ROLE OF BIOLOGICAL SCIENCE IN HUMAN WELFARE

The development of science and technology is directly related to the development of human race. The developing civilizations utilized the knowledge of science and technology for their growth. We can say that the better conditions of human living are all based on the scientific inventions. The knowledge of biological science has really benefited the mankind. Some of its effects are:

Food

Food is a major requirement for all human beings. Our country is a thickly populated country and growing and supplying adequate food for all citizens is a major problem faced by our governments. The knowledge of biology has helped the farmers as well as scientists to develop better quality seeds, healthy agricultural practices, resistant varieties, hybrids, pest control techniques, and obtain a better yield of food grains. Advanced techniques like tissue culture, production of synthetic seeds, and bio-control techniques can also be explained to the farmers to obtain better yields. The growth of poultry and aquaculture is the result of biological science, the knowledge of biology has helped in the Green Revolution and White Revolution in our country.

Health

The knowledge of biological science has revolutionized the field of medicine. It has improved the value Of human life and increased the human lifespan. The research in this field has resulted in developing vaccines and medicines for eradicating the dreadful diseases. Here we can quote the eradication of diseases like small pox and control of plague and others. We have recognized the importance of balanced diet and have developed methods to control malnutrition and mineral deficiencies by taking appropriate food. New inventions in pharmaceutical field led to production of new drugs in the areas of cancer, heart ailments, AIDS etc., bringing a ray of hope to the ailing. Development of microsurgery, laser surgery, and non-invasive surgical

techniques have made surgeries simple. Development of advanced diagnostic techniques have helped in the identification and cure of diseases. Advancement in life sciences has really helped in improving the standard of health in the human beings.

Population

Increase in population is the root cause of all problems in the world. The uncontrolled explosion of population results in scarcity of food, which causes a number of problems for the human beings. The knowledge of science helps in educating the people about problems of over population and importance of population control. The need for family planning and advantages of small family norms, maintaining the health of the family, importance of health of the mother and child etc are all understood by the knowledge of biological science.

Improvement of Domestic/Wild Animals

The growth and development related practices like poultry, dairy farming, aquaculture and pisciculture (fish farming) are all required for developing self-sufficiency by the people. The know• ledge of biology gives an insight into these practices and helps in development of cross-breeds for giving more yield of meat and milk, disease resistance and vaccines for diseases and developing artificial breeding methods for improvement of population.

Production of Bio-products

Today is the age of biotechnology. Every individual has focused his attention on producing something from biological organisms. The development of alternative sources of food the algal proteins from single cell cultures of chlorella, and spirulina have already taken place. Biological control of pests and diseases, production of bio-fertilizers in the place of conventional chemical fertilizers are the result of advancement of science and technology.

Conservation of Natural Resources

Conservation of environment is a major task of all the people today. Protection of our environment helps in protecting our human race. Forests are the natural sources which help in

maintaining and balancing our environment. But degradation of this wealth and misuse of it has created a lot of imbalance, which has a negative effect on all aspects of our environment. The increase in temperatures, reduction of rainfall, depletion of our forest resources, loss of the ozone cover, extinction of a number of plant and animal species is directly or indirectly related to the environmental degradation. To protect our mother nature it has become mandatory for every person to help in conservation of social forestry programmes and afforestation programmes and animal-protection programmes have become the need of the day.

New Innovations for Improvement of Living Beings

Great advancements have occurred in the field of genetics resulting in the development of many scientific techniques, which could open new vistas of knowledge relating to the basic chromosome structures and DNA and RNA. This resulted in a vast exploration of biological principles pertaining to plants, animals and man. The advanced concepts of DNA Fingerprinting, Eugenics, Preservation of the Gene Pool, Chromosome Mapping etc. are the result of this explosion of knowledge. These have resulted in identifying genetic disorders, improving plant and animal gene pool, and the mapping of human gene. The Human Genome Project is the culmination of the efforts of all scientists which when completed will bring an all-round development of human life.

Biology and Environment

Biology and environment are very closely related with each other. The study of biology develops knowledge and understanding of the environment. Most of the aspects of biology can be applied to the environment. It helps the individual to realize the importance of nature and appreciate the nature. It creates awareness about the interrelationships among the organism and the problems like environmental pollution, population explosion and maintaining the health and sanitation of people, the deforestation and depletion of natural

resources, and importance of maintaining ecological balance Today it has become important to relate the teaching of science to environment. It is called as Environmental Education. Environmental education can be defined as "an individual's awareness of environment". With the growing trade of destruction of forest areas due to increased population pressure and dependency on forest resources, there is an urgent need for creating an appropriate level of peoples participation in environmental protection and conservation. The chief goal of environmental education is to "prepare citizens capable of acting on behalf of the environment" by integrating information from different disciplines like social ctences and natural sciences. Integration of mathematics, and physical science and biological science with the environment can be productively used in educational system. The goal of environmental education can be achieved by using concepts of environment as a tool to teach mathematics and science, there by infusing in the students the capability to tackle environmental problems successfully in their everyday life.

The National Policy on Education (1986) has recommended that it is essential to develop an awareness of the environment by combining the classroom teaching with the application of environmental principles.

The UNESCO, Tbilisi Declaration, 1978 has said that Environmental education is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters *attitudes, motivations, and commitments* to make informed decisions".

The Objectives of Environmental Education are:

a) to develop an awareness of environment, and the physical, social and aesthetic aspects of environment. To maintain a dynamic equilibrium between all the six elements that support living system i.e., air, water, land, flora, fauna and light.

b) to develop the knowledge and understanding of the environment and its related problems.

c) to develop an attitude of responsibility towards environment and its conservation.

d) to acquire critical thinking skill to identify and solve environmental problems.

e) to actively participate in environmental projects.

f) to plan the utilization of resources not only by present generation but also future generations without any exploitation.

Environmental education can be taught as part of topics in biological science or as a separate subject. The activities that form part of the learning experiences of the students to develop environmental awareness are:

Conducting discussions and debates on topics related to environment.

