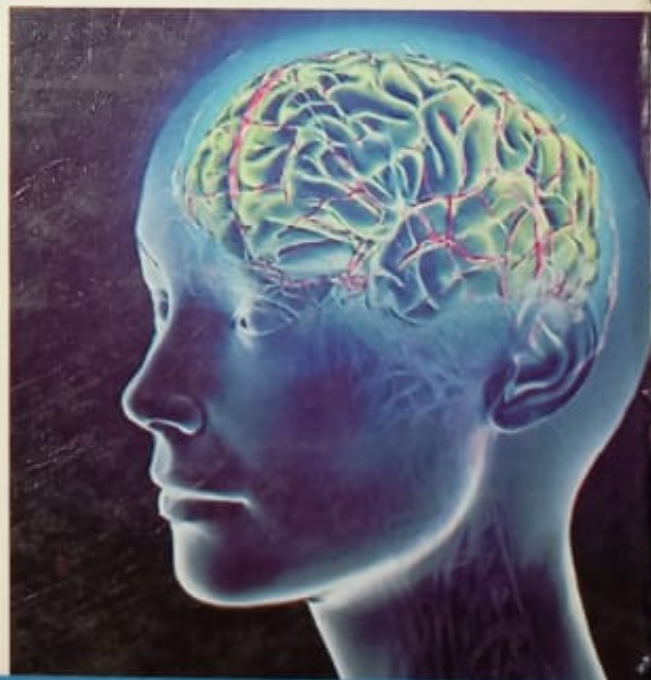
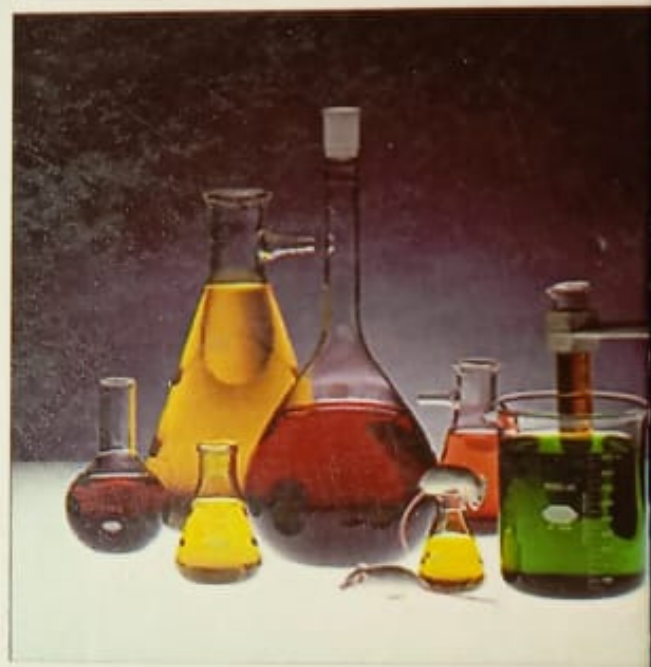
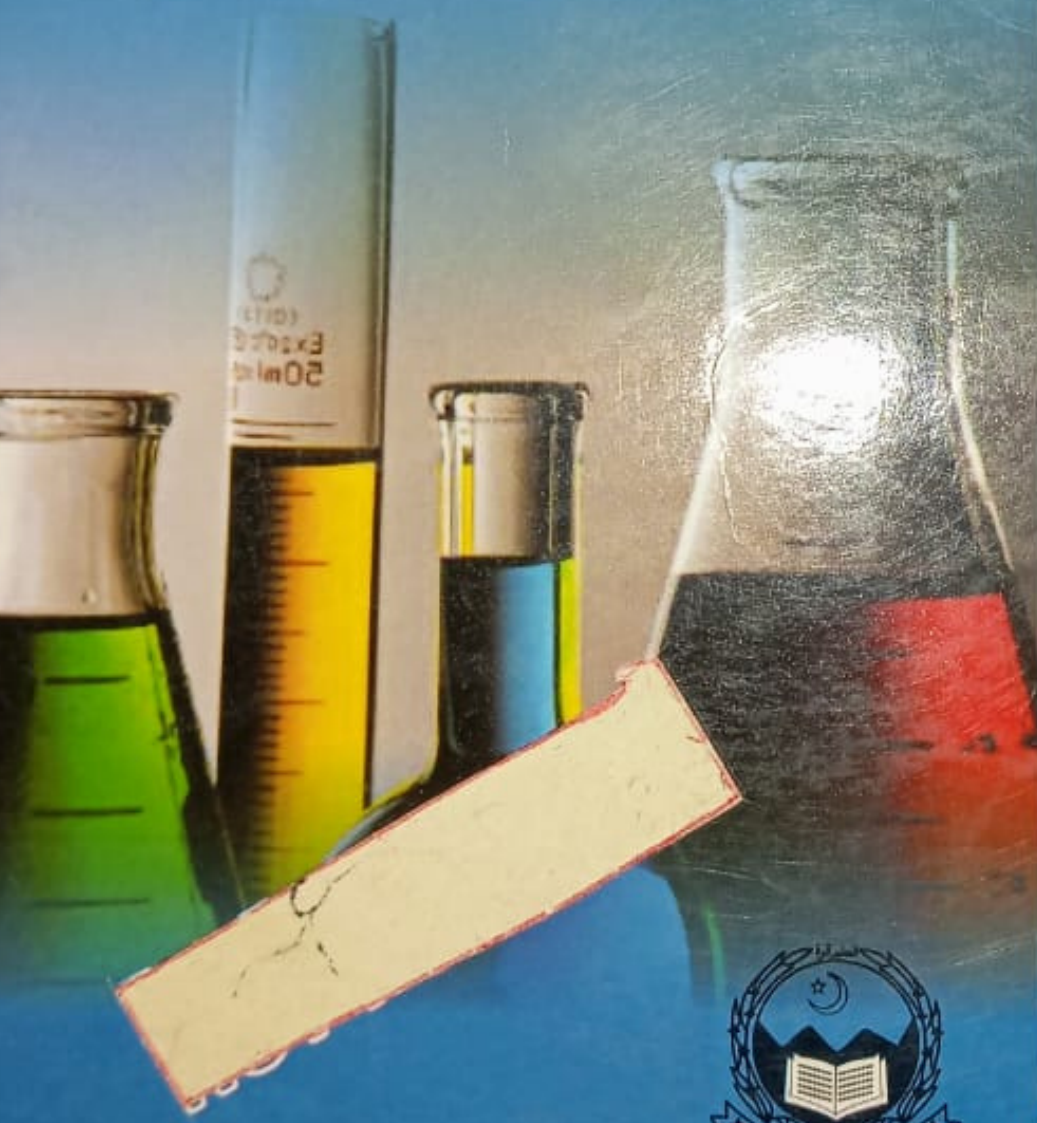


