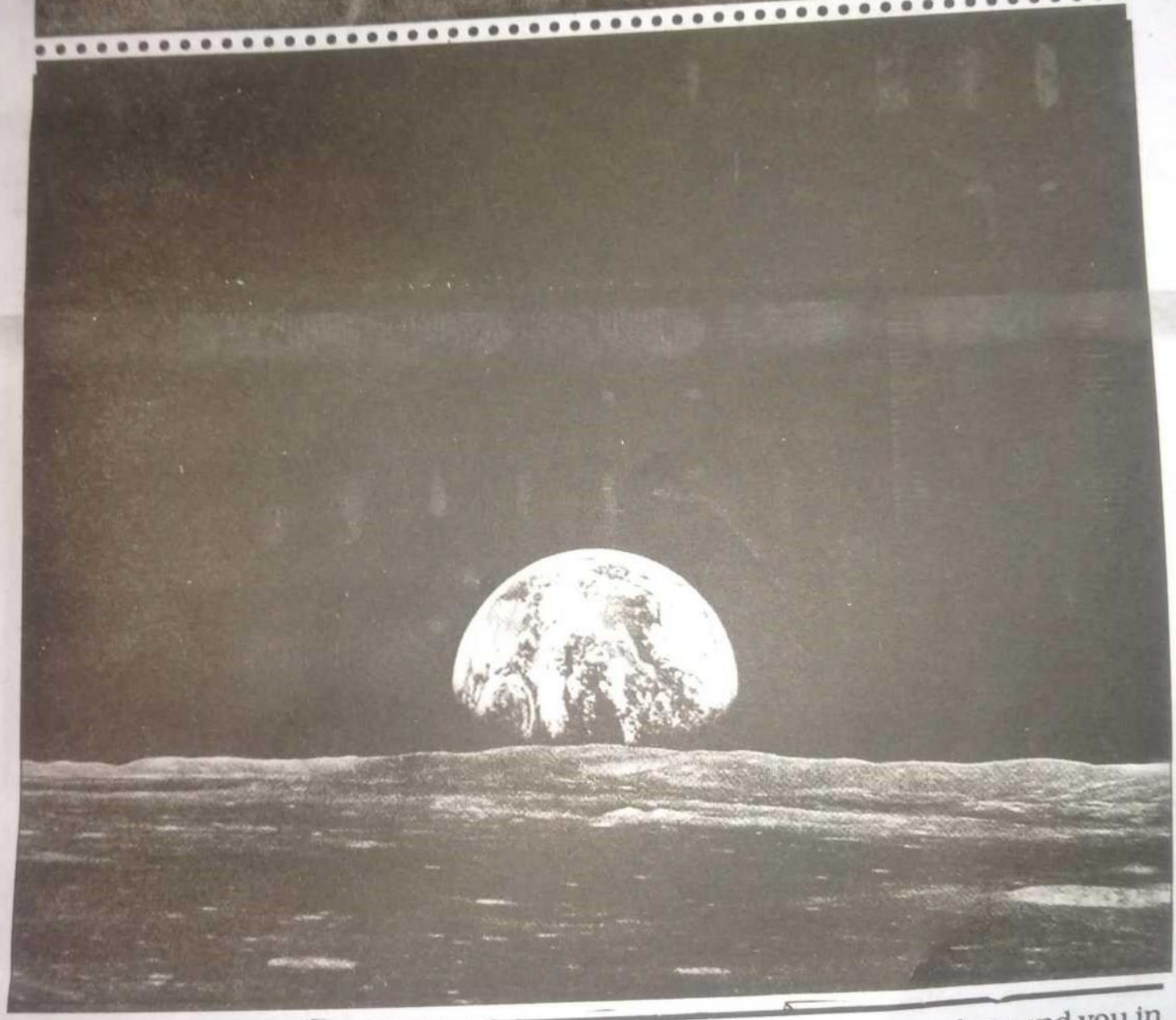
بسم الله الرحمن الرحيم

SECTION-I

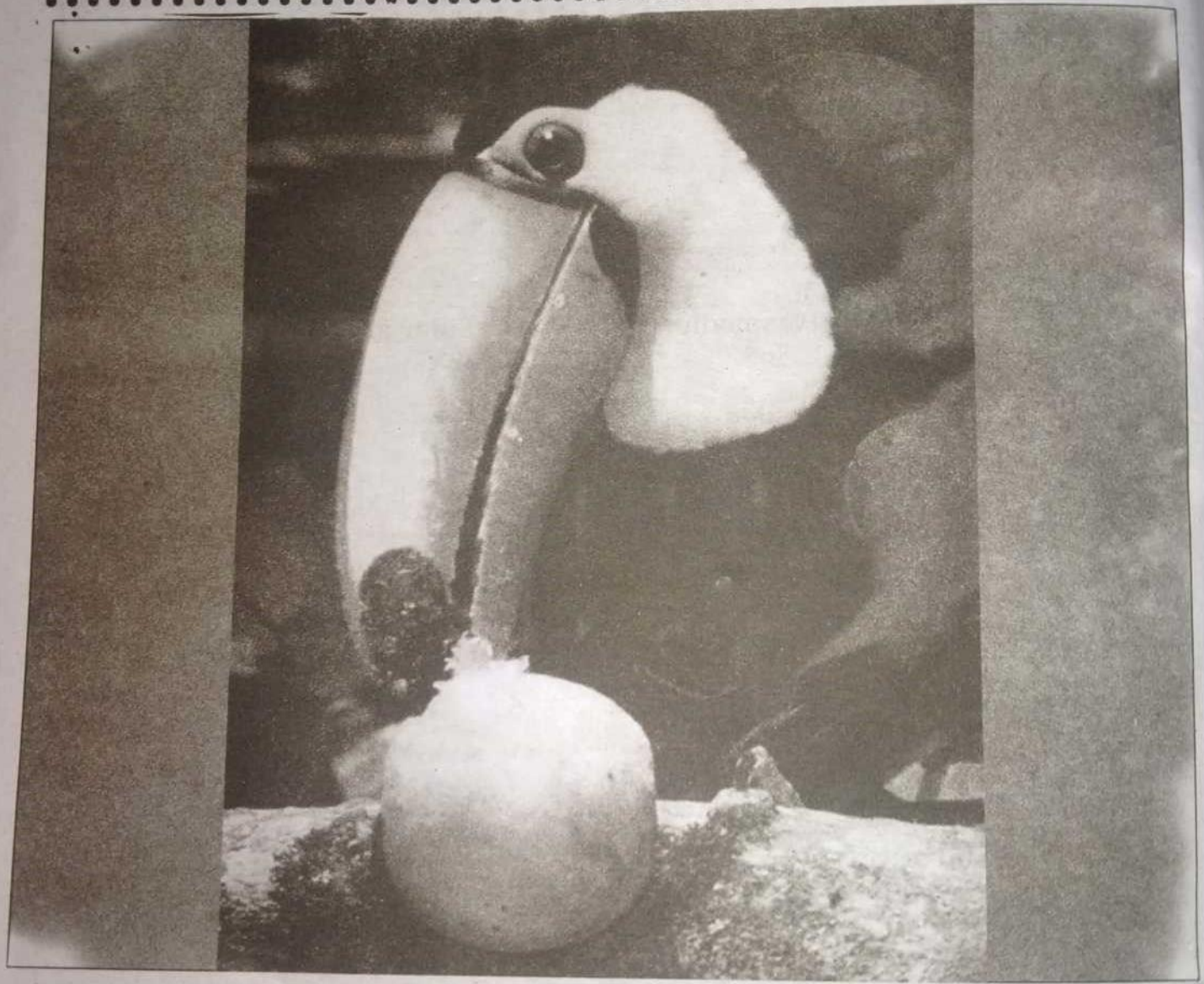
INTRODUCTION



Biology or the science of life is not unfamiliar to you. It is in you and around you in greatly diverse forms. Every where you see, in water, in air, and on land, you find living things which call your attention to ponder. Why do they exist? How do they exist and what is the underlying unity among them? When and how they came into being? If you have developed this intellect than you are very close to knowing about the Creator and His creations.

CHAPTER 1

THE BIOLOGY



The Biology recalls your previous exposure to biology in early classes. It gives you some novel thoughts, a modern and clearer vision of the biginnings of living things, from the molecular levels up to the level of complex organisms. It provides you the basis for systematic observations, hypotheses, predictions and experimentations. Finally, this chapter gives you few examples of various brilliant biologist's endeavours, such as modern diagnostics, therapeutics, control of diseases and techniques like cloning, hydroponics etc.

1.1 BIOLOGY AND ITS MAJOR FIELDS

Biology is one of the natural sciences, which deals with the things that exhibit the properties of life. Scientists call these things as "organisms". The word biology has been derived from Greek words Bios, life + Logos, discourse. Formerly living organisms were classified into two kingdoms i.e. plant kingdom and animal kingdom. The plants were studied under the subdivision **Botany** and the animals were studied under the subdivision **Zoology**. The latest research has discarded the old concept of two kingdoms of living organisms. According to modern system of taxonomy, living organisms have been classified into the following **five kingdoms:**

1. **Kingdom Prokaryotae (Monera):**
   It includes almost all the prokaryotes, e.g. bacteria and cyanobacteria.