Organizing field trips to impart an understanding of the nature and its problems.

Developing simulated situations for environmental studies. Organizing project work on environmental problems.

Creating an interest in environment by developing reading habits.

Evaluation

1. Scientific knowledge is a combination of both a Process and a Product - Critically analyze the statement.
2. Explain the significance of a scientific theory.
3. Describe the nature of science in relation to its structure.
4. Discuss in detail the relation of Biological Sciences with the natural environment.

History of Science - An Overview

Around 600 B.C. Greeks began the age of theoretical science, a science based on logic and reasoning. As the records available in later periods indicate, the Hindus were already familiar with some of the sciences of the Greeks and probably of the Babylonians too. Atreya, Susruta and Charaka in medicine and surgery are the important names in the history of science in India. There were no further developments in science in India during the later periods till the twentieth century when we can now proudly refer to the great talents of Ramanujam, Raman, Bose, Bhaba, Khorana, Narlekar and many other scientists of international repute.

The Greeks looked into the events of the world with a new interest. They were a prosperous race with enough leisure to think. They considered the mysteries of nature from the philosophical point of view and tried to interpret their observations on the basis of reasoning and logic. They gave a new trend to thought process and scientific pursuits. The science, which was earlier pursued as a learned craftsmanship and from a utilitarian point of view, now received its theoretical and logical foundations. The Greeks were great theoreticians but hated practical experimentation in science. In the different areas of science they produced brilliant theories and thus theoretical science replaced practical arts of the past. They accepted slavery and this led to the separation between practical and intellectual aspects of science. Some historians even blame the Greeks for their inaccurate' observations and for erecting lofty theories on unsound foundations. Though the Greek science ultimately did not stand the test of time, whatever, scientific theories this wonderful civilization gave to the world, held sway for more than twenty centuries. This period has produced great thinkers whose contributions are responsible for changing the entire course of world civilization of later times. With the fall of Greek civilization and the death of the philosophers and the scientists of Greece, a dark period prevailed upon the earth. The progress of civilization, as it came to a temporary halt in Europe, almost nothing significant could be added to the practical science that existed and the theoretical scientific ideas of the Greeks during the long stretch of about a thousand years till the end of the middle ages. The Dark Age continued up to the twelfth and thirteenth centuries and there was almost complete intellectual stagnancy, especially in Europe. But the world was now ready for the transition of a new phase of regeneration eventually leading to the emergence of Renaissance in Europe. As the ancient science could no longer satisfy the physical and mental needs of the people, they began to rely only on what they actually found rather than what the ancients had written or told. Thus, we find that the fifteenth and the sixteenth centuries heralded the dawn of the new science-the experimental science. The development of printing techniques during the later part of the fifteenth century made all kinds of publications easier and the dissemination of ideas became wider. The scientist of the period began to

verify the scientific ideas handed down by the Greeks and other ancient civilizations. The Italian genius of the fifteenth century, Leonardo da Vinci (1452-1519) gave great Support to the new approaches to science through his drawings in anatomy and the biological and physical scientific objects.
By the sixteenth century, the world received an intelligible and useful picture of science and nature, and the world in the next three centuries was to see the marvelous advancements in science, shrinking the total knowledge and achievement of all earlier civilizations spread over several million years, into insignificance. l'hc study of science from the seventeenth century onwards is marked by the use of all components of scientific process. The scientists of this period observed facts, verified them, measured and repeated them before coming to any conclusion, and finally published results of investigations for discussion in the society. The research trend in science became established. There had been a rapid development in all aspects of human living such as agriculture, medicine, engineering, industry, trade and commerce and these in turn demanded still greater developments in science. The period from the fifteenth to the eighteenth century saw the development of scientific talent, which was instrumental in leading us to our present position of living as a member of a modern scientific society. The scientists of the twentieth century hardly need mentioning as they are too conspicuous in the scientific world and we remember them for our very existence in the modern world. Modern science, characterized by its speed and accuracy has now established its supremacy over all avenues of knowledge.

THE NATURE OF SCIENCE & SCIENCE TEACHING

Meaning and Definition of Science

What is Science?

The word science is taken from a Latin word ‘Scientia’, simply means knowledge' or to know'. Curiosity of man to know about himself and the surroundings has led to an accumulation of a vast body of knowledge which is called 'science'.

Science generally referred as an organized or body of knowledge. Science is known as a classified verifiable knowledge of facts. But science is not always about the collection of facts or development of new concepts or ideas. It’s all about the passion for the discovery that drives one to explore environment and the nature on the whole.

Science was basically founded to investigate the nature and processes Although there are a number of other methods that be utilized to acquire the knowledge about nature, science

is the only one that results in the acquisition of liable knowledge. Hence, Rene Descartes once said, "Science is method of investigating nature that discovers reliable knowledge about it."

Science also includes the investigation of new phenomena, previous theories, analyzing ideas etc. Science is both particular kind of activity and also the results of that activity which uses tools like observation, measurement and scientific and is entirely based on the truth.

Therefore Science is an amalgamation of observation, identification, description, experimentation, investigation and theoretical explanation of the phenomena that occur in nature.

In common terms, science can be described as the study, which attempts to depict and understand the nature of the universe in whole or part.

Definitions

During early times people perceived science, as what the scientist does. There are many definitions available but not a single one, which is universally accepted. Some of the widely used definitions are mentioned here:

According to Columbian Dictionary "science is an accumulated and systematized learning in general usage restricted to natural phenomena".

"Science is an attempt to make the chaotic diversity of our sense experience correspond to logically uniform system of thought"-*Einstein*

"Science is a cumulative and endless series of empirical observations, which results in the formation of concepts and theories, with both concepts and theories being subject to modification in the light of further empirical observations. Science is both a body of knowledge and the process of acquiring it" *Fitzpatrick*.

