullock labour) in agriculture. Therefore, buffalo and cattle production is done for milk, draft (labour) and dual purposes, *i.e.*, both for milk and draft purposes. Common breeds of indigenous buffaloes are **Murrah**, **Mehsana** and **Surti**. Indigenous cows are **Red Sindhi**, **Sahiwal** and **Gir**.

Indigenous breeds of cow. Indigenous breeds of dairy cows are mainly of *three* types (varieties):

***(i)* Red Sindhi.** This cow is medium in size and red in colour with dark and light red shades (Fig. 1.8).

***(ii)* Sahiwal.** This breed of cow is superior to other dairy cows. The animal is large and of heavier built (Fig. 1.9).

***(iii)* Gir.** This is the native breed of Gir forest in Gujarat. This cow is medium in size and fairly good milk yielder (Fig. 1.10).

Figure 1.8. Red Sindhi cow.

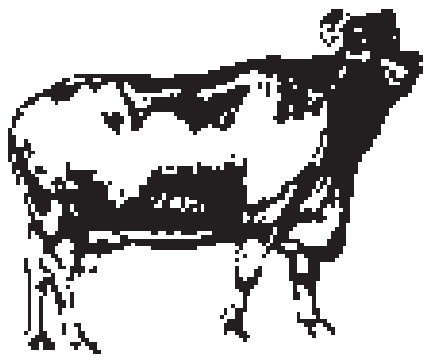


Figure 1.9. Sahiwal cow.

2. Breeds of Buffaloes

In India, buffaloes are domesticated in great number. There are ten breeds of buffaloes in our country. The important breeds of buffaloes with high yield of milk are as follows :

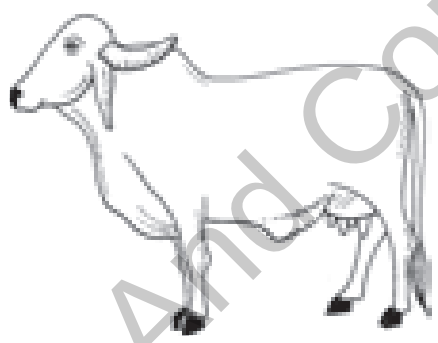


Figure 1.10. Gir breed of cow.

Figure 1.11. Murrah, a high milk-yielding breed of buffalo.

***(i)* Murrah.** This is original breed of Haryana and Punjab (Fig. 1.11). This breed has massive body ; short and tightly curved horns ; adult female weighing 430-500 kg and male 530-575 kg. During its lactation period, its average yield of milk is 1800 to 2500 litres with fat contents up to seven per cent.

***(ii)* Mehsana.** This is a breed of Gujarat especially from Vadodara and Mehsana districts. It is cross between Murrah and Surti. Usually black or gray. Their milk production is about 1200 to 2500 litres. They are known for giving milk at comparatively early age with regular breeding intervals. The bullocks/he-buffaloes (average weight 569 kg) are slow but good for heavy work.

***(iii)* Surti.** This breed of buffalo is native of Kaira and Vadodara districts in Gujarat. Black or brown, eyes prominent, horns are sickle-shaped. Their average milk yield is from 1600 to 1800 litres. The fat content of milk is about 8 to 12 per cent. This breed of buffalo is capable of adjusting in other parts of the country.

Quality of Buffalo Milk

Buffalo is potentially the most productive economic animal. It has an exceptionally long productive life of about 20 years. Also, buffalo's milk is richer in fat, tocopherol (vitamin E), proteins,calcium, phosphorus and contains low sodium, potassium, cholesterol. Buffalo's milk is ideal for making milk products such as khoa, rabri, dahi, ghee, etc., and is always in great demand. Milk in comparison to other food products from animals such as egg and meat contain all the major food constituents such as carbohydrates (sugars), protein, fat, minerals (mainly phosphorus, calcium) and water. Certain vitamins such as vitamin A and D are also present in milk. The nutritional value of animal products is given in Table 1.10.

Table 1.10. Nutritional values of animal products.

Animal product	*Per cent (%) Nutrients*					
	Fat	*Protein*	*Sugar*	*Minerals*	*Water*	*Vitamins*
1. Milk (cow)	3.60	4.00	4.50	0.70	87.20	B_1, B_2, B_{12}, D, E
2. Egg	12.00	13.00	*	1.00	74.00	B_2, D
3. Meat	3.60	21.10	*	1.10	74.20	B_2, B_{12}
4. Fish	2.50	19.00	*	1.30	77.20	Niacin, D, A

* Present in very little amount.

Breed Improvement for Higher Production of Milk

Milk production of milching animals depends on their **lactation period**, *i.e.*, period of milk production between birth of a young one and the next pregnancy. For example, lactation period of some indigenous breeds of cows are as follows :

1. Red Sindhi – 231 to 345 days
2. Sahiwal – 184 to 354 days
3. Gir – 230 to 394 days

So, milk production can be increased by increasing lactation period. For achieving this target the technique of **selective breeding** has been used.

In India, the poor genetic material of most of the livestock is one of the prime reason for the meagre produce. Efforts are underway to improve the yield by the development of new and better varieties of livestock by the practice of selective breeding (Box 1.17). This involves mating parents of different varieties, each having some desired trait which are then passed on to the offspring. The different desired traits or characteristics of the parent generally chosen for breeding are the following : 1. tolerance to climatic conditions ; 2. lactation period ; 3. high yield of the produce (milk/meat) ; 4. resistance to diseases ; 5. proper age of reproduction ; 6. good health ; 7. general appearance.

Box 1.17

Breeding means to reproduce. In case of animals, breeding is done to obtain animals with desired characters. The two individuals of desirable characters can be selected as parents. These are then crossed to obtain new breed of the animals, e.g., by cross breeding a cow of low milk yielding breed with a male bull of high milk yielding breed, we can get a new breed of cow which produces more milk.

In fact, the production of milk from our *indigenous dairy breeds* of cows comes to an average of 6–8 litres per day, whereas *exotic breeds* of cow (Box 1.18) provide on an average 60 litres of milk in a day. The **lactation period** of exotic breeds is relatively longer than our indigenous breeds. To improve the production of milk of our indigenous cows, cross breeding programme has been undertaken at a number of research centres in our country.

Methods of breeding animals. There are two methods of breeding animals: (*i*) Natural method; (*ii*) Artificial method.

(*i*) Natural method of breeding. It is a traditional method of breeding. It takes place by cross-breeding between the desi (indigenous cow) and the bull of high milk yielding exotic breed by the natural physical mating process during the heat period (fertility period) of cow.

The yield of milk and prolongation of lactation period have significantly improved in successful crossbreeds (Table 1.11). Improved crossbreeding programme has been widely extended to entire country by the process of artificial insemination.

Table 1.11. Milk production during lactation period by various breeds of cow.

Dairy breeds of cows	*Average milk production (litre)*	*Lactation period*
1. Sahiwal	2800	300
2. Freiswal	5000	326
3. Holstein-Friesian	16000	365

(*ii*) Artificial method of breeding. Scientifically this method is called **artificial insemination.** The process of injecting the semen obtained from desired male bull of high milk yielding breed into the genital or reproductive tract of female animal during heat period is called **artificial insemination**.

It generally gives improved breeds. This method is widely used to improve the qualities of cow, buffaloes, poultry, horse, sheep, goats and pigs.

Box 1.18

Exotic Breeds of Cows

1. **Jersey** (Native of Island of Jersey, in English channel).
2. **Holstein - Friesian** (Native of Holand)
3. **Brown Swiss** (Native of Switzerland)

Improved Breeds of Cows in India

1. **Karan Swiss** (Brown Swiss X Sahiwal)
2. **Karan - Fries** (Holstein - Friesian X Thaparkar)
4. **Frieswal** – (Holstein - Friesian X Sahiwal)

Technique of artificial insemination. The semen of a healthy and tough animal of high milk yielding breed is collected and preserved by freezing or chemical methods. This preserved semen is then injected artificially into the genital tract of the female animal during fertility (heat) period (During heat period, cows and buffaloes are sexually excited and ready to mate). It is a more reliable method of animal breeding. The first experiment in this field was performed in the year 1780 by **Spallanzani** to obtain pups (young ones of dog).

More than 6000 artificial insemination centres have been established in the different parts of India to benefit the dairies and farmers at village level. One such centre is located at **Indian Veterinary Research Institute (IVRI)**, Izatnagar.

Precautions for Artificial Insemination

The various precautions to be observed to ensure high fertility by artificial insemination method are as follows:

1. The semen should be obtained from high quality (healthy and high yielding) male animal.
2. The female animal selected should-be healthy and of sound breeding age (*i.e.*, proper age for reproduction).
3. Artificial insemination should be carried out only at the proper heat-period of female animal.
4. The instruments used in artificial insemination should be properly sterilised. Proper technique should be used for artificial insemination.

Advantages of Artificial Insemination

Artificial insemination method of breeding has following advantages:

1. Bulls of selected breeds are kept in climatic conditions most suitable for their healthy living.
2. The bulls are reared in most hygienic conditions under the direct supervision of experts.
3. Through selective breeding, animals of desired characteristics can be raised.
4. It is economical (*i.e.*, cheaper) because semen from a single bull can be used to impregnate several thousand cows (about 3000).
5. Semen can easily be transported, even to remote places.
6. High quality semen is available all the time and all the places. However, a high quality bull is not always available at all the places.
7. This method is more reliable and hygienic than the natural method of breeding animals by mating.
8. It gives high rate of successful fertilization.

Box 1.19

Superovulation and embryo transplantation

Generally one ovum is released from each ovary at the time of ovulation. But by hormone injection, more ova can be produced from the ovary. This is called **superovulation**. In USA in 1979, a prized cow was super ovulated, mated and the embryos were removed. The embryos were implanted in foster mothers. In that year, this one cow could have produced 89 calves by this method.

In the technique of embryo transplantation the developing embryo from a pregnant superior breed is removed and transferred into another female with inferior characters, for further development. The Superior breed can be made to bear another embryo in quick succession.

ACTIVITY 1.4

Visit a livestock (e.g., Dairy) farm. Note the following :

1. Number of cattle
2. Types of different breeds and their number.
3. Production of milk on daily basis from different breeds.

Give your comments whether improvement of cattle breed is required or not.

B. Farm Management Practices

In a farmhouse, the requirement of proper cleaning and shelter for cows and buffaloes is must due to two reasons : *(i)* for the production of clean milk; *(ii)* for the health of the animal. Both cow and buffaloes require regular grooming (brushing) to remove dirt and loose hairs. They are sheltered under roofed sheds that protect them from rain, heat, direct sunlight and cold. The floor of the cattle shed is made brick-lined and sloping for facilitating cleaning and keeping their sitting place dry. Generally a cow requires about six square metre space and buffaloes need little more space. In the shelter, the animals are provided with feeding passage and feeding trough. The sheds or shelters should be provided with **cross ventilation** with sufficient number of inlets and outlets.

The food eaten by animals is called **feed**. **Feeding of animal** means providing food to animal. The food requirement of dairy animals is of two types :

1. Maintenance requirements. The food is required by the animal to support it to perform the basic functions of life.

2. Milk producing requirement. It includes the type of food required during lactation period. Maintenance part of the ration depends upon the **body weight,** while milk production part is dependent upon the **level** and **composition of the milk**.

1. Components of Cattle Feed

The animal feed includes *two* types of substances :

***(i)* Roughage.** It largely contains fibres such as green fodder, silage, hay (straw of cereals) and legumes (*e.g.,* berseem, lucerne, cow pea and agathi).

***(ii)* Concentrates.** The concentrates used in feed of cattle and bufalloes are a mixture of substances which are rich in one or more of the nutrients (*e.g.,*carbobydrates, fats, protein, minerals and vitamins). Concentrates are low in fibres and contain relatively high proteins and other nutrients. Concentrates include cotton seeds, oil seeds, grains of maize, oats, barley, jowar, bajra, gram and their byproducts such as wheat barn, rice barn (polish), gram husk, oil seed cakes and molasses.

Box 1.20

1. Milk yield of an animal depends upon the amount and the kind of food provided to it.

2. Oil cakes are mainly fed to milching cows. Oil cakes are made from the residues available after extraction of oil from the oil seeds such as mustard, cotton seed, groundnut, etc.

3. A calf needs more food and nutrients than an old cow. This is because more energy is required for the growth process of the calf.

4. In India, the attitude of feeding animals with waste material from the farm is gradually changing because the farmers are now cultivating such grasses as lucerne, alfalfa and are making available green fodder.

The dairy cattle is given a **balanced ration**, which contains all nutrients in proportionate amounts. A **ration** is the amount of food which is given to the animal during a twenty-four hour period. The daily average feed (ration) of a cow is given below:

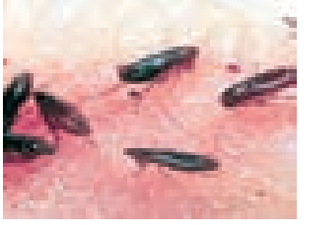
1. Green fodder and dry grasses (roughage) = 15 to 20 kg
2. Grain mixture (concentrates) = 4 to 5 kg
3. Water 30 to 35 litres.

Besides above mentioned nutritious food material, dairy animals require certain additive feeds, which contain **antibiotics**, **minerals** and **hormones**. Such additive feeds promote the growth of the animals, facilitate good yield of milk and protects them from diseases. **A poor quality of feed directly affects the yield of milk in cows and buffaloes**.

2. Diseases of Cattle and Buffaloes

Cows and buffaloes suffer from various diseases. The diseases adversely affect the production of milk and cause mortality of sick animals.

Diseases of dairy animals are broadly classified into following *three* categories : 1. parasitic diseases: 2. infectious diseases; and 3. non-infectious diseases.



Fleas on cattle.

1. Parasitic diseases. The parasites of cattle may be both external and internal. The **external parasites** include **fleas**, **lice** (blood-sucking lice), ticks and mites. They live on skin of cows and buffaloes and mainly cause skin diseases. Buffaloe leech (*Hirudinaria granulosa*) sucks blood of bufalloe and causes **anaemia** disease. The **internal parasites** such as worms (*e.g., Ascaris ritulorum*) affect stomach and intestine of cows and buffaloes and flukes (*e.g., Fasciola gigantica* and *F. hepatica*) of the host (cow/buffaloe) damage the liver.

Foot and Mouth disease.

2. Infectious diseases. Infectious diseases are mainly caused by viruses and bacteria. They are contagious diseases and spread by contact from animal to animal.

(a) **Examples of viral diseases. Foot and mouth disease**, **cow pox** or **vaccinia** and **Rinderpest**. Symptoms of foot and mouth disease include blisters on feet and mouth, excessive formation of saliva (trail of saliva hangs from the mouth), soreness of mouth, diminished appetite and high fever.

(b) **Examples of bacterial diseases. Anthrax**, **Hemorrhagic septicemia**, **Black quarter**, etc. Hemorrhagic septicimia is caused due to infection of *Pasteurella multocida* and black quarter is caused by *Clostridium chanroei.*

Table 1.12. Common diseases of cattle and their symptoms.

Viral Disease	*Symptoms*
1. Cow pox	Fever accompanied by appearance of small nodules.
2. Rinder pest	Constipation followed by severe diarrhoea, discharge from the eyes and nostril, loss of appetite.
3. Foot-and-mouth	Blisters appear on the mouth and foot resulting in extreme soreness of the parts. Loss of appetite, excessive salivation, high fever accompanied by shivering. Inability to work.
4. Rabies	Marked changes in behaviour, restless, paralysis (symptoms appear in 14-90 days).
5. Dermatitis	Irritation, blisters and eruptions on the skin surface.

Bacterial Disease	*Symptoms*
1. Anthrax	Fever with swelling of body, milk secretion reduced.
2. Haemorrhgic septicemia	High fever, anorexia, increased respiration, marked salivation.
3. Black quarter or Black leg	A fatal toxemia especially of young cattle.
4. Tuberculosis	Fever, infection of udders, lungs, intestines and other parts.
5. Brucellosis	Sterility due to infection in the reproductive organs, *e.g.*, uterus in females and testes in males.
6. Mastitis	Fever, udders become swollen, milk is watery.
7. Salmonellosis	Fever, diarrhoea with blood clots.
Fungal Disease	*Symptoms*
Ringworm	Small, circular, discoloured raised patches
Parasitic Disease	
1. External parasites (Lice, ticks)	Live on skin and cause skin disease
2. Internal parasities (Worms, fluke)	Live in the stomach, intestines and damage the liver of cattle

There are some of the diseases of domestic animals that can be transmitted to human beings (Box 1.21).

Box 1.21

Diseases of Animals Transmitted to Human Beings

1. **Viral diseases.** Rabies, Cow pox, Encephalitis.
2. **Bacterial diseases.** Anthrax, Tuberculosis, Brucellosis.
3. **Fungal diseases.** Actinomycosis, Aspergillosis, Ringworm.
4. **Parasitic diseases.** Amoebiasis, Trypanosomiasis, Ascariasis.

Box 1.22

Dr. V. Kurien

Born on 26th November, 1921, **Dr. V. Kurien** is the founder chairman of the **National Dairy Development Board (NDDB).** NDDB designed and implemented as the world's largest dairy development programme, called **"Operation Flood"**. Operation flood programme was started with the pledge to provide milk to one and all. Dr. Kurien is known as the **Architect of India's Modern Dairy Industry** and the **Father of White Revolution**. White revolution means huge increase in milk production and it becomes possible by using new, improved breeds of cattle and buffalo, giving them better feed and care.

Dr. V. Kurien

1.4. POULTRY FARMING

The poultry industry with its production in the form of eggs and meat is of particular importance in providing a balanced diet for the human population. Poultry birds serve human beings in various ways. They are not only efficient converters of agricultural byproducts, particularly of wastes into high quality meat

but also provide egg, feathers and rich manure. **Proper management** of poultry includes improved methods of hatching, rearing, housing, sanitation, prevention from diseases and a sound marketing arrangement.

The word, *poultry* has originated from the old French word ' *poult*' means chicken, the young one of common domestic fowl. So this word should have been used only for domestication (rearing) of chicken or fowls. However, poultry also includes ducks, geese, turkeys, guinea-fowls and pigeons. Poultry is the choice of millions as staple food world over. The constant efforts in the field of poultry farming has made it possible to increase the production of eggs in our country. India has become 5th largest country in the world in poultry production after China, former USSR, USA and Japan.

An egg laying poultry is called **egger** or **layer** and the poultry reared for obtaining meat is called **chicken** or **broiler**. Poultry farming is undertaken basically to raise domestic fowl for egg production and chicken meat.

Table 1.13. A comparison between layers and broilers.

Layers	*Broilers*
1. Layers are egg-laying birds, managed for the purpose of getting eggs.	1. Broilers are maintained for getting meat.
2. Layers start producing eggs at the age of 20 weeks. So they are kept for layer period depending upon laying period (about 500 days).	2. They are raised upto 6-7 weeks in poultry farms and then sent to market for meat production.
3. They require enough space and adequate lighting.	3. They require conditions to grow fast and low mortality.
4. They require restricted and calculated feed with vitamins, minerals and micronutrients.	4. Their daily food requirement (ration for broilers) is rich in protein and vitamin A and K. The fat content also should be adequate.

1. Poultry Breeds

In India, available poultry breeds are included in following *three* categories :

1. Desi or indigenous breeds. We have only four pure breeds of indigenous or desi fowls. They are **Aseel, Chittagong, Ghagus** and **Busra**.

Aseel or **Indian game** is most popular breed of India and selected for poultry farming. This breed provides high yield of meat and also is good egg layer. The average weight of cocks varies from 4 to 5 kg and of hens from 3 to 4 kg. There occur only four popular varieties of Aseel, namely (*a*) **Peela** (golden red), (*b*) **Yakub** (black and red), (*c*) **Nurie** (white), and (*d*) **Kajal** (black).

The indigenous breeds of poultry are hardy (strong) and possess natural immunity against common diseases. The disadvantages of *desi* hens are (i) They are smaller in size; (ii) They are slow growing ; (iii) They lay less number of eggs (*i.e.*, 60 eggs per year) and (iv) They produce small sized eggs.

(*ii*) Exotic breeds. Exotic breeds mean varieties of other countries or foreign breeds. There are present numerous exotic breeds of poultry which have been successfully acclimatized in India. The following two exotic breeds of poultry are most popularly used in our country :

(*a*) White Leghorn. This very popular exotic breed of fowl produces long white eggs. Since white leghorn has small body size (body weight 2.7 kg of cock and 2.0 kg of hen), so need less feed for its maintenance. Thus, its farming proves quite economical.

(b) Rhode Island Red. This breed of fowl was developed on the farm of Rhode Island in U.S.A. This is a dual type of breed, it is fairly good egg layer and also meat yielding (broiler). Some other exotic breeds of fowls in our country are **Black Minorcha**, **Plymouth** and **Light Sussex** (Fig. 1.12).

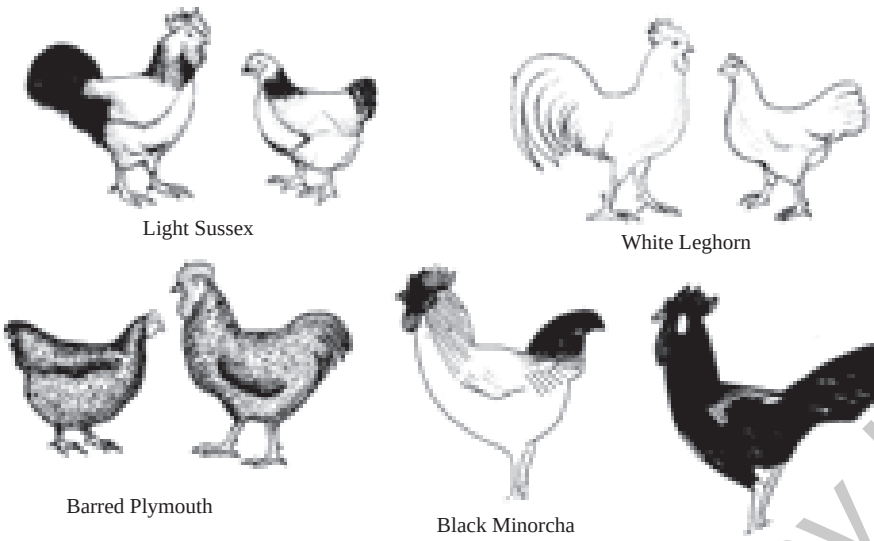


Figure 1.12. Some exotic breeds of fowl.

(*iii*) Cross breeds or Improved breeds of poultry. The majority of the present day chickens used for production of egg and meat are the crossbreed blocks. In India, a number of research programmes are going on to produce improved quality commercial egg layers and broilers through cross breeding. Some improved crossbreed strains of fowl are **HH-260, IBL-80, B-77** and **ILS-82**.

Box 1.23

1. Poultry industry has shown a phenomenal growth in last two decades. Large increase in egg production in India has been named **silver revolution**.

2. Central Poultry Breeding Farm at Bombay, Bhubaneshwar, Hassarghatta and Chandigarh are engaged in scientific poultry breeding programme and have developed high egg producing hybrid and fast growing broiler breeds.

2. Variety Improvement

The programmes of cross breeding between Indian (indigenous) and foreign (exotic) breeds for variety improvement are focused to develop new varieties for the following desirable traits :

1. Quantity and quality of chicks ;
2. Dwarf broiler parent for commerical chick production for summer adaptation capacity/tolerance to high temperature ;
3. Low maintenance requirement ;
4. Improvement in hen housed for egg production and reduction in the size of the layer with ability to utilize more fibrous, cheap diet formulated using agricultural byproducts.

Egg and Broiler Production

There are two basic targets of poultry farming : (*i*) obtaining more and more eggs; (*ii*) getting flesh.

1. Production of Eggs

In chickens, egg production is the most important economic trait. A layer starts laying eggs at the age of 20 weeks. The egg production period in commercial layer is 500 days.

To develop new varieties or to improve quality of chicken with respect to quantity and quality of eggs, the following points are considered : 1. Egg number ; 2. Sexual maturity ; 3. Egg weight ; 4. Body weight;

5. Feed efficiency ; 6. Egg size; 7. Egg shape ; 8. Shell colour ; 9. Shell quality ; and 10. Internal quality of egg.

Production of vegetarian eggs. The fertile eggs rot rapidly than the infertile eggs, thus, the production of infertile eggs is desired. Hens can lay eggs without a cock and the eggs thus obtained are infertile. Such eggs are called **vegetarian eggs**.

2. Production of Broilers

Chickens are raised up to 6-7 weeks in the poultry farm. They grow to a weight of 700 gm to 1.5 kg in this period. They are fed with vitamin rich supplementary feed for good growth rate and better feed efficiency. Care is taken to prevent mortality and enable feathering and maintain carcass quality. They are produced as broilers and sent to market to be sold as meat.

3. Poultry Care

Good management practices are essential for producing good poultry. These practices are often different for broilers and egg layers.

A. Housing, Shelter and Feed

Both layer and broiler breeds require different type of care :

1. Care for the layers. There are following two distinct phases in the life of a layer:

(*i*) Growing period. The first phase of the life of poultry (*i.e.*, the layer) is growing period (upto sexual maturity). During this period the chickens are called **growers**. The growers require enough space. Over-crowding tends to suppress their growth. The feed is given in a restricted and calculated manner.

(*ii*) Laying period. The period from sexual maturity till the end of egg laying is called **laying period** and the chickens are known as **eggers** or **layers**. The layers require enough space and adequate lighting. Light's intensity and its duration has favourable effect on the laying output of the hens. Feed with vitamins, minerals and micronutrients also influence hatchability of eggs.

2. Care for the broilers. The housing, nutritional and environmental requirements of broilers are different from layers. Conditions provided have to be favourable for the fast growth and low mortality of broilers. The ration for broilers is protein rich with sufficient fat. In the poultry feed, the contents of vitamin A and K are kept high.

B. Diseases of Poultry

The poultry birds suffer from various diseases caused by *viruses* (Flue, Dermitis, Fowl pox, Ranikhet), *bacteria* (Tuberculosis, Cholera, Diarrhoea), *fungi* (Aspergillosis), *animal parasites* (worms, mites, lice), etc. They also suffer from nutritional deficiency diseases. Some common diseases of poultry have beeen highlighted in Table 1.14.

Table 1.14. Some common diseases of fowl and their symptoms.

Name of disease	*Causative organism*	*Symptoms*
1. Dermitis	Virus	Irritation, blisters and erruption on the skin surface.
2. Fowl pox	Virus	Wart-like pox lesions on comb, wattles, eyelids and feet, lesions in mouth, difficulty in breathing, yellow cheese like dishcarges from eyes and nose.
3. Fowl cholera	Bacteria	Loose motions and dehydration.
4. Aspergillosis	Fungus	Patches on skin due to growth of moulds.

ACTIVITY 1.5

Visit a local poultry farm. Observe types of the breeds and make a note on the type of ration, housing, lighting facilities and incubator facilities given to them. Identify the growers, layers and broilers. Find if the management of the poultry farm is proper and adequate.

1.5. FISH PRODUCTION

Fish is an important aquatic food which is rich in proteins. A large section of Indian population uses fish as food, particularly that living in coastal areas. It is highly nutritious and easily digestible. Fish can be useful in eradicating problem of malnutrition. Fish liver oil is rich in vitamin A and D. Out of the total fish obtained from the Indian oceans, 45% is procured by India.

Fisheries

Fisheries are establishments connected with capture, preservation, exploitation and utilization of various types of fishes, prawns, lobsters, crabs, oysters, other molluscs, etc. On the basis of product, fisheries are of *two* types :

(*a*) Fin fishery. It is capture, management and exploitation of cartilaginous and bony fishes.

(*b*) Shell fishery. It is the capture management and exploitation of crustaceans (crabs, prawns, lobsters) and molluscs (oysters, mussels, octopods, etc.).


Fishery.

Depending up on the mode of obtaining fish, fisheries are of *two* types, capture and culture.

1. Capture fishery. The fish is caught from natural waters, both marine and inland. Modern technology is used for capture and storage before marketing. Electronic equipment is used to locate fish in the sea. Mechanised fishing boats and deep sea trawlers are often employed in capture fishery.

2. Culture fishery. It is cultivating, rearing and harvesting of fish. Culture fishery is also called **fish farming** or **pisciculture.** The growing of various types of aquatic organisms in water bodies is called **aquaculture.**

Table 1.15. Differences between capture fishery and culture fishery.

Capture fishery	*Culture fishery*
1. It is a method of obtaining fish from natural resources.	It is a method of obtaining fish from fish farming (water agriculture).
2. There is no seeding and raising of fish.	The fish is seeded and reared.
3. Capture fishery is undertaken in both inland and marine waters.	Culture fishery is undertaken mostly inland and near sea shore.

Box 1.24

1. In common usage, the term fish has often been used to describe a mixed assortment of water-dwelling animals. we speak of jelly fish, cuttlefish, starfish and shell fish, knowing fully well that when we use the word "fish" in such combinations, we are not referring to a true fish.

2. A true fish is a gill-breathing, ectothermic, aquatic vertebrate that possesses fins and skin that is usually covered with scales.

3. The word *fish* is commonly used both as singular and plural, but a zoologist uses *fishes* to mean more than one kind of fish.

Seventy per cent of the Earth is covered with water. Based on the water sources of fish production, following *three* types of fisheries can be recognised.

1. Marine fisheries. They include capture fisheries of oceans and seas.

2. Fresh water fisheries. They include capture and culture fisheries in freshwater systems such as rivers, canals, lakes, reservoirs, tanks, ponds and paddy fields.

3. Brackish water fisheries. They include fishing activities in brackish water (slightly salty) such as *estuaries* (last part of river that gets tidal water from sea), *lagoons* (shallow salt water lakes separated from sea bank, coral reef, etc.) and *mangrove swamps* (tropical trees growing in mud of sea-shore).

Fresh water fisheries and brackish water fisheries are collectively called **inland fisheries**.

With the increase in our population, fish production has been increased both for food and as a business activity. Modern technologies are being used both for capturing and culture of fish in marine and freshwater ecosystems. In this section we will study various methods for increasing the production of fish in all sort of aquatic ecosystems (Box 1.25).

Box 1.25

Few Facts about Indian Fisheries
(include both capture and culture)

1. Total fish production in India – 7th position in world
2. Marine fish production in India – 10th position in world
3. Aquaculture production in India – 2nd in South East Asian countries
4. Fish industry contribution – Rs. 400 crores annually as foreign exchange
5. Kinds of Fresh water Fish Culture Systems :
   - (*i*) Carp culture (composite fish culture)
   - (*ii*) Sewage fed fish culture
   - (*iii*) Air breathing fish culture
   - (*iv*) Fish culture in cages
   - (*v*) Paddy-cum-fish culture
   - (*vi*) Integrated fish culture
   - (*vii*) Fish culture in cold water
   - (*viii*) Fish culture in bundhs
   - (*ix*) Fish culture in seasonal ponds
   - (*x*) Freshwater pearl culture

1. Marine Fisheries

India has a vast scope of marine fishery. Our marine fishery resources include 7500 kms coast line and extensive deep sea. Marine waters providing profitable fishing are Arabian sea, Bay of Bengal, many small bays, gulfs, lagoons, coral reefs, etc. Central Marine Fisheries Research Institute (CMFRI) at Ernaculum, Cochin, Kerala has been set up to explore and utilise the marine resources of the country. Following 12 marine fishes of India are most preferred sea fishes or **table fishes**, *i.e.*, popularly consumed fishes :

1. Pomphrets, 2. Mackerels, 3. Tuna, 4. Sardines, 5. Bombay duck, 6. Eel, 7. Hilsa, 8. Salmon, 9. Ribbon fish, 10. Flat fish or sole, 11. Seer, 12. Flying fish.

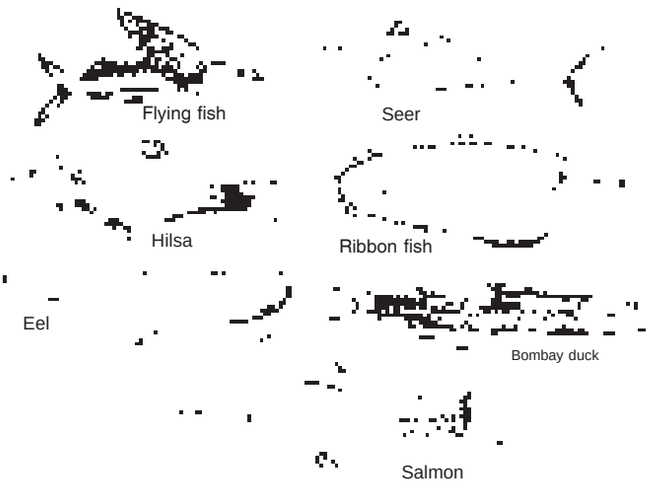


Figure 1.13. Some marine table fishes of India.

These marine table fishes are caught by fishing nets and gears operated by fishing vessels. A vessel that drags a net behind it is called **fishing trawler** ; such fishing trawlers fitted with electronic fish locating device have been put into service for boosting deep-sea fishing. The modern technologies for catching more fish includes **echosounders** and use of **satellites** to fish shoals or schools (assembleages of fish).

2. Aquaculture

Aquaculture pertains to production of useful (*i.e.*, of high economic value) aquatic plants and animals such as fishes, prawns, crayfish, lobsters, crabs, shrimps, mussels, oysters and seaweeds by proper utilisation of available waters in the country. It is an important means of increasing the country's food output. India has a great potential for the aquaculture because of a lengthy coastline and numerous inland water spreads.

Aquaculture includes mariculture and freshwater culture fisheries.

Mariculture. The marine fishes cultured in coastal waters of India on commercial basis include mullets, *bhetki*, pearl spots, sardines, eel and milk fish.

Freshwater culture fishery of exotic carps has good prospects in lakes. These carps include the common carp, English carp, tench and trouts. Trout hatcheries have been established in Kashmir and other places.

3. Inland Fisheries

It includes (*i*) riverine fishery ; (*ii*) reservoir fishery ; (*iii*) lake or lacustrine fishery ; (*iv*) pond fishery and (*v*) estuarine fishery. Inland capture fisheries are rapidly expanding in our country.Introduction of exotic species from abroad and inter-regional transplantation of fish from northern to southern waters have proved to be great boon. Increasing pollution of water is adversely affecting the inland fisheries. Construction of dams have harmed many regional fisheries. Indiscriminate fishing is also causing immense damage to fisheries.

Major share of fish production from inland resources is, however, through aquaculture practices. For table fish production, common and most advantageous culture system is **composite fish culture**. Fish culture in **integrated fish culture system** is also taken up with agriculture farming include *paddy-cum-fish culture* (Box 1.26). Different types of fish culture systems have been given in the Box 1.25. Some interesting fish culture systems are following :

1. **Cage culture.** Fish is cultured in large cages, made of bamboo or steel, which are lowered into the river. Generally, carnivorous species are cultured in cages.

2. **Integrated fish culture.** Fish culture is practiced along with some agricultural crops such as paddy, banana and coconut to give higher yield. Fish is also cultured in ponds near the poultry or piggery, and the excreta of these animals is used as food in ponds.

Box 1.26

Paddy-cum-fish culture

The fish species that can be stocked in paddy fields include *Catla catla, Labeo rohita, Cirrhinus mrigala, Clarias* spp. (catfish), *Channa* spp. (murrels), *Mugil* spp., *Lates calcarifer*, etc. These species are able to live in shallow water of paddy fields and able to tolerate high temperature or turbidity.

4. Composite Fish Culture (Polyculture of Fish)

Fish production by culturing a single species in a pond (called **monoculture**) using old traditional methods gives a low yield ; but if several species of fish are stocked together in a pond, the production increases with the same cost. Hence it is necessary to select species having different feeding habits so that all the available food in the pond is effectively utilised. Fast growing compatible species are selected, so that, there is little competition between them and all ecological zones are exploited for achieving maximum yield. This method is called **composite fish farming** or **polyculture of fishes**.

Experiments have shown that Indian major carps (*i.e.*, Catla, rohu and mrigal; Fig. 1.14) when stocked along with three species of exotic carps (*i.e.*, silver carp, grass carp and common carp, Fig. 1.15; all the three species are transplanted from China), the yield goes up 8–9 times, as compared to monoculture. The food habits of these six species are as follows:

1. The silver carp (*Hypophthalmichthys molitrix*) is a **surface feeder** and feeds on phytoplankton.
2. The catla (*Catla catla*) is also **surface feeder** and it feeds on zooplankton.
3. The rohu (*Labeo rohita*) feeds in middle zone of the pond, *i.e.*, **column feeder**, and feeds on decaying plants and detritus.
4. The grass carp (*Ctenopharyngodon idella*) feeds on all macro-vegetation and consumes the aquatic plants/weeds not used by other species in this group.
5. The mrigal (*Cirrhinus mrigala*) is a **bottom feeder** using decaying plants and detritus.
6. The common carp (*Cyprinus carpio*) is an omnivorous **bottom feeder**.

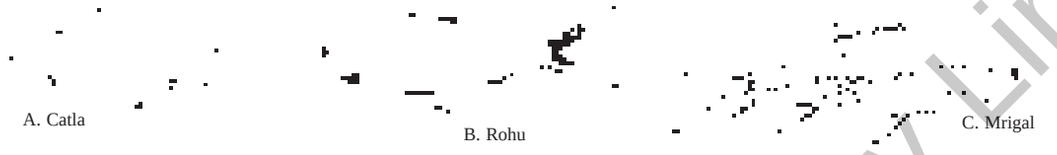


Figure 1.14. Indian major carps.

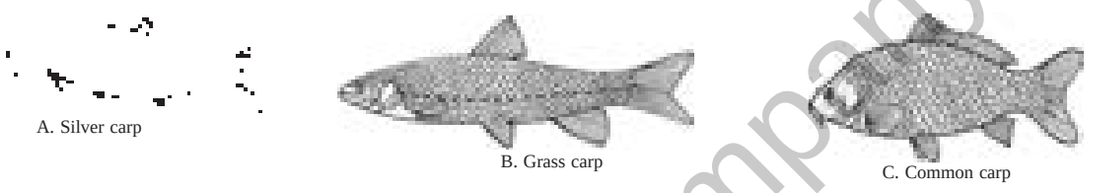


Figure 1.15. Exotic carps used in composite culture.

These six species have complementary feeding habits and do not harm each other, and constitute a good combination of polyculture.

Important factors to be taken into consideration for fish culture include: (*i*) Topography or location of pond ; (*ii*) Water resources and quality ; (*iii*) Soil quality, *i.e.*, composition of particle size as well as nutrients. The time of stocking also depends on the water temperature. Low water temperature (18–20°C) is most favourable for growth.

Qualitative and Quantitative Improvement of fish and fish seed. The different fish used in the composite culture do not breed in pond environment. The carps breed in rivers during monsoon month (July, August). The eggs and seeds collected from riverine water were seldom pure. [*Note. Fish seed* is a commercial term for (*i*) **spawn** (fertilized developing eggs); (*ii*) **Hatchlings** (upto 4-5 mm size); (*iii*) **Fry;** (*iv*) **Fingerlings** (adult-like fish)]. The problem of quality seed and breeding the carps in ponds was solved by **Alikunhi** (1957) through the technique of **induced breeding** by injecting fish pituitary hormones (called **hypophysation).** This technique of induced spawning (release of fertilized developing eggs) in fishes led to blue revolution through fish culture. Currently synthetic hormones such as **ovaprim, ovatide** and **nova** are used for induced breeding. This technique ensures supply of pure seeds of fish in desired quantity.

ACTIVITY 1.6

During educational tour of your school visit a fish farm in breeding season of fishes (*e.g.*, monsoon for Indian carps) and note the following :

1. Varieties of fish in the ponds.
2. Types and number of each type of ponds.
3. Ingredients in supplementary feed being used in the farm.
4. What is the annual production of the fish farm ?
5. From where fish seeds brought to the farm for stocking.
6. Observe male and female ripe breeders of catla, rohu and mrigal. Try to identify male fish from female fish.
7. Visit a fish hatchery farm to learn about methods of induced breeding.

Based on the observations, explain what are the problems being faced by the fish farmers.

1.6. BEE KEEPING

Bee keeping or **apiculture** (L. *apis* = bee; *culture* = cultivate) is the rearing , care and management of honey bees for obtaining honey, wax and other substances. Honey is known to have medicinal value. It is found to be quite useful in the treatment of various disorders of humans related to digestion, dysentery, vomiting and stomach or liver ailments. Honey is considered as a blood purifier, a cure against cough, and cold sore throat, ulcers of the tongue, ulcer of stomach and intestine, etc. Since honey is rich in iron and calcium, it helps in growth of human body. Honey is also used as a source of sugar in confectionary items such as pasteries, cakes, etc. Visualising these important uses of honey, bee keeping has been undertaken on commercial basis as a business.

Bee keeping being, a low-investment enterprise, has become a favourite source of some extra income for the Indian farmers. Bee keeping also helps in cross pollination of flowers of crop plants, since pollens are transferred from one flower to another by bees while they are collecting the nectar (Box 1.27).

Box. 1.27

How is nectar changed into honey?

Nectar is a sweet viscous secretion secreted by flowers of plants ; by attracting the insects it helps in pollination. When the bee sucks the nectar from the flowers, it passes this nectar to its **honey sac** where it gets mixed with some acid secretion. In honey sac, sucrose (sugar) of the nectar is converted into dextrose and levulose by the action of invertase enzyme. After regurgitation the treated nectar finally changes into honey which is stored in special cells of hive for future use.

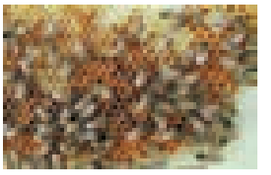
I. Products Obtained From Apiculture

Apiculture or bee keeping provides us the following useful products : honey, wax, propolis, royal jelly and bee venom.