General Science 9



**Khyber Pakhtunkhwa Textbook Board
Peshawar**



In the name of Allah, the most beneficent, the most merciful

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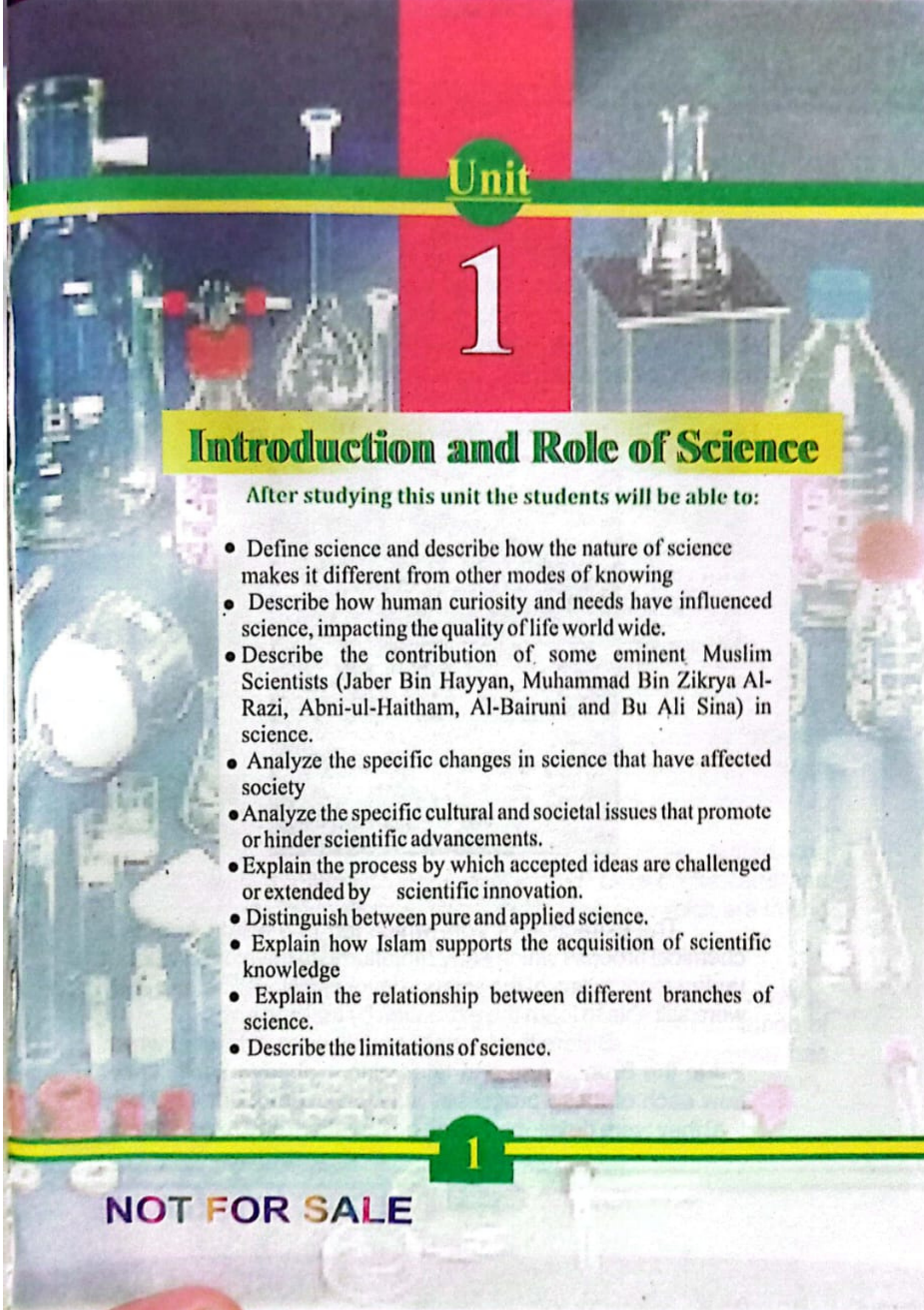
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Unit

