Chapter 1

INTRODUCTION

1.1 Meaning, Nature, Scope and values of Science, Impact of Science and Technology on Society, Role of Science in sustainable development

The world around us is full of nature's marvels, be it rich variety of plants and animals including human beings, flowing rivers, gigantic mountains, rainbow in the sky; there is science in every bit of it. Why is the sky blue and grass green and not vice versa? Why do all things fall downwards? Why all leaves are not green in colour? Such questions can only be answered with the scientific explanations. Science is a thing of beauty and joy for everyone. The civilizations have come a long way and the evolution they have undergone right from stone-age to modern day technological world is beyond imagination. In Fact Science and technology has brought the world together and now it is termed as a 'global village'. There is no aspect which has not been touched by Science and practically it has revolutionised our modern day living and made our life easier and comfortable. For this we are forever grateful to the contributions of science and the tremendous influence that science has on us.

This unique importance of Science has led **Kothari Education Commission (1964-66)** to remark, "The basic approach and philosophy underlying to reconstruction of education adopted by us rests on our deep conviction that the progress, welfare and security of the nation depends critically on the rapid , planned and sustained growth in the quality and extent of education and research in science and technology."

What is Science and Technology?

Before understanding the impact of science and technology on our life, it is imperative to understand the two terms.

1.2

Science is basically a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the nature and universe. Etymologically word 'Science' has been derived from the Latin word '*scientia*' which means 'knowing' and in the broadest sense, it is any systematic knowledge capable of resulting in prediction. Science is a branch of knowledge of the physical or material world or study dealing with a body of facts or truths systematically arranged and showing the operation of general laws through observations and experimentation.

Science has been defined by various scientists and authors.

Thomas Henry Huxley (1825-1895) who was a famous biologist said that "Science is simply common sense at its best that is, rigidly accurate in observation, and merciless to fallacy in logic."

Thomas Hobbes (1588-1679), a philosopher and great author viewed "Science is the knowledge of consequences, and dependence of one fact upon another."

The great Nobel scientist and philosopher **Albert Einstein** (1879-1955) remarked "The most beautiful experience we can have is the 'mysterious'. It is the fundamental emotion which stands at the cradle of true art and true science."

State Science Council (2009) has defined Science as "the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence."

Technology is a collection of techniques, methods or processed used in the production of goods or services or in the accomplishment of objectives, such as scientific investigation or any other consumer demands.

As per www.dictionary.com "technology refers to the branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society, and the environment, drawing upon such subjects as industrial arts, engineering, applied science, and pure science. It is the application of this knowledge for meeting practical ends."

Whereas science serves the purpose of to know and to do, the former is concerned with understanding and latter with action; technology on the other hand is concerned with practical application of scientific knowledge for practical purposes, especially in industry.

Science describes the world as it is, technology remakes the world to serve human needs.

Nature of Science

- **Science is both a body of knowledge and self-generating process:** Science is a self-renewing, self-correcting and self-generating process.

- **Science as a process of scientific enquiry:** It covers the method or the way facts are established such as observing, measuring, estimating, inferring, classifying, hypothesizing, experimenting and inferring. For e.g scientific attitude, scientific method, science-mindedness.
- **Science as a product:** It includes facts, definitions, concepts, theories, principles and laws.
- **Science is an intellectual activity and creation:** It arises from personal experience and takes place in the minds of human beings. Facts do not themselves make science but are just intellectual interpretation of the data.
- **Science is a way of Thinking and understanding:** Science is based upon evidences and is influenced by background knowledge such as nature's laws.
- **Different from other forms of Knowledge:** because it has to meet reality to establish rationality.
- **Scientific statements can be checked:** by anybody, anywhere in the world.
- **Scientific concepts are developed systematically:** by conducting lab work and field study.
- **Science is objective in Nature:** Science establishes objectivity through observation, experimentation, formulation of hypotheses and then by testing and drawing inferences.
- **Scientific knowledge is long lasting yet tentative:** It is so because; we make new observations and tend to reinterpret the existing observations. The figures and data keeps changing to keep pace with fast changing nature of scientific research.
- **Empirical evidence is used to refine and support ideas in Science:** The scientific evidence is supporting but not absolutely confirmatory.
- **Science is supported by social and historical factors:** As these factors play a role in the construction of scientific knowledge.
- **Laws and theories play a central role**: Laws and theories help in developing scientific knowledge, yet they have different functions.
- **Validation of scientific ideas:** Accurate record keeping, peer review, and replication of experiments help to validate and confirm scientific ideas and principles.
- **Science is a creative endeavour:** Scientific creativity opens the gateway to nurture future scientists of the country.
- **Science is exciting process:** While discovering facts and figures, one derives a sense of pleasure and satisfaction.
- **Science is useful for everyone:** The applications of science and technology are useful for all. For e.g. electrical gadgets, all modern inventions etc.