1. Honey. Honey is a sweet, viscous edible fluid containing sugars, water or moisture, minerals, vitamins, amino acids, enzymes and pollen. Sugars present in honey include levulose, dextrose, sucrose and dextrin. Minerals of honey are calcium, iron, phosphate and manganese. Vitamins present in honey are Pantothenic acid, Biotin, Pyridoxin, Choline, Ascorbic acid, Thiamine, Riboflavin and Niacin. The colour, flavour and odour of honey usually depend on the flowers from which nectar is gathered. One kilogram of honey contains 3200 calories and is an energy rich food.

Honey.

2. Bee wax. It is a wax of high melting point (about 140°F). It is secreted by wax glands of worker bees. Bee wax is utilised in the construction of hive. This wax is used by human beings for several purposes such as manufacturing of cosmetics, cold creams, shaving creams, polishes, candles, ointments, lipstics, lubricants, in modelling work, etc.



Bee wax.

3. Propolis and balms are other collections of bee from the plants. These substances are used in repairing and fastening of comb.

4. Poison of bee is used in manufacturing of certain Ayurvedic and Homeopathic medicines.

II. Honey Bee Varieties Used for Bee Keeping

Both indigenous and exotic varieties of honey bees are used for commercial production of honey in India.

A. Indigenous Varieties of Honey Bees

1. *Apis cerana indica F.* (Indian bee); 2. *Apis dorsata F.* (Rock bee); 3. *Apis florae F.* (Little bee).

B. Exotic Varieties of Honey Bees

1. *Apis mellifera* (European or Italian bee); 2. *Apis adamsoni* (South African bee).

Italian bee (*Apis mellifera*) is commonly domesticated in India to increase yield of honey.

Italian bee is preferred because

(i) It is gentle in nature

(ii) It has good honey collection capacity.

(iii) It has the ability to protect itself from enemies, and

(iv) It has prolific queen with less swarming.

III. Colony and Castes of Honey Bee

Honey bee is a social insect. The nest of the honey bee is known as the **bee-hive** (Box 1.28). Honey bees provide a good example of team work and division of labour.

Box 1.28

In nature, honey bees raise their nests, called **hives**, on tall trees in forests or cities and even on tall buildings in urban areas. Compartments made by workers with the wax of their wax glands are called **combs**. A comb is a vertical sheet of wax, composed of double layer of hexagonal cells. The hexagonal shape of cells contain maximum space in minimum use of wax and labour. Storage cells of comb contain honey and pollen. Brood cells contain young stages and are of three types : worker cells, drone cells and a queen cell. Queen cell is single and largest. Adults do not live in cells but move on the surface of comb.

Honey bees live in a colony and different tasks are done by different groups of bees in the same colony. A colony of Italian bee normally has one queen, 40,000 to 100,000 workers and few hundred (up to 300) of drones. Due to existence of several morphological forms, called **castes**, bees are said to be the **polymorphic species**. A *caste* can be defined as a collection of individuals within the colony that are morphologically distinct from individuals in other castes and perform specific tasks. According to roles, there are following three types of castes in the colony of bee :

1. Queen. The body size of queen is much larger than other castes of bees of the colony. Her legs are strong for she is always walking about on the comb. The queen, as the mother of the colony, is responsible for laying eggs. She lays up to 2000 eggs everyday of each season. Queen lays both fertilized (diploid, $2n$) and unfertilized (haploid n) eggs. Queen and workers emerge from the fertilized eggs, where as drones come out from unfertilized eggs. Thus, queens are larger, they mate, lay eggs, eat proteinaceous food (Box 1.29) and often do not forage or defend the colony.

Box 1.29

Eggs of queen hatch into white, legless **larvae** which spin delicate silken cocoons around themselves and turn into **pupae**. Each pupa develops into an adult. The adult comes out by cutting wall of cocoon first and secondly by breaking the wax cap of the cell.

During first 2 to 3 days, all larvae of bee are fed on a special proteinaceous food, called "**Royal jelly**" or **bee milk** which is secreted by the hypopharyngeal glands of the young workers. After that coarser food, the "**Bee Bread**", which is mixture of honey and pollen grain is given. However, the queen forming larvae are fed on royal jelly for the full larval life and these larvae are also taken for further development into a special chamber called the queen's chamber or cell.

Figure 1.16. Three different castes of a colony of honey bee.

2. Drone. It is haploid, fertile male. Drones are larger is size than workers and are quite noisy. They are unable to gather food, but eat voraciously. Drones are stingless and their main role is to mate with queen

and remain in colony to sleep and eat honey. Since their role is only in the breeding season, therefore, they are made to leave the hive to save honey from them.

3. Worker. Worker is diploid, sterile female (*i.e.*, it can not reproduce). The size of worker is the smallest among the castes of bee. Workers are the most active members of the colony ; they have almost all responsibilities on their shoulder. For various indoor and outdoor chores the workers are provided with a variety of organs such as *hypopharyngeal glands* (for secretion of bee milk), *wax glands* (for building the cells of comb), *pollen baskets* on their hind legs (for the collection of pollen), *sucking type* mouth parts (for collecting the nectar), high level of secretion of *invertase* enzyme (in the honey sac for honey formation) and a *sting* at the tip of abdomen (for the defence of the colony; Box 1.30).

Workers live for 3 to 12 months. The function of workers change with age. During the first half of their life, workers are engaged in indoor duties as scavengers, nurse bees, fanner bees and guard bees. During the second half, they perform outside duties as scout bees and forager bees, the worker been of a hive fall under three major age groups. These are

(*a*) **Scavenger bees.** For the first three days, each worker bee acts as a scavenger. Cleaning the walls and floor of empty cells of the colony for reuse.

(*b*) **Nurse bees.** From the fourth day onwards, each worker bee feeds the entire brood, like a foster mother, with a mixture of honey and pollen. By seventh day it starts producing royal jelly, which is fed to queen and future queen bees. Nurse bees also perform guard duties. They defend the colony from intruders. They kill the intruder by stinging but also get killed with the loss of sting.

(*c*) **Foraging or field bees.** They explore new sources of nectar (as scout bees). Forager bees collect nectar, pollen and propolis. Nectar is changed into honey in their crops.

Box 1.30

Worker bees tend to maintain a constant temperature of the bee hive by their behaviour, *i.e.*, by flapping their wings for cooling and by huddling together for warming.

Forager bees communicate about the location of the foraging grounds with their colony mates in the form of **round-dance** and **waggle-dance**. For decoding the meaning of these dances, a Austrian Zoologist **Karl von Frisch** (1886 – 1982) took 20 years of research and got Nobel Prize in 1973 for his discovery.

Helping behaviour existing between members of a social group (workers) is called **altruism** (which means self-sacrifice).

IV. Management for High Yields of Honey

For the purpose of commerical production of honey, apiaries are established. An **apiary** is a place where bee hives (wooden boxes) are kept to get honey and other products of bee. To obtain good quality and higher yields of honey the following considerations are done :

1. Pasturage/Crop/Flora. The quality and taste of honey depends upon the flora, pasturage or orchards available for the nectar and pollen collection.

Pasturage/orchard flora of honey bees include a variety of flowering plants such as Mango (*Aam*), Coconut (*Narial*), Almond (*Badam*), Tamarind (*Imli*), *Ber, Berseem*, *Litchi*, Cotton, Shishame, Apple, *Mahua*, Coriander, Cashew, Coffee, Rubber plants, Guava, Sunflower, *Neem*, etc.

2. Bee-hive. In India, generally three types of artificial bee-hives are used in apiaries : 1. Langstroth (Fig. 1.19); 2. Newton and 3. Jeolikote. Newton and Jeolikote type hives are mostly used in plains and Langstroth hive is used in hill region.

Bee-hive is a box (Fig. 1.17) raised over a stand. The box has a wire gauze covered brood chamber for egg laying and a multiframe honey chamber for honey collection as honey reserve. Each bee-hive is of 46× 23 cm size.

3. Apiary location. Apiary means setting up of a number of bee-hives in good and desirable locations in such a systematic way which allows maximum nectar and pollen collection. An apiary should be set in a locality rich in vegetation especially the flowering plants ; rich flora should be available in 1 to 2 km radius for honey collection. Each hive should face East. It should receive sunlight during morning and evening and some shade during mid-day. Water should be available nearby and an open space in the front of hive entrance is also necessary.

4. Honey flow and seasons. At a given location in a season yield of honey is dependent on the duration for which abundant flora is available. The total time during which honey bees collect nectar and pollens is called **honey flow period**. Therefore, to obtain large quantities of honey, apiaries should be established, at a location, where there is abundance of flowers for the longer duration.

5. Swarming (Reproduction). It is a natural phenomenon whereby mass movement of bees from one place to another takes place. In honey bees, swarming is done in spring season for the purpose of reproduction. For swarming, new (young) queen leaves the old hive along with some workers and drones and takes a new shelter. Frequent transfer results in low yield of honey and maintenance cost of hives is also increased.

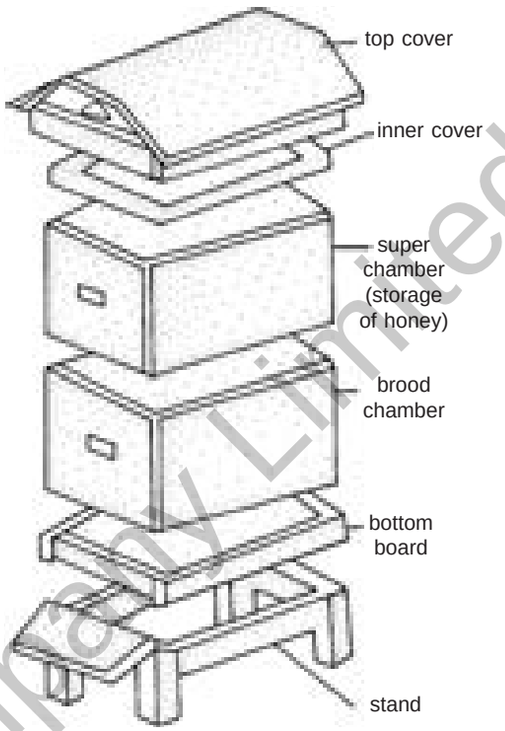


Figure 1.17. Outer view of a two-story Langstroth frame hive.

6. Selection of variety of honey bee and site selection for bee keeping. Less swarming variety is selected such as *Apis mellifera* (Italian bee) ; this bee also has other desirable characteristics (as discussed earlier). Suitable site for apiary should have good pasturage which have longer honey flow time.

V. Diseases and Enemies of Honey Bee

Honey bees are commonly infected by viruses, bacteria, fungi and protozoa. For example, the bacterium *Bacillus apisceptious* infects blood of bee causing septicemia. **Brood foul** disease takes place by Schizomycetes (fungi). **Nosema disease** and **amoeba disease** are caused by protozoan pathogens *Nosema apis* and *Vahlkampfia mellifica*, respectively. Common pests / enemies of bees are wasps, wax moths and mites. Dysentry, paralysis and acrine diseases are caused by a parasitic mite *Acarapis woodi.* Various birds such as king crows, blue tits, fly-catchers, chaffinch, green blue eater, sparrows, etc., use bee as their meal. Wasps are controlled manually (*i.e.,* by destroying the wasp nests from the locality of apiary). Wax moth is controlled by exposing bees in bee hive to sun, by increasing temperature. Bee-eater birds are scared away by some device.

SUMMARY

- Plants serve as food for humans and their domestic animals.
- Agriculture is the cultivation of desired economic plants or crops in a field.
- Crops are the plants of same kind grown at a place.
- Crops depending on season are of two kinds : Rabi season crops (winter crops) are grown from November to April and Kharif season crops (rainy season crops) are grown from June to October.
- Kharif season crops are paddy (*dhan*), soyabean, *arhar*, maize, cotton, *urad* and *moong* ; rabi season crops include wheat, gram, pea, mustard and linseed.
- 16 nutrients are essentially required by crop plants. Four nutrients are required in large quantities; they are called macronutrients. Nine nutrients are used in small quantities ; they are known as micronutrients.
- Manures and fertilizers are the main sources of nutrient supply to the plants.

- Manures are natural fertilizers. They include farmyard manure, compost, green manures and vermicompost.
- Fertilizers are commercially manufactured material from chemicals. They mainly supply nitrogen, phosphorus and potassium (NPK).
- The process of supply water to crop plants by means of canals, reservoirs, wells, etc., is called irrigation.
- Mixed cropping is growing of two or more crops simultnaeously on the same piece of crop field. Main objective of mixed cropping is to minimise the risk of crop failure.
- Intercropping is growing two or more crops simultnaeously in a same field in definite row patterns. Main objective of such a farming practice is to increase productivity per unit area and time.
- The growing of different crops on a piece of land in pre-planned succession is called crop rotation.
- Breakthrough in cereal production due to use of seeds of higher-yielding varieties, higher dose of fertilisers and assured irrigation is known as green revolution.
- Harbinger of green revolution in India is Dr. Swaminathan.
- Varietal improvement is required for higher yield, good quality and changing situations.
- Plant breeding can be defined as a science as well as an art of improving genetic make up of crop plants in relation to their economic value. It is based on hybridisation and DNA recombinant technology.
- Field crops are infested with a variety of pests such as weeds, insects, mites, nematodes, rodents, fungi, bacteria and viruses. These pests have to be controlled by the use of pesticides (biocides) and biological control.
- Cows, buffaloes, fowl, fish, goat and sheep are useful animals. They provide us food, *i.e.*, milk, egg and meat (fowl and goat). Buffalo milk has great economic value.
- Farm animals require proper care and mangement such as shelter, feeding, breeding (by artificial insemination) and disease control. This is known as animal husbandry.
- Artificial insemination is a technique to facilitate cross breeding at large scale. It is available at the veterinary aid units all over the country.
- Poultry farming is done to raise domestic fowls, ducks, geese, turkeys, pigeons, etc.
- Poultry production includes egg production (by layers) and poultry meat production (by broilers).
- To enhance the poultry production, cross breeding is done between Indian and exotic breeds for variety improvements.
- Chickens are raised up to 6 to 7 weeks in the poultry farm and as broilers marketed when they grow to 700 g to 1.5 kg in weight.
- By captured fisheries, fishes may be obtained from seas, *i.e.*, marine resources and inland resoures.
- By fish culture (a part of aquaculture), choiced variety of fishes are cultured in marine and inland ecosystems to increase their production.
- Fishes are caught by fishing nets and gears operated from fishing vessels having modern devices such as echo-sounders and navigational gadgets.
- In freshwater fish culture, induced breeding technique is very useful in obtaining quality fish seeds in large quantities.
- Fish seed may include spawn (fertilized eggs), hatchlings, sac fry, fry, juveniles, fingerlings and yearlings.
- Polyculture or composite fish culture system is used commonly to produce table fish such as silver carp, catla, rohu, grass carp, mrigal and common carp.
- Fisheries is comprised of fin fishes (true fishes) and shell fish (prawn, molluscs, etc.).
- Fish are obtained from sea and marine ecosystems. Marine fisheries deal with catching or capturing of fish. Mariculture deals, with culture of fish in marine ecosystems near sea costs. India has a 75000 kms long coastline.
- India has 1.6 million hectare of inland water resources covering river, lakes, reservoirs, ponds, lagoons, estuaries, etc.
- Beekeeping is done to get honey and wax.
- A colony of Italian honeybee (*Apis mellifera* which is most commonly reared in India) has one queen, 40,000 to 100,000 workers and drones are in hundreds (300).
- Pasturage or flora include flowering crops such as mango, coconut, tamarind, litchi, *ber*, *berseem*, *badam*, apple, guava, neem, etc.
- Honey flow period is the total time period during which bee collect nectar and pollen.

A. CLASS ASSIGNMENT

I. True or False Questions

1. Jersey is an Indian breed of cow.
2. Mehsana is a breed of buffaloe.
3. Rinderpset is a parasitic disease.
4. Karan Swiss is produced by crossbreeding between Jersey and Red Sindhi.
5. The process of introducing new plants from the place of their cultivation to a place with different climate is termed as acclimatization.
6. Hybridisation involves crossing of genetically similar plants.
7. Ganga 5 is the variety of rice.
8. K850 is the variety of chicken pea.
9. HD2687 is the variety of wheat.
10. Organic farming is the method of farming where synthetic chemicals are used.
11. Japan is known to have lowest pesticide load on their crop.
12. Awareness to use organic food is very high in developed societies.
13. Nutrients can be provided to crops by fertilizers only.
14. Weed management techniques aim at keeping the land weed free.
15. Sussex is an exotic breed of poultry.
16. Mixed cropping is an insurance against crop failure due to abnormal weather conditions.
17. Aphids are insect pests that attack plant such as mustard.
18. Worm castings in the vermicompost have nutrients that are 97% utilizable by the crop plants.

ANSWERS

True or False Questions

1. False;	2. True;	3. False;	4. False;	5. False;	6. False;
7. True;	8. True;	9. True;	10. False;	11. False;	12. True;
13. False;	14. True;	15. True;	16. True;	17. True.	18. True.

II. Fill in the Blanks

1. *Puccinia* causes ..... disease in wheat.
2. Blast is a ..... disease of paddy.
3. Chemicals used to kill weeds are called ..... .
4. Pesticides are ..... chemicals.
5. ..... are plants that grow in places where they are not wanted.
6. .... is a method of control of pest or weed in which one living organism is used to control another living organisms.
7. Organic materials which are added to soil of crop field to improve its physical conditions are called ..... .
8. The aphid is a pest of ..... plants.
9. ..... and ..... climate is more congenial for infestation of weeds, insect-pests and diseases.
10. Growing two or more crops but in the definite row pattern is known as ..... .
11. The practice of growing of two crops simultaneously on the same piece of land is called ....
12. Long white eggs are produced by..... .
13. ..... is a carp.
14. Aseel is a popular breed of ..... .
15. Kasturi the variety of .....
16. Ganga 5 is the variety of .....
17. Vikas is the variety of .....
18. Organic farming is a method of farming wherein.....chemical is not used in any form.
19. Food grown on organic farming principles is called.....food.
20. Japan is known to have highest.....load on their crop.
21. In organic farming diseases are controlled by..... and.....methods.
22. India has.....major river basins and ..... composite river basins that form the surface water resource.
23. The process of supplying.....to crops in the fields by means of canals, reservoirs, wells, river valley systems and river lift systems is known as ..... .
24. Open wells are not very ..... .
25. ..... wells are very deep.
26. Organic manures include ..... manure, compost, ... manure and vermicompost.
27. Vermicompost is a type of soil made by ..... and microorganisms.
28. Mixed cropping is done to reduce the ..... between component crops for ....., nutrients and water.
29. ..... involves breeding among unrelated animals.
30. ..... is the maintenance of honey bee colonies, commonly in hives, by humans.

ANSWERS

1. Rust; 2. Fungal; 3. Weedicides; 4. Toxic;
5. Weeds; 6. Biological control; 7. Manures ; 8. Mustard ;
9. Humid, warm 10. Intercropping ; 11. Mixed cropping ; 12. White Leghorn;
13. Catla; 14. Fowl; 15. Rice; 16. Maize;
17. Rice; 18. Synthetic; 19. Organic; 20. Pesticide;
21. Cultural, biological; 22. 12, 8; 23. Water, irrigation; 24. Deep;
25. Tube; 26. Farmyard, green; 27. Earthworm; 28. Competition, light;
29. Outbreeding; 30. Beekeeping/Apiculture.

III. Matching Type Questions

1. Single Matching. Match the articles given in column I and column II

Column I	*Column II*
1. C306	(*a*) Maize
2. Navjot	(*b*) Wheat
3. Ganga 5	(*c*) Rice
4. Kasturi	(*d*) Maize
5. Green manure	(*e*) Brown-Swiss
6. Exotic breed	(*f*) Guar
7. Pella	(*g*) Black
8. Yakub	(*h*) Golden red
9. Nurie	(*i*) Black and red
10. Kajal	(*j*) White

2. Double Matching. Match the columns I, II and III.

Column I	*Column II*	*Column II*
1. Oil seeds	(*a*) Red Sindhi	(*i*) Sahiwal
2. Intercropping	(*b*) Mustard	(*ii*) Sunflower
3. Local breeds	(*c*) Vitamin A	(*iii*) Maize
4. Poultry feed	(*d*) Soyabean	(*iv*) Vitamin K

3. Check List or Key Items

In composite fish culture mark the fish as surface feeder (S), middle zone feeder (M) and bottom feeder (B)

Fish	*Feeding*
(*a*) Catla	
(*b*) Common carp	
(*c*) Mrigal	
(*d*) Rohu	

4. Match the stimulus with appropriate response

Seed	*Cereal A*	*Pulse B*	*Oil seed C*
(*i*) Lentil			
(*ii*) Sesame			
(*iii*) Millets			
(*iv*) Black gram			
(*v*) Maize			

ANSWERS

1. **Single Matching**
   1 – (*b*); 2 – (*d*); 3 – (*a*); 4 – (*c*); 5 – (*f*); 6 – (*e*); 7 – (*h*); 8 – (*i*); 9 – (*j*); 10 – (*g*).
2. **Double Matching**
   1 – (*b*) (*ii*); 2 – (*d*) (*iii*); 3 – (*a*) (*i*); 4 – (*c*) (*iv*).
3. **Check List**
   (*a*) S; (*b*) B; (*c*) B; (*d*) M.
4. (*i*) – B; (*ii*) – C; (*iii*) – A; (*iv*) – B; (*v*) – A.

IV. Question — Answer

1. Define crop ?Name the various types of crops. What are Kharif and Rabi crops ?
2. Describe the mechanism of crop variety improvement.
3. How are minerals replenished in the soil of a crop field ?
4. What is organic farming ? What are its advantages?
5. What is irrigation ? Discuss the various methods of irrigation.
6. Describe the various cropping patterns.
7. Write an essay on crop protection management.
8. What all treatments grains are subjected to under prophylatic treatment ?
9. Define animal husbandry. Write about its scope.

10. Write a note on cattle feed.
11. What is artificial insemination ? Give its uses.
12. Write down symptoms of sick animals. Discuss any two diseases of cattle.
13. Name two exotic and two indigenous breeds of cow.
14. Name two indigenous and two exotic breeds of poultry. Write a note on egg production and broiler production.
15. Name the various types of fisheries. Write a note on culture fishery.
16. Write a note on bee keeping.
17. How many centres have been established in India for artificial insemination of cows and buffaloes ?
18. Name the components of cattle feed.
19. How much drinking water is required daily for a cow ?

V. Multiple Choice Questions (MCQs)

1. Increase in oil production is
   (*a*) golden revolution (*b*) yellow revolution
   (*c*) white revolution (*d*) blue revolution
2. The place for keeping and studying dry plants is called :
   (*a*) arboreum (*b*) vasculum
   (*c*) herbarium (*d*) museum
3. 'Organic farming' does not include
   (*a*) green manures (*b*) chemical fertilizers
   (*c*) crop rotation (*d*) compost and farmyard manures
4. Pulses are rich in
   (*a*) carbohydrates (*b*) proteins
   (*c*) oils (*d*) vitamins and minerals
5. The technique used to obtain variety with high yield and other desirable characters is
   (*a*) introduction (*b*) selection
   (*c*) hybridization (*d*) both (a) and (b)
6. Pusa Lerma is an improved variety of
   (*a*) rice (*b*) wheat
   (*c*) maize (*d*) soyabean
7. Growing two or more crops in definite row pattern is
   (*a*) mixed farming (*b*) mixed cropping
   (*c*) inter-cropping (*d*) crop rotation
8. The botanical name of Dhaincha is
   (*a*) *Crotolaria juncea* (*b*) *Lens culinaris*
   (*c*) *Trifolium alexandrium* (*d*) *Sesbania aculeata*
9. The botanical name if Sunn hemp is
   (*a*) *Crotolaria juncea* (*b*) *Lens culinaris*
   (*c*) *Trifolium alexandrium* (*d*) *Sesbania aculeata*
10. The botanical name of lentil is
    (*a*) *Crotolaria juncea* (*b*) *Lens culinaris*
    (*c*) *Trifolium alexandrium* (*d*) *Sesbania aculeata*
11. The botanical name of Egyptian clover is
    (*a*) *Crotolaria juncea* (*b*) *Lens culinaris*
    (*c*) *Trifolium alexandrium* (*d*) *Sesbania aculeata*
12. Which one is a micronutrient for the crop plants ?
    (*a*) calcium (*b*) iron
    (*c*) magnesium (*d*) potassium
13. The common biofertilizers used in organic farming are
    (*a*) margosa (*b*) pyrethrum
    (*c*) green manure
    (*d*) nitrogen fixing bacteria and cyanobacteria
14. Growing different crops in the same field in a preplanned succession is
    (*a*) crop management (*b*) crop rotation
    (*c*) intercropping (*d*) plant breeding
15. Maximum milk yielding buffalo is
    (*a*) nagpuri (*b*) surti
    (*c*) mehsana (*d*) murrah
16. Lactation period is maximum in
    (*a*) Frieswal (*b*) Sahiwal
    (*c*) Holstein-Friesian (*d*) Karan-Swiss
17. Exotic breed of poultry bird having high egg laying capacity is
    (*a*) White leghorn (*b*) Broilers
    (*c*) White cornish (*d*) New Hemisphere
18. The fungus disease causing maximum death of poultry bird is
    (*a*) coryza (*b*) pullorium
    (*c*) rickets (*d*) aspergillosis
19. The method maximum used in cattle breeding is
    (*a*) random mating
    (*b*) artificial insemination
    (*c*) controlled breeding
    (*d*) super ovulation and embryo transfer
20. Which of the following is the high milk yielding variety of cow?
    (*a*) Holstein (*b*) Dorset
    (*c*) Sahiwal (*d*) Red Sindhi
21. Wax glands of honey bee are present in :
    (*a*) queen (*b*) drones
    (*c*) workers (*d*) both (a) and (c)
22. "Drones" in the honeybee colony are born out from:
    (*a*) unfertilized eggs
    (*b*) fertilized eggs and well nourished larvae
    (*c*) same as worker bee
    (*d*) fertilized eggs giving heat treatment
23. Several embryos can be produced at a time in a single cow by the process of
    (*a*) hybridization
    (*b*) artificial insemination
    (*c*) embryo transfer
    (*d*) random mating
24. Rinderpest disease of poultry is caused by
    (*a*) insects (*b*) bacteria
    (*c*) virus (*d*) protozoa

25. The Jersey bull used for cross breeding is exotic variety from
(*a*) England (*b*) Scotland
(*c*) Switzerland (*d*) Holland

26. Layers continue to produce eggs upto
(*a*) 350 days (*b*) 425 days
(*c*) 500 days (*d*) 600 days

27. Alikunhi is famous for development of the technique of
(*a*) hypophysation
(*b*) composite fish culture
(*c*) mariculture
(*d*) shell culture

ANSWERS

1. *b*	2. *c*	3. *b*	4. *b*	5. *c*	6. *b*	7. *c*	8. *d*	9. *a*	10. *b*	11. *c*	12. *b*	13. *d*
14. *d*	15. *d*	16. *c*	17. *a*	18. *d*	19. *b*	20. *a*	21. *c*	22. *a*	23. *c*	24. *c*	25. *a*	26. *c*
27. *a*												

B. CLASS RESPONSE

VI. Oral Questions

1. What is the time of sowing rabi crops ?
2. What is HYV ?
3. From where do plants obtain hydrogen ?
4. Who is father of green revolution in India ?
5. What are macronutrients of the plants ?
6. What are advantages of manure ?
7. Name two ecological problems which are caused by application of synthetic chemicals to crop fields.
8. What are weeds ?
9. Give name of a solid fumigant.
10. What are the signs of infestation of stored grains?
11. Enlist four types of diseases of animals which can also be transmitted to human beings.
12. How many varieties of Aseel are popular among Indians ?
13. What are broilers ?
14. When do the layers start laying eggs ?
15. What is aquaculture ?
16. Give names of six fishes used in composite fish culture in India.

VI. Quiz

1. What is green revolution ?
2. Name three patterns of cropping.
3. Give names of some fodder crops.
4. What is that technique of farming which does not disturb the balance of nature ?
5. Name a high yielding variety of rice.
6. What is the complete fertilizer ?
7. Which one is the best system of irrigation ?
8. Why are leguminous plants often used in crop rotation ?
9. What is biological control ?
10. For proper storage of grains what is the ideal moisture content of grains?
11. What is the name of cow breed having milch females?
12. Give example of cow breed which provides draught animals.
13. What are symptoms of foot and mouth disease of cattle ?
14. What is normal body temperature of cow and buffalo?
15. Name two viral diseases of chickens.
16. Which vitamins occur in abundance in fish liver oil?
17. What is sugar content of honey ?
18. What is nosema disease ?

C. HOME ASSIGNMENT

VIII. Answer the following Qustions

1. Give examples of different rabi and kharif crops
2. Enlist different desired traits of the parents chosen for selective breeding.
3. Name the two external factors that have favourable effect on egg-laying of hens.
4. Mention different aspects of fish culture.
5. Mention the factors affecting stored grains and describe their preventive measures.

D. GROUP DISCUSSION

IX. Organise group discussion on each of the following topics.

1. Various measures to control the insect-pest infection of crops. Discuss also its ecological hazards.
2. Some people have a fixation that products obtained from organic farming should only be consumed. Critically analyse their claim.
3. Need of animal husbandry in a predominantly agricultural based country such as India.

E. SEMINAR / SYMPOSIUM

X. Organise a seminar / symposium on each of the following topics.

1. Should we stop killing the domesticated animals for our food, instead depend solely on a vegetable diet?
2. Poultry - India's most efficient converter of low fibre food stuff into high nutritious animal protein food.

3. India should give equal care to crop production and crop's safe storage.
4. Ecological hazards of Agriculture.

F. GROUP ACTIVITY

XI. Investigatory Projects

1. Collect samples of bees found in different crop fields and try to identify each of them.
2. Collect some crop plants available locally and study whether they are infested with any pathogen. Try to identify some diseases of the crop plants.
3. Collect information related to the production of milk and milk product in nearby dairy farm.

XII. Experimental Projects / Survey

1. Collect information regarding poultry birds of India. You can collect photographs of different breeds of chickens and paste them in your scrapbook or chart.
2. Visit a nearby crop field and collect information regarding techniques of removal of weeds and chemical control of insect pests.
3. Visit a fish farm in fish breeding season and study types of ponds, varieties of fish in the ponds, feed ingredients, production capacity and common problems faced by the fish farm owners.

Open-ended Questions

Q.1. Categories the following under (a) Poultry , (b) Livestock, and (c) Fishery: Turkey, Prawns, Crabs, Cows, Fowls, Buffaloes.

Ans. (a) **Poultry:** Turkey, Fowls
(b) **Livestock:** Cows, Buffaloes
(c) **Fishery:** Prawns, Crabs

Q.2. Which one is nutrient specific—fertilizer or manure?

Ans. Fertilizers are nutrient specific and provide specific nutrient to the soil.

Q.3. Which one of the following crops require a minimum quantity of NPK or urea for its proper growth: paddy, peas, wheat, sugarcane

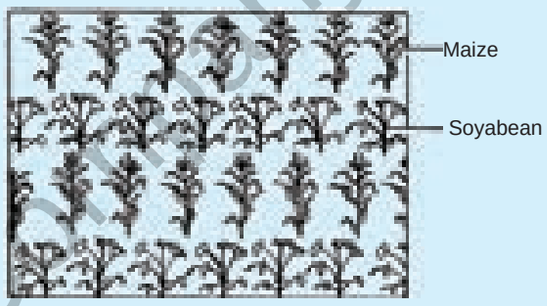
Ans. The crop of peas would require a minimum quantity of NPK or urea because pea is a dicot and its roots contain nitrogen fixing bacteria in root nodules.

Illustration-Based Questions

Q.4. What type of irrigation is showed in the figure

Ans. Drip irrigation.

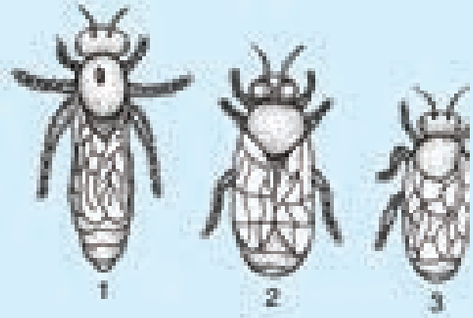
Q.5. A field with maize and soyabean plants is shown here



(a) What pattern of cropping does the field shows?
(b) Mention any two advantages of this type of cropping pattern.

Ans. (a) The field shown intercropping of maize and soyabean crops.
(b) The advantages of intercropping are as follows:
(i) Intercropping increases the productivity of crops per unit area.
(ii) Intercropping helps maintain soil fertility and makes better use of resources.

Q.6. Look at Figures 1, 2 and 3 given along side and answer the following questions:



(a) What do these figures show all together?

(b) Which one is queen bee?
(c) Which one of them is the haploid, fertile male? What is it called?
(d) What is the status of the insect shown in the figure: individual/social?

Ans. (a) These are different castes of honey bee.
(b) Figure 1 shows the queen bee.
(c) Figure 2 is a haploid and fertile male bee. It is called a drone bee
(d) Honey bee is a social insect.

Communication Skill-Based Questions

Q.7. What should be do to get maximum benefit from a crop field?

Ans. To get the maximum benefit from a crop field, we should
(i) maintain the soil fertility through judicious use of manure and fertilizers.
(ii) practise crop rotation.
(iii) employ mixed cropping and intercropping method of agriculture.
(iv) keep the weeds and insect pest population under control.

Q.8. What are biofertilizers? In what sense are they better than chemical fertilizers?

Ans. Some microorganisms such as nitrogen fixing bacteria, cyanobacteria, fungi and other microflora harbour near the roots of plant inside soil. They convert nitrogen of the air into nitrogenous compounds (ammonia and nitrate) which serve as plant nutrients. Since these microorganisms enrich the soil with nutrients and improve soil fertility, hence also collectively known as biofertilisers.

Q.9. The production of food from animal sources has increased greatly in the last few decades. Justify it.

Ans. The ever increasing human population and the resultant decrease in agricultural land has compelled human beings to move towards animal husbandry to obtain food from animal sources. The last few decades have seen enormous rise in animal meat production and byproducts. Poultry, fisheries, piggery, cattle, sheep and goat farming have developed considerably. Through Operation Flood and the Silver Revolution, milk and egg production have registered a record increase.

Q.10. Each beehive consists of thousands of hexagonal thin-walled fragile cells. Name the material which is used to make these cells and mention the significance of the hexagonal shape of the cell.

Ans. Bee hive is made up of wax which is secreted from the wax glands present in the abdomen of worker bees. The hexagonal shape of the cells cover maximum space with minimum use of wax and labour.

Multiple Choice Questions

Type 1. Interpretation Type Questions

1. All animals are
(*a*) parasitic (*b*) saprophytic
(*c*) autotrophic (*d*) heterotrophic

2. Which is the most important source of food and fodder ?
(*a*) algae (*b*) fungi
(*c*) lichen (*d*) cereal

3. Application of nitrogenous manure to a plant causes
(*a*) vigorous vegetative growth
(*b*) early flowering
(*c*) early fruiting
(*d*) growth retardation due to toxicity of NH_3

4. The element which is required in largest quantity by plants is
(*a*) sulphur (*b*) calcium
(*c*) phosphorus (*d*) nitrogen

5. Nodules with nitrogen-fixing bacteria are present in
(*a*) mustard (*b*) wheat
(*c*) gram (*d*) cotton

6. Inland fisheries is referred to
(*a*) culturing fish in freshwater
(*b*) trapping and capturing fishes from sea coast
(*c*) deep sea fisheries
(*d*) extraction of oil from fishes

7. Plants can be made disease-resistant by
(*a*) heat treatment
(*b*) hormone treatment
(*c*) colchicine treatment
(*d*) breeding with their wild relatives

8. The process of cross breeding two different varieties of crop plants each having a desired characteristic, is known as
(*a*) selection (*b*) hybridization
(*c*) crossing (*d*) introduction

9. Milk does not provide
(*a*) vitamin A and D
(*b*) carbohydrates, proteins and fats
(*c*) minerals such as phosphorus and calcium
(*d*) iron

10. Which of the following statement is correct about fertilizer ?
(*a*) it is nutrient specific
(*b*) it is water insoluble
(*c*) it is readily absorbed by the plant
(*d*) it is compact and easy to transfer

11. Which of the following is incorrect for greenmanure ?
(*a*) it supplies organic matter
(*b*) it supplies nitrogen
(*c*) it prevents soil erosion
(*d*) it allows leaching

12. When both crops and livestock are raised on the same farm, it is known as
(*a*) mixed farming
(*b*) mixed cropping
(*c*) intercropping
(*d*) crop rotation

Type 2 : Identity- Relationship Type Questions

1. Living organisms are used in
(*a*) organic manure (*b*) biofertilizers
(*c*) natural insecticides (*d*) pesticides

2. The principal cereal crop of India is
(*a*) wheat (*b*) rice
(*c*) maize (*d*) sorghum

3. Gundhi bug is a pest of
(*a*) sugarcane (*b*) cotton
(*c*) rice (*d*) wheat

4. Sustainable agriculture involves
(*a*) mixed farming (*b*) mixed cropping
(*c*) crop rotation (*d*) all of the above

5. Which of the following have been artificially selected ?
(*a*) cabbage (*b*) cauliflower
(*c*) broccoli (*d*) all of these

6. Kranti, Pusa agarni and pusa bold are improved varieties of
(*a*) urad bean (*b*) sunflower
(*c*) chick pea (*d*) mustard

7. Which of the following is not a draught animal ?
(*a*) camel (*b*) elephant
(*c*) sheep (*d*) horse

8. Which of the following is a leguminous green fodder commonly available in winter ?
(*a*) cow pea (*b*) elephant grass
(*c*) berseem and lucerne (*d*) rice and jowar

9. Which one of the following is micronutrient ?
(*a*) nitrogen (*b*) phosphorus
(*c*) potassium (*d*) boron

10. Which of the following is not an exotic breed of cow ?
(*a*) Jersey (*b*) Holstein-Friesian
(*c*) Sahiwal (*d*) Brown Swiss

11. The first experiment in artificial insemination was performed by
(*a*) Aristotle (*b*) Berzelius
(*c*) Spallanzani (*d*) Linneaus

12. Which of the following yields maximum milk/year ?
(*a*) Holstein-Friesian (*b*) Frieswal
(*c*) Red sindhi (*d*) Sahiwal

13. What is pulse rate of buffalo/minute ?
(*a*) 16-18/minute (*b*) 40-45/minute
(*c*) 40-60/minute (*d*) 70-72/minute

14. Which of the following poultry bird lays maximum number of eggs?
(*a*) ILS-82 (*b*) B-77
(*c*) HH-260 (*d*) IBL-80

15. Which one of the following is the fastest growing carp ?
(*a*) rohu (*b*) catla
(*c*) mrigal (*d*) singhara

16. Which of the following is gaseous fumigant ?
(*a*) DDT
(*b*) aluminium phosphide
(*c*) ethylene dichloride
(*d*) methyl bromide

17. Which of the following is natural insecticides?
(*a*) nicotene (*b*) neem
(*c*) pyrethrum (*d*) all of these

18. Which of the following is broad leaf weed ?
(*a*) *Chenopodium* (*b*) *Convalvulus*
(*c*) *Amaranthus* (*d*) all of the above

Type 3. NCERT Question Bank

1. Find out the wrong statement from the following :
(*a*) white revolution is meant for increase in milk production
(*b*) blue revolution is meant for increase in fish production
(*c*) increasing food production without compromising with environment quality is called as sustainable agriculture
(*d*) none of the above

2. To solve the food problem of country, which among the following necessary ?
(*a*) increased production and storage of food grains
(*b*) easy access of people to the food grain
(*c*) people should have money to purchase the grains
(*d*) all the above

3. Which one is an oil yielding plant among the following ?
(*a*) lentil (*b*) sunflower
(*c*) cauliflower (*d*) *Hibiscus*

4. Which one is not a source of carbohydrate ?
(*a*) rice (*b*) millets
(*c*) sorghum (*d*) gram

5. Weeds affect the crop plants by
(*a*) killing of plants in field before they grow
(*b*) dominating the plants to grow
(*c*) competing for various resources of crops (plants) causing low availability of nutrients
(*d*) all the above

6. Find out the correct sentence
(*i*) hybridisation means crossing between genetically dissimilar plants
(*ii*) cross between two varieties is called as inter-specific hybridisation
(*iii*) introducing genes of desired characters into a plant gives genetically modified crop

(*iv*) cross between plants of two species is called as inter varietal hybridisation

(*a*) (*i*) and (*iii*) (*b*) (*ii*) and (*iv*)
(*c*) (*ii*) and (*iii*) (*d*) (*iii*) and (*iv*)

7. Which one of the following species of honey bee is an Italian species ?

(*a*) *Apis mellifera* (*b*) *Apis dorsata*
(*c*) *Apis florae* (*d*) *Apis cerana indica*

8. Find out the correct sentence about manure

(*i*) manure contains large quantities of organic matter and small quantities of nutrients
(*ii*) it increases the water holding capacity of sandy soil
(*iii*) it helps in draining out of excess of water from clayey soil.
(*iv*) its excessive use pollutes environment because it is made of animal excretory waste

(*a*) (*i*) and (*iii*) (*b*) (*i*) and (*iii*)
(*c*) (*ii*) and (*iii*) (*d*) (*iii*) and (*iv*)

9. Cattle husbandry is done for the following purpose

(*i*) milk production (*ii*) agricultural work
(*iii*) meat production (*iv*) egg production
(*a*) (*i*), (*ii*) and (*iii*) (*b*) (*ii*), (*iii*) and (*iv*)
(*c*) (*iii*) and (*iv*) (*d*) (*i*) and (*iv*)

10. Which of the following are Indian cattle ?

(*i*) *Bos indicus* (*ii*) *Bos domestica*
(*iii*) *Bos bubalis* (*iv*) *Bos vulgaris*

(*a*) (*i*) and (*iii*) (*b*) (*i*) and (*ii*)
(*c*) (*ii*) and (*iii*) (*d*) (*iii*) and (*iv*)

11. Poultry farming is undertaken to raise following

(*i*) egg production (*ii*) feather production
(*iii*) chicken meat (*iv*) milk production
(*a*) (*i*) and (*ii*) (*b*) (*i*) and (*iii*)
(*c*) (*ii*) and (*iii*) (*d*) (*iii*) and (*iv*)

12. Poultry fowl are susceptible to the following pathogens

(*a*) viruses (*b*) bacteria
(*c*) fungi (*d*) all the above

13. Which one of the following fishes is a surface feeder ?

(*a*) rohus (*b*) mrigals
(*c*) common carps (*d*) catlas

14. Animal husbandry is the scientific management of

(*i*) animal breeding (*ii*) culture of animals
(*iii*) animal livestock (*iv*) rearing of animals
(*a*) (*i*), (*ii*) and (*iii*) (*b*) (*ii*), (*iii*) and (*iv*)
(*c*) (*i*), (*ii*) and (*iv*) (*d*) (*i*), (*iii*) and (*iv*)

15. Which one of the following nutrients is not available in fertilizers ?

(*a*) nitrogen (*b*) phosphorus
(*c*) iron (*d*) potassium

16. Preventive and control measures adopted for storage of grains include

(*a*) strict cleaning (*b*) proper disjoining
(*c*) fumigation (*d*) all the above

ANSWERS

Type 1 MCQs

1. (*d*); 2. (*d*); 3. (*a*); 4. (*d*); 5. (*c*); 6. (*a*)
7. (*d*); 8. (*b*); 9. (*d*); 10. (*b*); 11. (*d*); 12. (*a*)

Type 2 MCQs

1. (*b*); 2. (*b*); 3. (*c*); 4. (*d*); 5. (*d*); 6. (*d*)
7. (*c*); 8. (*c*); 9. (*d*); 10. (*c*); 11. (*c*); 12. (*a*)
13. (*b*); 14. (*c*); 15. (*b*); 16. (*d*); 17. (*d*); 18. (*d*)

Type 3 MCQs

1. (*d*); 2. (*d*); 3. (*b*); 4. (*d*); 5. (*c*); 6. (*a*)
7. (*a*); 8. (*a*); 9. (*a*); 10. (*a*); 11. (*b*); 12. (*d*)
13. (*d*); 14. (*d*); 15. (*c*); 16. (*d*)

NCERT TEXTBOOK QUESTIONS AND EXERCISES WITH ANSWERS

NCERT Questions

Q.1. What do we get from cereals, pulses, fruits and vegetables?