1

Introduction and Role of Science

After studying this unit the students will be able to:

- Define science and describe how the nature of science makes it different from other modes of knowing
- Describe how human curiosity and needs have influenced science, impacting the quality of life world wide.
- Describe the contribution of some eminent Muslim Scientists (Jaber Bin Hayyan, Muhammad Bin Zikrya Al-Razi, Abni-ul-Haitham, Al-Bairuni and Bu Ali Sina) in science.
- Analyze the specific changes in science that have affected society
- Analyze the specific cultural and societal issues that promote or hinder scientific advancements.
- Explain the process by which accepted ideas are challenged or extended by scientific innovation.
- Distinguish between pure and applied science.
- Explain how Islam supports the acquisition of scientific knowledge
- Explain the relationship between different branches of science.
- Describe the limitations of science.

1.1 Science and its Nature

Humankind has always been inquisitive, needing to understand why things behave in a certain way, and trying to link observation with prediction. In about 4000 BC, the Mesopotamians tried to explain their observations by suggesting that the Earth was the center of the Universe, and that the other heavenly bodies moved around it. Humans have always been interested in the nature and origins of this Universe. But they weren't only limited to astronomy.



Fig: 1.1 Iron Age tools used for daily life activities

The extraction of iron, which led to the Iron Age, is a chemical process which early metallurgists developed without understanding any of the science involved. Nevertheless, they were still able to learn the extraction by trial and error.

Before this, copper and tin were extracted which led to the Bronze Age and later, zinc. Nobody exactly know how each of these processes was discovered, but it is likely that they were developed using observation and experiments

in a similar way to that used by today's scientists. These early developments are clear evidences that Science and Scientific Attitude is something which is part of human nature.



Fig: 1.2 Bronze Age tools

The word science is originated from Latin word "scientia" which means, "to know". It is an organized form of knowledge obtained by observation and experimentation.

It is the knowledge, which is systematic, tested and brought under general principles. It helps to understand and describe various processes and phenomena, which are taking place around us.

For every branch of knowledge there is a specific way to study it. In order to study Science we use scientific method of study. This systematic approach to the study of science has made it different to other branches of knowledge like history, literature etc.

Over the last few hundred years we have seen that the use of the scientific method as a way of learning about the natural world has yielded useful technologies and discoveries.

Scientific method involves collecting data, developing hypotheses about that data, and then testing those hypotheses with experimentation. This practical approach in science to issues related to our day to day problems has made it unique from other branches of knowledge.

1.2 Human Curiosity and Social Development

Human beings have innumerable range of characteristics. Some are innate, some are formed through experiences and some are developed through wisdom and understanding.

One of the most fundamental of these human features is that of curiosity. It is the curious nature of man that has led him to wonder, ponder and then learn.

It is curiosity in man's nature which drives him to understand different phenomena in life identify his problems and work to find their solutions, build communities and develop societies.

Though modern science is of relatively recent origin, it has made very rapid progress and completely transformed our lives in the past one hundred years than it did in thousands of years earlier.

Scientific knowledge has been accumulated over the last three centuries and its practical application in the form of technology has made a great impact on our lives. For example, rise in population has created a demand for higher yield and pest resistant crops.

Progress in the field of agriculture addressed these problems and now we see that quality of food has been improved and quantity of food has been increased.



Fig:1.3 Use of modern technology has revolutionized the agriculture sector.

The modern technology has made the agriculture a profitable business. The use of modern machines like tractors, scrapers, harvesters and tube wells have greatly helped the man to get maximum production.

With the help of modern technology to a certain extent we have been able to overcome the deadly menace of water logging and salinity. By doing so, a vast land has been reclaimed and used for agriculture.

Tissue culture and genetic engineering techniques are playing prominent roles in increasing the yield by producing disease and drought resistance varieties. Modern technology has also played an important role in the field of medicine.

For Your Information

In 1967 the World Health Organization (WHO) started a worldwide campaign to eradicate smallpox. This goal was accomplished in 10 years due to massive vaccination efforts.

The last case of smallpox occurred in Somalia in 1977. On May 8, 1980, the World Health Assembly declared the world free of smallpox.

Many epidemic diseases such as, Plague, Cholera, Typhoid, Polio and Pneumonia, which were known as killer diseases, have now been controlled with the help of vaccines and drugs. In the near past these diseases played havoc with the human society.

