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**GNS 211
THE HISTORY AND PHILOSOPHY OF
SCIENCE**

An Integrated Approach

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Chapter One

The Seed of Modern Science: A General Introduction

The human mind has indefinite capacities; it continuously emits thoughts and wonders why and how things happen and most of all how to be in control. This has been the giant stride of continued scientific development over the ages. Science attempts to explain nature in its own terms, and to predict how matter and energy (including life) will behave, and hence control them. It is the ordered knowledge of natural occurrences. The philosophy of science attempts to do for science what philosophy in general does for the whole of the human experience (Caws, 1965). Philosophy constructs theories about man, his environment and the entire universe, thus proffering such theories as the basis for beliefs and actions. It also analyses everything that may be proffered as basis for beliefs or actions with a view to the elimination of inconsistencies and errors. In a similar vein, science constructs theories about man, his environment, and the entire universe. Furthermore, science brings critical methods to bear on these theories in experiments. Science and philosophy therefore appear to have a closely knit relationship; in their origins, science and philosophy were indistinguishable. The greatest philosophers in human history, including Aristotle, Thales, Plato, Socrates, Pythagoras and a host of others, constructed and tested several scientific theories. Even in this day and age, some learned science journals and University professorships are referred to as natural philosophy. In fact, Broad (1923) in his attempt to distinctly separate philosophy from science wrote that science aims at explaining and is therefore 'speculative philosophy' while philosophy aims at understanding and is therefore 'critical'. However, these apparently distinct aspects of philosophy are indistinguishable and cannot stand entirely alone. It would be irresponsible to construct theories without analysis, and analysis without construction is unproductive and of no importance.

Many times scientists construct theories and only later test such theories to see whether they fit the facts of the problems in hand. Sometimes these theories do not solve the problems, and new systems have to be developed. It does not, however, mean that the effort of developing the first is wasted, since it is possible to learn by experience why the theory failed, and possibly construct a more successful system. Most of the accounts of the history and philosophy of science are accounts of scientific ideas, theories and discoveries that dominated particular ages, and accounts how successive philosophers and scientists improved on existing theories and the development of new ones. On the other hand, the contemporary status of any scientific discipline is better comprehended and oriented by the student who has knowledge of its beginning and development. The history and philosophy of science is a fascinating subject because one learns not only of the men responsible for it and their contributions, but also that from all these contributions, a new thing is being evolved through a dynamic science and technology based on

such theories. By acquainting oneself with these scientists one finds that their scientific contributions become of more lasting interest.

Prehistoric records of how man tried to systematize knowledge reveal that Paleolithic man painted on walls of caves, and carved on bones and stones. There are also numerous archeological artifacts which are evident of some sort of Neolithic civilizations. The importance of archeology and anthropology in the history and philosophy of science is therefore second to no other subject. The technology in use today was not available to the primitive man and yet he made tools from iron, stones and woods; he domesticated some animals, he performed some arithmetic, geometry, trigonometry and astronomy; he could forecast weather, identified non-poisonous food items and species, and started tilling the soil; he mastered the sea and started controlling diseases. He was able to do these because he continually wondered why and how?

Protoscientific studies from Egypt, India, Mesopotamia and China were the earliest recorded history of science. In these records were lists of chemical substance, diseases, astronomical studies and a variety of mathematical tables. These documentations were of practical nature with little rational organization. Soon after man had made tools for hunting and tilling the soil he discovered that his territorial ambitions could be realized with these same tools. There were therefore wars and several violent upheavals. Around the same time, many philosophers started searching for true explanation of certain facts of the universe, and of man himself. For example, Thales in the ancient times theorized that the earth was flat and floats on the universal element water. Pythagoras on the other hand postulated that the earth was spherical and moves in a circular orbit around a central fire (i.e the sun). By the 4th century B.C., Ionian natural philosophy and Pythagorean mathematical science combined to produce the synthesis of the philosophy of Plato and Aristotle. Whereas Plato emphasized deductive reasoning and mathematical representation, Aristotle emphasized inductive reasoning and qualitative description. Thales, Pythagoras, Plato and Aristotle were all Greeks.

There were many other notable Greeks in the history and philosophy of science. These include Eratosthenes, mathematician, astronomer and geographer who accurately measured the earth; Aristarchus of Samos who supported a heliocentric planetary system; Archimedes the mathematician, inventor and founder of mechanics and hydrostatics; Theophrastus, the philosopher and scientist and founder of botany; Hipparchus, the astronomer who developed trigonometry; Democritus and Leucippus, the philosophers who developed a type of atomic theory; Hippocrates, a mathematician, physician and founder of medicine. These men lived and worked in the Hellenistic age in history. Rome later conquered Greece just before the Christian era, and most of the subsequent scientific events bore Roman authority. However, the Roman science was principally a reflection of the Greek. It is worth noting that some scientific writings were already in Latin by the 1st century B C and in the succeeding century A.D. However, most of the dominating scientists such as Pliny, Ptolemy Galen, and a host of others were still Greeks, even up to the 7th century A.D.

The middle ages in recorded human history were marked by Muslim conquest of the geographical area known as the Mediterranean world. Within this period, 9th to 11th century A.D, most Greek knowledge including scientific writing was translated into Arabic. By the 15th century A.D, the period of the renaissance, typography (printing) had been discovered in Europe,

and Christopher Columbus had sailed round the world, and the new-world was discovered. The East and West were brought together, having been hitherto separated by religious strife. The plague of the 15th century christened 'Black Death'¹, and the numerous wars between 1337 and 1453 disrupted scientific progress for more than a century. The 16th century witnessed a revival of scientific activities, and in 1543 Nicholas Copernicus, a Polish astronomer published 'De revolutionibus orbium coelestium (Revolution of the Heavenly Bodies)', which revolutionized astronomy. Within the same year, 1543, a Belgian human anatomist, Andreas Vesalius, published 'de orporis human fabrica'¹ which modernized the medical teachings of Galen, and subsequently the discovery of blood circulation. An Italian mathematician, physician and astrologer, Geronimo Cardano (1501 -1576) initiated modern algebra in 1543.

The 17th century was a remarkable period in the development of science and technology. At the top of the century, Galileo developed the first astronomical telescope (1609), and therefore revolutionized the science of astronomy. In 1610 this same scholar and artisan invented the microscope which made it possible to discover that organisms were composed of individual units now known as cells. The 17th century, the century of genius, marked the beginning of modern science. It was in this century that the barometer was discovered by an Italian mathematician and physicist, Evangelista Torricelli; the pendulum clock by the Dutch mathematician, physicist and astronomer, Christian Huygens; the emergence of the great Isaac Newton who theorized and published the laws of gravitation. Newton was an English mathematician, physicist and astronomer who became a Professor of mathematics before the age of twenty three. He developed several theories some of which were published in his mathematical principles of natural philosophy, and most of which are still operative today, not having been disproved.

Before the 18th century life processes were seen purely from a physical and or chemical point of view. Thereafter, social scientists began to influence human activities and reasoning. Many 'materialism' rather than 'idealism' theories emerged. Then came the French revolution of 1789. Quantitative chemistry was developed by 1790 after the efforts of Antonie Laurent Lavoisier, and by the 19th century John Dalton, a Briton, developed the atomic theory of matter; Michael Faraday and James Clerk Maxwell, called James Prescott Joule formulated the theories of energy conservation. Similarly, a British naturalist propounded one of the most dynamic theories of the life sciences, the theory of evolution in his book the 'origin of species by means of natural selection' (Dutta, 1977), Charles Darwin's work (1859) was not taken kindly by many, especially by Christian religious groups and law officers. Most of the controversies appeared, however, to have developed from a lack of the thorough understanding of the tenets of Darwin's work. The controversies continued throughout the remaining part of the 19th century. However, by the beginning of the 20th century certain facts of the theory of evolution had been generally accepted, although the genetic processes through which these take place are still disputed. The 'Quantum theory' and the theory of Relativity' were also developed in the 20th century, by Albert Einstein.

We have come thus far in scientific development because after each theory is developed, scientists, at that prevailing age and afterwards, make efforts to challenge it, and improve on it with all the attendant academic freedom. Knowledge or intelligibility of anything cannot be 'caged' away from challenge. And that is our science. Science (from the Greek word 'Scire' to "know") means knowledge; Philosophy (from the Greek word 'Philein' to love' and 'Sophia'

wisdom, means love of wisdom). These are by no means the definitions of science or philosophy. The point we are making here is that knowledge comes from verifiable knowledge and not from wild guesses and should not under any circumstance be equated with a practical skill of some kind. For example, the theoretical scientist knows that the boiling point of copper is 2310°C , that the element thorium decays with the emission of an alpha particle, which a conflict between desires and rules may lead to psychoneurosis (Caws, 1965). Laymen do not know these things; but what is the scientist able to do with them that the layman cannot do?

Sometimes, pseudo-science (false science or pretence to theory) may be seen as genuine science (true theory). For example, whereas astrology is pseudo-science, astronomy is true science; the contemporary pharmacist works, according to scientific principles, while the witch doctor does not. But there are borderline cases in which the decision is much more difficult and in which acrimonious disputes spring up between those who wish to see their own activities dignified by the name of science (Caws, 1965) and those who think that the name would be cheapened by the inclusion of such activities under it. Such borderline controversies are resolved by the 'scientific method', the most popular concept of the uniqueness of science. This method is one of hypothesis, deduction, and test. (It maybe important to mention here-in that science does not always use it, and also that the scientific method can be applied to a number of other inquiries).

The philosophy of science is in fact devoted, as it were, to the scientific method. The scientific method involves the development of hypothesis (unproven theory), testing the hypothesis by means of experiments, observations and the drawing of conclusions. Sometimes, the scientist may make observations of events (phenomena), collects data, hypothesizes and tries to prove it by experimentation. As was said earlier, the theory may succeed or fail; its failure does not necessarily mean the effort in propounding it was useless. The scientific method as it is known today gradually evolved from the earlier works of Sir Francis Bacon (in the 17th century), influenced by the work of Galileo, Descartes, and Kepler, and finally polished by Isaac Newton. The scientific theories (hypotheses) and experiments of scientists are usually subjected to a number of verifications before acceptance. The methods and results for any experiment must be reproducible. The import of all these is that true science is able to predict 'what?' and control 'how?' Thus is the seed of our science.

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Chapter Two

The Human Being in His Cosmic

A. The Human Being in His Cosmic Environment

The human being is always considered in relation to his environment, sometimes as producer and sometimes a product of it. Insofar as he is an aspect of nature he is a product of his environment in terms of the atmospheres that surround his being and acting. But insofar as he is a rational being, he is capable of foreseeing and bringing about changes in his environment. Thus, the human being is said to be the only creature that not only adapts to his environment but adapts his environment to himself. Ancient culture revolved around the 'cosmos' or nature, and saw the human being merely in relation to that. In the middle ages, the human being came in as part of the order established by God.

The modern mind separated the human being from such supports and set it out on its own, but predominantly as 'subject'¹ or reason. This is not without a price as this reason became perceived as the transcendental subject (Rene Descartes), or- pantheistically as absolute reason (Immanuel Kant). In the process, the real human being was lost in favour of abstract 'subject' and abstract reason.

Finally, modern thinkers became aware of the nihilism of these constructions and veered back to the historical and personal concreteness of the human life that precedes all concepts. The human being thus becomes the theme of all philosophizing. It became worthwhile to study the human being and all other things only with respect to the human being. Therefore, philosophy began to change more or less into anthropology and was often absorbed by it.

The first move in this direction was taken by Friedrich Wilhelm Joseph Von Schelling (1775-1854) and by Soren Kierkegaard (1813-1855). Schelling was the founder of the philosophy of identity which holds that subject and object coincide in the Absolute. Then the development moved through Friedrich Nietzsche's (1844-1900), life philosophy and phenomenology, to Max Scheler, who explicitly formulated the anthropological theme as such. Finally, existential philosophy accomplished the most recent philosophical synthesis and attained a certain definite conclusion.

There are three rather distinct interpretations of the nature of the human being; the classical or rationalistic view, inherited largely from Greece and Rome; the Judaeo-Christian view, which comes largely from Palestinian sources; and the naturalistic or biological view, which is largely the product of the natural sciences as they have developed during recent centuries.

a. The Classical Rationalistic View

According to the classical rationalistic view, what most distinguished humans is the fact that they are rational. This view is based on the fact that the human being has a soul with reason. Thus Plato was one of the progenitors of this view.

The Stoics saw in the universe a cosmic reason, or logos, which pervades all things. For them the ideal person is one who governs his or her world by reason having overcome the emotions. Reasons must check the testimony of the sense, since the "assent of reason" is central in human knowledge. For Socrates, Plato and their followers, the one who is intelligent is the one who is reckoned to be virtuous. To know the right is to do it. Vice is the result of ignorance.

b. The Judaeo-Christian Religious View

Next to the classical rationalistic view is the Judaeo-Christian view in which humans are seen as God's image and likeness. As such they stand at the point where nature and spirit meet. The human being is a finite creature that is bound to the earth. This explains human weakness and sinfulness. Nevertheless, the human being is also in part a spiritual being who transcends nature. This gives him or her uniqueness and worth beyond other species. Humans are therefore an expression of the intelligence and moral purpose present in the universe. They transcend the natural conditions of life; and do not become themselves until they are devoted to the highest reality which is God.

This view of the human being is religious and theological and places humans in a meaningful and purposeful universe. Humans are ends in themselves, and are never to be used merely a means. The conviction that people have great intrinsic worth is what makes a society possible. The human being is a creature of almost unlimited possibilities for good or for evil. In weakness he or she may fall to the level of the animals and live as one of them, but in strength, he or she may rise to great heights. The human being has both moral freedom and responsibility.

c. The Scientific View

The modern scientific interpretations of human nature are many and varied, depending on the science to which one turns. The human being is a part of the physical order of nature and like other organisms, is subject to physical and chemical laws. Like other objects, the human being has size, weight, shape, and colour. He or she occupies space and time; and is subject to the laws of nature, such as the law of gravitation.

Humans absorb foreign substances into the body, where they are changed into compounds necessary for their life processes. Chemical changes take place during breathing and digestion, and as a result of glandular action. When a human body is analyzed, the same chemical elements are found as in air, water, earth, and stars. Thus, the human being is said to be one of the animals. As in the plants and in other animals, the unit component of the human body is the cell. By this it shares many characteristics in common with other animals, including being part of the process of evolution.

Humans can be classified under a single species *Homo sapiens*. They can be distinguished under three main racial groups: the white or Caucasoid; the yellow or Mongoloid; and the black or negroid. Technically speaking, there is already no white or black or yellow human being according as colours are designated, but the designations are a practical one considering how dark or light the skin pigment is. All the existing races of humans are believed to have a common

origin or ancestry; and the different races might have developed as the result of mutations in the genes and varying geographical factors. They can and do intermarry and produce fertile offspring. There is no basis in any claim that any race is inherently superior or inferior to another, for there are superior and inferior individuals among all the racial groups.

B. Philosophy and the Human Person

Philosophy is interested in the nature and destiny of the human person. Therefore questions of what a human person is all about, and the place of humans in the universe are of special interest to philosophy. It is interested in such questions as whether humans are free or determined.

The aspect of philosophy that treats such questions is philosophical anthropology. In the past, philosophical anthropology was variously referred to as rational psychology or philosophical psychology.

At first the word anthropology was used for the physical science, which investigates the human being in its bodily characteristics with scientific methods. But in recent times, thanks to the influence of Max Scheler, philosophical anthropology has asserted itself decisively. Today, has become the central theme of philosophy. This has not always been so.

a. The Concept of the Human Person

In its earlier development, anthropology was concerned with all living organisms i.e with natural bodies that are able to move themselves, and so could readily be seen as a part of the general study of nature. In more recent times it has focused almost exclusively on higher organisms capable of at least sentient life. Topics discussed in philosophical anthropology include life in its various manifestations, knowledge, appetition, the human soul and its different powers, and the relationships that exist in humans between soul and body. The human being is discussed as a **person**, i.e an individual substance of a rational nature. He has a physical, mortal body that is united to a spiritual, immortal soul. His existence must be as a composite of soul and body, never separated from each other. He has reason to understand, to think, to judge; he has a will that decides and chooses, he can love, he is mortal.

b. Characteristics of the Person

Thomas White (1991) defines a person is a self-conscious, intelligent living being who can communicate¹. He distinguishes between the concepts "human" and "person", observing that not all persons are human. For example, the concept of person refers both to humans and to the divine Trinity. Thomas White (1991) has sketched ten identifying characteristics of a human person to include:²

- (1) Being alive
- (2) Being aware
- (3) Feeling positive and negative sensations
- (4) Having a sense of self (self-consciousness) with emotions
- (5) Controlling its own behaviour (being able to be held responsible).
- (6) Recognizing other persons and treating them appropriately.
- (7) Being capable of analytical, conceptual, thought.
- (8) Being able to learn; retain and recall information
- (9) Being able to solve complicated problems with analytical thought.
- (10) Having the capacity for communication that suggests thought.

It is important to add at this point that in spite of appearances to the contrary, neither the infant nor the imbecile, nor anyone with any degree of physical or mental disability is hereby excluded by these characteristics. In the above characterization, White, has set down a framework for a functional human person, without necessarily denying the special circumstances that might arise in the case of the infant, the imbecile or the patient of any degree of physical or mental disability. Maritain (1945) gives in an impressive but comprehensive package all that describes or distinguishes a human person from all other types of reality:

Whenever we say that a man is a person, we mean that he is more than a mere parcel of matter, more than an individual element in nature, such as is an atom, a blade of grass, a fly or an elephant. Where is the liberty, where is the dignity, where are the rights of an individual piece of matter? There would be no sense in a fly or an elephant giving its life for the liberty, dignity, or rights of the fly or the elephant. Man is an animal and an individual who holds himself in hand by his intelligence and his will. He exists not merely physically; there is in him a richer and nobler existence; he has spiritual super existence through - knowledge and through love. He is thus in some fashion a whole, not merely a part; he is a universe unto himself, a microcosm in which the whole great universe can be encompassed through knowledge; and through love he can give himself freely to beings who are, as it were, other selves to him...³

c. The Human Being and the Realm of Knowledge

The greatest philosophers like Socrates, Plato, Aristotle, Plotinus, Augustine, Aquinas, Duns Scotus, Descartes, Malebranche, Leibniz, Spinoza, Berkeley, Fichte, Schelling, Hegel, and many others have thought that it is in the power of humans to get to the non-empirical principle of reality. In other words, these philosophers admit of the possibility of a metaphysical explanation of the universe. The reason for this kind of view is based on the nature of human knowledge itself. Humans simply know. Not only that, they know that they know. In other words, they know themselves in the first person as the subjects that know, or the knowing subjects. Only humans enjoy that status of being subjects and referring to themselves as such.

a. The Knowing Subject: the I or Ego

He who knows, and knows that he knows is a wise man, seek him

He who knows, and knows not that he knows, is asleep, wake him.