Ans. The cereals (*i.e.,* wheat, rice, maize, millets and sorghum) provide us carbohydrates. The pulses (*i.e.,* gram, pea, black gram, green gram, pigeon pea, lentil, etc.) give us protein. Fruits and vegetables give us carbohydrates, proteins, fat, vitamins, minerals, and lots of fibers.

Q.2. How do biotic and abiotic factors affect crop production?

Ans. Crop production can go down due to *biotic (diseases* due to infection by viruses or fungi, insects and nematodes) and *abiotic* (drought, salinity, water logging, heat, cold and frost) *stresses* under different situations.

Q.3. What are the desirable agronomic characteristics for crop improvement?

Ans. If we develop those varieties of crops which contain desired agronomic traits (*e.g.,*high yield, dwarfness, early maturing, etc.) then it will help in setting higher production. Thus, tallness and profuse branching are desirable characters for fodder crops. Dwarfness is desired in cereals, so that less nutrients are consumed by these crops. Dwarf varieties of cereals also provide protection from lodging.

Q.4. What are the macronutrients and why are they called macronutrients?

Ans. The macronutrients are nitrogen, phosphorus, potassium, calcium, magnesium and sulphur. They are called macronutrients because they are required by crop plants in large amounts.

Q.5. How do plants get nutrients?

Ans. There are *three* different sources from where a plant gets the 16 essential nutrients: air, water and soil (see Table 1.2). The nutrients taken from air and water are carbon, oxygen and hydrogen and these are taken by stomata (of leaf), lenticel (of stem) and root-hairs (of roots). Rest 13 nutrients are obtained from soil. These 13 nutrients remain dissolved in water in the soil and are absorbed by the plant roots.

Q.6. Compare the use of manure and fertilizers in maintaining soil fertility.

Ans. Manure contains many organic substances of biological origin which can be easily degraded and absorbed by plants. It helps in recycling of biological waste. Manures increase the fertility of soil for long duration without causing any harm. However, the chemical fertilizers (*e.g.,* urea) improve soil fertility for short duration but cause environmental hazard. Continuous use of fertilizers in a particular area/crop field causes destruction of soil fertility.

Q.7. Which of the following conditions will give most benefits? Why?
(*a*) Farmers use high quality seeds, do not adopt irrigation or use fertilizers.
(*b*) Farmers use ordinary seeds, adopt irrigation or use fertilizers.
(*c*) Farmers use quality seeds, adopt irrigation, use fertilizers and use crop protection measures?

Ans. The conditions of (*c*) will give the most benefits because all these conditions are required for good crop production. High quality seeds germinate properly and grow to healthy plants. Irrigation helps crop plants to fight against draught stress. Fertilizers provide desired nutrients and crop protection measures (*e.g.,* use of pesticides, etc.) protect the crop plants from diseases, weeds and pests.

Q.8. Why should preventive measures and biological control methods be preferred for protecting crops?

Ans. Preventive measures (such as use of resistant varieties of crops) and biological control methods should be preferred for protection of crops because they are ecologically safe, target specific and harmless to other life forms.

Q.9. What factors may be responsible for losses of grains during storage?

Ans. There are *two* main factors responsible for lose during storage. **A. Biotic factors** include:

1. Insects, *e.g.,* grubs of pulse beetle; grubs and adults of rice weevil; wheat weevil; catterpillar of grain and flour moth; larvae and adult of rust red flour beetle; larvae of rice moth and grubs and adults of lesser grain borer.
2. Rodents, *e.g.,* striped squirrel, house rat, house mouse, lesser bandicoot rat, etc.
3. Birds, *e.g.,* parakeet, sparrow, bulbul, blue rock pigeon, crow, etc.
4. Mites; 5. Fungi; and 6. Bacteria.

B. Abiotic factors. They include moisture, temperature and other non-living environmental factors.

Q.10. Which method is commonly used for improving cattle breeds and why?

Ans. The milk production of cattle can be increased by the technique of selective breeding. This is done by cross breeding between a local breed (indigenous breed, *e.g.,* Red Sindhi, Sahiwal) cow and an exotic (foreign breed, *e.g.,* Brown Swiss) bull. The local cow is selected for the character of disease resistance. The exotic breed of bull is selected for the character of prolonged period of lactation and high yield of milk. The breeding may be done by natural methods or by artificial insemination (*i.e.,* injecting the semen obtained from the desired bull into reproductive tract (vagina) of the cow during fertility period). The desired characters are thus obtained in the next generation.

Q.11. Discuss the implication of the following statement:
" It is interesting to note that poultry is India's most efficient converter of low fiber food stuff (which is unfit for human consumption) into highly nutritious animal protein food".

Ans. Poultry birds utilise such agricultural products which are unfit for human consumption. In return, they give us eggs and high quality meat which serve as a cheap source of animal protein.

Q.12. What management practice are common in dairy and poultry farming?

Ans. In both dairy and poultry farming, there are: (*i*) Maintenance of temperature; (*ii*) Proper housing facilities having hygienic conditions; (*iii*) Proper feeding ; and (*iv*) Prevention and control of diseases and pests.

Q.13. What are the differences between broilers and layer and in their management?

Ans. See Table 1.13.

Q.14. How are fish obtained?

Ans. There are two methods of obtaining fish. One method is **capture fishing** in which the fish are obtained from natural resources such as fresh water resources (*i.e.,* canals, pools, reservoirs and rivers), brackish water

resources (*i.e.,* estuaries and lagoons) and marine fishery resources (*i.e.,* coastline and deep seas). The other method is by **fish farming** (or **culture farming),** which is concerned with culturing, feeding, breeding and fish production. Fish farming is based on **aquaculture** which pertains to production of useful aquatic plants and animals such as fishes, prawns, crayfish, lobsters, crabs, shrimps, mussels, oysters and seaweeds by proper utilisation of available waters in the country. Aquaculture includes mariculture and freshwater culture fisheries.

Q.15. What are the advantages of composite fish culture?

Ans. Composite fish culture is also called **polyculture of fishes.** It is advantageous, economical and profitable from business point of view. It yields about 8-9 times more production as compared to **monoculture.** In composite fish culture, 5 or 6 speciess of fast growing fish are cultured in single fish pond which do not compete with each other for space and nutrition. They live in distinct zones inside the pond and have distinct feeding habits. For example, a highly yielding Indian fish pond may contain following six species of fishes : 1. Silver carp which is a surface feeder and feeds on phytoplankton; 2. Catla which is also a surface feeder but it feeds on zooplankton; 3. Rohu which is column feeder and it feeds on detritus; 4. Grass carp which feeds on aquatic plants (including weeds); 5. Mrigal which is a bottom feeder and it feeds on detritus; and 6. Common carp which is omnivorous bottom feeder.

Q.16. What are the desirable characters of bee varieties suitable for honey production?

Ans. The desirable characters of bee varieties suitable for honey production are : 1. They sting less. 2. They stay for longer periods in a given bee hive. 3. They breed well. 4. They produce comparatively more honey and wax.

Q.17. What is pasturage and how is it related to honey production?

Ans. Pasturage is the availability of flowers for nectar and pollen collection for the honeybee. The quality and taste of the honey is determined by the kind and quantity of pasturage.

NCERT Exercises

Q.1. Explain any one method of crop production which ensures high yields.

Ans. Refer the heading Nutrient Management.

Q.2. Why are manures and fertilizers used in fields?

Ans. Manure and fertilizers are added to the soil of crop field to increase the fertility of soil and productivity of crop. They overcome the deficiency of nutrients in the soil of the field.

Q.3. What are the advantage of inter-cropping and crop-rotation?

Ans. Refer the heading 'Cropping Patterns'.

Q.4. What is genetic manipulation? How is it useful in agriculture practices?

Ans. Refer the heading 'Crop variety Improvement'.

Q.5. How do storage grain losses occur?

Ans. Refer the heading 'Storage of Grain'.

Q.6. How do good animal husbandry practices benefit farmers?

Ans. Refer text of Animal Husbandry.

Q.7. What are the benefits of cattle farming?

Ans. Refer Section 1.3. Animal Husbandry.

Q.8. For increasing production. What is common in poultry, fisheries and bee-keeping ?

Ans. Variety improvement, housing, rearing, sanitation, disease control and marketing.

Q.9. How do you differentiate between capture fishing, mariculture and aquaculture ?

Ans. In following table a comparison has been made between capture fishing, mariculture and aquaculture.

Capture fishing	*Mariculture*	*Aquaculture*
In capture fishing, the fish catching is done from various natural resources, lakes, rivers, oceans, seas, etc.	In mariculture, culture of marine fishes is done in the coastal water. The desired marine fishes and and other animals are cultivated and obtained.	In aquaculture, culturing of fish is done using any water body which may contain salt water or fresh water. Mariculture is a type of aquaculture.

Questions Based on NCERT Question Bank (Exemplar Problems in Science)

Q.1. Fill in the blanks

(*a*) ..... are rich in vitamins.
(*b*) The crops which are grown in rainy season are called ..... crops.
(*c*) ..... crop grows in winter season.
(*d*) Pigeon pea is a good source of .....

(*e*) Berseem is an important ..... crop.

Ans. (*a*) Vegetables; (*b*) Kharif; (*c*) Rabi; (*d*) Protein; (*e*) Fodder.

Q.2. Match the items of column A with those of column B.

Column A	*Column B*
(*a*) Fish farming	(*i*) Bottom feeder
(*b*) Catla	(*ii*) Culture fishery
(*c*) Rohu	(*iii*) Surface feeder
(*d*) Mrigal	(*iv*) Middle zone feeder

Ans. *a – ii*; *b – iii*; *c – iv*; *d – i*.

Q.3. What is GM crop? Name any one crop which is grown in India.

Ans. GM or genetically modified crop is the one which has been developed through introduction of some specific genes from other sources, *e.g.*, insect resistant Bt cotton (being grown in India), vitamin A rich Golden rice.

Q.4. List out some useful traits in improved crop ?

Ans. (*i*) Higher yield; (*ii*) Improved quality; (*iii*) Resistance to biotic and abiotic stresses; (*iv*) Change in maturity; (*v*) Wider adaptability; (*vi*) Desirable agronomic trait.

Q.5. Why is organic matter important for crop production ?

Ans. Organic matter forms **humus.** It is essential for crop production because it makes the soil fertile. Organic matter has the following advantages:

(*i*) It improves soil structure by forming soil crumbs.
(*ii*) It increases water holding capacity of sandy soils.
(*iii*) It improves aeration of clayey soils.
(*iv*) During its decomposition, it liberates minerals (inorganic molecules) which enrich the soil.
(*v*) Biochemicals present in decaying organic matter improve growth of crop plants.

Q.6. Why is use of excess fertilizer deterimental for environment ?

Ans. Use of excess fertilizers tend to cause :

(*i*) Mineral loading of underground water.
(*ii*) Excess minerals in the crop plants.
(*iii*) Salinization of soil.
(*iv*) Run off from fertilizers rich soil, will cause eutrophication of water bodies.

Q.7. Give one word for the following :

(*a*) Farming without the use of chemicals as fertilizers, herbicides and pesticides is known as .....
(*b*) Growing of wheat and groundnut on the same field in called .....
(*c*) Planting of soyabean and maize in alternate rows in the same field is called .....
(*d*) Growing different crops on a place on a piece of land in preplanned succession is known as.
(*e*) *Xanthium* and *Parthenium* are commonly known as .....
(*f*) Causal organism of any disease is called as .....

Ans. (*a*) Organic farming ; (*b*) Mixed cropping ; (*c*) Inter-cropping ; (*d*) Crop rotation ; (*e*) Weeds ; (*f*) Pathogen.

Q.8. Match column A and column B

Column A	*Column B*
(a) Milch	(*i*) Milk producing female
(*b*) Sahiwal, Red Sindhi	(*ii*) Broiler
(*c*) Cattle used for tilling and carting	(*iii*) Draught animals
(*d*) Indian breed of chicken	(*iv*) Local breed of cattle
(*e*) Chicken better fed for obtaining meat	(*v*) Aseel

Ans. *a – i*; *b – iv*; *c – iii*; *d – v*; *e – ii*.

Q.9. If there is low rainfall in a village throughout the year, what measures will you suggest to the farmers for better cropping.

Ans. (*i*) Reduce tilling; (*ii*) Enrich soil with humus which increases its water holding capacity; (*iii*) Use of drought resistant and early maturing varieties of crop.

Q.10. Group the following and tabulate them as energy yielding, protein yielding, oil yielding and fodder crop: Wheat, Rice, Berseem, Maize, Gram, Oat, Pigeon gram, Sudan grass, Lentil, Soybean, Groundnut, Castor and Mustard.

Ans. (*i*) Energy yielding crop : Wheat, Rice, Maize, Oat.

(*ii*) Protein yielding crop : Gram, Pigeon gram, Lentil, Sudan grass.
(*iii*) Oil yielding crop : Groundnut, Castor, Mustard, Soybean.
(*iv*) Fodder crop : Berseem, Oat, Sudan grass.

Q.11. Define the terms hybridization and photoperiod.

Ans. **Hybridisation.** It is crossing of two (or more) types of individuals with different useful traits in order to bring them together in the progeny.
Photoperiod. It is duration of day light that influences plants and other organisms in their growth, reproduction and maturation.

Q.12. Fill in the blanks :

(*a*) Photoperiod affect the ..... .
(*b*) Kharif crops are cultivated from ..... to ..... .
(*c*) Rabi crops are cultivated from ..... to ..... .
(*d*) Paddy, Maize, Green Gram and Black gram are .... crops.
(*e*) Wheat, Gram, Pea and Mustard are ..... crops.

Ans. (*a*) Flowering (of plants) ; (*b*) June, October ; (c) November, April ; (*d*) Kharif ; (*e*) Rabi.

Q.13. Cultivation practices and crop yield are related to environmental conditions. Explain.

Ans. All crops do not grow under similar conditions. Some require high temperature, some low temperature, longer duration of sunlight, shorter duration of sunlight, more humidity , low humidity, moderate humidity, loam soil, sandy soil, etc. Apple cannot be grown in plains because it requires several days of low temperature. In plains, there are two major seasons of crop plants : kharif (rainy season) and rabi (winter season).

Q.14. Fill in the blanks :

(*a*) A total of ..... nutrients are essential to plants.
(*b*) ..... and ..... are supplied by air to plants.
(*c*) ..... is supplied by water to plants.
(*d*) Soil supplies ..... nutrients to plants.
(*e*) ..... nutrients are required in large quantity and called as ..... .
(*f*) ..... nutrients are needed in small quantity for plants and are called ..... .

Ans. (*a*) 16 ; (*b*) carbon, oxygen ; (*c*) Hydrogen ; (*d*) 13 ; (*e*) Six, macronutrients, (*f*) Seven, micronutrients.

Q.15. Differentiate between compost and vermicompost.

Ans.

Compost	*Vermicompost*
1. It is prepared from all types of organic remains-garbage, sewage, sludge, animal refuse, farm waste, straw, uprooted weeds, etc.	1. It is prepared from domestic waste, vegetable waste, uprooted weeds and farm refuse.
2. Organic remains are decomposed by released enzymes of the microorganisms.	2. Organic remains are fed by earthworms and in pulverized state.
3. It takes 3 to 6 months to prepare.	3. It takes 1 to 2 months to prepare.

Q.16. Arrange these statements in correct sequence of preparation of green manure :
(*a*) Green plants are decomposed in soil
(*b*) Green plants are cultivated for preparing manure or crop plants are used.
(*c*) plants are ploughed and mixed in soil
(*d*) After decomposition, it becomes green manure.

Ans. (*b*) → (*c*) → (*a*) → (*d*).

Q.17. An Italian variety Apis mellifera has been introduced in India for honey production. Write about its merits over other varieties.

Ans. See text.

Q.18. In agriculture practices, higher input gives higher yield. Discuss how ?

Ans. In agriculture, higher yield can be obtained only by applying higher yielding varieties, improved farming practices, modern technology, latest agricultural machines and implements, nutrient supply, etc. All these require high cost and knowledge of new techniques and improvements. Therefore, a farmer's purchasing capacity for inputs determines the cropping system and production exercises.

Q.19. Discuss the role of hybridisation in crop improvement.

Ans. See text.

Q.20. Define (i) Vermicompost ; (ii) Green Manure ; (iii) Biofertilizers.

Ans. ***(i)*** **Vermicompost.** It is a manure rich pulverised organic matter and worm castings. Vermicompost is formed by the activity of earth worms on organic remains.

(ii) **Green Manure.** See text. ***(iii)*** **Biofertilizers.** See text.

Q.21. Discuss various methods of weed control.

Ans. See text.

Q.22. Differentiate between the following.

(*i*) Mixed cropping and inter cropping.

(*ii*) Capture fishery and culture fishery.

(*iii*) Bee keeping and poultry farming.

Ans. (*i*) Differences between Mixed cropping and Inter cropping. See text.

(*ii*) Differences between Capture fishery and Culture fishery. See text.

(*iii*) Difference between Bee keeping and Poultry farming.

Bee keeping	*Poultry farming*
1. It is the practice of rearing, care and management of honey bees.	1. It is the practice of raising domestic fowl.
2. It provides honey, bee wax and related products.	2. It provides egg and meat.
3. Bees obtain their food from flowers.	3. Poultry birds are provided with feed by their reaers.

Q.23. Give merits and demerits of fish culture.

Ans. **Merits.** 1. Economically important desired fishes are made available.
2. A large number of fishes are raised in a small area.
3. Fishes are made to breed in different seasons.
4. There is a little mortality in the younger stages of the fishes.
5. Through selective hybridisation, yield and quality of fishes are improved.

Demerits. 1. Only some selected high yielding and economically important breeds are reared.
2. Fish culture is a threat to biodiversity, since other forms of aquatic organisms are being ignored. Even natural waters are being seeded with economically important fishes ; this too is affecting the natural biodiversity of the water bodies.

Q.24. What do you understand by composite fish culture ?

Ans. See text.

Q.25. Why bee keeping should be done in good pasturage ?

Ans. See text.

Q.26. Write the modes by which insects affect the crop yield.

Ans. See text.

Q.27. Discuss why the pesticides are used in very accurate concentration and at very appropriate time.

Ans. Pesticides are very toxic substances, they should not be used indiscriminately. Only very accurate dose should be applied at appropriate time. Even slight excess of the pesticides is extremely harmful.

(*i*) Pesticides are harmful to soil biota. Therefore, they reduce soil fertility.

(*ii*) They pass into ground water and make it toxic.

(*iii*) They enter the crop plants and make their products (leaves, stem, flowers, fruits and seeds) toxic.

(*iv*) Pesticides pass into surface water through run off form sprayed fields and harm the aquatic biota.

Q.28. Name two types of animal feed and write their functions.

Ans. See text.

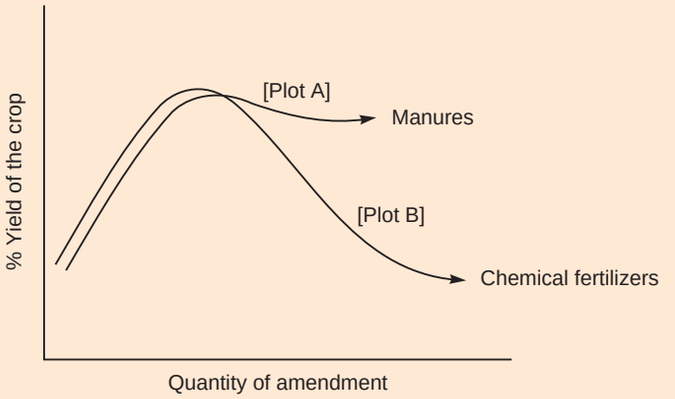
Q.29. What would happen if poultry birds are larger in size and have no summer adaptation capacity ? In order to get small sized poultry birds having summer adaptability, what methods will be employed ?

Ans. Larger sized birds require more feed. Summer adaptation is connected with egg laying. Little summer adaptation reduces egg laying. In order to get small sized poultry birds having summer adaptability, it is desirable to (*i*) Either introduce the required exotic birds from outside and (*ii*) Cross breed the local birds with exotic birds from outside. Small sized poultry birds are preferred for (*a*) Lower requirement of feed ; (*b*) Higher egg laying capacity ; (*c*) Lower requirement for space.

Q.30. Suggest some preventive measures of the diseases of poultry birds.

Ans. See text.

Q.31. The figure shows two crop fields (plots A and B) have been treated by manures and chemical fertilizers, respectively, keeping other environmental factors same. Observe the graph and answer the following questions:



(*i*) Why does plot B shows sudden increase and then gradual decrease in yield ?

(*ii*) Why is the highest peak in plot A graph slightly delayed?

(*iii*) What is the reason for the different pattern of the two graphs.

Ans. (*i*) **Sudden increase.** Chemical fertilizer supplies the minerals immediately in good quantity.

Gradual decrease. It is due to depletion of nutrients caused by absorption by plants, leaching to lower layer of the soil and killing of decomposer microorganisms.

(*ii*) Manures decompose slowly so that release of minerals is also delayed. Manures take time to mix up with the soil and form crumbs, that increase water holding and aeration of the soil.

(iii) The difference in the two graphs indicates that manuring the soil of crop fields is more beneficial than the use of chemical fertilizers. Rather, use of chemical fertilizers is harmful in the longer run.

QUESTIONS OF CBSE SAMPLE PAPER

Q.1. Give one example of an Indian and foreign poultry breed which when crossed produce an improved variety. List any one desirable trait expected from such cross breeding. (2 marks : 2010)

Ans. Indian poultry breed — Aseel

Foreign poultry breed — Loghorn.

Desirable trait after cross breeding — Better quantity and quality of eggs and meat with good tolerance of local conditions.

Q.2. (a) What are the two ways of obtaining fish ?

(b) What is the major problem faced in fish farming ? How can it be overcome. (2 marks : 2010)

Ans. (a) The two ways of obtaining fish are

(i) **Capture fishery.** Fish is caught from natural waters both marine as well as inland (freshwater bodies).

(ii) **Culture fishery.** Fish is grown in water bodies through human efforts. The mature fish is harvested.

(b) **Major problem of fishery (or fish farming).** It is procurement of pure seeds of high quality fish. This problem has been solved through hypophysation or hormonal treatment of selected fishes in breeding hapas.

Q.3. (a) Discuss two ways of incorporating desirable characteristics into crop varieties.

(b) What is inter-cropping? How are crops selected for inter-cropping? (3 marks; 2010)

Ans. Desirable characteristics can be incorporated in a crop variety by two methods:

(i) **Hybridization.** This is a genetical technique. This method involves crossing of the selected plants having one or more of the desirable characteristics (ii) **Genetic engineering.** Introduction of desirable characteristics with the help of techniques available in biotechnology.

(b) **Intercropping.** It is growing of two or more crops simultaneously in the same field but in different row patterns.

Crops are selected for intercropping on the basis of different nutrient requirement and different sowing and reaping (harvesting) times, *e.g.*, soybean and maize.

Q.4. Aditya added 1-2 drops of iodine to three test tubes A, B and C, containing 2 ml of food samples. A dark blue-black colour appeared in test tubes A and B. The correct order of food samples taken in test tubes A, B and C is : (1 mark , 2010)

(a) rice, dal, potato (b) rice, potato, dal (c) potato, dal, rice (d) dal, rice, potato

Ans. (b)

Q.5. The following statements, describe the steps to detect the presence of metanil yellow in dal. One of the four statements given below is incorrect. (1 mark , 2010)

(a) take 2 ml of food extract

(b) grind 3-5 g of dal and prepare solution

(c) add 2-3 drops of concentrated H_2SO_4

(d) fitter the contents and collect the filter

Ans. (c).

PAPER-PEN TEST

Time 30 minutes **Maximum marks 17**

MCQ 1. Bee keeping is known as

(*a*) pearl culture (*b*) pisculture (*c*) sericulture (*d*) apiculture 1

Blanks 2. Ganga 5 is the variety of ----------. 1

T/F 3. Concentrates are low in fibres but rich in proteins and other nutrients. 1

Matching 4. Match the items of column I and II

Column I	*Column II*
1. Green manure	(*a*) Carp
2. Micronutrient	(*b*) Rice
3. Catla	(*c*) Iron
4. Kasturi	(*d*) Cluster bean(guar)

2

HOTS 5. Write down the composition of a fresh water composite fish culture. How is competition avoided between fishes ? 2

S.A.I 6. Compare layers and broilers. 2

S.A.II 7. What are weeds ? How do they affect crop plants ? Describe biological control of weeds 3

L.A 8. Describe fertilizers and compare them with biofertilizers and composts. 5

REVISION QUESTIONS

Very Short Answer Questions (Carrying 1 mark each)

1. What is green revolution ?

Ans. The enormous increase in the production of food grain (especially wheat) during the last three decades, due to use of seeds of HYV (= High Yielding Varieties), higher dose of fertilizers and pesticides, and irrigation is known as **green revolution.**

2. Mention the crop whose production has increased by blue revolution and yellow revolution.

Ans. Fish and oil production.

3. Give one example each of kharif and rabi crops.

Ans. Rice and what, respectively.

4. What are plant nutrients ?

Ans. Plant nutrients are inorganic raw materials that are absorbed from soil (water and air) by the plants for building up organic matter.

5. Name the three most important mineral elements required for plant growth.

Ans. Nitrogen, Phosphorus and Potassium.

6. Name any two micronutrients, required by plants.

Ans. Manganese and Zinc.

7. Name any two macronutrients required by plants.

Ans. Carbon and Sulphur.

8. What name has been given to the elements required by plants in (*a*) smaller amount, (*b*) larger amount.

Ans. (*a*) Micronutrients; (*b*) Macronutrients.

9. State whether iron is a micronutrient with respect to plants.

Ans. Iron is a micronutrient of plants.

10. What is manure ?

Ans. Manure is partially decomposed organic matter formed from animal wastes (such as dung of cattle) and crop residue that is added to soil for increase in fertility.

11. Why are manures used in bulk to increase soil fertility ?

Ans. Since the manures contain nutrients in small quantities they have to be used in bulk.

12. Name two potassic fertilizers.

Ans. Potassium sulphate and potassium chloride.

13. Name the nitrogenous fertilizers.

Ans. Urea and ammonium nitrate.

14. Why even excessive application of manure does not cause pollution ?

Ans. Manures are biodegradable, so they do not cause harm to soil.

15. Name one inorganic nitrogenous fertilizer.

Ans. Ammonium sulphate.

16. Which one is nutrient specific, fertilizer or manure ?

Ans. Fertilizer.

17. What will happen, when we use sodium nitrate excessively in the soil ?

Ans. Soil becomes alkaline.

18. Define green manure. Give one example.

Ans. A quick growing crop which is cultivated and ploughed under, to incorporate it into the soil for the purpose of improving its physical structure and fertility, is known as green manure. For example, sunn hemp (sanai)- *Crotalaria juncea.*

19. Give one disadvantage of fertilizers.

Ans. Fertilizers cause water and soil pollution.

20. Name the substance which has been traditionally used as manure in our country.

Ans. Dung of cattle (cow and buffalo).

21. Define irrigation.

Ans. The process of providing water to crop plants in the fields through human efforts by means of canals, wells, reservoirs, etc., is known as irrigation.

22. Name one crop which can tolerate water logging in the fields and one which cannot.

Ans. Paddy crop can tolerate water logging but wheat crop cannot.

23. At what time is irrigation required by all crops?

Ans. At the time of germination of seeds, irrigation is required by all crops.

24. What is water logging ?

Ans. The excessive accumulation of water in the soil that drives away air is called water logging.

25. Name two factors on which irrigation requirements of crop depends.

Ans. Nature of crop and nature of soil.

26. What happens when a matured wheat crop is irrigated ?

Ans. If matured wheat crop is irrigated, lodging will take place.

27. Mention two functions of multipurpose dams.

Ans. To control flood and generate hydroelectric power.

28. What percent of cropped area of India is still unirrigated ?

Ans. 45%.

29. Give one example of mixed cropping.

Ans. Groundnut and Sunflower are grown together in mixed cropping.

30. Mention one criterion for selection of mixed crops.

Ans. Root pattern of both of the crops.

31. Mention one advantage of mixed cropping.

Ans. No risk of crop failure.

32. Define intercropping.

Ans. Growing two or more crops simultaneously in a same field in definite row pattern is called **intercropping**.

33. Mention one advantage of intercropping.

Ans. Farmer can apply fertilizers and pesticides as per need of the crop.

34. A farmer grows gram crop between two cereal crops. What agricultural practice is being followed ?

Ans. Crop rotation.

35. Define crop rotation.

Ans. An agricultural practice in which different types of crops are grown alternately in the same field in a pre-planned succession is called **crop rotation**.

36. Name the bacteria found in root nodules of leguminous plants.

Ans. *Rhizobium*.

37. Mention one advantage of crop rotation.

Ans. It helps in the control of weeds, pests and diseases of crop plants.

38. Give one example of two year crop rotation.

Ans. Maize-Potato-Sugarcane-Pea.

39. Define selection.

Ans. The sorting out of best individual plant or groups of plants from mixed population is known as **selection**.

40. Name the oldest method of crop improvement.

Ans. Introduction.

41. Name the improved varieties of the following crops: (*a*) pigeon pea ; (*b*) wheat

Ans. (a) Manak **;** (b) PBW 154.

42. In which form the new crops are introduced ?

Ans. The new crops are introduced in the form of seeds, bulbs or cutting.

43. What is plant breeding ?

Ans. The plant breeding means production of new varieties or strains by a programme of artificial selection spanning several generations of the organism concerned.

44. What is pest ?

Ans. Organism which damages cultivated plants or plant products or make them unfit for human consumption is known as **pest.**

45. Define pesticide.

Ans. The chemical which is used to eliminate (kill) pests is called **pesticide.**

46. Give one word for the following: A toxic substance effective against insects.

Ans. Insecticide.

47. Name one insecticide.

Ans. Chlorophyriphos.

48. Name the crop plant which is affected by red rot.

Ans. Sugarcane.

49. Name the common disease of wheat plant.

Ans. Rust.

50. Give example of an insect pest of rice.

Ans. Gundhy bug.

51. Name the following: (*a*) seed borne disease; (*b*) air borne disease.

Ans. (*a*) Red rot of sugarcane; (*b*) Rust of wheat.

52. Name one common disease of paddy.

Ans. Blast.

53. Give an example of biological weed control.

Ans. Cochineal insects are used to eradicate the weed called *Opuntia.*

54. Give one example of natural insecticide.

Ans. Leaves of Margosa (Neem).

55. Define the weed.

Ans. The unwanted plants which grow along with a cultivated crop are called **weeds.**

56. What percent of food grains produced in our country is lost every year ?

Ans. 9.3%.

57. Mention two factors which affect food grains.

Ans. Biotic and abiotic factors.

58. Write down two harmful effects of biotic factors on food grains.

Ans. Degradation in quality of food grains and poor germination capacity.

59. What percent of moisture should be present in the food grains at the time of storage?

Ans. Belo 15%

60. Give one example of solid and one of liquid fumigant.

Ans. Solid fumigant: Aluminium phosphide; Liquid fumigant: Ethylene dichloride-carbon tetrachloride.

61. Which method is most effective for destroying insects in stored grains, spraying or fumigation?

Ans. Fumigation.

62. How the food grains should be dried on commercial basis ?

Ans. By using mechanical drier.

63. Name two natural pesticides.

Ans. Pyrethrum and fruit of black pepper.

64. What is feed ?

Ans. Domestic animal's food that contains essential components needed for the growth, development, and general maintenance of body is called **feed.**

65. Name one (*a*) Leguminous green fodder, (*b*) Non-green dry fodder.

Ans. (*a*) Berseem; (*b*) Pounded straw of wheat (Bhusa).

66. Give two examples of concentrates.

Ans. Grains of maize and oil cakes.

67. How are oil cakes are formed?

Ans. Oil cakes are formed from remains of oil seeds after the extraction of oil by oil mills.

68. Name two main groups of cattle feed.

Ans. Roughage and concentrates.

69. Name one high yielding breed of cow and one of buffalo respectively.

Ans. Karan-Swiss and Murrah respectively.

70. Name two indigenous breeds of draught cows.

Ans. Nageri and Malvi.

71. Name two breeds of buffalo

Ans. Murrah and Surti.

72. What is the lactation period of Holstein-Friesian ?

Ans. 365 days.

73. What is the yield of milk from Murrah buffalo?

Ans. 1800-2500 liters of milk (during lactation period).

74. How are the following breeds developed ?
(*a*) Karan Swiss (*b*) Frieswal

Ans. By the crosses between following breeds of cow:
(*a*) Brown Swiss and Sahiwal ;
(*b*) Holstein-Friesian and Sahiwal.

75. What are fat content in milk of: (*a*) Murrah; (*b*) Surti ?

Ans. (*a*) 7% (*b*) 8-12%

76. Write full form of NDRI.

Ans. NDRI-National Dairy Research Institute.

77. Name any one Indian breed of: (*i*) cows and (*ii*) buffaloes.

Ans. (*i*) Gir; (*ii*) Murrah.

78. Name two exotic varieties of cow.

Ans. Holstein-Friesian and Brown Swiss.

79. Give name of one improved crossbreed cows.

Ans. Karan-Fries.

80. Who performed first experiment in artificial insemination ?

Ans. Spallanzani.

81. Give one advantage of artificial insemination.

Ans. It is economical, more reliable and hygienic method.

82. How many cows can be impregnated from a semen of single bull ?

Ans. 3000 cows.

83. Who is regarded as 'Father of white Revolution'?

Ans. Dr. V. Kurien.

84. Name two viral diseases of the cattle.

Ans. Pox and rinderpest.

85. What are the symptoms of the foot and mouth disease of cattle?

Ans. Blisters on feet and mouth, excessive salivation.

86. Name the diseases of cows against which vaccination is available.

Ans. Rinderpest and foot and mouth diseases.

87. Name the disease of cow in which high fever, excessive salivation and lesions of mouth occur.

Ans. Rinderpest.

88. Name one cause of non-communicable diseases.

Ans. Nutritional deficiencies.

89. What is (*a*) the normal body temperature of cow ? (*b*) the normal body temperature of buffalo ?

Ans. (*a*) 38.3°C (*b*) 37.2 – 38.2°C

90. Name two HYV of poultry.

Ans. NH-260 and IBL-80 (or B-77 and IIS-82).

91. Name two indigenous breeds of hen of India.

Ans. Aseel and Busra.

92. Name two exotic breeds of hen which have been successfully acclimatised in India.

Ans. White Leghorn and Rhode Island Red.

93. Name the most efficient converter of low fibre food stuff into highly nutritious animal protein food.

Ans. Poultry.

94. Name the two phases in the life cycle of poultry.

Ans. Growers and layers.

95. Write down two diseases caused by bacteria in poultry.

Ans. Cholera and tuberculosis.

96. Why special care of broiler is taken ?

Ans. Special care is taken to avoid mortality and maintain feathering and carcass.

97. Name one bacterial and one viral disease of poultry respectively.

Ans. Cholera and Ranikhet respectively.

98. Name two fresh water fishes of India.

Ans. Rohu (*Labeo rohita*) and catla (*Catla catla*).

99. Name two marine fishes of India.

Ans. Salmon (trout; *Salmo sola)* and Bombay-duck (Nehari; *Harpodon nehereus).*

100. Name one fresh water and one marine fish of India.

Ans. Fresh water fish-Catfish (lachi; *Wallago attu);* Marine fish – Flying fish (*Exocoetus*).

101. Define pisciculture.

Ans. Pisciculture is the rearing and breeding of fishes under controlled conditions.

102. Name two types of fisheries.

Ans. Fin fishery and shell fishery.

103. Name two other sea food items except fish.

Ans. Lobsters or crabs and oysters

104. Define inland fisheries

Ans. Inland fisheries deal with the fishery aspects of fresh and brackish water.

105. Define culture fishery

Ans. Culture fishery is the type of inland fishery practiced in small water bodies where desired fish is reared and then harvested.

106. What is polyculture ?

Ans. Growing of two or more than two fishes together in the same water body.

107. Name the most advantageous fish culture system.

Ans. Composite fish culture.

108. Give the technical term for bee keeping.

Ans. Apiculture.

109. Name three castes of honey bee family.

Ans. Worker, queen and drone.

110. Name the species of honey bee, which is used for commercial production of honey.
Ans. *Apis mellifera.*
111. Name a protozoan disease of honey bee.
Ans. Nosema.
112. Name two products of honey bee, except honey.
Ans. Bee wax and bee venom.
113. What is swarming ?
Ans. The process by which a queen leaves the old hive along with approximately one half of the workers in that colony and takes a new shelter in called swarming.
114. Which is most active member of honey bee colony.
Ans. Worker (*i.e.*, sterile female).
115. How many eggs are laid by queen bee in a single day ?
Ans. 2000 ova (or eggs).
116. How is wax moth controlled ?
Ans. Wax moth is controlled by exposing bees in hive to sun for increasing temperature.
117. How does honey bee help in cross fertilization ?
Ans. Bee keeping helps in cross pollination of flowers of crop plants, since pollens are transferred from one flower to another by bees while they are collecting the nectar.

Short Answer Questions (Carrying 2 marks each)

1. Distinguish between micronutrients and macronutrients. Give suitable examples.
2. Classify nutrients according to their sources.
3. How plants get nutrients ?
4. Name three most important nutrients required for plant growth.
5. Choose plant's micronutrients and macronutrients from the following
Iron, Chlorine, Sulphur, Copper, Nitrogen, Calcium, Manganese, Potassium, Zinc, Magnesium, Molybdenum, Phosphorus.
6. What are advantages of using manure ?
7. Give two limitations of using manure.
8. Compare the use of manures and fertilizers in maintaining soil fertility.
9. Write down two advantages of fertilizer over manure.
10. During the downpour in a village, the rain water carried away excess of nitrogenous and other compounds present in the soil to a pond. How will they affect the growth of algae and phytoplankton in the pond ?
11. Explain the term eutrophication with suitable example.
12. How does chemical nature of the soil change due to continued use of chemical fertilizers ?
13. Explain various methods of fertilizer application.
14. Distinguish between farmyard manure and compost manure.
15. Define manure. What are different manures and how do they affect the soil ?
16. What is green manuring ? Give suitable examples for green manures.
17. What are fertilizers ? Classify fertilizers.
18. Give a short account of biofertilizers.
19. Explain why a legume crop does not require nitrogenous fertilizers ?
20. Why is irrigation essential ?
21. How does excessive irrigation lead to soil salinity ?
22. Mention three effects of excessive irrigation.
23. Why water should be used judiciously ?
24. Explain advantages of irrigation.
25. Explain, how efficiency of irrigation can be increased.
26. Explain the various factors which are responsible for the loss of stored food grains.
27. Explain the various preventive measures which are taken before storing the food grains.
28. Describe how drying of food grains is done.
29. Write down three unique characteristics of storage structure.
30. Describe the various methods of controlling pests attacking stored grains.
31. As an incharge of a grain store, how will you find out the presence of pests ?
32. How does fumigation differ from spraying ?
33. 'Milk is a very nutritious food'. Use the table given in the book to justify statement.
34. Name four animals which provide us food.
35. Write down the names of animal products which are used as food.
36. How does roughage differ from concentrates with reference to cattle feed ?
37. Give an example of average daily feed of a cow.
38. What are the sources of "concentrates" given in a cattle feed?
39. Write down four main characteristics of good cattle shelter.

