

# **CHAPTER 1**

## **CONCEPTUAL FRAMEWORK**

### **1.0. INTRODUCTION**

There have been many calls for reforming Science Education in India. If these are to be attended to, attention needs to be directed towards the Life Sciences, including Biology Education Research. The basis for this claim is found in elementary, middle, and high school classrooms throughout the country. Life Science content is commonly taught at all levels. One reason is that elementary teachers tend to be most comfortable teaching Life Science topics. In addition, for students at both the elementary and secondary levels, learning about living things, including themselves, is a dire necessity. Thus, research that enlightens on teaching and learning Biological Concepts has the potential to improve the Biology Education that students receive. This may be particularly important because today we are in the midst of a Biological Revolution -- one that will continue to present significant political, economic, ethical, and educational issues for our society to grapple with.

Properly designed Educational Multimedia on Multimedia Computers supports active participation and puts the students in control. Such multimedia demands the right teaching architecture, as explained here. Learning about people and the various ways in which they interact with each other and with the various environments in which they find themselves is very essential. The way to make people aware of and about themselves and their environment is through education. The subject of Biology which directly deals with every form of life and the environment in which they live, carries a special responsibility of preparing young children to become well informed, constructive participants in society and capable of developing healthy and harmonious relationships. The aim of providing education to the children is the all round development of their personality. The scope of Biology is very vast and in fact as wide as the world itself and as lengthy as the history of life on the earth. Modern Technologies can make learning Biology an engaging affair. It

allows students to find information which they construct into their own knowledge using computer production software. In the proposed research, the investigator is taking an effort to use modern technologies in the form of Multimedia Instructional Software Package to teach some important components or concepts of Biology to standard XII students of (GSHSEB) Gujarat Secondary and Higher Secondary Education Board.

### **1.1 IMPORTANCE OF BIOLOGY**

The subject of Biology which directly deals with every form of life and the environment in which they live, carries a special responsibility of preparing young children to become well informed, constructive participants in society and capable of developing healthy and harmonious relationships. The aim of providing education to the children as we all know very well, is the all round development of their personality. Study of Biology is important to increase knowledge about all aspects of organisms, to encourage greater benevolence in the relationship between humans and the natural environment and to implement biological factors into various technologies or management techniques.

The study of biology aims to increase the understanding of living systems and to allow the student to consider the systems in relationship to the self and other organisms in the natural environment. The goal is to be able to test theories developed about living things by utilizing the scientific method and then to apply the new information in a beneficial way.

Biology has many applications, both in the natural environment and the environment of health and education. Studying biology allows health-care workers to understand the living systems of the body and to apply the knowledge in direct ways to recover and to maintain the physical health of both animal and human patients. Educators rely on biology to teach the study of life to future generations. Field biologists use biology to understand relationships between living organisms and to notice what is beneficial and what is imbalanced and dangerous.

Studying biology prepares a student for a career, working either in an educational institution or in an industry in which he/she can be directly involved in the research and in the development of drugs, food-related items and biotechnology. Also, by studying biology he/she can become qualified to work for the government in managing such things as environmental research of animals, river systems or biological wastes.

## **1.2 MEANING OF BIOLOGICAL SCIENCE**

The Greek word 'bio' means life and 'logos' means study of or science of. Therefore, Biological science is a study of living organisms. It is also called as "Biology". In the late 1700s Pierre-Antoine de Monet and Jean-Baptiste de Lamarck coined the term biology. Earlier, study of living things was restricted to the pure Science 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, which gave rise to a very broad science called Biological science. It is an extensive study covering the minute workings of chemical substances inside our cells, to broad scale concepts like 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 each other and with 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 in Biological science. Today it is also called by a new name – Life science.

Life science can be defined as "a systematic study of living things or study of nature". Teaching of life science basically deals with the providing information about the latest developments in the field of Biological science all over the world.

And the knowledge of Biological Science helps the student:

- To develop the individual's sensitiveness to nature and make him/her feels at home with it.