- **Science is a dynamic enterprise:** The research in the field of science and technology is ongoing, ever-demanding and ever-changing.
- **Science is universal:** All scientific theories, facts, applications and laws are universally true.
- **Science is a community enterprise:** Participating in scientific community involves scrutinizing the work of others and allowing your own work to be evaluated by others.

What Science is not?

- There is no right or wrong, good or bad in science, unless proved.
- Science does not make ethical or moral judgments.
- Value judgments are made by people not by science.
- Science and Technology are not the same, but they have impact on each other.

McComos (1998) proposed 15 incorrect ideas and myths about nature of Science:

1. Hypotheses become theories that in turn become laws.
2. Scientific laws and other such ideas are absolute.
3. A hypothesis is an educated guess.
4. A general and universal scientific method exists.
5. Evidence accumulated carefully will result in sure knowledge.
6. Science and its methods provide absolute proof.
7. Science is procedural more than creative.
8. Science and its methods can answer all questions.
9. Scientists are particularly objective.
10. Experiments are the principal route to scientific knowledge.
11. Scientific conclusions are reviewed for accuracy.
12. Acceptance of new scientific knowledge is straightforward.
13. Science models represent reality.
14. Science and technology are identical.
15. Science is a solitary pursuit.

It is important to understand the role of these myths in understanding the nature of Science nd in planning how these can be discussed with learners. Teachers should organise various ctivities so that learners can understand that these statements are only myths.

Scope/Importance of Science/Impact of Science & Technology on Modern Living

Science knows no bounds. It is all around us from the core of the earth to the sky, even beyond, science will follow you. It applies to all, living or dead. It is omnipresent. Thus science is followed by everyone and everything around everywhere.

Since the art of making fire and creating handcrafted tools, our civilization has come a long way. Science and Technology are making advances at an amazing rate, be it education, medicine, agriculture, communication; cars to rockets and satellites. As we look over the bright side of the achievements of science, we come to realize that there is hardly any sphere of life that has not been enhanced by the creative abilities of science. *Truly*.....Science has given:

- Ears to the Deaf
- Eyes to the Blind
- Limbs to the Crippled.

Science in Agriculture

The development in the agricultural front which is the backbone of our country is really encouraging. New improved techniques have helped to increase crop yield. Methods like drip irrigation, invention of hybrid varieties of seed have gone a long way to help agriculturists. The advantages of science is not restricted to the urban population but it has successfully catered to the rural population with the latest implements, high yielding variety seeds and scientific techniques of cropping. Production of disease resistant seeds leads to high yield and has paved way for the 'Green Revolution'.

Science in Medicine

Technology can allow quicker diagnosis which allows prevention, early treatment thus saving more lives. Newer technology allows better treatments and higher success rates of cure or slowing progression of the disease process. The latest devices help to diagnose diseases at an early stage itself, thus bringing the death rate down and have increased average life expectancy. Alternative form of medicine involves treatment which does not use synthetic drugs or surgery in response to the symptoms of disease but the aim is to treat the patient as a whole. They involve use of herbal remedies and techniques like acupuncture, acupressure, homeopathy and chiropractic. Various Developments Like HPV vaccine, Targeted Cancer Therapy, Human genome mapping, are the biggest breakthroughs of the 21st century. Organ transplantation has become reality and Test tube babies have become common in India as well. All these Developments hold the potential to prolong and improve life.