2. **Kingdom Protoctista (Protista):**
   It includes all the unicellular eukaryotic organisms, which are no longer classified as animals, plants or fungi. e.g. Euglena, Paramecium, Chlamydomonas, Plasmodium etc. Multicellular algae and primitive fungi have also been included.

3. **Kingdom Fungi:**
   It includes non-chlorophyllus, multicellular (except yeast) organisms having chitinous cell wall, absorptive heterotrophs and have non motile spores/ gametes e.g. Agaricus (mushroom) yeast, etc. They are absorptive hetrotrophs.

4. **Kingdom Plantae:**
   It includes all the eukaryotic, multicellular, chlorophyllus, photosynthetic autotrophs having cell wall made up primarily of cellulose, zygote retained to become embryo and exhibiting heteromorphic alternation of generation. e.g. Moss, Fern, Pines, Apples, etc.

5. **Kingdom Animalia:**
   It includes all eukaryotic, non-chlorophyllus, multicellular, ingestive heterotrophs with no cell wall. e.g. Hydra, Earthworm, Human beings etc.

Scientists have discovered and named more than one and a half million species of living organisms which exist in a great variety of forms – shapes and sizes. For example, the smallest microscopic ones, bacteria, which may measure no more than 0.0001mm to probably the largest animal, whale, in the world, which may measure up to 40 metres in length and weigh 150 tons and trees, redwood tree, measuring over 300 feet in height.

Modern biology does not only concern with the recognition and classification of these species but also deals with their vital structural and functional aspects.

This has led to the division of biology into a large number of extremely specialised branches. Some of the major branches or fields of specialisation in biology are defined below:

Molecular Biology:

It is a recent branch of biological science that deals with the structure and function of the molecules which form structure of the cell and its organelles that take part in the biological processes of a living organism (Nucleic acids—Protein molecule).

Micro-Biology (micro = very small):

It deals with the study of micro organisms (viruses, bacteria, protozoans and pathogenic fungi), which can only be seen under microscopic.

Environmental Biology:

It deals with the study of environment and its effects on organisms. Previously it was known as ecology.

Marine Biology:

It deals with the study of organisms inhabiting the sea and ocean, and the physical and chemical characteristics of their environment.

Fresh Water Biology:

It deals with the life dwelling in the fresh water bodies, their physical and chemical characteristics affecting it.

Parasitology (Para=Beside, Sitos=Food, Logs=Science/Study):

It deals with the study of parasitic organisms, their life cycles, mode of transmission and interaction with their hosts.

Human Biology:

This branch of biology deals with all biological aspects of man regarding evolution, anatomy, physiology, health, inheritance etc.

Social Biology (Sociare=Companion):

Social biology is concerned with the social interactions within a population of a given animal species, specially in human beings, focuses on such issues as whether certain behaviour are inherited or culturally induced.

Biotechnology (Bio = life; Technologia = systematic treatment):

This is a very recent branch introduced in biological sciences. It deals with the use of the data and techniques of engineering and technology for the study and solution of problems concerning living organisms particularly the human beings.

1.2 LEVELS OF BIOLOGICAL ORGANIZATION

Living organisms are highly complex and organized. This complexity and organization is composed of grading of structures with each level based on the one below it, and providing the foundation for the one above it. Life is built on a chemical foundation. This foundation is based on elements, each of which is a unique type of matter. As we know, an ***atom*** is the smallest possible unit of an element, which retains all the properties of that element. Further division of this unit produces isolated ***subatomic particles*** of which an atom is composed. Atoms may combine in specific ways to form ***molecules***. Simple molecules are formed spontaneously, for example, carbon dioxide. Extremely large and complex molecules are manufactured by living matter (within the bodies of living organisms). The molecules of living matter are mostly based on carbon and provide building blocks of living matter. These are called ***organic molecules***. Molecules of different elements comprise a ***compound***. Along with organic compounds, inorganic compounds (minerals) are also associated with living organisms, for example, human blood.

The simple organic molecules are sugar, glycerol, fatty acids, amino acids, purines and pyrimidines. In the bodies of living organisms simple organic molecules are converted into more complex organic molecules. They are recognised as the three categories of food or natural ***macromolecules*** and are required by living organisms. These are carbohydrates, lipids and proteins.