He who knows not, and knows that he knows not is a child, teach him. But he who knows not and knows not that he knows not is a fool, shun him!

I know. I know that I know. I know things and persons and ideas. I knew yesterday, I know today, I will know tomorrow, I know myself and others, and I know that it is I who know. I know when I know, and I know when I do not know. I feel and affirm the fact that I know, even after I have slept and woken, travelled or been absent, fallen sick or recovered. *All my acts of knowledge are shot through and illumined internally by the presence of a conscious ego or subject called "Me", which is the principle and support of my acts of knowing.* The sphere of

knowledge stretches out through time. I knew yesterday, last year, the last occasion. Today I still know. Yesterday and today are not synonymous terms and yet the subject or ego that knew yesterday and today is one and the same. This subject or ego escapes from the clutches of the flow of time in the measure in which, being conscious of itself it recognizes itself in the measure in which it is the constant witness of the events that succeed one another.

At the present moment I can recognize the present as such. The same goes for the past and the future. I am not immured in any of moments of time and I do not disappear with them. When I consider time from a non-temporal point of view, I consider it as a whole, and can pass judgement on it. By thought I can transcend the course of time. Thus I can at one and the same moment represent it to myself, make it present to my mind, embrace it in a single glance, and in a sweeping panorama get at it in all of its instants.

The same is true with my conscious grasp of space. I am here and I am there. Here and there are opposed to each other, just as yesterday and today. For someone next to me I am "here". And for someone far away I am "there" even without leaving my position. I still remain the same whether I am "here" or "there", or "elsewhere". Wherever I am my consciousness bears witness to the persistent presence of one and the same subject or *ego*. In changing from one place to another, I do not change my identity. Here and there thus become relative terms, and I grasp them as such.

b. Conclusion: The Human Being - A Mystery

The foregoing has been a discussion of the theme of human being from the environmental, the ontological and the epistemological perspectives. The resulting image has been nothing short of marvellous, and even mysterious. As can be seen from the brief discussion above, the views of what the human being is sometimes differ, sometimes are contradictory to each other, and very often are directly opposed to each other. That would confirm that the human being is indeed a mystery not only in his being, but also in his knowing and in his manifestation. The ancient Greek philosopher Sophocles remarks about this mysterious character of the human being in his *Antigone* (1.332): "Many wonders there are, but naught more wondrous than man." Shakespeare's *Hamlet* goes even further to marvel at the mystery that is the human being in his being, in his person, in his faculties, and in his activities.

What a piece of work is man! How noble in reason!
How infinite in faculties! In form and moving how
express and admirable! In action how like an angel! In
apprehension how like a god! The beauty of the world,
the paragon of animals (Act II, Scene ii, II 312-316)

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3. Maritain J. (1945). *The Rights of Man and Natural Law*, Lord Geoffrey Bless: The Centenary Press, pp. 4-5.

Chapter Three

Man as the centre of Science: His Origin

Man as the centre of science

Man is a singular creature and the most remarkable of all the creatures that live on earth. He is equipped with a lot of attributes which set him apart from the rest of the animals. Only man, amongst the other creatures has intellectual faculties, spiritual as well as physical qualities. The spiritual nature or part of man is called his soul. His intellectual capabilities are attributed to his possession of a complex brain which is very superior to that of other creatures of the earth. His physical qualities include his ability to stand erect, and the possession of creative working hands.

The unique nature of man makes him not to be just a figure in the landscape. He is ubiquitous animal, who is able to modify the environment to suit him. He has developed for himself, means of surviving in different environments, makes and uses different tools for different purposes, makes fire, builds houses with varying materials, and is able to manipulate almost everything around him to suit himself including the ability to travel through the air, even when he is not physically built to fly. Man has been able to improve himself and his environment through his singular ability to think, reason, question, and make plans without relying only on instinct. Man has, in addition, developed for himself very efficient ways of communication. In body and in mind, man is the explorer of nature, who did not find but has made his home in every continent.² He has also domesticated plants and other animals, is able to control their life pattern as well as their evolutionary trend, to suit his needs.

The inquisitive and exploratory nature of man, as well as his insatiable quest for knowledge, led to the discovery of science. Science is precisely defined as a systematic study of nature. Dr. W. Weaver, President of the A. P. Sloans Foundations described science as a hazardous activity of the spirit of man, which is mainly an artistic understanding, excited mostly by curiosity, served largely by disciplined imagination and based greatly on faith in the probability of the regularity and beauty of the universe of which man forms a part.¹ Man is not unique because he studies science but because science is an expression of the marvellous plasticity of his mind. Through science, man has been able to unlock many secrets of the universe including the structure of atoms, composition of plants and animals, composition of the earth, even the shape of the earth as well as the world outside the earth.⁴ Through science also, man has been able learn about himself and ways to improve himself as well as enhance his survival on earth. Science covers the broad field of human knowledge concerned with facts, which are held together by principles (rules). People who devote themselves to the study of science are called scientists. Scientists probe, discover as well as test facts and principles through an orderly system, known as the scientific method.

The Origin of Man

Man has been on earth for more than 3 million years. Details on his origin are still not complete. Members of the Christian religion believe that God created man, forming him from the sand of the earth "in his own image", and breathing into him, his breath of life.⁵ A lot of scientists however, believe otherwise. Over the years, a lot of scientists have devoted themselves to the study of the prehistoric man (men who lived in the period before man invented writing) and almost all of them believe that man developed from manlike apes that first lived on earth more than 5 million years ago.⁶ These manlike apes were called "Australopithecus" (southern apes). Fossils of these man-like apes have been found in some parts of Africa (East and South), Java Island in South-Eastern Asia. Fossils are remains or particles of animals or plants that had been in existence in the distant past.

The australopithecine walked erect, had a brain about one-third of the size of modern man's. Two basic types of australopithecine were believed to have existed; the larger type which stood about 5 feet (1.50 meters) tall and weighed about 54 to 68 kilograms; and the smaller type which stood 4 feet (1.20 meters) tall with a weight of about 45 to 54 kilograms. Many scientists believed that the first human beings developed from the smaller australopithecines while the larger ones become extinct. This belief is based on fossil records of smaller australopithecine found-mainly in Eastern Africa, which showed that these creatures looked more like man than the larger type. Some scientists believe that these creatures were possibly the first human beings and should be called *Homo habilis* (skillful man) because there are evidences that they made and used tools, lived together in groups like humans.

Over the years, by about 1,200, 200 B.C., a form of early man emerged. This early man was mentally and physically more advanced than the australopithecines with a height of 5 feet (1.50 meters), a sloping forehead, large chinless jaw, and a brain about twice that size of that of an australopithecine. He was called *Homo erectus* (erect man), by the scientists. The *Homo erectus* live in Africa, Asia and Europe. He made and used choppers, chopping tools and hand axes. He also made and used fire, wore clothes as well. Fossils of *Homo erectus* have been found in Java, near Heidelberg Germany and near Peking China.

Homo erectus was followed by *Homo sapiens* (wise man). Scientists, however, know little about how and where *Homo sapiens* developed from and replaced *Homo erectus*. Fossil records found in Swanscombe near London, Steinheim in Southern West Germany, showed that the *Homo sapiens* were the same size as the *Homo erectus*, but had a larger brain. Further, the shape of their skull resembled closely that of modern man. The best known example of early *Homo sapiens* is the Neanderthal man, who lived in parts of Africa, Asia and Europe from about 100,000 B.C, to about 35,000 BC. The Neanderthal man was heavily built, had a height of more than 5 feet (1.50 meters), with brain as large as that of modern man.

Fossils of these more modern looking man have been found in Omo River Valley in Southern Ethiopia, Solo, Java (near Surakarta, Indonesia). A fossil of another more modern looking man, called Rhodesian man, was found in Southern Africa. Scientists however, do not know the age of the Rhodesian man, nor do they know how these early men and the Neanderthals are related to modern man.

The modern man, *Homo sapiens, sapiens* a subspecies of *Homo sapiens* is thought to have developed about 35, 000 BC. Fossils found dating from that time and later have shown human forms resembling various peoples of today. An example is the Cro-Magnon man, who lived in Northern Africa, Western and Central Asia, and Southern Europe. The Cro-Magnon man, had a height of 51/2 feet (1.70 meters), he also had a very close resemblance to the present-day Scandinavians. Till date, there is no conclusive evidence on the origin of man. The Christian belief of his creation from the biblical account is based on faith, while the scientists base most of their observations on fossil records. Fossil records are however not conclusive because they do provide information on exactly how, when and why these developments occurred, thus the inability to trace man's development in details.

Origin of Science

Science is as old as man himself. It started thousands of years ago, even before man learnt to write. Science started as man studied his environment, learnt through the centuries to make and use a more complicated tools, cultivate wild plants as well as improve them, harvest the crops quickly and store it in an edible condition for the lean months, domesticate animals thereby providing for himself source of meat, milk, hides for clothing and even companionship. Science prevailed as a man continually increased his knowledge about his environment, learning more and more to control the biosphere, as his urge to explore, as well as control nature increased. It is not known who first discovered fire, developed bow and arrow, invented writing, invented the wheel, tried to explain the rising and setting of the sun as well as using it to tell time. These are all major advances in science, handed down and improved upon over the centuries.

Today science is very important in our daily lives. Science has made it possible for man to communicate with one another anywhere in the world, even outside the earth, in space, through the use of devices such as telephones, radios, computers, televisions, satellites dishes etc. Through science, man can travel through the air, land and water. Even in our homes, science has made life much easier and more pleasant. There is electricity to light the houses, run machines such as refrigerators, air conditioners, sewing machines, heaters for houses in temperate regions, washing machines, electric cookers, microwave ovens etc. Man has, through science given himself a longer, healthier and more pleasant life.

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Chapter Four

The Continuity of Life: An Overview of Early Thoughts and Events that Bore Modern Genetics, Organic Evolution Cytology and Embryology

Heredity

Introduction:

One of the most exciting fields of the life sciences is heredity (or genetics). The facts of heredity are so familiar that they were long generally taken for granted. An old proverb has it that "Like begets like" (Sinnott et al, 1958). Human babies are always cast in the human mould and usually resemble in particular ways their parents and siblings. Puppies always grow to be dogs and usually have the body shape, size, colour, and other characteristics of their breed.

Genetics is the study of the mechanism of heredity by which traits are passed from generation to generation. Not only has modern genetics had a compact history, being essentially a product of the twentieth century, but it has made explosive progress from the rediscovery in 1900 of Mendel's basic observation of the 1860s to a fairly full comprehension of underlying principles at the molecular level. As our knowledge of these operating mechanisms developed, it became apparent that they are remarkably similar in their fundamental behaviour for all kinds of organisms, whether man or bacterium. But geneticists' quest for truth and understanding is far from being completed; as in other sciences, the answer to one question raises new ones and opens whole new avenues of inquiry (Burns, 1976).

Genetics is personally relevant to everyone. Man is a genetic animal; each of us is the product of a long series of mating. People differ among themselves with regard to the expression of many traits; one has some inherited characteristics of his father and certain ones of his mother, but often, as well, some are not exhibited by either parent (Burns, 1976). Familiar examples include hair or eye colour, curly or straight hair, height, intelligence, and baldness etc. Less obvious genetic traits include such diverse ones as form of ear lobes, ability to roll the tongue, red-green colour blindness, hemophilia or "bleeder's disease", extra fingers or toes, or ability to produce insulin (lack of which results in diabetes). Look about you at your friends and family for points of difference or similarity. Most of these characteristics have genetic bases. You are undoubtedly aware also of mentally retarded persons in our population, and of infants so grossly deformed that they are born dead or die within a very short time. Many of these unfortunate cases have underlying genetic and/or cytological causes. The determination of one's sex and the occurrence of sex intermediates (hermaphrodites and pseudo-hermaphrodites) also have genetic and cytological causes.

A Survey of the Underlying Philosophies of Genetics

As much as 6000 years ago man kept records of pedigrees of such domestic animals as the horse or of crop plants like rice (Burns, 1976). Because certain animals and plants were necessary for his survival and culture, man has, since the beginning of recorded history at least, attempted to develop improved varieties.

As one examines the developments of ideas relating to these mechanisms, he finds the way replete with misconceptions many of them naive in the light of modern knowledge. These theories may be divided roughly into three categories (a) vapours and fluids (b) pre-formation, (c) particulate inheritance.

Theories of Vapours and Fluids

The Greek philosopher Pythagoras (500 B.C) proposed that vapours derived from various organs unite to form a new individual. Then Aristotle assigned a "Vitalizing" effect to semen, which he suggested, was highly purified blood (Burns, 1976).

Theories of Preformation and Epigenesis

With the development of microscopes, biologists in the 17th and 18th centuries discovered sperm cells. Some of the ideas formulated at that time still influence biologic thoughts, even though their inadequacy in their original form has long been recognized.

An observer endowed with too lively an imagination and a faulty microscope claimed in 1694 that he could see inside the human spermatozoon a miniature figure of a man - a "homunculus" or a manikin (i.e animalcules) (Sinnott et al 1958). According to the preformationists, as adherents of this school of thought were known, the sperm or ovum contained replicas of the adult which unfolded and grew like a bud (Ambrose and Easty, 1970). Literature of that time contained drawings of such models within sperm heads which imaginative workers reported seeing. Theories of preformation persisted well into the eighteenth century, by which time the German biologist. Caspar Friedrich Wolf (1738-1796) offered experimental evidence with chick embryos that no preformed embryo existed in the egg of the chicken.

Theories of Particulate Inheritance

Maupertuis (1800s) recognized that preformation could not easily account for transmission of traits to the offspring from both parents, and proposed that minute particles, one from each body part united in sexual reproduction to form a new individual (Burns, 1976). In some instances, he reasoned, particles from the male parent might dominate those from the female, and in other cases the reverse might be true. Maupertuis was actually closer to the truth, in general terms than anyone realized for more than a century.

Charles Darwin (1802 -1882) suggested in the nineteenth century essentially the same basic mechanism in his theory of pangenesis, the central idea of which had first been put forward by Hippocrates (400 B.C). Under this concept, each part of the body produced minute particles (gemmules) that were contained in the blood of the entire body but eventually concentrated in the reproductive organs. Thus an individual would represent a "blending" of both parents. Moreover, acquired characters would be inherited because as parts of the body changed, so did

the pangenes they produced. A champion weight lifter, therefore, should produce children with strong arm muscles such transmission of acquired traits we know does not occur.

Pangenesis was disproved later in the same century by the German Biologist, Weismann (Burns, 1976). In a well-known experiment he cut off the tails of mice for 22 generations, yet each new lot of offspring consisted of only animals with tails. If the source of pangenes for tails was removed, how, he reasoned, could the next generation have tails? Yet, in spite of these early problems with the idea of particulate inheritance, its basic concept is the central core of our modern understanding of heredity.

Most attempts to explain observed breeding results failed because investigators generally tried to encompass simultaneously all variations, whether heritable or not. Nor was the progress of scientific thought or the development of suitable equipment and techniques ready to help point the way. It was the Austrian monk, Gregory Mendel (1822 - 1884), who laid the groundwork for our modern concept of the particulate theory (Dutta, 1964). He did so by attacking the problem in logical fashion, concentrating on one or a few observable, contrasting traits in a controlled breeding program. Both by his method and by his suggestion of causal factors (which we now call genes), Mendel came closer to a real understanding of heredity than had anyone in the preceding 5,000 years or more, yet he only opened the doors for others. Mendel performed his experiments on garden pea. The results of his eight years breeding experiments were read before the Natural History Society of Brunn in 1865, and subsequently published by the Society (Mendel, 1865), a publication with limited circulation. Consequently his work remained unnoticed until 1900, when three distinguished botanists, Hugo De Vries in Holland, Tschermak in Austria and Correns in Germany, working independently in the same line, discovered its significance and importance (Dutta, 1964). Since then Mendel's work had formed the basis of studies in genetics, and it has been called Mendelism as a mark of honour to Mendel. Mendel died before he could see his work accepted and appreciated. The reason is not far to seek. The internal mechanism of the cell leading to heredity was still unknown; chromosomes and genes directly concerned with the transmission of hereditary characters remained undiscovered.

A fraction of a century ago, the scientific community at large knew nothing of genetic mechanisms. Now, however, geneticists can with considerable accuracy, construct molecular models of genes, atom by atom. In fact, one relatively simple gene has been synthesized in the laboratory (Agarwal et al., 1970). Besides being a fascinating intellectual discipline, genetics has much important practical application today. These include its importance in improvement of food crops and domestic animals by selective breeding; applications in general medicine especially in the knowledge of such inheritable diseases as hemophilia, some types of diabetes, sickle cell, Rh incompatibilities, some form of cleanness and blindness; its legal applications include settlement of disputed parentage, baby mix-ups in hospitals, illegitimate children and estate claims which can always be clarified by genetics.

Evolution

Introduction; Evolutionists believe that higher and more complex forms of plants and animals have evolved from earlier and simpler forms. Christians and many other religions believe that different species of plants and animals were created in the forms which they exist today. There was also the belief that minute organisms like bacteria develop spontaneously in putrefying

material. Louis Pasteur, a French scientist and founder of the science of bacteriology, proved definitely in 1864 that spontaneous generation is absolutely impossible; and that bacteria would grow in favourable conditions.

