UNIT 1 THEORIES OF ORIGIN OF LIFE

Contents

1.0 OBJECTIVES

Ever since the dawn of human consciousness, we have been plagued by questions regarding our origin: Where did we come from? And as we grew in our understanding of the natural world around us, came the query: Where did these things come from? The current assumption of solar system formation is the Nebular hypothesis, first proposed in 1755 by Immanuel Kant and independently formulated by Pierre-Simon Laplace. It states that our solar system was formed from a gaseous cloud called the Solar nebula.. As we understand it, the superheated, rotating disc of dust and gaseous matter aggregated and broke away, cooling down to form the planets and eventually, the rocks, atmosphere and water on Earth. There does not seem to be much debate on this issue, considering that the galaxies hold sufficient examples of such systems in formation.

During your study of this unit you may ask the following questions:

Why is the debate still raging on the origin of life?

What is it that makes living things so very different from the non-living, that we cannot accept a simple, straightforward theory of spontaneous generation?

What makes life so unique and complex, that it cannot be explained in the manner of other natural phenomena?

Why is it that we look at several different theories including that of creationism, to explain it?

1.1 INTRODUCTION

For answers to these questions, we shall have to look at a definition of life itself. The Earth is estimated to be about 4.5 billion years old, and for much of that history it has been home to life in one strange form or another. Indeed, some scientists think that life appeared the moment our planet's environment was stable enough to support it. The earliest definite evidence for life on Earth comes from fossilized mats of cyanobacteria called stromatolites in Australia that are about 3.4 billion years old. Ancient as their origins are, these bacteria (which are still around today) are already biologically complex—they have cell walls protecting their protein-producing DNA, so scientists think life must have begun much earlier, perhaps as early as 3.8 billion years ago. Despite knowing approximately *when* life first appeared on Earth, scientists are still far from answering *how* it appeared.

1.2 DEFINITION OF LIFE

As we all know, living things are differentiated from the non-living by certain characteristics: Respiration, Response to stimuli, Locomotion, Metabolism, Growth and Reproduction. But what is it that causes these special characteristics to occur in living things?

To get to the heart of the matter, we shall have to look at life from a very fundamental perspective, that of the cellular structure. Very simply described, each cell is constituted of a cell wall or membrane, the protoplasm or fluid substance within, and the organelles floating inside such as the Nucleus and the Mitochondria. These organelles contain biochemical information in the form of chains of molecular bases linked to sugar or phosphate groups, that code for every structure and function in the body, and drive every cellular process from metabolism to replication. These chains of bases with the attached backbone of sugar and phosphate molecules, constitute the ordered sequences of nucleic acids that hold the key to every life-process. It could be said therefore, that these building blocks of nucleic acids are the very basis of life. In other words, out of clusters of essentially 'lifeless' biochemical molecules, spring the basic processes and functions that define ‘life’. These nucleic acids are in fact, the master codes for the synthesis of proteins. As living organisms are complex systems, the multitude of daily functions are helped to be carried out by the hundreds of thousands of proteins existing inside each one of us. These proteins are produced locally, assembled piece-by-piece to exact specifications. An enormous amount of information is required to manage this complex system correctly. This coded information, detailing the specific structure of the proteins inside our bodies, is stored in the set of molecules called nucleic acids that comprise the DNA and RNA. Proteins are made up of amino acids, and generally have from about a hundred up to several hundred amino acids arranged in a precise order or sequence. Twenty different kinds of amino acids are found in proteins, so it may be said that the protein "language" has twenty letters. Just as the letters of the alphabet must be arranged in a precise sequence to write this sentence, or any sentence, so the amino acids must be arranged in a precise sequence for a protein to possess biological activity.

To sum up, we can say that the macromolecules of life are structured in the following manner: Proteins are organic compounds that are essential biomolecules of all living organisms. Amino acids are the building blocks of proteins and they are arranged in a precise sequence to form various proteins. They are composed of the elements hydrogen, carbon, oxygen, nitrogen and sulphur. Human bodies only make use of 20 amino acids but in meteorites we can detect over 70 amino acids. The direction for the assembly and synthesis of amino acids to form proteins is carried out from the code detailed by the DNA and RNA in cells. These nucleic acids are organic molecular structures consisting of nitrogenous bases attached to a chain of sugar and phosphate molecules. In addition, there exists a group of fatty acids known as lipids which are a large group of organic compounds constituting cell membranes, and which have a multitude of other important roles.