40. Which method will you suggest for improving the cattle breed and why ?
41. Write short notes on:
    (*a*) General utility breeds of cow
    (*b*) Breeds of buffalo.
42. Mention four steps involved in artificial insemination.
43. Define artificial insemination. Write down two advantages of it.
44. Write down four symptoms of sick animals.
45. Write the characteristic symptoms of :
    (*a*) Mastitis (*b*) Foot-and-mouth-disease
46. How are high yielding breeds of poultry advantageous over indigenous breeds ?
47. Mention four advantages of fishery.
48. Write a short note on 'Prevention of poultry diseases' ?
49. Write advantages of bee keeping.
50. What are the advantages of composite fish culture ?

Short Answer Questions (Carrying 3 marks each)

1. Write notes on plants and animals as sources of food.
2. Define green revolution, what are the common objectives of crop improvement ?
3. What we do get from cereals, pulses, fruits and vegetables ?
4. Explain the objectives of mixed cropping. How are crops selected for mixed cropping.
5. Distinguish between mixed cropping and intercropping.
6. Explain the advantages and disadvantages of mixed cropping.
7. Define intercropping. How does it differ with mixed cropping ?
8. Write down disadvantages of crop rotation.
9. Write about three main criteria which should be considered while selecting the crops for rotation?
10. Why are leguminous crops desirable in crop rotation?
11. Explain various steps in hybridization of crop plants.
12. Define plant breeding ? Describe the various methods of plant breeding.
13. Describe the biological method of weed control.
14. Classify plant diseases depending upon their occurrence and transmission.
15. Mention three different ways in which insect pests can attack the crop plant.
16. Explain the methods of controlling insect pests.
17. Give two examples each of
    (*a*) Narrow leaved rabi season weed.
    (*b*) Broad leaved kharif season weed.
18. Explain various methods of weed control.
19. Explain various effects of weeds on crop plants.
20. What are crop's pests ? Suggest preventive measures to control pests.
21. What is the advantage of using insect resistant varieties ?

Long Answer Questions (Carrying 5 marks each)

1. Distinguish between fertilizer and manure. Give suitable examples. What are advantages and disadvantages of using fertilizer ?
2. Explain the mechanism of compost formation.
3. Explain what will happen if in a cultivated field only manures are supplied and in another field only fertilizers are supplied, keeping all other conditions similar.
4. Define irrigation. Why is irrigation of crops essential ? Mention the harmful effects of excessive irrigation.
5. Explain various types of irrigation systems in India. How can efficiency of applied water be increased in agriculture.
6. Compare between mixed cropping and intercropping. Write down from advantage of both of these techniques.
7. Explain the various methods of crop improvement. Name one improved variety of Rice, Maize, Soyabean, Sunflower and Mustard.
8. Discuss the various methods which are used to control plant diseases.
9. Explain the various preventive measures against insect pests.
10. What is feed ? What are different type of feed ? How is it differ with respect to age and functions ?

11. What is artificial insemination ? Describe this technique.
12. Write a short note on prevention of animal diseases.
13. How bee colony works ? What values can be seen in the organisation of bee colony ?
14. Write down the desirable characters of bee variety suitable for bee keeping.
15. What is pasturage and how it is related to honey production ?
16. For increasing production, what is common in poultry, fisheries and bee-keeping ?
17. How do you differentiae between capture fisheries, inland fisheries and aquaculture?
18. Explain the role of workers in a bee colony.

VALUE BASED QUESTIONS

Q.1. On holidays, Rahul used to go to morning walk with his grandfather and on the way he used to collect milk from milk man for his home. One day, the milkman told dadaji that he is going to purchase a Murrah breed buffalo as he is not able to fulfill the demand of his customers to supply good quality milk. Rahul asked his grandfather following questions:

(*i*) What are Murrah buffaloes ?

(*ii*) What are the advantages of keeping them in dairy ?

Ans. (*i*) Murrah is a high-milk yielding variety of buffaloes. It can yield 1800-2500 liters of milk. [Cross breeds of buffalo have been developed at National Dairy Research Institute (NDRI), Karnal, Haryana].

(*ii*) Murrah gives higher quantity of good quality milk in comparison to other local breeds that is why dairy owners prefer to keep them in dairy.

Q.2. Ramlal has been cultivating wheat crop year after year in the same field. Recently he has observed decline in the yield despite best inputs. Agriculture inspector of the area suggested him to sow some legume crop (*e.g.*, pea, chick pea or soyabean) for one or two years before again using the field for wheat crop. What is the logic behind this suggestion.

Ans. Sowing the same crop in the same field year after year results in reduction of nutrients from the particular depth of the soil, increase in populations of soil borne pathogens and pests of wheat crop and growth of weeds, infections and infestations.

Growing some root - nodules containing legume crops such as pea, chick pea, soyabean, etc., in the field will improve soil structure and fertility as it will draw water and nutrients from different levels of soil and add nitrogen salts to the soil (Box 1.31). Weeds, soil borne pathogens and pests of wheat crops will be eliminated as they do not find their host.

Box 1.31

Biological Nitrogen Fixation

Legume plants are involved in biological nitrogen fixation. Nitrogen of air is converted into organic nitrogen only by prokaryotic cells: bacteria and cyanobacteria. A group of Gram negative bacteria, the **rhizobia**, from symbiotic association with numerous legume host plants and produce root nodules where nitrogen fixation occurs. Root nodules of soyabean (*Glycine max*) has *Sinorhizobium meliloti* (old name *Rhizobium meliloti*). While root nodules of pea (*Pisum sativum*) and chick pea (*Cicer arietinum*) have *Rhizobium leguminosarum*.

In the process of nitrogen fixation, dinitrogen (N_2) of air is taken by endosymbiotic bacteria of root nodules and is converted into ammonia (NH^+) which diffuses out of bacteria. Inside tissues of root nodule, this ammonia is converted either in amide amino acid (glutamine, *e.g.*, pea) or ureides (*e.g.*, soybean) which are exported via xylem tissue to leaves of host plant. In leaves amides and ureids are used in the synthesis of various amino acids.

If legume plants grown in the presence of nitrogen fertilizers (*e.g.*, nitrate – NO_3^-), they will use this fertilizer as a source of nitrogen nutrition and they will not form symbiotic root nodules (*i.e.*, there will be no biological nitrogen fixation).

Q.3. Pawan went to attend a wedding reception with his mother and father. There was a good variety of food items. He tasted many items and left many items in the plate. This was done by many guests attending the party. His parents drew his attention to the amount of food wasted in this manner.

(*a*) Why was Pawan's parents concerned about the wastage of food ?

(*b*) What steps you can suggest to ensure food security ?

Ans. (*a*) With Indian population reaching 1.3 billions by the end of year 2020, we will require about 240 million tonnes of grains production every year. In order to produce such an enormous amount of grains, we need extra land for cultivation which is beyond our scope as it is surely going to create ecological disturbances. Therefore, it is essential to wisely use the available food resources.

Further, due to unemployment, poverty and inflation, millions of Indians are unable to get adequate meals. Hunger and rampant mal-nutrition of poor sections of human society can be managed by proper utilisation of food items served in the lavish parties of marriages, birthdays, inaugurations, etc.

(*b*) We can adopt the following methods for ensuring food security.

(*i*) Development of disease resistant, high yielding crop varieties having low maturity durations.

(*ii*) By improving production management.

(*iii*) Crop protection management.

(*iv*) Proper storage and distribution of agriculture produce.

Q.4. Why should organic foods be preferred over conventional foods ?

Ans. The conventional foods are raised using chemical fertilizers and chemical pesticides. These agrochemicals are often toxic, xenobiotic (human made) and nonbiodegradable. These agrochemicals pass into conventional foods in small traces. Repeated use of conventional foods increases the concentrations of agrochemicals in our bodies. Ultimately they become toxic and cause a number of ailments (*e.g.*, cancers) and harms can occur to us or our pets. By rains and floods, chemical fertilizers are washed out from crop fields and contaminate and pollute our water bodies such as ground water and surface water such as ponds, lakes and rivers. They result in eutrophication and other ecological accidents such as depletion of oxygen in water and death of aquatic life such as fishes.

On the other hand, organic foods are free from any traces of agrochemicals as they are raised by using manures, biofertilizers (*e.g.*, Nitrogen fixing crops and cyanobacteria), biopesticides (neem products) and biological control. Being nontoxic, organic foods should be preferred over conventional foods. Manure used in raising organic foods is environmentally clean method of disposing off and recycling organic wastes.

Q.5. Why is fumigation regarded a better option than spraying in godowns ? Give examples of both types of pesticides.

Ans. Fumigation is comparatively a safe and economical option of pest control than spraying of stored grains due to following reasons:

(*i*) In fumigation, the worker does not come in contact with the fumigant. There is some contact with the pesticide during spraying. In spraying, the worker suffers irritation in eyes, nose, vomiting, etc.

(*ii*) No residue persist over articles in fumigation. In spraying some residue can enter the sprayed articles.

(*iii*) Fumigants are volatile while sprays are seldom volatile.

(*iv*) Fumigation disinfects the whole areas. Spraying disinfects only the sprayed articles.

(*v*) In fumigation less amount of pesticide is used. While in spraying, large volume of pesticide is consumed.

(*vi*) Examples of fumigants are aluminium phosphate, EDCT and methyl bromide. Pesticides which are sprayed include BHC, malathion and pyrethrum.

Q.6. What is the need of crossing the exotic breeds of cattle with local (Indian) breeds, when exotic cattle have higher yield as compared to the hybrid breed of cattle ?

Ans. Hybrids produced by cross breeding exotic breed with local breed yields less milk as compared to the exotic breed. Even then, exotic breed cannot be incorporated in our dairy farms due to following reasons:

(*i*) Most of the exotic breeds have come from colder countries. Colder areas are limited in our country.

(*ii*) The exotic breeds will fall prey to local pests and pathogens easily as they are not resistant to them.

(*iii*) The feed available locally does not match with the feed required by the exotic breeds.

Therefore, best available option is to import a few exotic cattle and cross-breed them with local cattle for obtaining hybrid cattle acclimatised to local climate and resistant to local diseases.

Q.7. Vikash went to vegetable market with his elder sister, a M.Sc. Botany student. There he saw many varieties of different vegetables such as different kinds of chilies (short, long, round, pungent, less pungent, green, reddish, orange), several varieties of potato and tomatoes. He asked his sister the following questions:

(*i*) What is the need of producing so many varieties of different crop plants.

(*ii*) What is the name of branch of science which deals with crop improvement ?

(*iii*) What are the methods used by plant breeders ?

(*iv*) What is hybridization ?

Ans. (*i*) There exists a great variety of agro climatic conditions and different varieties of a vegetable are suitable for preparing different food items. A particular variety of a crop plant generally gives good yield in a particular set of agro climatic conditions. Therefore, different varieties with varying traits are produced in keeping in view the agro climatic conditions and market demands.

(*ii*) Plant breeding (a branch of Genetics).

(*iii*) Techniques of plant breeders include following steps:

(*a*) Introduction; (*b*) selection;

(*c*) Hybridization;

(*d*) Recombinant DNA Technology or Genetic Engineering by which GM crops or genetically modified crops are produced.

(*iv*) Hybridization is a technique in which the two plants having the desired characters are made to cross and develop hybrid seeds.

CHAPTER

2

The Fundamental Unit of Life: Cell

2.1. WHAT IS THE LIVING BEING MADE UP OF ?

Our earth is inhabited by different kinds of living organisms, who look very different from each other. These living organisms are archaebacteria, eubacteria, protista (*Amoeba*, *Chlamydomonas*), fungi, plants and animals. The bodies of living organisms are made up of microscopic units called **cells**. The cell has same central position in biology as an atom in the physical sciences. *The cell is the basic structural and functional unit of living organisms.*

Present-day cells share common fundamental properties. For instance, all cells employ DNA as their genetic material, are surrounded by a plasma membrane, and use the same basic mechanisms for energy metabolism. On the other hand, present-day cells have evolved a variety of different life-styles. Many organisms, such as bacteria (both archaebacteria and eubacteria), protozoa (*e.g.*, amoeba) and yeasts, consists of single cells (called **unicellular organisms)** that are capable of independent self-replication. More complex organisms, called **multicellular organisms**, are composed of collections of cells that function in a coordinated manner, with different cells specialized to perform the particular tasks. The human body, for example, is composed of more than 200 different kinds of cells, each specialized for such distinctive functions as memory, sight, movement and digestion. The diversity exhibited by the many different kinds of cells is striking; for example, consider the differences between bacteria and the cells of human brain.

All cells, whether they exists as one celled organisms (unicellular organisms) or as a part of multicellular organisms are capable of carrying out certain basic functions such as nutrition, respiration, growth and reproduction. These functions are essential for the survival of the cells.

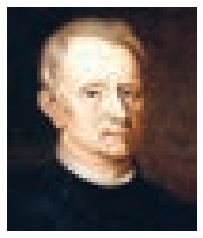
Table 2.1. Differences between unicellular and multicellular organisms.

Unicellular organisms	*Multicellular organisms*
1. An unicellular organism is represented by a single cell.	1. A multicellular organism consists of large number of cells.
2. All activities of the organisms are performed by a single cell.	2. A single cell performs one or few activities of the organisms.
3. There is no division of labour as the single cell perform all life activities.	3. Cells are specialized to perform different functions of the body so that there is a division of labour within cells.
4. Reproduction consumes a single cell.	4. Only some cells of the body called germ cells take part in reproduction. Other cells (somatic cells) remain intact.
5. The life span of an individual is short.	5. The life span of an individual is long.

The most important and fundamental level in the organisation of living world is the **cellular level.** *Cells are the fundamental structural and functional units of living organisms and are the basic unit of life.* **Cell biology** is the study of cells in all aspects of structure and functions.

Discovery of Cell

While studying a thin slice of cork, **Robert Hooke** saw that the cork resembled the structure of honeycomb consisting of many little compartments. Cork is a substance which is obtained from the bark of a tree. This was in the year 1665 when Hooke made this chance discovery through a self designed microscope (Fig. 2.1.) Robert Hooke called these boxes — cells. Cell in Latin means "little room" (Box 2.1). Robert Hooke's discovery was important, because it indicated for the first time that living organisms consisted of a number of smaller structures or **units.**



Robert Hooke.

Box 2.1
Cell Theory

The word cell is derived from the Latin word '*cellula*' which means "a little room". An English scientist, **Robert Hooke** (1635 – 1703), in 1665 discovered and named the cells, while examining a thin slice of bottle cork under a primitive microscope made by him (Fig. 2.1). Hooke observed cork's honeycombed or porous structure (Fig. 2.2). Hooke found porous structure of cork to resemble with monasteries and called the units, cells. He published his work in a book "*Micrographia*" in 1665.

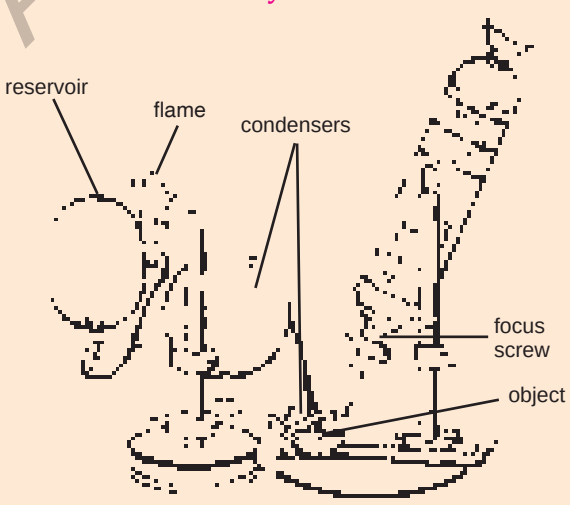


Figure 2.1. Robert Hooke's microscope.

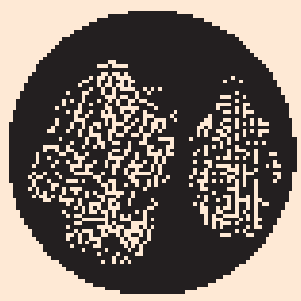


Figure 2.2. Dead cork cells as seen by Robert Hooke.

In 1674, **Anton von Leeuwenhoek** (1632 – 1723), a Dutch microscopist, made an improved microscope (Fig. 2.3) and using this microscope he discovered the free living cells in pond water for the first time (1674). In 1678, he discovered sperm and identified the sperm cells of humans, dogs, rabbits, frogs, fish and insects.

However Hooke had only seen the thickened walls of the cells and not the substance contained within these walls. In 1831, a Scottish botanist, **Robert Brown** (1773 – 1858) discovered and named the **nucleus** in plant cells. **J.E. Purkinje** (1787 – 1869), a Czech animal physiologist, in 1839 gave the term **protoplasm** for the living fluid substance present inside the cell. In 1866, **Haeckel** established that the nucleus was responsible for storing and transmitting hereditary characters.

Cell Theory. In 1838, **Jakob Matthias Schleiden** (1804 – 1881), a German botanist, first proposed the idea that all plants consist of cells. A year later, in 1839, **Theodor Schwann** (1810 – 1882), a German zoologist, independently asserted that all animals and plants are made up of cells. This joint finding forms the basis of the **cell theory**.

The cell theory was refined further in 1855, when another German biologist, **R. Virchow** presented the idea that all cells arise from pre-existing cells (His actual aphorism was '*Omnis cellulae a cellula*'). Thus, the cell theory comprises of the following postulates :

1. All organisms are composed of cells and cell products (*e.g.*, secretions).
2. All metabolic reactions take place in cells. Thus, cells are structural and functional units of life.
3. All cells arise from pre-existing cells only. No cell can originate spontaneously or *de novo* (anew) but comes into being only by division of already existing cells.
4. Every organism starts its life as a single cell. Viruses are an exception to cell theory.

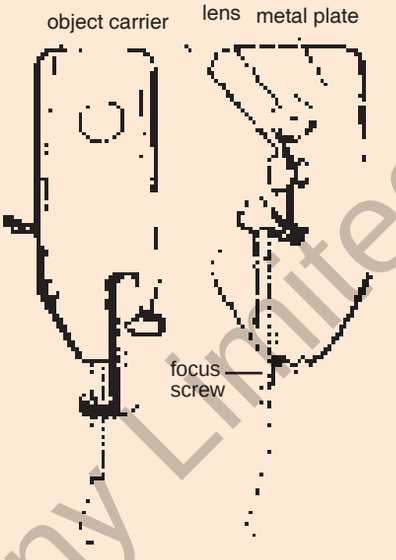


Figure 2.3. Leeuwenhoek's microscope.

Box 2.2

Instruments for Studying Cells

Cells are too small to be seen with naked eyes. Cells are studied with the help of **microscopes.** Microscopes are high resolution instruments that are used for observing the fine details of very minute objects. Two common types of microscopes are light microscope and electron microscope.

1. Light or Compound Microscope

The simple student's microscope which is often used in schools is called **compound microscope.** In these microscopes many lenses are combined together and their magnification power range from 300 to 1500 times. These microscopes use light (generally sunlight) to illuminate the object, so these compound microscopes are called **light microscopes.** Let us try to get acquainted with various parts of a light microscope.

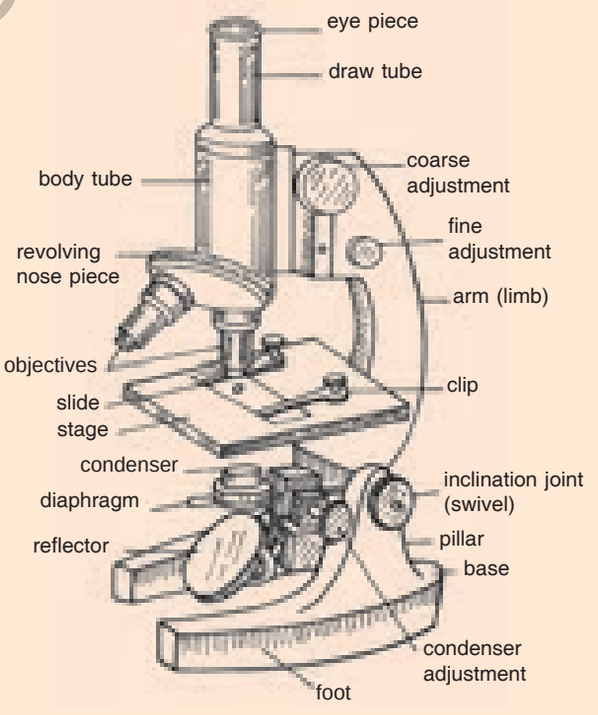
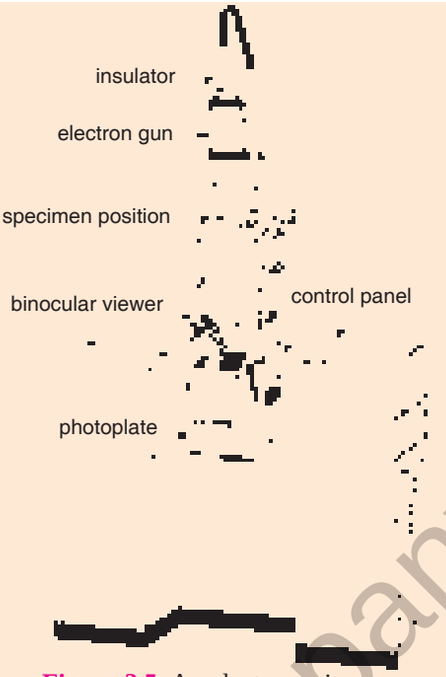


Figure 2.4. Light or Compound microscope.

As shown in Fig. 2.4 the **object** or **specimen** on a **glass slide** is kept on a stage under an objective piece (having lenses) almost in the middle of the microscope. Light is passed through the object/specimen with the help of a mirror (called **reflector**) and a condenser from below the stage. From the eyepiece on the top one can see a magnified image of the object/specimen. A sharp image forms by focussing the side knobs properly. The upper and large knob is meant for **coarse adjustments** and it is used for rapid and precise focussing of the object. The lower and small knob is used for **fine adjustments** (*i.e.*, for getting perfect image of the object). The magnification of an image can be increased or decreased by changing the objectives of high or low power (5 X, 10 X, 15 X, etc.) accordingly.

2. Electron Microscope

As shown in Fig. 2.5, an electron microscope is a very large instrument that uses electromagnets for magnification and electrons for illumination. This remarkable instrument was developed by **Knoll** and **Ruska** of Germany in 1932 and it was put to use in 1940. It uses very high voltage electricity. Electron microscope helps in observing subcellular structures which cannot be seen through a compound microscope. An internal vacuum is essential for its working. The object must be ultra thin and dry. It is impregnated with some metal to enhance contrast. The image of the object is obtained on a photographic film or screen. Magnification is 100,000 to 500,000.



Electron microscope.

Figure 2.5. An electron microscope.

Table 2.2. Differences between light microscope and electron microscope.

Light microscope	*Electron microscope*
1. It uses glass lenses.	1. It uses electromagnets.
2. It uses a beam of light to illuminate the object.	2. It uses a beam of electrons instead of light.
3. Internal vacuum is not required.	3. Internal vacuum is essential.

ACTIVITY 2.1

Let us take an inner fleshy leaf of onion bulb. With the help of a set of forceps, we can peel off the skin (called the **epidermis** ; it is one cell thick) from the concave side (inner layer) of the onion. This layer can be put immediately in a petridish (a glass dish) or watch-glass containing water. This will avoid the peel getting folded and getting dry also. What do we do with this onion peel?

Let us take a glass slide, put a drop of clean water on it and transfer a piece of peel from the petridish or watch-glass to the slide. Make sure that peel is perfectly flat on the slide. You may need a thin camel hair paint brush to help you to transfer the peel. At this stage put a drop of iodine solution on the piece of onion peel followed by a cover slip. In this way you have prepared a **temporary mount** of onion peel. You can observe this slide under the low and high power of a **light compound microscope** (Fig. 2.4).

What do you observe as you look through the lens? Can you draw the structures that you are able to see through the microscope in your observation sheet? Does it look like the Figure 2.6B.

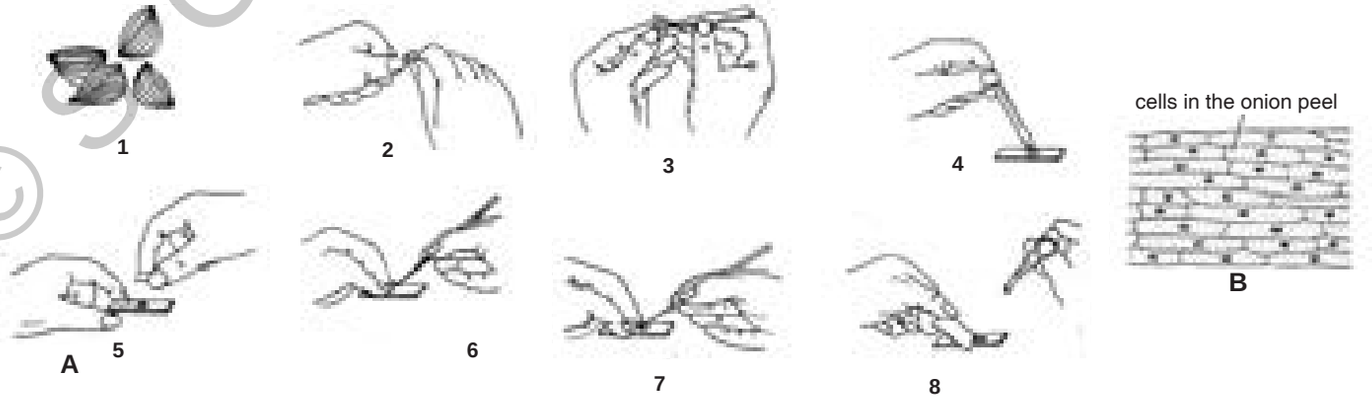


Figure 2.6. A–How to mount a sample of onion peel on a microscopic slide; B–The cells of the onion peel.

If you prepare temporary mounts of onion peels with different sizes, you will observe that they all have similar small structures. These structures look similar to each other and together they form a big structure such as an onion bulb. These small microscopic structures that you see in an onion peel are the *basic building units of onion bulb*. These structures are called **cells**. Not only onion but all organisms that you see around are made up of cells.

ACTIVITY 2.2

You can try preparing temporary mounts of leaf peels, tip of roots of onion or even peels of onions of different sizes. For this purpose, you can take leaf of maize, mustard or *Tradescantia*.

Take a red coloured Tradescantia leaf. With a sudden jerk a small segment can be peeled off from the lower surface of leaf. Make a temporary mount of this peel and observe under the microscope. You will observe that each cell is filled with red coloured cell sap.

By performing experiments of Activities 2.1 and 2.2 you will be able to answer the following queries regarding the cell : *Do all cells look alike in terms of shape and size* ? You should answer that the cells of an multicellular organism are different in shape and size. Cells of different organisms are different. *Can you find differences among cells from different parts of a plant body*? During discussion of plant tissues you will find that indeed cells of different parts of plant body are different in shape, size and structure. *What similarities can you find in different types of cells* ? Basic similarities among all cells of higher organisms are as following: they have a plasma membrane, a cytoplasm with organelles and a nucleus.

Box 2.3

1. Protoplasm. The contents of a living cell, contained within the plasma membrane, form protoplasm. Protoplasm is usually differentiated into the nucleus and cytoplasm.

2. Gene. It is a distinct unit of hereditary information. Gene is inherited from one generation to next and determines an observable characteristic or trait of an organism. Genes have to carry coded information of parents to their children or progeny, so that children remain exactly like their parents. Generally a gene is made of DNA molecule, but sometimes it is made of RNA molecule as observed in Tobacco mosaic virus (TMV).

3. DNA. Deoxyribonucleic acid; a polymeric nucleic acid.

4. RNA. Ribonucleic acid; a polymeric nucleic acid.

Prokaryotic and Eukaryotic Cells

All living organisms present on Earth can be classified into following *two* types:

1. Non-cellular organisms that do not contain any cell in their body organisation, *e.g.*, viruses. Viruses lack any membrane and hence do not show characteristics of life until they enter a living body (*i.e.*, prokaryotic cell or eukaryotic cell) to use its cell machinery to reproduce.

2. Cellular organisms that contain either one or many cells in their bodies, *e.g.*, bacteria, plants and animals.

Cellular organisms are again divided into following *two* main types :

(*a*) **Prokaryotes.** These organisms have primitive and incomplete cells. Thus, they contain **prokaryotic cells** in their body structure. Prokaryotic cells have all three basic structures of a typical cell but lack nuclear membranes around their genetic substances (DNA).

Nuclear material of a prokaryotic cell consists of a single chromosome which is in direct contact with cytoplasm. Here the undefined nuclear region in the cytoplasm is called **nucleoid**, *i.e.*, there is no nuclear membrane. In a prokaryotic cell other membrane bound organelles, such as mitochondria, are also absent. Ribosomes, however, are present in prokaryotic cells. The prokaryotes include **archaebacteria, bacteria** and **cyanobacteria** (which earlier called **blue-green algae**).

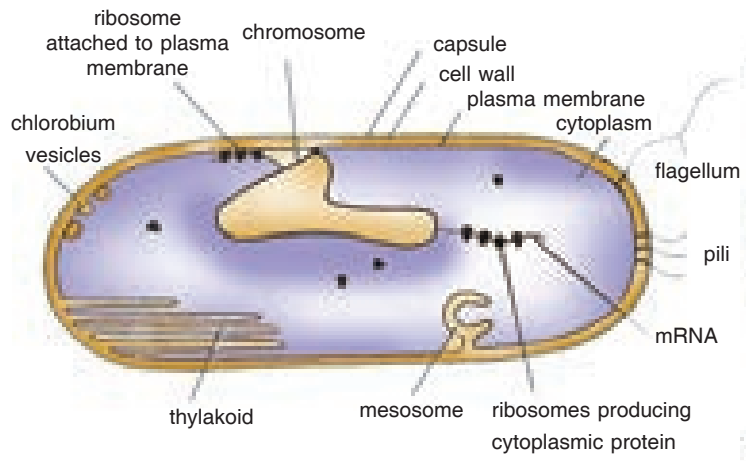


Figure 2.7. A typical prokaryotic cell of a bacterium.

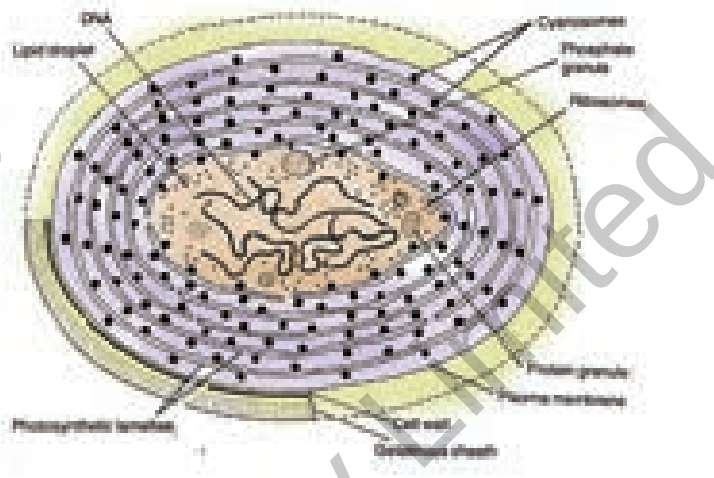


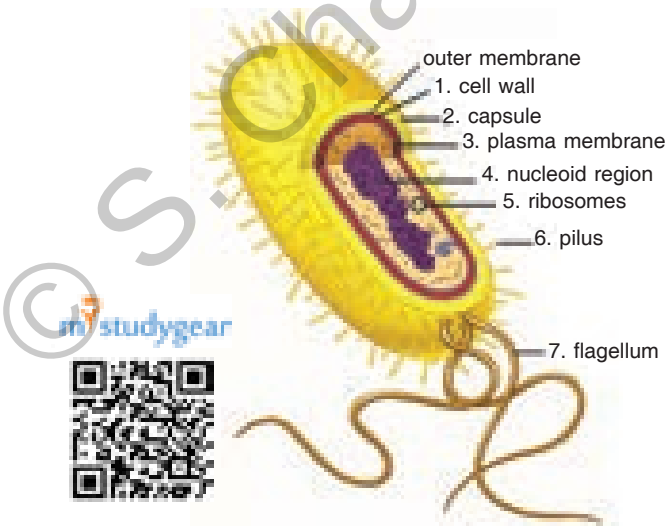
Figure 2.8. Photosynthetic prokayotic cell. Ultrastructure of a cell of blue-green algae or cyanobacteria.

(*b*) Eukaryotes. These have advanced and complete cells. These cells contain membrane bound nuclei and other cellular organelles and are called **eukaryotic cells.** Such cells are found in unicellular and multicellular plants and animals and contain plasma membrane, nucleus, DNA and cytoplasm with ribosomes and cellular organelles such as mitochondria.

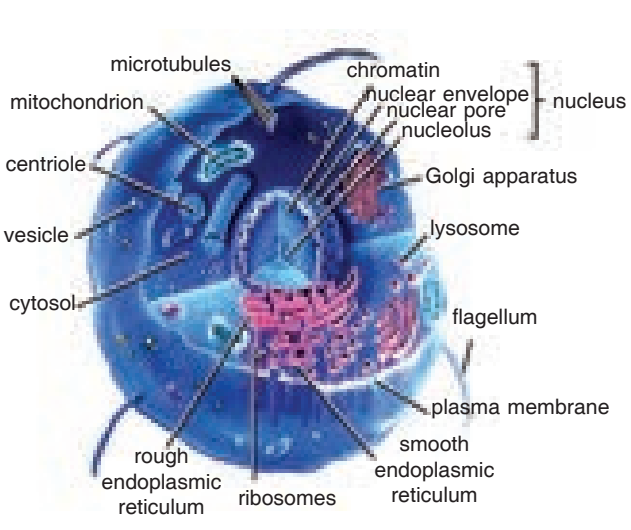
The differences between prokaryotic cell and eukaryotic cell are given in Table 2.3.

Table 2.3. Differences between prokaryotic cells and eukaryotic cells.

Prokaryotic cell	*Eukaryotic cell*
1. Size of a cell is generally small (1–10 mm).	1. Size of a cell is generally large (5 – 100 mm).
2. Nucleus is absent (Nuclear region or nucleoid is not surrounded by a nuclear membrane).	2. Nucleas is present (Nuclear material is surrounded by a nuclear membrane).
3. It contains single chromosome.	3. It contains more than one chromosome.
4. Nucleolus is absent.	4. Nucleolus is present.
5. Membrane bound cell organelles are absent.	5. Membrane bound cell organelles such as mitochondria, plastids, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, etc., are present.
6. Cell division takes place by fission or budding (no mitosis).	6. Cell division occurs by mitotic or meiotic cell division.



Prokaryotic cell.



Eukaryotic cell.

Table 2.4. Differences between nucleus and nucleoid.

Nucleus	*Nucleoid*
1. It is larger in size.	1. It is comparatively smaller in size.
2. It has a covering of double membrane envelope.	2. A covering membrane is absent. It lies free in the cytoplasm.
3. Nucleolus is present in it.	3. Nucleolus is absent in it.
4. Its DNA content is equal to two or several DNA molecules.	4. Its DNA content is equal to a single DNA molecule.
5. Its DNA is associated with histone proteins to form chromatin.	5. In it histones are absent. DNA of a nucleoid is often naked.

Division of Labour

If you closely study the Figure 2.10, you will notice that an organism such as a human being can have cells of different kind, *e.g.*, sperm, leucocyte (white blood cell), osteocyte (bone cell), muscle cell, nerve cell, fat cell, etc. This is due to the fact that *there is a division of labour within multicellular organisms*, *e.g.*, human beings. This means that different parts of human body perform different functions. Human body has heart to pump blood, stomach to digest food, skeletal muscles to perform movement and locomotion and so on. Heart has a special type of muscle cells called **cardiac muscles** which contract rapidly, rhythmically and tirelessly ; they never fatigue during life time of an organism. Stomach has special cells such as **mucous cells** to secrete mucus for lubricating the food, **zymogen cells** (or Chief cells) to secrete a proenzyme of protein digestive enzyme, the pepsin, called **pepsiogen, parietal cells** or **oxyntic cells** to secrete hydrochloric acid (HCl) activating pepsinogen into functional pepsin and also for killing germs of food. Skeletal muscles are striated and voluntary muscles, *i.e.*, their contraction depends on your will or control. Due to this property of skeletal muscle cells, you are able to move your hands and ten fingers in desired ways.

Like the human body, the cell itself has got division of labour. In fact, each cell has got certain specific components within it known as **cell organelles** (Table 2.5.)**.** Each kind of cell organelle performs a special function, *e.g.*, making of new material in the cell such as protein synthesis by ribosomes, food (glucose/ starch) synthesis by chloroplasts, clearing up the waste substances from the cell by the lysosomes, etc. Thus, a cell is able to live and perform its functions because of these organelles. These organelles together constitute the basic building blocks called **cells**. Quite interestingly, all cells are designed to have the same basic structure, no matter what their function is or what organism they are found in.

Table 2.5. Differences between organs and organelles.

Organs	*Organelles*
1. They are found in multicellular organisms.	1. They are found in all eukaryotic cells.
2. They are large sized or macroscopic.	2. They are very small sized, either microscopic or submicroscopic.
3. They may be external or internal to the body of an organisms.	3. They are mostly internal (*i.e.*, intracellular).
4. The organs are formed of tissues, tissues comprise of cells and cells are formed of organelles.	4. An organelle is made up of micromolecules and macromolecules.
5. Organs coordinate to form organ systems, while organ systems form the body of an organism.	5. Organelles coordinate to produce the cell.

Cell Shape

The basic shape of eukaryotic cell is spherical, but the shape of cell is ultimately determined by the specific function of the cell. Thus, the shape of the cell may be **variable** (*i.e.*, frequently changing its shape) or **fixed.** Variable or irregular shape occurs in *Amoeba* (Fig. 2.9) and white blood cells or leucocytes. In fact, leucocytes

are spherical in circulating blood, but in other conditions they may produce pseudopodia and become irregular in shape. Fixed shape of cell occurs in most plants and animals (including *Euglena* and *Paramecium*). In unicellular organisms, the cell shape is maintained by tough plasma membrane (*e.g., Paramecium*) and exoskeleton (*e.g., Elphidium* or *Polystomella*). In multicellular organisms, the shape of a cell depends mainly on its functional adaptations and partly on the surface tension, viscosity of the protoplasm, the mechanical action exerted by adjoining cells and rigidity of the cell membrane (*e.g.,* presence of rigid cell wall in plant cells). Thus, cells may have diverse shapes such as **polyhedral** (with 8, 12 or 14 sides), **spherical** (*e.g.,* eggs of many animals), **spindle-shaped** (*e.g.,* smooth muscle fibre), **elongated** (*e.g.,* nerve cells), **branched** (*e.g.,* chromatophores or pigment cells of skin), **discoidal** (*e.g.,* erythrocytes or red blood cells) and so on (Fig. 2.10).

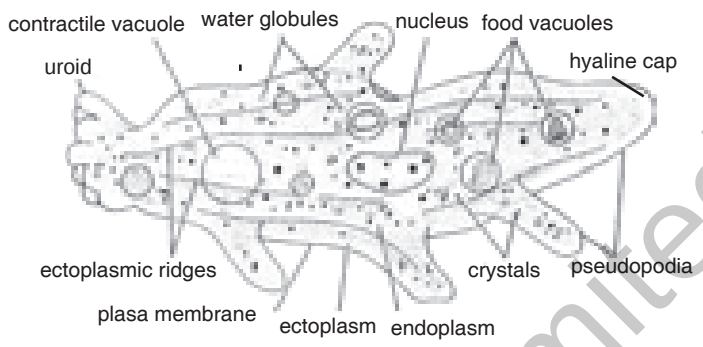


Figure 2.9. *Amoeba* showing its irregular body shape.

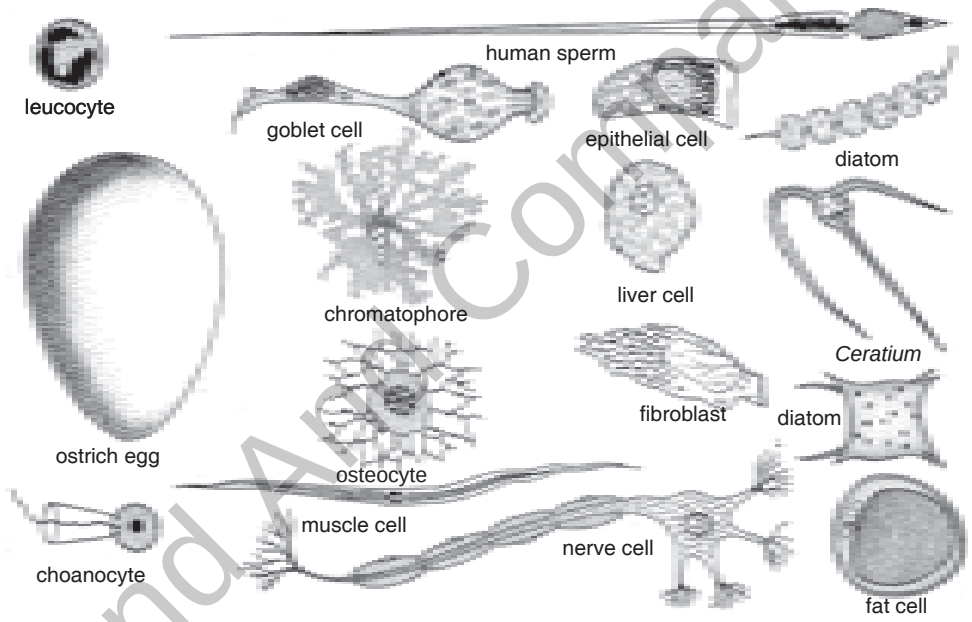


Figure 2.10. Various types of eukaryotic cells showing different shapes. In this figure, except certain cells such as diatom, *Ceratium*, ostrich egg and choanocyte, all remaining cells are showing diversity of cells in human body.