Pre-Darwinian Philosophies of Evolution:

The idea of evolution dates back to the earliest period of human civilization (Sinnet, 1958). The oldest theories discussed much about the origin of life, but they were mere speculations rather than facts. These may be grouped under three headings (Dutta, 1964):

(a) Theory of eternity of the present conditions. The believers of this first theory argued that there was neither beginning nor end to the universe. The life forms which existed many millions of years ago have remained unchanged till the present date and would continue to be the same throughout eternity.

(b) Theory of special creation preached by Christians. The basis of the belief was the account of the creation of the world by God, and everything in this world including animals, plants and man.

(c) The theory of catastrophism introduced by Cuvier, a paleontologist. Cuvier believed that at one time world-wide catastrophes brought about the death of the old fauna; their extinction caused the creation of a new fauna which, according to him, took a long time covering millions of years due to the changed conditions of the environment.

The idea of evolution emanated from the researches of many early Greek philosophers of whom Empedocles was the first. He believed that organisms did not improve through successive generations but nature tried to produce perfect organisms many times, and during these period unfit forms were eliminated. Later, Aristotle philosophized that there was an inherent tendency among the organisms in nature to attain greater and greater perfection according to the changes in the environment, and that was the reason why there was a perfect gradation from the lowest to the highest evolved in nature (Dutta, 1964).

Lamarck's Theory of Evolution (Inheritance of Acquired Characters)

The first modern theory of evolution was put forward in 1809 by French biologist Lamarck (1744-1829) (Dutta, 1964; Burns, 1976). His theory resolves itself into three factors - (a) influence of the environment, (b.) Use or disuse of parts and (c) Inheritance of acquired characters.

Lamarck held the view that environment plays the principal part in the evolution of living organisms. He noted many instances where individuals of the same species grown under different environmental conditions showed marked differences. From such observations Lamarck concluded that plants react to external conditions and that as a result of cumulative effects produced by the changed conditions through successive generations new species make their appearance. In the case of animals, Lamarck believed that evolution is brought about by the use and disuse of parts. The use or exercise of certain parts results in the development of those parts; while disuse or want of exercise results in the degeneration of the parts. He further believed that new characters, however, minute acquired in each generation under changing conditions of the environment, are preserved and transmitted to the offspring (inheritance of acquired characters). Lamarck cited the example of the giraffe as having evolved from horse-like ancestors that lived

in arid regions of Africa, and had to feed on the leaves of trees. There are, however, several objections to this theory.

Darwin's theory of evolution (Natural Selection)

Charles Darwin (1809-1882) published the 'origin of species by means of natural selection'¹ (Dutta, 1964). His theory based on a mass of accurate observations and prolonged experiments led the whole scientific world to believe in the doctrine of evolution. His theory is based on the three important factors:

- (a) Over-production of offspring and a consequent struggle for existence.
- (b) Variations and their inheritance, and
- (c) Elimination of unfavourable variation (survival of the fittest).

Darwin's explanation of natural selection is this: animals and plants are multiplying at an enormous rate. As we know, no two individuals are exactly alike, the new forms naturally show certain variations. Some variations are favourable or advantageous so far as their adaptation to the conditions of the environment is concerned, and others are not so. In a population a keen struggle for existence ensues, and those individuals with favourable variations and are therefore, better fitted naturally survive, and the rest perish. Through this survival of the fittest the species change steadily owing to preservation and transformation of minute variations, and gradually give rise to newer forms. Darwin called this process 'natural selection' from analogy to artificial selection.

De Vries' Theory of Evolution (Mutation)

Huge De Vries (1848-1935) in 1901 held that small variations, which Darwin regarded as the most important from the standpoint of evolution, are only fluctuations around the specific type (Dutta, 1964). De Vries held that large variations appearing suddenly and spontaneously in the offspring in one generation are the cause of evolution. These variations De Vries called 'mutations'

Cytology

Galileo developed the first astronomical telescope in 1609, thereby revolutionizing the science of astronomy. A year later (1610), Galileo invented the microscope which led to the discovery that organisms are composed of individual units now known as cells. The microscope invented by Galileo was a simple one while Robert Hooke made the first compound microscope (Ambrose and Easty, 1970). Hooke examined thin slices of cork under his microscope in 1665, and saw that the cork was composed of box-like compartments which he called cells.

At about the same time as Robert Hooke was working in London, a Dutch drapper called Antony Van Leeuwenhoek was building himself a simple microscope, with lenses of short focal length which he ground his spare time. With this microscope he observed single-celled organisms in a drop of pond water. Leeuwenhoek was also the first to observe the nuclei of living cells, in the red corpuscles of salmon blood, although he did not, of course, appreciate the significance of what he saw. He noticed too that there were bacteria present in the tartar deposits which form on teeth. His work with the microscope let him to doubt the theory, commonly held at that time, that

living creatures could be born from dead matter. Leeuwenhoek felt certain that microbes as well as all other small living creatures are produced from their likes by means of egg, seeds or spawn, according to the nature implanted in them at their first 'generation'(Ambrose and Easty, 1970).

These early experimental observations by microscopists were the beginning of cell biology (or cytology). By the beginning of the 19th century Dutrochet put forward a unifying theory of the composition of tissues, based on careful studies of both plant and animal material. He concluded that all of these tissues were composed of globular cells of an extreme smallness'. He further suggested that these cells he observed were held together in the tissues only by 'cohesion'. These ideas of Dutrochet's are still regarded as important contributions to present day thinking on the organization of cells in tissues.

The work of Schleiden on plant cells and Schwann on animal cells, both published in 1819, led to a clearer definition of cells and their function. The deduction of these two microscopists formed the basis of what came to be known as the cell theory (Ambrose and Easty, 1970). This simply stated more clearly than had been done before that all living matter from the simplest of unicellular organisms to very complex higher plants and animals, is composed of cells, and that each cell can act independently but also function as integral part of the complete organism.

During the next decade, biologists thought that minute new cells were formed inside older ones, or that perhaps cells were formed simply by crystallization from fluid. But studies of developing embryos showed that during growth, cells duplicate themselves, one parent cell giving rise to two daughter cells, a process called cell division. This was described by Virchow in 1855 (Ambrose and Easty, 1970).

About the middle of the 19th century biologists also began to realize that what was actually contained inside cells must be of fundamental importance. Purkinje, in 1839, gave the name 'protoplasm' to the contents of cells. Although many earlier microscopists had described the nucleus, it was Robert Brown who gave it the name nucleus. After studying several species of flowering plants he found that a nucleated cell appeared to be common to all of them. It was also observed that the nucleus is always involved in cell division. Its precise role, however, remained uncertain until the development of dyes in the later part of the 19th century; some dyes specifically stain the nuclear material, and made it possible for microscopists to observe the behavior of the nucleus more clearly (Ambrose and Easty, 1970; Dutta, 1964). It is now known that cells contain many different structures which perform a wide range of functions.

The cell theory put forward by Schleiden and Schwann in 1839 forms the basis of protoplast, cell, tissue and organ culture which constitute one of the most innovative aspects of plant science today. In other words, the cell theory says that somatic cells from various parts of the plant can given appropriate conditions, develop into a whole new organism (i.e. the cells are totipotent- they have the full potential for development exhibited by the zygote).

Embryology

Aristotle in the 4th century observed chick embryos and thought that the development of organisms is brought by a causal interaction between their parts - that is, by epigenesis. Many years thereafter, embryology remained a descriptive science (Ambrose and Easty, 1970).

The first notable systematic study of developmental biology or embryology was made in 1877 by the American biologist, Louis Agassiz who investigated the embryos of starfish. Besides the two rival schools of preformationists and epigeneticists, an additional unifying concept was the recapitulation theory by Meckel in 1810. Meckel stated that the developing embryo of an animal such as bird or a mammal passes through a series of stages which resemble the adults of the forms ancestral to it; for example, the embryo of bird has gill slits at a stage of development, which have an obvious function in the adult fish but disappear in the bird at an advanced stage. Von Baer also confirmed with an improved microscope that the gill slits in the bird embryo are like those of a fish embryo but only remotely resemble those of an adult fish. Haeckel became the chief exponent of Meckel's theory of recapitulation, which became the guiding principle of embryology for many years (Ambrose and Easty, 1970).

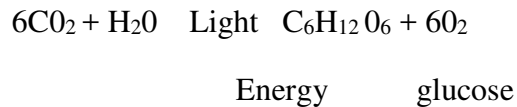
Later other embryologists including De Beer demonstrated that Von Baer's views were much more realistic. It is currently understood that it is the later stages of embryonic development, which involve minor changes in structure that are likely to be modified during evolutionary change. In the intermediate stages, embryos can develop in a limited number of ways which are controlled in part by structural and geometrical limitations, so that most embryos tend to be rather similar at those stages. It is important to point out however, that the early stages of development differ considerably in different groups. By the end of the 19th century, embryology was turned around. Many biologists began to investigate the mechanisms underlying the changes seen during development. This new line of study was pioneered by two Germans, Wilhelm Roux and Hans Driesch. Roux's investigation was called *Entwicklungsmechanik* (Le developmental mechanics). Roux performed an experiment in which he made a hole with a hot needle in one of the cells of an amphibian embryo at the two-cell stage, and found that the remaining cell gave rise to a half embryo. Weismann in 1892 put forward the theory that the course of development is laid down in the fertilized egg and that every cell is endowed with a definite fate in future development, with the result that the young embryo can be looked upon as a mosaic. The later experiments by Enders in 1895 and Herlitazka in 1897 led to the modification of Weismann's view point.

Hans Driesch, on the other hand, carried out a number of experiments with sea urchins in which individual cells, when separated from each other, develop into normal embryos. He concluded that the egg is a harmonious equipotential system and that by entelechy (from the Greek entelekhia, of perfection). Similarly, a number of great advances in the field of experimental embryology were made by the beginning of the 20th century. For example Spemann and his school showed that grafting tissues from one part of an embryo to another could modify development. He reflected on Aristotle's original postulate that embryos develop through a casual interaction between the parts.

Photosynthesis

Aristotle thought that light was necessary for the growth of plants, but it was Stephen Hales in 1717 who first clearly recognized that light was required in the process by which plants gain nourishment from the air. Previously it had been thought that plants obtained their substance only from water and the soil. During the period 1790 to 1825, experiments by Priestly, Ingen-Housz, Senebier, and de Saussure established that the green parts of plants absorb CO_2 from the atmosphere and produce O_2 when illuminated, the process being reversed in the dark. It was soon recognized that water is also absorbed and converted into organic matter in light. By the middle

of the 19th century, the German physiologist Mayer had recognized the true importance of light in photosynthesis (Bidwell, 1974), and indeed its importance to the whole biotic world, in supplying the energy for all biological processes through photosynthesis. By 1900 photosynthesis had been extensively studied and had been put on a quantitative basis shown in the equation below:



Physiologists tried to understand this reaction. Unfortunately the wrong questions were being asked and, hence, much of the work produced only puzzling results that could not be interpreted.

The groundwork for the correct approach was laid by the English physiologist F. Blackman in 1905 in his work on the interrelations of light and temperature effects on photosynthesis. He found that the rate of photosynthesis varied with temperature at high light intensities but was unaffected by temperature at low light. Further experiments indicated that the temperature-sensitive portion of photosynthesis could also be limited by reducing CO₂ concentration whereas the temperature insensitive portion did not require CO₂ (Ambrose and Easty, 1970).

Sequel to the finding of C.B. Van Niel (1924), an American microbiologist, S. Ruben and M. D. Kamen (1941) established that all of the O₂ produced in photosynthesis was derived from water, and none from the CO₂. The oxygen we breathe comes from plants. This concept of O₂ evolved in photosynthesis was related to the biological system in 1937 by the work of the English biochemist, R. Hill, who was the first to get a partial reaction of photosynthesis to work in isolated chloroplasts. His preparations could produce O₂, and simultaneously reduce added electron acceptors in light, a process that has been called "Hill reaction".

Much later M. Calvins group (1957) in California was able to demonstrate finally that the dark reaction of photosynthesis can indeed go on in darkness (Bidwell, 1974).

Photosynthesis is today regarded as the most important reaction in the world. It is in photosynthesis that the food eaten by man, animals, micro organisms and the plants themselves are produced. The oxygen used in oxidation of substances (including respiration) is produced during this process. Similarly, fuels of several sorts (fossil and non fossil fuels) are produced directly or indirectly from the products of photosynthesis.

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Chapter Five

Aspects of the History and Philosophy of Orthodox Medicine

Introduction

The very important moral characteristic of the human condition is the dual experience of freedom of the will personal responsibility. Since freedom and responsibility are two aspect of the same phenomenon, they invite comparison. People like freedom because it gives mastery to things and fellow humans. They dislike responsibility because it constrains them from satisfying their wants. That is why one of the things that characterize history is the unceasing human effort to maximize freedom and minimize responsibility. To achieve this, there has always been difficulty. This is because, increase in human freedom – (whether at the Bar-Beach Lagos – Nigeria or at the Trafalgar Square- London; in the chemical laboratory, in physics laboratory or in biology laboratory), brings with it a proportionate increase in responsibility. So the effort to do it our own way employing our own experience and expertise is accompanied with grave responsibilities. Thomas Szasz in his book on the Theology of medicine, stated: “Human life, that is a life of consciousness and awareness is unimaginable without suffering. Without pain and sorrow, they could be on pleasure and joy; just as without death there could be no life; without illness, no health; without ugliness, no beauty; without poverty, no riches and so no with the countless human experience we categories desirable and undesirable feelings while maximizing desirable ones.

This natural human tendency which is a fact of life in a complex interplay with human spiritual through the ages has formed the bedrock of the practice of medicine.

History of medicine

Without bothering the reader with the humble origins of medicine, beginning from its labyrinthine development from the Egyptian Papyri to the Greek Cult of Aesculapius and Hippocratic Oath, medicine has grown from its very humble beginnings of ritualistic treatment to a multifaceted array of disciplines, and so have the professions within the medical fraternity.

The idea of medical practice dates back to very many years ago. The early Greek Mythology has given the medical world its present day professional symbol-the legendry sign.

According to the Greek mythology, the snake represents the wizard. The stick is a symbol for the god of health. The whole picture thus represents the legendry story of the time when the healers (doctors) either jumped on top of patients, or hit them several times with a stick, and the snakes (symbol of wizard-carrier of ill health) jumped out of the patient until the later got healed.

Today the understanding and practice of medicine has gone better than this. Apart from the mythological stories, obviously among the earliest recorded stories about medical practice are those told in the Holy Bible. We are familiar with the story in which Jesus Christ used a mixture of sand and clay with his saliva to give sight to a man who has been born blind. We have heard of the story of the Pool called Bethesda in which patients jumped in if they could or were pushed in, if they could not, as soon as the water was stirred, and such patients came out of the water completely cured of their ill health. There is yet another Bible story in which St. Peter caused a cripple to rise and walk. Two of the three healing stories mentioned above surely had some divine overtone. Nevertheless, it is not quite clear whether the water in the pool had any therapeutic chemicals which made it possible for the patient to get cured.

Because the scope of the present write up cannot allow more than only a cursory survey of some of the outstanding contributions to the development of certain aspects of medicine, only very few of them from two disciplines of medicine will be given: Laboratory medicine and rehabilitation medicine.

The two versions of medicine are therefore Laboratory medicine and rehabilitation medicine. In ancient India and China, the practice of variolation in which protection against small pox was obtained by inoculating live organisms from disease postules² was in practice. The practitioners, however, did not understand their act. In 1798, Edward Jenner developed a system in which he demonstrated the protective effect of vaccination with non-virulent cowpox organisms against small-pox infection², thus providing scientific evidence to an ancient practice. In 1881, Louis Pasteur developed a vaccine for anthrax using attenuated organisms. In 1883 Metchnikoff utilized phagocytes in the development of immunity in man. In 1890, Von Behring recognized antibodies to diphtheria toxins in human serum. From, this, further work was done to discover that the human lymphocytes have got other antibody properties against infections, and this knowledge has been utilized to man's advantage for treatment of diseases. In 1899, Bodet observed that cells could be lysed by antibodies and that this action required the co-operation of certain serum factors called complement.

Blood transfusions are now common place throughout the hospitals of the world. During the medieval days, blood, usually of animal origin, was administered by drinking it. With the exception of those suffering from iron deficiency anemia, the drinking of animal blood produced little ill effect on the recipients. However, Christopher Wren later developed a type of intravenous, needle. When human beings were given blood with the system described for dogs, great mishaps occurred to the recipients. A break-through came when Landsteiner (1890) demonstrated the popular ABO grouping³. In 1675 Antony Van Leeuwenhock³ described some experiments which gave the first indication of the science of Microbiology, while in 1836 it was further discovered that Leeuwenhoek's micro-organisms could cause diseases. It then followed that if such micro-organisms could be destroyed in the course of a disease then, the victim (the patient) could be treated. Robert Koch (1843 -1910) made several contributions to the development of medical practice. He developed methods of fixing and staining bacteria using aniline dyes. He isolated the tubercle bacillus, and isolated the anthrax bacillus in pure cultures. He discovered the causative organisms for cholera. Indeed, the works of Robert Koch published in 1881 was the beginning of our present day culture media which is essential for both bacteria isolation and sensitivity testing.

Just as the historical development was going on in Laboratory medicine, (the same was going on in other aspects of medicine including Rehabilitation medicine, otherwise known as physiotherapy⁴. Physiotherapy is a medical specialty concerned with the treatment of chronic disabilities and the restoration of normal functioning to the disabled through physical modes of treatment such as exercise. Physical medicine is one means employed to assist these patients to return to a comfortable and productive life often despite the persistence of medical problems.