Life: A biochemical phenomenon?

So how could the bio-molecules, which are the basis of life, have come to exist? The subject matter is generally divided into five stages:

The synthesis of organic compounds

The synthesis of biochemical substances (experiments have mainly reported on the production of amino acids under presumed pre-biological conditions).
The production of large molecules such as proteins.
The origin of organized cellular structures.
The evolution of macromolecules and metabolism.

We thus have a basic definition from which to explore the possible ways that life could have originated on planet Earth.

1.3 THEORIES ON THE ORIGIN OF LIFE

The theories can be broadly classified as follows: Creationism or Intelligent Design (I.D.), Abiogenesis or the beginning of life from non-living earthly matter, Panspermia or Exogenesis, and Extraterrestrial Origin.

CREATIONISM

In the recent past, the challenge to scientific theory has come from a new breed of sophisticated, scientifically trained creationists who are pushing the theory of "intelligent design" or I.D. The `ID-ers' do not interpret the Bible literally. They accept fossil records as evidence of the evolution of human beings from apes, and they accept that the earth is about 4.6 billion years old (and not 6,000 years old, as the earlier generation of Biblical creationists believed.) But they draw the line at natural selection, the hallmark of Darwinian evolution. They insist that the complexity in biological structures - the intricacy of the eye, for example - could not have come about by natural causes alone. From this they surmise that there must be an intelligent designer responsible for the wondrous complexity of life.

Check Your Progress I

Note: a) Use the space provided for your answer

b) Check your answers with those provided at the end of the unit

1) Explain briefly the basic elements of life.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………..

…………………………………………………………………………………………….

2) Enumerate the five stages of the development of bio-molecules?

…………………………………………………………………………………………….

……………………………………………………………………………………………..

……………………………………………………………………………………………..

…………………………………………………………………………………………….

ABIOGENESIS

Leading scientific theories based on abiogenesis or the spontaneous origin of life on Earth could be divided into two main groups: a) the 'RNA world' hypothesis b) origin under high temperature and pressure. The formation of amino acids and other organic compounds is presumed to have been a necessary step in the genesis of life; it is certain, at least, that somewhere along the line all life became dependent on DNA and RNA for reproduction. Scientists thus presume that the first self-replicating molecules were similar to the nucleic acids of modern organisms. (These early molecular systems need not have been as complex as the self-replicating systems that comprise modern cells. Researchers have recently shown, by detecting genes that even the genetically simplest bacteria alive today can reproduce with much less than their full natural complement of DNA.) Once molecules that could self-replicate were formed, the process of evolution would account for the subsequent development of life.

The 'RNA world'

Many researchers believe the first self-replicating molecule was RNA. This is because RNA can do various things in addition to carrying genetic information. Some of these activities seem similar to what would be required for self-replication, something that DNA can't do, strictly speaking. DNA needs the help of other molecules to copy itself. Also, since RNA still exists in living cells and performs various functions many scientists think RNA must have been there from the beginning. Most biologists consider the RNA world hypothesis at least plausible, but it has some problems. It is not easy to explain how the first self-replicating RNA molecules might have arisen. One of the most promising explanations is as follows: RNA molecules tend to fall apart under warm conditions outside of cells. This would prevent the buildup of the rather long, complex RNA molecules that would probably be needed to conduct life processes, according to Laura F. Landweber and her colleagues at Princeton University in New Jersey. Various conditions can prevent RNA molecules' breakdown, the researchers argue. These include various types of water solutions, and freezing. But freezing may have been the one that most likely occurred on early Earth.

These scientists argue that ice might have been a favorable environment to generate the first self-replicating molecules, a precondition for life. New findings are backing up a theory that life originated in ice. If it's true, it could boost the chances that life might turn up in places considerably colder than our planet. The theory departs from mainstream thinking on the origins of life, which usually assumes a warm, or hot and wet environment was necessary.