Science and Communication

The cellular technology created the miracle of enabling communication over the wireless

media. The communication facilities provided by the Internet worked wonders in speeding long-distance communication. Internet mails get in a few seconds in reaching destinations countries. With the means of communication available a few clicks away, the tendency of taking pains to reach the loved ones has vanished. The internet has brought new opportunities to government, business and education. For the purpose of communication, satellites are there having relay stations in space for sending telephone, television, telex and other messages around the world. Messages are sent to and from the satellites via ground stations. Most communication satellites are in geostationary orbits, appearing to hand fixed over one point on earth's surface. These communication satellites are very important as they link the whole world together.

Science and Space

Science helps us to know what exists beyond earth's atmosphere. Above 120 Km/75 miles, very little atmosphere remains, so objects can continue to move quickly without extra energy. The space between the planets is not entirely empty but filled with weak gas of the solar wind as well as the dust specks. The study of space is done with space probe which is an instrumented object sent beyond earth to collect data from other parts of the solar system. Space shuttle is reusable crewed spacecraft. The first one was developed by NASA. The space between the planets is not entirely empty Space exploration and technology in India has brought great respect for the country. It has fuelled the nation to move into the world of high technology, a place previously occupied only by a few developed countries. Recently, India has concentrated much of its space development work on complex applications satellites and more powerful rockets. The nation's two primary interests are satellites for remote sensing and communications – used for Weather forecasting and Disaster warnings.

Science and Robotics

Robot is any machine controlled by electronic chip or computer that can be programmed to do work. The most common types are robotic arms, when fixed to the floor or a workbench, they perform functions such as paint, spraying or assembling parts in factories. Others include radio-directed or computer controlled vehicles for carrying materials and a miscellany of devices from cruise missiles and deep sea and space-exploration craft to robotics toys.

Science and Navigation

Through the application of science and technology, we can find the position, course and distance travelled by a ship, plane or other craft. Traditional methods include the magnetic compass and sextant. Today the geo-compass is usually used together with highly sophisticated electronic methods, employing beacons of radio signals. Satellite navigation uses satellites that broadcast time and position signals.

Science and Satellites

Satellite is a small body that orbits a larger one, can be natural or artificial. The first artificial

satellite Sputnik 1 was launched by the USSR (now Russia and other countries) in 1957. Artificial satellites are used for scientific purposes, communications, weather forecasting and military applications. The largest artificial satellite made can be seen with naked eye. The various applications of satellites are scientific experiments and observations, reconnaissance and mapping applications, weather monitoring, navigation and communication.

Science and Nuclear Energy

Science and technology can be applied to obtain energy from the inner core or nucleus of the atom. This can be obtained in two ways through nuclear fission and nuclear fusion. Nuclear fission as in atom bombs is a chain reaction. This happens very quickly. Nuclear fusion involves fusion of Hydrogen nuclei into Helium nuclei with an accompanying release of energy.

Science and Radiation Technology

Science has contributed very largely in using radiant energy as particles or waves. For e.g. heat, light, alpha particles and beta particles. Radiation technology is used in food preservation, crop improvement, health care and also in treatment of cancer. Radiation processing of food involves treatment of food items by ionizing radiation mainly by Gamma rays. Radiation technology is an important means in modifying the properties of seeds at genetic level. Out of these, good quality seeds are chosen. Radioimmunoassay (RIA) is an important medical application of radio-isotopes.