For centuries, man used such natural and physical agents as hot springs and sunlight to treat his ailments, but the development of physical medicine as a specialized medical service took place largely after the First World War. Two factors influenced its growth in the 20th century. These were epidemic poliomyelitis, and the two world wars, both of which created large numbers of young, seriously handicapped persons. Physical medicine was definitively established through the American Physician - Howard A Rusk's efforts to rehabilitate wounded soldiers during and after the world war II. Physical medicine then, became available for the treatment of patients with such diverse problems as burns, fractures, tuberculosis, painful backs, strokes, nerve and spinal cord injuries, diabetes, birth defects, arthritis as well as vision and speech impairment.

The objectives of physical medicine (and indeed all other forms of medicine) are the relief of pains, improvement and maintenance of functions such as strength and mobility. Physical medicine underwent a rapid expansion during the late 20th century largely because of the development of antibiotics and other fundamental advances in modern medicine which not only saved the lives of men who would not have survived illness or injury in the early decade, but also prolonged life in general.

The aim of a medical practitioner may be looked at in two ways. Let us find out these two ways by considering the two types of patients mentioned in the Holy Bible. Jesus Christ treated one patient at the pool of Bethesda. This patient was really ill, not only that he suffered untold misery and discomfort, the most important point about him, however, was that if he was not treated he also stood a chance of losing his life much earlier than expected. The action of Jesus Christ in healing this patient therefore, solved two problems. First, it prolonged the patient's life. Secondly, Christ's action removed the discomfort in the patient's life.

The other patient was blind from his mother's womb. From this man's action, it was obvious that he was suffering a lot of discomfort. However no part of the story gave any indication that there was any threat to his life. It therefore appear that the action of our Lord Jesus Christ was aimed at making the man's life more comfortable.

When a surgeon carries out a surgical operation to remove a benign growth on a patient's eyelid, the surgeon does that because his patient complained of discomfort thinking about this out growth. When a Medical Lab Scientist detects the presence of an organism which is causing an ill-health in a patient he is on the way to launching an attack on the organism. He may go further by carrying out a sensitivity test on the patient's specimen. When he makes the results of his findings known to the patient's doctor, and the doctor uses the result for a successful treatment, because there was a threat to this patient's life, the action of the medical Lab Scientist and indeed that of the doctor has been aimed at prolonging the patient's life. A nurse who is in the hospital ward looking after a patient ensures that the patient takes his drugs. She does more; the kind words as well as the feminine touch all help the patient's early recovery. These prolong the

patient's life. If we look at the action of every health professional in bringing his patients health back to normal, we will find that professional is either helping to prolong the patient's life or at least making him/her more comfortable.

It is therefore right to say that the overall aim of any medical practice is to ensure that the patient's life is saved and made longer and to ensure that such patient's life is made worth living.

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Chapter Six

Environmental (Natural) Disasters

Introduction

The history of disaster on mother earth can be traced to the Holy Bible when God in annoyance threw out the first man (Adam) and woman (Eve) from the Garden of Eden after eating the forbidden fruits. Ever since this first disaster, mankind has never stayed on earth without woes (man-made and natural disasters). The early man lived under the perpetual fear of volcanic eruption, earthquake and a host of other natural disasters without protection. His life was based on the principles of survival of the fittest in the harshest of environment. With time modern man has developed to continue to battle with these disasters. Even with virtually everything at the disposal of modern man to make the world a better place for all to live in, the world is faced with greater disasters. In the process, numerous lives are lost daily.

Today, these disasters are devastating the world with ease. Since human beings have no control over most of the natural disasters, the disasters have a field day in deciding where and when to strike without hindrance. Volcanic eruption, earthquakes, drought, flood, disease etc, have claimed numerous lives and caused untold hardships to humanity.

Epidemics of killer diseases are a common experience worldwide with African countries taking the lion share. This situation in Africa is not unconnected with poor sanitary conditions, weather, poor economy, hunger and starvation, unpardonable neglect and ignorance. In the rural communities, drinkable water supply is luxury. The inhabitants share the same stream and stagnant pools of water with animals, germs and dirt. Electricity supply and good road network are not considered a necessity. Even as the world is faced with all these woes, a lot of money is being expended on wasteful ventures like acquisition of military wares - capable of total extermination of human existence.

Today, natural and man-made disasters are competing keenly for human destruction. Where man-made disasters hands-off, natural ones take over and vice-versa. In the present text, few of the major natural or environmental disasters of man (diseases, flood drought and earthquakes) are discussed with a lot of local examples.

One of the natural disasters facing human population in the world today is disease. This is especially important in Africa. Undoubtedly, diseases have seriously impeded human mastery of environment and some have greatly affected population distribution. Endemic diseases which are notoriously prevalent in Africa have not only caused high mortality but have a very debilitating effect upon human vitality. Among the wide variety of pestilential diseases which occur, the most serious problem is malaria; especially as it is so widespread. Malaria which is caused by plasmodium parasites is transmitted by the vector mosquito. It is believed by historians to be responsible for the dramatic failure of several

expedition to West Africa by conquering European adventurers. Also the designation of the West Coast of Africa as the 'Whiteman 's grave' is no small tribute to malaria.

(1) Malaria is essentially a disease of the tropics and subtropical countries; common among impoverished and low income group of people; wherever a high rate of biting by *Anopheles* mosquitoes is characteristic. In Africa, south of Sahara with about more than 400 million people, more than one million infants and children die of malaria annually. Nearly 50% of all deaths in the developing countries of Africa occur in children under 5 years of age from a combination of viral, bacterial and parasitic infections aggravated by malnutrition. Among the parasitic diseases, malaria is the main killer and the reference to it as "King Herod" of diseases is justified.

(2) Sleeping sickness or trypanosomiasis is a communicable disease caused by trypanosome parasites and transmitted by the vector tsetse flies. This disease is a major scourge in Africa. The early fall of the rich and powerful Mali Empire was attributed partly to human trypanosomiasis. Also sleeping sickness which has been called the "bane of Africa" also prevented permanent settlement in the interior of tropical Africa by Arabs, the continents first colonists. This disease is still regarded as a disaster to the continent, being a severely disabling and highly fatal disease. Also it is at present a major obstacle to the development of Africa between the Sahara and its southern part. It is responsible for over 7,000 human deaths each year. In addition to great loss of human life from the disease itself, it also causes human starvation and malnutrition resulting from the removal of cattle by nagana, a fatal disease of cattle.

(3) Though not as widespread as malaria, Yellow fever (YF) is a major disease whose epidemic outbreaks have caused a lot of human death and untold hardship. The YF virus (both forest and urban) is transmitted by mosquito vectors. In Africa, the groups of mosquitoes known to be naturally infected are the *Haemagogus* and *Aedes* genera. However, monkeys are the natural host of the virus. Yellow fever is known all over the world as a terrible killer disease. It is capable of wiping out a large population where and when it decides to strike. It had claimed millions of lives all over the world. As example, Britain lost 20,000 - 27,000 men to epidemics in 1741, France lost 29,000 to Yellow fever in 1802, America lost 20,000 in 1878. In Ethiopia, about 30,000 deaths were recorded between 1960- 1962.

In West Africa and other African countries many causes of yellow fever disaster might have passed unrecorded. In Nigeria, two typical cases did not go unrecorded. In Ogbomoso in Oyo State, cases of yellow fever mostly among the Europeans were reported in 1913 and 1934. Another outbreak was recorded in 1946 during which 160 persons were infected without death records. Between 1951 and 1952, the biggest yellow fever disaster devastated the then Eastern Nigeria. Though there was no accurate death registration but 600 deaths (472 males and 128 females) were recorded. In 1969, there was outbreaks of yellow fever in the Jos Plateau and in 1967, at Okwoga District of Benue Plateau, a total of 60 lives were lost in these outbreaks.

The last series of the cases of yellow fever epidemics in Nigeria is the latest outbreak in September 1986 in some parts of Benue. In this devastating outbreak a conservative estimate of 470 lives were claimed by the disease before it was put under control.

Recently, in 1987, the disease swept across to Cross River State where it left more than 170 people dead.

(4) One of the major natural disaster's that has quietly spread across the continents of the world is the Acquired Immuno-deficiency Syndrome (AIDS) which is commonly called "Slim-disease" in Africa. This disease which is caused by AIDS virus (Human Immuno-deficiency virus or HIV) first surfaced in 1980 - 81. The origin or source of this virus is still a matter of controversy.

Today, this highly contagious disease is spreading rapidly through so many routes. One horrifying aspect of AIDS is that at the meantime, the consensus is that all infected individuals will eventually die of AIDS. Of the 30,000 cases of AIDS reported to the US Department of Health by January 1987, 15,000 have died. It is estimated that at least 1.5 million people in US carry the AIDS virus. It is projected that by 1991, 270,000 people will have AIDS and 179, 000 would have died. Although detailed figures of AIDS cases in Africa are difficult to collect, more than two million carriers, and 50,000 deaths were estimated by WHO. Kenya was the first country in Africa to acknowledge officially the presence of AIDS. In Nairobi, of the blood samples from prostitutes in 1984, 6% showed evidence of infection. In 1985, 2% of the 1000 women in labour showed signs of infection. In Nigeria, the Minister of Health, early in 1988 announced the presence of AIDS in the country but it is uncertain what proportion of the population is infected (that is those in whom AIDS anti-bodies are present). However, AIDS has claimed the life of two prostitutes in the recent times.

(5) Onchocerciasis - River Blindness. The vector is the blackfly (Simulium).

(6) Other serious pestilential disease of man include cholera, measles, filariasis, plague, bilharziasis etc, These and many other diseases have contributed massively to the very high morality in African countries which is nearly always 100 – 200 per thousand.

Flood

Flood is high-water stage in which water over-flows its natural or artificial banks on to normally dry land, such as a river inundating its flood – plains (that is, flat land area adjacent to a stream composed of unconsolidated sedimentary deposits - alluvium). Floods are generally associated with the normal season of high water levels, as then the soil is usually saturated; but they occur exceptionally as a result of violent storms which rapidly saturate the upper layers of the soil and leave the lower parts dry. Moreover, in snow covered regions, flooding may sometimes be the result of an exceptional and temporary rise in temperature, bringing about the melting of the snow over a considerable vertical section. The danger of flooding is automatically increased by factors such as steepness of gradient and impermeability, which increase the rate of flow.

The effects of floods on the well-being of man range from unqualified blessing to catastrophes. The regular seasonal spring floods of the Nile River prior to construction of the Aswan dam, for example, were dependent upon to provide moisture for the fertile flood plains of its delta. The uncontrolled floods of rivers in most cases, however, have repeatedly caused natural disaster when these rivers habitually rechart their courses.

Uncontrollable floods likely to cause considerable damage commonly result from storms or excessive rainfall over brief periods of time as, for example, the floods of Paris in 1658 and 1910; Warsaw (1964), of Frankfurt Main 1930. In Nigeria the Ndiogoro and Ogunkpa flood disasters in recent times are typical examples. These flood disasters in Nigeria caused hardship and untold misery to the inhabitants - which include damage to property, houses and crops as well as population maladjustment, hunger, famine and disease.

Prevention of floods or reduction of possible damage from them can be achieved through the construction of retainer structures such as dams on principal water courses, which provide storage reservoir space for flood waters. Embankments, levees and bypass spillways are provided in areas where the terrain prohibits the construction of high-level dam construction.

Drought

Drought is lack or insufficiency of rain for an extended period that causes a considerable hydrolic (water) imbalance and, consequently, water shortages, crop damage, stream-flow reduction, and depletion of ground water and soil moisture. It occurs when evaporation and transpiration (the movement of water in the soil through plants into the air) exceed precipitation for a considerable period. Drought is the most serious physical hazard to agriculture in nearly every part of the world. Efforts have been made to control it by seeding clouds to induce rainfall, but these experiments have had only limited successes.

There are basically three kinds of drought:

- (1) Permanent drought characterizes the driest climate: the sparse vegetation is adapted to aridity, and agriculture is impossible without continuous irrigation.
- (2) Seasonal drought occurs in climates that have well-defined annual rainy and dry seasons; for successful agriculture, planting must be adjusted so that the crops develop during the rainy season.
- (3) Unpredictable drought involves an abnormal rainfall failure; it may occur almost anywhere but is most characteristic of humid and sub-humid climates. Usually, brief and irregular, it often affects only a relatively small area.
- (4) A fourth kind, invisible drought, can also be recognized: in summer when high temperature induce high rates of evaporation and transpiration, even frequent showers may not supply enough water to restore the amount lost; the result is a borderline water deficiency that cuts crops yields.

A period of abnormally low rainfall of shorter duration and less severe than a drought is called a dry spell. Attempts have been made to differentiate a drought from a dry spell, according to the number of rainless days; but differentiation should be based on the effects of these dry periods, not on some arbitrary length of time.

In much of West Africa drinking water for man and beast is poor in quality and inadequate in quantity. Since cropping depends mostly on rainfall, a delay in the rain often result in loss of crops and famine while long drought may cause extensive starvation, mass migrations of people to urban centers, where water is available and loss of thousands of herds of livestock. For instance, during the Sahelian drought of 1973/74 in West Africa, Mali alone lost 1.7 million cattle and 4.5 million sheep and goats.

In Nigeria, Borno and its surroundings have historically been one of the drought regions of the country, part of it lying in the Sahara's climatic zone. This area has periodically suffered from drought and the first record of it was made in 1908. In 1942, Lake Chad suffered the driest drought in living memory. In 1972, thirty years later, after reaching peak levels, it began to recede again. Within 4 years the Lake had receded by at least 80km; during which period the annual rainfall dropped by some 75%. By this great drought, this area was designated "disaster zone". This disaster (1972 - 1974) claimed thousands of livestock in Borno which is the country's largest producer of livestock. About 900,000 tones of major crops were lost to this drought. The relief supplied to drought victims was enormous in monetary terms. For instance, between 1972 and 1974, the Federal Government gave 13 million naira to the drought affected states, that is, in addition to the aid provided by various agencies within and outside the country.

In Nigeria, certain farming practices, such as the indiscriminate felling of trees, over-grazing and shifting cultivation, aggravated drought conditions to such an extent that some farm lands were turning into desert. Long-term solution to drought includes water conservation, intensive tree-planting programmes and the setting up of meteorological station. Large-scale development of irrigation projects and rural water supplies through damming rivers and tapping the underground water resources by digging wells are also part of long term solution to" drought problems.

Earthquake

The forces that produce earth movements cause the build-up of great pressures resulting in *fractures, faults* or *displacement* in the rocks. These rocks become deformed, but are held in place by frictional drage, until the strain becomes so great, that rocks suddenly fracture in a series of jarring movements, releasing their pent-up energy in the form of *EARTHQUAKE*.

Earthquakes shock waves spread out in all directions, their speed varying with type of rock. In dense rock such as granite, the speed is far greater than in loose sand or gravel. The shock waves are strongest near the centre of the earthquake or *epicentre* as it is called, and becomes weaker as they travel outwards. Even so, the shock waves from a major earthquake may travel right round the earth. When the volcanic island of Krakatau exploded in 1883, the shock waves were felt over 3000 miles away in Australia.

It is estimated that a million earthquakes occur every year throughout the world. Fortunately, most are weak. Violent earthquakes have caused great destruction and terrible loss of lives. For instance in Messina in the island of Sicily in 1908, over 100,000 people died, and the Japanese earthquakes o 1923 caused 142,000 deaths.

Chapter Seven

Philosophy of Agriculture

Industrial and Agrarian Revolutions.

After the collapse of the Roman empire in 476 A.D, which may be regarded as the end of the ancient times and the beginning of the medieval period, there was no major progress in the realm of agriculture until in the 18th century

At the beginning of the Medieval period or Middle Ages (476 - 1378 A.D) most peoples of the world were highly superstitious and were interested mainly in warfare and religion. Although the ancient people of Egypt, Mesopotamia and Greece bequeathed much to mankind in the area of scientific discoveries, there was very little progress made in the advancement of science during this period. Farming was largely left in the hands of illiterate feudal peasant farmers or vassals who had nothing to contribute to the advancement of agriculture. Notwithstanding that civilization had earlier spread from Egypt and the Middle East to Europe, notably Greece and Rome, the majority of the people of Europe were not accustomed to the Greek and Roman learning and culture. Therefore, during the period known as the "Dark Ages" (500 - 800 A.D) there was no visible progress in learning and civilization.

However, towards the end of the medieval period there arose a new type of civilizing influence which began in Europe. Thus, there was a great desire in the minds of people to know more about the world and their environment. Initially this new-awakening called 'Renaissance' was confined to discovery of new geographical areas and to literary leaning. This Renaissance spirit reached its peak in the 15th and 16th centuries when human thought and activity spread to all branches of learning including science. However, although learning, commerce and discoveries started to attract man's attention during the Renaissance period little was done in agricultural development.

During this period almost all the occupations of the learned urban dwellers had no direct contribution towards food supply, and all the food requirement of the town dwellers had to come from the rural vicinity. The migration of people from the rural areas to the more decent urban life further helped to compound the situation due to increase in urban population, depletion in the number of rural farmers and consequent decrease in food supply. As a result of diminishing supply of feed and raw materials people were no longer interested in only identifying problems

and their effects but also in finding practical solutions to these problems. This led to the 18th century industrial revolution.

Industrial Revolution was characterized by discoveries and inventions of labour and time saving machines and, especially, the harnessing of steam, fuel and electrical energy to provide the motive force to drive these machines. This new development which started in Britain extended to other western European Countries and the United States of America in the 18th Century and it resulted on the establishment of industries and factories whose output were aimed at bettering the human lot.

Industrial Revolution brought along with it the Agrarian Revolution, i.e, a great beneficial change in farming techniques. As the output of factories and industries increased, the demand for further supplies of agricultural raw materials rose. Furthermore, as people left the farm for more lucrative jobs in the factories and industries both the farming population and agricultural raw material supply decreased drastically. As a result of these, attention was focused towards increasing farm and labour productivity through the application of science and technology. Consequently, labour and time saving machines as well as new scientific methods and practices were introduced into the farm. In other words, agriculture and industry became interdependent for their survival, and drudgery was removed in the farm.