- To explain the living world in terms of scientific principles and appreciating those organisms behave in different ways.
- To show capabilities, which differ from one another.
- To satisfy the curiosity of the students.
- To generate interest about his/her surroundings.

The scope of Biology is very vast and in fact as wide as the world itself and as lengthy as the history of life on the earth. Let us now look into the scope of Biology.

### **1.3 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 in this earth. The knowledge of biology also helps in understanding the biochemical processes and the metabolic reactions occurring in the living cells and organisms. It throws light on the genetic material the DNA, RNA and their role in heredity and reproduction. It also provides knowledge about the nature and importance of microorganisms on this earth. It gives an insight into applied and 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 behaviour and ecology of animals and plants. Their studies encompass both basic and applied science because today's biologists play an increasingly important role in the progress of agriculture, human and animal health, and in business and industry.

Whether in the laboratory, in the office, or in the field, biologists meet the daily challenges of preserving our environment, developing new defenses against diseases, increasing agricultural productivity, and expanding our understanding of the basic processes of life. There is an increasing need for biological scientists to meet these new and emerging challenges. Now let us look into the aims of teaching Biological science.

## 1.4 AIMS OF TEACHING BIOLOGICAL SCIENCE

*“There is of course one thing about which we feel no doubt or hesitation. Education, science based and in coherence with Indian culture and values, can alone provide the foundation as also the instrument for the nation’s progress, security and welfare”.*

-Indian Education Commission (1964-66)

In this modern era of science and technology the knowledge of science is very important for the human beings. All the aspects of human behaviour are governed by the basic knowledge of biology. The food we eat, the cleanliness and sanitation measures we follow, the healthy habits we inculcate, the agricultural methods we utilize, the industrial processes we develop are all based on application of scientific principles. The subject of biological science is valued the most for its practical application in the day-to-day life of the human beings. The teaching of biological science should equip and prepare an individual with certain values, attitudes and skills in science. A biology teacher has to realize the aims of biological science teaching and inculcate the values of science in the students.

The science policy resolution of the government of India (1958) stated: “the dominating feature of the contemporary world is the intense cultivation of science on a large scale and its application to meet the country’s requirements.”

The aims develop from the goals of education. An aim tries to achieve something. The aims give rise to objectives. Aims are directive in their function. And the objectives are the steps towards achievement of the aims. The main aims of teaching Biology are:

- ❖ To provide a comprehensive knowledge of biological science.
- ❖ To develop skills and abilities to understand and utilize the processes and procedures in biology.
- ❖ To develop an interest and appreciation of nature and environment.
- ❖ To develop scientific attitudes and training in scientific methods.

- ❖ To prepare students to be committed, concerned and competent citizens of the society and nation.

## **1.5 OBJECTIVES OF TEACHING BIOLOGY**

The most important objectives of teaching biology for the students are:

1. Making the students receptive to impressions of nature, training them to observe biological phenomena and giving them an insight into the stream of life and consequently instilling in their minds a respect for life and respect for nature.
2. Imparting students with knowledge of human beings and their status in the biological world.
3. Giving insight into the interrelations of the living and non-living world.
4. Preparing pupils for further biological studies, for which specific knowledge and general understanding of living beings are desirable.
5. Providing practical knowledge of the content.
6. Providing advanced information in the field of Biology.
7. Developing skills, knowledge, interests, appreciation, application and understanding through the teaching of Biology.
8. Stimulating the spirit of investigation and invention.
9. Improving the power of observation and experimentation.
10. Developing the problem solving capacities.
11. Understand the utility of biological science to the modern life.
12. Inculcating the ideals like truthfulness, open-mindedness and reflective thinking in the learners.

## **1.6 GUIDING (BASIC) PRINCIPLES OF TEACHING BIOLOGY**

We live in the middle of a revolution in the relationship between humanity and the rest of the living world. Never before has Biological knowledge accumulated and changed our understanding of life with such astonishing acceleration. Never before has breakthroughs achieved by Biologists contributed in improving the quality of human life. And never before has ignorance of Biological concepts and consequences as well, been so potentially hazardous to individuals and societies.