Science and Nanotechnology

Nanotechnology is building of devices on a molecular scale. Micromachines such as gears smaller in diameter than a human hair have been made at AT & T Bell Laboratories in New Jersey, USA. A robot small enough to travel through the bloodstream and into the organs of the body, inspecting or removing diseased tissue is the biggest advantage of nanotechnology. In India efforts to promote research, in nanotechnology began early in the millennium. The 'Nano Science & Technology Initiative, started with a funding of Rs.60 crores. In 2007, the govt. launched a five-year program called 'Nano mission'. Multiple institutions like Deptt. on IT, DRDO, CSIR, Deptt. of Biotechnology along with National centers for Nanoelectronics and Nano fabricantion were started in IISC, Bangalore and IIT, Mumbai.

Science and Intermediate Technology

It involves the application of mechanics, electrical engineering and other technologies based on inventions and designs developed in scientifically sophisticated cultures but utilizing material assembly and maintenance methods found in technologically less advanced regions for e.g. simple wind mill.

Science and Industry

The discoveries of science have brought about drastic changes in the ways and processes of

industry. The textiles industry is highly advanced due to science. All the processes, including production of yarn, the weaving of cloth, giving fine finish etc. are carried out by automatic machines. The printing industry, manufacture of electrical appliances, radio, television, drugs, agricultural implements , armature industry have all been revolutionized by the magic wand of science.

Science and Leather Technology

Leather technology is primarily used in manufacturing footwear. It is also used for designing accessories like purses, jackets, bags, hand gloves, belts, sports goods and even dresses. Leather technology involves a variety of machines, including scuff-resistant testers, heat resistant testers, flexometers, water vapour testers, spectrophotometers and auto-titrators.

Science and Computers

Computers are the greatest boon of science to our society. They are the programmable device that processes data and other symbol manipulation tasks. There are 3 types of computers available today: Digital computer, analogue computer and hybrid computers. Computer Assisted Instructions (CAI) and networking have become the buzz words these days. Interactions with other students in different cities, countries and cultures help students with the development of critical thinking and creativity based skills and appreciation for learning outside the classroom walls have seen the light of the day because of this biggest invention of mankind. Besides, it results in increased involvement and motivation for learning, as teachers and students can communicate beyond the walls of the classroom making classroom learning more applicable to the needs of all the individuals involved.

Science and Graphics

Graphics involves use of computers to display and manipulate information in pictorial form. This is the most common technique used in movies now-a-days. The output may be as simple as a pie chart or as complex as an animated sequence in a science fiction film or a seemingly 3-D blueprint. Graphics are increasingly used in computer-aided-design (CAD) and to generate models and stimulations in engineering, meteorology, medicine, surgery and other fields of science.

Science and Education

Online education (MOOCs) has the potential to be used as a tool to bring education to a whole new population of students and provide easy access for those already in school. The potential for interactive learning through computers is boundless. Online education would allow many students in lesser-developed countries to obtain a degree without leaving their home. Online Encyclopedias & Dictionaries did wonders in overhauling the traditional education system in India. Audio Visual teaching Aids such as multimedia and e-learning resources have totally revolutionized the educational scenario.

Science and Entertainment

Science has provided a source of entertainment to man in the form of films, television, radio, tape recorders etc.

While making films, light rays shine onto the movie screen to produce the image we see as a moving picture that are recorded on a film. The film is a long strip of translucent images, positioned in the middle of a movie projector. Behind the film is a very bright lamp sitting inside a concave reflector. White light from the lamp is concentrated though two lenses called a condenser onto the film. The rays emerging from the condenser pass through the film. The images on the film act like a series of multicoloured filters. The filtered light, carrying the image on the film, then passes through a series of lenses that spreads the light out and focuses it onto the movie screen. When the light strikes the screen, the image produced is therefore many times larger than the original tiny picture on the film. The movie screen then reflects the light that forms this image back to our eyes. These days, digital video has transformed the movie industry. Instead of traditional film, movies can now be recorded digitally onto a computer and stored on a DVD. This makes the shooting, editing, and distribution of a movie much cheaper. Modern digital media can store information in a way that is less likely to degrade. Every time a traditional film is run through a projector, it may get a bit stretched or dirty. Except for scratches or breakage, a DVD retains its quality over time.

