KUNTHAVAI NAACHIYAR GOVT. ARTS COLLEGE (WOMEN), THANJAVUR

I MA HISTORY, SECOND SEMESTER

HISTORY OF SCIENCE AND TECHNOLOGY

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UNIT I

Development of Science and technology in Ancient Greece

- Greece was the mother of European Science and modern ideas. The scientific spirit developed by the Greeks 2500 years ago laid the foundation for the future European civilization.

- Greek Science arose in the district called Ionia, a strip of land on the west coast of Asia Minor and a group of nearby islands. From about 600 B.C., the Greeks made progress in philosophy and geometry. In this period Ionia became a renowned centre of learning.

- The wise men of Ionia had an unquenchable thirst for knowledge. They sought reasonable explanations for everything and considered science as a part of philosophy.

- The first great Ionic philosopher was Thales of Miletus (C.625-42 B.C.). He believed that all things were made of water.As an astronomer, he learned much about eclipses. His ideas influenced the development of science to a great extent.

- Another man of Miletus, Anaximanes (611 - 547 BC) lived in the sixth century B.C. He believed that the earth was in the form of a flat round disc, floating in a sea of air and that the heavenly bodies revolved around it. He made sundial to calculate time. He stated that the earliest organism lived in water and later it passed to dry land.

- Democritus of Miletus who lived in the fifth century B.C was famous for his atomic theory. He developed the idea that the world is made up of infinitely small particles. According to him atoms differed from one another in shape and size.

Pythagoras (582 - 500 B.C.)

- The most important factor that acted as the main reason for the development of science in Greece in the early days was the great interest in science shown by the curious group known as Pythagorean brotherhood.

- It was once a religious cult, a philosophical school and a political movement. The founder of the group, Pythagoras was born in Samos, an island in the Aegean Sea, in the early part of the sixth century B.C.

- The Pythagorean brotherhood continued to be powerful till 500 B.C. The Pythagoreans devoted themselves to mathematics and they believed that its principles were the basis of everything. Steeped in geometry, the Pythagoreans sought to express numerical relation by means of geometrical figures.

- The Pythagoreans investigated certain numbers as triangles and others as squares. They made many solid contributions to learning, particularly to mathematical knowledge. One of their best known demonstrations was the right triangle. In a right triangle, the longest side, the one opposite to the right angle is called hypotenuse. The Pythagoreans showed that the square of the hypotenuse of a right triangle is equal to the sum of the squares of the other two sides.

- They showed that the equation worked in all cases. It is still called a Pythagorean Theorem, The Pythagoreans worked on many theorems which are still to be found in the geometry text books.

Hippocrates (460 - 377 B.C.)

- Hippocrates was an eminent Greek physician who developed medicine into science. He was the first and the most famous of the Greek physicians who formed a school of medicine He was a contemporary or a near contemporary of Plato and Aristotle.

- This renowned physician freed medicine from superstition and speculative hypothesis. Born in the island of "Cos" in the Aegean Sea about 460 B.C., he showed interest in medical science, as his father Heraclides belonged to the guild of physicians. He travelled extensively throughout Greece and Macedonia.

- His main medical works were "Epidemics I and III. Regimen in Acute Diseases and Prognostic". Hippocrates stressed the importance of careful observation and classification of clinical medicine. According to him, the proper understanding of the human body was the basis of medical treatment.

- The general principles to be followed in the case of acute fever are written in his book. In the second group of treatise he writes largely about the technical work on wound in the head, fractures and joints. Another group of books included essays, incomplete work, compilations representing highly speculative theories on physiology and diseases.

- Diagnosis was the central point of Hippocratic doctrine. In the early days, illness and health were thought to be determined by the gods. Though Hippocrates did not deny the existence of gods, he challenged the doctor-priests by claiming that every disease was natural and had a natural cause.

- He set out to cure illnesses using his knowledge of natural sciences. In one of his books, Ancient Medicine', he pointed out the importance of a patient's diet in the healing process. He first suggested that diseases were caused by changes in the weather, nature of water and imbalances of four humours of the body.

- Hippocrates laid down a code of conduct for the medical practitioners and it is still taken by graduates of a great number of medical schools, The code of conduct is popularly called "Hippocratic Oath" For his valuable contribution to medical science, he has been called the "Father of medicine").

Socrates (470 - 339 B.C)

❏ In the fourth century B.C., Greek philosophy reached its peak with the arrival of intellectuals like Plato and Aristotle. The large city-state of Athens was the centre of the golden age of philosophy.

❏ The philosopher, Socrates (470-399B.C). an Athenian, was the creator of a method of inquiry and dialectics He was a great scholar and a popular teacher. He advised the people not to accept anything blindly.

❏ He believed in honest, free and frank thinking. His teachings came very close to the heart of true scientific methods. One segment of the Athenians felt that his teachings were dangerous.

❏ In 399 B.C. he was officially accused of introducing strange Gods and was brought to trial. Athens condemned him to death. He was ordered to drink 'hemlock'. a dangerous poison. He has become immortal for his views and courage. His teachings were written and preserved by his students.

Plato (427-347 B.C)

➔ Plato, a disciple of Socrates was one of the greatest thinkers of all times. Born in Athens, Plato was the son of Ariston and Perictione, who belonged to important Athenian families.

➔ Plato stressed the importance of inquiry of mathematics as a tool to explore the interdependence of different fields of knowledge. consequently he decided to establish a school.

➔ Plato returned to Athens with the inspired idea of establishing a school of learning and explored the systematic interrelation of various branches of knowledge. As a result, an academy was formed in Athens in 387 B.C., the first university in the Western world.

➔ The systematic pursuit of philosophical and scientific research was carried out in this academy. Plato was interested in the science of mathematics, especially geometry and thought that mathematics formed the basis of all systems of thought.

➔ He took his mathematical ideas from the writings of Pythagorean and came to believe that the entire universe was constructed upon numerical relationship. These fundamental ideas were incorporated in his own philosophical systems.

➔ Like other mathematicians of the day, Plato believed that different kinds of matter that appeared to the eye were governed by some basic laws. These matters, realised by our senses, are the real world of ideas.

➔ These ideas give meaning and substance to new thinking Plato said that senses do not impart truth and that knowledge is the gateway to truth. It is possible to attain truth only by attachment to knowledge which gives general and not individual notions.

➔ The internal thought and the external well being are similar. (The motto of philosophy is the attachment of wisdom. This new understanding and thinking of the Greek is to have a high value of philosophy.