With different chemical arrangements and formation of complex molecules, the life emerges on the level of a ***cell***. Like an atom is the smallest unit of matter, a cell is the smallest unit of life. Fundamentally, all cells contain **genes**, which are functional units of **DNA**. The genes provide necessary information needed to control the life of the cell. The sub-cellular structures, called ***organelles***, function as chemical factories and use the information in the genes to keep the cell alive. A thin covering called cell membrane encloses the cytoplasm along with its inclusions. Some organisms, mostly microscopic, consist of one cell, but larger organisms are composed of many cells. In these multicellular organisms, cells of similar type form **tissues**, which perform a particular function, for example nervous tissues, connective tissues, xylem tissues etc. Various tissue types combine to make up an ***organ***, for example the brain. Several organs that collectively perform a single function form an ***organ system***, for example, together, the brain, spinal cord, sense organs, and nerves form the nervous system. Altogether, different organ systems functioning in a highly advanced co-ordination and co-operation make up an ***individual whole organism***.

Biological organization can be divided into the following levels.

Biosphere	That part of earth inhabited by living organisms; includes both the living and non-living components
Ecosystem	A community together with its non-living surroundings.
Community	Two or more populations of different species living and interacting in the same area.
Population	Members of one species inhabiting the same area.
Species	Very simillar, potentially interbreeding organisms.
Multicellular organism	An individual living thing composed of many cells.
Organ system	Two or more organs working together in the execution of a specific bodily function.
Organ	A structure within an organism usually composed of several tissue types that form a functional unit
Tissue	A group of simillar cells that perform a specific function.
Cell	The smallest unit of life.
Organelle	A structure within a cell that performs a specific function.
Molecule	A combination of atoms.
Atom	The smallest particle of an element that retains the properties of that element.
Subatomic particles	Particles that make up an atom.

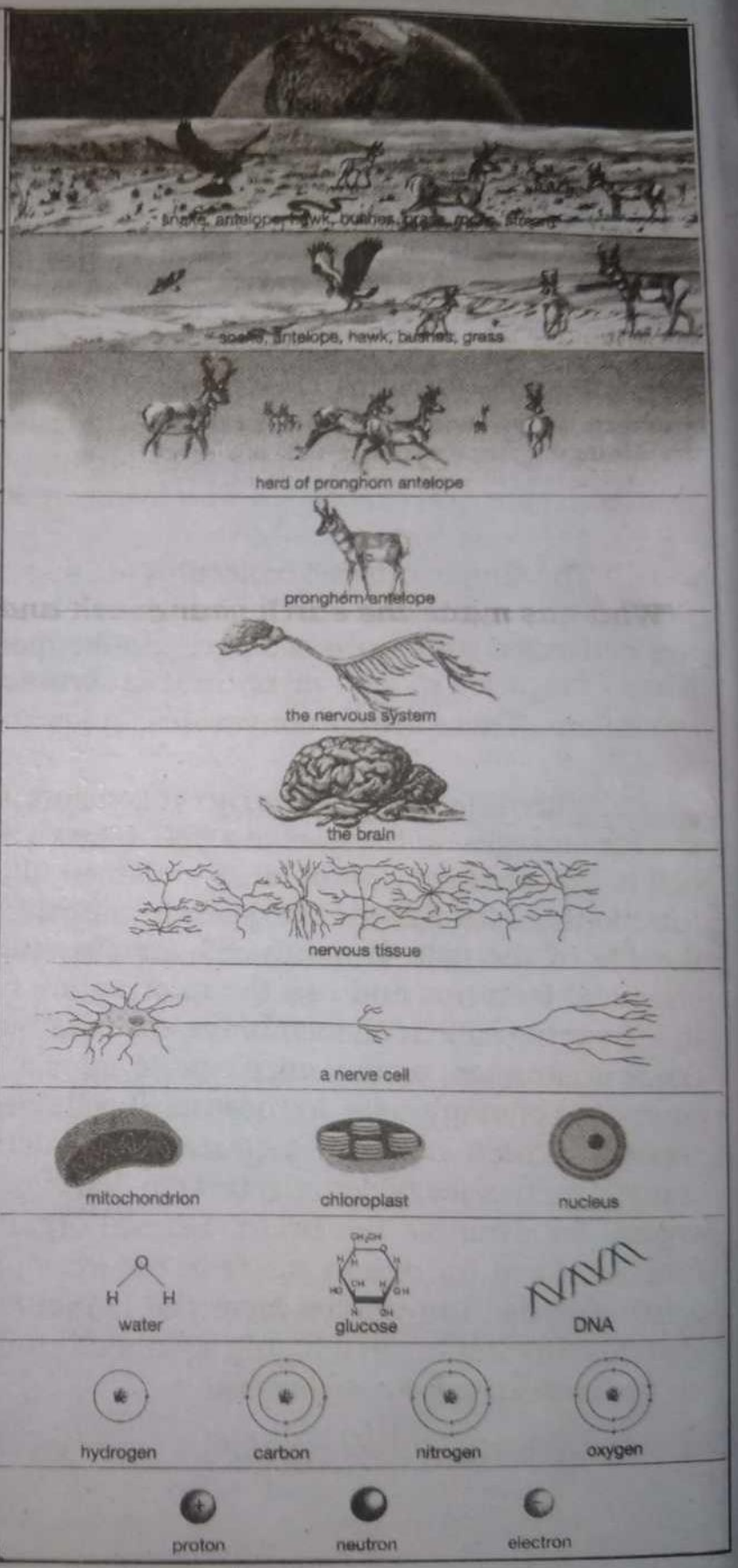


Fig. 1.1 Levels of organization

Beyond living organisms are broader levels of organization. A group of very similar interbreeding organisms constitutes a **species**. Members of the same species living in close association in a given area are considered a ***population***.

