Institute for Christian Teaching
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THE AMAZING CELL - EVIDENCES OF GOD'S CREATORSHIP

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INTRODUCTION

Objectives

This paper attempts to demonstrate the integration of spiritual truths in the presentation of the origin, structures and functions of the living cell. The author hopes that: (a) the reader will perceive and come to agree that the data on the cell fit the creation model more than the evolutionary model, and (b) that this illustration will give impetus to the integration of faith and learning in the classroom particularly in the natural sciences.

E.G. White, in her book Education, wrote, "The book of nature and the written word shed light upon each other. They make us acquainted with God by teaching something of the laws through which He works."

Thus a natural science course, handled by a committed christian teacher, should be a convenient and "natural" setting for the integration of faith and learning. In so doing the christian teacher emulates the Master Teacher who frequently drew lessons from the natural world.

"In teaching" Holmes wrote, "integration should not be moralizing tacked on at the end of a supposedly factual recital, nor should it be pontificated." Often a well placed question at the end of an interesting discourse directs the thought of the listeners to spiritual truths better than a statement does.

WHAT IS A CELL?

The cell is the fundamental structural and functional unit of all living organisms, just as the atom is the fundamental unit in chemical structures. An organism may be composed of only one cell, such as in an amoeba in which the cell performs all the functions necessary to sustain and reproduce itself. Or the organism may be composed of billions upon billions of cells as in humans.

Cells are all nearly uniform in design. Even though shapes may differ, yet each cell follow the same general blueprint in every living organism - be it a leaf, ant, dog or man. Every organism starts as one cell. Later some of these cells diversify into different types of cells to perform various functions. This diversification is "programmed" to occur at an appointed time in the life of the organism.

Many years ago, Charles Darwin and other scientists of the day referred to the "simple single cell." As science advanced and new insights were gathered the "simple cell" is anything but simple. The cell, complicated in the extreme, is a highly sophisticated mechanism arranged intricately to carry out the most awe-inspiring job: the creation and support of life in all its form.

Cells communicate with each other through chemical signaling. Communication is required to regulate their development and organization into tissues, to control their growth and division, and to coordinate their diverse activities.

Cells recognize each other. If cells from the same or different tissues are mixed together and shaken, similar cells would aggregate and stick together. Furthermore, if an "alien" cell is introduced among the cells of the body of an organism, it will be identified as an "intruder", rejected, and destroyed.

Integration of Faith What could be the reason for the nearly uniform design of every cell? Did it come about by chance? Or was it designed by a superior intelligence? There are two worldviews that attempt to explain this situation: the Creation model and the Mechanistic model. When you come to learn that the functions are so organized as well you will lhave your answer.

THE ORIGIN OF THE CELL

The Creationistic Worldview

The Holy Scriptures starts with the story of how God created living things at the beginning of this world. The inspired writer of the first book of the Bible wrote:

> "And God said, Let the earth bring forth grass, and herb yielding seed, and the fruit tree yielding fruit after his kind, whose seed is in itself, upon the earth and it was so."
> ". . .Let the waters bring forth abundantly the moving creature that hath life, and the fowl that may fly above the earth in the open firmament of heaven."
> ". . .Let the earth bring forth the living creature after his kind, cattle, and creeping thing, and beast of the earth after his kind, and it was so." (Gen. 1:11-26)

Looking at the parts of all the living things mentioned above under the microscope scientists came to the conclusion that: a) all living things are made up of cells and, that b) every living cell came from preexisting cell (Cell Theory). What God did during the creation week then was to create the first living cells. It was

Robert Hooke who gave the name "cell" to these units.

A thing is living because the cells composing it have life. Biologists refer to the living substance in the cell as the <u>protoplasm</u> which Thomas Huxley defined as the "physical basis of life." Chemists have determined that a living cell is composed of a restricted set of elements, six of which (C,H,N,O,P,S) make up more than 99%of its weight. The rest are inorganic minerals. This composition differs markedly from that of the earth's crust.