Television involves reproduction at a distance by radio-waves of visual images. For transmission, a television camera converts the pattern of light it takes into a pattern of electrical charges. This is scanned line by line by a beam of electrons from an electron gun, resulting in variable electrical signals that represent the visual picture. Radio involves the transmission and reception of radio waves. In radio transmission a microphone converts sound waves into electromagnetic waves that are then picked up by a receiving ariel and fed to a loudspeaker which converts them back into sound waves.

Science and Defense

Tanks, arms, missiles, nuclear weapons etc. are only possible because of science. Missiles are the rocket-propelled weapons which may be nuclear-armed. Modern missiles are classified as surface-to-surface, air-to-air missile, surface-to-air missile or air-to-surface missile. Tanks are the armoured fightening vehicle that run on tracks and are fitted with weapon systems capable of defeating other tanks and destroying life and property. Nuclear warfare involves the use of nuclear weapons. Nuclear weapons of attack include bombs (atom bombs, Hydrogen bombs and Neutron bombs), missiles etc. Nuclear methods of defense include antiballistic missile.

Science is Vehicle of War

Advances in medicine and agriculture have saved vastly less lives than have been lost in all the wars in history. Endowed with tremendous power modern science is yoked to the chariots of war. Science has its significance for the human lives only if the later continues to exist on earth.

Modern wars are being fought with scientific weapons like tanks, aero planes, guns, bombs, missiles and rockets, etc. Modern wars are more deadly and destructive than ancient ones. They work havoc on an alarmingly large scale.

Science and Democracy

Many qualities of a good citizen for democracy have been taught to us by science. The unique human ability think logically and rationally, receptivity to new ideas, scientific mindedness, intellectual integrity, scientific truthfulness, service to mankind, respect for other's point of view etc. are the democratic virtues that science teaches us. According to Burnett, "a common myth is that the scientist is a man without bias. This is non-sense. The scientist is simply a trained individual who has found a useful method of checking his habits in terms of his professional work. What he has learnt, the democratic people must also learn."

Science and Modern Civilization

The modern civilization is the product of modern science . Our thinking and ways of life have been greatly affected by the tremendous advances in industry, agricultural , entertainment, transport, communications and treatment of human diseases. Age old superstitions and unfounded beliefs are fading away. Old customs are being replaced by simple formalities. Ignorance and illiteracy have no place in the present day world. Our moral ideas, our attitudes towards religion, marriage, birth control etc. all have undergone drastic changes all due to contribution of science.

Science gives rise to many vocations and future careers

Science leads to choosing a variety of vocations which is far more in number than any other field such as Agriculture, Astronomy, Biochemistry, Bioinformatics, Biostatistics, Earth Sciences, Electronics, Environmental Science, Forensic Science, Food Technology & Processing, Geology and many more. You may be a businessman, artist, manager or lawyer or even a homemaker, science is needed by everyone in their daily life.

VALUE DEVELOPMENT THROUGH SCIENCE

Science leads to value development among students which is an area of concern. Responsibility of value development lies on the teachers. There are values which are universal across the disciplines as well as discipline specific also. There is a need to adopt integrated approach for value development in which values should not be taught as content rather they should be imbibed in the process and activities of various subjects.

Role of teachers at secondary level is to facilitate learners with such activities where they can not only create knowledge and develop understanding of scientific phenomenon but also inculcate values among themselves. A good Science curriculum should promote values like honesty, interdependence, co-operation, objectivity, freedom from fear and prejudice, and

develop in the learner a concern for life and preservation of environment (National Focus Group on Teaching of Science, 2006, p. 1).