➔ Plato's successful ideal was mathematical corpuscular physics. He constructed the physical world without matter in the form of ideas as a metaphysical structure (fle introduced logic into the study of mathematics, He was also interested in astronomy, because he held that the heavenly bodies and their movement in heaven were perfect examples of geometric forms.

➔ As a mathematician he expressed quality in terms of numerically determined quantity. In this sense he stood nearer to modem physical science. The details of cosmology, physiology and psychophysics of the Dialogues are of great importance for the history of science. Plato says that the qualities of a horse makes an animal. a horse.

➔ Similarly all living things have a common code. The greatest common code is beneficial to man and the benefit is the basis for all other codes. Only philosophy could identify the status and relationship of the codes.

Aristotle (384-322 B.C.)

- Plato's work was often criticised by Aristotle, his student. He was a great Greek philosopher, psychologist, logician, political thinker, biologist and the founder of literary criticism. He was born in a Greek colonial town Stagira on the north western shores of the Aegean Sea in 384 B.C.
- He was the son of Nicomachus, a doctor who served as court physician to Amyntres II, the father of Philip of Macedonia. Aristotle became a pupil of Plato at the age of seventeen at the Academy of Athens, He worked for twenty years with Plato. Sometimes after 347 B.C. he was called to the court of Macedonia where he became tutor to young Prince Alexander.

- More than 400 separate treatises were attributed to Aristotle by ancient scholars, but approximately only 50 have survived under his name. Aristotle possessed the spirit of enquiry and touched all branches of knowledge.

- Aristotle examined the biological structure of living things and devised a classification for all kinds of plants and animals. Later, he took a similar approach to weather, metaphysics and logic, human society, human behaviour and poetry.

- In each case he collected and arranged evidence. Then he drew up distinction and classification and finally arrived at a general conclusion. His observations were balanced, showing the correct view, supported by evidence. His work was inspired by common sense and diagrams were used to illustrate the different points.

- Within the field of biology, his greatest contribution was the observation and classification of animals, their compound parts and their behaviour. To classify the animals, he effected an arrangement and classification on the basis of reproduction.

- Another form of classification of animals was with reference whether they were with blood or without blood are cited in broader terms. Each biological specimen may be concerned not merely with sex and hereditary but also with environmental factors and fight for survival.

- He analysed the various functions and behaviours of the animals in the light of the particular organs and parts of the animals. In addition to analysing generations, he examined the locomotion, growth and nutrition of human beings.

- Though primarily a philosopher, Aristotle is considered the Father of Science'. For almost two thousand years after his death, Aristotle reigned as the supreme authority in scientific matters. In the Middle Ages when interest in scientific experiment and direct observation was at a low ebb, Aristotle's word was law.

- Under these circumstances the errors of Aristotle, particularly in astronomy held up scientific progress for physics and astronomy held centuries till Galileo and Newton. Aristotle laid down the principles on which science was pursued for centuries.

- When these principles were forgotten in Europe, the Arab world preserved them. In the thirteenth century Arab scholars in north Africa, Sicily and Spain returned to the West. These scientific works formed the groundwork for the development of science in modern times.

Alexandrian Library

- Ptolemy, was a patron of learning and he instituted the famous library at Alexandria. The Alexandrian Library was the most celebrated library in antiquity and was the largest library of the ancient world. Ptolemy 1 (323-285) founded the Museum seat of Muses) and an academy where the arts and sciences were cultivated.

- It included a library that became the finest library in the ancient world. He inaugurated the library with the works "Corpus Hippocraticum" of Hippocrates and ten thousand other manuscripts brought from Greece. The museum was conceived as an international academy.

- The Library had collected works of Greek philosophers, Plato, Macedonian philosopher, Aristotle, Athenian historian, Thucydides, Hippocrates, Father of Medicine and the great geometrician Euclid. Callimachus, Hellenistic poet became the Father of Library sciences, by being the first writer of a catalogue of books classified by topic and author.

- During the reign of the second Caliph (634-644 A.D.) Omar, the books were used as fuel to heat the city's 4,000 baths for six months. Thus many priceless treasures of learning were destroyed. Large parts of the library perished and Alexandria took a much lower rank in learning.

Mathematics

❖ The greatest victories of Alexandrian science were in geometry. The first scholar to win fame at Alexandria was the mathematician Euclid who flourished about 300 B.C. He studied at the Museum of Alexandria. This Greek mathematician's work "Element of Geometry" is the basic work of geometry.

❖ Diophantus who lived in the third century A.D has been called the Father of algebra. His treatise entitled 'Arithmetica' is really the first known treatise on algebra.

Astronomy and Calendar

★ Astronomy was another area of discovery made by the Alexandrian scientists. Aristarchus (280-264) B.C, of Sames maintained that the planet revolved in a circle around the sun which was the central fire.

★ His treatise on "Size and Distance of the Sun and the Moon" deals with astronomical ideas. His book contains heliocentric theory which won for Aristarchus the title "Copernicus of Antiquity". He correctly calculated that the moon was smaller than the earth.

★ Hipparchus of Nicaea (in Bithyma) who lived in the second century B.C, was one of the greatest astronomers of antiquity.

★ He put together a new catalogue of stars for the benefit of future astronomers. In 192 B.C, he made a catalogue, a map and a globe of the heavens and gave position of 1080 stars in terms of celestial latitude and longitude.

★ He clarified these stars in six magnitude according to the degree of brightness-a system that is still in use in modified form.

Medical Science

➢ During the period of Ptolemies, Alexandria became a well-known centre of medical science. The Alexandrian school of medicine flourished as a separate science under the Ptolemies.

➢ Herophilus distinguished arteries from veins and found that arteries carrying blood from the heart to various parts of the body. He discovered the circulation of blood.

- ➢ Erasistratus of Chious was a younger contemporary of Herophilus. He was born in Ceos, studied in Athens and practised medicine in Alexandria about 258 B.C.

- ➢ He was a famous physiologist and was considered as the Father of Physiology.

Archimedes (287 - 212 B.C)

- ➔ Archimedes was a greatest Greek mathematician, physicist and inventor. He founded the fields of statics and hydrostatics. He invented a mechanical device useful in times of war and peace.

- ➔ He also invented Archimedes screw, a device for raising water, the compound pulley and established the principles of the lever.

- ➔ The discovery of the law of floating bodies and a method for measuring specific gravity was a permanent contribution to physics. The achievements of Archimedes probably made him the foremost scientist until Newton.