The diagnosis of diseases is very important for its proper treatment. The modern scientific studies have analyzed and discovered each and every part of human body and its working. Many instruments have been devised for the proper diagnosis of the diseases. X-rays, sonography, biopsy etc which help in the diagnosis of diseases.

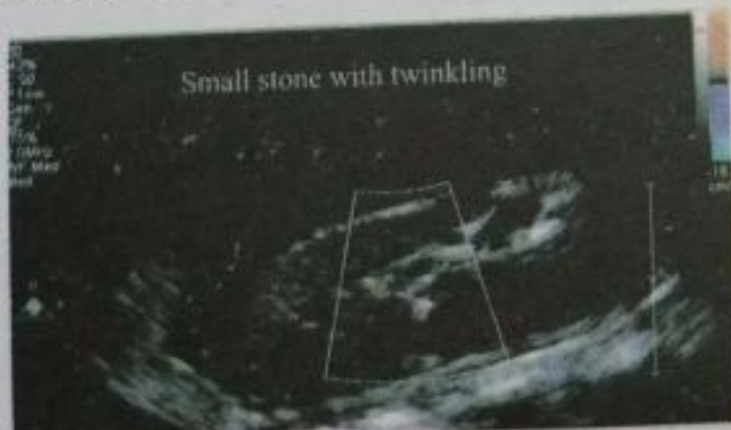


Fig: 1.4 Sonography or ultrasound is being used as an effective way of monitoring the development of fetus in the mother body.

The Laser technology is used to kill the cancer cells and also has its applications in the field of microsurgery.

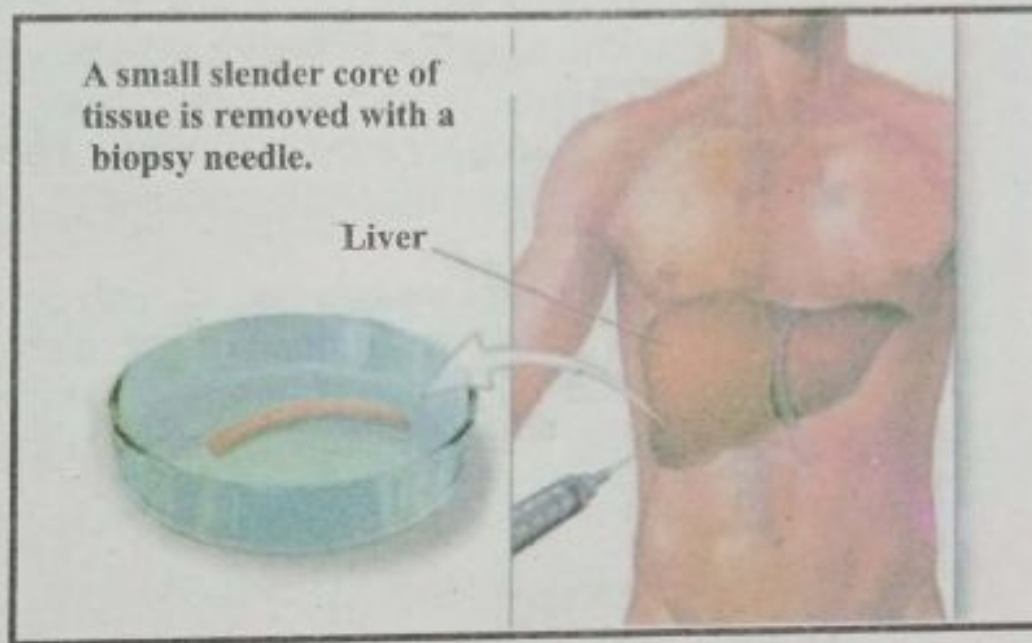


Fig: 1.5 A biopsy is a medical test involving the removal of cells or tissues for examination.

Treatment of retina with the help of laser is an example of microsurgery. The repair of the heart valves, the bypass grafting and the use of pace maker is very helpful to heart patients.

The field of transplant of organs has also gained great importance. Transplant of eye, heart, kidneys and lungs is now a common feature.

Although at present we have not been able to find cure for a number of diseases, yet it was the scientific attitude of the scientists which made possible the control and cure of several fatal diseases. Vaccination against various diseases is considered as a major step towards the development of healthy future.

Same is the case with communication technology. People are in touch with each other even if they are separated by thousands of kilometers. Telecommunication has been greatly facilitated by the use of inter-continental satellite system.

Internet has revolutionized our life. Rapid land and air traveling has become possible. Energy has been vital for human activities. New energy resources have been discovered. Alternate form of energy resources have been identified keeping in view the limitation posed by the fossil fuels.

In this short account we saw how human curiosity lead to the identification of problems and their possible solutions which has ultimately made our life comfortable, healthy and more secure and our living standards have risen with the passage of time.

1.3 Contributions of Muslim Scientists

Muslim scientists and scholars have contributed immensely to human knowledge especially in the period between 7th and 13th century. A brief contributions of a few Muslim Scientists are given below briefly;

a. Jaber bin Hayyan (722 – 817 A.D)

Jaber bin Hayyan is considered to be the father of chemistry. He had established his own laboratory.