"Science is the organization of our knowledge in such a way that it commands or makes possible the explanation of more of the hidden potentialities found in the environment"

- *J. Bronowski.*

"Science is a way of thinking, an attitude towards the solution of problems, a means of solving problems as well as products of the investigation of natural phenomena"-*Richardson*

"An inter-connected series of concepts and conceptual

schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and observation" - *Conant*

"Science is a human endeavor that seeks to describe with ever increasing accuracy of the events and circumstances which occur or exist within our natural environment".

-*J. Woodburn and E.O. Obourne*

A comprehensive definition of science would be "science is a body of knowledge, a way of thinking, and a way of investigation, a way of experimentation in the pursuit of exploring the nature".

Science = methods + knowledge

= process + product

= scientific method + scientific attitude + scientific knowledge

Nature of Science

Following are some of the important characteristics of science:

Science is a process as well as a product:

Science is a combination of process and product. The continuous processes that we observe in nature as well as in the laboratory give rise to development of scientific knowledge. The methods of inquiry play a major role in the process of science. The process of science gives rise to a number of products of knowledge like the facts, concepts, theories and generalizations. These products of science are of great utility to the human beings.

Scientific knowledge is durable:

Although scientists reject the idea of attaining absolute truth and accept some uncertainty as part of nature, most scientific knowledge is durable. The modification of ideas, rather than their outright rejection, is the norm in science, as powerful constructs tend to survive and grow more precise and to become widely accepted. The growing ability of scientists to make accurate predictions about natural phenomena provides convincing evidence that we really are gaining in our understanding of how the world works. Continuity and stability are as characteristic of science as change is, and confidence is as prevalent as tentativeness.

Scientific knowledge is based on inquiry: Fundamentally, the various scientific disciplines are alike in the irreliance on evidence, house of hypothesis and theories, the kinds of logic used, and much more. Nevertheless, scientists differ greatly from one another in what phenomena they investigate and in how they go about their work; in the reliance they place on historical data or one experimental findings and on qualitative or quantitative methods; in their recourse to fundamental principles; and in how much they draw on the findings of other sciences. Still, the exchange of techniques, information, and concepts goes on all the time among scientists, and there are common understandings among them about what constitutes an investigation that is scientifically valid.

Science is based on scientific methodology: The very nature of science involves a particular, methodical approach towards it. These methods are observations and inquiry. It is always essential to choose a right kind of approach for further investigation. The right approach also means a series of questions to be asked and answers to be found out by the scientist. All these teach us that we need to follow standard methods for experimentation, while at the same time not restricting ourselves.

Scientific knowledge is based on evidence:

The validity of scientific claims is settled by referring to observations of phenomena. Hence, scientists concentrate on getting 'accurate data'. Such evidence is obtained by observations and measurements taken in situations that range from natural settings (such as fields)to completely artificial ones (such as the laboratory). To make their observations, scientists use their own senses, instruments (such as microscopes) that enhance those senses, and instruments that tap characteristics quite different from what humans can sense (such as magnetic fields). Because of this reliance on evidence, great value is placed on the development of better instruments and techniques of observation Scientists observe passively(earthquakes, bird migrations),make collections (rocks, fossils, shells),and also actively probe the world to collect the valuable data.

Science is a blend of logic and imagination:

Although all sorts of imagination and thought may be used in coming up with hypotheses and theories, sooner or later scientific arguments must conform to the principles of logical reasoning—that is, to testing the validity of arguments by applying certain criteria of inference, demonstration, and commonsense. Scientists do not work only with data and well-developed theories. Often, they have only tentative hypotheses about the way things maybe. Such hypotheses are widely used in science for choosing what data to pay attention to and what additional data to seek, and for guiding the interpretation of data. In fact, the process of formulating and testing hypotheses is one of the core activities of scientists. To be useful, a hypothesis should suggest what evidence would support it and what evidence would refute it. A hypothesis that cannot in principle be put to the test of evidence may be interesting, but it is not likely to be scientifically useful.

Science explains and also predicts:

The essence of science is validation by observation. But it is not enough for scientific theories to fit only the observations that are already known. Theories should also fit additional

observations that were not used in formulating the theories in the first place; that is, theories should have predictive power. Demonstrating the predictive power of a theory does not necessarily require the prediction of events in the future. The predictions may be about evidence from the past that has not yet been found or studied. A theory about the origins of human beings, for example, can be tested by new discoveries of human-like fossil remains.

Science is **an enterprise:**

Science as an enterprise has individual, social, and institutional dimensions. Scientific activity is one of the main features of the contemporary world and, perhaps more than any other, distinguishes present times from earlier centuries. As an endeavor for learning how the world works, it provides a living for a very large number of people. It is important for students to understand how science is organized because, as adults in a democracy, they will be in a position to influence what public support will be provided for basic and applied science. Other important aspects of the scientific enterprise are its social structure, its discipline and institutional identification, its· ethics and the role of scientists in public affairs.

There are an indefinite number of characteristics of science a part from the above-mentioned ones. Some of them are:

- Science is empirical
- Observations - Process Concepts
- Science knowledge is replicable
- Scientific knowledge is dynamic and tentative in nature.
- Scientific knowledge is holistic and humanistic
- Scientific knowledge is based on values of objectivity, rationality and neutrality.
- Science is based on critical discrimination -that is, it is objective, impartial and unbiased.

- Science is a body of knowledge accumulated through reasoning and reflection. It is self corrective.
- Science makes predictions, descriptions and explanations of various phenomena
- Science is universal, that is facts, and concepts, generalizations, theories and laws have universal acceptance and applications.
- Scientific knowledge is based on assumptions accumulated over years of experience.

Scientific Knowledge (Nature of Science)

Scientific knowledge is based on:

- Observations of the universe.
- Belief in universal uniformity of knowledge.
- Belief in probabilities but not in certainties.

Over the course of human history, people have developed many inter-connected and validated ideas about science. Those ideas have enabled successive generations to achieve an increasingly comprehensive and reliable under-standing of the human species and its environment. The means used to develop these ideas are particular ways of observing, thinking, experimenting, and validating. These ways represent a fundamental aspect of the nature of science and reflect how science tends to differ from other modes of knowing.