- ➔ The greatest scientist Archimedes was born about 287 B.C in Syracuse, Sicily a Greek colony. His father Pheidias was an astronomer. Archimedes was a relative of King Hiero II of Syracuse. Archimedes went to Alexandria, there he studied under the successors of Euclid and derived an inspiration for mathematics.

- ➔ During his stay in Alexandria, he invented a screw for raising water from the Nile to irrigate fields. The Archimedes screw is based on two geometrical forms, the helix and the cylinder.

- ➔ After his return to Syracuse, he devoted himself mainly to science. Ten of Archimedes' works survive which reveal his scientific contribution.

Archimedes Principles

1. Archimedes discovered the fundamental law of hydrostatics, the equilibrium between a floating body and the pressure of the liquid in which it floats.
2. In his treatise “On Floating Bodies”, Archimedes stated that “a body immersed in a fluid is buoyed up by a force equal to the weight of the displaced fluid”.
3. He discovered the principle that “a body immersed in fluid loses much weight as the weight of equal volume of that fluid”. The Archimedes principle is a permanent contribution to humanity.

- Archimedes devoted his attention to every branch of mathematical science and is considered as the greatest ancient mathematician. In his mathematical treatise on "The Measurement of a Circle", he calculated the value of ībetween 3 1/7 and 3 10/7.

- Today the ratio which is represented by the Greek letter II(pi) has been more closely calculated as 3.14159. His best known book is "The Sphere and the Cylinder". Archimedes

proved that when a sphere is inscribed in a cylinder, it is one and a half times as great as those of sphere.

- Archimedes considered this as his foremost contribution to mathematics. He asked to inscribe the symbols on his tomb stone by an appropriate diagram. He also developed treatises on circle, sphere, cylinder, parabola, mechanics and hydrostatics.

- Archimedes established the principle of the lever and studied mechanical laws underlying the lever. Archimedes announced that if he had a fixed fulcrum to work with, he could move anything.

- He proved that a great force could be moved by a little force. Archimedes arranged a series of cogs and pulleys in such a way that he alone sitting at the end of the point was able to draw the loaded vessels out of the water into the land.

- He designed war machines to fight against Roman armies. In 215 B.C a Roman fleet sailed against the city of Syracuse in Sicily. Great catapults hurled massive boulders at the approaching ships. Other ships were lifted clean out of the mechanical claws operated from the shore. Hence the Romans decided to anchor the ships in safe distance from the city.

SCIENCE AND TECHNOLOGY IN ROME

- When the Romans conquered Greece the ancient scientific inquiry of the Greek was continued and practised in the Roman Empire. From the days of their conquest of Greece, an intimate contact was maintained with the Greek people in the third century B.C.

- Many of the Romans had been dazzled by the highly developed culture of Greeks, Rome conquered the world, but the Greek learning conquered Rome. The Greeks were the source of inspiration for the development of science and technology in the Roman Empire.

Julian Calendar

★ The introduction of the Calendar system was the greatest legacy of the Roman Civilization to the world.

★ Julius Caesar took the first step to reform the Roman calendar by adopting the Egyptian calendar. He called upon a famous Greek astronomer Sosigenes of Alexandria and assigned the task of devising a new calendar. Sosigenes gave a calendar of 365 days plus a quarter day of six hours.

★ In this calendar quarter days were withheld from the year until a full day had accumulated. The day was then added to a common year as leap year.

★ This happened once in every four years. This calendar was popularly called Julian Calendar and was adopted for the official use of the Roman empire in 44 B.C. Julian Calendar was followed till 1582 A.D in the West.

Roman Numbers

❑ The number system that was invented in ancient Rome is called Roman Number System. The Roman used seven letters of the alphabet as basic symbols to write any number. Roman system uses the symbol I, V, X to write counting number upto 39.

❑ The symbol V for 5 was derived from the open hand and the thumb being held apart from the open hand represented for I. Two "V"'s placed apex to apex would be given X for 10. There is no symbol for zero in the Roman system.

❑ The number 11 to 39 are split in terms of tens and ones. They used L for 50 and D for 500. C for 100 and M for 1000 which represented the initial letter of the words 'Centum' and 'Mille'.

40 - XL, 50 - L, 60 - LX, 80 - LXXX, 90 - XC, 100 - C

❑ At present along with the Hindu, Arabic numeral system, the Roman numerals are in use in such places as the date of imprint books, the number on the dials of the clock and dates on the cornerstones of many buildings.

- ❏ Thus the Roman numeral system is maintained for 2000 years in commerce, in scientific and theological writings.

Medical Science

The most extensive product of Italian science was the "Historia Naturalis" of Pliny the Elder (23-79 A.D) published in 77 A.D. Pliny was the greatest Roman naturalist, a man who travelled widely and produced an enormous work of scholarship in thirty seven volumes.

Galen (C.130 - 200 A.D.)

- ❖ Besides the calendar system, Romans contributed much to the development of medicine. Galen, the Greek physician in the Roman empire, was the founder of experimental physiology.
- ❖
- ❖ He was a distinguished physician of antiquity after Hippocrates, the father of medicine. Galen was the first physician in medical history, who studied physiology through detailed experiments with animals.

- ❖ In search of knowledge, he roamed through Greece, Cilicia. Phoenicia, Palestine, Crete, Cyprus and finally visited the famous medical school of Alexandria, the renowned centre of the Roman Empire. There he received additional training and completed twelve years of medical studies.

- ❖ In 168 A.D., Galen was ordered by Emperor Marcus Aurelius to proceed to the military base at Aquileia to deal with the plague there. After his return to Rome, he was appointed as court physician to look after the health of the youthful commander, the heir of Marcus Aurelius.

- ❖ This period provided him with the necessary leisure to proceed with his scientific studies. At this time, he wrote an important physiological treatise entitled "The Natural Faculties on the Use of Parts and on Respirations".

- ❖ In 192 A.D., Galen returned to his native place Pergamon and finished his last major work namely "The Art of Healing"

- ❖ Galen's industry was prodigious. His writings comprised about 400 treatises on philosophy, grammar, mathematics, ethics, anatomy, dietetics, pharmacy, pathology as well as commentaries on the works of Hippoicrates.
- ❖ Galen's anatomical investigations were noted for their fullness and accuracy. Although he did not study human anatomy directly, he dissected and carried out numerous experiments on many different animals, especially the tailless monkey called barbary ape.

- ❖ From his studies, he systematised the description of bones and muscles. His physiological experiments were ingenious and sometimes he arrived at false conclusions. Inspite of the defects. the overall value of his book was great in the medical world.