Cell Size

The size of different cells ranges between broad limits. Some plant and animal cells are visible to the naked eyes. Most cells, however, are visible only with a microscope, since they are only a few micrometres in diameter. A micrometre (µm) is one thousandth of a millimetre. The size of cells varies from the very small cells of bacteria (0.2 to 5.0 µm) to the very large eggs of the ostrich (18 cm) (Among the multicellular plants, the largest cell is the ovule of *Cycas*.) Some nerve cells of human beings have a metre long 'tail' or axon. The single marine alga, *Acetabularia*, measures nearly 10 cm in height (Fig. 2.11). The fibre cells (*i.e.,* sclerenchyma cells) of Manila hemp similarly, are over 100 cm in length.

The prokaryotic cells usually range between 1 to 10 µm. The eukaryotic cells are typically larger (mostly ranging between 10 to 100 µm). Size of

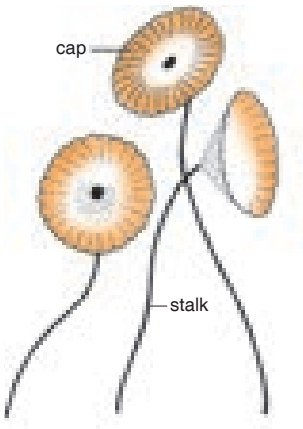


Figure 2.11. *Acetabularia.*

unicellular organisms is larger than a typical cell of multicellular organisms. For example, *Amoeba proteus* is biggest among the unicellular organisms; its length being 60 µm. The size of typical cells of multicellular organisms ranges between 20 to 30 µm. The smallest cells are those of *Mycoplasma gallisepticum*, an organism intermediate between virus and bacteria. Their size is about 0.1 µm.

Box 2.4

Measurement of cells

1. Millimetre (mm) 1 mm = 1000 μ
2. Micrometre (mm) or micron (μ) *
3. Nanometre (nm) or millimicron (mm) 1μ = 1000 mμ
4. Angstrom (A°) 1A° = 10^{-1}mμ = $10^{-4}\mu$ = 10^{-7} mm

*Micron (μ) is a unit of length in the CGS system, equal to one millionth of a metre. In SI units it is replaced by the micrometre (μm).

Cell Volume

The volume of a cell is fairly constant for a particular cell type and is independent to the size of an organism. For example, kidney or liver cells are approximately the same size in a bull, horse and mouse. The difference in the total mass of the organ or organism depends on the number, not on the volume of the cells. Thus, the cells of an elephant are not necessarily larger than those of other tiny animals or plants. The large size of an elephant is due to the larger number of cells present in its body.

Cell Number

The number of cells in most multicellular organisms is **indefinite**, but the number of cells may be fixed in some multicellular organisms such as rotifers and nematodes (Box 2.5).

Box 2.5

In the nematodes (e.g., *Ascaris*), the number of cells in various organs is fixed and it is attained by the time hatching takes place. Most growth in size of a nematode results from an increase in cell size. The phenomenon of having a constant and genetically fixed number of cells is called **eutely.** In eutelic animals mitosis stops following embryonic development.

The number of cells in multicellular organisms usually is correlated with the size of an organism. Thus, small-sized organism has less number of cells in comparison to large-sized organisms. For example, large-sized organisms such as elephant, whale, camel, neem tree or banyan tree have countless number of cells. In human beings, the number of cells is estimated to be about 100 trillion (10^{14}). [**Note.** Trillion is a cardinal number. In numeration system of USA in a trillion 1 is followed by 12 zeros.]

2.2. STRUCTURE OF CELL

Though their shape, size and activities vary, all cells have following *three* major functional regions :

1. The cell membrane or plasma membrane, and cell wall,
2. The nucleus, and
3. The cytoplasm.

The outer boundary of the cell is the **plasma membrane**. Inside it lies the **cytoplasm**. Various **cellular** or **cell organelles** and **inclusions** are suspended in the cytoplasm (Table 2.6). All activities inside the cell and interaction of the cell with its environment is possible due to these features. Out of these organelles, **nucleus** is visible under a light microscope. The other organelles can be seen under an electron microscope only.

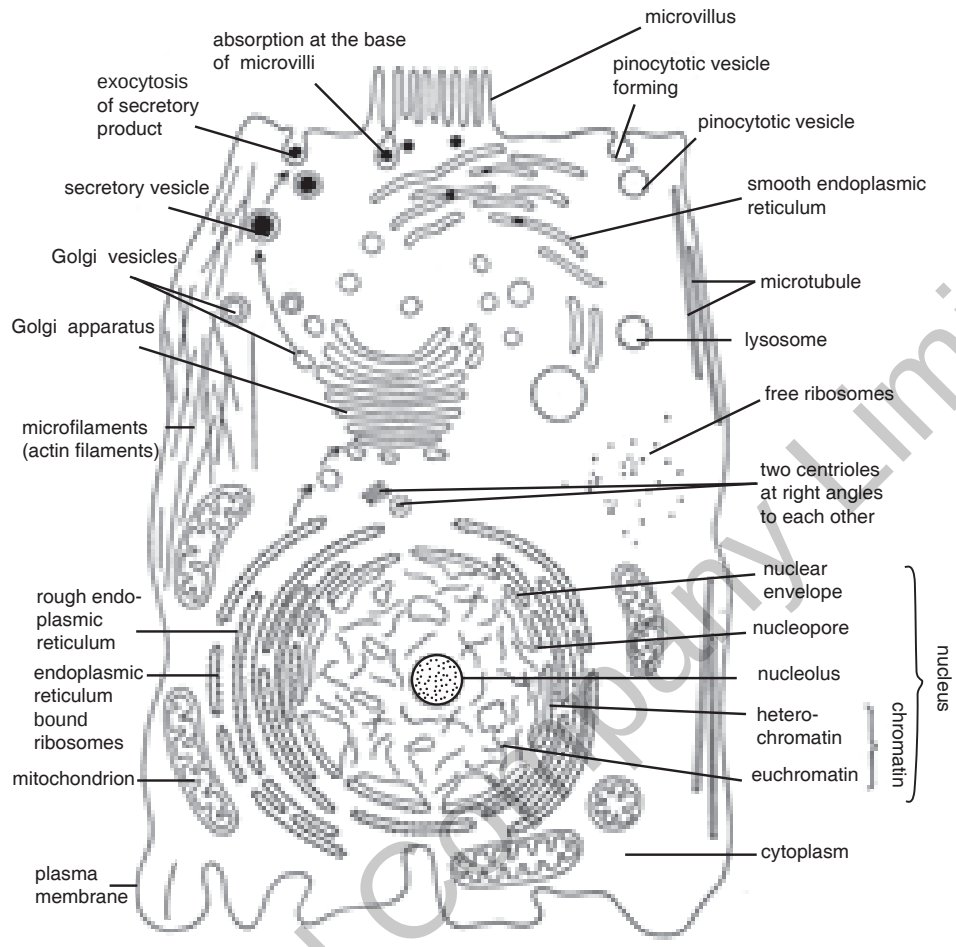


Figure 2.12. Ultrastructure of a generalised animal cell as seen with electron microscope.

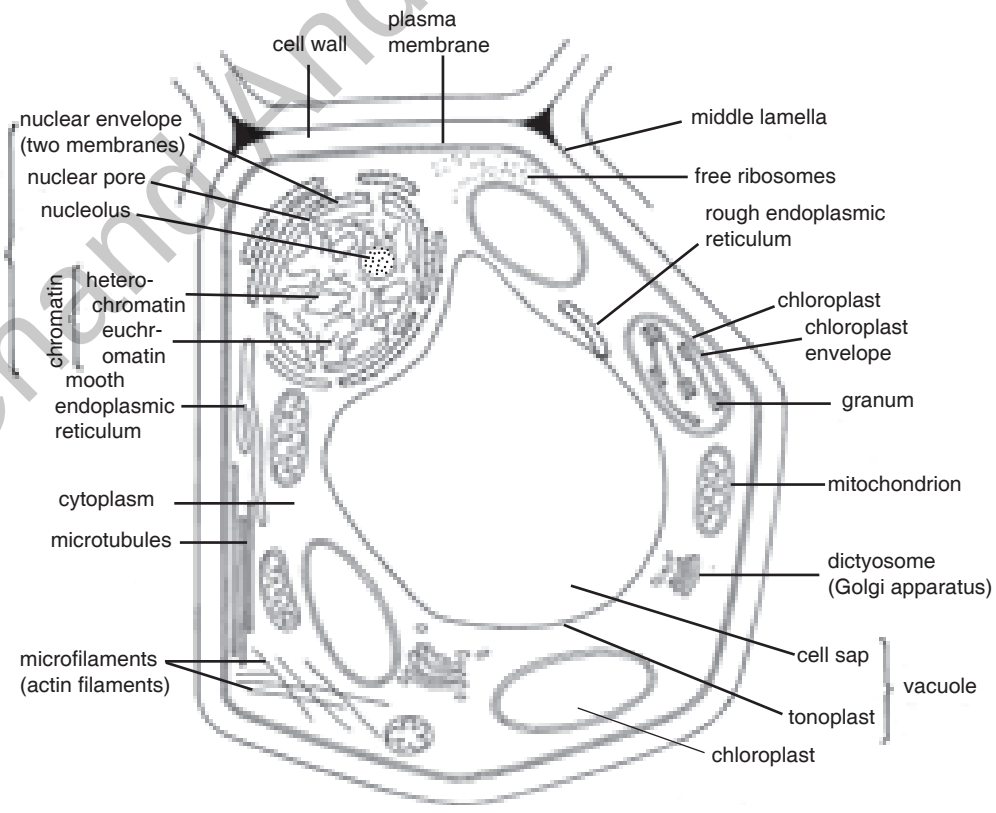


Figure 2.13. Ultrastructure of a generalised plant cell.

1. PLASMA MEMBRANE

Nature and Occurrence

Most cellular organelles such as mitochondria, chloroplasts, lysosomes, peroxisomes, Golgi apparatus, nucleus and endoplasmic reticulum, are all enclosed by the unit membrane. The cell surface membrane or plasma membrane is the outer covering of each cell. It is present in cells of plants, animals and microorganisms.

Structure

Plasma membrane is a living, thin, delicate, elastic, selectively permeable membrane. It is about 7 nm (70Å) thick. Under a light microscope this merely appears as a single line. However, the development of electron microscope has made it possible to investigate the detailed structure of biological membranes (*i.e.*, plasma membrane and other membrane of cellular organelles).

Table 2.6. Cell organelles and inclusions.

A. Living parts of a cell	*B. Non-living parts of a cell*
1. Plasma membrane 2. Cytoplasm (*i*) Endoplasmic reticulum (ER) (*a*) Smooth ER (*b*) Rough ER (*ii*) Mitochondria (*iii*) Golgi apparatus (*iv*) Ribosomes (*v*) Lysosomes (*vi*) Centrioles (animals only) (*vii*) Plastids (plants only) 3. Nucleus	1. Cell wall (plants only) 2. Vacuoles 3. Granules (cell inclusions)

Chemical analysis has shown the membrane to be 75 per cent **phospholipids**. In addition, the membrane contains **proteins**, **cholesterol** and **polysaccharides**. However, it is the phospholipids that form key elements in the structure of plasma membrane.

In 1972 **Singer** and **Nicolson** suggested a model, called **fluid mosaic model**, to explain the ultrastructure of the plasma membrane or any other membrane of the cell. According to them plasma membrane is made up of a bilayer (two molecule thick layers) of phospholipids. Two types of protein molecules 'floated about' in the fluid phospholipid layer : **Intrinsic proteins**, which completely covers the lipid bilayer and **extrinsic proteins**, which occur either on the outer surface or on the inner surface of the lipid membrane. The fluid mosaic model of the membrane has been described as "*a number of protein icebergs floating in the sea of lipids*". This model is the most accepted one, as it describes both properties and organisation of the membrane.

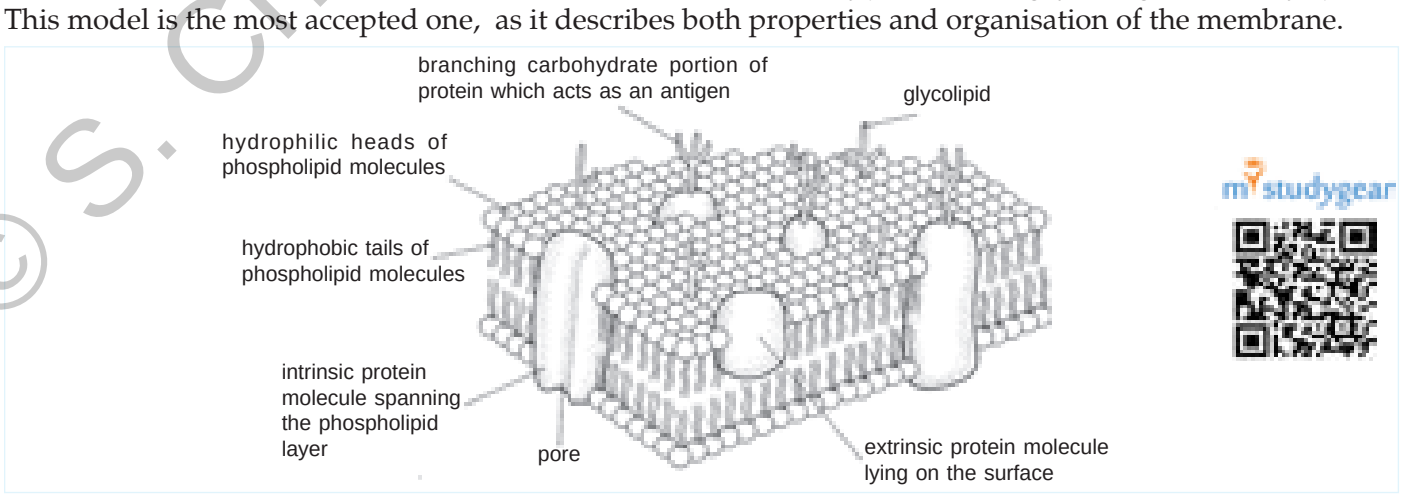


Figure 2.14. Fluid mosaic structure of the plasma membrane.

The proteins are present not to give strength to the membrane but to serve as (*i*) **enzymes** (catalyse chemical reactions within the membrane), (*ii*) **transport proteins** or **permeases** (for movement of water soluble ions) ; (*iii*) **pumps** (for active transport) and (*iv*) **receptor proteins** (for endocytosis). Presence of lipids and proteins provides flexibility to the plasma membrane. This property of flexibility of the plasma membrane helps in endocytosis.

Box 2.6

Advantages of selective permeability

Selective permeability of plasma membrane ensures that

1. The useful molecules enter the cell
2. The metabolic intermediates remain within the cell, and
3. Secretions and wastes leave the cell.

Thus, selective permeability of the cellular membranes enables the cell to maintain **homeostasis**, *i.e.*, a constant internal environment inspite of the changes outside it.

The substances generally drawn in the cell includes: (1) raw materials for metabolism, *i.e.*, food, water, salts and oxygen; and (*ii*) regulatory substances, *e.g.*, vitamins and hormones.

The substances generally ousted of the cells include : (*i*) the products of metabolism, namely nitrogenous wastes and carbon dioxide; and (*ii*) secretions such as proteins, proenzymes, hormones, milk, tear, mucus, immunoglobulins (antibodies), etc.

Functions

Plasma membrane permits the entry and exit of some materials in the cells. Therefore, the plasma membrane is called a **selective permeable membrane.** Let us see how the movement of substances takes place in out of a cell !

Studies on function of plasma membrane have shown that, it performs certain physical activities, such as diffusion and osmosis for the intake of some substances. Also certain biological or physiological activities such as active transport and endocytosis are performed by the plasma membrane.

1. Diffusion. Some substances (molecules, ions) such as carbon dioxide (CO_2), oxygen (O_2), water, etc., can move across the plasma membrane through a process called **diffusion.** These substances are of very small size, so, they diffuse readily through the phospholipid layer of the plasma membrane. To understand this process let us perform Activity 2.3.

ACTIVITY 2.3

Let us take a glass beaker or a glass tumbler half filled with clean water. Put a few drops of blue ink or any coloured fluid into the beaker or tumbler. What do you observe ? Does the water in the beaker or tumbler gets uniformly coloured throughout at once ?

You will observe that the ink diffuses into the water gradually until the ink molecules get uniformly distributed in the water. This is a spontaneous movement of a substance from a region of its high concentration to a region where its concentration is low.

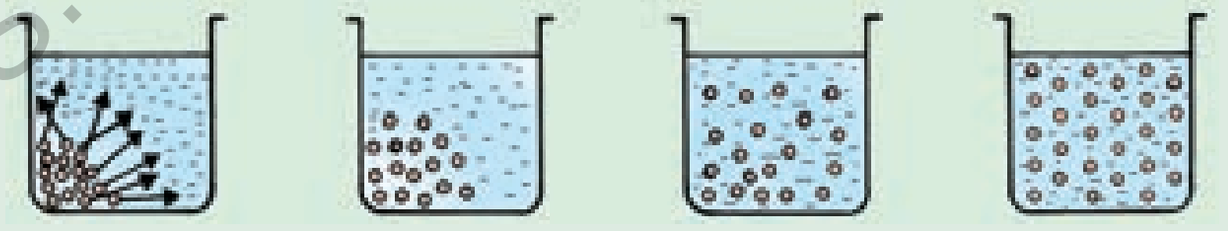


Figure 2.15. Representation of diffusion which is the movement of molecules or ions from an area of higher concentration to the region of lower concentration.

Thus, diffusion is the spontaneous movement of molecules from a region of high concentration to one of lower concentration, until uniform concentration is finally achieved. Diffusion is faster in the gaseous phase than in liquids and solids.

Something similar to diffusion of ink in Activity 2.3 happens in cells when for example, a gas such as CO_2 gets accumulated in high concentration inside a cell. In the external environment of cell, the concentration of CO_2 is low as compared to inside of the cell. As soon as there is a difference of concentration of CO_2, inside and outside of a cell, CO_2 moves out of the cell, *i.e.*, from region of its high concentration to region of low concentration by the process of diffusion. In a similar way, oxygen (O_2) enters the cell (*e.g.*, *Amoeba* ; Fig. 2.16) by the process of diffusion when the level or concentration of O_2 inside the cell decreases.

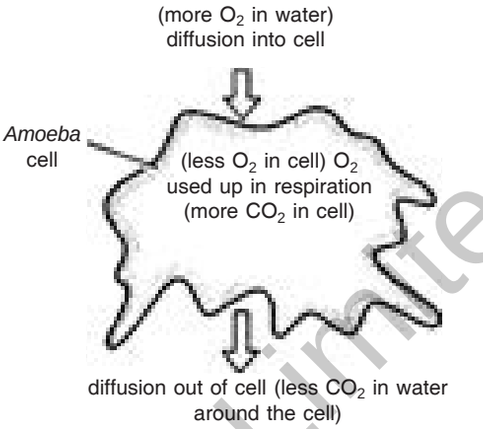


Figure 2.16. Diffusion of oxygen (O_2) and carbon dioxide (CO_2) across the plasma membrane of *Amoeba* (an unicellular organism).

2. Osmosis. Water also follows the law of diffusion. The spontaneous movement of water molecules through a selective permeable membrane (*e.g.*, plasma membrane) is called **osmosis.** The movement of water across the plasma membrane of the cell is affected by amount of substance dissolved in water. Thus, *osmosis is the passage of water from a region of high water concentration through a semi-permeable membrane to a region of low water concentrations* (Fig. 2.17). Osmosis is purely a mechanical diffusion process by which cells absorb water without spending any amount of energy.

Let us see what will happen if you put an animal cell (*e.g.*, red blood cells or RBCs) or plant cells (*e.g.*, *Rheo* leaves) into a solution of sugar or salt prepared in water ? One of the following *three* things could happen:

1. If the medium surrounding the cell has a higher water concentration than the cell, *i.e.*, if solution is a very dilute solution, the cell will gain water by osmosis. Such a dilute solution is called **hypotonic solution**.

While water molecules are free to pass across the plasma membrane in both directions, more water will enter the cell than leave. The net (over all) result is that water enters the cell. In such a situation, cell is likely to swell up, *i.e.*, become inflated or turgid (Fig. 2.18A). Such swollen RBCs may ultimately burst, *i.e.*, haemolysed. (Fig. 2.19B).

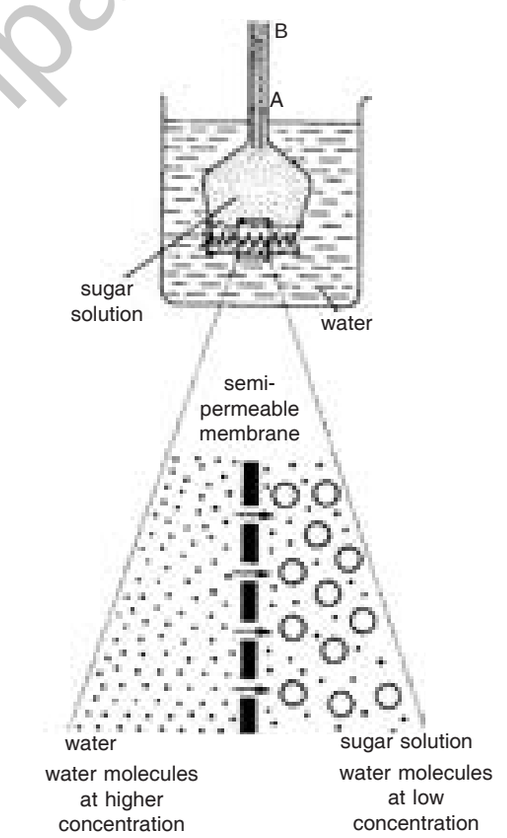


Figure 2.17. Experiment to explain the process of osmosis.

2. If the medium surrounding the cell is of exactly the same water concentration as the cell, there will be no net movement of water across the plasma membrane (Fig. 2.18B and Fig. 2.19 A). Such a solution is called **isotonic solution** (*e.g.*, Ringer's solution is an isotonic solution for the animal cells).

In this case, water crosses the plasma membrane in both directions, but the amount going in is the same as the amount going out, so there is no overall movement of water. In such a situation, the cell will maintain the same size.

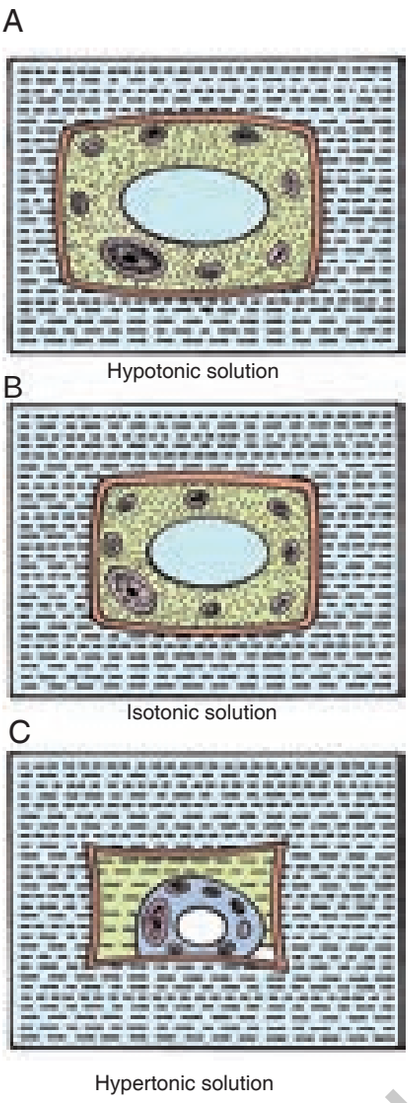


Figure 2.18. Effect of different solutions on plant cells.

3. If the medium has a lower concentration of water than the cell, *i.e.*, if it is very concentrated solution, the cell will lose water by osmosis. Such a concentrated solution is called **hypertonic solution**.

In this case too, water crosses the plasma membrane in both directions, but this time more water leaves the cell than enters it. Therefore, the cell will shrink. In this situation, plant cell is said to be **plasmolysed** (Fig. 2.18C and Fig. 2.26D) and animal cells (Red blood cells) is said to **crenated** (Fig. 2.19C)

To understand osmosis more clearly, you can perform the Activities 2.4, 2.5 and 2.6.

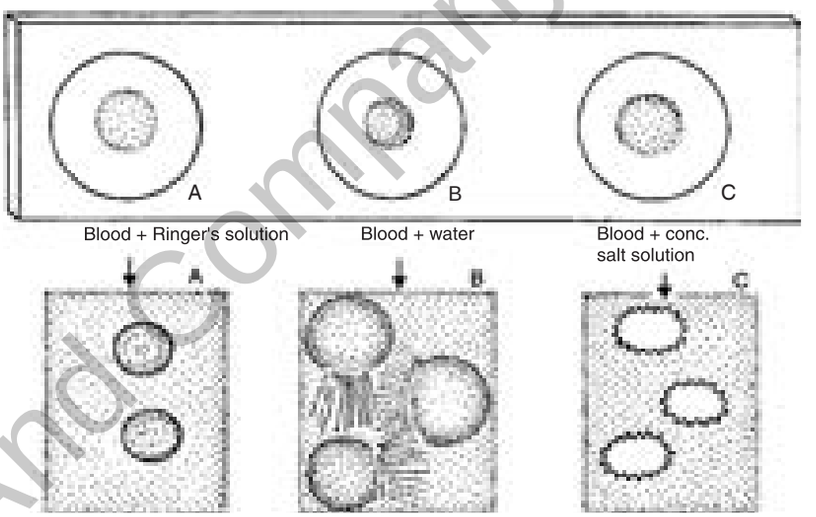


Figure 2.19. Slide showing normal RBCs (A); swollen and haemolysed RBCs (B) and shrunken or crenated RBCs (C).

ACTIVITY 2.4

Osmosis with Human RBCs

Under the supervision of your teacher, clean ring finger of your left hand with spirit and prick it with a disposable needle. Take three drops of blood on a plain slide and mark them as A, B and C. To drop A add a drop of Ringer's solution (an isotonic solution). (Ringer solution is a balanced aqueous solution that contains chloride, sodium, potassium, calcium, bicarbonate and phosphate ions. This solution is used as an isotonic medium for animal cells in the physiological experiments). To drop B add a drop of water (a hypotonic solution) and to drop C add a drop of concentrated salt solution (a hypertonic solution) (Fig. 2.19).

Observe the blood drops under a light microscope. Circular, biconcave, non-nucleated red blood cells (RBCs) are seen in drop A. In drop B, RBCs appear swollen and haemolysed/bursted. In drop C, RBCs appear shrunken (crenated).

ACTIVITY 2.5

Osmosis with an Egg

Take a hen's egg and remove the egg shell by putting the egg in diluted hydrochloric acid (HCl) solution. The shell of an egg is made up mainly of calcium bicarbonate. A thick outer skin (called **shell membrane**), now encloses the egg. Put this processed egg in pure water and observe after 3–5 minutes. You will observe that the egg swells because water enters the egg by osmosis.

In another set of experiment, place a smilar processed egg in a concentrated salt solution and observe for 5 minutes. You will observe that the egg shrinks. The egg shrinks, since water passes out of the egg solution into the salt solution as the salt solution is more concentrated.

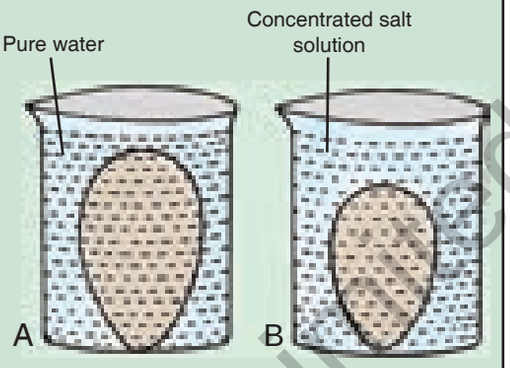


Figure 2.20. Deshelled hen's eggs showing endosmosis (A) and exosmosis (B).

ACTIVITY 2.6

Osmosis with Raisins and Apricots

Put dried raisins and apricots in pure water and leave them for some time (Fig. 2.21). Then place them into a concentrated solution of sugar or salt. Each gains water and swells when placed in pure water due to endosmosis. When such swollen raisins/apricots are placed in the concentrated solution, each of them loses water, and consequently shrinks again(due to exosmosis).

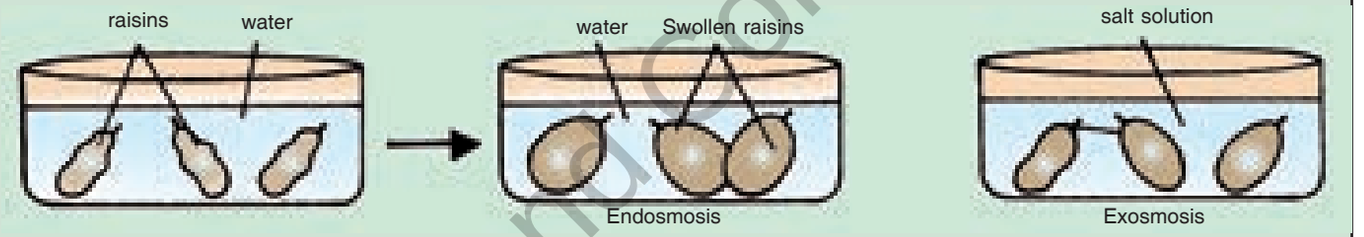


Figure 2.21. Dried raisins placed in water to demonstrate endosmosis and exosmosis

Examples of osmosis. Unicellular freshwater organisms and most plant cells tend to gain water through osmosis. Absorption of water by plant-roots (*i.e.*, by root hairs) is an example of osmosis. (Fig. 2.22).

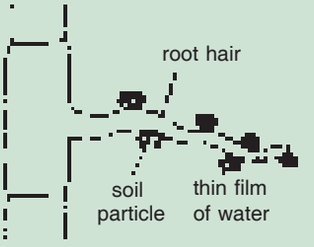


Figure 2.22. Absorption of soil water by root hair through osmosis.

Table 2.7. Differences between diffusion and osmosis.

Diffusion	*Osmosis*
1. Diffusion can occur in any medium.	1. It occurs only in liquid medium.
2. The diffusing molecules may be solids, liquids or gases.	2. It involves movement of solvent molecules only.
3. Semipermeable membrane is not required.	3. Semipermeable membrane is required.
4. It is dependent upon the free energy of the molecules of diffusing substance only ; presence of other substances in the system is of no importance.	4. Though it is the diffusion of solvent molecules only, yet influenced by the presence of other substances (solutes) in the system.
5. An equilibrium in the free energy of diffusion molecules is achieved in the system.	5. Equilibrium in the free energy of solvent molecules is never achieved.

3. Mediated Transport

We have seen that the cell/plasma membrane acts as an effective barrier to the free diffusion of most molecules of biological significance. Yet, it is essential that some materials enter and leave the cell. Nutrients such as sugars and materials of growth such as amino acids must enter the cell, and the wastes of metabolism must be thrown out. Such molecules are moved across the membrane by special proteins called **transport proteins** or **permeases**. Permeases form a small passageway through the membrane, enabling the solute molecule to cross the phospholipid bilayer. Permeases are usually quite specific, only a limited group of chemical susbstances or perhaps even a single substance they recognise and transport.

Types of Mediated Transport

It is of following *two* types :

(1) Facilitated transport/diffusion. In this case, the permease assists a molecule to diffuse through the membrane that it cannot otherwise penetrate.

(2) Active transport. In this case, the energy is supplied to the system (called **pump**) to transport molecules in a direction opposite to a concentration gradient.

Facilitated diffusion, therefore, differs from active transport in that it promotes movement in a downhill direction (*i.e.*, in the direction of concentration gradient) only and requires no metabolic energy to drive the transport system. In many animals, facilitated transport (or facilitated diffusion) aids in the transport of glucose (blood sugar) into the body cells that oxidises it to get ATPs. The concentration of glucose is greater in the blood than in the cells that consume it, favouring inward diffusion. Glucose is a water soluble molecule that by itself is unable to penetrate the membrane rapidly enough to support the metabolism of many cells. The carrier system (*i.e.*, mediated transport) increases the inward flow of glucose.

Table 2.8. Differences between active transport and diffusion.

Active transport	*Diffusion*
1. It is a rapid process.	1. It is a slow process.
2. It can move materials through a biological (cellular) membrane against the concentration gradient.	2. It can move materials across a biomembrane down the concentration gradient.
3. It takes place in one direction only	3. It takes place in both directions.
4. It needs carrier (or transport) proteins to occur.	4. It occurs without the help of carrier proteins.
5. It uses energy of ATP.	5. It does not use energy.
6. It brings about selective uptake of materials.	6. It allows all transmissible molecules to pass through membrane.
7. It leads to accumulation of materials in the cell.	7. It does not accumulate material in the cell.

In **active transport**, molecules are moved uphill against the forces of passive diffusion. Active transport always involves expenditure of energy (from ATP) because materials are pumped against the concentration gradient. The most important active transport system in all animals are those, that maintain *sodium and potassium gradients* between cells and the surrounding extracellular fluid or external environment. *Most animal cells require a high internal concentration of potassium ions for the protein synthesis by the ribosomes and for certain enzymatic functions*. The potassium ion concentration may be 20 to 50 times greater inside the cell than outside. Sodium ions, on the other hand, may be 10 times more concentrated outside the cell than inside. Both of these ionic gradients are maintained by the active transport of potassium ions into and sodium ions out of the cell.

4. Endocytosis

Endocytosis is the ingestion of material by the cells through the plasma membrane. It is a collective term that describes three similar processes : **phagocytosis** ("cell eating), **potocytosis** ("cell drinking) and **receptor-mediated endocytosis** (Fig. 2.23). These processes are pathways to specifically internalize solid particles, small molecules and ion, and macromolecules, respectively. All of them require energy, so they may be regarded as different forms of active transport.

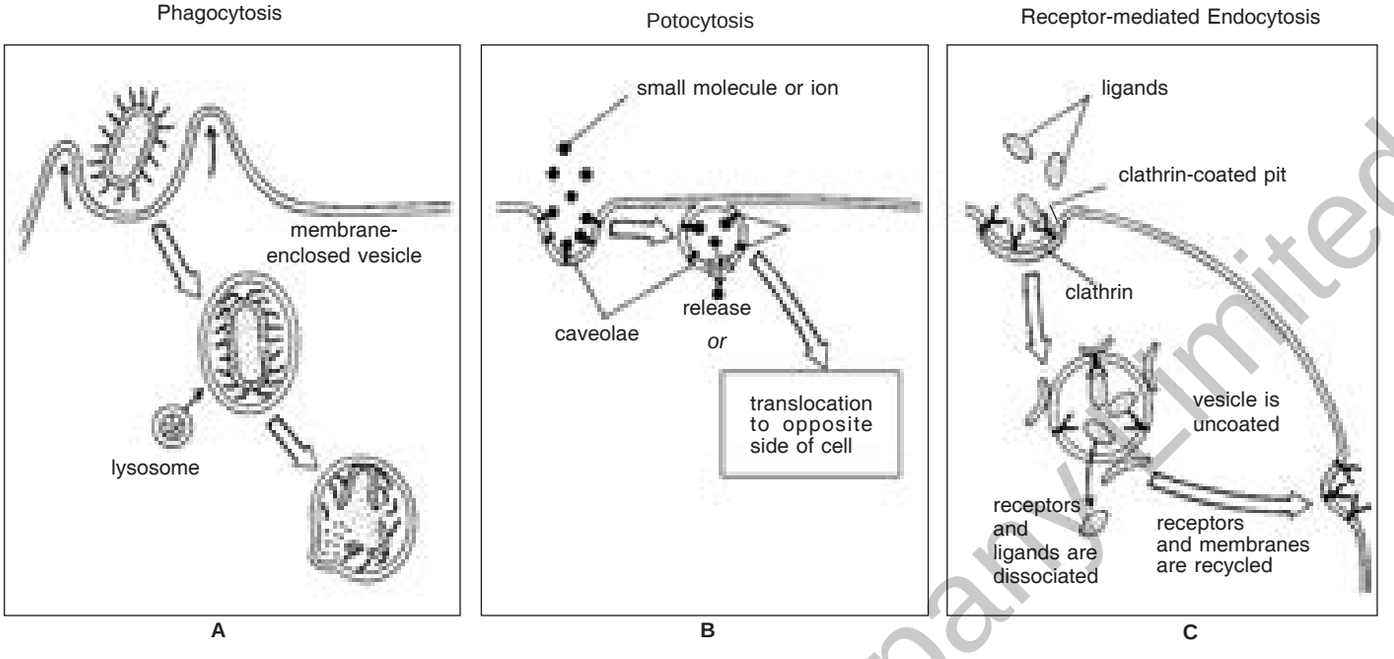


Figure 2.23. **Three types of endocytosis.** In *phagocytosis* the plasma membrane binds to a large particle (adsorption) and extends to engulf it. In *potocytosis* small areas of plasma membrane, bearing specific receptors for a small molecule or ion, invaginate to form caveolae. *Receptor-mediated endocytosis* is a mechanism for selective uptake of large molecules (the ligands) in clathrin-coated pits. Binding of the ligand to the receptor on the surface/plasma membrane stimulates invagination of pits.

Phagocytosis. It literally means "cell eating". It is a common method of feeding among the protozoa (*Amoeba*) and lower metazoa (*e.g.*, sponges). It is also the way in which white blood cells (leucocytes) engulf cellular debris and uninvited microbes (viruses and bacteria) in the blood. Like WBCs, there are other phagocytes, such as the macrophages found in connective tissue and liver sinusoids. In the phagocytosis, an area of the plasma membrane, coated initially with **actin-myosin**, forms a pocket that engulfs the solid material (*e.g.*, bacteria, debris). The membrane-enclosed vesicle, *phagosome*, then detaches from the cell surface (= plasma membrane) into the cytoplasm where its contents are digested by lysosomal enzymes (Fig. 2.24).

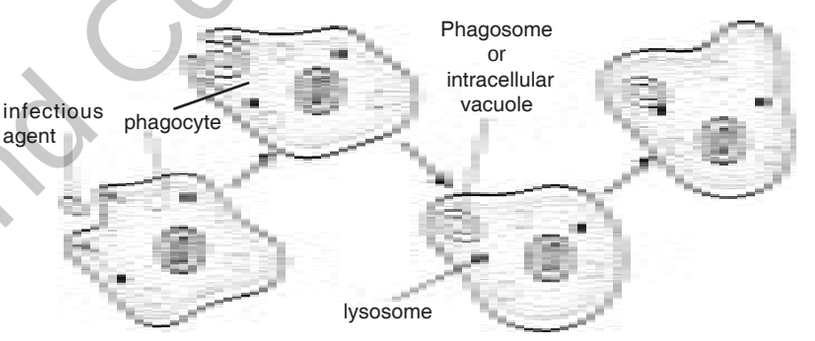


Figure 2.24. **Phagocytosis.** In pseudopodial movement, the phagocyte (a type of white blood cell) engulfs the particle. Lysosomes join with the vacuole containing ingested particle, and pour their contents (the digestive enzymes) into the vacuole, to destroy the particle.

Table 2.9. Differences between endocytosis and phagocytosis.

Endocytosis	*Phagocytosis*
1. It is the intake of extra-cellular fluid, droplets and macromolecules.	1. It is the intake of extracellular particles.
2. Plasma membrane invaginates to take up the materials.	2. Plasma membrane grows around the particle as pseudopodia.
3. It is a nutritive process.	3. It is a nutritive and a defensive process.
4. Endocytotic vesicles are only 0.1 µm wide.	4. Phagocytotic vesicles are 1 to 2 µm or more wide.

5. Exocytosis

Just as materials can be brought into a cell by invagination and formation of a vesicle, the membrane of a vesicle can fuse with the plasma membrane and extrude its contents to the surrounding medium. This process is called **cell vomiting** or **exocytosis**. Exocytosis occurs in various cells to 1. remove undigested residues of substances brought in by endocytosis, 2. secrete substances such as hormones, enzymes, and 3. transport a substance completely across a cellular barrier. For example, a susbstance (*e.g.*, IgA or immunoglobulin/ antibody) may be picked up on one side of the wall of blood vessel by phagocytosis, moved across the cell, and released by exocytosis.

In the process of exocytosis (Fig. 2.25), the undigested waste-containing food vacuole or the secretory vesicle budded from a Golgi apparatus, is first moved by cytoskeleton from the interior of the cell to the surface. The vesicle membrane comes in contact with the plasma membrane. The lipid molecules of the two bilayers rearrange themselves and the two membranes are, thus, fused. A passage is formed in the fused membrane and the vesicle discharges its contents outside the cell.

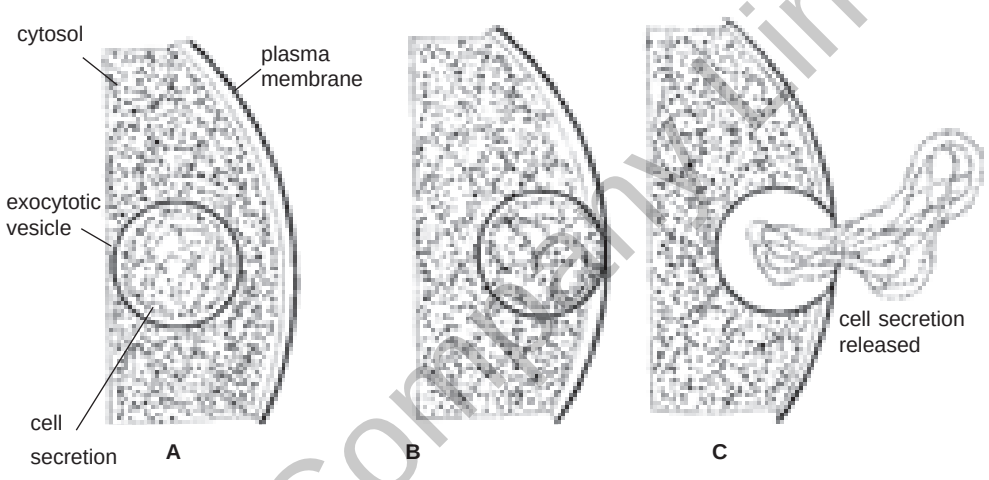


Figure 2.25. Exocytosis by a cell.