These elements combine to form four families of small organic molecules: the simple sugars, the fatty acids, the amino acids, and the nucleotides. In turn, these small organic molecules form larger molecules namely, the polysaccharides, the nucleic acids, the lipids, and the proteins. The cell contains 75% to 85% water, 10 to 20% protein, and 2 to 3% lipids (mostly in cell membrane).

The amino acids composing each polypeptide (protein) chain is of the <u>left-handed</u> variety only. In nature equal amounts of left-handed and right-handed amino acids are available.

<u>Integration of Faith.</u> What could be the reason why only left-handed variety of amino acids are used in living cells when there are equal amounts to choose from? Could that happen by chance. If you toss a coin a million times would it always come up head?

The act of creation of the first forms of life was a one-time event which cannot be replicated. It takes faith to accept the reality of creation just like it does to believe other theories on the origin of life.

The Mechanistic Worldview

The Modern Theory of Chemical Evolution of Life.

In the beginning it is envisioned that the early earth atmosphere contained such gases as hydrogen, methane, carbon dioxide, carbon monoxide, ammonia, nitrogen, <u>but no free oxygen</u>.

About 3.5 billion years ago, the earth's surface had cooled to under 100oC which allowed for the survival of various organic molecules.

Various forms of energy; such as shock waves lightning, geother mal heat, and UV light (which was strong then due to the absence of ozone layer) bathed the earth and drove reactions in the atmosphere to form wide variety of simple organic molecules like amino acids.

The simple compounds formed in the atmosphere were washed down by rain into the ocean where they were presumably concentrated into a "dilute soup." Innumerable bodies of water, such as lakes, shallow pools, etc. gradually "thickened" the soup by evaporation.

The conditions were now right for the development of protocell.

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Protocells were supposedly not true cells with a membrane and sufffficient functional capacity to survive an interim period. Finally life itself gained its first foothold. This theory maintains that natural processes alone operated to form life on this planet.

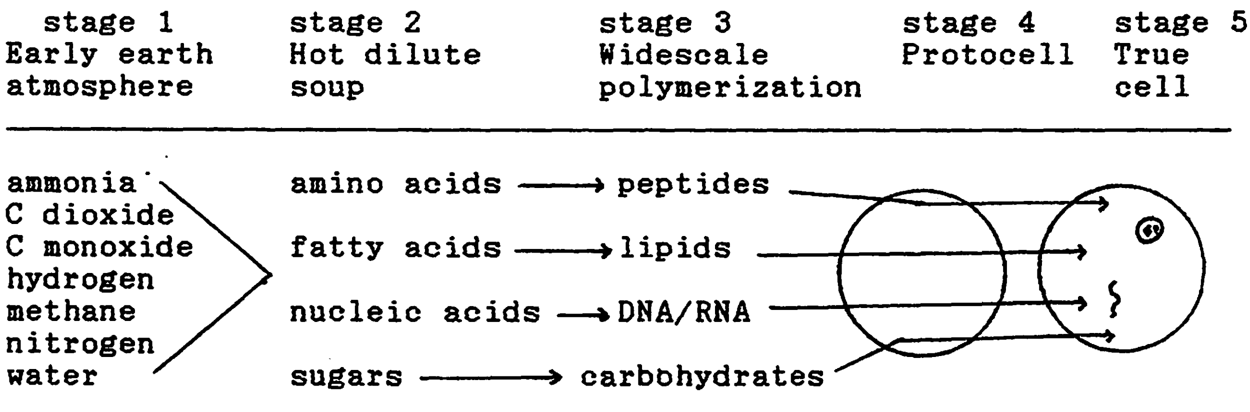

Fig.1 Stages in chemical evolution (Adopted from Thaxton et al.)

<u>Integration of Faith:</u> No free oxygen in the atmosphere? What is the basis for assuming that there was no free oxygen in the early atmosphere? Walker answers:

> "the strongest evidence for an atmosphere without oxygen is that we know chemical evolution took place. If oxygen was present all organic compounds such as the precursor of chemicals that accumulated for chemical evolution to proceed are decomposed quickly in the presence of oxygen. Furthermore if even just a trace quantity of oxgyen was present, organic molecules would be oxidized as soon as they are formed."