- ❖ Galen demonstrated the relationship of blood flow and the aeration of the blood through the lungs. The valves of the heart are accurately described by him.

- ❖ Galen took the first step towards the correct understanding of body metabolism. He also provided the first theory of kidney secretion and experiments on the nervous system.

- ❖ The anatomists of the sixteenth and seventeenth centuries accepted the names of the structure of the body introduced by Galen through his observations. Thus his works constituted an extensive base for the evolution of modern medicine.

Astronomy and Geography

Ptolemy (100 - 170. A.D.)

- ★ Ptolemy was a Greco-Egyptian mathematician, astronomer and geographer in the Roman Empire. He set forth a geocentric (earth centre) view of the universe, that dominated astronomy until the advent of the heliocentric system (Sun centre) of Copernicus in the sixteenth century.

- ★ His main work was carried out at Alexandria and his astronomical observation was calculated between 127 and 151 A.D. The Arabian traditions claimed that Ptolemy died at the ripe age of seventy eight. Fourteen of Ptolemy's works survive.

- ★ The important among them are The Almagest. Geography, Optics, Analemma, Planisphaerium and Tetrabiblos.

- ★ The major work of Ptolemy was his astronomical work, the Algamest. The book had the mathematical treatment of astronomical phenomena and is one of the most influential scientific treatises from classical times to the scientific revolution by Copernicus.

- ★ This work was written on the basis of observations made by Ptolemy and his predecessors, particularly Hipparchus (150 B.C.). The work explains and illustrates the principle of astronomy in a remarkably clear and orderly way. It consists of thirteen books that deal with the astronomical system of the universe.

- ★ The early two parts of the book are an introduction dealing with Ptolemy's conceptions of earth and heavens and his astronomical methods. He set forth the view that the earth is stationary at the centre of the universe and this view developed the Ptolemic system of the universe.

- ★ Accordingly an explanation of the heavenly bodies and their relation to the earth was described systematically by Ptolemy. In the Ptolemic system the earth was a stationary globe at the centre of the universe around which the sun, the moon and the stars revolved in circular orbits and at uniform rates.

★ In the third part of the book, the method of computing daylight at a given latitude is explained. The next two parts deal with the motion of the sun, the length of a year and the motion of the moon and the length of the month.

★ Book V & VI include Ptolemy's own lunar theory and estimate of the dimension of the moon and the earth. It also explains the compute data of the lunar and solar eclipse. The next two books consist mainly of a catalogue of 1022 stars partly based on the earlier catalogue of 850 stars of Hipparchus.

★ The last five books discuss the motion of Mercury, of Venus, of Mars, of Jupiter, of Saturn and the inclinations of the orbit of the planets, relating to the eclipse and planetary motion in latitude.

★ Ptolemy was also an eminent geographer. His reputation as a geographer is mainly due to his famous work, Guide to Geography, which exerted a great influence on the future generation.

Engineering

- Another rich legacy left by the Romans to the world civilization is engineering. Roman emperors employed Roman Greek and Syrian engineers to construct roads, bridges and aqueducts. They raised heavy loads or stones by pulleys on cranes or vertical beams worked by windlasses or treadmills turned by animals or men.

- The Romans built cities in Italy, Spain, Gaul, Asia Minor, North Africa and England. They built roads to connect cities. These roads covered a distance estimated at 90,000 kms. Besides the main roads, they built 2,00.,000 kms of secondary roads passing through mountains, marshes, tunnels and rivers.

- They were from sixteen to twenty four feet wide. But near Rome additional width of sidewalk was paved with rectangular stone slabs. They were most durable road in history, the bridges that carry these roads were themselves high exemplars of wedded engineering technology.

- The Romans inherited the principles of hydraulic engineering from Ptolemic Egypt. They laid strong foundations and constructed piers under water. Eight bridges were constructed across the river Tiber in Rome is the best example. They built bridges in a hundred thousand streams across Europe.

- The remains of these great roads existed throughout the whole of the Roman Empire and even passed through tunnels. The tunnels which cut through mountains were sometimes two and a half kilometres in length. The method of technology they transmitted remained unchanged in modern times

- The construction of aqueducts were Rome's greatest achievement. The Roman engineers skillfully brought abundance of water into the city for many public and private uses. They marvellously pierced the mountains to construct aqueducts.

- From distant springs fourteen aqueducts totalling 1300 miles brought through tunnels and over majestic arches into Rome some 30,00,00,000 gallons of water daily. Again they knew the technique to drain the sewage water.

- The Romans also perfected the art of erecting buildings. The evolution of their technical knowledge grew independently. In 80 A.D. They built a big auditorium known as colosseum in Rome. Its style was marked by massiveness and strength. By using cement, concrete and marbles, they built arches and storeys. The palaces, amphitheatres and granaries were the monuments of the Roman architecture.

- The Roman Empire which lasted for several centuries till 476 A.D, contributed much in the field of science. They made marvellous contributions in the calendar system, medical science, numerical system, geography and engineering. The Roman roads are a permanent contribution to posterity. The Renaissance architects developed or revived these classical scientific techniques in the fifteenth and sixteenth century.

ARAB SCIENCE

❏ The Islamic scientists of the Middle Ages contributed a lot to modern science. The Roman Empire had been divided in the fourth century into Western and Eastern part. The Westem Roman Empire was overthrown in 476 A.D. which marked the beginning of the Dark Ages.

❏ The Eastern Roman Empire which came to be known as Byzantine Empire. continued till 1453 and preserved the intellectual spirit during this period. Since the languages of the Eastern Empire were Greek, scholars came to have contact with the works of Plato and Aristotle and the other great representatives of Greek thought.

❏ But the Byzantine court was particularly interested in theology studies because science was to be served by a group of heretical Byzantines called Nestorians. They followed the teachings of Nestorius. the patriarch of Constantinople. He died about 451 A.D. He was earlier dismissed from his post for unorthodox views and exiled.

❏ His followers eventually settled in south western Persia and developed an outstanding intellectual movement. They translated the ancient classics, including the works of Aristotle, Hippocrates. Archimedes, Ptolemy and Galen into Syriac.

❏ In the seventh century, the intellectual movement was continued by the entry of a new religious force called Islam.

❏ The Nestorians came to good terms with the Arab conquerors who were greatly impressed by the leaming of the heretical Christians.

❏ In the years that followed the Greek learning was transmitted to the Arabic world chiefly through the . agency of the Nestorians. At first Syriac was the language of science and learning in the Arabic empire.