ACTIVITY 2.7

Note about electron microscopes from resources in the school library or through the internet. Discuss it with your teacher.

2. CELL WALL

In plant cells, there occurs a rigid **cell wall** which lies outside the plasma membrane. Cell wall is non-living and freely permeable and is secreted by the cell itself for the protection of its plasma membrane and cytoplasm. It determines the shape of a plant cell and prevents desiccation of cells. It is made up of a fibrous polysaccharide (carbohydrate) called **cellulose**. The plant cell wall, thus, consists of tiny cellulose fibres called **microfibrils**, glued together by a mixture of polysaccharides. Each microfibril is made up of thousands of cellulose molecules bound together by pectins and hemicellulose.

As you may recall from your observation of cells of onion peel, the presence of cell wall make plant cells clearly visible as distinct units when viewed under a microscope.

Functions of a cell wall. Cell wall of plants performs the following functions :

1. It permits the plant cell to become **turgid**. As water enters the vacuole through osmosis, the plant cell expands. The cell wall has to be strong enough to resist this expansion and so enables the cell to become turgid.
2. It provides mechanical strength to support the cell. The cellulose microfibrils are very strong. The strength may be further increased by the addition of **lignin** in tissues such as xylem. In cells such as collenchyma, extra cellulose is added to the cell wall to increase mechanical support.
3. It is freely permeable to water and substances in solution.

4. It has narrow pores, called pits, through which fine strands of cytoplasm, called **plasmodesmata**, are able to pass. These intercellular connections allow exchange of materials between the living cell contents.
5. The cell walls of adjacent cells are glued together by the **middle lamella**. Middle lamella is a jelly-like substance made up of calcium and magnesium pectate.

Plasmolysis. When a living plant cell loses water through osmosis, there is a shrinkage or contraction of the protoplasm away from the cell wall (Fig. 2.26). This phenomenon is called **plasmolysis**. Thus, if a living plant cell is immersed in a concentrated sugar solution, the concentration of water molecule inside the cell will be higher than outside. As a result, water will move by *osmosis* from the *higher water potential* inside the cell to the *lower water potential* outside. The cell contents will shrink away from the cell wall and it will be plasmolysed (Activity 2.8).

ACTIVITY 2.8

Mount a complete *Rheo* leaf in water on a slide and examine cells of leaf under the high power of a microscope. Note the location of small green granules which represent the chloroplasts having chlorophyll pigment. Put a few drops of strong solution of sugar or salt on the mounted leaf on the slide. Wait for a minute, so that process of osmosis may occur and water may come out from the leaf cells. Again observe the leaf under the microscope. You will observe that the cell contents are separated from the cell wall, *i.e.*, space between cell wall and chloroplast-containing cell content (protoplasm) is widened (Fig. 2.26 D).

These changes can be explained by the fact that outer medium is hypertonic, so water moves out leaf cells to cause plamolysis.

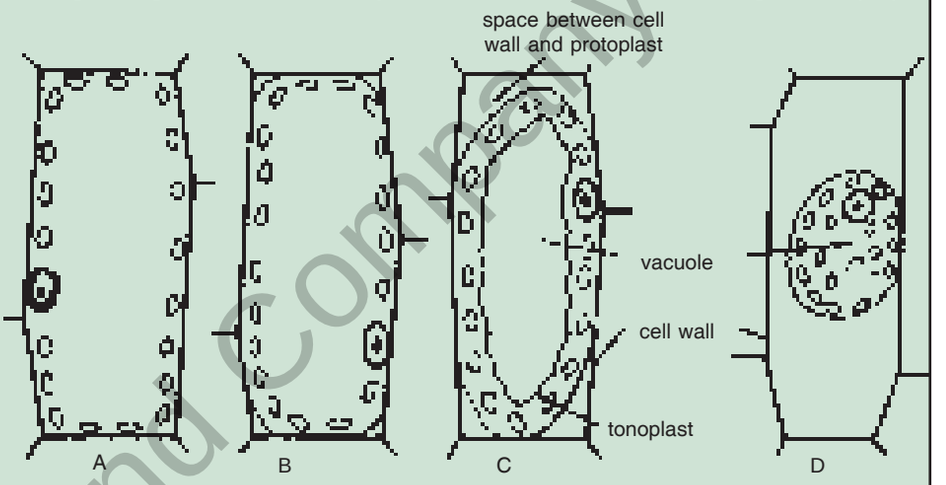


Figure 2.26. Plasmolysis. A–A turgid or normal plant cell of *Rheo* ; B – D – Successive stages in the shrinkage of cell content (protoplasm) from the cell wall.

Now place some *Rheo* leaves in boiling water for a few minutes. This kills the cells of a leaf. Then mount one boiled leaf on a slide and observe it under the microscope. Put a few drops of strong solution of sugar or salt on the mounted leaf on the slide. Wait for a minute and observe it again. In this experiment, you will observe that plasmolysis does not occur. This means that the process of osmosis does not occur in boiled plant (leaf) cells. In other words, it is proved by this experiment that property of selective permeability exists only in the living plasma membrane.

Thus, only living cells possess selectively permeable plasma membrane and they are, therefore, able to absorb water by osmosis.

Table 2.10. Differences between cell wall and plasma membrane.

Cell wall	*Plasma membrane*
1. It occurs in plant cells.	1. It is found in both plant and animal cells.
2. It lies outside of the cells.	2. It lies on the outside of animal cells and inner to cell wall in plant cells.
3. It is nonliving and quite thick in plant cells.	3. It is living and quite thin.
4. It is rigid.	4. It is flexible.
5. It is generally permeable.	5. It is selectively permeable.
6. It is formed of cellulose, hemicellulose and pectin.	6. It is formed of lipids and proteins and small number of small carbohydrates (*i.e.*, oligosaccharides).
7. Its major function is to provide protection and strength to the cell.	7. Its major function is to hold cellular contents and control passage of materials in and out of the cell.

3. NUCLEUS

Nature and occurrence. The nucleus is a large, centrally located spherical cellular component (Activity 2.9). It is bounded by two nuclear membranes, both forming a **nuclear envelope** (Fig. 2.27). Nuclear envelope encloses a space between two nuclear membranes and is connected to a system of membranes called the ER (endoplasmic reticulum; Fig. 2.28).

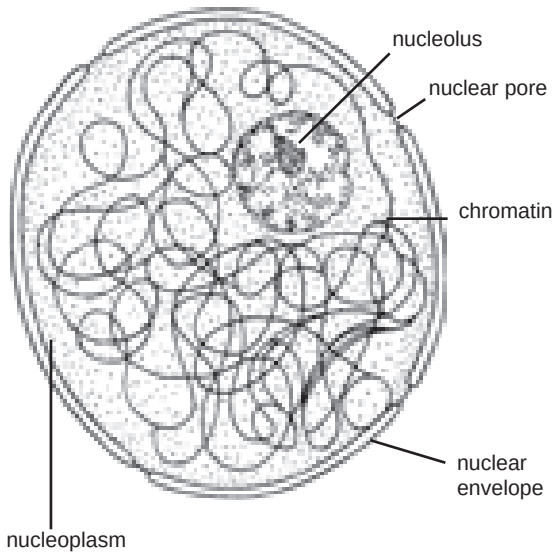


Figure 2.27. Structure of a nucleus.

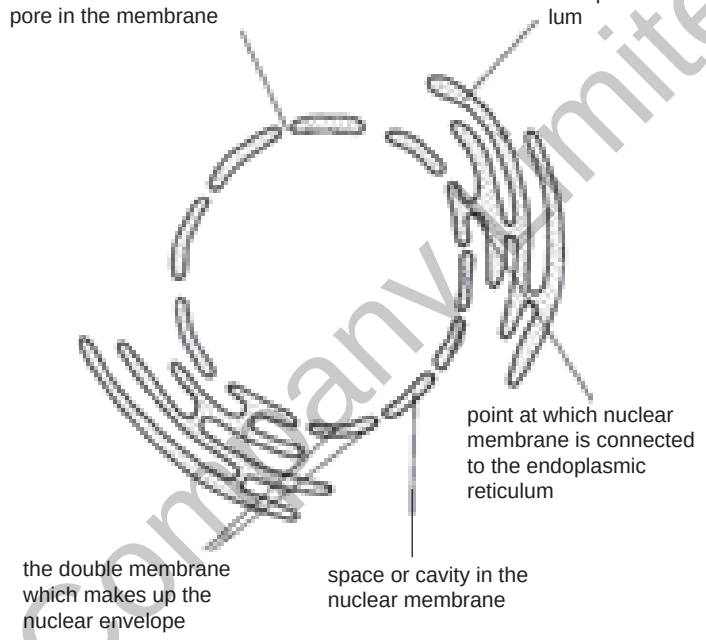


Figure 2.28. Connection of nuclear envelope with ER.

The nuclear envelope separates the nucleus from the cytoplasm. The nuclear envelope contains many pores (the **nuclear pores**) and encloses the liquid ground substance, the **nucleoplasm**. Nucleopores allow transfer of materials between the nucleoplasm and the cytoplasm. Within nucleoplasm two types of nuclear structures are embedded—the nucleolus and chromatin material. The **nucleolus** may be one or more in number and is not bounded by any membrane. It is rich in protein and RNA (ribonucleic acid) molecules and acts as the site for ribosome formation. Nucleolus is known as **factory of ribosomes**. Ribosomes are helpful in protein synthesis in the cytoplasm.

ACTIVITY 2.9

Observation of Nucleus in the Animal Cells

Take a glass slide and put a drop of water on it. This is done to put the material under microscopic observation. Using a toothpick or an ice-cream spoon you can scrape the inside surface of your cheek. With the help of a needle you can transfer this material and spread it evenly on the cleaned glass slide. To colour this material, you can put a drop of **methylene blue** solution/stain on it. Finally put a coverslip over this stained material and observe this temporary mount/slide under the high power of a microscope. You will observe a spherical or oval dot-like structure, called **nucleus** near the centre of each cheek cell (Fig. 2.29). In the chapter of Tissues, you will learn that these cells are of squamous epithelium. You can draw diagrams of these cells on your observation sheet and label them. Similar structure (*i.e.,* nucleus) has been observed in the onion peel cells.

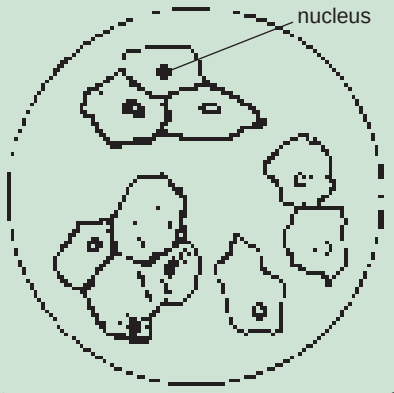


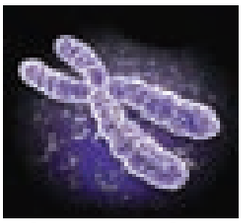
Figure 2.29. Microscopic view of cheek cells.

The **chromatin material** is a thin, thread-like intertwined mass of chromosome material and composed of the genetic substance **DNA** (deoxyribonucleic acid) and proteins (*i.e.,* histones). Basically chromatin is formed of repeating subunits, the **nucleosomes**, each of which has a DNA molecule coiled around a disc of histones. DNA stores all the information necessary for the cell to function (*i.e.,* metabolism), to grow and to reproduce further cells of the next generation. Distinct segments of DNA are called **genes**. The chromatin is condensed into two or more thick ribbon-like **chromosomes** during the division of cell.

Table 2.11. Differences between nucleus and nucleolus.

Nucleus	*Nucleolus*
1. It represents the whole eukaryotic complex that contains genetic information.	1. It is a component of nucleus.
2. It is covered by a two membrane envelope.	2. It does not have a covering membrane.
3. It controls the structure and working of cells.	3. It synthesizes ribosomal subunits.

Structure of Chromosomes



A chromosome during cell division

Chromosomes are thread-like structures usually present in the nucleus that become visible only during cell divisions (mitosis and meiosis). Chromosomes contain hereditary information of the cell in the form of genes (hereditary units; see Box 2.3). Each chromosome is made up of *two* components :

1. DNA (deoxyribonucleic acid), and
2. Proteins (*e.g.,* histones and acidic proteins).

DNA is the most important component of chromosome. It is the material of genes (*i.e.,* genetic material).

Most chromosomes consist of two **arms** that extend out from a specialised region of DNA, called the **centromere** (meaning" middle body"). Centromere or **primary constriction** gives a particular shape to chromosomes due to it's position. The chromosome extremities or terminal regions on either side are called **telomeres.**

Chromatids. Before a cell divides, it duplicates its chromosomes (*i.e.,* each DNA molecule of each chromosome makes a copy of itself and becomes associated with proteins). The two copies of chromosomes remain attached at their centromeres. As long as two copies of a chromosome are attached to the common centromere, they are called **sister chromatids.** Both chromatids of a chromosome are identical, with identical genes. During cell division, the two sister chromatids separate and each chromatid becomes an independent daughter chromosomes (Fig. 2.30).

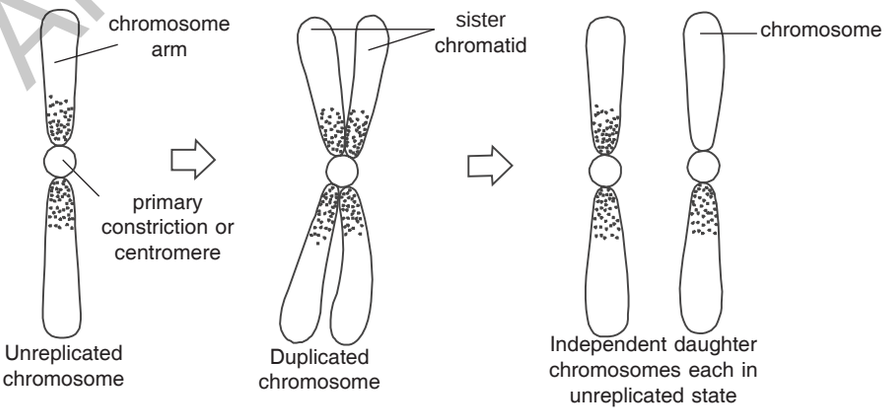


Figure 2.30. Sister chromatids and daughter chromosomes.

Diploid and Haploid Number of Chromosomes

Every eukaryotic species has a fixed number of chromosomes in its cells. The number of chromosomes varies from minimum two (in roundworm, *Ascaris megalocephala*) to a few hundred in different species. In human beings there are 46 chromosomes (44 autosomes + 2 sex chromosomes) in each body (or somatic) cell. There is always a pair of chromosomes of each kind (Box 2.7). The paired condition of chromosomes

is known as **diploid** and a cell which has the full number of chromosomes (*i.e.,* two of each kind) is called **diploid cell.** Body cells in human beings are diploid.

A set comprising of unpaired chromosomes of each kind is said to be **haploid** and a cell which has half the number of chromosomes (*i.e.,* one of each kind) is called a **haploid cell.** The gametes in human beings are haploid.

Box 2.7

Significance of Diploidy

Diploid state of organisms is originated during process of fertilization of sexual reproduction. During fertilization, two haploid cells or gametes of different types : sperm of man and ovum of woman are fused together to produce a diploid egg (zygote). This egg divides by mitotic cell divisions to form numerous diploid body cells, making the body of the diploid organism.

Thus, 46 chromosomes (*i.e.,* two of each kind or 23 pairs) in each body cells in human beings represent diploid number and 23 chromosomes (*i.e.,* one of each kind) in the sex cells or gametes (sperm and ovum) in human beings represent haploid number.

Box 2.8

Cells which lack the nucleus

1. Red blood cells of humans and other mammals lose their nuclei and this enables them to carry more haemoglobin and hence pick up more oxygen.
2. Phloem sieve tubes provide the transport system for sucrose in plants. They lose most of the cell organelles including their nuclei. This makes it easier for materials to flow through it.

Functions :

1. The nucleus controls all metabolic activities of the cell. If the nucleus is removed from a cell, the protoplasm ultimately dries up and dies.
2. It regulates the cell cycle.
3. It is concerned with the transmission of hereditary traits from the parent to offspring.

4. CYTOPLASM

Nature and occurrence. The part of the cell which occurs between the plasma membrane and nuclear envelope is called the **cytoplasm.** The inner granular mass of the cytoplasm is often called **endoplasm**, while the outer, clearer (glassy) layer is called **cell cortex** or **ectoplasm.**

Cytoplasm consists of an aqueous ground substance, the **cytosol**, containing a variety of cell organelles and other inclusions such as insoluble waste and storage products (starch, glycogen, lipid, etc.).

(a) Cytosol

It is the soluble part of cytoplasm. It forms the ground substance or "background material" of the cytoplasm and is located between the cell organelles. Cytosol contains a system of protein fibres called **cytoskeleton** (Box 2.9), but otherwise appears transparent and structureless in the electron microscope. Cytosol is about 90 per cent water and forms a solution which contains all biochemicals of life. Some of these are ions and small molecules forming **true solutions** such as salts, sugars, amino acids, nucleotides, vitamins and dissolved gases (Table 2.12). Others are large molecules such as proteins which form **colloidal solution**. A colloidal solution may be a **sol** (non-viscous) or a **gel** (viscous); often ectoplasm is more gel-like.

Box 2.9

Cytoskeleton

Recently complex networks of fibrous protein structures have been shown to exist in the cytosol of eukaryotic cells. These networks collectively form **cytoskeleton** which contains three types of protein fibres :

1. Microtubules (of tubulin protein),
2. Microfilaments (of actin protein),
3. Intermediate filaments (of keratin and other types of proteins).

These fibrous proteins help in cellular **movement** *i.e.,* amoeboid movement and cyclosis). They also help the cells to maintain their shapes.

Table 2.12. Chemical constituents of the cytoplasm or cytosol.

Chemical	*Percentage*
1. Oxygen	64.00
2. Carbon	18.00
3. Hydrogen	10.00
4. Nitrogen	0.3.00
5. Trace elements (Ca, P, Cl, S, K, Na, Mg, I, Fe)	0.5.00

Functions :

1. Cytosol (cytoplasm) acts as a store of vital chemicals such as amino acids, glucose, vitamins, ions, etc.
2. It is the site of certain metabolic pathways, such as glycolysis. Synthesis of fatty acids, nucleotides, and some amino acids also take place in the cytosol.
3. Living cytoplasm is always in a state of movement.

(b) Cell Organelles

A cell has to perform different functions with the help of its various membrane-bound organelles (Table 2.6):

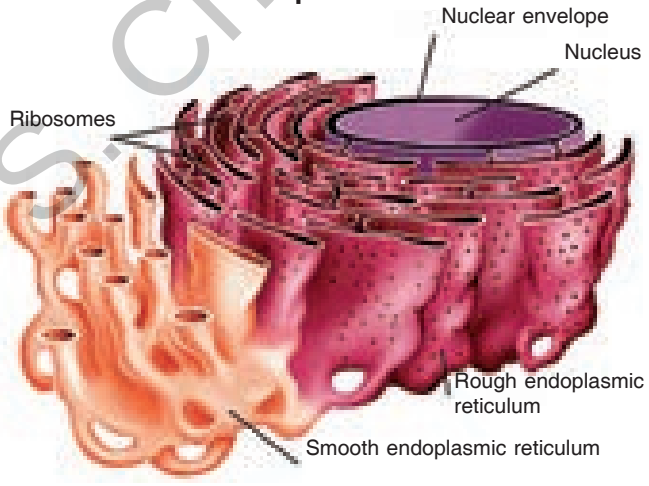
1. It has to **synthesize** substances, *e.g.,* protein synthesis by ribosomes, lipid synthesis on the surface of smooth endoplasmic reticulum (SER), photosynthesis of food (*e.g.,* glucose, starch) by chloroplasts.
2. It has to **secrete** cell products, *e.g.,* enzymes, hormones, mucus, etc.
3. It has to **digest** those substances which are taken up by the cell during endocytosis. Such intracellular digestion is done by enzymes of lysosomes.
4. It has to **generate energy**, *e.g.,* synthesis of energy-rich ATP (adenosine triphosphate) by mitochondria.

Membrane is a remarkable cellular structure. Every cell is bounded by a membrane and thus, keeps its own contents separate from the external environment. Larger or more evolved cells, or cells from multicellular organisms, have a great deal of metabolic activities to support their complicated structure or function. To keep metabolic activities of different types separate from each other, cells have membrane bound organelles within themselves. Cell organelles are "small organs" of the cell and are found embedded in the cytosol. They form living part of the cell and each of them has a definite shape, structure, and function. Examples of such organelles are nucleus, mitochondria, chloroplasts, endoplasmic reticulum, Golgi apparatus, lysosomes, ribosomes, etc. We have already discussed about the nucleus in a previous section. In this section, we will discuss the cellular organelles one by one.

1. Endoplasmic Reticulum (ER)

Nature and occurrence. Inside the cell there exists a membranous network enclosing a fluid-filled lumen which almost fills up the intracellular cavity. It is called **endoplasmic reticulum** (**ER**). At one end ER is connected to the outer membrane of the nucleus and at the other end to the plasma membrane. ER occurs in *three* forms : **cisternae** (*i.e.,* closed, fluid-filled sacs), **vesicles** and **tubules** (Fig. 2.31). It is of two types :
1. Rough endoplasmic reticulum (RER) with ribosomes attached on its surface for synthesizing proteins.
2. Smooth endoplasmic reticulum (SER) which is without ribosomes and is meant for secreting lipids.

Three-Dimensional Endoplasmic Reticulum



Endoplasmic Reticulum.

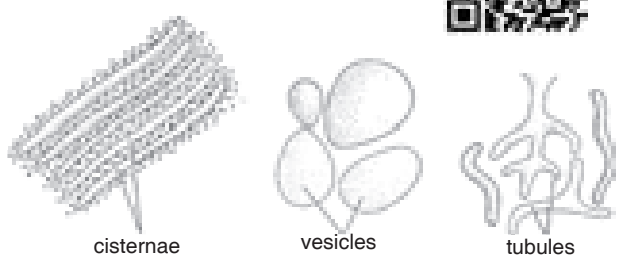


Figure 2.31. Various parts of ER.

The ER is absent in the red blood cells of mammals.

Functions :

1. It forms supporting skeletal framework of the cell.
2. ER provides a pathway for the distribution of nuclear material from one cell to the other.
3. Certain enzymes present in smooth ER synthesize fats (lipids), steroids and cholesterol.
4. Rough ER is concerned with the transport of proteins which are syntehsized by ribosomes on their surface.

Some special functions of endoplasmic reticulum. Endoplasmic reticulum performs the following important functions :

1. Smooth ER of liver of vertebrates helps in **detoxification**. It metabolises various toxic or poisonous substances such as drugs, aspirin, insecticides (DDT), petroleum products and pollutants. These toxic substances make their entry in animal's body through food, air or water.
2. Smooth ER plays an important role in the biosynthesis of **glycolipids, phospholipids** and **cholesterol**. These lipids are used in the formation of plasma or cell membrane and various steroid hormones.
3. Hormones are either steroids or proteins. Smooth ER synthesizes steroid hormones such as estrogen, testosterone and cortisol.
4. Enzymes are proteins. Digestive (hydrolytic) **enzymes of lysosomes** are produced by rough ER. Any enzyme which is meant for the lysosomes is synthesized on the ribosomes attached to the surface of rough ER. It then enters in the lumen of rough ER. From the rough ER this enzymatic protein is transported to Golgi apparatus where it is marked to be included into lysosome.
5. Plasma membrane and other cellular membranes are also formed by endoplasmic reticulum. The **lipid molecules** for cell membrane are formed and inserted into the smooth ER membrane by smooth ER itself. The **protein molecules** of cell membrane are mostly synthesized and inserted into membrane at the level of rough ER. In the process of **glycosylation**, short chains of sugars, called **oligosaccharides**, are added to molecules of proteins and lipids at the level of Golgi apparatus. For example, the formation of plasma membrane, called **membrane biogenesis**, involves the following organelles, all forming the so-called **endomembrane system :**
   Rough ER → Smooth ER → Golgi apparatus → Secretory vesicle → Plasma membrane.
6. Proteins which are synthesized by the cell and then are released into outer medium of the cell, are called **secretory proteins**. Examples of secretory proteins include mucus, digestive enzymes and hormones (*e.g.*, insulin). These proteins are synthesized by rough ER.

Table 2.13. Differences in rough endoplasmic reticulum (RER) and smooth endoplasmic reticulum (SER).

Rough Endoplasmic Reticulum	*Smooth Endoplasmic Reticulum*
1. It contains flattened sacs called cisternae.	1. It is mainly formed of vesicles and tubules.
2. Ribosomes are attached to the outer surface of its membrane.	2. It does not contain ribosomes.
3. It is specialized to synthesize proteins.	3. It is specialized to synthesize lipids and steroids.
4. It is abundant in exocrine pancreatic cells and antibodies secreting plasma cells.	4. It is abundant in liver and the testicular cells (*e.g.*, Leydig cells) synthesizing steroid hormones.

2. Ribosomes

Nature and occurrence. Ribosomes are dense, spherical and grannular particles which occur freely in the matrix (cytosol) or remain attached to the endoplasmic reticulum (RER). Chemically, the major constituents of ribosomes are the ribonucleic acid (RNA) and proteins. Lipids are not present in ribosomes. Ribosomes are not bounded by a membrane. They are present both in prokaryotic and eukaryotic cells (except mammalian RBC).

Function. Ribosomes play an important part in the synthesis of proteins (Fig. 2.32).

3. Golgi Apparatus (Golgi Body or Golgi Complex)

Nature and occurrence. Golgi apparatus consists of a set of membrane-bounded, fluid-filled vesicles, vacuoles and flattened cisternae (closed sacs). Cisternae are usually stacked together (placed one above the other) in parallel rows(Fig. 2.33). Golgi apparatus exists as an extensive network near the nucleus in the animal cells. However, the plant cells contain many freely distributed subunits of Golgi apparatus, called **dictyosomes.** Cisternae are formed at one end of the stack, called *cis* face of Golgi. They are budded off as vesicles at the other face of Golgi apparatus, called *trans* face of Golgi.

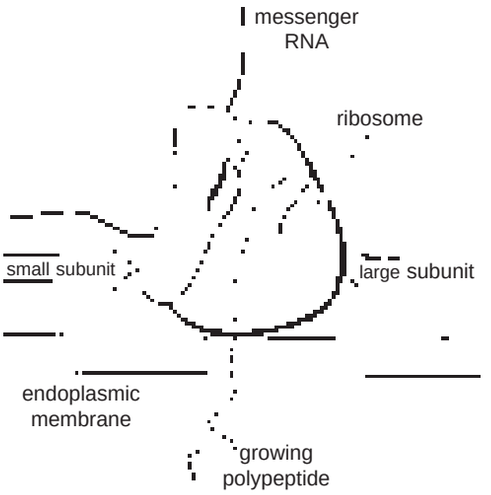


Figure 2.32. Protein synthesis on the Ribosome of RER.

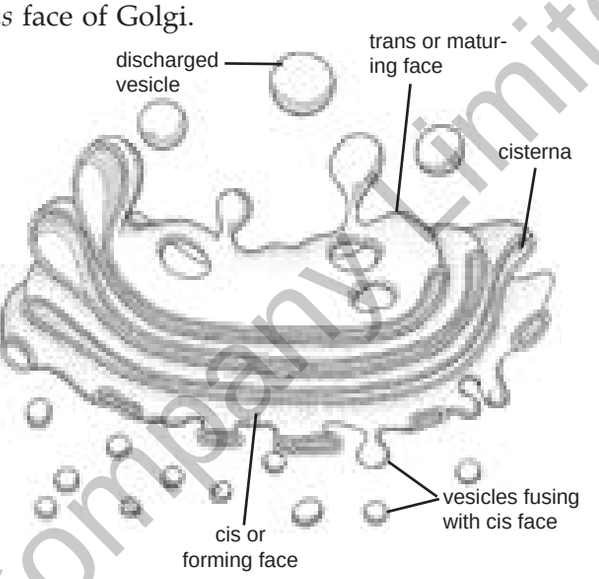


Figure 2.33. Golgi apparatus.

Golgi apparatus is absent in bacteria, blue-green algae, mature sperms and red blood cells of mammals and other animals.

The Golgi apparatus arises from the membrane of the smooth endoplasmic reticulum, which in turn originates from the rough endoplasmic reticulum. The proximal Golgi saccules (cisternae at cis face) are formed by fusion of ER-derived vesicles, while distal saccules (cisternae at trans face) "give their all" to vesicle formation and disappear. Thus, Golgi saccules are constantly and rapidly **renewed**.

Functions :

1. The main function of the Golgi apparatus is **secretory.** Golgi apparatus acts as a way-station or assembly area for the storage, processing and packaging of various cellular secretions. It **packages** materials synthesized in the cell and **dispatches** them either to intracellular targets such as plasma membrane and lysosomes or extracellular targets (*e.g.*, zymogens).
2. It produces **vacuoles** or **secretory vesicles** which contain cellular secretions, *e.g.*, enzymes, proteins, cellulose, melanin pigment, lactoprotein of milk, etc.
3. Golgi apparatus is also involved in the synthesis of cell wall, plasma membrane and lysosomes.

4. Lysosomes

Nature and occurrence. Lysosomes are simple tiny spherical sac-like structures evenly distributed in the cytoplasm. Each lysosome is a small vesicle surrounded by a single membrane and contains powerful enzymes. These enzymes are capable of digesting or breaking down all organic materials. Lysosomal enzymes are made by RER.

Functions :

1. Lysosomes serve as intracellular digestive system, hence, called **digestive bags**. They destroy any foreign material which enter the cell such as bacteria and virus. In this way they protect the cells from bacterial infection.

2. Lysosomes also remove the worn out and poorly working cellular organelles by digesting them to make way for their new replacements. In this way, they remove the cell debris and are also known as **demolition squads**, **scavengers** and **cellular housekeepers**. Thus, lysosomes form a kind of **garbage disposal system** of the cell.

3. During breakdown of cell structure, when the cell gets damaged, lysosomes may burst and the enzymes eat up their own cells. Therefore, lysosomes are also known as **suicide bags** of a cell (Box 2.10).

Box 2.10

Significance of Lysosomes

1. **In WBC or leucocytes.** Cells of leucocytes digest foreign proteins, bacteria and viruses.
2. **In autophagy.** During starvation, the lysosomes digest stored food contents such as proteins, fats and glycogen of the cytoplasm and supply the necessary amount of energy to the cell.
3. **In metamorphosis** (**Frog**). During the transformation of a tadpole into frog, the embryonic tissues such as gills and tail are digested by the lysosomes and utilized by other body cells.
4. **In fertilization.** The lysosomal enzymes present in the **acrosome** of sperm cells digest the limiting membrane of the ovum (egg). Thus, the sperm is able to enter the ovum and start the fertilization.

5. Mitochondria

Nature and occurrence. The mitochondria (singular : mitochondrion) are tiny bodies of varying shapes (cylindrical, rod-shaped, spherical) and size (0.2 mm to 2 mm), distributed in the cytoplasm. Each mitochondrion is bounded by a double membrane envelope. Outer membrane is porous. The inner membrane is thrown into folds and, therefore, have an area several times the surface of area of the outer membrane (Fig. 2.34). These folds are called **cristae** and are studded (dotted) with small rounded bodies known as **F_1 particles** or **oxysomes**. The interior cavity of the mitochondria is filled with a proteinaceous (gel-like) **matrix** which contains a few small-sized ribosomes, a circular DNA molecule and phosphate granules. Mitochondria are absent in bacteria and the red blood cells of mammals.

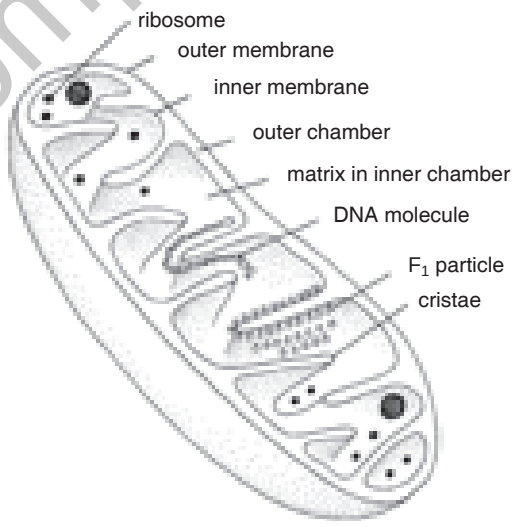


Figure 2.34. A longitudinally cut mitochondrion showing its internal structure.

Functions :

Mitochondria are sites of cellular respiration. They use molecular oxygen from air to oxidise the carbohydrates and fats (lipids) present in the cell to carbon dioxide and water vapour. Oxidation releases energy, a portion of which is used to form ATP (adenosine triphosphate). Since the mitochondria synthesize, energy-rich compounds (ATP), they are known as '**power house**' of the cell. The energy stored in ATP is used by the cell.

ATP stands for the organic compound adenosine triphosphate. ATP is generally known as **energy carrier** or **energy currency** of the cell. It is a common cellular fuel, *i.e.*, it is used to drive numerous energy-requiring processes of the cell. The body of an organism uses the energy stored in ATP for 1. **synthesis of chemical compounds** (*e.g.*, DNA replication, transcription of RNAs, and synthesis of proteins, carbohydrates and lipids) and 2. **mechanical work**, such as contraction of muscles (for movement, locomotion, peristalsis), movement of cilia and flagella, conduction of nerve impulse and production of heat, electricity (*e.g.*, electric eel), and light (*e.g.*, fire flies).

Mitochondria are able to make some of their own proteins; so, they are regarded as **semiautonomous organelles**.

6. Plastids

Nature and occurrence. Plastids occur in most plant cells and are absent in animal cells. Like the mitochondria, the plastids also have their own genome (*i.e.*, DNA) and ribosomes. They are self-replicating organelles like the mitochondria, *i.e.*, they have the power to divide. Plastids are of following three types :

1. **Chromoplasts.** Coloured plastids (except green colour).
2. **Chloroplasts.** Green-coloured plastids.
3. **Leucoplasts.** The colourless plastids.

Table 2.14. Differences between leucoplasts and chromoplasts (nongreen plastids).

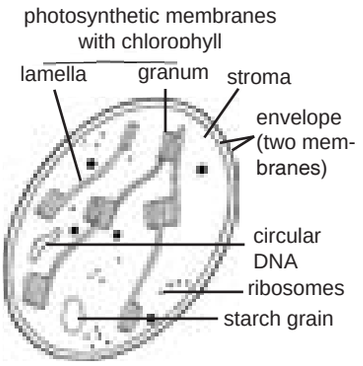
Leucoplasts	*Chromoplasts*
1. They are colourless.	1. They range from brownish to reddish in colour.
2. They are cylindrical or rounded in shape.	2. They are irregular in shape.
3. They are found in unexposed cells.	3. They are found in both exposed and unexposed cells.
4. They can change to other types of plastids.	4. They do not change into other types of plastids.
5. They take part in storage of food, *e.g.*, amyloplasts (carbohydrates), elaioplasts (lipids), aleuroplasts (proteins).	5. They provide colour to organs to attract pollinators and disseminators.

Table 2.15. Differences between chloroplasts and chromoplasts.

Chloroplasts	*Chromoplasts*
1. They are green plastids.	1. They are non-green coloured plastids.
2. They contain chlorophylls and carotenoids.	2. Chlorophylls are absent. Only carotenoids are present.
3. Lamellae are present.	3. Lamellae are absent.
4. Chloroplasts are sites of photosynthesis.	4. They add colour to the organs (*e.g.*, flowers, fruits) for attracting animals to perform pollination and fruit dispersal.

7. Chloroplasts

Nature and occurrence. Chloroplasts are present in green algae and higher plants. They have a green pigment called **chlorophyll** and they are involved in the photosynthesis of food. So chloroplasts are the "**kitchens of the cells**". Each chloroplast (Fig. 2.35) is bounded by two unit membranes like the mitochondria. It shows two distinct regions : **1. Grana** are stacks of membrane-bounded, flattened discoid sacs (called **thylakoids**) containing the molecules of chlorophyll. They are the main functional units of chloroplasts. **2. Stroma** is the homogeneous matrix in which grana are embedded. Stroma contains a variety of photosynthetic enzymes, starch grains, DNA and ribosomes.



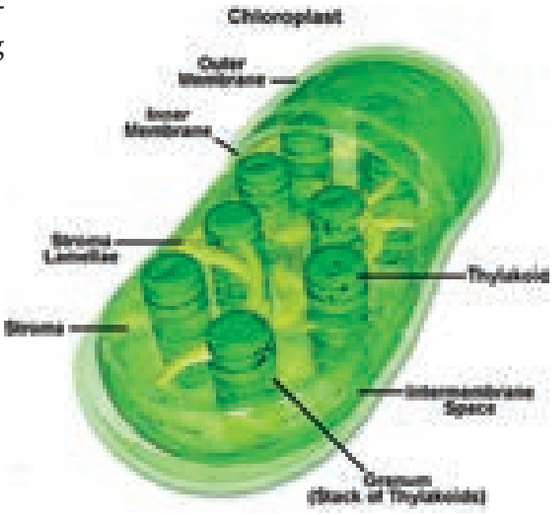


Figure 2.35. Internal structure of chloroplast.

Granum is the site of **light reaction** during photosynthesis, while stroma is the site of **dark reaction** during photosynthesis.

Functions :

Plastids perform the following functions :

1. Chloroplasts trap solar energy and utilises it to manufacture food for the plant.
2. Chromoplasts impart various colours to flowers to attract insects for pollination.
3. Leucoplasts store food in the form of carbohydrates (starch), fats and protein.

Table 2.16. Differences between mitochondria and chloroplasts.

Mitochondria	*Chloroplasts*
1. They occur in the cells of aerobic organisms (plants and animals) with the exception of mammalian RBCs.	1. They occur in the cells of green photosynthetic parts (*e.g.*, leaves) of plants.
2. They are colourless.	2. They are green in colour.
3. The shape is rod-like or sausage-shaped.	3. They are generally disc-like in outline.
4. Inner membrane of each mitochondrion is thrown into folds called cristae.	4. Their inner membrane forms flattened sacs called thylakoids or lamellae.
5. They liberate energy.	5. They trap solar energy and convert it into chemical energy.
6. They perform oxidation of food.	6. They synthesize food by photosynthesis.
7. They consume O_2 and liberate CO_2.	7. They consume CO_2 and liberate O_2.

8. Vacuoles

Nature and occurrence. Vacuoles are fluid-filled or solid-filled and membrane-bounded spaces. They are a kind of storage sacs. In animal cells, the vacuoles if present are small and temporary. They store water, glycogen and proteins. The vacuolar membrane is typically a single unit membrane and is often associated with the maintenance of water balance (*e.g.*, they serve as osmoregulatory organelles in protozoans) or ingestion of nutrient material (food vacuole). Thus, food vacuole of a single celled organisms such as *Amoeba* or *Paramecium,* contains the food item that the animal has consumed.

In plant cells, the vacuoles are large, distinct and permanent. In mature plant cells the vacuole occupies almost the entire (*i.e.*, 90%) volume of the cell. Because of the central position of a vacuole, the nucleus and other cell organelles in plant cells are pushed near the boundary wall. The vacuole is bounded by a membrane, called **tonoplast**. The vacuole is filled with **cell sap** which is a watery solution rich in sugars, amino acids, proteins, minerals and metabolic wastes (such as anthocyanins, alkaloids).

Functions. Vacuoles help to maintain the osmotic pressure in a cell (osmoregulation). They store toxic metabolic by-products or end products of plant cells. They provide turgidity and rigidity to the plant cells.

9. Peroxisomes

Nature and occurrence. Peroxisomes are small (0.3 to 1.5 mm in diameter) and spherical organelles containing powerful oxidative enzymes. They are bounded by a single membrane. Peroxisomes are mostly found in kidney and liver cells. Inner contents of peroxisomes are finely granular, but sometimes a **crystalline core** is visible by electron microscope in the centre of peroxisomes. This crystalline core is a crystallized protein, called **catalase enzyme**.

Functions :

Peroxisomes are specialized for carrying out some oxidative reactions, such as **detoxification** or removal of toxic substances from the cell (Box 2.11).

Box 2.11

Catalase enzyme of peroxisomes, catalyses the decomposition of **hydrogen peroxide** (H_2O_2) to water and oxygen (hence the name, '*peroxisome*'). Hydrogen peroxide is a byproduct of certain cell oxidations and is also very **toxic**, so must be eliminated immediately.

10. Centrosome

Nature and occurrence. Centrosome is found only in the animal cells. It is not bounded by any membrane but consists of two granule-like **centrioles**. Centrioles are hollow and cylindrical structures which are made up of microtubules (Fig. 2.36). In plant cells, the **polar caps** perform the function of centrioles.

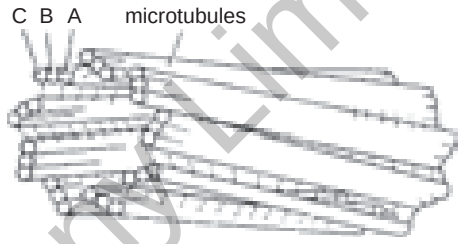


Figure 2.36. Centriole.

Functions :

1. Centrosome helps in cell division in animal cells. During cell division centrioles migrate to the poles of animal cells and are involved in the formation of the spindle.
2. In plant cells, cell division involves polar caps for the spindle formation.

Each cell, thus, acquires its distinct structure and function due to the organisation of its membrane and organelles in a specific way. As a result each type of cell has a basic structural organisation. Such an organisation helps different cells to perform some basic functions such as respiration, obtaining nutrition, clearing of waste material, forming new proteins, etc. A cell is the fundamental **structural unit** of living organisms. It is also the basic **functional unit** of life. This conclusion forms the main point of the cell theory.