Conditions associated with freezing, rather than 'warm and wet' conditions, could have been of key importance for the chemical reactions that led to life, wrote four researchers in the July 21 advance online issue of the *Journal of Molecular Evolution*, a research publication. These molecules would be of the type called ribonucleic acids, or RNA—a cousin of DNA which makes up genes.

Freezing usually slows down chemical reactions, which is why cold places are generally considered hostile to life. But freezing actually speeds up some of RNA's key activities, Landweber and colleagues argue. This is because ice contains hard, tiny compartments that hold the molecules in one place, where they can react together. Some of these reactions result in the creation of bigger RNA molecules.

In liquid water by contrast, the molecules don't come close enough together often enough to react as much. Thus they tend to fall apart faster than they can react to create bigger products. In essence, the small compartments in ice play the role that cells today play in bringing the molecules together to react, Landweber and her colleagues say. Dehydrated substances could also have provided a function similar to ice.

Origin under high temperature and pressure

Some scientists believe that the young Earth was too inhospitable a place for life to have developed on its surface at all. Lacking Oxygen, the atmosphere would also have lacked its present-day stratospheric layer of ozone (O_3), which screens large quantities of harmful ultraviolet radiation from the surface. They believe that a more likely environment for abiogenesis (life from pre-life) was in the vicinity of deep-sea vents, which are gaps in the crust under the ocean from which hot, mineral-laden water flows.

A controversial theory put forward by Thomas Gold in the 1990s has life first developing not on the surface of the earth, but several kilometers below the surface. It is now known that microbial life is plentiful up to five kilometers below the earth's surface in the form of archaea, which are generally considered to have originated around the same time or earlier than bacteria, that mostly live on the surface including the oceans. It is claimed that the discovery of microbial life below the surface of another body in our solar system would lend significant credence to this theory.

In the 1980s, Gunter Wachtershauser in his Iron-Sulfur world theory postulated the evolution of (bio) chemical pathways as fundamentals of the evolution of life. He presented a consistent system of tracing today's biochemistry back to ancestral reactions that provide alternative pathways to the synthesis of organic building blocks from simple gaseous compounds.

Instability is a most fundamental objection to any type of system that can be proposed to bridge the gap between molecules and living cells. All of the proposed models suffer this basic and fatal weakness. One of the reasons living cells are stable and can persist is that they have membranes that protect the system within the membrane and hold it together. The membrane of a living cell is very complex in structure and marvelous in its function. A coacervate or a protein microsphere may have a pseudomembrane, or a concentration or orientation of material at the point of contact with the surrounding medium, that gives it the appearance of having a membrane.

Origin of life breakthrough

A team of Japanese researchers announced that they had managed to recreate the conditions from which life itself may have sprung. In a major breakthrough in the never-ending debate about how life started, Koichiro Matsuno and colleagues at the Nagaoka University of Technology, Japan, built an artificial system simulating the environment of undersea thermal vents, where water heated deep below erupts through the seabed into cooler ocean water. By this they were able to produce some of the elementary building blocks from which proteins essential to life are formed. Writing in the journal Science, Matsuno described how his team simulated a process called polymerisation in which complex molecules are formed from simpler amino acids. This process was likely to be repeated numerous times, possibly aided by heating in dry and wet conditions, day-and-night cycles, tidal waves and dry-wet conditions in lagoons.

An Indian researcher A.K. Lal has mentioned in his paper the existence of ‘extremophiles’, which are usually unicellular microbes that can survive in the harshest of environments on earth. “Such microorganisms thrive in extreme cold, extreme heat, extreme acidic, and extreme alkaline conditions. Some thermophiles have been found to flourish at a depth of 2.8 km in gold mines in South Africa, while methane-oxidising microbes have been reported to be thriving at a record depth of 1.62 km beneath the Atlantic seabed at simmering temperature of 60-100 degree Celsius,” he writes in the paper.