The societal implications as well as practical applications of Modern Biology span the entire spectrum of human concerns and the full range of the phenomena we call "life", from the tiny world of molecules, genes, and cells to the blanket of life that covers our *spaceship planet* earth. That wide-ranging relevance is what makes Biology so exciting and so important (Levine & Miller, 1994).

The importance of the impact of Biological knowledge and issues on society and human life compel all mankind to learn more about the science behind them to make informed judgments and justifications on perplexing questions raised every day. Do we know enough to create new forms of life in the laboratory safely? Have we enough ethical and legal safeguards in place to allow alternation of human genes? What should be done to evaluate and deal with the effects of human activity on global environment? None of these questions have simple answers. All of them demand the attention of scientifically well informed citizens, able to appreciate the power and responsibility conferred upon us by discoveries in the world of life. Yet because Biology is tied so closely to so many facets of human life, Biology can be more controversial, in more different ways, than it has ever been before (Hurd, 1993). Almost any active and important field in Biology - from the study of evolution, to genetic engineering, to human ecology - directly affects the beliefs, economic interests, or political convictions of some, if not all segments of society. Perhaps in the past, there was a time when Biology was a quite isolated discipline, remote from the concerns of society. That certainly is not the case in the 21<sup>st</sup> century. The biologically related challenges the world face, range from protecting endangered species and fragile environments to deciding whether or not to use genetic engineering in efforts to design new organisms or cure inherited diseases. Whether we admit it or not, Biology finds itself, at the centre of some of the most serious controversial issues of our time (Levine & Miller, 1994).

A field of study having such impact on our lives needs very careful consideration when it comes to be learned by our schoolboys and girls. They need to be educated in a way that makes them intellectually, ethically, morally and socially prepared to face the challenges of the future (El-Nemer, 1997). Biology teachers are, essentially, those who take the

responsibility of delivering such education to the young people in schools and universities.

## **1.7 PRESENT SCENARIO IN TEACHING OF BIOLOGY**

Studies on present position of teaching Biology are not yet carried out elaborately, but the teachers of Biology though qualified to teach the subject, mostly adhere to lecture method or chalk-and-talk method or what we call it as the traditional method. Necessity of teaching Biology with the help of audio-visual and other learning aid is ignored to a great extent. Time factor at disposal in an academic year restricts the number of field-trips, educational tours and excursions. Lack of needed facilities in the schools and the required knowledge by the teachers to teach the subject restricts the scope of teaching Biology effectively. Unfortunately, it does not have a history of being well taught or taught with interest for children. Our process to teach Biology is general, routine, teacher centered, traditional and authoritative stressing upon rote learning. Part of the reasons for the generally ineffectual teaching of Biology in the schools has been the lack of an inadequate background which teachers themselves have had in Biology. This being the case, teachers have held closely to the classroom textbook. Keeping sufficiently, ahead of the children but lacking the depth of understanding which would make their teaching inspiring and worthwhile. Learners today accumulate a substantial amount of non-functional and unrelated facts that are promptly forgotten as it becomes very difficult for the children to link the provided knowledge to their life and thereby making it ineffectual and utterly boring for the students.

In the present world of hyper-technology, where change leads the life, there is a need to bring some drastic changes in the way the knowledge of Biology is being imparted to the children, has become crucial. Students have to be exposed to new approaches and methodologies to transfer the knowledge of Biology for them to understand the Biological concepts properly. The National Focus Group in National Curriculum Framework (2005) endorsed the point made by the Yash Pal Committee, as well as by NCFSE 2000 that we should try to minimize the emphasis on retention of information without comprehension. It is important that our national standards today should also be

able to meet the challenges of global competition by designing a variety of courses; producing a variety of instructional materials such as Audio, Visual and Multimedia packages; and innovating improved evaluation tools.