Discoveries and inventions that Resulted in

Agrarian Revolution

Some of the inventions and discoveries that brought about the Agrarian Revolution are discussed below:

Seed Drill: This was a horse drawn cultivator that planted seeds in rows. It also loosened the soil and eliminated weeds.

Crop rotation: This increases soil fertility by rotating crops of different nutritional requirements and rooting characteristics in a piece of land, instead of the use of shifting cultivation.

Stock breeding: This involves the mating of animals with desirable hereditary traits to increase the productivity of farm animals.

Inorganic fertilizer: This is a chemical substance that enriches impoverished soil. This not only increases crop yield but also makes possible the use of piece of land over and over again.

Cotton gin: This facilitates the process of separating cotton wool from cotton seeds.

Agricultural writing: This popularized the new inventions and discoveries so that a great number of people made use of them.

Tractor: This is an internal combustion engine to which are coupled implements that facilitate the tilling of a large area of land and also weed control.

The Steam Engine; Gasoline and Electric Motor; These are engines that speed up farm operations by providing motive forces generated by steam, petrol or electric current respectively, to drive farm implements.

Threshing machine: This is a machine that simplifies the separation of husks from the grains.

Steel plough: This is a steel implement that is coupled to the tractor to help in the tilling and cultivation of large area of land in a short time.

Cotton planter: This is similar to the seed drill for planting of cotton seeds.

Electric milking machine: This increases the efficiency of milking dairy animals especially cattle.

Cream Separator: This is a machine that facilitates the separation of the fat or oily part of milk, which can be used in the making of butter.

Refrigerated car: This helps in the preservation of the nutritional quality of food product for some length of time.

Automatic chicken brooder: This is a device that enables artificial brooding of a large number of day-old chicks at the same time.

The incubator: This is a device for artificial hatching of a large number of fertilized poultry eggs at the same time.

The Combined harvester: This is a machine that simplifies and quickens the cutting and gathering of grains as well as binding the grains into sheaves, or threshing of the grains.

Artificial Insemination (A.I): This is the process of collecting semen from a high grade male and transferring the semen into the reproductive tract of a female. The off-spring resulting from egg fertilized by this process usually possesses the traits or characteristics desired by the farmer. A.I. technique also facilitates the transfer of the good traits of superior animals to distant places through collection, storage and transportation of the semen for the upgrading of non-descript scrub animal.

The Green Revolution

Green Revolution refers to the scientific break-through in the early sixties of this century which led to an increase in agricultural productivity.

This was mainly due to;

- (i) Discovery and adoption of new high-yielding, early maturing and disease resistant varieties of crops particularly cereal grains, and
- (ii) The introduction and adoption of new agricultural techniques and practices suitable for the local environment. These two events started in the less developed, poor and highly populated Southeast Asian countries that formerly could not produce enough food for their populace.

This revolution occurred as a result of awareness of the importance of research to develop better and improved varieties of crop that could thrive well in these regions. There was also the realization of the importance fertilizer, pesticide, herbicide, locally adapted agricultural machinery as well as irrigation and other better farm management practices for increased food production for man and livestock. As a result of this break-through many of these Southeast Asian Countries such as Philippine, Pakistan and India with high population density and high birth rate are now able to meet their domestic need of such staple foods of cereal grains. These countries are also now great exporters of these products.

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Chapter Eight

Environmental Effects of Chemicals, Plastics, Textile Wastes, and Other Materials

Introduction

The study of our environment has expanded rapidly in recent years. Although this study is one of the oldest interests of human beings, it can also be considered one of the newest. Like other living creatures, human beings live in, depend on, and influence the environment. Thus every human society has beliefs, myths, and attitudes about the environment. Our rapidly expanding technological civilization creates new demands on all aspects of the environment. Because more people are alive today than have ever lived on the earth at one time, we are using more resources rapidly than any civilization has used before. We also produce more wastes more rapidly than any previous civilization. Human beings affect the environment in many ways, chemicals produced in various countries of the world have been found throughout the oceans and in Antarctic creatures, burning of fossil fuels has increased the carbon IV oxide concentration of the atmosphere; industries spew smoke that makes lakes acidic, kills fish, and leaves toxic metals in and on the soil, thus killing crops.

Man's concerted effort towards industrialization and protection of territorial integrity has led to the contamination of the natural environment. This is environmental pollution. Environmental pollution may result from industrial and commercial activities when substances resulting from these activities enter the environment and attain levels which may cause discomfort and/or harm to man and his environment. The pollution of these environments has been found to result from man's determination to match desire with production through the establishment of various industries with potentials to pollute the environment. Industry, big or small, is a source of pollution of land, water and air.

Paints wastes are in the form effluent and sludge; and in the case of sludge, one is no longer faced with water pollution problems but a solid waste disposal situation. However, leaching may result in the contamination of both soil and underground water with toxic and hazardous materials, notably heavy metals. Environmental contamination by heavy metals such as cadmium, lead, zinc and copper has aroused great concern in the last decade because these metals constitute hazards to man and other organisms when accumulated within a biological

system. The most affected of these biological systems are natural waters which often receive industrial effluents replete with metals such as mercury, zinc, cobalt, silver, cadmium, lead and chromium into our environments.

Environmental pollution may also result from spills of toxic chemicals, gasoline, liquid propane gas and other hydrocarbons, leakages from hazardous wastes landfills, unlined lagoons and septic pits. Other forms of pollution include high nitrate (e.g. from excessive fertilizer application), pesticides and herbicides, cattle feed-lots and acid-rain resulting from industrial waste-air pollution among others.

Environmental Pathology

A branch of pathology concerned with exogenous factors that influence human health. These factors are by convention limited to non-living physical and chemical agents, such as the following:

- (i) Chemicals: Metals (mercury, cadmium, lead, arsenic, beryllium); Organic solvents/textiles wastes (benzene, toluene); Aromatic hydrocarbons; Alcohols (ethanol, methanol); Fungal and plant toxins; Afla-toxins; Tobacco; Caragenans.
- (ii) Synthetic Chemicals and drugs: Pharmaceuticals (diethylstilbestrol, thalidomide); Pesticides (dioxin, Organophosphates); Polychlorinated biphenyls (PCBs); Aldehydes (Formaldehyde, acetaldehyde).
- (iii) Physical agents: Ultraviolet radiations; ionizing radiations; Kinetic injury.

The responses to environmental agents may be divided into two classes: immediate and delayed. The immediate or acute effects are usually easily identified in establishing a cause-and-effect relationship, even though the mechanisms involved may be very complex. A casual relationship between an agent and the delayed or chronic effect is much more difficult to establish, and many of these associations have only begun to be established. The exposure producing a delayed effect may be small, and the substances common place and difficult to identify. Furthermore, the environmental agent may be one of several factors eliciting a disease process. Virtually any type of pathological process may result. Reproductive and developmental abnormalities, neoplasia, mutagenesis, inflammation, and degenerative diseases are examples of long-term consequences shown to be influenced by environmental agents. For example, exposure to such agents as asbestos, plastics, arsenics, or tobacco may be associated with an increased incidence of cancer of the lungs a decade or more, later. The presence of these chemicals in the atmosphere may also affect weather in a number of ways. Heavy precipitation is attributed a substantial source of air pollution. Industrial smoke reduces visibility and also ultraviolet radiation from the sun. These affect the photosynthetic efficiency of crop plants.

Investigation of these etiological agents and the response or reaction by organisms has led to the development of some general principles regarding exposure to toxic substances.

- (1) All chemicals are toxic; none are harmless. It is the dose, rate of exposure, and route of entry into the body that determines whether toxic responses will occur or not.
- (2) All agents evoke multiple biological responses in the body.
- (3) Most of the biological responses are undesirable, leading to the development of pathological lesions.
- (4) A given dose of an agent does not produce the same degree of response in all individuals.
- (5) The time and extent of the response is influenced by genetic factors of the organisms and other physical and social factors such as age, nutrition and intercurrent diseases which include those produced as a result of accidental or purposeful drug over-dose, drug interactions, poisoning which is job-related, and toxic responses to naturally occurring chemical agents. Among the problems of principal concern are the control of air quality, excessive exposure to some toxic trace metals, plastics, textiles wastes, asbestos, and the exhaust fumes of internal combustion engines. Furthermore, self-applied agents, such as alcoholic beverages and tobacco smoke represent major environmental concerns. Pesticides, essential for maintaining high levels of food production for large population, and their breakdown products pose major challenges to environmentalists.

Environmental Effects of Metals

Metals of particular toxic significance in humans are arsenic, zinc, gold, silver, copper, mercury, lead, cadmium, manganese, chromium, cobalt and molybdenum. Heavy metals have a density of at least five times greater than that of water. They are of particular toxicological importance. Some metals such as iron, zinc, copper, molybdenum, chromium, cobalt and manganese are essential for life but can be toxic in high doses. A dietary deficiency of these metals can lead to certain pathologic conditions. Others, such as platinum and tantalum, appear to be inert within the human body still, others such as mercury, nickel, tin, lead and cadmium have not yet been shown to be essential to life but are present in human tissues and are toxic in high doses. Although heavy metals have many physical properties in common, their chemical reactivity is quite diverse and their toxic effects on biological systems are even more diverse.

A metal can be regarded as toxic if it injures the growth or metabolism of cells when it is present above a given concentration. Almost all metals are toxic at high concentration. Copper, for example, is an essential constituent of cells, but if the copper intake is increased it becomes highly toxic. Like copper, each metal has an optimum range of concentration, in excess of which

the element is toxic. When the optimum range for a particular metal is narrow, the risk of toxicity increases, thus even a minor environmental increase can have serious effects.

Metals exert their toxicity on cells by interfering with cell metabolism in any of several ways. The most important of these are the effects on enzyme systems. The more strongly electronegative metals (such as copper, mercury, and silver) bind with amino acids, carboxylate, and sulfhydryl groups of enzymes, thus blocking enzyme activity. Another mechanism of action of some heavy metals (gold, cadmium, copper, mercury, lead) is to combine with the cell membranes, altering membrane permeability. Others displace elements that are important structurally or electro-chemically to cells which then can no longer perform their biological functions

Specific effects of heavy metals

Arsenic intoxication: Arsenic is an element that is not essential for human nutrition but is normally found in trace amounts in human tissue (less than 0.10 part per million). It has been used therapeutically in small doses since ancient Greek civilization for a variety of disorders, ranging from skin rashes and anemia to cancer. During the 19th century, organic arsenical such as arsphenamine were used in the treatment of syphilis. In higher doses, arsenic compounds are extremely poisonous and have been used as herbicides, insecticides, rodenticides, and have even been implicated in homicides. The biological effects of arsenicals vary. In general arsenic compounds are protoplasmic poisons that block cell and tissue respiration. Arsenicals also paralyze smooth muscle; disrupts the continuity of capillary endothelium, causing small hemorrhages and blocks cell division.

Cadmium diseases: Food poisoning from contamination of food and drink by Cadmium-plated containers have been recorded. However, the principal human risk is from industrial exposure, namely, inhalation of cadmium dust. Cadmium is primarily a respiratory poison and has lethal potential than most other metals, with mortality rate of 15 percent in poisoning cases. Mild cadmium intoxication causes smarting of the eyes, dryness and irritation of the throat, tightness in the chest, and headache. With increased exposure, the respiratory distress increases with uncontrollable cough and gastrointestinal pain, nausea, vomiting and diarrhea.

Chromium intoxication: Chromium occurs in nature in several Chemical forms and valiancy states. A deficiency in chromium increases the toxicity of lead. Pathological changes are associated with the excessive intake of hexavalent chromium compound. These compounds are irritating and corrosive when absorbed through the digestive tract, skin or alveoli of the lungs. Inhalation of dusts or mists of hexavalent chromium is irritating to the upper respiratory passages and causes sneezing, nasal discharge and vascular congestion. Spasm of airways (bronchospasm), resembling an asthmatic attack, may occur, and could possibly cause death if it is prolonged.

Chromosomal aberration: An aberration is *a* change in the normal component (Karyotype) of chromosome involving an alternation either in chromosome number (heteroploidy) or in chromosome structure (structural change). Structural changes within and between chromosomes result from damage to the DNA, leading to breakages across the chromatids. Structural aberrations occur spontaneously, and in humans their incidence increases with age. However, their frequency can be very much increased on exposure to physical mutagens (X-rays, neutrons, ultraviolet light) or chemical mutagens/carcinogens (aflatoxin, burnt products of plants and animal origin, alkylating agents).

Other metals and their intoxication/poisoning effects are: Cobalt -paralysis and enteritis; Copper-nausea, vomiting, diarrhea, abdominal cramps, comatose, Gold - disordered blood formation; Lead - headaches, dizziness and insomnia; manganese - hallucinations, delusions, loss of facial expression, rigidity, slowness of movement and impairment of speech; Mercury - numbness, staggering gait, constriction of visual fields, convulsions and mental retardation; and Molybdenum- irritation of the eyes and mucous membranes of the nose and throat.

Environmental Effects of Plastics

Although enormous quantities of man-made fiber and elastomers are produced each year, the major consumption of synthetic polymers are Plastic-materials used in the form of sheet, pipes, films, and most important of all moulded objects such as toys and bottles, knobs, handles and switches, dishes, pens, automobiles, valves, gears, bearings, cases for radios and television sets; boats , and even houses. The molecular structure of plastics is of two general kinds; long molecules, either linear or branched, and space-network molecules.

The linear and branched polymers may be more or less crystalline and include some materials also used in fibres, nylon for example. They include the various polyalkenes, e.g. polyethylene polyvinyl chloride, polystyrene etc. On heating, these polymers soften, and for this reason are, called THERMOPLASTIC. It is in this softened state that they can be molded or extruded.

Space-network polymers (or resins) are highly cross-linked, to form a rigid but irregular or three-dimensional structure, as in phenol-formaldehyde or urea-formaldehyde resins. A sample, of such materials is essentially one gigantic molecule. Heating does not soften it, since softening would require of covalent bonds. Indeed, heating may cause formation of additional cross links, and thus make the material harder. Such polymers are called THERMOSETTING polymers. Certain linear, thermoplastic polymers are, like the space-network polymers, amorphous. On cooling their molecules from a rigid but irregular three dimensional structure which are held together not by covalent cross links, but by dipole-dipole forces which lock molecules into position before they can settle down into the regular arrangement required of a crystal. These materials are called GLASS poly (Methymethcrylate) - Plexiglas of which Lucite is the commonest.

We wear these man-made materials, eat and drink from them, sleep between them, sit and on them, turn knobs, pull swatches, and grasp handles made of them; with their help we hear sounds and see sights remote from us in time and space; we live in houses and move about in vehicles that are increasingly made of them yet the use or misuse of these plastics constitute serious environmental hazards. Man sometimes deplores the resistance to the elements of these seemingly all too immortal materials, and fears that civilization may someday be buried beneath a pile of plastic debris; plastic cigar tips-broken glasses, damaged cars, and damaged toys are found littered everywhere in our environment. They make the environment dirty and unhealthy.

Environment Effects of Radioisotopes

Low levels of radiation occur naturally from several sources. Natural radiation can come from earth materials, originate in outer space, or result from the action of radiation on materials in the biosphere. Some radioactive elements occur as natural minerals in the earth's crust. Uranium mined for use in atomic energy in nuclear power plants, is one such element. Minerals containing Uranium and other radioactive elements emit radiation into the environment, but characteristically, at very low levels. Potassium 40 is among the more common radioisotopes, and it is one of the elements required for all living things. Potassium 40 occurs in soils and rocks particularly granites. The distribution of radioisotope bearing minerals like the distribution of all mineral resources, is not uniform, and the background radiation from, such sources varies considerably around the earth.

An important characteristics of a radioisotope is its half life, which is the time required for one half of a given amount of the isotope to decay to another form. Every radioisotope has a unique, characteristic half-life. Radioactive iodine for example, has a short half-life of 8 days. Radioactive carbon (carbon- 14) has an intermediate half-life of 5570 years. Uranium-235 has a half-life of 700 million years. A radioisotope's degree of danger to the environment or to human health depends on the kind of energy the radiation emits, its half-life, and the ordinary chemical activity of the isotope.

Radioisotopes affect the environment in two ways

- (a) *emitting radiation that affects other materials, and*
- (b) *entering the normal pathways of mineral cycling and ecological food chains.*

The explosion of an atomic weapon does damage in both ways. At the time of the explosion, intense radiation of many kinds and energies is sent out which kills organisms. The explosion generates large amounts of radioactive isotopes, which are dispersed into the environment. Nuclear bombs exploded in the atmosphere produce huge clouds that send radioisotopes directly into the stratosphere, from where the radioactive particles may be widely dispersed by winds. Atomic "fallouts", the deposit of these radioactive materials around the world was a major

environmental problem the 1950s and 1960s when the United States, Russia, China, France, and Great Britain were testing and exploding nuclear weapons in the atmosphere.

One of the radioisotopes emitted and sent into the stratosphere by atomic explosions was Cesium-137. This radioisotope was deposited in relatively small concentrations but widely dispersed in the Arctic region of North America. It fell on reindeer moss, a lichen, that is a primary winter food of the Caribou. A strong seasonal trend was found in the levels of cesium-137 in Caribou. The level was the highest in winter when reindeer moss was the principal food, and was lowest in the summer. The more a group depended on Caribou as its primary source of food, the higher was the level of the isotope in their bodies.

The cesium was moved a long distance by biospheric phenomena. After entering specific ecosystems through the vegetation, it underwent biomagnifications, or ecological food-chain concentration. This biomagnification was unknown until radioisotope and toxic organic compounds were found to be occurring at higher and higher concentrations at higher and higher trophic levels. Food-chain or trophic level concentration is one of the major ecological factors in environmental toxicology.

Environmental Effects of Organic Compounds

Organic compounds are compounds of carbon produced either by living organisms or artificially. It is difficult to generalize about the environmental and health effects of artificially produced organic compounds because there are so many of them. They have so many uses, because they have a potential for so many different kinds of effects. Artificial organic compounds are used primarily in industrial processes, pest control, pharmaceuticals, food additives, and other consumer products.