The first experimental test of the theory of chemical evolution was done in 1952 by Stanley Miller, a graduate student, working in the laboratory of Harold Urey at the University of Chicago.

Miller devised an experimental approach to simulate the formation of biomonomers on the early earth. The simulated atmosphere consisted of methane, ammonia, hydrogen and water vapor. The apparatus for Miller's experiment consisted of a small boiling flask containing water, a spark discharge chamber with tungsten electrodes, a condenser, and a water trap to collect the products.

In all, ten of the twenty amino acids have been positively identified as well as about thirty nonproteinous amino acids.

Others, using other sources of energy like UV light, shock waves, and heat obtained similar results.

Integration of Faith Did Stanley Miller and the others really create life when they succeeded in synthesizing amino acids from atmospheric gases? Do you see the possibility of man creating life in the laboratory someday? Why not? How about this type of reasoning? The cell theory states that life can come only from pre-existing life. Jeus said, "I am the Life, I was before the beginning of the world." Therefore, He alone can give life.

Even if scientists would actually create living forms in the laboratory someday two responses are appropriate: 1) highly intelligent beings designed and carried out the experiment, 2) no one can witness that is how it actually happened in the beginning

CELLULAR STRUCTURES

Under a light microscope a typical cell appears to consist of a small mass of protoplasm with a dense body called, the nucleus, supended in a translucent mass called the cytoplasm. This mass is separated from adjacent cells by a very thin plasma membrane which, in plant cells, is overlaid by a rigid cell wall. Under the electron microscope a panorama of highly complex but well ordered variety of structures, called organelles, are visible.

Each of these organelles has specific functions complementing the functions of the others. Among the major organelles are the following:

1. The cell membrane - an assembly of lipid bilayer and protein molecules held together by noncovalent interactions. It is highly selective filter that maintains the unequal concentration of ions on either side and allows nutrients to enter and waste products to leave the cell. All cell membranes are dynamic fluid structure: most of their lipid and protein molecules are able to move about rapidly in the plane of the membrane.

Membrane lipid molecules are amphipathic, and most of them form bilayers when placeed in water. There are three major classes of lipid molecules in the plasma membrane bilayer and the lipid compositions of the inner and outer monolayers are different. In addition the different membranes of a single eukaryotic cell have distinct lipid compositions.

Proteins are responsible for most membrane functionss,serving as specific receptors, enzymes, or transporters. Transport proteins form continuous protein pathways across the bilayer. Many transport proteins act like enzymes with specific binding sites. A type of transport proteins forms an open chaannel across the bilayer through which small molecules cam move down their electro chemical gradients by simple diffusion.

2. Endoplasmic reticulum (ER) - a vast network of endomembranes that subdivides the cytoplasm into two main compartments, one enclosed within the membranes, the other situated outside and constituting the cytoplasmic matrix or cytosol.

The ER comprisses two part differentiated by the presence or absence of ribosomes on the outer surface: the rough (RER) and the smooth (SER). The rough ER have attached ribosomes attached on their surface. Ribosomes are sites for synthesis of proteins destined for secretion, as well those to be delivered to several other intracellular organelles. The selection process is usually guided by the presence of a signal sequence at the amino terminus of the growing polypeptide chain.

The ER serves as a factory for the production of protein and lipid components of most the the cell's organelles. Its extensive membranes contain many different biosysnthetic enzymes including those responsible for almost all of the cell's lipid synthesis.

3. Golgi Apparatus - consists of dictyosomes formed by stack of curved cisternae, associated tubules, and secretory vesicles. The cisternae lack ribosomes and are surrounded by a zone in which organelles are excluded.

One of the major functions of Golgi is glycosidation of lipids and proteins to produce glycolipids and glycoproteins. But the main function of Golgi complex is the accurate sorting and secretion of proteins for selective export. This sorting is thought to be mediated by a set of receptors in the Golgi membrane that recognize specfic markers on the proteins to be transported.