2.3. DIFFERENCES BETWEEN PLANT AND ANIMAL CELLS

The cells of animals and plants have the following differences :

Table 2.17. Differences between animal and plant cells.

Animal cell	*Plant cell*
1. Animal cells are generally small in size.	1. Plant cells are larger than animal cells.
2. Cell wall is absent.	2. The plasma membrane of plant cells is surrounded by a rigid cell wall of cellulose.
3. Except the protozoan *Euglena*, no animal cell possesses plastids.	3. Plastids are present.
4. Vacuoles in animal cells are many, small and temporary.	4. Most mature plant cells have a permanent and large central sap vacuole.
5. Animal cells have a single highly complex and prominent Golgi apparatus.	5. Plant cells have many simpler units of Golgi apparatus, called dictyosomes.
6. Animal cells have centrosome and centrioles.	6. Plant cells lack centrosome and centrioles.

GIVE IMPORTANT FACTS ABOUT CELLS

- Smallest Cellular Organelle – Ribosome.
- Largest cellular organelle in plants – Plastid.
- Largest cellular organelle in animals – Mitochondria.
- Largest cell structure – Nucleus.
- The thin protoplasmic projections connecting two adjacent plant cells – Plasmodesmata.
- The connecting layer between two adjacent plant cells – Middle lamella.
- The membrane of vacuole in plant cell is called tonoplast.
- Mitochondria and plastids can replicate themselves (they both have DNA and ribosomes).
- Viruses are neither prokaryotic nor eukaryotic.
- Viruses are molecular organisms.
- In eukaryotic cell, the cell organelles have membranous coverings. Mitochondria, chloroplasts and other plastids and nucleus have two membranes around them whereas Golgi apparatus, endoplasmic single reticulum, vacuoles and lysosomes have single membrane. There are also naked (without membrane) cell organelles such as ribosomes, nucleolus and centriole.
- In prokaryotic cells, DNA is not enclosed in a nuclear membrane. So it is called nucleoid.
- In prokaryotic cells, ribosomes are present but are of smaller size (*i.e.*, 70 S in contrast to 80 S ribosomes of eukaryotes.

SUMMARY

- Cell is the smallest unit of structure and function of all organisms (except viruses).
- A typical cell is bounded by plasma membrane, has cytoplasm and genetic material (DNA) and RNA.
- Cells of bacteria and blue green algae (cyanobacteria) do not contain a distinct nucleus. They are called prokaryotic cells. Such cells have only one membrane and that is the plasma membrane.
- Plant cells and animal cells have eukaryotic cells. Each of these cells has a true nucleus (a nucleus which is bounded by nuclear membranes). These cells also have various membrane bound organelles such as ER, Golgi apparatus, mitochondria, plastids, etc.
- Activities performed by an organism are the sum total of the actions performed by its constituent cells.
- Unicellular organisms (*e.g.*, *Amoeba*) have only one cell in their bodies.
- Multicellular organisms (*e.g.*, human beings) have many co-ordinated compartments in their bodies, the cells.
- Plasma membrane is a living selectively permeable membrane. Chemically it comprises phospholipids, cholesterol, proteins and carbohydrates molecules. These molecules are organised in such a way that plasma membrane is said to have a fluid-mosaic structure.
- Functions of plasma membrane include diffusion, osmosis, mediated transport (*i.e.*, facilitated diffusion/ transport and active transport) and endocytosis (*i.e.*, phagocytosis, potocytosis and receptor-mediated endocytosis). *Amoeba* takes food by phagocytosis.
- Each plant cell is covered by a cell wall which is a non-living, rigid, freely permeable, layer of cellulose microfibrils. When a plant cell is put in a hypertonic solution (having less water), it loses water due to osmosis (exosmosis) and as a result its protoplast (*i.e.*, plasma membrane, cytoplasm and nucleus) is shrunk away from the cell wall. This phenomenon is called plasmolysis.
- The colloidal ground substance of cytoplasm is called cytosol.
- Cellular organelles without any membrane are ribosomes, centrioles and nucleolus. Ribosomes also occur in the prokaryotic cells.
- Various membrane-bound cell organelles present in a eukaryotic cell are nucleus, endoplasmic reticulum, Golgi apparatus, mitochondria, plastids, lysosomes, peroxisomes, etc.
- Nucleus, mitochondria and plastids are covered by two membranes.
- Mitochondria form the power house of the cell. They use molecular oxygen and generate energy-rich compound, the ATP. ATP is used as energy currency for various cellular activities such as biosynthesis of DNA, RNA, proteins, carbohydrates and lipids and mechanical work such as muscle contraction, ciliary/ flagellar movement, endocytosis, etc.
- Chloroplasts are chlorophyll-containing green plastids. They use water and carbon dioxide and convert radiant energy of sunlight into chemical energy of carbohydrates. This process is called photosynthesis.

- Both mitochondria and chloroplasts are semiautonomous organelles, since both of them have their own genome (DNA) and ribosomes to synthesize some of their own proteins.
- Ribosomes are sites of protein synthesis.
- Endoplasmic reticulum (ER) may be of smooth (SER) or rough (RER) type. SER synthesizes lipids and RER synthesizes proteins.
- Golgi apparatus is an assembly area for the storage, processing and packaging of various cellular secretions (*e.g.*, cellulose, glycoproteins, glycolipids, etc.). It is also a site of origin of lysosomes.
- Lysosomes form garbage disposal system of animal cells. With the help of their various digestive enzymes, lysosomes are capable of digesting most types of organic molecules (which are present in ingested viruses, bacteria and damaged cellular organelles).
- Nucleus controls all metabolic activities of the cell. A cell without a nucleus dies in short time, *e.g.*, human erythrocytes.
- Nucleus of a non-dividing cell contains chromatin, which is an uncoiled thread-like material of chromosome. Chromatin contains a DNA molecule and almost equal amount of basic histone proteins. Chromosomes occur during cell division and they are formed due to coiling and folding of chromatin having bead-like units called nucleosomes.
- Genes are hereditary units and they represent various segments of DNA. They carry parental hereditary information to next generation.

A. CLASS ASSIGNMENT

I. True or False Questions

1. Viruses are non-cellular living organisms.
2. *Amoeba* is a multicellular organism.
3. Plant cells are bounded by a wall composed of cellulose.
4. Cellulose is a protein.
5. Plasma membrane is present in all cells.
6. Blue green algae have prokaryotic cells.
7. All kinds of plastids have pigments.
8. Nucleolus has a limiting membrane.
9. Outer and inner membranes of chloroplasts have chlorophyll pigment.
10. Ribosomes are made up of deoxyribonucleic acid and proteins.
11. The oxidation of food in a cell takes place in mitochondria.
12. Plastids are called the kitchen of a plant cell.
13. Cell wall of plant cell is a living structure.
14. Cork comes from bark.
15. Robert Brown discovered protoplasm in 1831.
16. Cell forming body of *Amoeba* has an ever changing shape.
17. Movement of a substance from the area of low concentration to an area of high concentration is called diffusion.
18. A dilute solution is called hypertonic solution.
19. Lysosomes keep the cells clean by digesting foreign materials and worn out cell organelles.
20. Smooth endoplasmic reticulum detoxifies many poisons and drugs.
21. Central vacuole occupies 10-20% of plant cell volume.

ANSWERS

Alternate Response Type Questions

1. T	2. F	3. T	4. F	5. T	6. T	7. F
8. F	9. F	10. F	11. T	12. F	13. F	14. T
15. F	16. T	17. F	18. F	19. T	20. T	21. F

II. Fill in the Blanks

1. The ..... are an exception to cell theory.
2. The nuclear region of prokaryotic cells is called ..... .
3. The term protoplasm was coined by ..... .
4. Ultrastructure of cell organelles can be studied by ..... .
5. An ostrich egg is the ..... animal cell.
6. *Amoeba* can change their ..... continuously.
7. Cell is the basic ..... and ..... unit of all living organisms.

8. Cellular organelles called ..... are often referred to as suicidal bags.
9. Ribosomes are concerned with the synthesis of ..... .
10. Function of mitochondria is ..... production.
11. Chromosomes are made up of nucleic acid and ..... .
12. Cell theory was first given by ..... and ..... .
13. The additional protective layer in plants present outside the plasma membrane is called ..... .
14. Cell wall is found only in ..... cells.
15. Mitochondrial cristae form a large surface area for ..... generation reactions.
16. Plant cell wall is mainly composed of ..... .
17. Cell organelles perform ..... function in all organisms.
18. Cell theory was refined by ..... .
19. Cells were discovered by Robert Hooke in ..... .

ANSWERS

Fill in the Blanks :

1. Viruses; 2. Nucleoid; 3. J.E. Purkinje; 4. Electron microscope; 5. Largest; 6. Shape;
7. Structural, functional; 8. Lysosomes; 9. Proteins; 10. Energy
11. Proteins; 12. Schleiden, Schwann; 13. Cell wall; 14. Plant. 15. ATP;
16. Cellulose; 17. Similar; 18. Virchow 19. 1665.

III. Match the Columns

1. Single Matching Questions

Match the contents of the column I and II.

Column I	*Column II*
1. Robert Hooke	(*a*) protoplasm
2. Robert Brown	(*b*) cell theory
3. Schleiden and Schwann	(*c*) the term 'cell'
4. Von Mohl	(*d*) diffusion
5. Cellulose	(*e*) nucleus
6. Glycogen	(*f*) inheritance
7. Mitochondria	(*g*) energy
8. Chromosomes	(*h*) glucose synthesis
9. Chloroplasts	(*i*) Golgi apparatus
10. Nucleus	(*j*) storage
11. Cell wall	(*k*) Cellulose
12. Central vacuole	(*l*) DNA plus histone
13. Chromatin	(*m*) double membrane
	(*n*) cell sap

ANSWERS

Match the Columns (Single Matching)

1. (*c*) 2. (*e*) 3. (*b*) 4. (*a*) 5. (*i*) 6. (*j*) 7. (*g*)
8. (*f*) 9. (*h*) 10 (*m*) 11. (*k*) 12. (*n*) 13. (*l*).

2. Double Matching Questions

Match the contents of Columns I, II and III.

Column I	*Column II*	*Column III*
(*a*) Multicellular organisms	(*i*) Lipids	I. Turgidity
(*b*) Mitochondrion	(*ii*) Plants	II. Inner folded membrane
(*c*) Plasma membrane	(*iii*) Cell sap	III. Proteins
(*d*) Central vacuole	(*iv*) Outer permeable membrane	IV. Animals
(*e*) Chloroplast	(*v*) Digestive enzymes	V. Phagosome
(*f*) Lysosomes	(*vi*) Carbon dioxide	VI. Thylakoid

ANSWERS

Match the columns (Double Matching)

(*a*) - (*ii*) - IV; (*b*) - (*iv*) - II; (*c*) - (*i*) - III; (*d*) - (*iii*) - I; (*e*) - (*vi*) - VI; (*f*) - (*v*) - V

3. Key or Check List Items

Which type of metabolism, anabolism (A) and catabolism (C) are performed by the following organelles.

Organelle	*Metabolism*
1. Mitochondria	.....
2. Lysosomes	.....
3. Chloroplasts	.....
4. Endoplasmic reticulum (ER)	.....
5. Golgi apparatus	.....

ANSWERS

1. (C); 2. (C); 3. (A); 4. (A); 5. (A).

IV. Question – Answer

1. Write down three basic characteristics of a cell.
2. What do you mean by unicellular and multicellular ?
3. What is division of labour? Explain it in context of multicelluear organisms.
4. Why does viruses form a exception to cell theory?
5. Name the largest plant cell.
6. Define the following terms: cell, prokaryotic cell, eukaryotic cell, organelle.
7. Briefly describe the structure and functions of cell wall.
8. Describe the structure and functions of nucleus.
9. What are diploid and haploid number ?
10. Describe structure of a chromosome.
11. Describe structure and functions of plasma membrane.
12. What do you mean by passive and active transport ? Write a note on diffusion.
13. Describe the mechanism of osmosis. Give its importance.
14. Write a note on plasmolysis.
15. What is endoplasmic reticulum ? Give its types and functions.
16. Describe structure and functions of Golgi apparatus.
17. What are lysosomes ? How are they formed ? Give their functions.
18. Discuss the structure and functions of mitochondria.
19. With the help of a labelled diagram describe the structure of a chloroplast.

V. Multiple Choice Questions (MCQs)

1. The term 'cell' was given by
   (*a*) Leeuwenhoek (*b*) Robert Hooke
   (*c*) Flemming (*d*) Robert Brown
2. Who proposed the cell theory ?
   (*a*) Schleiden and Schwann
   (*b*) Watson and Crick
   (*c*) Darwin and Wallace
   (*d*) Mendel and Morgan
3. The longest cell in the human body is
   (*a*) nerve cell (*b*) muscle cell
   (*c*) liver cell (*d*) kidney cell
4. The number of lenses in compound light microscope is
   (*a*) 2 (*b*) 3
   (*c*) 4 (*d*) 1
5. The history of the cell began in 1665 with the publication of *Micrographia* in London by
   (*a*) Robert Hooke (*b*) Robert Brown
   (*c*) Straburger (*d*) Dujardin
6. The idea '*omins cellula e cellula*' which means that all living cells arise from preexisting cells was given by
   (*a*) Robert Brown (*b*) Purkinje
   (*c*) Rudolf Virchow (*d*) Schleiden
7. Which of the following has an irregular or variable shape ?
   (*a*) *Euglena* (*b*) *Paramecium*
   (*c*) *Amoeba* (*d*) *Acetabularia*
8. Genetic material of a eukaryotic cell is contained in
   (*a*) nucleolus (*b*) nucleus
   (*c*) nucleoplasm (*d*) nucleoid
9. Nucleolus is a seat of
   (*a*) protein synthesis (*b*) ribosome synthesis
   (*c*) enzyme synthesis (*d*) mRNA synthesis

10. Middle lamella is formed of
(*a*) calcium pectate (*b*) cellulose
(*c*) hemicellulose (*d*) lignin

11. Plasma membrane is
(*a*) permeable
(*b*) selective permeable
(*b*) semipermeable
(*d*) impermeable

12. A cell placed in solution swells up. The solution is
(*a*) hypertonic (*b*) isotonic
(*d*) hypotonic (*d*) both *a* and *b*

13. A cell placed in hypotonic solution bursts up. It is
(*a*) animal cell (*b*) bacterial cell
(*b*) fungal cell (*d*) plant cell

14. Bulk transport occurs through
(*a*) endocytosis (*b*) exoctosis
(*c*) endosmosis (*d*) both A and B

15. Cytoplasm is
(*a*) unit mass of protoplasm
(*b*) protoplasm excluding plasma membrane
(*c*) protoplasm excluding plasma membrane and nucleus
(*d*) protoplasm excluding plasma mebrane and cell organelles

16. Rough ER contains
(*a*) detoxification centres
(*b*) carbohydrate synthesizing machinery
(*c*) ribosomes
(*d*) lysosomes

17. Protein storing plastid is
(*a*) aleuroplast (*b*) amyloplast
(*c*) elaioplast (*d*) both *b* and *c*

18. Seat of photosynthesis is
(*a*) leucoplast (*b*) chloroplast
(*c*) chromoplast (*d*) both *a* and *c*

19. Mitochondria are seats of
(*a*) aerobic respiration
(*b*) Krebs cycle of aerobic respiration
(*c*) glycolysis of aerobic respiration
(*d*) anaerobic respiration

20. Golgi apparatus is involved in synthesis of
(*a*) new membranes
(*b*)new membranes and lysosomes
(*c*) cellulose
(*d*) glucose

21. Lysosomes are also called
(*a*) suicide bags (*b*) digestive bags
(*c*) demolition squads (*d*) all the above

22. Contractile vacuoles take part in
(*a*) absorption of water from outside
(*b*) osmoregulation
(*c*) excretion
(*d*) both *b* and *c*

23. Centrosome occurs in
(*a*) plant cells
(*b*) animal cells
(*c*) animal cells and some lower plant cells
(*d*) all the above

ANSWERS

1. (*b*)	2. (*a*)	3. (*a*)	4. (*a*)	5. (*a*)	6. (*c*)	7. (*c*)
8. (*b*)	9. (*b*)	10. (*a*)	11. (*b*)	12. (*d*)	13. (*a*)	14. (*d*)
15. (*c*)	16. (*c*)	17. (*a*)	18. (*b*)	19. (*a*)	20. (*c*)	21. (*d*)
22. (*b*)	23. (*c*).					

B. CLASS RESPONSE

VI. Oral Questions

1. Who discovered the cell ?
2. Name the publication in which Robert Hooke (1665) described his discovery of the cell.
3. Who coined the term protoplasm for living matter?
4. Who did propose cell theory ?
5. Name the largest cell.
6. Name the longest animal cell.
7. Give an example of prokaryotic cell.
8. What is example of a eukaryotic cell ?
9. Name the phenomenon by which raisins placed in water swell up.
10. Whether ATP molecules are consumed in the process of osmosis ?
11. What is the function of lignin deposition in cell wall ?
12. What is the characteristic of nuclear envelope ?
13. What structures are involved in the formation of chromatin ?
14. Where is nucleus located in a cell ?
15. What is the term used for subcellular structures having characteristic forms and functions ?
16. What is cytosol ?
17. How is food vacuole formed ?
18. What is the name of membrane surrounding sap vacuole?
19. What is the name of fluid contained in a vacuole of a plant cell ?
20. What is dictyosome ?
21. Where are vesicles are formed in Golgi apparatus?
22. Where does ATP synthesis occur in mitochondria?

VII. Quiz

1. When did Robert Hooke discover cell ?
2. Who among Schleiden and Schwann was zoologist and botanist ?
3. Who developed electron microscope ?
4. What is shape of a RBC ?
5. What is the peculiarity of nerve cell ?
6. What will happen if a plant cell is placed in a hypertonic solution ?
7. What will happen if an animal cell is placed in hypertonic solution ?
8. Cytoplasmic bridges between adjacent plant cells are called ?
9. How many chromosomes are present in human cells ?
10. What is tonoplast ?
11. Inner mitochondrial membrane has a number of infoldings called ..... .
12. Which one are the protein factories of the cells?
13. Where are photosynthetic pigments present in chloroplast ?
14. Where do contractile vacuoles occur ?

C. HOME ASSIGNMENT

VIII. Answer the Following Qustions

1. Differentiate between the following
(*i*) Endocytosis and exocytosis
(*ii*) Cis and trans faces of Golgi apparatus
(*iii*) Chromosome and chromatid
(*iv*) Write function of nucleolus
2. Describe secretion in cell.

D. GROUP DISCUSSION

IX. Organise group discussion on each on the follwing topics.

1. Plasma membrance
2. Golgi apparatus
3. Semiautonomous cell organelles

E. SEMINAR / SYMPOSIUM

X. Organise a seminar / Symposium on each of the following topics

1. Grana – The kitchen of the cell
2. Mitochondria- Oxygen consumer
3. Lysosomes-Scavengers of the cell

D. GROUP ACTIVITY

XI. Investigatory Projects

1. Study the basic differences between animal and plant cells.
2. Collect the information about chromosome number of organisms known to you.

XII. Experimental Projects / Survey

1. Perform an activity to study the principle of diffusion
2. Study the plasmolysis in *Rheo* leaf peels

MCQs AND VIVA-VOCE BASED ON PRACTICAL SKILLS

Experiment 1. To prepare stained temporary mounts of (*a*) onion peel , and (*b*) human cheek cells and to record observations and draw their labelled diagram.

Note: Refer the following figures (Fig. 2.37 and Fig. 2.38) before answering the questions .

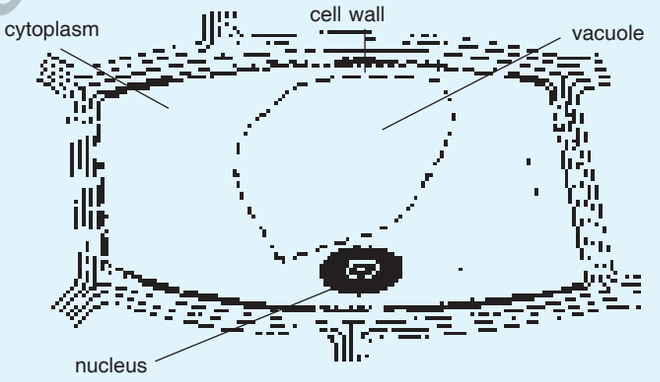


Figure 2.37. A cell of stained epidermal peel of onion bulb to show the detailed structure.

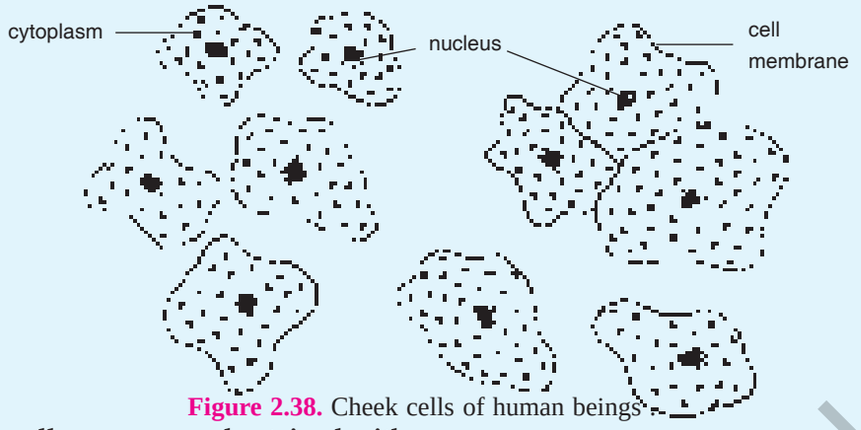


Figure 2.38. Cheek cells of human beings

1. Human cheek cells are commonly stained with

(*a*) safranin (*b*) methylene blue
(*c*) acetocarmine (*d*) eosine

2. Name the stain which is commonly used to study plant cells

(*a*) safranin (*b*) cotton blue
(*c*) methylene (*d*) acetocarmine

3. Temporary mount of a tissue is made in

(*a*) wax (*b*) alcohol
(*c*) glycerine (*d*) xylene

4. Safranin is a reagent that is used to stain

(*a*) nucleus (*b*) cytoplasm
(*c*) cell wall (*d*) plasmodesmata

5. We generally mount the material in the slide

(*a*) in the centre
(*b*) on the left side of slide
(*c*) on the right side of slide
(*d*) both (*b*) and (*c*)

6. Coverslip is put on the mounted material on a slide very gently to

(*a*) avoid the crushing of mounted material
(*b*) avoid the entry of air bubble
(*c*) avoid oozing of stain
(*d*) avoid oozing of glycerine

7. Definite shape of cell is seen in case of

(*a*) plant cell
(*b*) animal cell
(*c*) both animal and plant cell
(*d*) neither animal nor plant cell

8. The outer most layer of human cheek cells is

(*a*) cytoplasm (*b*) plasma membrane
(*c*) cell wall (*d*) nuclear membrane

9. The outer most covering of a plant cell is

(*a*) plasma membrane (*b*) cell wall
(*c*) vacuole membrane (*d*) nuclear membrane

10. Cell wall in plant cells is made of

(*a*) starch (*b*) glycogen
(*c*) cellulose (*d*) chitin

11. The structural or functional unit of life is

(*a*) tissue (*b*) organ
(*c*) organ system (*d*) cell

12. Nucleus was discovered by

(*a*) Robert Hooke (*b*) Robert Brown
(*c*) Virchow (*d*) Schleiden

13. In plant cells , nucleus is generally placed

(*a*) in the centre
(*b*) on one side of the cell
(*c*) attached to plasma membrane
(*d*) on one corner of the cell

14. In human cheek cells, nucleus is generally located

(*a*) near the plasma membrane
(*b*) on one side
(*c*) in the centre
(*d*) on border

15. In plant cells, cell wall is

(*a*) dynamic and live
(*b*) rigid and nonliving
(*c*) dynamic and non - living
(*d*) rigid and living

16. In plant cells, cell to cell contact is maintained through

(*a*) tight junctions (*b*) desmosomes
(*c*) interdigitation (*d*) plasmodesmata

17. In plant cells , nucleus is generally

(*a*) cylindrical (*b*) rounded
(*c*) discoidal (*d*) elliptical

18. Plant cells generally have

(*a*) big but less number of vacuoles
(*b*) small but large number of vacuoles
(*c*) no vacuole at all
(*d*) all equal sized vacuoles

19. The cells are first focussed in microscope under

(*a*) 40 X (*b*) 10X
(*c*) 100 X (*d*) any of these

20. The organelle not present in human cheek cells is

(*a*) nucleus
(*b*) plasma membrane
(*c*) mitochondria (*d*) chloroplast

21. The cell wall of plants is made up of cellulose which is a

(*a*) lipid (*b*) protein
(*c*) polysaccharide (*d*) amino acid

ANSWERS

1. (*b*);	2. (*a*);	3. (*c*)	4. (*c*);	5. (*a*);	6. (*b*);	7. (*b*);
8. (*b*);	9. (*b*);	10. (*c*);	11. (*d*);	12. (*b*);	13. (*b*);	14. (*c*);
15. (*b*);	16. (*d*);	17. (*b*);	18. (*a*);	19. (*b*);	20. (*d*);	21. (*c*).

VIVA - VOCE ON EXPERIMENT 1

1. What is microscope ?

Ans. Microscope is an optical instrument consisting of a lens or combination of lenses which renders minute objects distinctly visible.

2. What is microscopic ?

Ans. Any object visible only by the aid of a microscope, e.g., *Amoeba*, bacteria.

3. Name the instrument used for obtaining magnified images of small objects .

Ans. Microscope .

4. Name the parts of a compound microscope in which two different types of lenses are used.

Ans. Eye piece and objectives .

5. How can you calculate the magnification of a microscope ?

Ans. Magnification of a microscope is calculated by multiplication of the power of eyepiece and objective, e.g. , if you are using a 5 X eyepiece and 10X objective , the magnification is 5 ×10 = 50.

6. Why is light microscope called a 'compound microscope' ?

Ans. Light microscope is called compound microscope because it consists of two or more lens system.

7. Give one main difference between a light microscope and an electron microscope .

Ans. Visible light (sunlight , lamp light) is used in a light microscope where as electrons are used in the electron microscope .

8. What is the use of glycerine in mounting of stained materials on slides ?

Ans. The stained material remains in its normal condition for a long period when mounted in glycerine . It does not get dried easily .

9. Why should you hold coverslip only from its edges ?

Ans. It is because dust particles of our fingers may make the coverslip dirty if it is handled from its upper and lower surfaces .

10. What is outer most layer found in animal cells?

Ans. Plasma membrane .

11. What is outer most layer found in the plant cell ?

Ans. Cell wall .

12. Name two structures found in plant cells and not in animal cells .

Ans. Chloroplast and cell wall.

13. Give one single character , on the basis of which you can say that the given diagram is of a plant cell .

Ans. Presence of cell wall.

14. Name two structures found only in animal cells and not in plant cells .

Ans. Lysosomes and centrioles.

SOME ACTIVITY BASED QUESTIONS

Q. 1. A drop of ink is placed gently at the base of a beaker containing water by means of a dropper. What will happen ?

Ans. The ink slowly moves in all directions and ultimately makes the water uniformly coloured. This happens due to diffusion.

Q .2. Plasma mebrane is permeable to water. How does a cell show endosmosis or exosmosis ?

Ans. Water passes through the plasma membrane both inwardly as well as outwardly. Net movement occurs along its concentration gradient, from the side of pure water or dilute solution (high water concentration) to the side of concentrated solution (low water concentration). A cell placed in dilute solution (hypotonic solution) will show endosmosis because the external solution has higher concentration of water. A cell placed in hypertonic solution (*i.e.*, concentrated solution) will show exosmosis because cell sap has higher concentration of water.

Q.3. Hypertonic solution causes plasmolysis where the protoplast shrinks and withdraws from the cell wall at most places. What is present between the shrunken protoplast and cell wall ?

Ans. Hypertonic solution.

Q.4. What is crenation ?

Ans. It is a wrinkled appearance of animal cells (*e.g.*, human erythrocytes) placed in a hypertonic solution.

Q.5. What would happen if shelled raw egg and deshelled boiled egg are placed in water ?

Ans. There will be no change in the size of the eggs. In case of raw egg, shell acts as an impermeable covering. The boiled egg does not show any change because its membranous covering has become dead.

Q.6. Why do dry apricot placed in salt solution do not swell while they do so when kept in water ?

Ans. Dry apricot swell up in water because their cells have a high osmotic concentration which causes passage of water into them (endosmosis). They do not swell up when placed in salt solution because the external solution is hypertonic.

PAPER-PEN TEST

Time : 30 minutes **Maximum marks : 17**

V.S.A. **1.** What type of organisation is found in plasma membrane ? 1

M.C.Q. **2.** Double membrane is absent in 1

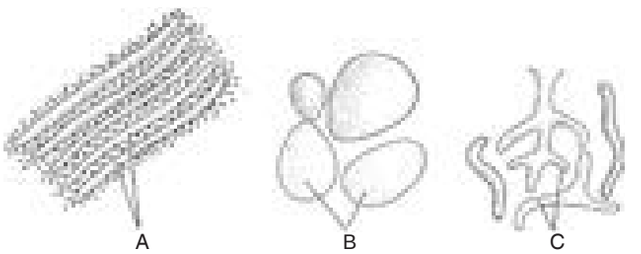
(*a*) nucleus (*b*) mitochondria (*b*) chloroplast (*d*) lysosomes

Blanks **3.** Plasmolysis in plant cells occurs due to 1

True / False **4.** Lysosomes form a kind of demolition squads of the animal cell. 1

Matching **5.** Match the stimuli with response 1

Organelle	*Storage of protein A*	*Oxysome B*	*Cell division C*
1. Mitochondria 2. Centrioles 3. Aleuroplasts			



HOTS **6.** What does the figure depict ? Label A, B and C 2

S.A.I **7.** Differentiate between plasma membrane and cell wall. 2

S.A.II **8.** Describe the structure and function of nucleus. 3

L.A. **9.** Describe the structure and functions of mitochondria. Write two differences in function of mitochondria and chloroplarts 2 + 2 + 1

Multiple Choice Questions

Type 1. Interpretation Type Questions

1. **Main difference between animal cell and plant cell is**
   (*a*) nutrition (*b*) growth
   (*c*) movement (*d*) respiration
2. **Animal cell lacking nuclei would also lack in**
   (*a*) chromosome (*b*) ribosome
   (*c*) lysosome (*d*) endoplasmic reticulum
3. **Plasmolysis occurs due to**
   (*a*) absorption (*b*) endosmosis
   (*c*) osmosis (*d*) exosmosis
4. **Solute concentration is higher in the external solution**
   (*a*) hypotonic (*b*) isotonic
   (*c*) hypertonic (*d*) none of the above
5. **A cell placed in hypotonic solution will**
   (*a*) shrink (*b*) show plasmolysis
   (*c*) swell up (*d*) no change in shape or size
6. **Which of the following is known as "physical basis of life" ?**
   (*a*) gene (*b*) protoplasm
   (*c*) nucleolus (*d*) mitochondria
7. **Which of the following is incorrect pair ?**
   (*a*) chloroplast - kitchen of the cell
   (*b*) mitochondria - power house of the cell
   (*c*) lysosome - secretory granules
   (*d*) nucleus - brain of the cell
8. **Photosynthetic pigments are located in**
   (*a*) stroma
   (*b*) outer membrane of chloroplast
   (*c*) grana
   (*d*) inner membrane of chloroplast
9. **Which of the following act as garbage disposal system of the cell ?**
   (*a*) Golgi apparatus (*b*) lysosome
   (*c*) vacuole (*d*) peroxisome
10. **Ribosomes are made up of**
    (*a*) lipoprotein (*b*) RNA
    (*c*) protein (*d*) both (*b*) and (*c*)
11. **Colourless plastids are known as**
    (*a*) leucoplasts (*b*) chromoplasts
    (*c*) chloroplasts (*d*) none of the above
12. **Chlorophyll is present in**
    (*a*) matrix (*b*) stroma
    (*c*) cristae (*d*) thylakoid

Type 2. Identity - Relationship Type Questions

1. **Cell wall of plant cells is chiefly composed of**
   (*a*) hemicellulose (*b*) cellulose
   (*c*) phospholipids (*d*) proteins
2. **Intercellular connections in plant cells are called**
   (*a*) middle lamella (*b*) microfibrils
   (*c*) matrix (*d*) plasmodesmata
3. **The infoldings in mitochondria are known as**
   (*a*) cristae (*b*) matrix
   (*c*) cisternae (*d*) grana
4. **Aleuroplasts in a cell store**
   (*a*) starch (*b*) oil
   (*c*) protein (*d*) nutrients
5. **Well defined nucleus is absent in**
   (*a*) plant cell (*b*) animal cell
   (*c*) eukaryotic cell (*d*) prokaryotic cell
6. **Mitochondria are the seat of**
   (*a*) anaerobic respiration
   (*b*) trapping of sunlight
   (*c*) Krebs cycle
   (*d*) Calvin cycle
7. **First living cells were observed by**
   (*a*) A.V. Leeuwenhoek (*b*) Robert Hooke
   (*c*) R. Virchow (*d*) Robert Brown
8. **Membrane which allows passage of only solvent through it is**
   (*a*) differentially permeable
   (*b*) semipermeable (*c*) impermeable
   (*d*) both (*a*) and (*b*)
9. **Unicellular organisms take in oxygen and pass out carbon dioxide through**
   (*a*) diffusion (*b*) exosmosis
   (*c*) endosmosis (*d*) active transport
10. **Root hairs of plants absorb water from soil through**
    (*a*) diffusion (*b*) imbibition
    (*c*) osmosis (*d*) all the above

Type 3. MCQs from NCERT Question Bank (Exemplar Problems)

1. **The undefined nuclear region of prokaryotes is also known as**
   (*a*) nucleus (*b*) nucleolus
   (*c*) nucleic acid (*d*) nucleoid
2. **The only cell organelle seen in prokaryotic cell**
   (*a*) mitochondria (*b*) ribosomes
   (*c*) plastids (*d*) lysosomes

3. Cell theory was given by
(*a*) Schleiden and Schwann
(*b*) Virchow
(*c*) Hooke
(*d*) Haeckel

4. Cell arise from pre-existing cell was stated by
(*a*) Haeckel (*b*) Virchow
(*c*) Hooke (*d*) Schleiden

5. Kitchen of the cell is
(*a*) mitochondrion (*b*) chloroplast
(*c*) endoplasmic reticulum
(*d*) Golgi apparatus

6. Organelle without a cell membrane is
(*a*) ribosome (*b*) nucleus
(*c*) mitochondrion (*d*) chloroplast

7. Which of the following are covered by a single membrane ?
(*a*) mitochondria (*b*) vacuole
(*c*) nucleus (*d*) plastid

8. Lipid molecules in the cell are synthesized by
(*a*) smooth endoplasmic reticulum
(*b*) rough endoplasmic reticulum
(*c*) Golgi apparatus
(*d*) plastids

9. The proteins and lipids, essential for building the cell membrane, are manufactured by
(*a*) endoplasmic reticulum
(*b*) Golgi apparatus
(*c*) mitochondria
(*d*) peroxisomes

10. Lysosomes arise from
(*a*) endoplasmic reticulum
(*b*) Golgi apparatus
(*c*) nucleus
(*d*) mitochondria

11. *Amoeba* acquires its food through a process termed as
(*a*) exocytosis
(*b*) endocytosis
(*c*) plasmolysis
(*d*) exocytosis and endocytosis both

12. Which cell organelle plays a crucial role in detoxifying many poisons and drugs in a cell?
(*a*) Golgi apparatus
(*b*) lysosmes
(*c*) smooth endoplasmic reticulum
(*d*) vacuoles

13. Chromosomes are made up of
(*a*) DNA (*b*) protein
(*c*) DNA and protein (*d*) RNA

14. Organelle other than nucleus, containing DNA is
(*a*) endoplasmic reticulum
(*b*) mitochondria
(*c*) Golgi apparatus
(*d*) lysosome

15. Find out the false statement
(*a*) Golgi apparatus is involved with the formation of lysosomes
(*b*) nucleus, mitochondria and plastid have DNA, hence they are able to make their own structural proteins
(c) mitochondria is said to be the power house of the cell as ATP is generated in them
(*d*) cytoplasm is called as protoplasm

16. Cell wall of which one of these is not made up of cellulose ?
(*a*) bacteria (*b*) *Hydrilla*
(*c*) mango tree (*d*) cactus

17. A cell will swell up if
(*a*) the concentration of water molecules in the cell is higher than the concentration of water molecules in surrounding medium
(*b*) the concentration of water molecules in surrounding medium is higher than water molecules concentration in the cell
(*c*) the concentration of water molecules is same in the cell and in the surrounding medium
(*d*) concentration of water molecules does not matter

18. Plasmolysis in a plant cell is defined as
(*a*) break down (lysis) of plasma membrane in hypotonic medium
(*b*) shrinkage of cytoplasm in hypertonic medium
(*c*) shrinkage of nucleoplasm
(*d*) none of them

19. Which of these is not related to endoplasmic reticulum ?
(*a*) it behaves as transport channel for proteins between nucleus and cytoplasm
(*b*) it transports materials between various regions in cytoplasm
(*c*) it can be the site of energy generation
(*d*) it can be the site for some biochemical activities of the cell

20. Select the odd one out
(*a*) the movement of water across a semipermeable membrane is affected by the amount of substances dissolved in it.
(*b*) membranes are made of organic molecules such as proteins and lipids.
(*c*) molecules soluble in organic solvents can easily pass through the membrane.
(*d*) plasma membranes contain chitin sugar in plants.

21. Following are a few definitions of osmosis. Read carefully and select the correct definition.

(*a*) movement of water molecules from a region of higher concentration to a region of lower concentration through a semipermeable membrane.

(*b*) movement of solvent molecules from its higher concentration to lower concentration.

(*c*) movement of solvent molecules from higher concentration to lower concentration of solution through permeable memberane.

(*d*) movement of solute molecules from lower concentration to higher concentration of solution through a semipermeable membrane.

ANSWERS

Type I MCQs

1. (*a*); 2. (*a*); 3. (*d*) 4. (*c*); 5. (*c*); 6. (*b*); 7. (*c*);
8. (*c*); 9. (*b*); 10. (*d*); 11. (*a*); 12. (*d*).

Type II MCQs

1. (*b*); 2. (*d*); 3. (*a*) 4. (*c*); 5. (*d*); 6. (*c*); 7. (*a*);
8. (*b*); 9. (*a*); 10. (*c*).

Type III MCQs

1. (*d*); 2. (*b*); 3. (*a*); 4. (*b*); 5. (*b*); 6. (*a*); 7. (*b*);
8. (*a*); 9. (*a*); 10. (*b*); 11. (*b*); 12. (*c*); 13. (*c*); 14. (*b*);
15. (*d*); 16. (*c*); 17. (*b*); 18. (*b*); 19. (*c*); 20. (*d*); 21. (*a*).

NCERT TEXTBOOK QUESTIONS AND EXERCISES WITH ANSWERS

NCERT Text Book Questions

Q.1. Who discovered cells and how?

Ans. **Robert Hooke** in 1665 discovered the cells. He examined a thin slice of cork under a self-designed crude microscope and observed that the cork resembled the structure of a honey comb. The latter consisted of many tiny compartments. Hooke called them **cellulae** (singular cellula), now termed cells. Cellula is a Latin name which means 'a little room'. Such rooms were also present in monastries.

Q.2. Why is the cell called the structural and functional unit of life?

Ans. All living organisms are made up of cells. Thus, cell is the structural unit of life. Each living cell has the capacity to perform certain basic functions that are characteristics of all living forms. Each cell acquired distinct structure and function due to the organization of its membrane and cytoplasmic organelles in specific way. Each kind of cell organelle performs a special function, such as making new materials in the cell (*e.g.*, chloroplast, ribosomes), clearing up the waste materials from the cells (*e.g.*, lysosomes), utilisation of oxygen in oxidation of food and energy production (*e.g.*, mitochondria), movement (microtubules containing spindle, cilia, flagella), etc. A cell is able to live and perform all its functions because of these organelles. These organelles together constitute the basic unit of structure and function called the cell.

Q.3. How do substances like CO_2 and water move in and out of the cell?

Ans. Carbon dioxide (CO_2) moves in and out of the cells by the process of diffusion. Diffusion involves movement of molecules from higher concentration to lower concentration across the plasma membrane.

Water moves in and out of the cells by **osmosis.** Osmosis is the movement of water or solvent through a semipermeable membrane from a solution of lower concentration of solutes to a solution of higher concentration of solutes to which the membrane is relatively impermeable.

Both diffusion and osmosis are physical or mechanical processes and do not require spending of energy for their performance by the cells.

Q.4. Why is plasma membrane called a selectively permeable membrane?

Ans. Plasma membrane is called selectively permeable membrane because it allows the movement of only selected molecules across it and not all of them.

Q.5. Fill in the gaps in the following table illustrating differences between prokaryotic and eukaryotic cells.

Prokaryotic cell	*Eukaryotic cell*
1. Size: generally small (1 – 10 µm,); 1µm = 10^{-6} m	1. Size: generally large (5 – 100 Mm)
2. Nuclear region: .... and known as	2. Nuclear region: well defined and surrounded by a nuclear membrane
3. Chromosome: single	3. Chromosome : more than one
4. Membrane – bound organelles: absent	4. ....

Ans. 2. It lies in the cytoplasm and not covered with a nuclear membrane, nucleoid.

4. Membrane-bound cell organelles such as mitochondria, plastids, Golgi apparatus, lysosomes, etc., are present in the cytoplasm.

Q.6. Can you name the two organelles we have studied that contain their own genetic material?

Ans. (*a*) Mitochondria; (*b*) Chloroplasts (plastids).

Q.7. If the organization of a cell is destroyed due to some physical and chemical influence, what will happen?