A good Science teacher should inculcate following values among the students through the teaching of science:

1. **Honesty :** Honesty is the best policy. This is commonly heard everywhere. Science promotes value of honesty as the scientists have to report and present true facts in front of people. They give due credit to the work of other fellow scientists. Science is synonymous for intellectual honesty.
2. **Interdependence :** Science is inter-connected and inter-dependent enterprise. Science is quite a complex and vast kind of subject, because of which the task of correlating it with other subjects of curriculum seems to be quite easy. Deliberate efforts should be done by the science teacher to bring about co-relation in between the science and other subjects of the curriculum, which are being imparted to the students.
3. **Co-operation :** Students of science should be encouraged to cooperate and work in collaboration with each other in any scientific pursuit be it making projects, writing assignments or preparing any model. This promotes healthy interaction among the students and learning is greatly facilitated.
4. **Objectivity :** Objectivity in science is an attempt to uncover truths about the natural world by eliminating personal biases, emotions, and false beliefs. Objectivity is necessary to get an accurate explanation of how things work in the world. Ideas that show objectivity are based on facts and are free from bias or personal opinion. In science, even hypotheses, or ideas about how something may work, are written in a way that are objective.
5. **Environmental concern :** Science education has an important part in developing understanding of concepts that may address various environmental issues such as green house effect, global warming and sea level rise, ozone layer depletion, acid rain etc. Science should develop proenvironmental behaviour among the students by examining the environmental consequences of human behaviour.
6. **Freedom from Prejudices :** Science paves way to liberate our minds from age old prejudices, biases and superstitions. Science verifies everything and nothing can be believed just on the basis of opinions of people. There has to be a solid rationale to believe anything that can be proved experimentally. In this way it develops scientific attitude among people.
7. **Concern for life :** Science has revolutionised our way of living. It has given us health and longevity at the same time has improved our quality of life. Science and technology has made us appreciate every life, however big or small it may be, from as big as a Whale to as small as a single-celled Amoeba. Extensive research has taken place in every field that has developed concern for every life in this universe.

SCIENCE TECHNOLOGY AND SOCIETY (STS)

There is a strong relationship between Science and Society. The impact of science and technology on society is evident. But society also influences science. There are social influences on the direction and emphasis of scientific and technological development, through pressure groups on specific issues, and through generally accepted social views, values and priorities.

1. Role of Society

- **Society provides the Resources for Science and Scientific Research :** The society provides the resources for science and scientific research to take place and so is entitled to have a say in the direction that such research takes. Society has and ought to have an interest in scientific research because it is supported by, and for the good of, society. The products of scientific research, because of their potential to change society and the lives of its members, constitute a force (or more negatively, a threat) that society should control as a protective measure. Society has obligations concerning the welfare and protection from harm of its members. The scientific research, particularly medical research has the ability to promote the welfare of members of society and protect them against harm.
- **The Scientific Endeavour is not isolated from Society :** The institutions of science are societal institutions and the individuals who participate in the processes of science are members of society. All are products of the histories, traditions and cultures of each society and as such are a part of its fabric.
- **Society provides freedom of choice :** Going by the tradition of libertarianism, it is the society that provides the resources that enable freedom of choice and that some individuals choose to engage in science. So the trends and directions of development in science are best left to the free choices of individuals and/or markets, rather than being subject to the controlling influence of the larger group. Thus, scientific research is the product of the freedoms that exist in society, and it is the duty of society (in the form of its institutions) to intervene as little as possible and only to protect individuals from harms and infringements of their liberties.
- **Welfare vs. Harms caused by the Society :** The society causes both welfare and harms but a careful examination proves that there are more benefits than harms to society if science is left to determine its own direction with a minimum of interference.
- **Science and Scientific Research should be Accountable to Society:** It is the responsibility of society to provide for the welfare and protection of its members. Thus science and scientific research should be accountable to society because it is supported by society for the benefit of society and its members.

2. Role of Science in Building Societies

Having considered very briefly the question of whether science should be accountable to society, we turn our attention to the ways in which this accountability might be established and maintained.