4. Lysosomes and Peroxisomes. Lysosomes are organelles specialized for intracellular digestion. They contain a wide variety of different hydrolytic enzymes-called acid hydrolases-because they characteristically operate best at a pH of about 5, the internal pH of the lysosome. The hydrolases are synthesized in the ER and processed through the Golgi apparatus whence they are transported to lysosomes by means of special coated vesicles. The mechanism by which these proteins are sorted out and routed toward the lysosomes is as yet unknown .

Peroxisomes are organelles specialized for carrying out oxidative reactions using molecular oxygen. They generate hydrogen peroxide which they both use and destroy by means of the catalaze they contain.

Serious genetic diseases result from the absence of even a single lysosomal hydrolase, demonstrating the importance of lysosomal digestion processes for normal cell function. Studies on diseases led to the discovery that a special mannose-phosphate containing oligosaccharide is normally attached to the lysosomal hydrolase as an address marker allowing them to be sorted out by a receptor protein located in the Golgi membranes. It appears that different oligosaccharides and other features of the protein surface are used as address markers for the intracellualr sorting of proteins.

Integration of Faith I am constrained to comment on the sorting out functions of the above organelles. What could have brought about the sorting out mechanism if these evolved by chance

5. Mitochondrion. These are organelles present in the cytoplasm of all eucaryotic cells. They contain 2 compartments-an inner one filled with the mitochondrial matrix and limited by an inner membrane, and an outer one located between the inner and outer membranes. Complex infolding of the inner membrane, called mitochondrial crests, project into the matrix. The shape and disposition of these crests vary in different cells and their number is related to the oxidative actvity of the mitochondrion.

Mitochondrion functions as energy-transducing organelles into which the major degradation products of cell metabolism penetrate and are converted into chemical energy (ATP) to be used in the various activities of the cell.

6. Chloroplasts - these are chlorophyll-containing plastids in which photosynthesis occurs. Their shape, size, number and distribution vaery in different cells sbut fairly constant for a given tissue.

Many chloroplasts show small granules called grana embedded within the matrix. Th electron microscope reveals their three main component: the envelope, stroma and thylakoids. The envelope is made of two membranes, but no continuity between the inner membrane and the thylakoids. The stroma is a gel-fluid phase that contains 50% of the chloroplast proteins. It has ribosomes and DNA. The thylakoids are flattened vesicles forming a membranous network. They contain about 50% of the chloroplast proteins and all componenets essential to photosynthesis.

LIpids represent about 50% of the thylakoid membrane; these includes those directly involved in photosynthesis such as chlorophylls. Chlorophyll is an asymmetrical molecule having a hydrophilic head made of four pyrrole rings bound to each other and forming a porphyrin around a magnesium atom. Chlorophyll is a pigment capable of absorbing energy from the sun and storing this in the high energy bonds of a molecule called ATP (adenosine triphosphate.)

7. Nucleus. The nucleus is enclosed by an envelope (absent in prokaryotes) consisting of concentric pair of membranes and a perinuclear space. Nuclear pores represent openings in this enve-

lope at sites where the two membranes are in contact. The pores are plugged by a cylinder of protein materials. The outer nuclear membrane is continuous with the endoplasmic reticulum membrane and the perinuclear space between it and the inner nuclear membrane is continuous with the ER lumen. All of the cell's RNA molecules and ribosomes are made in the nucleus and are exported to the cytosol while all of the proteins that function in the nucleus are synthesized in the cytosol and must be imported.

The nuclear membrane regulates the passage of ions and macromolecules by way of the pore complex. Nuclear proteins are able to accumulate inside the nucleus after microinjection. Nuclear proteins contain in their mature molecular structure a signal that enables them to accumulate inside the nucleus. The mechanism involved in this selective distribution of proteins is very different from that involved in the intracellular segregation of export proteins.

Within the nucleus are colored (when stained) bodies, called chromatin, the number depending on the organism. Chromatin is a complex of a large molecule called DNA (deoxyribonucleic acid) and histones (a protein which is absent in prokaryotes) together with other non-histone proteins.