❏ Then Arabic began to replace Syriac for the purpose. As the Arabs were extensive conquerors, they collected the manuscripts from Byzantium, Persia and India.

- ❏ In the eighth century, during the reign of the Caliph Al-Monsur (753-774), a number of Indian scholars went to Baghdad, and among the books they took with them were works on mathematics and astronomy.

- ❏ They influenced the development of mathematics and astronomy in the Arab world, and Indian numerals were introduced.

- ❏ Caliph Mamun who ruled the empire from 813 10 833 created a famous centre of learning called "House of Wisdom". It consisted of a library, a translation bureau and a school. Mamun sent emissaries as far as Constantinople to collect Greek works and brought them to Baghdad for translation into Arabic.

- ❏ The works of Aristotle, Ptolemy, Galen and other Greek notables were translated into Arabic which proved to be well adapted to scientific writings. One of the foremost Islamic scholars, translated the works of Galen into Arabic.

- ❏ In the ninth century, the Arabs became the chief standard bearers of science and philosophy. The golden age of Arabic science lasted for about two centuries, roughly from 900 to 1100 A.D.

- ❏ Many of the best Arab scientists were neither Arabs nor Muslims. They were Syrians, Persians and Jews who had Arabic names and wrote in Arabic languages.

- ❏ The world owes a great debt of gratitude to the Muslim Caliphs for their support of learning. Between the ninth and fourteenth centuries, Muslim chemists, physicians, astronomers, mathematicians and geographers kept alive the discipline of Greek sciences. Moreover, they extended their range by enriching themselves with new ideas of science. Thus they laid the foundation on which modern science is built. Modern science owes a debt to the Islamic scientists of the Middle Ages.

Mathematics

- The Arabs made important contributions to mathematics, In this discipline, Muslims showed their genius by borrowing their ideas from India and Greece.

- They refined and developed them before passing them to the West. From India they took the numerals, the decimal system and the concept of zero.

- Al-Khwarizmi. His book "Hisab-al Jabr Wa'l-Muquabala" was an easily understandable text on the subject based, to a certain extent, on the Indian mathematicians. The name 'algebra' is of Arabic origin. It comes from "al-jebr" meaning the union of broken parts.

- Another famous Persian mathematician was Omar Khayyam who lived in the twelfth century and solved many mathematical problems.

Astronomy

- ★ The Arabs were greatly interested in astronomy. The Caliph Mamun built a splendid observatory in Baghdad in 829 A.D. His astronomers made regular observations of the heavens.

- ★ The Arabs took keen interest in the planets and the stars, as astronomy was important to religion. They accurately calculated the hours of prayers, the direction of Mecca, the moment of the first appearance of the moon of Ramadan. They discovered new stars by their own efforts.

- ★ Caliph Harun-al-Rasidh (786-809) took an interest in the scientific understanding of the heavens. During his time, an Arab astronomer translated the 'Almagest', the work of the Greek astronomer Ptolemy.

- ★ The most important instrument the Muslim astronomer used was the "astrolabe", a device which they had borrowed from the Greeks.

MEDICINE

- ➔ One of the celebrated Persian physicians of the period was Razi who lived from 865-925. He wrote more than 200 books on medicine, alchemy, theology and astronomy. About half of the books were on medicine which included a well-known treatise on small pox.

- ➔ Be differentiated between specific diseases, which enabled doctors to diagnose and predict the course of disease like small pox and measles.

- ➔ Avicenna (980-1037 A.D.) of Bokhara was an eminent physician. He was the author of a huge medical text book called "The Canon of Medicine".
- ➔ Avicenna summed up the knowledge of medicine inherited from the Greeks and made additional contribution of the chief Arab writers on medicine. The translation of the book became a favourite medical text book in western Europe.

Avicenna (980-1037 A.D.)

- ❖ In 980, a great scientist was born in the eastern part of the Muslim Empire. He was an Arab speaking Persian, better known in history by the name Ibn-Sina and in the West by his Latin name Avicenna.

- ❖ He was a great physician who contributed a lot to the realm of medicine and was influential both in the Islamic world and the Latin Middle Ages. Europe owes him a deep debt of gratitude for his authoritative books on science and philosophy.

- ❖ Ali-Hussain-Ibu-Hussain-Ibn-Sina was born in Afsana in the province of Bokhara in Central Asia. He received his early education there and even at the young age of ten, he memorised the entire Koran. During his next six years, he became proficient in philosophy, mathematics and astronomy.

- At the age of seventeen, he cured Samanide Sultan Aluruddin Manur of Bokhara of a serious disease and became his personal physician As a reward, he was given the free use of the rich and well-equipped royal library.

- The young scholar had a special aptitude for medicine and made a systematic study of subjects He was able to establish an extensive medical practice. His reputation for scholarship and learning spread far and wide.

- After the collapse of the Samanide empire in 999 A.D., he left the place. Then he acted as Vizier to Hamdanide Sultan Sham Abdulla. In 1024, the ruler of Isfahan captured the Hamdan kingdom. Under the new ruler he was admitted as a Royal physician.

- He spent the remaining thirteen years of his life in the company of Ala-ad-Daula, the ruler of Isfahan, till his death in 1037 at the comparatively early age of fifty eight after treating himself unsuccessfully for an illness.

- His enemies, jealous of his vast knowledge and great fame, observed that his medicine could not save his body from death. He was buried in Hamdan where his grave is still to be seen.

- Avicenna was the most celebrated scientist of Islam. He systematised all contemporary scientific learning and laid down the fundamentals of various physical sciences. They were regarded as standard principles for several centuries.

- He wrote some 170 books on Philosophy, medicine, mathematics, astronomy and poems as well as religious works. Avicenna's most renowned achievement was "Canon of Medicine" (Al-chaun-tit-Tibb) a systematic encyclopaedia on medicine. It is an encyclopaedia of medical and surgical knowledge divided into five parts. The first two parts deal with physiology and hygiene.

- The next two deal with the method of treating diseases and the last one describes the composition and preparation of the appropriate remedies. They also cover his personal observation concerning the courses of various diseases.

- In this book all medical science of the Greeks was systematically composed and later the contributions of the Arab medical books were added. It deals with every phase of the treatment of diseases.

- No other medical work of its kind was studied so widely from the twelfth to the seventeenth centuries. The work became extremely popular not only in the Islamic world, but also in the West.

- The book was translated into Latin in 1187 A.D. and soon it became the text book for medical education in all the countries of Europe right upto the year 1650 A.D. This great book served as the chief guide to medical science in the West. It was the basis of lectures on medicine in European universities.