Organic compounds can have physiological, genetic, or ecological effects. Because artificial organic compounds are new and organisms have had little time to adjust to them, they are more likely to be toxic to living organisms than natural organic compounds. Some organic compounds are potentially more hazardous than others. For example, rapidly degrading substances are less likely to cause problems as chronic hazards than slowly degrading ones. Fat-soluble compounds are likely to undergo biomagnifications. The likely problems posed by an organic compound depend on the pathways it will follow through the environment. The likely path can be determined for a chemical by testing its solubility in water, absorption by natural solids leaching rates, volatility, and oil or fat solubility. Artificial organic compounds are spread widely throughout the biosphere and can be found in many species.

Environmental Effect of Pesticides

Ever since the beginnings of agriculture, pests have been the bane of farmers. Pests have been known to consume about one third of the total potential crops before harvest and 10 percent after harvests. Pesticides have been used in one form or another for more than 2000 years, but pesticides use became widespread only in the last century. The ideal pesticide would be a "magic bullet", a chemical that affects only the pest and no other living thing or any other aspect of the environment.

The first modern chemical pesticides were arsenic compounds used on potatoes, cotton, and apples. Although these are effective on the insect pests of those crops the compounds are also highly toxic to human beings and to other forms of life. Modern pesticides have been mixed blessings and the center of major environmental controversies. Pesticides help to reduce some human diseases that are spread by insects. The primary problem with pesticides is that they are intentionally toxic, and if they are toxic to undesirable organisms, they may also be toxic to desirable ones, including humans. This danger was brought to public attention in 1962 with the publication of Rachel Carson's *SILENT SPRING*, a book that popularized the view that DDT and other chemicals might be affecting the reproduction of birds. DDT is a classic case of pesticide thought to be safe and effective. It contributed to the control of at least 27 diseases, and was credited with saving 5 million lives and preventing 100 million illnesses. Early experiments including those with human volunteers indicated that DDT had little direct (i.e. acute) toxic effect on people, although it was later discovered that the compound was stored in body fat. DDT and other chlorinated hydrocarbons are known to be persistent. At first, this appeared to be an advantage; for example, they could be sprayed on the walls of a house; and they could kill mosquitoes for a long time afterwards. However, their persistence in the environment became a problem.

The drainage of DDT into rivers, swamps, and coastal waters killed crabs and fish in streams that drained forests where DDT had been sprayed to control the spruce budworm. Its wide distribution in the biosphere was evident when it was detected in Antarctic penguins at very low level, and in canned milk, fresh cow's milk, and human milk. In high concentrations, DDT was found to injure the liver of animals, and there is some controversial evidence that it might cause cancer. In the 1960s DDT fell from its earlier status as a miraculous saver of lives and crops to a symbol of all that was bad in our misuse of the environment. After decades of discussions, DDT still remains controversial, including its actual effects on human health and the extent to which it has caused environmental damage compared with other artificial organic compounds and other forms of pollutants. Defenders of the use of DDT have pointed out that chemicals used in plastic industry have similar effects and are difficult to distinguish from DDT. Because of the problems caused by the persistence of chlorinated hydrocarbons such as DDT, short-lived chemicals such as organic phosphate have been used more widely. These, however, tend to have a higher acute toxicity in people and must be handled carefully

Summary and Conclusion

The major forms of pollutants include; toxic chemicals (organic and inorganic), radioisotope, particulates, heat, and noise. Pollutants tend to simplify ecosystems. They also tend to favour species that are adapted to variable environment and harsh conditions; organisms that are characteristic of early stages in ecological succession; and organisms that are hardy and have high reproductive rates and short life-spans. .

Toxic chemicals act directly on individuals and populations, and are likely to be persistent in the environment. Their toxicity depends greatly on their particular chemical form, which may be altered biologically, especially by microbes in waters and soils. Heavy metals are a particularly important kind of environmental toxin.

Organic compounds are produced artificially for use in industry, in consumer products, as pesticides, as food additives and as pharmaceuticals. Among organic chemicals, pesticides have caused the most environmental concern. Organic compounds can affect individuals, populations, ecosystem, and the biosphere. They can affect physiology of individuals, cause mutations, promote the growth of cancer or affect heredity. Ecosystem effects occur through biomagnification, and the tendency of toxic organic compounds to simplify ecosystems.

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Chapter Nine

The Origin and Philosophy of Numbers

In the early concepts, there is in man a natural need for knowing quantity. There is the amusement and social need for matching and comparing even among toddlers. These human experiences demand the recognition of for example, the difference between “oneness” and twoness”. In addition there is an environmental necessity or cultural stress arising from the awareness in man’s social and cultural problems such as problems of justice and equity in exchange and sharing, which therefore demands as well the recognition of this difference between “oneness” and twoness” etc. In observing set of objects, comparing or matching them and recognizing that there is a property by which these collections may be the same or differ.

A collection may have as many members as another or may not. Number a concept of “how many members set contains’. Every primitive tribe invented number words to some extent. Counting is a process by which a correspondence is set up between different collections of objects. Anthropologists have found some form of counting in all primitive cultures even though it may have been represented by a few number words. Evidently the rudiments of counting form a cultural necessity, anthropologists call such a culture universal, i.e. an item which occurs in every culture known to history.

Records, anthropological and historical, show that counting and ultimately, numeration form the inception of mathematics in all culture. The mathematics is founded on counting numbers. Here are some notions that generate the idea of numbers.

as many members as

few members

more members

one more than.

This fourth notion determines natural order.

What we today regard as "number" passed through stages of development from different individuals and from different tribes. This resulted from man's consciousness towards answering questions posed by nature. Today we are able to speak about such large numbers as the distance

to the nearest star, the number of molecules in a quart of water, the *size* of the national debt, etc. Numbers enable the mind to grasp the abstract concepts, which would have been otherwise impossible.

For this chapter, we shall consider how numbers became necessary and how the symbols for these numbers became more amenable to manipulation.

Idea about Numbers

The idea about numbers came before the time, when it was possible to put on record the history of its development. This is not to say that mankind, even in most primitive times, has no sense of numbers. To say the least, mankind at that time could recognize more or less when some objects were added to or taken from a small group as these stories revealed.

Thomas Welsh had a flock of sheep. He was interested in preventing his flock against pilfering from his neighbors. He has no need to count but he could tell at a glance the difference between his live sheep he expected to see and the four which he saw. He knew that something was wrong. This man was not using the abstract process of the mind; instead he used the physical evidence of the senses.

For another shepherd, there were series of names which helped him to know his different sheep. Names like lop-Ears, no Tail, Limp, Scrawny, Sleek etc were used to identify his sheep. When one was missing, he would say, for example, "Sleek is missing, and nothing more. One would ask the question:

Is it possible, for this shepherd to memorize many names for his large flock? Certainly not. It will be too great a feat of memory. Another shepherd who has more sheep devised a more modern technique for preserving his flock. He has his sheep driven through a narrow gate with a pile of pebbles. He drops a pebble in a pot as each sheep passed by. If the last sheep passed as the last pebble was dropped, then he had all his sheep.

One can deduce from the last story that the shepherd has set up a one-to-one correspondence, which is an important concept in mathematics, a method nearer to counting than naming. The only difference between this system and number is that one cannot say how many sheep one has. He can only point to a pile of pebbles or stones or palm kernels which is a concrete method.

Written Number System

Here, we are going to read how the early man evolved a new list of name called numbers which could apply not only to his flocks but to any group of objects. More also, symbols to represent these numbers were given.

Words expressing numerical ideas were slow in evolving. After the initial stage of development, there was an effort to harmonize vocal sounds as words tally with the number of objects in a small group. For example, one, two, three, four ... etc, 9 and 10, 20,30..... 90 were represented on the left hand and the numbers 100, 200.....900 and 1000, 2000.....9000 on the right hand. In this way any, number up to 10,000 was representable by the use of the two hands. 1 was represented by partially folding down the little finger, 2 by partially folding down the little and the ring finger, 3 by partially folding down the little, ring and middle fingers, 4 by folding down the middle and ring fingers, 5 by folding down the middle finger; 6 by folding down the ring finger; 7 by completely folding down the little finger; 8 by completely folding down the little and ring fingers and 9 by completely folding down the little, ring and middle fingers.

Later, with the refinement of writing, an assortment of symbols was evolved which represent these numbers. Various written number systems gradually evolved from these primitive efforts to make permanent number records. The Egyptians had their way of number representations, the French, the Roman numeral and the different tribes in Africa and Nigeria all had their different representations. Number is a concept of "how many member a set contains. The concept is an abstraction from the nature of objects. In the abstraction a person forgets the material (e.g. pencil, banana) itself but thinks of the twoness. This abstraction is universal.

Number word, (number) is the name for each number; it had linguistic difference.

Symbols	0	1	2	3	4	5	6	7	8	9	10
English	Zero	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten
French		Un	Dou	Trois	Quatre	Cinq	Six	Sept	Huit	Neuf	Dix
Roman	0	i	ii	iii	iv	v	vi	vii	viii	ix	x
Igbo	Efuru	Otu	Abuo	Ato	Ano	Ise	Isii	Asaa	Asato	Itolu	Iri
Yoruba	Odo	Okan	Meji	Meta	Merin	Marun	Mefa	Meje	Mejo	Mesan	Mewaa
Hausa	Sifili	Daya	Biyu	Ukku	Hudu	Biyar	Shidda	Bakwa	Takwas	Tara	Goma

The relationships between numbers were studied from dual approaches; as from practical application the other was from philosophical interest. Practical applications in reckoning or

checking the completeness of property, in exchange or in measured amounts. The Babylonians and *Egyptians* provide records of early practical applications. The operations of addition, subtraction, multiplication and division occur frequently in human experience.

The Egyptian Pyramid involved much mathematics to make the buildings possible. From the writings of Herodotus and Platos one finds general statements of the rise of mathematics in Egypt. According to Aristotle, mathematics originated because the priestly class in Egypt had the leisure conducive to its study. This information was corroborated by Papyrus discovered two thousand years later. A document written by the priest, Ahmes, who died before 1700 B.C - "direction for knowing all dark things" was a collection of problems in geometry and arithmetic. It was much concerned with the reduction of fraction such as $\frac{2}{2n+1}$ to a sum of fractions each of whose numerators is unity.

Egyptians made remarkable outstanding, if not astonishing progress in the science of exact measurement. They had land surveyors who were known as "rope-stretchers" using ropes in the ratio 3: 4:5. They formed right angles and right angled triangles. They also constructed pentagon, heptagon etc. The Egyptian mathematical progress into fractions and ratios was definitely the beginning of the concept of rational numbers. Rational numbers are ratios between two integers. Among the Greek, we find those whose genius prepared the way for our present golden age of mathematics. Four may be singled out: Zeno (495-435 BC), Eudoxus (408 - 355 BC), Archimedes (257 - 212 BC) and Euclid (Circa 300 BC).

Zeno of Elea, a self-taught country boy, was a friend of the philosopher, Parmenides. He shocked the philosophers by inventing four paradoxes: on dichotomy, Achilles, arrow and stadium. These paradoxes concerned the infinity of points on a straight line segment, and the continuity of space and time.

(a) The Dichotomy: Motion is impossible because whatever moves must reach the middle of its course before it reaches the end; but before it reaches the middle it must reach the quarter-mark, and so on, indefinitely. Hence the motion cannot start.

(b) Achilles: Achilles, the fastest runner in Greece, cannot overtake a crawling tortoise, the slowest animal, because he must first reach the starting point of the tortoise, by then the tortoise must have moved. Thus at every stage the tortoise must be ahead.

(c) The Arrow: An Arrow can only move in a stretch of time; at any instant the arrow is at rest. If instant is indivisible the arrow cannot move, for if it did the instant would be divided. But time consists of instants. As the arrow cannot move in any instant, it cannot move in any time. Hence it always remains at rest.

(d) The Stadium: Proof that half the time may be equal to double the time. These may seem idle consideration to non-mathematical but they are the sort of problems that have perplexed mathematicians for centuries. Zeno lost his head for treason.

Eudoxus of Cnidus inherited the "mess" which Zeno bequeathed the world. He suffered from extreme poverty in his youth but studied with Archytus and under Plato's academy. He travelled to Egypt with Plato and was influenced by Egyptian thought. He also travelled to Egypt to Italy and Sicily, returned to Athens about 368 BC at the age of 40. His areas of mathematical interest included straight line, lengths of curves and areas of curved surfaces. As regards to 'number' he placed the doctrine of irrationals on a sound basis. This study of higher arithmetic was stimulated by Theodorus Cyrene (Plato's teacher and a Pythagorean) who discovered many irrationals, 3, 5, 6, 7, 8, 10, 12, 14, 15, 17. (2 had been discovered by Pythagoras through the ratio of diagonal to side of a square).

Archimedes entered the general methods of finding areas of curvilinear plane figures and volumes bounded by curved surfaces. He gave a method for calculating Pi (the ratio of a circumference of a circle to its diameter) and fixed the value as lying between $3\frac{1}{7}$ and $3\frac{10}{71}$; he also gave methods for approximating square roots.

Euclid settled in Alexandria and taught in the University - a library founded by Ptolemy (the successor of Alexander) about 300 B.C. He wrote the Elements including theory of numbers (Pythagorean), prime and composite numbers; his perfect number (e.g. 6, 28, 496) each of which is equal to the sum of its factors, irrational numbers.

The above discussion has touched on the origin of counting or whole numbers, and their extension to rational numbers. The appearance of 2, 3, 5 etc show an extension to irrational numbers. In essence, rational and irrational numbers do not tell "how many members" a set contains", they rather originate as a result of mathematical operations.

Thales (C. 624 - 547 BC) was an Ionian Greek. The very idea of abstracting solidity or area from material shape, such as a square, a triangle, and reflecting on it as a pattern of lines, seems to be due to Thales. He also appeared to have been the first to suggest the importance of a geometrical locus, or curve traced out by a point moving according to a definite law. He was always mindful of the debt that he owed to the priests of Egypt, and when he was an old man he strongly advised his pupil Pythagoras to pay them a visit. This Pythagoras did, and with much benefit of experience.

Pythagoras (584 - 495 BC) was also an Ionian Greek from Samos. The more attentive of his pupil formed themselves into a society or brotherhood known as the order of the Pythagoreans. The badge of the brotherhood was the beautiful star pentagon.

In mathematics, the Pythagoreans made very great progress, particularly in the theory of numbers and the geometry of areas and solids. To Pythagoras we owe the very word mathematics and its doubly two-fold branches

Mathematics

The discrete		The continued	
The absolute	The Relative	The Stable	The Moving
Arithmetic	Music	Geometry	Astronomy

The mathematical operations with natural numbers are addition, subtraction, multiplication and division. Natural numbers are closed with regards to the operations of addition and multiplication (i.e. if two natural numbers are added or multiplied the answer will always be found in the field of natural number) but not so with subtraction and division. To get answers always for the operation of addition, the number system is extended to negative numbers. There exist therefore the integers which are the numbers of the set of all positive and negative whole numbers; similarly, for the operation of division rational numbers are introduced. Thus there exists the real number system which is the set of all integers, rational and irrational numbers.

The problem of solving equations such as $x^2 + 1 = 0$ also arose. The solution cannot be found in the system of real numbers. Therefore a new number system was evolved where the unit 1 is equal to the square root of -1 is called the imaginary unit, and the system is that of imaginary numbers. The combination of real and imaginary numbers form the complex numbers.

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Chapter Ten

Abstract Thinking in the Physical Sciences

Why abstract?

Science prides in empiricism. Empiricism is the view that recognizes experience as the only source of knowledge; thus its special concern is the explanation of general concepts and of general judgements through experience alone.

This stand had not been the initial approach to science. Among the ancient Greeks and Romans, science was not separated from philosophy (love of wisdom). Leading philosophers founded brotherhoods within which they expressed their speculative thought on matters of common interest. For example, the principal concern of the brotherhood founded by Pythagoras (582 - 507 BC) in Southern Italy was the discovery of harmonics and symmetries in the physical world, and their expression as numerical ratios. Socrates (470 - 399 BC) and Plato (427 - 347 BC) were not "scientists" but influenced the development of speculative and analytical modes of thought in all field

Aristotle (348 - 322 BC) a student of Plato and a philosopher, developed a wide range of interest which carried him beyond pure philosophy. He wrote "Physics" and "On the Heavens". His views on cosmology and on many other topics had enormous influence on later thinkers; and it was with immense difficulty that scientific thought was freed from its Aristotelian bond. In his work in 'Physics,' observations played a negligible role whereas speculation reigned unchallenged. In Aristotelian mechanics, all heavy bodies had a natural motion towards the centre of the universe which was believed to be the centre of the earth; motion in any other direction was violent motion which contradicted the ordinary tendency to move towards the natural place. Rest is the natural thing; it was motion, not rest that required explanation. Aristotle's universe was one where "nature abhorred vacuum"; it had the door for spirits, and intelligences rolled the planetary sphere. Thus where motion existed, and however long it existed, the mover must be in tact with the moving body imparting motion to it all the time.

Democritus (470- 400 BC) tried to explain the origin of matter in terms other than the senses. For him, to describe a thing as bitter or sweet was to describe only attributes; the essential being should be accounted for by the concept of "atoms" - the indivisible indestructible particles which

make up an object. The universe therefore consisted of atoms and vacuum. Aristotle rejected this atomic theory and, in particular, the possibility of a vacuum. The theory was revived by Epicurus (341-270 BC).

Lucretius (95-55 B.C.), a Roman, speculated on the composition of everything in the physical world. He wrote "De rerum natura" a thesis based on the views of two Greek philosophers, Democritus and Epicurus.

Ptolemy (circa 130-150 A.D) born in Egypt, was a mathematician, astronomer, geographer, and physicist - one of the outstanding figures in the history of science. The foundation of his system of astronomy was the geocentric principle of Hipparchus. The basic features of the Ptolemaic model of the universe followed the Aristotelian pictures: The earth was at the centre of the universe, and the stars and planets revolved in circular orbits about it. Ptolemy got his inspirations from Hipparchus (in Mathematics and Astronomy), and Marinus of Tyne (in Geography). His work fell into two major divisions:

- (a) The Mathematical Treatise (Almagest) and
- (b) The Geographical Treatise.