- **Importance of Products of Science to Society :** The products of science – like technology and medicine – are increasingly important in our lives and we are increasingly reliant upon them. However, there is growing suspicion about the direction of much of the scientific research that takes place within our society, about who is in control of it and what their motivations are. The tension between these two competing pressures means that the relationship between science and society is, at least, difficult. Within this situation a number of trends can be discerned.
- **Scientific Developments have a Global Impact :** There is increased scope for scientific developments to have a global impact as well as to impact on fundamental aspects of human biological and social life. There is an increased level of commercial involvement in scientific research and in bringing the products of that research to the broader population. As a result of the first two trends, there is increased concern about the nature of the choices being made about the direction of scientific research and the possibility of exercising control over this direction.
- **Science and Governance:** The political and academic interest should focus on the relationship between science and governance. It is through the mechanisms of science governance, that the forms of accountability can be explored. For e.g Biotechnology, particularly in its medical applications, provides a useful focus for consideration of the governance of science as it brings significant social benefits than harms. There is a strong relationship between policy makers, which are generally experts from a range of disciplines and the outcomes of the research, which when well applied, has magnitude of benefits.
- **Science can be Economical :** Some science can be done without much money at all. You can make careful observations of the sparrows in your garden and do real scientific research without incurring any expenditure.
- **Science can be Expensive :** Scientific pursuits are not always cheaply addressed as it involves working in laboratories with expensive materials. Science as a whole simply can't progress in the absence of funds. This funding ultimately comes from the societies that will reap its benefits. Hence, those societies help determine how their money is spent. For example, a society that largely approves of stem cell research will encourage government support, stimulating advances in the field. However, a society that largely disapproves of stem cell research is unlikely to support politicians who provide funding for that research. In the latter situation, less research on stem cells will be done, and that society is unlikely to become a leader in the field.

- **Meeting society's needs :** Science responds to the needs and interests of the societies in which it takes place. A topic that meets a societal need or promises to gather the attention of society is often more likely to be picked up as a research topic than an ambiguous question with little prospect for a larger impact. For example, over the last 15 years, science has made tremendous research in the field of HIV-AIDS which has increased our understanding about it significantly. Society's desire to slow the spread of HIV-AIDS and develop effective vaccines and treatments has focused scientific research in this field. Science is done by people, and those people are often sensitive to the needs and interests of the world around them.

ROLE OF SCIENCE IN SUSTAINABLE DEVELOPMENT

Global change is creating enormous challenges for the humanity. The world's population is expected to grow from nearly 6 billion today to 8.5 billion by the year 2025. Global energy requirements will continue to increase. The newly industrialized countries are experiencing very rapid economic growth that is bringing modern society's environmental problems, including air and water pollution and waste problems, to wider areas of the globe.

The ecological problems caused by human economic activity are worsening and taking on global dimensions. Climate change, ozone-layer depletion, and loss of forest cover are important examples. At the same time, social conditions continue to worsen in many developing countries. It is estimated that more than 1 billion people now live in poverty without sufficient food, adequate educational opportunities, or any possibility of political participation. Although financial and economic markets are becoming more and more interconnected and we like to think in terms of a "global village," our efforts to enshrine environmental protection and development as the common task and responsibility of all countries have just begun to make headway.

The key aim for the 21st century is "sustainable development," which the international community embraced at the 1992 UN Conference on Environment and Development. Sustainable development seeks to reconcile environmental protection and development. It is defined as using resources no faster than they can regenerate themselves, and not releasing pollutants to such an extent than natural resources can assimilate them.

If we are to move towards sustainable development, the industrialized countries will have to accept special responsibility—not only because of their past ecological sins, but also because of their present technological know-how and financial resources. Yet, one must keep in mind that sustainable production and consumption involve not merely technical progress, but also cultural patterns of individual behaviour and values.