- The book was comprehensive in describing the discoveries of others. Its popularity was realised, when it had been printed fifteen times before 1500.

- Avicenna is credited with personal contribution to medical science as he has recognised the contagious nature of tuberculosis and certain skin diseases. He observed the psychological disorders and their effects. The diagnosis he made was the loss of weight and strength, fever and various chronic ailments.

- According to him, the cure was simple, once the correct diagnosis was made. He was the first to discover that certain diseases could be spread by water and soil, an advanced view of his time. For the treatment of cancer, Avicenna gave advice to remove the diseased tissue in its early stage.

- Another great book of Avicenna was "Kitab-ul-Shifa" (The Book of Recovery), a scientific and philosophical encyclopaedia including treatises on physics, mathematics,ethics, economics and politics.

- Thus Avicenna made immense contributions to medical science. He has been rightly called the "Prince of physicians" of the Medieval period.

Unit : II

Renaissance and birth of Modern Science

I. Progress in Astronomy.
   i. Nicholaus Copernicus.
   ii Johannes Kepler.
   iii Galileo Galilei.

II Progress in Technology
   i. Johann Gutenberg
   ii Leonardo da Vinci.

III Progress in Medical Science.
   i. Andreas Vesalius.
   ii William Harvey.
   iii Joseph Lister

IV. Physics.
   i. Isaac Newton.

V. Biological Science
   i. Charles Darwin.

Prepared by
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I Progress in Astronomy

i Nicholaus Copernicus [1473-1543]

Introduction:-

Nicholaus Copernicus a Polish astronomer, founded modern astronomical science and he formulated his world shaking Heliocentric Theory — the theory says that the Sun, Helio, in Greek is the centre of the Solar System.

Early Life:-

He was born in 1473 at Thorn on the Vistula river in Poland. He studied mathematics, astronomy, law and medicine at Cracow, Bologna, and Padua. In 1503 he received his doctorate from the University of Ferrara.

Achievements:-

In his major work "The Revolution of Heavenly Spheres", he maintained that

i. The earth is not the centre of the Universe.

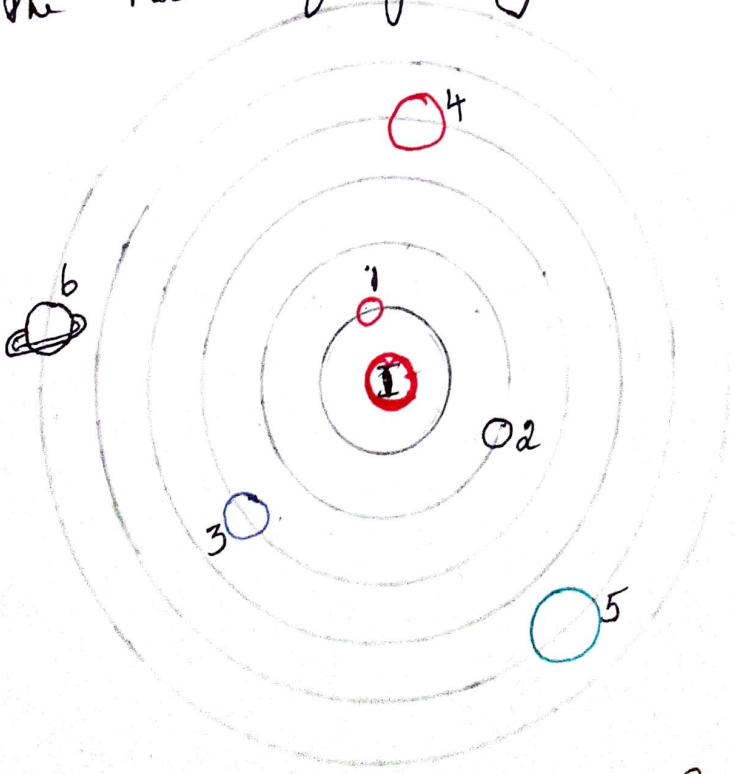
ii All the planets revolve around the Sun and therefore the Sun is the centre of the Solar system

iii What appear to us to be motion of the Sun arise not from its motions, but from the motion of the earth.

The earth revolves around the Sun like any other planet. The ideas about the Sun and his family came to accepted under the name of "Copernican System"

Copernicus assumed that the Sun is Stationary and he placed the Sun at the centre of the Universe. From this central position it could radiate its light and heat to the earth and other planets.

He correctly concluded that the earth revolves in an annual orbit around the Sun. Another fundamental concept that Copernicus discovered was the idea of Gravity.



I Sun.
1. Mercury.
2. Venus
3. Earth
4. Mars.
5. Jupiter
6. Saturn.

The Copernican Heliocentric System of the Universe.

ii Johannes Kepler [1571-1630]

Introduction:

The German astronomer Johannes Kepler made use of the planetary observations made by the Danish astronomer Tycho Brahe, and formulated his three laws of Planetary Motion. Kepler placed the discipline of astronomy on a scientific basis by his life long work on the planetary orbits. His work corrected and transformed the Copernican planetary System.

Early life:-

Kepler was born on Dec 27, 1571. at Weil in Wurttemberg in Germany. He received his school education at Weil, Leonberg and Adelberg and Maulbern. In 1588 he obtained his bachelor degree and entered the University of Tubingen. Political instability and religious conflict interrupted his scientific career and forced him to seek new posts in Graz for 6 year, in Prague for 12 yrs and in Linz for 14 year.

Kepler was primarily interested in the problems of the planetary system. Because of his firm faith in God, he believed that there must be a regulator of the relation between the orbits of the planets. He directed his major efforts towards discovering this relationship.

His major works :-

i. Mysterium Cosmographicum.

ii Astronomia Nova.

iii Harmonic Mundi.

iv. The Optical Part of Astronomy.

His Three laws of Planetary Motion

Kepler's First law :- [Law of Orbit]

Every planet revolves around the Sun in an elliptical orbit.

Kepler's Second Law :- [Law of Areas]

The planets move in their elliptical orbit at speeds that vary accordance with the Law

The line connecting the Sun and the planet sweeps out equal areas in equal intervals of time.

According to Kepler's second law, the speed of the planet is maximum, when it is closest to the Sun and is minimum, when the planet is farthest from the Sun.