Populations of several species living and interacting in the same area form a ***community***. A community with it's environment, including land, water and atmosphere, constitute an **ecosystem**. Finally, the entire surface region of the earth inhabited by living things is called the **biosphere**.

Living world in the light of Islamic thought:

Al-Quran, the last Holy book consisting of the final word of **Allah** for the spiritual guidance of man also contains some principle facts for the pursuit of knowledge including biology. The Quran has drawn our attention to look into the mysteries of His creation and has advised us to investigate them to the best of our abilities. As far as the relationship of plant and animal life with human welfare is concerned, it is too obvious to mention. Holy Quran says in plain words that:

"Who has made the earth your couch and the heavens your canopy; and sent down rain from the heavens; and brought forth therewith fruits for your sustenance."

(Sura Al-Baqra, Ayah 22)

Then again the Holy Quran says that:

"There is not on animal (that lives) on the earth, nor a being that flies on its wings, but (forms part of) communities like you."

(Sura Al-Anaam, Ayah 38)

The English translations of the two Quranic verses, (by Abdullah Yusuf Ali 1934) reproduced here refer to important biological phenomena. In these and a number of other Quranic verses referring to biological and other scientific facts, Quran emphasizes upon us to study them carefully.

"Say: Behold that is in the heavens and on earth."

(Sura-Yunus, Ayah 101)

And again the Holy Quran says that:

"Behold: In the creations of the heavens and the earth and the alternation of the night and day, there are indeed signs for men of understanding. And contemplate the (Wonders of) creation in the heavens and the earth."

(Sura Aal-e-Imran, Ayah 190-191)

Contemplation, careful observation and study of scientific phenomena leading to human welfare are of paramount importance according to the teachings of Quran. It would be a religious duty to study the biological processes, so vital a part of creation on the earth.

Living world in space:

Life arose in this world almost two and a half billion years ago. It has been postulated that the first living forms were of simple unicellular organization. As a consequence of gradual modifications in the genetic material of some or all of those living forms, new types of living organisms were evolved. This provided the basis for the present day diversity in the form of organisms, which exist as millions of species all around the earth in each and every type of habitat.

Majority of living organisms occur as free-living forms but those who failed to do so have developed ways of interactive life i.e. they live in some kind of association with other living organisms i.e. Symbiosis, (Commensalism, Mutualism, Parasitism, etc.).

Living world in time:

As stated earlier, the first living forms were simple, unicellular organisms. How did we come to know this? Another query comes to mind how and when did the present day organisms develop? Such questions can be solved through the study of fossils which are the remains of ancient organisms that lived in ancient times. Fortunately, fossils of most of the groups of organisms have been discovered. Age of the fossils can be determined by using number of techniques. Through these techniques, it has been discovered that fossils of different groups of organisms have different age, supporting the concept that different organisms arose in different geological times as shown in figure 1.2.