Both include his astronomical work. Ptolemy and his successors devised the system of concentric and epicycles.

It is worth noting that even from early times, observation, experience and mathematical relationship had places in science. In the course of the history of physical sciences one can observe areas where abstract thinking has been predominant. They include, for example, nature of matter, shapes, motion, interaction, and method of study of science.

Nature and Shape of and the Universe

Aristotle, while still a member of the Academy, was critical of some features of Platonism. However his views on the physical world was platonic. Prior arguments were adduced for the opinion that the world was one, that it was in the form of a perfect sphere, that it necessarily consisted of the four elements (earth, air, fire and water), and that it had a soul. Democritus accounted for matter by the concepts of atoms; he saw the universe as consisting of atoms and vacuum. The Pythagoreans developed a religious attitude towards mathematics. Consequently, they described the universe exclusively in terms of number. They took number to be the matter as well as the form of the universe; number was the actual stuff of which their world was made.

The medieval view of the universe was full of variations, uncertainties, controversies and developments. Dante's (1256-1321) view can be regarded as the pattern or a synthesis of the medieval view. According to this view, the universe consists of a series of concentric spheres at the centre of which is the motionless earth. The bulk of matter is confined to the earth and its neighbourhood whose stuff is tangible, unstable and subject to decay. The skies and rotating

spheres, the stars, and the planets are made of tangible matters also, though more subtle and not subject to change and decay, nor subject to physical laws. The matter which forms the earth is composed of four elements namely: fire, air, water and earth which are graded according to their mobility - earth the meanest with the greatest tendency to fall, water, air, and then fire, the noblest, characterized by levity aspiring to the sky, its proper abode. The skies are not subject to change or decay for they are formed of a fifth element which is incorruptible and subject to a different set of physical laws. There are ten skies, the most enveloping of which is the Emperian Heaven, the abode of God.

The works of Geber (Circa 9th century A.D), Dalton (1766-1844), Gay-Lussaca (1769-1854), Boyle (1627-1691), Avogadro (1776 -1856), Black (1728-1799), Cavendish (1731-1610), Priestly (1733-1804), Lavoisier (1743-1794), all in the 17th and 18th centuries revealed the existence and behaviour of many elements and compounds atoms and molecules.

In the 19th and 20th centuries, the works of Thomson, Rutherford (1871 -1937) and Bohr (1885) have given insights into the structure and configuration of the atom, leading into the concept of wave-particle duality of matter.

Motion

The problem of motion is an intellectual hurdle which has confronted man for ages. As mentioned earlier, Aristotle's thinking was that all heavy bodies moved to the centre of the universe identified as the centre of the earth. Motion in any other direction was violent. His doctrine of inertia was a doctrine of rest; so whenever motion existed, and however long it existed, something had to keep it moving: once the mover ceased to operate, the movement stopped. Thus a constant force exerted on a body produced, not acceleration, but a uniform motion. Aristotelian teaching was such an intellectual feat that it was difficult for the human mind to disregard. For long, most commentators, to account for acceleration, adduced reasons like push of the air, jubilation of falling bodies because they were moving homewards to the place of rest. However, with time, commentators were developing other ideas: A body in motion acquired 'impetus'; God might have started the universe like a clock and let it run itself (Nicholas Oresme).

In the 14th century, a group at Merton College, Oxford and another group of Parisian scholar differed from Aristotle. They proclaimed the existence of empty space, of infinite universe, and of plurality of worlds. They explained that the projectile was impelled, not by a mover, but by impetus. The Oxford and Paris ideas passed into Italy. The original arguments of Aristotelian ideas became compromised by ideas resulting from astronomical observations.

Copernicus (1473-1543), a Polish Priest, was not a great observer but he did a theoretical analysis of astronomical data before him, and produced his great work, *De Revolutionibus*

Orbium (1543). As a geometer and a mathematician he seemed to have been struck by the redundancies and complications in the system, and maintained, in keeping with Aristarchus' views, that the sun was stationary, while the planets rotated about it. He held the views associated with Plato and Pythagoreans that immobility was nobler than movement and this affected his attitude to the sun and the stars. He further explained the apparent movement of the stars as being due to the earth's rotation. It was some sixty years after Copernicus' death before his theory began to shake the learned world.

Consequently, Francis Bacon (1561-1626) in his work 'Novum Organum' glorified the inductive method, while Rene Descartes (1596-1662) in 'Discourse on Method' and 'Le Monde' glorified Mathematics as Queen of Science (i.e quantitative approach to science) and placed emphasis on deductive method.

Galileo (1564-1642) asserted that it was absurd to think that God was so extravagant as to create the colossal universe just to serve man. In 1609 he constructed the telescope which revealed 'disturbing' phenomena in the skies

Kepler (1571-1630) was a pupil of Brahe. His work was an abstraction from his master's data, Copernican doctrine, and his belief that God created the universe in a simple pattern. From these he was obliged to question the fundamental assumption of circular motion and finally derived his three laws of planetary motion.

At this stage the resistance to Copernican hypothesis was common to both Catholics and Protestants. Galileo, an Italian Catholic, was persecuted by the Catholic Inquisition and burnt his works. The Protestant astronomer, Kepler, persecuted by the Protestant, Faculty of Tubingen, actually took refuge with the Jesuits in 1596.

Newton's doctrine of inertia was a doctrine of motion, not of rest. A body in motion is reluctant to change its speed or direction; force (which is an abstract mathematical concept) is needed not to keep it in motion but to change the motion. This modern law of inertia was not discovered by photographic observation; it is an abstract thinking, for we hardly see objects continuing their rectilinear motion in an empty space.

Led by Einstein, the twentieth century physicists' perspectives on motion were in terms of relativity. The special theory of relativity was based on two postulates: first, the laws of physics may be expressed in equations having the same form in all "-frames" of reference moving at constant velocity relative to one another; second, the speed of light in free space has the same for all observers, regardless of their state of motion. These postulates seem radical and subvert almost all the intuitive concepts of space and time which we form on the basis of our daily experience.

Interaction

This is a concept of event between two or more different substance. Interaction could be chemical or physical. Chemical reaction is the rearrangement of the particles in elements or compounds to form different elements or compounds.

The concept of physical interaction can be formed through some physical experience. If we push a huge body we feel a pressure back on us. "When two bodies collide we observe velocity change in each of them, and we think that each experiences an opposing force which changes its velocity. When two electrically charged light bodies suspended on light strings are near each other, they either repel or attract each other. Physical problems confront us with a wide array of such interactions. Newton saw physical interaction as action and reaction. Thus he postulated that to every action there is an equal and opposite reaction (Newton's 3rd law of motion). Newton's three laws are not experimental laws; they are theoretical abstractions, but are in keeping with observations.

One view of interaction is action-at-a-distance. This view is held in the theory of gravitation and electromagnetic interaction. Two masses at a distance apart exert gravitational force between them; such a force keeps planets in their orbits. Similarly two charged particles at a distance exert electrical force. For more dynamic application, a moving charge (current) exerts a magnetic force at a distance. Before Faraday's time, the force acting between charged particles was thought of as a direct and instantaneous interaction between the two particles. This action-at-a-distance view was also held for magnetic and for gravitational forces.

Thus A.M. Ampere (1775 -1836) who was an advocate of the action-at-a-distance point of view did not formulate his results on the relationship between current and magnetic field in terms of fields. This was first done by J.C. Maxwell (1831 -1879), whose first paper on electromagnetic theory of light was entitled "Physical lines of Force" was soon followed by one on "A dynamical theory of Electro-magnetic Field".

To every point in space surrounding a mass, a charge, or a magnet we can mentally associate a field (gravitational, electric or magnetic respectively). This is the acceleration that a test-body (a unit mass, a unit charge, or a unit magnetic pole, as the case may be) placed at that point and left free, would experience. The concept of electric field as a vector was not appreciated by Michael Faraday (1791-1867) who always thought in terms of "lines of force".

Another view of interaction is in terms of energy change. Energy is a mathematical abstraction experienced in terms of work and has no material existence; this is why words used to express the laws of thermodynamics are primitive. Here the mind conceives of a "System which can be any object, or any quantity of matter or any region of space, selected for study and set apart (mentally) from everything else. The boundary of the system is an imaginary envelope which encloses it; this boundary may isolate the system from its surroundings and may also provide interaction.

Now, Newton's equations of motion based on the concept of force, describe motions that are simple; where there are constraints, it is necessary to know all forces of constraints. Alternative procedures, based on energy concept and minimal principle have been provided by W.R. Hamilton (1805-1865) and J. L. Lagrange (1736 -1813).

The search for minimal principles date from Hero of Alexandria (1st to 2nd century A,D) who postulated that a light ray followed a shortest possible path. In 1657, Pierre de Fermat (1601 - 1665), a lawyer, linguist and amateur mathematician, reformulated the principle by postulating that a light ray always travelled in a medium that requires the least time. In 1747 Maupertus asserted that motion takes place with minimum action.

However Hamilton postulated that of all possible paths the actual path a system may follow was that which minimized the time integral of the lagrangian (the lagrangian is the difference between the kinetic energies and potential energies). This Hamilton's principle has allowed a unification of many theories by means of a single basic postulate. It is one the most elegant and far reaching principles of physical theory.

Energy is transported from one point to another by waves. It was thought that a wave required material medium for its propagation. While this was observed tenable for sound, light was known to travel through "vacuum". So to support our thinking the aether was postulated to pervade "vacuum". The aether controversy raged until the Michelson and Morley experiment in 1887 shattered the mysterious aether.

Method

Much philosophical thought has gone into the method of science. The earliest evidence of scientific approach is in the gradual development of practical skill in man's mastery over his environment. The record of the works of the Greeks shows a further development of the scientific process. For example, from the particular rules of practical measurement evolved in Egypt, the Greeks produced an abstract generalization of deductive geometry. The Greeks also were so interested in speculations on the nature of the cosmos that they created imaginatively conceptions of the universe; implying certain laws which they considered would assist in the interpretation of the few available observations. For example, Plato was much concerned to discover whether observations conformed to a preconceived view of order, harmony, and beauty in the universe; but not all Greeks followed this method. Aristotle used the experimental technique of dissection in the study of animals, but was less experimentally minded in his approach to physics. Archimedes (287 - 212 BC) was a mathematician, scientist, and a leader in applied science. His abstract thinking involved deduction of physical laws and mathematical relations. Combining mathematics with experiments, he was able to set up hypotheses, test them, and make deductions there from. In him we find a synthesis of deductive, experimental and inductive methods.

The revolution in scientific thought which occurred roughly between the years 1450 and 1650 is comparable with the rise of the Greek philosophy. It is not that knowledge came to a standstill between the fall of Rome and the scientific revolution; rather, it is that the medieval tendency was to elaborate unchallengingly schemes of the universe constructed by authorities such as Aristotle.

Francis Bacon in "Novum Organum" glorified the "Inductive method as the correct method for scientific reasoning while Rene Descartes in "Discourse on Method" glorified mathematics and 'deductive method'. Inductive reasoning goes from the particular to the general, while deductive goes from the general to the particular.

Although formal deductive science is not ruled out in present day method, experimental or inductive science is in vogue. Experimental reasoning involves "judging from a sample, formulating and testing a hypothesis, developing a theory to cover a wide range of data, establishing a law or empirical formula, and designing or running a decisive experiment" (Nielson, 1950).

In physical science, explaining consists in bringing a particular phenomenon under a general law. In practice, an inquirer entertains ideas that explain the phenomenon, and identifies one of them as most plausible. This he tentatively adopts as the hypothesis to be tested. Testing a hypothesis involves, generally speaking, comparing evidence, checking out a number of other propositions that would normally be true if the hypothesis itself were true. Science aims at establishing laws which explain the behavior of observable things. This enables a scientist to relate his knowledge of particular events. It also enables him to predict events that would occur under given circumstances. Furthermore, if these circumstances could be established by man, the knowledge would enable applied scientists to control the course of nature.

For a modern theoretical physicist, the world consists of unimaginable large number of electrons, protons, neutrons, and photons etc, which are for him the stuff of the world. Though these particles are found out by somewhat indirect methods, accepting that the world consists of such things is high imaginative.

More esoteric are such concepts as field vector, electrons and Schrodinger wave function. Such concepts in science are not directly observable things, but theoretical concepts of their own class. An electron or a wave packet is not an abstract object of mathematics like a prime number. Nevertheless an electron is not observable in the sense in which light, scale reader, or a pointer is observed. The truth of the proposition about electrons is tested by observable behaviour of measuring instruments.

This discussion shows that science has not shaded speculative or abstract thinking from its method. Abstract thinking or theorizing is still important as a lead to new frontiers and new experiments, and for the analysis of data obtained by observation. Science is a collection of well tested theories which explain the patterns and regularities (and irregularities) among carefully

observed phenomena. Empiricism is doomed to failure when it attempts to explain universal concepts and this is where philosophy comes in to solve the problem.

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Chapter Eleven

Renewable and Non Renewable Resources - Man and His Energy Sources

Introduction

Energy is the capacity for doing work. In all man's activity energy is indispensable. Energy is required to grow a plant, to boil an egg or to drive a car. However, the amount of energy in the universe is constant. New energy cannot be created but the energy stock cannot be exhausted. Energy may be transformed from one form to another or dissipated into less useful forms.

Different forms of energy occur; namely chemical energy, electrical energy, heat energy, kinetic energy, light energy, potential energy and magnetic energy. In any given industrial process, different levels of transformations take place, for example, from chemical 'by burning coal' to heat to kinetic to electrical etc. The usable energy available in such a system thus decline steadily.

Man's Natural Resources

From where does man derive his energy? Man has been able to harness the energy of plants and animals, water, fire, wind, steam, soil and its minerals. These constitute his natural resources. Natural resources can be subdivided into renewable and non-renewable resources.

Renewable Resources

The sun, wind, water, forest are categorized as renewable resources because they are not dependent on reserves as in fossil fuel. Their energy sources seem virtually inexhaustible.

The sun - the star of our solar system - provides light and heat on which life on earth depends. Without it, there would always be night and we could all die from cold. The movement of the earth relative to the sun gives us the seasons. The gravitational pulls of the sun and the moon on

the earth result in the tides. Solar energy has been used in many ways throughout human history. It can provide the world far more energy than fossil fuel and nuclear power put together. The simplification of the technology needed to extract and store solar energy for regular domestic use requires fine-tuning. Like all stars, however, the sun will not remain hot and bright forever. It is believed that in billions of years it will die out.

Wind is another natural force recognized by man from the earliest times as a source of energy. The first ships were propelled by the wind. It was the sources of power for wind mills. It has been used to turn wheels of water pumps and to generate and store electricity in accumulators. The problem with wind energy is that its strength is inconsistent and unreliable.

Water is another important renewable resource. It is the life force of all growing plants and animals. Nothing lives without it. Water is a great source of power. The water-mill is one of man's earliest successful attempts to harness nature's energy. The falling and driving power of water operates hydro-electric power stations. Huge dams are constructed to conserve this water power and release it through special outlets which turn turbines and so work electric generators.

Forest resources are also renewable. In many cultures they constitute the foundation for man's economic activities. Forest resources encompass not only the resources obtained from forests in the strict biological sense of the word; they include resources from all wild-land not cultivated, together with the waters flowing through them. Some useful products from the forest include fuel, wood, charcoal, fibers, poles, timbers, fruits and nuts, bark, forage, edible leaves, wildlife, chemicals such as alkaloids, dyes, gums, resins, latex, essential oils and pharmaceuticals.

The protective and regulatory functions of forests make them also a vital resource. The multi-storied structure of a typical forest is more efficient in intercepting rain-drops than less complex plant covers. The forest therefore, more efficiently reduces run-off, floods and soil erosion. It promotes deep percolation of rain water; regulating quality and timing of release of stream-flow. The forest also absorbs, stores and releases carbondioxide, oxygen and water thus regulating their quantities in the environment and maintaining their quantities in the environment and maintaining their global balance. The forest intercepts, absorbs and transforms solar radiation during photosynthesis. It decreases wind velocity and thus helps to conserve humidity. The forest is used as shelter-belts and wind-breaks. It provides shelter for many plants and animals. In cultures where fertilizers are not traditionally used, shifting cultivation relies on the forest regeneration for rejuvenating the soil. Many nutrient conserving mechanisms involved in forest soil resuscitation are little understood.

Non-Renewable Resources

The non-renewable resources occur mainly as mineral or fossil fuel resources. Although their deposits may be enormous, but they are not limitless. They may be found in the ground, sea or beneath the sea bottom.

Minerals are naturally occurring chemicals e.g. Aluminum, Copper, Gold, Uranium that make up rock and stone. They occur as ore or in a pure form. About 1,500 different minerals are known. Minerals are components of many household goods such as talcum powder, graphite in "lead" pencil, salt in food. Other domestic appearances of minerals show in salt as preservatives; iodine or epsom salt in medicine cabinets; borax in bleaches, soaps and detergents; antimony and sulphur in the head and phosphorus on the striking surface of the safety matches. Minerals also feature in jewelry and as time keeper when we contemplate the quartz.

Sand, limestone, rock, marble, chalk, dolomite, gypsum, and lime in cement are used in building and as structural materials. Clay and especially the form kaolin are useful in ceramics. Rock phosphates, potash and mineral sodium nitrate are compounded into fertilizers. Corundum and magnetite are used in abrasive papers (sand paper). Asbestos, Mica and talc (soapstone) are either heat or acid resistant and used as good electrical insulators. Many minerals like sulphur and bauxite are essential in industry.

Perhaps the most important commodity in the world today is oil. Petroleum runs through the veins of modern civilization just as blood is needed by the body. Products from oil have transformed our way of life. They include synthetic fibers and plastics, detergents and synthetic rubber, explosive TNT, insecticides, weed-killers and fertilizers, paints and anti-freeze solutions, ink, pharmaceuticals and cosmetics, waxes for candles and polishes.