He invented sulfuric acid, nitric acid, hydrochloric acid and several other important compounds.

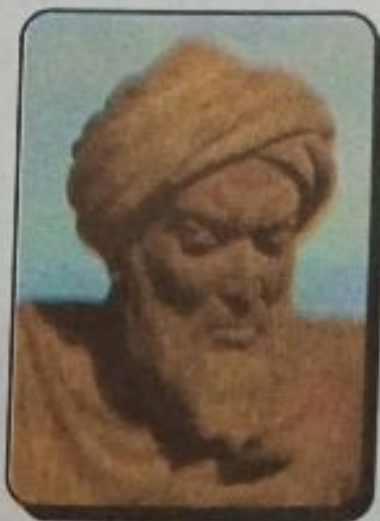


Fig: 1.6 Jaber bin Hayyan

Jaber bin Hayyan defined chemical reactions as union of the elements together in small particles too small for the naked eyes to see without loss of their character, as John Dalton (1766-1844), the English chemist and physicist discovered this reality ten centuries later.

His contribution to chemistry also includes some important scientific techniques such as crystallization, distillation, sublimation and evaporation.

b. Muhammad bin Zakriya Al- Razi (865 – 930 A.D)

Muhammad bin Zakriya Al –Razi was a great physician of his time. Before learning medicine, he studied philosophy, alchemy and music. At an early age he gained eminence as an expert in medicine and alchemy. Patients and students flocked to him from distant parts of Asia.

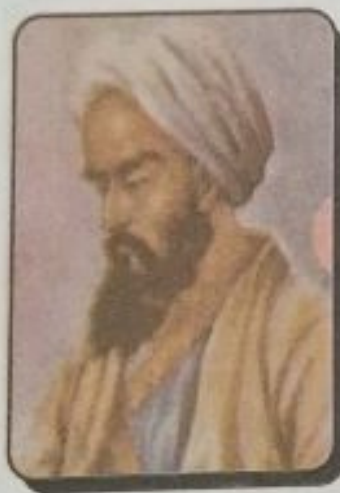


Fig:1.7 Muhammad bin Zakriya Al- Razi

One of his landmark contribution is Al-Hawi. It was the largest medical encyclopaedia ever composed till that time, containing all important information that was available from Greek and Arab sources.

Another major contribution is Kitab al-Mansuri fil-tibb. In this book he has written about the diseases, their symptoms and treatment. He was the first to discuss the details of small pox and measles. His books were translated into Latin, French and English. Al-Razi was the first man who used opium for anesthesia.

c. Ibn-ul-Haitham (965 – 1039 A.D)

Ibn-ul-Haitham is a renowned physicist of all times. He gave the basic principles of reflection and refraction of light. He worked on lenses and explained the working of eye. His famous book "Kitab-Al-Manazir" was translated into Latin. He is considered the father of optics.

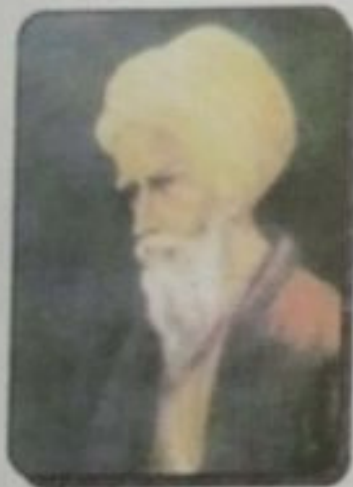


Fig:1.8 Ibn-ul-Haitham

d. Al-Bairuni (973 – 1048 A.D)

Al-Bairuni was a great scholar of physics, mathematics, geography and astronomy. He travelled through subcontinent and recorded his observations in his famous book "Kitab-ul-Hind".

In another famous book, "Qanoon-al-Masoodi Fil Hayat wan-Najoom" he has discussed astronomy, solar and lunar motions. He has written more than 150 books on various topics.



Fig:1.9 Al- Bairuni

His major contribution was to determine the diameter of Earth. His observatory was located in district Jehlum of Pakistan

e. Bu- Ali- Sina (980 – 1037 A.D)

Bu-Ali-Sina was the greatest scientist of his time. He wrote more than 100 books about medicine, science, philosophy and literature. His famous book about medicine, "Al- Qanoon Fil-Tib" was prescribed as a text book in medical institutes of Europe till 17th century.



Fig: 1.10 Bu- Ali- Sina

In another famous book "Al- Shifa" he made useful contributions to physics, chemistry, arithmetic, biology and even music.

Ibn Sina was also the first physician to describe meningitis (Meningitis is a bacterial infection of the membranes (meninges) covering the brain and spinal cord), parts of the eye, and the heart valves, and he found that nerves were responsible for perceived muscle pain.