New research links origin of life to ponds

Debunking the popular theory that life emerged from oceans, latest research effort shows it could have emanated from fresh water ponds. Most theories on the origin of cellular life presume that the first step was the formation of a spherical membrane called vesicle, that could enclose self-replicating chemical chains—the ancestors of modern DNA. The theory is that the ingredients for simple membranes were all present on the early earth and at some point spontaneously formed vesicles in water. It seemed most likely that this had taken place in the sea rather than in freshwater, largely because of the sheer size of the oceans. With their unique chemistry, deep-sea thermal vents and tidal pools are generally believed to be the most likely sites for such formation.

Now research by a team of graduate students led by Charles Apel of the University of California, Santa Cruz, has written off the ocean- theory claiming they were able to create stable vesicles using freshwater solutions of ingredients found on the early earth, and not with salty solutions. They have reported their findings in a popular issue of astrobiology.

"When sodium chloride or ions of magnesium or calcium were added, the membranes fell apart," Apel says. This happened in water that was even less salty than what the oceans are today. Geologist Paul Knauth of Arizona State University points out that the earth's early oceans were 1.5 to 2 times saltier than what they are today, making it even more unlikely that viable cells could have arisen there. Giant salt deposits called evaporates that formed on the continents have actually made the seas less salty over time.

"No one in his right mind would use hot sea water for laboratory studies on early cellular evolution," says biochemist David Deamer of the University of California, Santa Cruz, who is reporting the work along with Apel. "Yet, for years we all have accepted without a question that life began in a marine environment. We were just the first to ask if we were really sure of that."

PANSPERMIA OR EXOGENESIS

Did the first microorganisms arrive from space, riding piggyback on meteors that crashed into earth billions of years ago? Were the first seeds of life actually extraterrestrial 'spores', floating around in the infinite space on comets? This theory, known as Panspermia, is one that originated in the 19th century in opposition to the theory of spontaneous generation. It claims the 'spores' took root on primitive earth more than four billion years ago after the earth was bombarded by meteors for around 700 million years. Panspermia propounded that reproductive bodies of living organisms exist throughout the universe and develop wherever the environment is favorable. The basic tenet of panspermia is that primitive life, which originated some where else, was deposited on the Earth’s surface by means of a collision with some object that carried it. This theory has been re-popularized by the realization of the improbability that life formed through abiogenesis on earth, and is now more commonly called Exogenesis. The full theory of panspermia requires two events to explain the presence of life on earth:

The generation of life outside the earth, and then the transfer of this life to earth

Many scientists have objected that the generation of life cannot occur, or have occurred, outside of a planetary environment, where heavier elements are plentiful. Almost the only elements present in interstellar space are hydrogen and helium--and the latter, being an inert or noble gas, is not a component of life in any form known to man.

The generation objection by itself would not destroy panspermia. But the transference event requires a transit through space, followed by a passage through the earth's atmosphere and then an impact on the ground or at sea. Either of these events is fraught with danger. The unprotected space outside of an atmosphere is subject to unfiltered radiation in various forms. These include the products of radioactive decay, cosmic rays (the highest-energy form of electromagnetic radiation known to man), and the stellar wind, a stream of particles that fly out from any star as it continuously burns. Even if any life forms could survive the spatial passage, it must then somehow penetrate the atmosphere and risk incineration from sheer friction, and then must survive the impact.

A test done by attaching a piece of bacteria-smeared rock to a returning Russian spacecraft in September 2008 showed the difficulty of life surviving a fall through Earth's atmosphere, with temperatures on the rock reaching 1700 degrees Celsius, despite an entry speed which was a little more than half that a meteorite would experience.

EXTRATERRESTRIAL ORIGIN

If we surmise that life was created from non-living chemicals, another possibility is that amino acids that were formed extra-terrestrially arrived on Earth via comets. Why is the ‘Extraterrestrial origin of Life’ theory necessary? Scientists suspect that the early days on Planet

Earth were hot, dry and sterile. It is now clear that space debris bombarded the young planet, creating cataclysms equivalent to the detonation of countless atomic bombs. Impacts of this kind, common until 4.0 billions years ago, surely aborted any fledgling life struggling to exist before that time. The short time span for life to emerge implies that the process might have required help from space molecules.