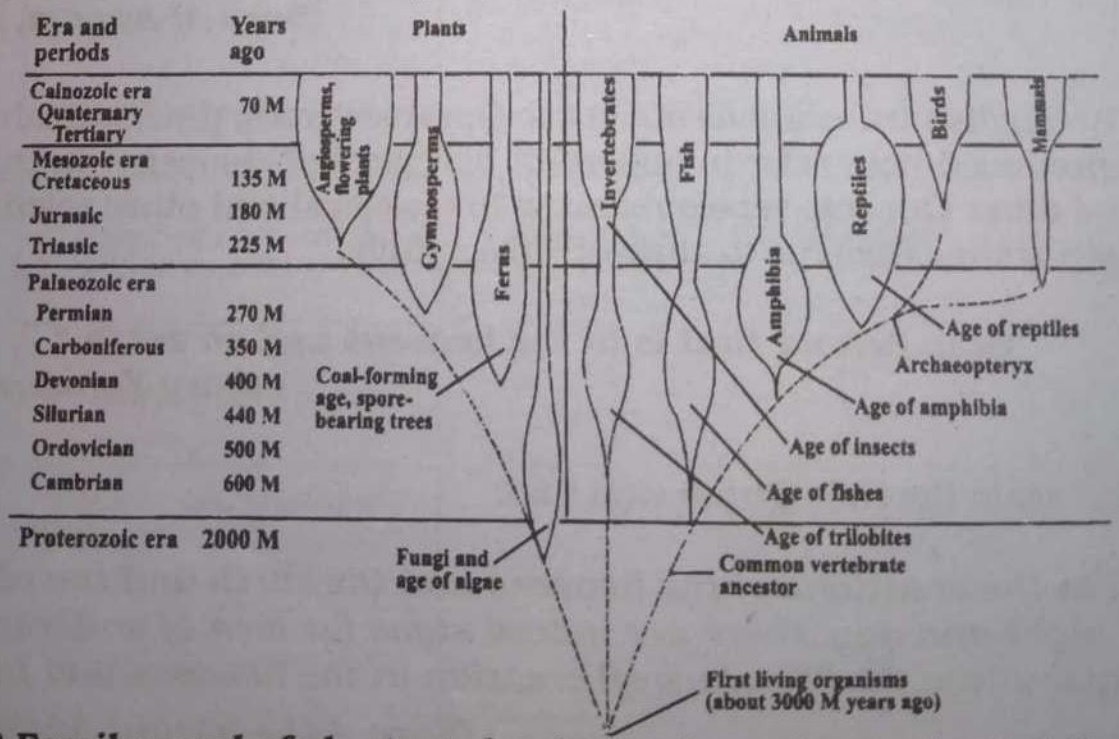


Fig. 1.2 Fossil record of plants and animals shown in a geological time chart

Phyletic lineage:

As discussed earlier, living organisms arose gradually forming populations during different geological periods through the process of evolution. It provides basis for establishing a common origin of species or phyletic lineage. It is believed to be an unbroken series of species, progressing from ancestor to descendent, with each group evolving from one immediately preceding it. If all the missing links are discoverd they may lead us to the origin of life itself.

1.3 BIOLOGICAL METHODS

The methods to tackle problems in the field of biology work almost on the same principles as in any other field of science. Biologists work out the topics and recognise them as problems to be solved. A systematic method of steps is followed in order to carry out the research (Fig.1.3). Scientists make keen **observations** and **collect the facts** already reported by others. On the basis of these facts, a scientist formulates a tentative statement, called ***hypothesis***. This hypothesis is used to guide further observations and experimentations. This part of the scientific method involves ***inductive reasoning***. In this, a scientist uses isolated facts to reach a general idea that explains a phenomenon. For example, *Robert Hooke* observed, a thin slice of cork being composed of units, which he called, cells. This led to further observations and experimentations on plant and animal material, by *M.J.Schleiden* and *T.Schwann*, who proposed the cell theory, stating that all forms of life are made up of cells.