1.4 Important Contributions of Peoples and Cultures to Scientific Innovations

The history of science is as old as human. The growth of science is a gradual process and it has taken a very long period of time to achieve the present status. The growth of scientific processes can be divided into four periods.

a. Greek Period (300-600 BC)

During this period great philosophers and scientists contributed a lot to the knowledge of science. Aristotle, Archimedes, Galen and Pythagoras are a few important names of this period. Greeks were the first to try and develop the theory on the basis of their observations. Pythagoras concentrated on a mathematical view of the world. Aristotle and Plato developed logical methods for examining the world around them. Similarly, it was the Greeks who first suggested that matter was made up of atoms — fundamental particles that could not be broken down further.

b. Muslim period (700-1300 AD)

The Muslim thinkers and scientists made valuable contributions to the field of chemistry, physics, medicine, mathematics and astronomy. They took full benefits of the Greek contributions and added their own research and observations to make it more logical. Jaber bin Hayyan, Muhammad bin Zakriya Al-Razi, Ibn-ul-Haitham, Al-Bairuni and Bu-Ali-Sina are a few great names of the Muslim period. Their contributions to Science have been already discussed.

The most important contribution of Muslim Scientists was their practical and experimental approach to solve scientific problems.

c. European Period (1700-1900 AD)

During 17th to 19th century scientific studies and research was conducted in European countries. The European scientists took great advantage of Muslim work. Many books of Muslim scientists and scholars were translated into English, French and German languages. These books are still available in the libraries of these countries.

It was in the 17th century that modern science was really born, and the world began to be examined more closely, using instruments such as the telescope, microscope, clock and barometer. It was also at this time that scientific laws started to be put forward for such phenomena as gravity, motion and the relation of volume, pressure and temperature of a gas. Much of basic biology and chemistry was developed in this period which is called as the Age of Enlightenment.

The 19th century saw some of the great names of science: people like John Dalton, who developed the atomic theory of matter, Michael Faraday and James Maxwell who both put forward theories concerning electricity and magnetism, and Charles Darwin, who proposed the (still) controversial theory of evolution.

d. Recent Period

In the 20th century the growth of scientific knowledge has been marvelous. It has revolutionized the human life. Super computers, genetic engineering, laser surgery and transplantation of human organs are the major achievements of 20th century. Nuclear energy and space invasion has opened new dimensions of scientific achievements

SOME EMINENT PAKISTANI SCIENTISTS

Dr. Abdus -Salam was born in 1926. He was a world fame physicist and was awarded Nobel Prize. His contribution was the presentation of theory of unification of two of four basic forces governing the universe. It was the great achievement in the discipline of physical sciences.



Dr. Abdul Qadeer Khan was born in 1936. He is the world fame Pakistani nuclear scientist, who excelled in the field of enrichment of uranium. Along with other scientists he successfully tested the nuclear devices at Chaghi in Balochistan on May 28, 1998. He established Kahuta Research Laboratories (KRL).



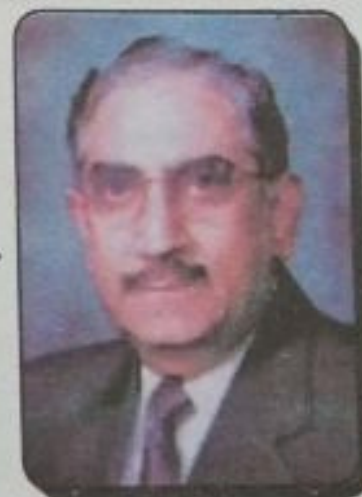
Dr. Ashfaq Ahmad Khan was born in 1930. He is an eminent nuclear scientist of Pakistan and remained chairman of Pakistan Atomic Energy Commission for 10 years. He established Global Change Impact Studies Center (GCISC). In recognition of his services, he was awarded the highest civil award of Nishan-i-Imtiaz by the Government of Pakistan.



Dr. Munir Ahmad Khan was born in 1926. He participated in various courses of International Institute of Nuclear Technology. He also served the International Atomic Energy Agency (IAEA) in Vienna. He contributed in the development of Science and Technology by the way of associating himself in the establishment of various research and teaching organizations including PINSTECH and Centre for Nuclear Studies.



Dr. Samar Mubarak Mand was born in 1942 in Rawalpindi. He joined Pakistan Atomic Energy Commission in 1962. During his professional carrier, he earned specialization in Application of Lasers, Fiber Optics Technology, Nuclear Instrumentation, Nuclear Diagnostics and Missile Technology.



1.5 Islam and Science

The Islamic world was in the midst of its "Golden Age," between 7th to 13th centuries paving the way for the growth of modern sciences. Rather than stifling science, the religion of Islam encourages its study.

In Islamic era scientific inquiry was widespread, and some of the greatest scholars and scientists of the world made unprecedented discoveries and inventions. Muslims led the world in the study of medicine, astronomy, mathematics, geography, chemistry, botany, and physics. They transmitted their studies to the West, where their work was built upon and further disseminated.

Islamic teachings are of universal and everlasting values. In the Holy book "Quran" great emphasis has been laid on the acquisition of knowledge. We find several verses in Quran that stimulate the man to seek knowledge and to ponder over the various processes and phenomena occurring in the universe and also exploring oceans, space, heavenly bodies etc.