Astronomers see signatures of a range of organic compounds throughout the universe, especially among the clouds. For example, a decade of research conducted by Allamandola and others has revealed that polycyclic aromatic hydrocarbons are the most abundant class of carbon-bearing compounds in the universe, trapping as much as 20 percent of the total galactic carbon in their molecular lattices.

Experiments reveal that even at the extremely low temperatures and pressure of space, UV radiation can break chemical bonds. When the atoms are locked in ice, this bond-breaking process can make molecular fragments recombine into unusually complex structures that would not be possible if these fragments were free to drift apart. Bertein started with a simple ice of frozen water, methanol and ammonia - in the same proportions seen in space ice - the experiment yielded complex compounds such as the ketones, nitriles, ethers and alcohols found in carbon-rich meteorites. They also created hexamethylenetetramine, or HMT, a six-carbon molecule known to produce amino acids in warm, acidic water. David W. Deamer found that some of the molecules in the cloud-chamber ice grains form capsule-like droplets in water. These capsules are strikingly similar to extracts from the Murchison meteorite.
Researchers found that interstellar amorphous ice too can flow, when exposed to radiation such as that found in deep space. Thus, it could be an explanation of how organic molecules may endure and react within the ice.

Emerging consensus in planetary science agree that the early pre-biotic atmosphere was a neutral one rich in carbon dioxide and molecular nitrogen. Early CO_2-rich atmospheres are implied by ‘hot accretion’ scenarios for Earth, in which core formation takes place quickly, leaving the upper mantle in an oxidized state. The short photo dissociation lifetimes of methane and ammonia in model paleo atmospheres reinforce this conclusion. There is a dense CO_2 content in the early terrestrial atmosphere, consistent with the early ‘faint sun paradox’. Synthesis of key pre-biotic molecules such as hydrogen cyanide and formaldehye would have been much more difficult in CO_2 atmospheres than in reducing ones.

A long standing objection to extraterrestrial origin is that the organic compounds would be totally dissociated by the heat of cometary atmosphere passage and the ensuing impact. However, researchers speculated that aerobraking (slowing by atmospheric drag) and uneven distribution of shock energy throughout the impacting projectile will conspire to yield some region of the comet for which temperatures remain low enough to allow at least the hardier organics to survive. Because gas-phase results on shock pyrolysis are not available, it is estimated that the amino acid Alanine could withstand temperatures of upto 700K for 1 second, whereas other amino acids should withstand temperatures in the range of 600 to 800K. Through modelling, it is shown that dense CO_2 atmospheres allow intact cometary organics to be delivered in large amounts to the surface of the planet.

Check Your Progress I

Note: a) Use the space provided for your answer

b) Check your answers with those provided at the end of the unit

1) Write a short note on RNA.

…………………………………………………………………………………………..
…………………………………………………………………………………………..
…………………………………………………………………………………………..
………………………………………………………………………………………….

2) What do you understand by *panspermia*?

………………………………………………………………………………………….
…………………………………………………………………………………………..
…………………………………………………………………………………………..
………………………………………………………………………………………….