The **National Curriculum framework** (2005) recommends that the needs of students belonging to different regional, cultural, and social backgrounds should be taken into consideration in a proper and careful manner and students' life at the school must be linked to their life outside the school. This principle marks a departure from legacy of bookish learning that continues to shape our system and causes a gap between the school, home and community. The syllabi developed on the basis of NCF signify an attempt to implement this basic idea. They also attempt to discourage rote learning and the maintenance of sharp boundaries between different subject areas. The methods used for teaching and evaluation will also determine how effective textbook proves for making children's life at school a happy experience, rather than a source of stress or boredom. Treating the prescribed textbook as a sole basis of examination is one of the key reasons why other sources and sites of learning are ignored. Including creativity and initiative is possible if we perceive and treat children as active participants in learning, and not as passive receivers of fixed body of knowledge. These measures if adopted can take us in the direction of a child-centered system of Education outlined in National Policy of Education (1986). Let us now see some of the essential roles of Biology teachers.

## **1.8 ROLE OF THE TEACHER IN TEACHING BIOLOGY**

Biology teachers are expected to assume a new role compatible with the meaning and implications of unexpected patterns, and speed of scientific and technological change and its impact upon the lives of individuals and societies.

1. Achieving life-long and multi-dimensional Biological literacy is the underlying goal of all teaching/learning opportunities future Biology teachers are supposed to offer through high school Biology curricula.

2. Future Biology teachers are expected to teach Biology in an unpredictably new intellectual environment, dominated by unprecedented flux of information — and

misinformation as well - of all kinds and directions. So, the expository and factual methods of instruction are no longer tolerated. Prospective Biology teachers are expected to teach that methods of testing the truth of information are as important as the facts themselves.

3. In a world that is changing so fast, concepts would lose their significance unless they are formed in a way that insures their integrity and coherence, as well as their *functional relevance* to the nature and the place of humankind in it. This is the primary goal of teaching Biology. In this sense, prospective Biology teachers are expected to correct currently distorted view of the living world most people possess so that they can make more enlightened decisions on matters involving Biological phenomena.

4. Proper pedagogy in Biology education requires that the Biology teachers have experience with scientific inquiry, establishing a safe and welcoming learning environment, classroom management, and the application of educational technologies. It is essential that Biology teachers have the opportunity to experience and plan inquiry-based activities that meet the standard and experience a learning environment that emphasizes hands-on and experience-oriented activities. Biology teachers should receive instruction in the proper use of multimedia computers as a pedagogical tool and classroom management in a lab or field situation.

## **1.9 COMPETENCIES OF A BIOLOGY TEACHER**

The essential competencies required by a Biology teacher are as follows:

- i. Competencies related to Programme Planning, Development, and Evaluation**
  - Visioning/strategic planning (Programme improvement).
  - Developing and writing general objectives for the programme.
  - Participate in the identification of the school's science education programme purposes and goals.
  - Effectively managing, maintaining and improving laboratories.
  - Effectively manage, operate and evaluate the programme on a continuous basis.

- Effectively able to manage finances, grants and special projects.
- ii. Instructional Competencies of a Biology Teacher**
  - Plans the content of the lesson.
  - Determines the students' needs and interests.
  - Plans the summary of the lesson.
  - Effectively plans for instruction.
  - Communicates well with others.
  - Effectively recognizes students' achievements.
  - Effectively motivates the students.
  - Has a love for biological science.
  - Effectively manages student behaviour and maintains discipline.
  - Encourages, counsels and advises the students.
  - Uses variety of teaching techniques.
  - Incorporates science and other areas of the school curriculum into to the programme.
  - Has excellent knowledge of the subject matter.
  - Is innovative; uses technology appropriately and adapts well to different situations.
  - Capable of solving problems and multitasking.
  - Is knowledgeable of teaching and learning theories.
  - Can give an assignment in clear and concise manner.
  - Can reinforce learning.
  - Direct students in applying problem solving techniques.
  - Effectively evaluates students.
  - Formulates a system of grading consistent with school policy.
  - Establishes criteria for evaluating student performance.
  - Determines students' grades based on related instruction.
  - Recognizes the individual differences in the students.
  - Exhibits decision making skills and
  - Exhibits mentoring skills.

### **iii. Professional Competencies**

- Maintains ethical standards expected of a professional teacher.
- Keeps up-to-date through professional literature.
- Acquires new occupational skills and information needed to keep pace with technological advancement in biological sciences.