The Holy Quran invites the man to travel and search the hidden realities of universe. The basic laws that govern the vital processes of life were explained in the Holy Quran.

There is no better example of close link between Islam and acquisition of knowledge than the saying of Prophet Muhammad (PBUH), "to acquire the knowledge is the duty of every Muslim man and woman".

Following are a few verses from Holy Quran that stress the acquisition of knowledge and search.

The Qur'an calls upon Muslims to look around them and study the physical world, so that they might appreciate the majesty of Allah's creation:

"Behold! in the creation of the heavens and the earth; in the alternation of the night and the day; in the sailing of the ships through the ocean for the benefit of mankind; in the rain which Allah Sends down from the skies, and the life which He gives therewith to an earth that is dead; in the beasts of all kinds that He scatters through the earth; in the change of the winds, and the clouds which they trail like their slaves between the sky and the earth -- (Here) indeed are Signs for a people that are wise.

"(Surah Al-Baqarah 2:164

"They ponder over the creation of earth and heavens (skies)"

(Sura Al -Imran, Ayah: 191).

"Indeed, the Creation of earth and heavens (skies), the difference of day and night, are the indications for the wise and intelligent"

(Sura Al -Imran, Ayah: 190).

"And He is the Allah, who created every living thing from water, out of them, some crawl, some are tetra-pods (four legged) and some are bipedal (two legged). Allah creates what he pleases. He the almighty and creator"

(Sura Nur, Ayah: 45).

Science is studied keeping in view the principles of scientific method. Scientific method is limited to a process which is measurable and repeatable. By definition, it cannot speak to issues of ultimate origin or morality. For such answers, science is dependent on the values and personal beliefs of those who use it. Science, therefore, has great potential for both good and evil. It can be used to make vaccines or poisons, nuclear power plants or nuclear weapons. It can be used to clean up the environment or to pollute it.

Science by itself offers no moral guidance or values to govern our lives. All science can do, is to show how natural law works, while telling us nothing about its origins.

Mankind has never devised a better tool for solving the mysteries of the universe than science. However, there are some kinds of questions for which scientific problem solving is not suitable. In other words, **science has limitations**.

There are three primary areas for which science can't help us answer our questions. All of these have the same problem: The questions they present don't have testable answers. Since testability is so vital to the scientific process, these questions simply fall outside the venue of science.

The three areas of limitation are;

1. Science can't answer questions about value. For example, there is no scientific answer to the questions, "Which of these flowers is prettier?" or "which smells worse, "Which is more valuable, one ounce of gold or one ounce of steel?" Our culture places value on the element gold, but if what you need build a skyscraper with then off course gold, a very soft metal, is pretty useless. So there's no way to scientifically determine value.

2. Science can't answer questions of morality. The problem of deciding good and bad, right and wrong, is outside the determination of science.

3. Finally, science can't help us with questions about the supernatural. The prefix "super" means "above." So supernatural means "above (or beyond) the natural world phenomenon."

The toolbox of a scientist contains only the natural laws of the universe; supernatural questions are outside their reach.

1.7 Process by which accepted ideas are challenged or extended by Scientific Innovation

Science is more than a body of knowledge and way of developing and validating that knowledge. It is also a social activity that reflects human values, including curiosity, creativity, and skepticism.

Scientific inquiry as both content and as a process for learning provides opportunities for students to develop critical thinking, and deepen their understanding of science contents.

Science is continually changing, though, and some innovative science ideas can challenge and even unseat widely accepted historic ones.

Scientific knowledge is based upon observations of the natural world. While some scientific ideas are theoretical and are derived from logic and reasoning, all scientific ideas must ultimately conform to observational or experimental data. Quantitative and qualitative data, forms foundation for scientific knowledge.

Scientific knowledge is both reliable and tentative. It should not be viewed as absolute, but tentative and revisionary. For example, many scientific ideas have remained largely unchanged over long periods of time; however, scientific knowledge can change in light of new evidence and new ways of thinking. New scientific ideas are subject to skepticism, especially if they challenge well-established scientific ideas. Once generally accepted by the scientific community, scientific knowledge is durable. Therefore, it is reasonable to have confidence in scientific knowledge.

Scientific knowledge is the product of creative thinking. Scientists do not solely rely on logic and rationality. In fact, creativity is a major source of inspiration and innovation in science. Scientists often use creative methods and procedures throughout investigations. Scientists use many methods to develop scientific knowledge. There exists no single "scientific method" used by all scientists. Rather, scientists use a variety of approaches to develop and test ideas and to answer research questions.

Principal strength of scientific knowledge is that it can change as needed and required to better fit existing data. However, it is important to realize that change in science is not arbitrary. Scientific knowledge changes only as a result of further inquiry, debate, collaboration, and evidence. Thus, changes in science move our understandings toward important "truths" about the natural world.

Although these truths should not be viewed as absolute or final, they are among the most reliable that we have at any given point in time. No other means of inquiry has proven more successful or trustworthy. One need only consider the advances in science-related fields such as medicine, agriculture, and engineering, for verification that science works.