It is the union of science and technology that forms the scientific endeavor and that makes it so successful. Although each of these human enterprises has a character and history of its own, each is dependent on and reinforces the others.. Why it is necessary to understand the very nature of science:'

- When we know what is the nature of science and how it works and how the experiments of science reach scientific conclusions, and what the limitations of such conclusions are,

we are more likely to react thoughtfully to scientific claims and less likely to reject them out of hand or accept them uncritically.

- Once we gain a good sense of how science functions along with a basic inventory of key science concepts as a basis for learning more later—we will be able to understand the science adventure story as it plays out during our lifetimes.
- The images that many people have of science and how it works are often distorted. The myths and stereotypes that young people have about science are not dispelled when science teaching focuses narrowly on the laws, concepts, and theories of science. Hence, it is very important to understand the basic nature and functioning of science.

The nature of science is generally compared to the structure of a building. In this framework the assumptions are the foundations on which the structure is built. Lacey in his book "Guide to Science Teaching" has listed some 15 assumptions for the nature. The most important among them are:

1. Principle of Causality: Belief in cause and effect relationship.

2. Principle of Consistency: When 2 sets of conditions are same, the same consequences are expected.

3. Principle of Continuous Discovery: Unfolding of the laws of nature will take place till a complete understanding of the universe is reached.

4. Principle of Dynamism: Nature is dynamic

5. Principle of Objectivity: Ability to examine facts and suspend judgment. "

The methods and processes of science form the horizontal Beams for the structure. The generalizations are the vertical beams. The work in science goes on with the methods and processes and they clarify, extend and add to these new generalizations.

Study of nature of Science is important as:

- It provides the basic knowledge required for understanding the natural phenomena in the light of facts, theories and laws of nature.
- It helps in developing scientific temperament and scientific attitude among the students.
- It helps in developing the curiosity and creativity among the students.
- It helps in recognizing the self-potentialities and capabilities and helps in building self-confidence among the students.
- It helps in generating values like broadmindedness, intelligence, creative thinking and dedication in the students.
- It helps in training students in scientific techniques.

Acquiring scientific knowledge about how the world works does not necessarily lead to an understanding of how science itself works and Neither does knowledge of the philosophy and sociology of science alone lead to a scientific understanding of the world. The challenge for educators is to weave these different aspects of science nature together so that they reinforce one another. *J.B. Conant* described the nature of science in the following manner: "Science emerges from the progressive activities of man to the extent that new concepts arise from experiments and I observations and the new concepts in turn lead to further experiments and observations". The description can be diagrammatically viewed as

Concepts -» Improved Concepts-» Modified Concepts-» New Concepts-» Body of Knowledge

The above diagram clearly states that the scientific knowledge is dynamic in nature and it is modifiable. Science is dynamic in nature and provides knowledge based on the system facts, concepts, theories, laws and generalizations.

1.3 Scope of Science

Man has always been curious to find answers to the mysteries posed by the reality he lives in. One of the deepest and most profound is the one that in itself searches for the answer to how he came to be, to how his world originated, to how and when he and all living beings merged from the nature they live in. All these questions are answered by science.

In a world filled with the products of scientific inquiry, scientific literacy has become a necessity for everyone. Everyone needs to use scientific information to make choices that arise every day. Everyone needs to be able to engage intelligently in public discourse and debate about important issues that involve science and technology. And every one deserves to share the excitement and personal fulfillment that come from understanding and learning about the natural world.

Scientific literacy also is of increasing importance in the workplace. More and more jobs demand advanced skills, enquiring that people be able to learn, reason, think creatively, make decisions, and solve problems. An understanding of science and the processes of science contributes to these skills. Other countries are investing heavily to create scientifically and technically literate workforce. To keep pace in global markets, our country also needs to have an equally capable citizenry. We may not realize it but everything we do has a scientific base. Try this though an experiment. Imagine a job that doesn't need some background in science. Law? Farming? Running a restaurant? Business? Hooking? Leg-spin bowling?

Lawyers must know about DNA testing, forensic evidence, which isresponsible, liable, in the operating theatre. Farmers are swamped with genetic modification choices, salinity problems, and worries about the lesser spotted godwit or precious purple frog requiring protection in the lower paddock. Business people are challenged constantly by

new technology, hookers by STDs and, as for leg-spin bowlers, think shoulder operations, drug tests and mobile phone evidence.

The point is there is no job in the 21st century that can be done effectively without some feeling for science. It has been truly said that as science and technology progress it encourages the study of some subjects. Most of the effort in science teaching is directed, these days to improve conditions of life and in tackling the new problems that arise. Therefore the importance of life sciences teaching in schools is increasing. The study of life sciences is quite helpful in eradication of certain problems. With the fast changing times more and more emphasis is put on the health of man. India shall need specialists in the fields of medicine, health, agriculture, animal husbandry, etc. The talent in these fields shall come from the study of biological science. It is for these reasons that the subject has become so popular in our secondary schools and is taught as a compulsory subject in secondary schools. It has now been realized that biological science has a grea trole to play and so it should be given its proper place in school curriculum.

Importance of Science

We cannot compare any subject with science as far as utility and importance in our daily life is concerned. Ours is an age of science. All the modern gadgets, which made our work easier, are a result of science. There is no doubt that science has helped in improving our standards of living. Some of the areas of science, which have a lot of utilitarian values, are: *Science and Agriculture:*

Science plays a very important role in the development of agriculture. Green revolution is the gift of science to the society. Development of a range of pesticides to ill different pathogens and insects (causing damage to the crop) possible due to scientific interventions and resulting in the higher yields. Several fertilizers essential for the growth of plants in development of different farming techniques and implements are also possible

due to scientific knowledge. Development of hybrids and transgenic plants resistance to diseases and pests are the most important contributions of science in the field of agriculture.