Kepler's Third Law [Law of Periods]

He calculated the ratio between the Square of time required by a planet to make a complete revolution around the Sun [t^2] and the cube of its average distance from the Sun [d^3] is a constant for all the planets in which 'd' is planet's distance from the Sun and 't' is its orbital period.

$$t^2 \propto d^3$$

In the 1670's Kepler's astronomical theories played a vital role in Newton's work and were confirmed in his celestial mechanics.

iii Galileo Galilei [1564 - 1642]

Introduction:

Galileo was an Italian astronomer, physicist and mathematician who initiated the scientific revolution of the 17th century in Italy. The renowned scientist was the first man to see the true face of the moon, the first to observe the infinite multitude of stars beyond the sight of the naked eye. He correctly defined acceleration, set forth the laws of falling bodies and developed the mathematical theory of projectile motion.

Early Life:-

Galileo was born at Pisa on Feb 15, 1564, received his early education at the monastery of Vallombrosa. In 1581 he entered the University of Pisa to study medicine but he found himself fascinated by mathematics and physical sciences.

His Important Discoveries:- The Pendulum Theory

The swinging lamp in the Cathedral which caught the his attention led to a discovery. He concluded that whether the swing was long or short, it appeared to take the same length of time.

Theory of Motion:- In this theory, he openly attacked the errors of Aristotle who believed that bodies of different weights ~~reached~~ fall at different speeds. He dropped three unequal weights from the top of the leaning tower of Pisa. They all hit the ground at about the same time.

Invention of Telescope:- He made a thorough study of the theory of refraction and constructed a number of telescopes with his own hands.

In 1610, he turned the new instrument for the 1st time to the sky. With the help of his telescope he discovered,

i mountainous surface of the moon was irregular
ii many new stars.
iii four satellites of Jupiter
iv. the milky way which consisted of a large collection of stars.
v. the sunspots
vi. the phases of Venus and
vii the rings of Saturn.

Important works:- i. Starry Messenger. Letters on Sunspots
iii Dialogue Concerning the Two Chief World Systems
The Copernican and Ptolemaic Systems

II Progress in Technology.

Introduction:- Man has been developing various techniques for his survival ever since the Stone Age.

Technology refers to the ways of making or doing things. The term 'Technology' is derived from the Greek word 'techne' meaning art or craft.

Technological development brought rapid development in human thinking during Renaissance. Technological discoveries transformed the mechanism of human life from primitive handmade work into a machine made one, which led to rise of Modern Science.

i Johann Gutenberg

The invention of printing in Europe in the middle of the 15th century represents one of the greatest landmarks in human history.

It is an outstanding industrial development in this century a stand point of

Science

Printing was ~~developed~~ important technique devised by the German inventor Johann Gutenberg.

He developed his first printing press at Strasbourg. He attempted to carve the letter in wood, cut the individual pieces from wood and fastened them together with ~~wires~~ that ran through holes cut into the base of each piece.

Finally he prepared an alloy of lead, tin and atimony that met the requirement of the press and by using ink, printed the materials with unprecedented beauty and clarity.

In 1448 Gutenberg demonstrated printing in Mainz.

Bible was the 1st book printed by Gutenberg

Its Uses:-

i. Printing was one of the greatest invention in the technical history of mankind

ii Printing made possible the wide dissemination of knowledge

iii Many people could learn to read and became more educated

iv. It laid the foundation for the outbreak of the Scientific Revolution.

ii Leonardo Da Vinci [1452 - 1519]

Italian painter, musician, architecture, Sculptor, Scientist, brilliant engineer and inventor.

As a universal man, he showed his curiosity about nature, which led him deep into anatomy botany, geology, mechanics and astronomy.

In more than 5000 pages of his research notes, he drew up plans that anticipated the inventions like the helicopter, the submarine, the machine gun and motor car.

He was an outstanding painter His master pieces of painting are

"Mona Lisa"

"The last supper"

He was a celebrated Sculptor - In 1493 clay model of horse was put on public display at Milan.

As an architect, he planned an enormous bridge over the Bosporus for Sultan Bayezid II

He was a pioneer anatomist

As an military engineer he designed new war weapons and designed portable bridges for the construction of Canals, battle ship.

He also showed much interest in the studies of the earth. He examined fossils and developed the theory of the origin of the earth

iii Progress in Medical Science.

Medicine is the science which deals with disease and its prevention, cure and treatment. The Renaissance was a great period for the growth of medicine and physicians were in search medical truth.

Andreas Vesalius produced the first great study of anatomy and revolutionized the medical field.

Ambrioise Pare a French Surgeon advanced surgery in this period by simplifying surgical practice.

Paracelsus refused to accept the ancient medical writings on faith alone. He questioned the ancient medical works and made fundamental contributions to medical knowledge and treatment.

i Andreaus Vesalius [1514-1564]

A Surgeon, teacher and brilliant anatomist Dr. Andreas Vesalius was the founder of modern medicine

Andreas Vesalius Flemish anatomist and physician was born in Brussels on 31 Dec 1514. He became a medical student at the University of Paris and later at the University of Louvain.

His six anatomical wax tables published in 1538. He was immensely successful in his profession. In 1543, Vesalius composed his most important work on the structure of the human body entitled "The Anatomy of the Human Body [De Humani Corporis Fabrica.] - "Fabrica"

This great work which heralded the advent of biology as a science. The book was based on actual dissections and observations of human bodies.

'The Fabrica' a book of epochal importance in the history of human studies marked the overthrow of traditional Galenic anatomy based upon non-human material.

The book is arranged in 7 parts

Seven Parts of The book deals with

i bones and Cartilages

ii ligaments and muscles

iii Veins and arteries

iv nerves

v Internal organs of digestion and reproduction

vi heart and lungs

vii brain and Sense organs

The book provides a Surprisingly Complete account of the structure of human body

The most important portions of the work are those dealing with

i. Osteology ii. Myology and iii Cardiology.

Vesalius is regarded as the founder of modern biological research. Vesalius one of the founders of modern Scientific thought wears the crown of the "Father of Modern Anatomy" the Father of University Science and the Father of Modern Biology.

ii William Harvey 1578-1657.

Introduction:-

An English physician William Harvey discovered the circulation of blood and established high landmark in the history of medical Science. Harvey recognised the real purpose and meaning of the heart in his research

Early Life:-

William Harvey was born at Folkestone in the South of England on April 1, 1578. He was sent to King's school Canterbury. He entered Cains College Cambridge. In 1597, he took his degree and departed for the University of Padua to study medicine.

After receiving his doctoin degree in 1602, Harvey returned to England to become physician in St. Bartholomew's Hospital in London. He became the physician to kings, James I and Charles I. In 1649 and thereafter he lived in retirement life and died in 1657.