1.8 Relationship between Different Branches of Science

Science is referred to as a system of objective knowledge obtained through deep researches done by the human being. In the scientific process observations, reasoning and experimentation are the basic tools. With the help of scientific methodology, the scientists have described many objects and solved many problems. Science is applied in every field and every aspect of life.

With the help of scientific inventions and techniques, we have got all the latest facilities and high living standards. To make the scientific knowledge more systematic, it has been divided into several branches and sub-branches.

1.9 Pure and Applied Sciences

The sciences that describe the physical universe are categorized in different ways. The largest distinction in science is whether a science is pure or theoretical or whether it is applied or practical. Pure science explains a phenomenon, while applied science determines how a particular phenomenon may be put to use. In general, pure science is divided into the following categories:

- Physical sciences, which deal with matter and energy and allow us to describe the material universe in terms of weight, mass, volume and other standard objective measures.
- Earth sciences, which explain the phenomena of Earth, its atmosphere, and the solar system to which it belongs.
- Life sciences, which describe living organisms, their internal processes and their relationship to each other and the environment

The physical science is associated with the nature and behavior of energy and matter. Physics includes the study of time, light and gravity. Chemistry deals with the properties, composition, structure and reactions of the matter. Astronomy involves the study of the universe beyond the earth. The earth science that involves the study of structure and composition of the earth includes different branches such as geology, oceanography, meteorology, paleontology, etc. Life science is also known as biology, which deals with the study of evolution, development, distribution, origin, structure and function of the living things. It is categorized into different branches such as botany, genetics, zoology, medicine, etc. The mathematical science involves different branches such as arithmetic, algebra, geometry and calculus.

However, these three categories of pure science have areas of overlap, where one type of phenomenon may be associated with another. For example, light (studied in physics) is the energy source behind the (chemical) process of photosynthesis, or food production, in plants (studied in biology). For this reason, distinctions between pure sciences, and even between pure and applied sciences, can blur, and a new compound science can develop. An example of this is biochemistry, in which the chemical processes of living things (such as photosynthesis, blood chemistry etc.) are observed and explained. Other examples are biophysics, biostatistics and environmental chemistry.

Science and technology (S&T) influence society as never before. Scientific achievements continue to push back the frontier of knowledge and increasingly contribute to the technological progress that affects how we live and work. New technologies help to protect the environment, to build safer homes, schools and factories, and to develop energy-saving transport systems. Advances in genetics save lives and improve health standards throughout the world.

Information and communications technologies (ICT) have enhanced productivity in the advanced economies and made it possible for a greater number of individuals, firms and countries to take part in the knowledge-based economy.

Continuing progress in biotechnology, nanotechnology and Information Technology, including broadband technologies, promises further improvements in living standards and economic field.

For Your Information

Nanotechnology is the study of manipulating matter on an atomic and molecular scale. It deals with developing materials, devices, or other structures possessing at least one dimension sized from 1 to 100 nanometres.

KEY

POINTS

- Science is an organized form of knowledge obtained by observation and experimentation. It is the knowledge, which is systematic, tested and brought under general principle.
- Curious nature of man has led him to wonder, ponder and then learn. It is curiosity in man's nature which drives him to understand different phenomena in life.
- The word science is originated from Latin word "Scientia", which means to know.
- Science can help us in predicting various phenomena and facts
- The Holy Quran lays emphasis on acquisition of knowledge.
- Muslims scientists and philosophers have made many contributions in various fields of science.
- All the branches of science are inter related to each other.
- Science is playing an important role in improving our living standards.
- Although science is successful in achieving certain goals but it has certain limitation also.

KEY POINTS

- The sciences that describe the physical universe are categorized in different ways. The largest distinction in science is whether a science is pure or theoretical or whether it is applied or practical.
- Science and technology (S&T) influence society as never before. Scientific achievements continue to push back the frontier of knowledge and increasingly contribute to the technological progress that affects how we live and work.
- Information and communications technologies (ICT) have enhanced productivity in the advanced economies and made it possible for a greater number of individuals, firms and countries to take part in the knowledge-based economy.

A. Select the best answers for the following questions.

- 26

- 27

- a. Life Science
- b. Earth Sciences
- c. Physical sciences
- d. None of these

B. Answer the following questions in detail.

1. Define science? Describe how the nature of science makes it different from other modes of knowing?
2. Write the contribution of three famous scientists of Pakistan.
3. Muslims scientists made significant contributions in the field of Science. Write some of the prominent contributions of Jaber bin Hayyan, Bu-Ali-Sina and Ibn-ul-Haitham in the field of Science.
4. Do you think The Holy Quran give due importance to the acquisition of knowledge and it compels its reader to ponder over the various processes and phenomena occurring in the universe. Support your answer by quoting some verses of The Holy Quran.
5. Give detail account of different branches of science and their interrelation ship with each other.
6. List down some of the important developments in the medical field which have provided relief to humanity.
7. What is the contribution of developments taken place in the field of agriculture and medicines for the welfare of mankind.
8. Write some important contributions of Greek in the field of science.