1.4 LET US SUM UP

Together with Lal we may conclude that prevailing theories like abiogenesis, RNA-World, iron-sulphur world (deep-sea-origin of life) and panspermia (life arrived from outer space) fail to provide clues on the exact origin of life. But it is not necessary to invoke scenarios of multiple universes or life-laden comets crashing into ancient Earth. Instead, life must have started with molecules that were smaller and *less complex* than RNA, which performed simple chemical reactions that eventually led to a self-sustaining system involving the formation of more complex molecules which began their journey about 13.7 billion years ago when the Universe flared forth into being. The Universe billowed out in every direction with its powerful elementary particles that stabilized themselves to enable the first atomic beings of hydrogen and helium to emerge. A billion years of uninterrupted activity enabled the Universe to prepare itself for the galactic clusters of about 100 billion galaxies, including our own Milky Way Galaxy. Each Galaxy contained its own unique interval dynamics with about 100 billion stars in each of them. About five billion years ago, our Milky Way gave birth to ten thousand new stars including the Sun. The Sun blasted off all the clouds of elements and spined the rest into a multibanded dice of matter out of which arose the solar system with our Sun and other nine planets such as Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto about four billion years ago, *Aries*, the first prokaryotic cells appeared on earth. On account of the balance of earth's own internal dynamics and its position in the structure of the solar system, matter existed as solid, liquid, and gas and flowed from one form into another to provide an incessantly creative chemical womb from which arose Aries, the first prokaryotic living cell. The primal prokaryotic cells had the power to organize themselves as did the stars and galaxies. The cells could also remember significant information, even the patterns necessary to knit together another living cell. The cells also possessed a new order of creativity to catch the pockets of energy hurled by the Sun at the speed of light and to use these quanta as food. Aries and the prokaryotes hydrogen from the ocean had released oxygen into Earth's system, which saturated the land and the seas. However, the prokaryotes unknowingly pushed Earth's system into an extremely unstable condition by altering earth's chemistry with this element of explosive power. Consequently, the prokaryote communities perished as their interiors were set ablaze by the oxygen. But out of this crisis arose Vikengla, a new and radically advanced being. *Vikengla* was the first eukaryotic cell which was capable of shaping oxygen's dangerous energy for its own purposes. The eukaryotes invented meiotic sex by which the universe's diversity expanded a hundredfold, through sexual union. Finally, the eukaryotes took that daring step of submerging themselves into a larger mind as trillion of them gathered together and evoked Argos, the first multicellular animal. About 600 million year ago, there arose multicellular organism. They included the coral, worm, insects, clams, starfish, sponges, spiders, vertebrates, leeches and other form of life. The animals followed the plants onto land heaved with amphibians, reptiles, insects and dinosaurs. About 67 million years ago there was an astronomical collision that changed earth's atmosphere and climate which nearly destroyed all forms of animal life on earth, including the dinosaurs. But such destructions opened up new possibilities seized upon by the birds and the mammals. The mammals entered earth's life about 200 millions year ago. They developed emotional sensitivity, a new capacity within their nervous systems for feeling the universe. This mammalian emotional sensitivity was deepened with the human nerval capability, the self-consciousness. Four million years ago in Africa, humans stood up on just two limbs and by two million years ago they began to use tools. Beginning around thirty-five thousand years ago, they began a new form of celebration that displayed itself in cave paintings deep within Earth. About 12 thousand years ago the first Neolithic villages were formed in Jericho, Catal Hiiyiik and Hassuna. It was the most radical social transformation ever to occur in the human venture. In this period, the decisive developments in language, religion, cosmology, arts, music and dance took their primordial form. The urban civilization began to shape itself about five thousand years ago giving rise to new power centres: Babylon, Paris, Persopolis, Banaras, Rome, Jerusalem Constantinople, Sion, Athens, Baghdad, Tikal of the Maya, Cairo, Mecca, Delhi, Tenochtitlan of the Aztec, London, Cuzeo, the Inca City of the Sun. Europeans initiated the third of humanity's great wandering about five hundred years ago. The first had brought *Homo erectus* out of Africa to spread throughout Eurasia. The second was that of the *Homo Sapiens* who wandered until they reached the Americas and Australia. The principal differences of the third wandering was that now the Europeans encountered humans wherever they went and they colonized them. More about the origin and development of human life we shall discuss in the next unit.

1.5 KEY WORDS

Homo Erectus: *Homo erectus* (from the Latin *erigere,* "to put up, set upright") is an extinct species of hominid that originated in Africa from the end of the Pliocene epoch to the later Pleistocene, about 1.8 to 1.3 million years ago.

Homo Sapiens: *Homo sapiens* (Latin: "wise human" or "knowing human") is the only extant member of the *Homo* genus of bipedal primates. Humans have a highly developed brain, capable of abstract reasoning, language, introspection, and problem solving. This mental capability, combined with an erect body, frees the hands for manipulating objects, has allowed humans to make far greater use of tools than any other species.