## **1.10 IMPORTANCE OF MULTIMEDIA IN EDUCATION**

### **1.10.1 General Meaning of Multimedia**

It is the combined use of media, such as movies, music, lighting, CD-ROMs, and the Internet, as for education or entertainment.

### **1.10.2 Etymological Meaning of Multimedia**

Multimedia (Lat. Multum + Medium) is media that uses multiple forms of information content and information processing (e.g. text, audio, graphics, animation, video, interactivity) to inform or to entertain the (user) audience. Multimedia also refers to the use of (but not limited to) electronic media to store and experience multimedia content. Multimedia is similar to traditional mixed media in fine art, but with a broader scope. The term "rich media" is synonymous for interactive multimedia.

### **1.10.3 Definition of Multimedia**

The term multimedia describes a number of diverse technologies that allow visual and audio media to be combined in new ways for the purpose of communicating. Applications include entertainment, education and advertising. Multimedia often refers to computer technologies. Nearly every PC built today is capable of multimedia because they include a CD-ROM or DVD drive, and a good sound and video card (often built into the motherboard). But the term multimedia also describes a number of dedicated media appliances, such as Digital Video Recorders (DVRs), interactive television, MP3 players, advanced wireless devices and public video displays.

#### **1.10.4 History of Multimedia (Multi-Media Once Meant Film and Slide-show Extravaganzas)**

The term Multi-Media, which was used during the 1970's to describe a particular theatre-based film and slide-show collage experience, has now been shortened to just the word "multimedia". From the mid 1980's through the late 1990's, the prevalent meaning of multimedia was a category of "authoring" software that allowed designers to develop interactive computer programs without having to have advanced programming skills. Examples include Apple's HyperCard, Icon AuthorWare, Asymetrix Toolbox, and Scala MultiMedia. This category of software still exists, and is sometimes referred to as multimedia, but the term is now used more generally to describe nearly every hardware or software technology that displays images or plays sounds.

#### **1.10.5 The Meaning of Multimedia has Expanded**

In recent years, the term multimedia has taken on more and different meanings to an ever-increasing audience. Some of us are experiencing a form of multimedia "narrowcast" through digital cable. The term "multimedia networking" is being used to describe the massive multi-million dollar content management systems used by large corporations to serve their video assets, as well as the digital signage advertising networks now appearing in retail. Home DVD editing software, some of which currently retails for under \$100, can be categorized as multimedia, along with the latest generation of mobile phones capable of taking and sending voice annotated photos. The term multimedia will continue to evolve, expand and take on as many new meanings as the technologies and applications it is being used to describe.

#### **1.10.6 Use of the term “Multimedia” in Education**

In Education, multimedia is used to produce computer-based training courses (popularly called CBTs) and reference books like encyclopedia and almanacs. A CBT lets the user go through a series of presentations, texts about a particular topic, and associated illustrations in various information formats. **Edutainment (Education + entertainment)** is an informal term used to describe combining education with entertainment, especially multimedia entertainment.

"Audiovisual education has developed rapidly since the 1920s by drawing on new technologies of communication, most recently the computer. History has shown that pictures, specimens, demonstrations, and other audio-visual means are effective teaching tools. John Amos Comenius (1640), Bohemian educator, was one of the first to propose a systematic method of audiovisual education. His *Orbis Sensualium Pictus* ("picture of the sensual world"), published in 1658, was profusely illustrated with drawings, each playing an important role in teaching the lesson at hand. Comenius was followed by other great educators, including Jean-Jacques Rousseau, John Locke, and J.H. Pestalozzi, who advocated the use of sensory materials to supplement teaching.

The human brain is an extraordinary piece of biological machinery. It is capable of coordinating the senses to acquire, process, and link vast amounts of information to help people learn, communicate, and survive. One can make a strong analogy between the function of the human brain and a computer 'brain'. All computers purchased today are Multimedia PC's. This means that the software installed in the system is capable of combining text, graphics, audio, and video with links and tools that help a user to navigate, interact, create, and communicate, learn and survive, both academically and socially (Hofstetter, 1997).