His Scientific Achievements:-

As an investigator and Scientific author Harvey recorded his studies on the circulation of blood in his famous work written in Latin. In 1628, he published his book "An Essay Concerning the Motion of the Heart and Blood in Animals

Harvey discovered that the heart is a muscular organ which serves as a pump, forcing blood into the arteries. The most important act is its contraction. During the forcing of blood into vessels it can be felt as the pulse beat. The heart beats 72 times in a minute.

He pointed out that there are four chambers in the heart. The upper two chambers are auricles and two ventricles and 2 auricles.

The left ventricle contracts and blood it contains passes into the artery called the aorta. The blood then makes way to smaller arteries and finally enters veins. It then returns to the right auricle of the heart and then the right auricle contracts. The blood it contains passes into right ventricle and then through the pulmonary artery to the lungs. From there it passes through pulmonary veins into the left auricle and then into the left ventricle, when the cycle begins again.

Harvey also made contributions to Embryology. According to him, all animals including man himself is evolved out of an egg. His work on embryology

"On the Generation of Animals"

RA - Right Auricle LA Left Auricle
RV - Right Ventricle LV Left Ventricle

iii. Joseph Lister 1827 - 1912

Joseph Lister an English Surgeon opened the modern era of surgery by introducing the antiseptic in the medical field. The practical success of Lister in reducing Surgical infection was his permanent legacy to medical Surgery.

Lister was born at Upton in Essex in England in 1827. He studied medicine at the University College in London. In 1852 he went to Edinburg to work with an eminent Scottish Surgeon James Syme. In 1856 he was made assistant Surgeon in the Royal Infirmary, 4 yrs later he became Prof of Surgery in Glasgow University

During his early years at Edinburg and Glasgow, Lister investigated variety of problems closely related to Surgery

Lister continued his search in find out Solution which would kill the harmful bacteria. Lister decided to use Carbolic acid to prevent Surgical infections and the consequent formation of pus by killing the microbes

Between 1861 and 1865 the fatal death rate after Surgery was 45%. The year 1869 marked the decrease of infection 6 only to 15%. When he died in 1912 he was buried at Westminster Abbey

IV Progress in Physical Science

Isaac Newton [1642 - 1727]

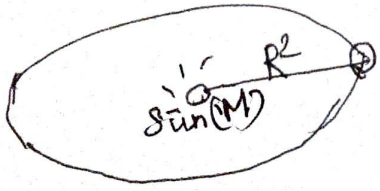
He was a natural philosopher - one of the greatest all rounders among the world scientists. He invented infinitesimal Calculus and a new theory of light and colour.

Newton transformed the structure of physical science with his three laws of motion. His supreme contribution was his law of universal gravitation.

Newton's research work combined the contribution of Copernicus, of Kepler, Galileo, Descartes and of others into a new and powerful synthetic form.

Theory of Universal Gravitation

Newton's law of gravitation states that, all matter is mutually attracted with a force [F] proportional to the products of the Masses [Mm] and inversely proportional to the ~~product~~ of square of the distance [R^2] between them. [G] is a constant whose value depends on the units used for mass and distance.



F = Force
M = Mass of the Sun
m_2 = Mass of the Earth
R^2 = Distance [Radius] between the Sun and the Earth.

$$F = \frac{GMm}{R^2}$$

Three Laws of Motion:

1. Everybody continue in its state of rest or of uniform motion in a straight line, unless it is compelled to change that state of force impressed upon it.

ii The change of motion is proportional to the motive force impressed and

iii To every action there is always an equal and opposite reaction.

Mathematical Discoveries

Newton discovered the binomial theorem, new methods for the expansion of infinite Series and his direct and inverse method of fluxions

Newton developed a more complete account of his method of infinitesimals which appeared as "Methodus fluxionuet" and "Serieum Infinitearum". Modern applied mathematics originated in Newton's Theory of universal gravitation.

Discovery of Optics:

His main discovery was that visible light is heterogeneous. With the help of ~~prism~~ prism he examined the 7 colours - Violet, Indigo, Blue, Green, Yellow, Orange and Red [VIBGYOR] which

constitute Sunlight. His book on optics "Opticks" was published in English in 1704.

Reflecting Telescope :-

He invented the 1st successful reflecting telescope and presented it to the Royal Society in 1671.

His Important Work - "Principia"

"The Mathematical Principles of Natural Philosophy" written in Latin - published in 1787. It is generally referred as Newton's "Principia".

Honours and Titles

In 1672, he was elected a Fellow to the Royal Society and became its President in the following year.
In 1689, he was elected to parliament to represent Cambridge
In 1695 - he was appointed a Warden of the Mint Later became the Master of the Mint - held this office till his death
In 1705 he was knighted by Queen Anne.
In 1727 he died in Kensington - was buried in West Minster Abbey

A fitting tribute to his Scholarship he was found in the inscription of his tomb,

"Mortuals congratulate yourselves that so great a man has lived for the honour of human race.

V. Progress in Biological Science

Biology is the science of life, the study of living things, animals and plants which make up organic nature. The word "Biology" is derived from the Greek word "bio" means life "logos" means discourse.

Charles Darwin 1809 - 1882

Charles Darwin, an English Naturalist firmly established the theory of Organic evolution of Species. The doctrine of Organic evolution profoundly influenced the thinking of mankind.

He was born in Shrewsbury in England on Feb 12 1809. His father Robert Waring Darwin and grandfather Erasmus Darwin were wealthy physicians. He went to Edinburg University to study Medicine but he disliked the subject. In 1828 he went to Christ College Cambridge; took degree in Theology in 1831

Darwin joined the H.M.S Beagle ship for surveying expedition in the Atlantic & Pacific Oceans as a naturalist for 5 years

He visited Cape Verde and other Atlantic Islands, South American coasts and the Galapagos Islands, New Zealand, Australia, Tasmania, Keeling Island, Maldives, Mauritius, St. Helena & Brazil.

Darwin published his famous theory in 1859, in his great work "On the Origin of Species by Means of Natural Selection"

In this work 'Origin of Species' Darwin presented an explanation of the working of natural selection

Darwin concluded that species had not been created but had descended like varieties from other species.

Another famous work "The Descent of Man" [1871] contains Scientific search for the origin of man and his history. In this book he has presented the evolution of man from apes.

The theory of organic evolution burst like a bombshell upon England. The theory was violently attacked by clergymen as it was contrary to the teaching of Bible. By the end of 19th century, the evolution theory had won wide acceptance.

Darwin died in 1882 he was buried in Westminster Abbey near the Newton's tomb.