1.6 FURTHER READINGS AND REFRENCES

Asimov, I. *In the Beginning.* New York: Crown, 1981.

Crick, F. J. *Life Itself: Its Origin and Nature.* New York: Simon and Schuster, 1981

Durant, J. R. *Human Origins.* New York: Claredon Press, 1989

Glaessner, M. F. *The Dawn of Animal Life.* Cambridge: Cambridge University Press, 1984.

Panthanmackel, George. *Coming and Going: An Introduction to Metaphysics from Western Perspectives.* Bangalore: ATC, 1999.

Prigogine, I. *From Being to Beginning.* San Francisco: W. H. Freeman, 1980.

Swimme Brian and Berry,Thomas. *The Universe Story*. New York: Harper Collins, 1994.

Weinberg, S. *The First Three Minutes: A Modern View of the Origin of the Universe.* New York: Basic Books, 1977.

Websites:

www.allaboutscience.org/**theories-on-the-origin-of-life**-faq.htm

*science.jrank.org/pages/.../**Origin-Life-Theories-origin-life**.html*

1.7 ANSWERS TO CHECK YOUR PROGRESS

Answers to Check Your Progress I

1.We can say that the macromolecules of life are structured in the following manner: Proteins are organic compounds that are essential biomolecules of all living organisms. Amino acids are the building blocks of proteins and they are arranged in a precise sequence to form various proteins. They are composed of the elements hydrogen, carbon, oxygen, nitrogen and sulphur. Human bodies only make use of 20 amino acids but in meteorites we can detect over 70 amino acids. The direction for the assembly and synthesis of amino acids to form proteins is carried out from the code detailed by the DNA and RNA in cells. These nucleic acids are organic molecular structures consisting of nitrogenous bases attached to a chain of sugar and phosphate molecules. In addition, there exists a group of fatty acids known as lipids which are a large group of organic compounds constituting cell membranes, and which have a multitude of other important roles.

2. So how could the bio-molecules, which are the basis of life, have come to exist? The subject matter is generally divided into five stages:

The synthesis of organic compounds
The synthesis of biochemical substances (experiments have mainly reported on the production of amino acids under presumed pre-biological conditions).
The production of large molecules such as proteins.
The origin of organized cellular structures.
The evolution of macromolecules and metabolism.

Answers to Check Your Progress II

1. Many researchers believe the first self-replicating molecule was RNA. This is because RNA can do various things in addition to carrying genetic information. Some of these activities seem similar to what would be required for self-replication, something that DNA can't do, strictly speaking. DNA needs the help of other molecules to copy itself. Also, since RNA still exists in living cells and performs various functions many scientists think RNA must have been there from the beginning. Most biologists consider the RNA world hypothesis at least plausible, but it has some problems. It is not easy to explain how the first self-replicating RNA molecules might

have arisen. One of the most promising explanations is as follows: RNA molecules tend to fall apart under warm conditions outside of cells. This would prevent the buildup of the rather long, complex RNA molecules that would probably be needed to conduct life processes, according to Laura F. Landweber and her colleagues at Princeton University in New Jersey. Various conditions can prevent RNA molecules' breakdown, the researchers argue. These include various types of water solutions, and freezing. But freezing may have been the one that most likely occurred on early Earth.

2. Did the first microorganisms arrive from space, riding piggyback on meteors that crashed into earth billions of years ago? Were the first seeds of life actually extraterrestrial 'spores', floating around in the infinite space on comets? This theory, known as Panspermia, is one that originated in the 19th century in opposition to the theory of spontaneous generation. It claims the 'spores' took root on primitive earth more than four billion years ago after the earth was bombarded by meteors for around 700 million years. Panspermia propounded that reproductive bodies of living organisms exist throughout the universe and develop wherever the environment is favorable. The basic tenet of panspermia is that primitive life, which originated someplace else, was deposited on the Earth's surface by means of a collision with some object that carried it. This theory has been re-popularized by the realization of the improbability that life formed through abiogenesis on earth, and is now more commonly called Exogenesis. The full theory of panspermia requires two events to explain the presence of life on earth: The generation of life outside the earth, and then the transfer of this life to earth