Science and Our Health:

Science made innumerable contributions in the field of medicine for improving our health. It provided medicines for almost all the known diseases and helped inventing different operational implements for the surgeons to operate on the patients. Awareness about personal hygiene and sanitation is possible due to the knowledge of science.The products of medical research and development like lasers, mechanical cardiac assist devices, mechanical valves, automatic internal defibrillators, have saved many lives. Science and technology will expand the current frontier of medical knowledge. Armed with this new knowledge, we will identify the causes, and eliminate most of the effects of the diseases that now plague mankind

Science and Industry:

The invention of radio, TV, printing machine and computers is the product of science. The development of several industries like pharmaceutical, alcohol, garments etc and the initiation of industrial revolution are the consequences of scientific knowledge.

ScienceandtheEnvironment:

Due to increased activities of man (pollution) and surplus exploitation of natural resources there is a danger of ecological imbalance and destruction of the environment. In this situation the only rescue for his survival could come from the intervention of science. *Science and its Role in Democracy:* For a responsible citizen of a democratic country, qualities like open- mindedness, cooperation, ability to accept new ideas, hardwork,

perseverance etc are essential. And science contributes a major share in the development of these qualities in the citizen.

1.4 Meaning of Biological Science

Biological science is the study of life and living organisms. It is also called as "Biology". The Greek word 'bio' means life and 'logos' means study of. In the late 1700s Pierre-Antoinede Monet and Jean-Baptiste de Lamarck coined the term 'biology'. Earlier study of living things was restricted to the pure sciences like Botany and Zoology that together comprise Biology. But as the time passed, new branches evolved, new technologies developed in pure subjects as well as in applied fields, giving rise to a very broad science called 'Biological Science'. Biological science is an extensive study covering the minute workings of chemical substances inside our cells, to broad scale concepts of ecosystems and global environmental changes. It is also concerned with the physical characteristics and behaviors of organisms living today and long ago, how they came into existence, and what interactions they possess with one another and their environments. Intimate study of details of the human brain, the composition of our genes, and even the functioning of our reproductive system are dealt within Biological Science. Today it is also called by a new name-Life Sciences. Life sciences can be defined as "a systematic study of living things or study of nature". Teaching of life sciences basically deals with providing information about the latest developments in the field of Biological Science all over the world.The knowledge of Biological Science helps the student

- To develop the individual's sensitiveness to nature and make him feels at home with it.
- To explain the living world in terms of scientific principles and appreciating why organisms behave indifferent ways, and show capabilities, which differ from one another satisfy the curiosity of students generate interest abou this surroundings.

1.5 Scope of Biology

The knowledge of biology is useful to know about the morphology, cytology, physiology, and reproduction of living organisms. It helps us to know the ecological relationships and evolution of organisms on this earth. The knowledge of biology helps in understanding the biochemical processes and the metabolic reactions occurring in the living cells. It throws light on the genetic material the DNA, RNA and their role in heredity and reproduction. It provides knowledge about the nature and importance of microorganisms on this earth. It also gives an insight into applied advanced scientific subjects like Biotechnology, molecular biology, biophysics, astrobiology, etc.

Biologists study many different facets of life from the molecules that make up individual cells to the behavior and ecology of animals and plants. Their studies encompass both basic and applied science because today's biologists play an singly important role in the progress of agriculture, human, animal health, and in business and industry.

Whether in the laboratory, in the office, or in the field, Biologist meet the daily challenges of preserving our environment, developing new defenses against disease, increasing cultural productivity, and expanding our understanding of the basic processes of life. There is an increasing need for biological scientists to meet the challenges.

The importance of Biology

The knowledge of Biological Science development of human race. Biological understanding the origin of life on earth.

- It helps in development of appreciation environs.
- It helps man to value the existence of other living organisms on earth.
- It helps in development of appreciation environs.
- It helps man to value the existence of other living organisms on earth.
- It develops discipline and orderliness in individual's life.

- It develops the power 'of observation and critical thinking and trains in problem solving.
- It develops scientific attitude and scientific methodology.
- It correlates the knowledge of other subjects with life of the individual.
- It develops open mindedness and truthfulness and prepares the individual to lead a modern lifestyle.
- It helps the individual to apply the important concepts like nutrition, health, natural resources and pollutions for betterment of his existence.
- It helps the individual to play a fruitful role in a society as responsible citizens of society.

The study of biology is very important because:

1. Biological Science teaches systematic usage of natural resources.
2. It helps in development of healthy living conditions.
3. It provides knowledge for production of hybrid breed of animals and varieties of crops.
4. It helps in planning the career.
5. It develops the interest and curiosity in students.
6. It develops modern outlook and living in individuals.
7. It improves scientific understanding and develops love for fellow human beings.
8. It helps in the control of diseases and population

Branches of Biological Science

Biological Science is basically divided into three branches:

1. Pure sciences
2. Applied sciences and
3. Related branches

Pure Sciences

They are botany and zoology which deal with the basic aspects about the plants and the animals respectively. Applied science have arisen from these pure science to

study in detail the particular fields Now the branches that have arisen from the pure science emerged as separate subjects due to huge research and developments in those fields.

Botany: It is the branch of *science* concerned with the scientific study of *plants*

Zoology: Zoology is the branch of science which deals with *animals*

Applied Sciences

Aerobiology: It is a branch of *biology* that studies airborne organisms and airborne biological particles, for example, *pollen* and *spores*.

Anatomy: Is the branch of *biology* that deals with the structure and organization of living things; thus there is animal anatomy *(zootomy)* and plant anatomy *(phytotomy)*. The major branches of anatomy include *comparative anatomy* and *human anatomy*.

Biochemistry: It is the study of the chemical reactions and interactions that take place in living *organisms*, especially the structures and functions of their components, such as *proteins*, *carbohydrates*, *lipids*, *nucleic acids*, and small molecules present in cells..