Ans. A well organized cell maintains **homeostasis,** *i.e.,* constant internal chemical composition. It is, therefore, able to perform basic functions such as respiration, obtaining nutrition, clearing of waste, forming new proteins, etc. If the organization of a cell is destroyed, it will not be able to maintain homeostasis and thus will not be able to perform above said basic functions and such a cell will ultimately die.

Q.8. Why are lysosomes are known as suicide bags?

Ans. Lysosomes contain digestive enzymes for almost all types of organic materials. If their covering membrane breaks as it happens during injury to cell, the digestive enzymes will spill over the cell contents and digest the same. As lysosomes are organelles which on bursting can kill cells possessing them, they are called **suicide bags.**

Q.9. Where are proteins synthesized inside the cell?

Ans. Proteins are synthesized in the ribosomes.

NCERT Exercises

Q.1. Make a comparison and write down ways in which plant cells are different from animal cells.

Ans. Refer to Table 2.17.

Q.2. How is a prokaryotic cell different from a eukaryotic cell?

Ans. Refer to Table 2.3.

Q.3. What would happen if the plasma membrane ruptures or break down?

Ans. Plasma membrane is a selectively permeable membrane of the cell that maintains its homeostasis, *i.e.,* constant internal composition of the cell. If it ruptures or breakdown the constant internal chemical composition of the cell will be lost and it will not be able to perform its basic functions. Such a cell with ruptured plasma membrane is killed.

Q.4. What would happen to the life of a cell if there was no Golgi apparatus?

Ans. There would not be any lysosome for intracellular digestion and cleansing, not complexing of molecules, no exocytosis and no formation of new plasma membrane.

Q.5. Which organelle is known as the powerhouse of the cell? Why?

Ans. Mitochondrion is known as the powerhouse of the cell because it contains enzymes that are needed for stepwise oxidation of food stuffs (carbohydrate, fats or lipids and proteins) present in the cells to CO_2 and water. Oxidation of food releases energy which is used to form high-energy ATP (adenosine triphosphate) molecules. ATP is known as **energy currency** of the cell and it is used as cellular fuel. Energy stored in ATP is used to bring about energy requiring activities of cell such as photosynthesis, protein synthesis and muscle contraction.

Q.6. Where do the lipids and proteins constituting the cell membrane get synthesized?

Ans. Proteins are synthesized in ribosomes of rough ER while lipids are synthesized over smooth ER.

Q.7. How does an *Amoeba* obtain its food?

Ans. *Amoeba* is unicellular animal. It acquires its food by the process of endocytosis. Plasma membrane of *Amoeba* is flexible with its help *Amoeba* engulfs food particles. The engulfed food particle passes into the body of organism as a phagosome. Phagosome combines with lysosome to produce **digestive** or **food vacuole.** Digestion occurs in food vacuole. The digested food passes into surrounding cytoplasm. The undigested matter is thrown out of the cell.

Q.8. What is osmosis?

Ans. Osmosis is diffusion of water from the region of its higher concentration (pure water or dilute solution) to the region of its lower concentration (strong solution) through a semipermeable membrane.

Q.9. Carry out the following osmosis experiment:
Take four peeled potato halves and scoop each one out to make potato cups. One of these potato cups should be made from a boiled potato. Put each potato cup into a trough containing water.
Now
(a) keep cup A empty;
(b) put one teaspoon sugar in cup B;
(c) put one teaspoon salt in cup C;
(d) put one teaspoon sugar in the boiled potato cup D;
Keep these for 2 hours. Then observe the four potato cups and answer the following:
(*i*) Explain why water gathers in the hollowed portion of B and C.
(*ii*) Why is potato A necessary for this experiment?
(*iii*) Explain why water does not gather in the hollow out portion of A and D?

Ans. (*i*) When unboiled potato cups B and C were put into a trough containing water, the cells of potatoes gained water by **endosmosis.** When a teaspoon of sugar and salt were added later in the hollowed portion of B and C cups respectively, water movement occurred through the plasma membranes of the cells from within the cells of potato into the hollowed portion of both B and C cups because of **exosmosis** (*i.e.*, exit of water molecules through permeable plasma membranes from within the cells of unboiled potatoes into the hollowed portions having hypertonic sugar and salt, respectively).

(*ii*) Potato cup A is necessary in the experiment as a 'control' for providing comparison with situations created in potato cups B, C and D. It indicates that the potato cavity alone does not induce movement of water.

(*iii*) Water does not gather in the hollowed portion of potato cup A because it does not possess higher osmotic concentration than the cells of potato.
Potato cup D is boiled potato cup. On boiling, potato cells die and the membranes of the potato cells lost their permeability. As a result, when teaspoon of sugar is added into the hollowed portion of boiled potato cup D, water does not come out from within the potato cells into the hollowed portion.

Questions Based on NCERT Question Bank (Exemplar Problems in Science)

Q. 1. Why are lysosomes known as "suicide bags" of a cell ?

Ans. See Q.8. In NCERT Text book Questions.

Q.2. Do you agree that "A cell is a building unit of an organism" ?

Ans. Yes, cell is a building unit of every living organism as every living being is made up of one or more cells. For example, in **unicellular** or **acellular organisms,** the single cell performs all the functions of life. In **multicellular organisms** all the cells have a similar basic structure and perform a similar basic life activities. However, they become specialised to form components of different structures that perform different functions. Cells are first organised into **tissues,** each with a specific function, *e.g.*, contraction by the muscular tissue. Tissues are organised to form **organs** with each organ performing a specific task, *e.g.*, heart, kidney, lung, stomach, eyes. Organs are grouped into **organ systems,** each with a major function, *e.g.*, circulatory system, excretory system, respiratory system, digestive system, skeletal system. A living organism has a number of organ systems. Thus, in all such organisational complexity, cell remains the basic building unit of the organism.

Q.3. Why does the skin of your fingers shrink when you wash clothes for a long time ?

Ans. Clothes are washed with soap or detergent solution. This solution is **hypertonic** as compared to osmotic concentration of our skin cells. The washing solution, therefore, results in **exosmosis** in the skin cells that come in contact with it for some time. Due to this reason, the skin over the fingers shrinks while washing clothes for a long time.

Q.4. Why is endocytosis found in animals only ?

Ans. **Endocytosis** is swallowing up of food and other substances (bacteria, viruses) from external medium by the plasma membrane. This is possible only when plasma membrane is in direct contact with external medium. It occurs only in animal cells. In plant cells, a cell wall is present over the plasma membrane. Therefore, their plasma membrane cannot perform endocytosis.

Q.5. A person takes concentrated solution of salt. After some time he starts vomiting. What is the phenomenon responsible for such a situation ? Explain.

Ans. Concentrated salt solution is a **hypertonic solution** so causes irritation and excessive dehydration in the wall of alimentary canal due to **exosmosis.** There is uncomfortable stretching which causes reverse movements and hence vomiting.

Q.6. Name any cell organelle which is nonmembranous.

Ans. Ribosome.

Q.7. We eat food composed of all the nutrients such as carbohydrates, proteins, fats, vitamins, minerals and water. After digestion, they are absorbed in the form of glucose, amino acids, fatty acids, glycerol, etc. What mechanisms are involved in the absorption of digested food and water ?

Ans. Digested food is taken in the intestinal cells by the following process:

(*i*) Glucose, amino acids and some ions—Active transport.

(*ii*) Fatty acids, glycerol—Diffusion (Passive transport)

(*iii*) Water—Osmosis.

Q.8. If you are provided with some vegetables to cook, you generally add salt into vegetables during cooking process. After adding salt, vegetables release water. What mechanism is responsible for this?

Ans. On adding salt, vegetables release water due to **exosmosis.** Exosmosis occurs whenever the external medium is hypertonic as compared to the osmotic concentration inside living cells.

Q.9. If cells of onion peel and RBC are separately kept in hypotonic solution what among the following will take place ? Explain the reason for your answer. (*a*) Both the cells will swell (*b*) RBC will burst easily while cells of onion peel will resist the bursting to some extent. (*c*) *a* and *b* both are correct (*d*) RBC and onion peel cells will behave similarly.

Ans. **(*b*)** RBC will burst as there is no mechanism to resist entry of water into them. Onion peel cells do not burst. **Endosmosis** causes some initial swelling in such onion peel cells but cell wall puts a mechanical barrier to promote entry of water. Therefore, these cells do not burst.

Q.10. Bacteria do not have chloroplasts but some bacteria are photoautotrophic in nature and perform photosynthesis. Which part of bacterial cell perform this ?

Ans. Photoautotrophic bacteria posses photosynthetic pigments inside small vesicles which may be attached to the plasma membrane.

Q.11. Match the items of A and B.

A	*B*
(*a*) Smooth endoplasmic reticulum	(*i*) *Amoeba*
(*b*) Lysosome	(*ii*) Nucleus
(*c*) Nucleoid	(*iii*) Bacteria
(*d*) Food vacuoles	(*iv*) Detoxification
(*e*) Chromatin material and nucleolus	(*v*) Suicidal bag

Ans. *a - iv; b-v; c-iii; d-i; e-ii.*

Q.12. Write the name of different plant parts in which chloroplast, chromoplast and leucoplasts are present.

Ans. 1. Chromoplast: Flower (petals) and fruits.

2. Chloroplast : Green leaves and green parts.

3. Leucoplast : Root and underground stem.

Q.13. Name the organelles which show analogy written as under

(*a*) Transporting channels of the cell .....

(*b*) Power house of the cell .....

(*c*) Packaging and dispatching unit of the cell .....

(*d*) Digestive bag of the cell .....

(*e*) Storage sac of the cell .....

(*f*) Kitchen of the cell .....
(*g*) Control room of the cell .....

Ans. (*a*) Endoplasmic reticulum; (*b*) Mitochondria; (*c*) Golgi apparatus; (*d*) Lysosome; (*e*) Vacuole; (*f*) Chloroplasts; (*g*) Nucleus.

Q.14. How is bacterial cell different from an onion peel cell ?

Ans. See differences between prokaryotic (bacterial cell) and eukaryotic (onion peel cells; Table 1.3).

Q.15. How do substances such as carbon dioxide and water move in and out of the cell ?

Ans. By diffusion and osmosis respectively.

Q.16. How does *Amoeba* obtain its food ?

Ans. See NCERT Exercise Q. 7.

Q.17. Name two organelles in plant cell that contain their own genetic materials and ribosomes.

Ans. (*i*) Plastids; (*ii*) Mitochondria.

Q.18. Why are lysosomes also known as "scavengers of the cell".

Ans. Lysosomes are called scavengers of the cell because they remove cell debris consisting of dead and worn out cell organelle by digesting the same. Rather they nourish the cells by sending out digesting nutrients into the cytoplasm.

Q.19. Which cell organelle control most of the activities of the cell ?

Ans. Nucleus, by controlling metabolism and cell activities. Genes express their effect through RNAs. RNAs control synthesis of proteins and enzymes.

Q.20. Which kind of plastid is more common in (*a*) Root of the plant, (*b*) Leaves of the plant, (*c*) Flowers and fruits.

Ans. (*a*) Leucoplasts in roots; (*b*) Chloroplasts in leaves; (*c*) Chromoplasts in flowers and fruits.

Q.21. Why do plant cells possess large sized vacuole ?

Ans. Vacuole of plant cells is large in size because it has to take part in following activities:

1. It stores salts, sugar, amino acids, organic acids and some proteins.
2. Metabolic wastes of the cell are dumped in the vacuole.
3. Lysosomal enzymes occur in the vacuole of plant cell.
4. The vacuole contains cell sap and helps in maintaining turgidity of the cell.
5. Plant cell vacuole contains an osmotic concentration which is required for the process of osmosis through plasma membrane.

Q.22. How are chromatin, chromatid and chromosome related to each other.

Ans. *Chromatin* is intertwined mass of fine thread-like structures made of DNA and protein. During cell division (mitosis or meiosis), chromatin condenses to form thicker rod-like structures called *chromosomes.* Each chromosome consists of two similar halves called *chromatids.* Formation of chromosomes having two similar halves or chromatids is meant for equitable distribution of chromatin which is hereditary material.

Q.23. What are consequences of the following conditions ?

(*a*) A cell having higher water concentration than the surrounding medium.

(*b*) A cell containing low water concentration than the surrounding medium.

(*c*) A cell having equal water concentration to its surrounding medium.

Ans. High water concentration occurs in hypotonic solution, low water concentration in hypertonic solution while equal water concentration in isotonic solution.

(*a*) A cell having higher water content or hypotonic cell sap will undergo exosmosis and, therefore, lose water. It may undergo plasmolysis.

(*b*) A cell having low water concentration or hypertonic cell sap will undergo endosmosis and absorb water from outside. It would become turgid.

(*c*) A cell having isotonic cell sap will neither gain nor lose water to the external medium.

Q.24. Draw a plant cell and label the parts which

(*a*) Determine function and development of the cell.
(*b*) Provides resistance to microbes and to withstand hypotonic external medium without injury.
(*c*) Packages materials coming from the endoplasmic reticulum.
(*d*) Is a fluid contained inside the nucleus.
(*e*) Is site for many biochemical reaction necessary to sustain life.

Ans. Draw figure of a plant cell as in Figure. 2.15, and label (*a*) Nucleus; (*b*) Cell wall, (*c*) Golgi bodies; (*d*) Nucleoplasm; (*e*) Cytoplasm.

Q.25. Illustrate only a plant cell as seen under electron microscope. How is it different from animal cell ?

Ans. (*a*) Draw Figure 2.13.
(*b*) For differences between plant and animal cells see Table 2.17.

Q.26. Draw a neat labelled diagram of an animal cell.

Ans. Draw Figure 2.12.

Q.27. Draw a well labelled diagram of eukaryotic nucleus. How is it different from nucleoid?

Ans. (*a*) Draw Fig. 2.27.

(*b*) See Table 2.4 for differences between nucleus and nucleoid.

Q.28. Differentiate between rough and smooth endoplasmic reticulum. How is endoplasmic reticulum important for membrane biosynthesis ?

Ans. (*a*) For differences in rough ER and smooth ER see Table 2.13. Membranes grow as newly synthesized proteins and lipids are inserted into existing membrane in endoplasmic reticulum (ER). Glycolisation of proteins of the membrane is started in RER but completed in Golgi apparatus. Glycolisation of lipids of the membrane occurs in Golgi apparatus. Flow of membrane occurs in the following manner.

RER ——→ (protein synthesis, integration and initiation of glycolisation of proteins)

SER ——→ (lipid synthesis on its surface and their insertion in membranes)

Golgi apparatus ——→ (glycolisation of proteins and lipids)

Secretory vesicles ——→ **Plasma membrane** (exocytosis)

Q.29. In brief state what happen when

(*a*) Dry apricot are left for some time in pure water and later transferred to sugar solution.

(*b*) A red blood cell is kept in concentrated salt solution.

(*c*) The plasma membrane of a cell breaks down.

(*d*) Rheo leaves are boiled in water first and then a drop of sugar syrup is put on it.

(*e*) Golgi apparatus is removed from the cell.

Ans. (*a*) When placed in pure water, dry apricots swell up due to endosmosis. On being transferred to sugar solution, they shrink due to exosmosis.

(*b*) In concentrated salt solution, red blood cells shrink and give a shrivelled appearance (crenation).

(*c*) Breakdown of plasma membrane will result in death of the cell as protoplasmic structures will get dispersed.

(*d*) Boiling shall kill the leaves. The dead leaves and their cells do not undergo plasmolysis.

(*e*) Formation of lysosomes, secretory vesicles will stop. Glycolisation of lipids and proteins synthesized by ER for membrane biosynthesis will not occur.

Q.30. Draw a neat diagram of plant cell and label any three parts which differentiate it from animal cell.

Ans. Draw Figure 2.13 showing chloroplast, large vacuole and cell wall. These three structures do not occur in the animal cell.

Questions of CBSE Sample Paper

Q.1. What happens to an animal cell when it is placed in a very dilute external medium? Why?

(2 marks ; 2010)

Ans. Endosmosis. As the external solution is very dilute or hypotonic, water passes into animal cell due to endosmosis the animal cell continues to swell up for some time but ultimately bursts up.

Reason. Bursting of animal cell with endosmosis is due to absence of rigid cell wall as found in plant cells.

Q.2. (a) Draw a plant cell and name seven important organelles found in it.

(b) Name one organelle that can make some of its protein in a plan cell and also mention one function of such organelle. **(5 marks ; 2010)**

Ans. (a) Draw Fig 2.13.

(b) Mitochondrion is a cell organelle that makes some of its own proteins with the help of its own DNA and ribosomes. It performs Krebs cycle part of (aerobic) respiration (*i.e.*, uses O_2 molecules during final oxidation of food and manufactures energy rich ATP molecules).

Q.3. (a) Name and draw a cell which does not have a well defined nuclear region. Label any four parts.

(b) Mention two ways by which a photosynthesing cell belonging to this group differs from a cell of your body. **(5 marks ; 2010)**

Ans. (a) Prokaryotic cell (e.g. bacterium, blue gree algae), Draw figure 2.7.

(b) Differences

Photosynthetic prokaryotic cell	*Human cell*
1. The cell possesses photosynthetic pigments in bag like membranous sacs. 2. A cell wall occurs around the cell. 3. A nucleus is absent. Instead nucleoid occurs embedded in the cytoplasm.	1. Photosynthetic pigments are absent. 2. Cell wall is absent. 3. A nucleus is present.

SOME TYPICAL OR ILLUSTRATIVE QUESTIONS

Q.1. What is functional unit of life ?

Ans. Cell is the functional unit of life. It is defined as a tiny mass of protoplasm covered by plasma membrane which is capable of performing all functions of life.

Q.2. What is the difference between plasma membrane and cell wall ? Give the functions of each one.

Ans. Plasma membrane is an elastic living membrane made up of lipids and proteins, where as cell wall is a rigid non-living covering made up of cellulose.

Plasma membrane acts as semipermeable membrane which allows only selective substances to pass through it.

Cell wall provides rigidity and protection to cell. It is permeable.

Q.3. Main cellular site of ATP generation is ..... .

Ans. Mitochondrion.

Q.4. Which cellular organelle uses molecular oxygen like mitochondria but protects the cell from toxic metabolic by products ?

Ans. Peroxisome.

Q.5. Differentiate between RER and SER.

Ans. See Table 2.13.

Q.6. Differentiate between chromatin and chromosome.

Ans. **Chromatin** is the nucleoprotein (DNA +protein) fibrous mass which stains strongly with basic dyes and is present inside nucleus.

Chromosome is a thread -like, stainable, condensed chromatin unit, visible at cell division.

Both chromatin and chromosomes contain hereditary information in the form of genes.

Q.7. Which molecules are present in chromatin.

Ans. DNA, histone proteins and acids proteins.

Q.8. Which types of ribosomes are found in prokaryotes and eukaryotes ?

Ans. Prokaryotes have 70S ribosomes and eukaryotes have 80S ribosomes. (**Note.** The S value is called **Svedberg unit**. It refers to the sedimentation coefficient of the RNA; the larger the number, the more rapidly the molecule moves through a field of force during centrifugation.)

Q.9. Which structure is called little nucleus ?

Ans. Nucleolus.

Q.10. Why is nucleus called director of the cell ?

Ans. Nucleus controls and coordinates all the metabolic functions of the cell.

QUESTIONS BASED ON HIGH ORDER THINKING SKILLS (HOTS)

1. Cell inclusions are

(*a*) non-living materials present in the cytoplasm

(*b*) another name of cell organelles

(*c*) cytoskeletal framework of cell

(*d*) combined name for cell wall and plasma membrane

2. Which of these is wrongly matched ?

(*a*) chloroplasts – chlorophyll

(*b*) elaioplasts – starch

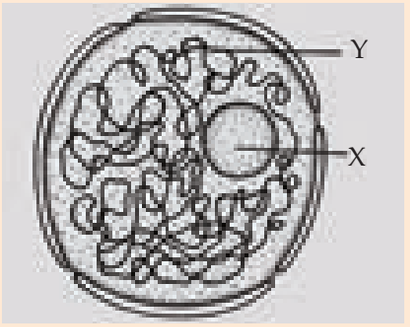
(*c*) amyloplasts – carbohydrates

Ans. 1. *a*; 2. *b*.

3. What will happen if chloroplast is taken out of the cell and illuminated ?

Ans. Chloroplast is a semiautonomous cell organelle of plant cells which on illumination can perform its function of photosynthesis and perform its function of photosynthesis and release oxygen even outside the cell provided it is kept in isotonic medium and receives raw material of carbon dioxide.

4.



(*a*) Identify the above figure

(*b*) Label X and Y

(*c*) What is the function of X ?

Ans. (*a*) It is figure of nucleus of an eukaryotic cell.

(*b*) X-nucleolus; Y-chromatin.

(*c*) Function of X (*i.e.*, nucleolus)-synthesis of ribosomes.

5.

(*a*) Identify A - and B-cells.

(*b*) What will happen if B-cells are kept in hypotonic solution.

(*c*) What will happen if A cells are kept in hypertonic solution ?

Ans. (*a*) A cells – Turgid cells; B–cells–Plasmolysed cells.

(*b*) If B cells kept in hypotonic solution they will become deplasmolysed if done so immediately after plasmolysis.

(*c*) A cells kept in hypertonic solution will become plasmolysed.

6. What will happen if

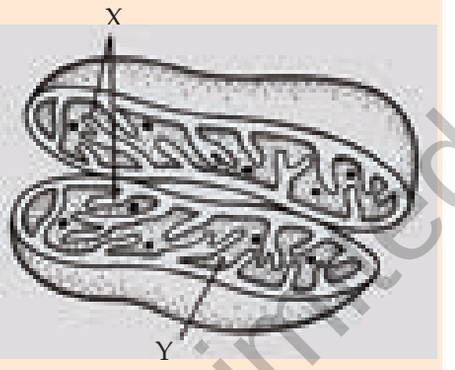
(*a*) Excess amount of fertilizer is added to a green lawn ?

(*b*) Salt is added to cut pieces of raw mango.

Ans. (*a*) Application of excess fertilizer (*i.e.*, urea) in green grass lawn will kill grass plants due to exosmosis and plasmolysis.

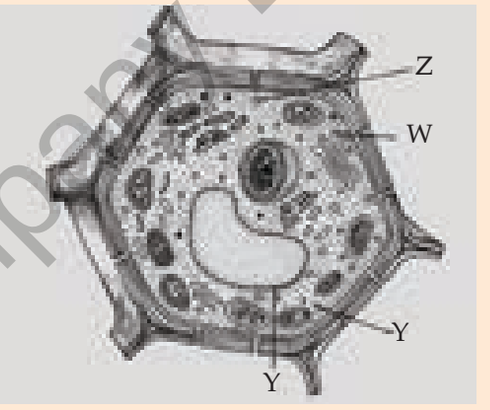
(*b*) Application of salt to mango pieces will release water (sap) due to exosomosis. Consequent less moisture in fruit protects the cut pieces of mango from bacterial and fungal attack (*i.e.*, it helps in the process of food preservation).

7. (*a*) Label X and Y.
(*b*) What is the function of X ?
(*c*) What is the composition of Y ?
(*d*) Identify the above diagram and what is its common name ?



Ans. (*a*) X — Cristae
(*b*) Y — Matrix
(*c*) Matrix is rich in ions, proteins, enzymes of Krebs cycles, DNA, RNAs and ribosomes.
(*d*) Mitochondrion (cut lengthwise). Its common name is power house of cell.

8. (*a*) Label W, X, Y, and Z.
(*b*) What is the covering membrane of X known as ?
(*c*) Which of them contain hydrolytic enzymes ?
(*d*) Which one of them takes part in storage modification and packaging of various chemicals?



Ans. (*a*) W-Dictyosome (*i.e.*, Golgi apparatus); X-Vacuole; Y-Ribosome; Z-Lysosome.
(*b*) Covering membrane of X is called **tonoplast.**
(*c*) Lysosome contains the hydrolytic enzymes.
(*d*) Golgi apparatus takes part in storage, modification and packaging.

9. (*a*) Name the phenomenon which helps fresh water unicellular organisms (*e.g.*, *Amoeba*) continuously gain water in their bodies. Also name the mechanisms by which these organisms throw out excess of water from their bodies.
(*b*) Give at least two examples in plants where similar phenomenon in used to gain water.

Ans. 1. *Amoeba* is a freshwater unicellular organism. It continuously gain water in its body due to **osmosis**. It contains contractile vacuoles to throw out excess of water from its body.
2. (*i*) Absorption of water by the plant root hairs occurs due to osmois.
(ii) In plants, cells, tissues and soft organs such as leaves, buds, young shoots, flowers, fruits maintain turgidity due to osmotic absorption of water.

REVISION QUESTIONS

Very Short Answer Questions (Carrying 1 mark each)

1. What is cell ?
Ans. Cell is the structural and functional unit of life.
2. What is prokaryotic cell ?
Ans. In a cell of bacteria and blue green algae (=cyanobacteria), a well organised nucleus is absent (*i.e.*, there is no nuclear envelope and nucleolus) and membrane-bound organelles are lacking. Such cells are called **prokaryotic cells.**
3. What is eukaryotic cell ?
Ans. In a cell of plants, animals, fungi and protists, a well organised nucleus is present (*i.e.*, such a nucleus is bounded by an envelope and has nucleolus) and membrane-bound organelles such as endoplasmic reticulum, mitochondria, chloroplasts and Golgi apparatus are present. Such cells are called **eukaryotic cells.**
4. Who coined the term cell ?
Ans. Robert Hooke.
5. Name the book in which Robert Hooke published his work.
Ans. Micrographia (1665).
6. Name the scientist who first studied living cell?
Ans. A.V. Leeuwenhoek (1674).

7. Name two factors on which shape of the cell depends.

Ans. Shape of the cell depends upon functional adaptations and viscosity of the protoplasm.

8. Name the smallest and the largest cell.

Ans. The smallest cell is PPLO and largest cell is ostrich egg.

9. Name the longest cell in the human body.

Ans. Nerve cell.

10. How many cells are present in human body ?

Ans. 100 trillion cells (10^{14}).

11. Name the structure from which all multicellular organisms develop.

Ans. Zygote (= fertilized egg).

12. Give two examples of prokaryotic cell.

Ans. Bacteria and cyanobacteria (= blue green algae).

13. Give one example each of unicellular and multicellular organism.

Ans. *Amoeba* and Margosa/Human being respectively.

14. Who proposed the cell theory ?

Ans. **M.J. Schleiden** and **T.Schwann** proposed the cell theory. **Rudolf Virchow** modified the cell theory and stated that every cell arises from pre-existing cell.

15. What is light microscope ?

Ans. An instrument consisting of a source of visible light and a system of glass lenses that allow an enlarged image of a specimen to be viewed.

16. What is electron microscope ?

Ans. An instrument that uses a beam of electrons to visualise cellular structures and thereby examine cellular architecture; the resolution is much greater than that of light microscope, allowing detailed ultra-structural examination.

17. Is plasma mebrane living or dead ?

Ans. Living.

18. What is plasma mebrane ?

Ans. Plasma membrane or cell membrane is a thin delicate living elastic membranous covering of the cell that separates the cell contents from the external environment.

19. Define the cell.

Ans. Cell is a unit mass of protoplasm which is covered by the plasma membrane and is capable of performing different functions of life.

20. What is protoplasm ?

Ans. Protoplasm or living matter is a complex semifluid mass of various biochemicals that are often compartmentalized to perform different functions of life.

21. Name the biomolecules present in plasma membrane.

Ans. Lipids (phospholipids, cholesterol), proteins and small quantity of carbohydrates (sugars and polysaccharides).

22. What is meant by selectively permeable membrane ?

Ans. Selectively permeable membrane is the one which allows entry of certain substances, exit of some substances but prevents the passage of other substances, through it.

23. What type of organization is found in the plasma membrane ?

Ans. Fluid mosaic organization.

24. Define Diffusion.

Ans. The process of movement of a substance (solid, liquid or gas) from the region of higher concentration to the region of lower concentration so as to spread uniformly is called diffusion.

25. What is osmosis ?

Ans. Diffusion of water through a semipermeable membrane from the region of its higher concentration (*i.e.*, dilute solution) to the region of its lower concentration (*i.e.*, concentrated solution) is known as **osmosis.**

26. What would happen if plasma membrane ruptures ?

Ans. Ruptured plasma membrane generally heals within no time but if rupturing does not heal, the cell contents will spill over and the cell is killed.

27. What is the main function of plasma membrane?

Ans. Plasma membrane defines the boundary of the cell and regulates the flow of materials into and out of the cell.

28. What is endosmosis ?

Ans. **Endosmosis** is the osmotic entry of water into a cell or system due to presence of hypotonic solution on the outside.

29. What is exosmosis ?

Ans. **Exosmosis** is the osmotic exit of water from a cell or system due to presence of hypertonic solution on the outside.

30. Define: (*i*) Hypertonic solution; (*ii*) Hypotonic solution, (*iii*) Isotonic solution.

Ans. **(*i*) Hypertonic solution** is the one which has higher osmotic concentration and less solvent concentration as compared to another solution.

(*ii*) Hypotonic solution is the solution that possesses lower osmotic concentration and higher solvent concentration as compared to another solution.

(*iii*) Isotonic solution is the solution that has the same concentration, osmotic as well as solvent, as that of another solution.

31. What is endocytosis ?

Ans. **Endocytosis** is the bulk transfer of materials from inside to the outside of a cell with the help of special vesicles formed by plasma membrane.

32. What is exocytosis ?

Ans. **Exocytosis** is the bulk expulsion of materials from inside to the outside of a cell with the help of special vesicles (which ultimately get fused with the plasma membrane and turn out their contents).

33. Write down names of three types of endocytosis.

Ans. 1. Phagocytosis, 2. Potocytosis (= pinocytosis) and 3. Receptor mediated endocytosis.

34. What is active transport ?

Ans. Membrane protein-mediated movement of a substance across a membrane against a concentration gradient. It is an energy-requiring process.

35. Is the plant cell wall living or dead?

Ans. Cell wall is dead.

36. Name two cell organelles, which contain their own genetic material.

Ans. Mitochondria and plastids.

37. Name the following :
(*a*) Kitchen of a cell; (*b*) Power house of cell.

Ans. (*a*) Chloroplast; (*b*) Mitochondrion.

38. What is the chemical composition of cell wall in plants and fungi respectively ?

Ans. In plants cell wall is made up of cellulose, where as, in fungi it is made up of chitin.

39. What is the main function of each of the following organelles ?
(*a*) Ribosome; (*b*) Cell wall

Ans. (a) Ribosome. It is site of protein synthesis in the cell.
(b) Cell Wall. It provides shape, rigidity and protection to the cell.

40. Name the cell organelle in which following structures are present :
(a) Cristae; (b) Stroma;
(c) Centriole; (d) Chromosome.

Ans. (*a*) Mitochondrion; (*b*) Chloroplast;
(*c*) Centrosome; (*d*) Nucleus.

41. What is the main function of each of the following organelles? (*a*) Golgi bodies; (*b*) Vacuole.

Ans. (*a*) Golgi bodies help in the formation of cell plate (during cell division of plant cells) and synthesis of lysosomes and secretory vesicles.
(*b*) Vacuoles are involved in the maintenance of water balance.

42. What cell organelle is responsible for release of energy as ATP ?

Ans. Mitochondria.

43. What for ATP stand ?

Ans. Adenosine triphosphate.

44. Name the nucleic acids that are present in an animal cell.

Ans. DNA and RNA.

45. Do the plant cells contain centriole ?

Ans. No.

46. Write two differences between plant cell and animal cell.

Ans. (*i*) Plant cells have cell wall which is absent in animal cell.
(*ii*) Plant cells lack centrioles whereas animal cells have centrioles.

Short Answer Questions (Carrying 2 marks each)

1. Distinguish between prokaryotic and enkaryotic cells.
2. Write down differences between organ and organelle.
3. Write down differences between nucleus and nucleoid.
4. Mention differences between light microscope and electron microscope.
5. Give a brief account of discovery of the cell.
6. Describe the proteins of plasma membrane.
7. Enumerate functions of plasma membrane.
8. Give an example of diffusion across plasma membrane.
9. Set up an experiment to demonstrate osmosis.
10. Write down the differences between diffusion and osmosis.
11. Write a note on endocytosis.
12. What would happen when eukaryotic cells are placed in hypotonic, hypertonic and isotonic solutions?
13. Name the following :
(*a*) Smallest cell organelle
(*b*) Largest cell organelle;
(*c*) ER studded with ribosomes
(*d*) Functional segments of the DNA molecule.
14. Distinguish between the following
(*a*) Chromoplast and chloroplast
(*b*) Ribosome and centrosome.
15. Write main differences between plant and animal cells.
16. What will happen in a cell if its nucleus is removed? Give reasons in support of your answer.
17. Explain why do spinach look green, papaya yellow and edible part of water melon red ?

18. Write down two main functions of
(*a*) Endoplasmic reticulum
(*b*) Lysosome.
19. Name the following
(*a*) The cell organelle which synthesizes protein.
(*b*) The type of plastid which stores food.
20. "Lysosomes are known as suicide bags". Why?
21. Define the following terms :
(*a*) Cell inclusions (*b*) Cytosol
(*c*) Protoplasm (*d*) Nucleoplasm.
22. Where do the ribosomes get synthesized ?
23. Write short notes on
(*a*) Mitochondria; (*b*) Plastids.
24. Write names of cell organelles.
25. What are three main functional regions of the cell ?
26. What is the location of following in the cell:
(*a*) Chromatin (*b*) Chromosome
(*c*) Tonoplast (*d*) Nucleolus
27. What are the genes ? Where are they located in the cell ?
28. Lysosomes are also called digestive bags. Why?
29. Which organelle is the " power plant" of eukaryotic cell. Write in brief its functions.
30. What are centrioles? Write about their function.
31. Where do lipids and proteins constituting the plasma membrane get synthesised ?
32. Draw a well labelled diagram of typical prokaryotic cell ?
33. What does the term plasmolysed mean when used to describe a cell ?

Long Answer Questions (Carrying 5 marks each)

1. Describe with a diagram the fluid mosaic organisation of the plasma membrane.
2. Draw a well labelled diagram of animal cell and mention one function of the main cell organelles.
3. Give an illustrated account of nucleus.
4. Write short note on the following :
(*a*) Golgi apparatus (*b*) Mitochondria

VALUE BASED QUESTIONS

Q.1. How does a cell show division of labour ? Is there any parallelism between working of the cell and our society ?

Ans. A cell has a number of organelles such as plasma membrane, chloroplasts, mitochondria, endoplasmic reticulum, Golgi apparatus lysosomes, ribosomes, nucleus, vacuoles, etc. Every cellular organelle perform its specific function such as regulation of entry and exit of vital molecules by the plasma membrane, food (carbohydrate) synthesis by chloroplasts: they are one type of **transducers** of cells, converting energy of sunlight into chemical energy of carbohydrates (glucose, sugar and starch); energy liberation by mitochondria (mitochondria are other types of transducers of the cells, converting glucose's energy into ATP molecules); protein synthesis by ribosomes; lipid synthesis by smooth endoplasmic reticulum, transport of manufactured products to Golgi apparatus or to lysosomes; packaging of synthetic and finished items (glycoproteins, proteins, lipids, carbohydrates) for export; scavenging or digestion and utilisation of wornout organelles and imported items (via endocytosis) by lysosomes; in plant cell vacuoles act as the pool or storage tank; control by nucleus (DNA of chromosomes regulate all the activities of all cellular organelles by manufacturing various types of RNA molecules which ultimately synthesize specific proteins both structural and functional, which are the key of diversity of cells and species.

Human society can be compared with a cell. Police and security persons check entry and exit of persons of a city; city planners develop infrastructure of a city such as residential areas, colleges, schools, hospitals, markets, malls, roads, flyovers, railways, sewers; power engineers ensure regular supply of electricity to various establishments/industries and to produce vital products of daily use of human beings such as bread, milk, butter, tea, eggs, clothes, furniture, building materials, soaps, detergents. In this way masons, electricians, carpenters, plumbers, transporters, scavengers, traffic controllers, teachers, doctors, farmers, shopkeepers, managers, security persons, all have some specialised job/task to do for the human society. Activities of all sections of the human society are well coordinated according to some written/unwritten laws.

Q.2. Khushi wanted to eat rice and kidney bean (rajmah). She requested her mother to cook the same for lunch tomorrow. At night her mother took a cup of kidney bean and put them in a container having some water. She kept the container covered overnight. Next morning, she cooked rice and kidney beans for lunch. Khushi inquired her mother the following questions:

(*i*) Why did she soak kidney beans in water

overnight ?

(*ii*) Name the scientific phenomenon involved in above process.

(*iii*) Name atleast one more food item that is cooked in this way.

Ans. (*i*) Kidney beans are seed and each cell of it is covered with porous cell wall and semipermeable plasma membrane. By the process of endosmosis, water is diffused in kidney beans upon soaking overnight and they get swollen and become palatable after cooking.

(*ii*) Endosmosis.

(*iii*) White grams (Kabul chana or choley or chicken pea (gram or chana).

Q.3. One day Muskan saw her mother making pickle. Her mother cut the carrots, turnips and cauliflowers into small pieces, washed them and put them in the sun for few hours. Thereafter, she mixed common salt, oil, paste of onion, ginger and garlic, gur, red chilli, turmeric powder, acetic acid, etc., as per requirement with the cut vegetables and heated them. After cooling, she put the contents in the air tight jar and kept it in the sun for many days.

(*i*) Why did Muskan's mother cut the vegetables into small pieces and put them in the sun for few hours ?

(*ii*) Why did she mix common salt in the cut vegetables and heated it ? Name the process involved.

(*iii*) Why did she mix acetic acid ?

Ans. (*i*) Muskan's mother cut the vegetables into small pieces and put them into the sun (to get sunlight) for few hours so that they lose water by diffusion and evaporation and become dry.

(*ii*) She mixed common salt to the cut vegetables so that the cells of cut vegetables lose further water by exosmosis. Heating was done to evaporate the water. This is done to check the growth of microorganisms such as bacteria and fungi on the vegetables.

(*iii*) Acetic acid is used as preservative; it kills the microorganisms.

Q.4. What is the basis of long life of pickles and jams ? What lesson one gets from this fact ?

Ans. Pickles and jams have high concentration of osmotically active substances (such as salt in pickles, sugar in jams). They do not allow the microbial spores to germinate over them. Even on contamination, a microorganism cannot survive in them as it will undergo exosmosis and die. Turmic and acetic acid (or any preservative) too kills the microbes. Because of being microbe/germ free, pickles and jams do not get easily spoiled.

Further life of pickles and jams is enhanced by keeping them in dry and cool places and handling of them by the neat and moisture - free (*i.e.*, dry) spoons.

An active and long life can also occur in human beings if they live in hygienic environment, avoid coming in contact with contaminated articles and visiting crowded places.

Q.5. Arvind sometimes go for late evening walk with his father who has a background of biology. While walking in the colony park, he observed many plants having colour flowers. He also saw few plants having white flowers. Most of these flowers emit pleasant fragrance (= aroma). Out of curiousity, Arvind asked his father the following questions:

(*i*) Why do plants have variously coloured flowers ? Give two reasons.

(*ii*) Why do certain flowers emit fragrance ? How does fragrance of flowers spread in the environment ?

(*iii*) Which scientific phenomenon is involved when (*a*) fragrance spreads in the house at the time of cooking of food in the kitchen; (*b*) exchange of gases occurs across the respiratory surface.

Ans. (*i*) (*a*) Plants have variously coloured flowers to attract insects and other animals for pollination. Coloured flowers attract diurnal insects such as honeybees and butterflies, while white flowers attract nocturnal insects such as moths.

(*b*) The flowers are meant for sexual reproduction in plants.

(*ii*) Flowers contain nectar and spread fragrance in the environment to attract insects and other animals for pollination.

Scent/fragrance spreads from flowers into surrounding environment through diffusion.

(*iii*) (*a*) Diffusion

(*b*) Diffusion.

Q.6. What are the functions of plasma membrane ? How is the plasma membrane able to perform diverse functions. Give an example of diversity in functioning in any segment of human society.

Ans. Plasma membrane of the cell is a living motile (fluid) structure having lipids, proteins and externally attached sugars. It has a number of functions such as providing shape to cell, acting as mechanical barrier between cell contents and environment, selective permeability, endocytosis (*e.g.*, paenocytosis, phagocytosis), recognition, flow of information, passage of water, flow of external

fluids by cilia or absorption of nutrients by its microvilli.

The diverse functions of the plasma membrane are possible due to adaptation of proteins to form channels, enzymes, carriers, receptors and their attachment to small carbohydrates (oligosaccharides).

Like proteins, every human being has to perform different functions in the human society. For example, Muskan is daughter of her parents, sister of her brother, student of her school, a table tennis player, a friend to several class fellows, a companion of her pet, a gardner in home garden, a helper to her mother, a caretaker of her grand parents, an active social worker, etc.

Q.7. (*i*) A fruit is green when unripe but become beautifully coloured when ripe. How does this change occur ?

(*ii*) What is the importance of this change ?

(*iii*) What is mutualism involved ?

(*iv*) Give an example of such a mutualism in human society.

Ans. (*i*) An unripe fruit is green because it contains chloroplasts in its skin. Towards ripening of the fruit, the chloroplasts are changed into chromoplasts which give the fruit an attractive non-green colour such as yellow, orange, reddish, pink, purple, brownish, etc.

(*ii*) The colour of ripe fruits attracts animals. The coloured fruits are often sweet and fleshy. Animals such as birds, monkeys, come to feed over the fruits.

(*iii*) While eating the flesh of fruits, the animals pick up the seeds and take them to different places visited by them. This helps in the dispersal of seeds. Therefore by this action both the animals and the plants are benefitted. It is mutualism.

(*iv*) Mutualism or mutual dependence is the law of human society. No body can live and work alone. Every body is dependent on somebody else for most of his/her activities. For example, household workers such as cook, utensil cleaner, washerman, gardner, driver, scavenger, hair dresser, tailor, etc., work for you for which you pay so that the worker is able to run his/her family.