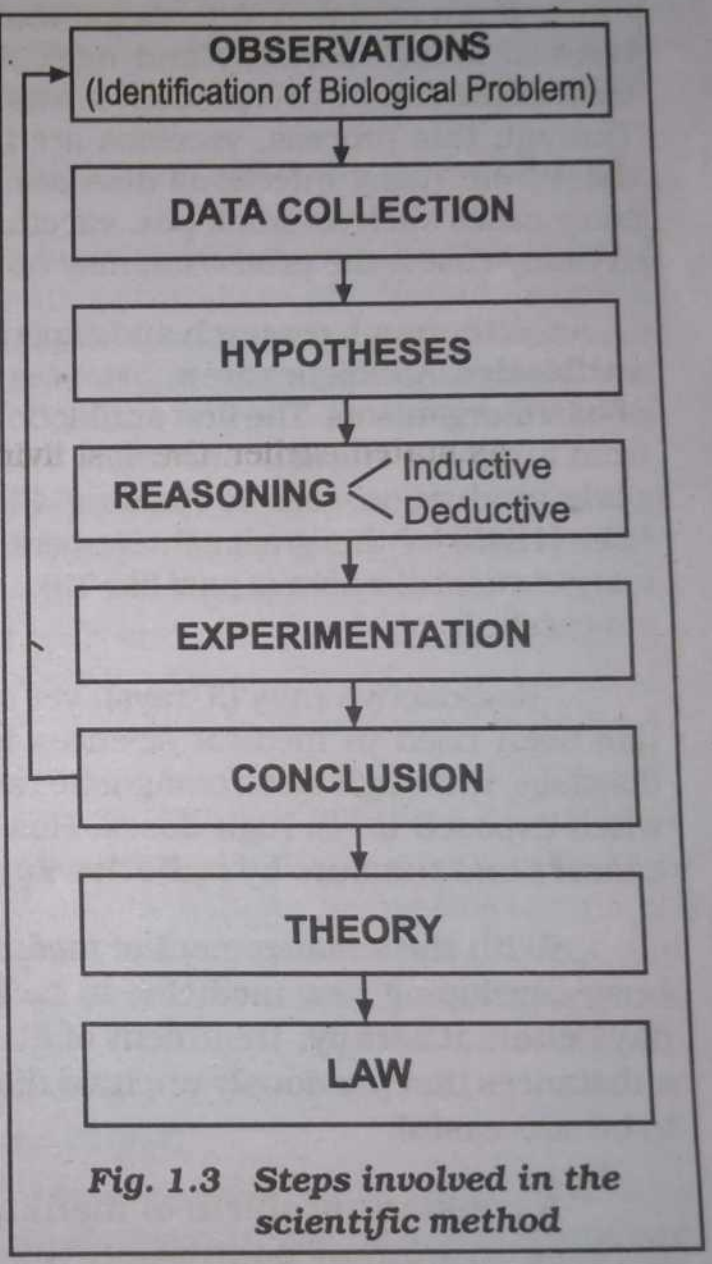


Fig. 1.3 Steps involved in the scientific method

Once the hypothesis is stated, ***deductive reasoning*** starts to play its role. It often involves an "if——then" statement. Based on the results of accurate experimentation, **conclusions** are drawn. If the conclusions come true the hypothesis is taken as true, otherwise it is not accepted. On the basis of true hypothesis, **a theory** is put forward which, in turn, when proved to be true under all tested circumstances, is accepted as a **law** (general principle).

1.4 APPLICATIONS OF BIOLOGY FOR THE WELFARE OF MANKIND

The practical contributions of biology to civilization have made most people aware of its importance. Knowledge of biology ensures a higher standard of living. It helps people to participate intelligently in programs designed to promote better health, protection and conservation of environment, application of modern techniques in the field of agriculture and medical sciences etc.

It is a common observation that in recent years, through out the world, the rates of infant mortality and morbidity have been greatly reduced. Thanks to **immunization** by vaccination. It was first introduced by Edward Jenner in 1795. Through this process, vaccines are introduced to animals and man to prevent them from many infectious diseases such as polio, small pox, hepatitis, etc. In some cases such as small pox, vaccination provides long life protection. However, in many cases, the protection may not be life long.

A thorough research and experimentation has enabled biologists to develop **antibiotics**. Antibiotics are substances which in low concentration inhibit the growth of micro-organisms. The first antibiotic to be discovered was penicillin. It was derived from fungus, *Penicillium notatum*. The credit for the discovery, isolation and large scale production goes to Fleming, Florey and Chain who jointly received Nobel Prize (1945) for this great achievement in medical sciences. Due to these antibiotics many critical diseases of past like T.B., leprosy and anthrax etc. have been controlled successfully.

Radioactive rays (X-rays), yet another achievement of biological research, has been used in medical sciences for the diagnosis and treatment of human diseases, although electromagnetic radiation is very destructive to human tissue, when exposed to, in high doses. However, recent medical technology of treating cancers and tumours by **radiotherapy** has been successfully introduced.

With the advancement of medicinal sciences, biologists have, and still are, busy developing new medicine to tackle the problems concerning health. These days **chemotherapy**, treatment of disease that with the help of certain chemical substances that previously uncured diseases like cancers and AIDS etc., has proved to be successful.

A constant problem of mankind has always been to get food. With the increase in human population this problem has become worse. Biologists have been trying their best to tackle this problem by developing effective techniques to be introduced in agricultural field to produce better quality crops.

Hydroponics (Hydro = water; ponos = work):

It is the science of growing terrestrial plants in an aerated solution. It is also known as soil less or water culture. Hydroponic farming of vegetables and other

essential plants is one of the techniques through which plantation in certain parts of the world has fulfilled the food requirement of the inhabitants. Hydroponics was developed to conduct experiments on the nutrient requirements of plants especially the micro-nutrients. The advantages of hydroponic farming are as follows:

1. It controls weeds and soil disease problems.
2. Area required for cultivation is reduced.
3. Crops are successfully grown in arid parts of the world to meet the food requirements of those areas. For example, tomato crops has been successfully grown in green-houses in some parts of the world through this technique.
4. It is used to determined which of the mineral elements are essetial.

Cloning: It is the production of duplicate copies of genetic material; either cells or entire multicellular living organisms. It occurs naturally in plants and animals. The copies are referred to as clones. Some common examples are identical twins or triplets in humans, asexual reproduction in plants and animals, regeneration and development of tumours and cancers.