Biotechnology:

Application that uses derivatives thereof, to specific use. Biotechnology is any technological biological systems, living organisms, or make or modify products or processes for specific use

Cell Biology (Cytology): It is the *study* of the physiological properties of *cells* and their interaction with one another and their *environment*, on the *microscopic* and the *molecular* level.

Genetics: It is that branch of *science* that relates to the study of *genes* and *biological inheritance* by which a predisposition to parental traits is passed on to offspring at *conception*

Microbiology: It is the study of *microorganisms*, including unicellular (single-celled) *eukaryotes* and *prokaryotes*, *fungi*, and *viruses*

Paleontology: It is the study of ancient *plants* and *animals* based on the *fossil record*, and evidence of their existence preserved in *rocks*. This includes the study of body *fossils*, tracks, burrows, cast off parts, fossilized *feces*, and chemical residues.

Phylogeny (orphylogenesis): It is the origin and *evolution* of a set of organisms, usually *species*. A major task of *systematics* is to determine the ancestral relationships among known species (both living and extinct),

Physiology: It Is a branch of *biology* that deals with the mechanical, physical, and biochemical functions of living organisms. Physiology has classically been divided into *plant physiology* and *animal physiology*.

Toxicology: It is the study of the symptoms, mechanisms, treatments and detection of biological *poisoning*, especially the poisoning of people.

Virology: It is the study of *viruses* and their properties

Xenobiology (orexobiology, or astrobiology):It is the term for a speculative field within *biology* which considers the possibility of, and possible nature of, *extraterrestrial life*.

Related Disciplines

Medicine: Medicine an area of human knowledge concerned with restoring *health*. It is, in the broadest sense of the term, the science and practice of the prevention and curing of human diseases, and other ailments of the human body or mind. However, it is often used only to refer to those matters dealt with by academically trained *physicians* and *surgeons*.

Agriculture Science: It is concerned with the cultivation of the field, tilling of the land, sowing of the seeds, planting and similar operations on the land.

THE CORRELATION OF BIOLOGICAL SCIENCE AND OTHER SUBJECTS

"Why does this magnificent applied science which saves work and makes life easier bring so little happiness. The simple answer is —because we have not learnt to make a sensible useof iit".

--Albert Einstein

The word correlation means a reciprocal relation between various subjects in the curriculum. The whole world is integrated and inter-related. The various phenomena and the processes that occur in the nature are all related to one a nother. No concept or a p r o c e s s can be understood in isolation. The entire universe is an integrated whole. The word correlation' occupies an important place in education. All the subjects in education are related. Education is also related with life. The principles of correlation maintain that various subjects should contribute to the child's education and help him to understand his environment in a better way. The various concepts and facts and principles have a relation with one other. These things have an application in the life of an individual. The child becomes interested in knowing the various phenomena of this world. He tries to develop the knowledge of these real life experiences. These principles are to be integrated while teaching the subjects. The field of biology incorporates a number of principles of physical science. The physical sciences include a number of mathematical derivations. The concepts of geography and history are related to development of general science. In this way all subjects are to be correlated to remove in teaching and providing a unified knowledge.

Science is an inter-disciplinary subject and it cannot be taught in isolation. It is not a watertight compartment and it requires integration and correlation with other subjects for an effective development of scientific understanding. The experience of students in learning of science can be greatly enhanced by correlating it with other fields of study. The application of science to human life is immense. A teacher's effectiveness lies in integrating the various

concepts of science to real life situations. Life science is a combination of various branches of science like• Biochemistry, Agriculture, Medicine, Microbiology, Genetics, Biotechnology etc. In addition to relating with general concepts, it has to be related with other subjects also. General science should be taught in the schools as an integrated whole rather than as a collection of unrelated topics. Cooperation of the science teacher with teachers of different subjects is of great value in the process of teaching science as an integrated whole.

The concept of correlation can be studied under the following subheads:

Correlation of science with life

Correlation of science with other school subjects

Correlation of science subjects with each other.

Correlation of Science with Life

The development of human race is directly related with the development of science. They are interwoven with each other. The knowledge explosion and modernization are related with each other. Science is the backbone of modernization of the society. It has penetrated deep into over everyday life. We find application of science in all general aspects of human life. The scientific knowledge encompasses almost all the areas of human requirement. We utilize the scientific knowledge from the time we start our day to the time we rest. We utilize the principles of science for cooking our daily meal. We understand the importance of science when we use transportation. We recognize the harmful effects of pollution because of our scientific knowledge. We understand the need for conservation of our environment and balance of our ecosystem as a result of science. The development of vaccines, the control of harmful pathogens, the improvement in their overall health and wellbeing of human beings is the result of science. Everything around us is directly or indirectly related to science. Therefore it is imperative on the part of the science teacher to relate the developments of science and application of scientific principles to the lives of the human beings. The teacher should

always provide simple real life examples while teaching a topic. These correlations create an interest and a realistic view of science among the students. The students tend to understand the importance of science in day-to-day life. The teacher should range visits to science museums, organize exhibitions, conduct science fairs and provide a deeper knowledge of application of science to human life.

The teacher can make a visit to an agricultural farm to quaint the students with the agricultural practices. A visit to a poultry farm or a dairy farm may give them an idea about the growth and development of these animals. The visit to a thermal station may provide an idea about the physical principles. The wage of disinfectants for eradicating the pathogens, manures for rowing the plants, a mirror for teaching the principles of light are some simple and common examples, which can relate the studyof science with life.

Correlation of Biological Science with Other Subjects

Correlation unifies the knowledge of different subjects and makes learning a meaningful whole. All the subjects possess a correlation among themselves. Biological Science is such a subject, which can be correlated very easily with others. This correlation in associating the knowledge the student gained in different subject classes. This makes the learning more meaningful. The relation of Biological Science with other subjects has been given below.