There are several possible ways to achieve environmental compatibility in lifestyles and economies. Technical and scientific innovations provide excellent prospects for environmental

protection. As we proceed in the 21st century, the industrial society is fast becoming a knowledge-based society. It is vital that we use our growing knowledge and capabilities responsibly, and that we use them in the interest of environmentally appropriate development. Science must play an important role in the pursuit of sustainable development, especially in the following categories:

Energy use

The key technologies of sustainable development include new energy and propulsion technologies that will help reduce emissions of climate-damaging greenhouse gases. Simply to stabilize atmospheric greenhouse-gas concentrations at twice their pre-industrial levels, we will have to reduce current global greenhouse emissions by over 50%. Achieving this goal involves focusing on improved thermal insulation in buildings, on the use of heat/power cogeneration, and on efficient support for the use of renewable energies. Currently the most progress is found in the area of wind energy; in the medium term, the use of solar energy, with photovoltaic technology, will continue to grow in significance. An honest consideration of our options indicates that we cannot afford to discontinue peaceful use of nuclear energy.

Closure of Substance Cycles

Modern micro-systems and control technologies are also providing new opportunities to design environmentally friendly production processes. While filter and wastewater-treatment technologies have considerably enhanced air and water quality in recent years, they have been surpassed by integrated environmental technology, that is, technology that optimizes the use of materials and energy. This involves material-efficient, energy-efficient production processes as well as the manufacture of environmentally compatible products, especially those that generate little waste. We have created the necessary framework for this with the Closed Substance Cycle and Waste Management Act, which came into force in 1996. Instruments such as eco-audits, which help identify the saving potentials from environmental protection investments, also promote development of such "clean" technologies.

Environmentally Compatible Mobility

Environmentally compatible traffic concepts are a particularly important category for innovation. In Germany, the automobile industry now accounts for about 20% of all industrial investments in research and development. "Three-litre cars" (that is, cars consuming less than 3 liters of gasoline per 100 km), natural-gas engines, electric cars, hydrogen engines, and fuel-cell engines can all play a role in eliminating motor-vehicle emissions. Telematics, a device that helps to monitor and record information about the driving behaviour such as speed, distance driven and instances of harsh breaking can ensure safe and cautious driving thus enabling traffic to move more efficiently. Information and communication technologies can eliminate the need for

physical transports in some areas, and computerized logistics in goods transports can reduce total transport distances.

Biotechnology and Sustainability

Biotechnology is expected to bring important advances in medical diagnosis and therapy, in solving food problems, in energy saving, in environmentally compatible industrial and agricultural production, and in specially targeted environmental protection projects. Genetically altered microorganisms can breakdown a wide range of pollutants by being used, for example, in bio-filters and wastewater-treatment facilities, and in the clean-up of polluted sites. Genetically modified organisms can also alleviate environmental burdens by reducing the need for pesticides, fertilizers, and medications.

Sustainability, as a Strategic aim

This involves optimizing the interactions between nature, society, and the economy, in accordance with ecological criteria. Political leaders and scientists alike face the challenge of recognizing interrelationships and interactions between ecological, economic, and social factors and taking account of these factors when seeking solution strategies. To meet this challenge, decision-makers require interdisciplinary approaches and strategies that cut across political lines. Environmental discussions must become more objective, and this includes, especially, debates about the risks of new technologies, which are often ideologically charged.

Working together towards Sustainability

Sustainable development can succeed only if all areas of the political sector, of society, and of science accept the concept and work together to implement it. A common basic understanding of environmental ethics is needed to ensure that protection of the natural foundation of life becomes a major consideration in all political and individual action. A dialogue among representatives of all sectors of society is needed if appropriate environmental policies are to be devised and implemented.

SUMMARY

This topic has discussed in brief about meaning, nature, scope and impact of science and technology on our life. As a Science teacher, you should help learners in resolving various myths about nature of Science. It also discusses certain values which are to be developed through teaching of science The topic has also elaborated how science has facilitated our society and how society brings development in the field of science and technology. Finally, role of science in bringing sustainable development, the biggest goal of 21st century has also been explained.