Computers are found just about everywhere in industrialized nations - at home, in the schools, work-places, vacation spots, cars, planes, and some computers are even attached to human beings! Therefore, one could argue that computer literacy is quickly becoming an essential basic skill to be ranked among the three R's -- reading, writing, and arithmetic. Since the human brain and multimedia applications work in such similar ways, it makes sense to incorporate biology with technology to stimulate better learning among high school science students. Computer Technology Research (CTR) supports the effectiveness of multimedia as a powerful tool in ensuring student's ability to remember and retain information (Hofstetter, 1997). Recent findings in brain research suggest that this is especially true when the student is engaged in activities that draw upon his/her multiple intelligence strengths. To be truly effective educators, teachers must recognize these implications of living in an Information Age and adapt their instruction to meet the

individual needs of all students. Understanding the ways in which learners learn best will help in choosing appropriate multimedia applications to optimize individual student's learning.

### **1.10.7 Teaching Biology through Multimedia**

It is an accepted fact in psychological and sociological circles that very young children imitate the behaviours of important people in their environment such as parents, teachers and peers. Children older than about two years of age engage in much more complex learning processes. Older children need to pay attention to behaviour, remember the behaviour and be motivated to reproduce it in one form or another. This process is called 'modeling' (as distinct from imitation) and shows that children often produce behaviours that are novel variations on what they have observed. This understanding has clear implications for the ways in which we understand the effects of multimedia on children. It also highlights the importance multimedia can play in the learning processes of children. Multimedia, if used appropriately in the classroom, provides opportunities for children to work together and hence learn co-operative and communication skills as they each contribute to a combined project. This way of using the multimedia resources available is already working well in many classrooms across the globe. However it must not replace the face to face interaction of the parent or the teacher with the child. Technology integrated instruction in various disciplines is highly desirable. Moreover, Biology being media-genic discipline, it can be well treated through technology.

### **1.10.8 Multimedia as an Educating / Learning Medium**

We are very well aware of the increasing use of Multimedia Technology, both in educational forums and to promote learning in general. The widespread availability of Multimedia Technology means that people have greater access to the broadest range of information ever available. Its importance in the Education of young people is now being realized. As a result, the introduction of Multimedia Technology into the way school curricula are developed is now gaining credence within the general education system. Accordingly, school students are now relying less on the traditional blackboard and textbook methods of learning and are instead emphasizing computer-generated

technology as the most significant learning tool. However, the largely unregulated nature of many resources such as the Internet, Video and Computer Games give rise to concerns over content, manipulation and exploitation. Educators are recognizing the potential for the use of multimedia to enhance learning outcomes. The National Council for Educational Technology (NCET) in identifying potential outcomes, states that the effective use of multimedia can:

- ✚ Provide the flexibility to meet the individual needs and abilities of each student.
- ✚ Reduce the risk of failure at school.
- ✚ Provide students with immediate access to richer source materials.
- ✚ Present information in new, relevant ways which help students to understand, assimilate and use it more readily.
- ✚ Motivate and stimulate learning.
- ✚ Enhance learning for students with special needs.
- ✚ Motivate students to try out new ideas and take risks.
- ✚ Encourage analytical and divergent thinking.
- ✚ Encourage teachers to take a fresh look at how they teach and ways in which students learn.
- ✚ Help students learn when used in well-designed, meaningful tasks and activities and offer potential for effective group work.
- ✚ Increases motivation through immediate feedback, multisensory involvement and greater enjoyment of learning.
- ✚ Increases involvement as more senses and activity are required of the student, more learning and progress occurs.
- ✚ Ensures instructional consistency because instruction progresses as mastery is achieved.
- ✚ Reduces learning time by as much as 50 percent.
- ✚ Increases retention of content over time.
- ✚ Enables students to have more privacy allowing them the experience of trial and error, failing tests and asking embarrassing questions without disclosure.
- ✚ Allows multiple access so the students can use the programs when they need and want them and at a variety of places.