Correlation with Mathematics

Study of Biological Science is not complete without a basic knowledge of mathematics. The knowledge of ratios, proportion, patrons, graphs, and statistics, is necessary for a comprehensive understanding of Biological Science, especially Biophysics, informatics etc. In a school co-operation between mathematics and a science teacher is very essential for developing a comprehensive knowledge of these subjects. The basic physical concepts cannot move a step further without the usage of mathematical principles. The data analysis of any topic requires an in-depth knowledge of statistical principles. Scientific

principles are given as examples when teaching mathematics and the knowledge of mathematical principles like co-ordinate geometry, quadrate equations, and trigonometry are used in teaching of science. Hence the teachers of mathematics and science should correlate and coordinate with each other for developing a comprehensive understanding of these two important subjects.

Correlation with Geography

Science and geography share many common principles. Both subjects are interdependent and inter-related. The lessons in geography are related with Biological Science. The topics on rainfall, climate, soil types, inter-relationships between plants and animals, movement of planets in the universe are all related in both Biological Science and geography. The geographical experiments utilize the scientific instruments. Secondary education commission has realized the interrelation between these two subjects and included geography in the science group. The teachers of science and geography should correlate these topics wherever necessary to make them interesting to the students.

Correlation with History

Science becomes very interesting when we relate it to the history. A number of scientific discoveries found their place in history. Historical events when connected with the scientific discoveries make an interesting study. The development of surgery and medicine, medical the inventions of instruments - all these make an interesting historical reading. The history of science is history of civilization of mankind. Hence the teachers of science and history may cooperate and design some projects, to correlate the scientists and scientific discoveries with historical data and further enhance the students' knowledge and an interest in the subject of science.

Correlation with Language

The language is a means for expressing the scientific ideas. Language is essential to express the individual views in a clear proper and appropriate manner. It is the responsibility of a Biological Science teacher and a language teacher to develop the required language skills like listening, reading and writing in the students. The student should be able to express his views, write the answers, and translate some material. Proper command on the language will help the students to participating in seminars, conferences and write scientific articles.

Correlation with Art

Art is also science and knowledge of Arts forms a base for Biological Science. Science needs creativity. Artists are creative. Art is dependent on creativity, and creativity is very much a part of science. The craft and drawings are important in science. The students draw diagrams, prepare charts and models. They need to know the appropriate usage of colors and proper spacing of visuals. For developing these skills a Biology student should possess a basic knowledge of art. He should be trained in drawingand painting.

Correlation of Science with Environment

Today's student is tomorrow's citizen. A Biological Science student should be aware of the importance of the environment. It is essential for a student of Biology to possess knowledge of environment. A number of scientific principles can be correlated with environment like the concepts of pollution, afforestation, conservation of natural resources, and production of bio-products. Students should be able to relate classroom learning with the environment. The role of the science teacher is as a facilitator. She has to develop value judgment in the students. The students should understand the importance of the fact that conserving our environment is safe-guarding ourselves. The plants and animals also have a right to existence and a role to play in balancing our ecosystems. The principle of

correlation helps a student to become a good citizen aware of the need and importance of environmental conservation.

Correlation with in Science

Science is a n inter disciplinary subject. All the branches of science are interrelated and interdependent on each other, as there are a number of facts and principles, which are common to a number of science subjects. The subjects of Botany, Zoology, Physics and Chemistry are all related through some common principles in them. New and applied sciences like Biochemistry, Biophysics, Biotechnology, and. Molecular Biology have been developed from traditional subjects Botany and Zoology. They are all inter-related with each other. An efficient science teacher has to integrate the different concepts of science wherever required to develop a comprehensive knowledge of science. The teacher should not bother about specialization in science as it is done for the sake of convenience. He /she should not remain tied down to their own subjects but venture into other areas to provide more clarity to learning.

Some examples of correlation within Science are:

Topics on food and health are related to maintaining health and hygiene and nutrition of the individual.

Working of parts of the body is related to some physical principles. E.g. structure and functioning of the eye can be related with functioning of the camera.

The photosynthetic activity is related to the bio- chemical reactions taking place in the plant body.

The various metabolic activities in the living organisms are related to physiology as well as biochemistry.

Principles of Light can be used to explain the mechanism or Vision in the eye.

The formation of curds and the softening of bread can be related to the processes of microbial fermentation.

The types of soil may be related with agricultural practices. The structure of cells, atoms and molecules all form part of biology and also organic chemistry.

Science when studied with a holistic approach will really give a comprehensive knowledge and understanding of the subject and benefit the mankind.

VALUE OF TEACHING BIOLOGICAL SCIENCE

There is an increasing demand for science education in the society as we are living in an era of science and technology. Science education is very important for the individual benefits and for the development of the society on the whole. Science is also very important in our day-to-day lives. Science education not only develops knowledge and competence in the subject but also helps in developing values of life. Knowledge of science prepares the individual to face the challenges of the ever-changing modern world. We can inculcate a number of values in the students through Biological Science education. The most important value among them are:

Intellectual Value

Biological Science develops our thinking and reasoning skills. It gratifies our intellectual instincts and makes us aware of our surroundings and ourselves. It increases our understanding of the complex matters existing around us. The primary aim of science education is the development of intellectual ability. Biological Science education inculcates the knowledge of facts, he spirit of enquiry, he technique of assumption, the power of obervation, and value judgment in the students. It helps in developing logical thinking, reasoning, analysis, and creativity in the students. It develops the scientific attitudes and provides raining in scientific methodology. It develops rational thinking in an individual and prepares him to face the challenges of the modern world with a scientific outlook. It sharpens our

minds and makes us intellectually honest and critical in our observation and reasoning. We usually tend to arrive at conclusions without any bias in the light of science Some of the important scientific attitudes, which are appreciated with science knowledge, are open-mindedness, curiosity, systematic thinking and reflective thinking. Biological Science helps in understanding and solving many problems like social, economical, political or cultural.

Utilitarian Value

As it is mentioned earlier, Biological Science has a number of applications in our every day life. Development of Biological Science can be related with the development of human race. The advances in the fields of medicine, improvement in the health and hygiene thereby improving the lifespan of human beings, is due to the enormous explosion of scientific knowledge. Science has influenced the lives of people so much that today we cannot imagine our lives without the involvement of science. Biological Science has a major impact in the field of medicines and health, preventing and curing number of diseases. The increased production of food for the ever-increasing population of the world is also the gift of Biological Science for the survival of man.