Oil is a lubricant. It protects metals from dirt and from the corroding effect of air and water. Bitumen, pitch, tar, asphalt are used for road surface, in waterproofing roofs and for sealing dry batteries. Food happens to be a remarkable new use of oil. Protein needed by man and livestock is produced by micro-organisms living on oil. Toxicity test shows that such protein is safe and pure.

The most familiar use of oil is perhaps as a fuel. Oil and its natural gas provide more than half the world's energy. Trucks, modern trains, most ships and heavy machinery run on and large space rockets. Natural gas liquified under pressure finds use as cigarette lighters and for domestic cooking.

Energy Reserves, Production and Consumption

a. Fuel Wood:

The utility posture adopted in presenting the world's natural resources underscores the pressure they undergo. For example, the estimated total area of natural forests of Africa was put at 645.43 million ha in 1975. By the year 2000, these forests of the continent are estimated to shrink to 188.2 million ha. Woody vegetation in all the sub-regions of Africa is threatened with extinction through over exploitation, mismanagement and conversion to agriculture.

Wasteful utilization and biodeterioration of products harvested from forest contribute to the rising consumption. Demand of wood products results from rising population and attempts to improve material standards of living. More importantly, extensive forest areas may be destroyed in the process of obtaining a few commercially desirable forest species. The rate of forest disappearance in Nigeria estimated at 250 km² per year in the mid 1970s is expected to rise to 1290 km² per year by the end of this century. Surprisingly, more than 90 percent of wood in Nigeria consumed is for fuel wood. Fuel wood, in spite of other energy sources for cooking and domestic heating will remain the single most important forest product in the foreseeable future.

b. Oil and Natural Gas

The Middle East has the largest reserves of oil and natural gas in the world. A flourishing trade in crude oil exists between oil producing and oil consuming nations. Saudi Arabia, Kuwait, Iran, former USSR, Iraq, United States of America, Libya, United Arab Emirates, Nigeria, China, Venezuela, Indonesia, United Kingdom, Algeria. Canada, Ecuador, Qatar, Norway, Oman, Pakistan, Australia, Brunei contain some of the largest world reserves.

High energy consumption seems to go hand in hand with national wealth. The United States of America, the richest country in the world, has about 6% of the world population but consumes about a third of the world's total energy production. On the average, the richer nations consume about 20 times as much energy as the poorer countries. Until the drastic historic change on the crude oil prices in 1973, consumption had historically doubled every ten years. Since then, attitudes to energy consumption in industrialized countries have substantially changed. Emphasis is now being placed on conservation,

c. Coal

The world's major reserves of Coal occur in former USSR, United States of America, China, India, West Germany, South Africa, Canada, Poland, Australia, Japan, United Kingdom, former Czechoslovakia and Yugoslavia, Germany, France, Spain, Belgium, South Korea and Bulgaria.

Coal has two main advantages over fossil fuels. First, the reserves are much greater and secondly, the largest deposits occur in countries with the highest energy consumption. In the past four decades, coal's share of the world's energy market has consistently dropped yielding its premier position to oil. Economic and environmental considerations make exploitation of certain coal reserves unacceptable. Strip mining and open casts, for example, result in extensive damage of the environment.

d. Nuclear Power

The United States of America has the largest known reserves of Uranium. Other countries with large deposits include Canada, South Africa, Sweden, Australia, France, Niger, Gabon, Argentina, Spain, Central African Republic, Portugal, Japan, Yugoslavia and Denmark. Large reserves may occur in other countries than those listed. The principal nuclear programmes of the world are located in United States of America, United Kingdom, France, Canada, Germany, Japan, Spain, Sweden, Switzerland, Italy and India.

Nuclear power's contribution to the world's energy supplies is about 2 percent. Although nuclear power is utilized in electrical power, the greater danger of nuclear power is found when directed towards weaponry. For this reason, a strong attempt at the monopoly of nuclear technology in armament is pioneered by the world powers. Disposal of radioactive waste is another complication leading to arguments against use of nuclear fuel

What to do

Modern civilization is heavily dependent on the world's energy resources renewable or non-renewable. For the renewable resources of the Sun, Water and Wind, research into more effective management strategies is advocated. With respect to the diminution of forest resources only radical changes in the present management practices accompanied by aggressive afforestation programmes are required - if wooded ecosystems adequate to supply the needs of now and the future are to exist.

End of the supply of nuclear and fossil fuel may mean the end of the world's civilization as we know it today. Unfortunately, the earth contains both energy sources in finite amounts. Their sudden disappearance would reduce the world's carrying capacity for man unless some alternative sources of energy are developed. For example, alcohol had been developed in Brazil from cassava - a renewable resource - to fuel cars. Such cars produce, less pollution than fossil fuel. In the long run, however, a reduction in the consumption pattern and a conservation of energy, no-matter whether it is from renewable or non-renewable source can guarantee the world's energy resources lasting long.

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Chapter Twelve

Generalizations, Observations, Explanations and Predictions in the Sciences

The emergence of society was characterized by the use of tools for the greater realization of man's daily needs which in turn made the quest for knowledge inevitable. Knowledge is needed for the appreciation of the laws of nature and also helps man with the instrument to control his environment.

Whatever knowledge man has or desires to have about nature, he strives to possess it entirely and thoroughly. And since knowledge is synonymous with an experience that is shared among the community of men, generalizations have become a cardinal factor in the acquisition of knowledge. Whoever has the will and the resources aspire to acquire and utilize any scientific knowledge for his immediate and future needs. For instance, that fire can be produced by striking a stick of match is a scientific knowledge and it is a generalization done from individual experience. We can always be assured that if we act in a given pattern that we are to have fire. Whoever believes in this pattern is expected to achieve this result. Thus the art of discovery is the art of correct generalization. We can talk about the shape or the size of the piece of match but this does not really constitute a strong factor in this generalization. What really counts strongly in general includes the state of the match - its nature - before it is used to produce fire. There is thus the need to make a distinction between relevant and irrelevant factors when we are building houses and wearing clothes and forging arms and sailing ships and cultivating the soil. This knowledge expanded with the advancement in human community.

Science dates back to ancient period. Scientists, at that, have succeeded in establishing quite a few generalization of a rather comprehensive kind that has been of immense benefit to mankind. For instance, the new laws of geometry, which holds for all parts of space without exception, laws of astronomy which govern time; and a number of physical and chemical laws such as the laws of the lever and the laws relating heat to melting. All these laws are generalizations: they say that a certain implication holds for all things of a specific kind. It is to be recalled that Dalton's atomic theory was derived from the earlier speculative thinking of Democritus who opined that atoms were eternal, unchanging and indestructible.

He made use of the mechanistic explanation of the universe. But Dalton later made use of this ancient idea to develop the atomic principles of modern science even though his thesis was debunked by advanced discovery in science which showed that atoms could be split.

THE RATIONALISTS AND THE GROWTH OF SCIENTIFIC KNOWLEDGE - K. POPPER, T. KUHN, P. FEYERABEND AND I. LAKATOS

The rationalists maintain what they see as a positive attitude in the development of science. Their works in the philosophy of science cover such areas as the methodology of scientific research, the status of scientific theories and the factors that could enhance the development of science.

Popper hangs on to falsificationism, Kuhn on what he called Normal Science. Lakatos stresses the essence of 'hard-core' theory in science whereas Feyerabend did not hide his resentment to methodology in science. We will state briefly the positions of these philosophers on the issues already raised.

Popper on Falsification

Popper conceives science as a dynamic discipline. It is an open system that is characterized by inputs of new ideas and abandonment of obsolete ones. There is no limitation to the acquisition of scientific knowledge. Thus, progress in science consists in the constant evolution of new ideas, testability and refutations of old and porous theories. And it (science) continues to be exciting as long as it remains an open system that welcomes criticism. In essence science is essentially critical, it consists of bold conjectures, controlled by criticism; and may be described as revolutionary. This does not mean that Popper was entirely opposed to every kind of dogmatism. A dogmatic scientist has significant part to play. He did not advocate that we should give in easily, for if we do so, we shall fail to notice where the real power of our theories lies.

A scientist, Popper stresses, is faced with the problem of getting close to the truth. In line with this tradition, he is confronted too with the task of how to falsify theories or replace already falsified ones or replace adhoc hypothesis. He also attempts to see the possibility of a merger of two already existing theories.

The totality of the endeavours here is meant as a very effective way of surmounting a given obstacle in quest of truth. If a scientist eventually achieves success in producing a theory that serves as a solution to the problem at hand, then his achievements would have been immense. Nonetheless, this is not the end to the challenge of a scientific enquiry: there are still much more requirements that are meant to be tackled.

The point is that we have at hand, a problem to be tackled, and there is a new theory meant for settling the problem. There are a number of requirements this new theory must have to meet. The new theory should proceed from some simple, new and powerful, unifying idea about some connection or relation (such as gravitation attraction) between hitherto unconnected things (such as planets and apples) or facts (such as inertia and gravitational mass).

The second requirement of our new theory is that it should be capable of facing independent testability. This is to say that, in addition to explaining all the explication, the new theory must have new and testable consequences (especially, novel consequences): It must also lead to the prediction of phenomena that so far have not been observed.

The imperative of our requirements as stated above is that in its absence, our new theory might be adhoc, as it is always possible to produce a theory to fit any given set of explicanda. The first two requirements are meant to check the range of our choice among the possible solutions, many of which not relevant to the issue at hand.

We would have, made some progress whatever the outcome of our new tests if the second requirement is met. This is because its testability is enhanced than the previous theory, as it is capable of explaining all the explicanda of the previous theory, in addition to giving rise to new tests.

Another significant impact of our second requirement is that we are assured that our new theory will to some extent be fruitful as an instrument of exploration, as it will suggest to us new experiments. Even these new experiments lead to refutation of the theory, we would have made an addition to factual knowledge resulting at least from the unexpected outcome of the new experiment. Besides, new problems will emerge from which are to be solved by new explanatory theories.

However satisfactory and thorough the above two requirement might be, the need to add the third one is very pressing. The difference between the third requirement and the previous two is that in the third requirement its fulfillment can only be established by testing the new theory empirically. This is a material requirement, a requirement of empirical success. And this third requirement sees more crucial than the previous two as it is indispensable in the decision as to whether the theory in question is to be accepted at all as a member within the scientific structure and also if it is an interesting and promising theory.

It is noteworthy, however, that it does happen at times that some of the most interesting theories are refuted at the first step of their testing. This shows that not even the greatest physicist can anticipate the secrets of nature; his inspiration can only be guessed and it is no fault of his theory, if it is refuted.

Newton's theory, in spite of its influences and general acceptability, was after all refuted. It is only by such happenings in the science arena that we keep on the tempo of sourcing for new

theories in addition to improving on the existing ones. A theory can be refuted at any point in time – ten months or ten years after its promulgation. It is all simply a matter of historical accident. If a theory is met by sudden death, popper believes that the scientist that propounded the theory should be remembered for making available to us a theory that unearthed to us new and perhaps still unexplained experimental facts coupled with new problems for the service it has by so doing rendered to the progress of science during its successful but short life.

What this suggests is that even if a theory is incapable of meeting up to the stipulations of our third requirements, it can still make a contribution to scientific growth. Nonetheless, the third requirement cannot be dispensed with. Scientists, as a matter of fact aim more than just contributing importantly to the growth of science. The aim to solve problems with their theories, where such theories are refuted before such problems are solved, it is only unfortunate.

We can only make and sustain progress in science if the third requirement is aimed at and possibly met. Which is to say that if the progress of science is to continue and its rationality not to decline, we need not only successful refutations, but also positive success. We should also aim always to produce theories that entail new predictions: moreover predictions of new effects, new testable consequences have embedded in the new theory that could be seen many significant well-to-be-novels. Instance of such predictions obey Kepler's law of that light, despite its zero mass, would prove to be subject to gravitational attraction that if Einstein's eclipse effect. The progress of science centers essentially in the predictions of this nature and a possible corroboration for them. This is necessary in view of the fact that scientific theories are meant to achieve conquest of the unknown, a new success in predicting what had never been thought of before. When a predicted theory is corroborated, a reasonable advancement is made in science. So, according to Popper, an unbroken sequence of refused theories would soon leave us bewildered and hopeless: we should have no clue about the parts of each of these theories or of our background knowledge to which we might tentatively attribute the failure of that theory.

As earlier noted science would be dormant and loose its empirical character if we are unable to obtain refutations. In the same vein, science would stagnate and loose its empirical character if we are unable to obtain corroboration of new predictions, that is, if we are only able to produce theories that meet our first two requirements and fail the third. If, for instance, we are to produce an unbroken sequence of explanatory theories, each of which would explain all the explicanda in its field, the experiments that refuted its predecessors inclusive, each would also be independently testable by predicted effects, yet each would be at once refuted when these prediction were put to the test. Thus each would satisfy our two requirements.

Kuhn on Normal Science

What a scientist does, according to Kuhn, in his daily enterprise amounts to what he calls Normal Science. Any scientist that does not preoccupy himself with superior scientific research must

meet up for the requirements of normal science. To Kuhn, normal science means the research that is firmly rooted upon one or more past scientific achievements.

Such achievements must be acknowledged by a given scientific community for a given point in time and it is such that provide the basis for further scientific enterprises. This kind of achievement, he argues, are today recounted, though not often in their original form by science text books – both elementary and advanced. Such books expand the body of accepted theories, illustrate many or of its successful applications and compare these applications with exemplary observations and experiments.

Some accepted instances of actual scientific practice according to Kuhn which includes law, theory, application and instrumentation give models from which emanate particular coherent tradition scientific research. A scientist possesses two essential attributes. Their achievement was sufficiently unprecedented to attract an enduring group of adherents away from competing models of scientific activity. Simultaneously, it was sufficiently open ended to have all sorts of problems for future group of practitioners to resolve.

Achievements that share these characteristics Kuhn calls “paradigms” a term which he says relates closely to normal science. This constitutes the tradition that the historian describes under such rubrics as “Ptolemaic Astronomy” or “Copernican” or “Aristotelian Dynamics” or “Newtonian Corpuscular optics” or “wave optics.”

The study of paradigms including many that are far more specialized than those already stated above in what fundamentally prepare the students for membership in a given scientific community in which he will later practice. Men whose research is tried is based on shared paradigms are committed to the same rules and standard for scientific practice. The commitment and the apparent consensus it produces are prerequisites for normal science i.e. for the genesis and continuation of a particular tradition. The ability to be acquainted with a paradigm in addition to the more esoteric type of research permits significant maturity and advancement in the development of any scientific field. For instance, the wave theory is embraced by almost all the practitioners of optical science. In the 18th century however, the paradigm for this field was provided by Newton’s optics which argue that light was material corpuscles. The transformation of the Paradigms of physical optics is scientific revolutions, and the successive transition from one paradigm to another via revolution is the usual development pattern of mature science.

In biology, for instance, part of its study centers on the study of heredity which is a most universally received paradigm. The essence of having paradigms in the view of Kuhn is essentially because history reveals that the road to a firm research consensus is extraordinarily arduous. Where there are no paradigms, all the facts that relates to the development of a given science may seem equally relevant.

Lakatos on Hard Core Theory

Lakatos enunciated what he terms "hard-core" in his methodology. This resembles to a reasonable extent Kuhn's paradigm, for scientists' tenets. The difference however is that in Lakatos' thesis, there are several 'hard-cores' competing at any stage in history.

The hard-core is a set of statements which are protected from refutation by the attempt to modify other assumptions when apparent refutation arises. It consists of a family of theoretical assertions and for a theory to be part of scientific research programme (S.R.P). It must share those assumptions. There is also the negative heuristic of the programme. And this is a methodological principle stipulating that the components in the 'hard-core' are not to be abandoned in the face of anomalies. For instance, the Newtonian gravitational theory, the three laws of dynamics and the law of universal gravitation are seen by Lakatos as constituting the 'hard-core' of Newtonian physics. The essence of the appeal to the negative heuristic is to ensure that anomalies emanating from the application of the theory are not taken as refuting these postulates. The heat produced by anomalies is to be cushioned by the modification of auxiliary hypothesis, observational hypothesis, or hypothesis stating initial condition. As to what is to be done in the face of anomalies, the guidance is provided by the positive heuristic of the programme. And this comprises of a partly articulated set of suggestions or hints as to how to change, develop the 'refutable variants' of the research programme, how to modify, sophisticate, the 'refutable' protective belt.

When successive modification by the positive heuristic is unable to produce any new independent tests which are passed, the research programme is 'degenerating'. If there is a remarkable success in the research programme in guiding us to new discoveries, then it is progressive. In the long run, progressive are chosen over degenerating research programme.

Feyerabend on Method in Science

Paul Feyerabend used an anti-methodology. He was opposed to any kind of methodology in science and he believes that science as a versatile and dynamic enterprises does not need any methodology. A methodology for science is like a chain tied round it which in essence is only disaster to its advancement. And progress, he argues, is very crucial as far as science is concerned, and the only principle that does not inhibit progress is anything goes, he believes that there is no single rule if we should go by historical research, however plausible and however firmly grounded in epistemology, that is not violated at some time or the other. Such violations certainly, he argues, cannot be attributed to accidental events, just as they cannot be seen as result of insufficient knowledge or of inattention that might have been avoided. Rather than to see it in any of the state ways, they are to be accepted as imperative for progress. He emphasizes that one

of the most salient points that is visible in the history of philosophy and science is the fact that the principle of proliferation of theories is necessary for scientific progress.

Events and developments such as the invention of atomism in antiquity, the Copernican Revolution, the rise of modern atomists (Kinetic Theory, dispersion theory, stereochemistry and the gradual emergence of the wave theory of light occurred only because some thinkers either decided not to be bound by certain obvious methodological rules or because they unwittingly broke them.

The practice of science is in consonant with this pragmatic attitude and it is only when practitioners of science conform to this requirement that progress in science could be assured. No matter how fundamental or crucial a rule in science may be, there are always circumstances when it is most valuable to ignore the rule and take the opposite, he asserts.