Artificial cloning has long been a focus of attention in biological sciences. The possibility that people might be cloned from the cells of a single adult human being had long been under study. Biologists have successfully cloned lower mammals. Recently, Dolly the sheep was a highly successful clone from a somatic cell, reported back in 1997. This has led scientists to take a step forward to clone humans. Cloning of human cells such as liver cells, skin cells and blood cells, have been very promising and scientists are quite hopeful to develop human organs in the laboratory by artificial cloning. There are enormous advantages of artificial cloning in areas such as agriculture and medicine. Vegetative reproduction of various fruits and nuts by grafting is one of the best examples. A major goal of this technique is to use it for treating diseases. Through this technology, production of medically significant substances such as insulin, growth hormones, interferon and antithrombin have been achieved.

Protection and conservation of environment:

Pollution has been the biggest problem of man for many years. Acid rain, stone cancer and green house effect are some of the aspects that have been increased with the increase in human population and industrialization.

Many of the waste products of modern technology are toxic. These toxic wastes have polluted our air, land and water, threatening not only human life but also other living forms. In this regard, improved and effective biological measures have been taken to identify different sources of pollution and techniques have been devised to help prevent and reduce pollution.

Man's activities mainly deforestation and industrialization have disturbed the balance of nature with catastrophic results. To maintain a stable and balanced ecosystem, it is very much needed to protect and conserve animal and plant species. Conservation of forests and parks helps to reduce soil erosion and flooding etc. It is also of scientific value as it provides useful information about plants that have medicinal or other importance.

1.5 CONCEPT OF BIOLOGICAL CONTROL AND INTEGRATED DISEASE MANAGEMENT

The use of natural processes to combat pathogens is very helpful. It involves introduction of pathogen's natural enemies into its environment. In case of malaria, for example, introduction of small fish in ponds and ditches has been an effective method to minimize the growth of larvae and pupae of mosquito vector. Biological pest control involves exposing them to predators and parasites.

Growing plants in climates that are unsuitable for the pathogen can control plant diseases. Interplanting, as it stimulates conditions in natural ecosystems by limiting the spread of infectious diseases can also control it. Another effective method in eradication of disease, is achieved by crop rotation. It is the practice of growing different crops on the same ground in successive years rather than repeatedly growing one year after year. Through crop rotation, the chances of establishing a particular parasitic weed affecting that crop is reduced. Moreover, soil fertility can be increased by introducing a crop of leguminous family which have nitrogen fixing bacteria in their root nodules.

KEY POINTS

- Biology deals with the study of living organisms.
- Modern system of classification divided organisms into five groups or kingdoms.
- The scope of biology has increased wiht the introduction of technical fields for study.
- Life is built on chemical foundation.
- Living organisms exhibit a gradual complexity in structure and function.
- Problems in biology are dealt with biological methods.

- An advanced approach, with an evolutionary point of view, can lead us to origins of life.
- Biological applications provide better health, better food, better environment for all organisms.

EXERCISE

1. Encicrle the correct choice:

(i) An autotroph may be placed in following group except:

(a) Monera (b) Protoctista
(c) Fungi (d) Plantae

(ii) Malaria is caused by:

(a) Virus (b) Bacteria
(c) Fungi (d) Plasmodium

(iii) All of the following are natural cloning except:

(a) Regeneration (b) Identical Twins
(c) Dizygotic Twins (d) Tumor

(iv) Pencillin was discovered by:

(a) Fleming (b) Jenner
(c) Robert Brown (d) Laveran

(v) Micro organisms are studied the disciplines of:

(a) Parasitology (b) Marine biology
(c) Micro-biology (d) Human biology

(vi) Hydroponics is the science of growing terrestrial plants in:

(a) Laboratory (b) Desert
(c) Lake (d) Aerated solution

(vii) Industrialization and over population has increased:

(a) Pollution (b) Disease

(c) Pest control (d) Productivity

(viii) Different comunities group together to form:

(a) Populations (b) Biosphere

(c) Ecosystem (d) Multicellular organisim

(ix) Life emerges at the level of:

(a) Organelles (b) Cell

(c) Water (d) Atom

(x) Crop rotation is one of the effective methords to eradicate:

(a) Disease (b) Parasites

(c) Predators (d) Bacteria

2. Write detailed answers of the following questions:

(i) Explain the levels of organization of life.

(ii) How antibiotics and vaccines contribute to health?

(iii) What do you mean by radiotherapy and chemotherapy?

(iv) Write an essay on "applications of boilogy for the welfare of mankind".

3. Write short answers of the following questions:

(i) What is biological method?

(ii) What do you understand by Hydroponics?

(iii) What is five kingdom system?

(iv) What is antibiotic?

4. Write short answers of the following questions:

(i) Biology (ii) Boitechnology (iii) Parasitology