Vocational Value

Biological Science is a multi disciplinary subject and creates a lot of awareness about many aspects of modern development. As a subject it has helped in generating a number of vocations. It has many applications and the students fit better into any vocation as they have a basic knowledge of science. Biological Science is a part of Dairy, Poultry, Agriculture, Veterinary, Microbiological, Bio-chemical, and Paramedical fields. Biological Science graduates may enter teaching, or enter industries related to Bio• products. The knowledge of science develops a number of skills like reasoning, analysis; critical thinking. It helps individuals to become technically competent and professional in their attitudes. It helps them to become self-sufficient. Scientific hobbies motivate the students to become

creative in their outlook. In every vocation scientific knowledge is required and hence basic knowledge science education is a must for every student. '

Moral Value

Biological Science as a process and product is based on belief in important values like truth, beauty and goodness. Among these values truth is most important, as the scientific experimentation is based mainly on truthfulness and honesty. We an say that science is truth. Success in science is purely dependent on the truthfulness of work. A student working on

',cicntific procedures should inculcate the values like patience, perserverance, truthfulness, honesty and determination. He should be rational in outlook and should accept critical feedback from others. A person who is pursuing science is considered as a seeker of truth. No success is achieved without being truthful. Thus, science not only develops scientific thinking skills but also develops moral values in students.

Aesthetic Value

Ours is a beautiful universe with many unfolding mysterie it. As a part of this beautiful universe we should be able to appreciate our mother nature. Aesthetic sense has its origin in nature. Biological Science helps us in unfolding the mysteries of this universe. A Science student appreciates the nature in a better way. Nature exhibits an order, which is governed by general laws and thus possesses a beautiful harmony. Einstein called it as "the pre-established harmony" We all know that the discovering of such beautiful harmonies is the concern of science. Keats once stated that "Truth is Beauty" and it is established that science is nothing but truth. Thus, Biological Science is the teacher, who teaches us to recognize the beauty of nature, appreciate the nature and make our lives worth living.

Cultural Value

Biological Science plays an important role in the civilization of man. From ancient civilization to the present modern world Science has become part and parcel of our everyday life. Science has a great impact on the culture of man in any society. Its application to the material and maintenance system brought a drastic evolution in the culture. The study of science inculcates scientific attitudes and methodology in the individuals. This affects the way of thinking and the way of living of the individuals. Science has aided the growth of our consciousness by developing awareness about the various facts, concepts, beliefs, customs and traditions of the world. This has heightened our intellectual abilities and helped in refining, understanding and discriminating the facts of life. Science develops cultural value as it forms an integral part of one's life and influences our social heritage. The knowledge of science has a major influence in bringing about a renaissance in our culture and traditions. The scientific knowledge helps in bringing about a cultural balance between the traditions of the past and the advances of the present, as they are undergoing constant change due to the practical applications of the scientific discoveries. The development of *our* society or civilization or culture is wholly dependent on scientific progress. Thus, science is an integral part of our cultural treasure.

Creative Value

Creativity is defined as an activity resulting in new products of a definite social value. It is the ability to think, create or do something new or original. It includes a series of actions, which create new ideas, thoughts and physical objects. We can say that science is also a product with social value, which is due to creative thinking of many scientists over a period of time. Science develops creativity in students. Students learn new concepts, identify new techniques and perform innovative experiments. They observe the

processes, conduct experiments successfully and even develop alternative methods of study. These develop the creativity in the learners.

Disciplinary Value

Science brings mental and physical discipline in the life of the individual. Problem solving, decision-making, critical thinking, perseverance and commitment to tasks are some of the mental disciplines, which a student develops by the study of science. The study of science teaches the student to undertake physical work like practical experimentation for long hours in the laboratory, collect the data, record, analyze and interpret the data and arrive at conclusions. All these activities result in development of self- discipline in the students.

Development of Scientific Attitudes

The knowledge of science results in the development of attitudes like critical observation, open-mindedness and unbiased thinking. It frees individuals from the superstitious beliefs and improves their rational thinking. Science brings a positive change the attitudes of individuals, which improve the life of the individual and help in satisfying the basic instincts of curiosity, creativeness, self-assertion, self-expression etc. The development of scientific attitude has a great impact on an individual's psychology i.e., the way of thinking.

Training in Scientific Method

The study of science trains the students to solve the problems by applying the scientific principles. They approach the problem using a definite scientific procedure called scientific method. Explanation or problem-solving scientifically is called as scientific methodology. With the help of scientific method, one easily solve any problem comfortably. Therefore, it, is necessary that the students are taught and trained in these scientific methods so that they can attack the problem instead of aping from it. The students make a survey of the problem, collect the data, formulate the hypothesis, analyze the

result, draw the conclusions and give the generalizations. Once the student is familiar with all the scientific methods, they can solve any type of problem even in their real life.

Value of Proper Utility of Leisure Time

An idle brain is a devil's workshop. It is very important for students' to utilize their leisure time in a proper manner. The knowledge of Biology should create interest and motivate the leaners to use their leisure in an appropriate manner. The leisure should be used to take up small time projects, or hobbies like collection of specimens of plants or insects and preserving them. The teacher may take the students to plant nurseries or poultry or dairy farms to develop the knowledge about the growth and development of plants and animals. The students may be asked to write articles for the newspapers or school magazines. They may also take up science club activities or take part in science fairs and make the best use of their leisure for enhancing their knowledge of biology.

Value of Science as a Basis for Better Living

The explosion of scientific knowledge has lead to much advancement in the field of science and technology. This made the human beings to lead a more peaceful, healthy and happy life. The developments in the field of medicine, health, industry, food and nutrition, environment and sanitation and also electronics and communication have revolutionized the world. They made this world a more happier and pleasurable place to live.