DNA is the major storage of genetic information. This information is copied or transcribed first into RNA (ribonucleic acid) molecules, the nucleotide sequences of which contain the "code" for the specific amino acid sequences. Proteins are then synthesized in a process involving translation of the RNA.

A DNA molecule consists of smaller molecular uits called nucleotides consisting of sugar (ribose), bases (purines and pyrimidines) and phosphoric acid. In DNA the purines are adenine and guanine and the pyrimidines are thymine and cytosine. In RNA thymine becomes uracil. Adenine always pairs with thymine and cytosine always pairs with guanine. Three consecutive pairs of these bases makes up a genetic code for a specific amino acid.

Nucleotides are linked together to form two strands like a spiraling ladder with the bases serving as the steps. Each strand consists of alternating sugar and phosphate moieties. The nitrogenous bases are attached to the sugars of these strands.

DNA is synthesized and replicated by highly specific enzymes. In turn enzymes are synthesized as coded in the bases of DNA with the aid of other specific enzymes.

<u>Integration of Faith</u> One may properly ask, "Where and how did the first DNA molecule come to be synthesized if its synthesis requires the action of enzymes which are the products of DNA? Just like the question, "Which came first, the chicken or the egg? This dilemma does not pop up in the creation model for the origin of living things.

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CELLULAR FUNCTIONS

The Release of Energy from Food - Oxidative Phosphorylation

The direct source of energy in a cell is glucose. In the absence of oxygen glucose is degraded into lactate by the process called glycolysis (splitting of glucose). If glycolysis is carried out under aerobic conditions the final products are pyruvate and coenzyme NADH. Glycolysis is achieved by a series of 10 enzymes all of which are located in the cytosol.

The last three processes of energy transformation occur in the mitochondria:

1. Krebs Cycle. The pyruvate derived from glycolysis is degraded to acetate which is taken into the mitochondrion by the coenzyme A. The Krebs cycle, carried out by a series of soluble enzymes present in the mitochondrial matrix, produces carbon dioxide by decarboxylation and removes electrons from metabolites.
2. Respiratory chain or electron transport system. The hydrogen derived from the Krebs cycle is used to reduce NAD+ to NADH and starts the electron transport to generate ATP. The chain also contains enzyme-bound copper and iron-sulfur proteins. The final hydrogen acceptor at the end of the chain is oxygen. The reaction results in the formation of water.
3. Phosphorylating System. This is tightly coupled with the electron transport chain which at three points gives rise to ATP. The biosynthetic processes involved in the release of energy from glucose within the confines of the mitochondrion is not now fully understood. To follow the overall energy balance the fate of a molecule of glucose is illustrative. A total of 36 ATPs is produced which represents about 40% of the total energy contained in a molecule of glucose.

<u>Integration of Faith</u> Why did the Creator not create living things, including us, so that they dont need to eat? Why did He not just make animals like the plants, with chloroplasts so that we can just lie down under the sun and be fed? I have an idea. So that you and I will have to work. And work is good for us all. Any other reason? The cell is designed to utilize food? To provide symbionts with plants? Good idea.

Synthesis of Carbohydrates - Photosynthesis

This is the process by which chloroplasts trap light quanta and transform them into chemical energy. Photosynthesis is, in some ways, the reverse process of oxidative phosphorylation. Using water as hydrogen donor and carbon diozxide from the atmosphere, carbohydrates are synthesized, and oxygen is released.

Photosynthesis consists of a photochemical reaction which occurs in the presence of light, and a dark or thermochemical reaction. In the first reaction, oxygen is released when chloroplasts are exposed to ight, in the second, caarbon dioxide is fixed and carbohydrates are formed.

In photosynthesis there are two photosystems that are excited at different wavelengths (PS I excited at 700 nm and PS II excited at 680 nm). In photosystem I two quanta of light boost elecrons that reduce ferredoxin which, in turn, transfers the electrons to coenzyme NADP+ reducing it to NADPH2.

The electrons in PS I are restored by PS II. Here the light quanta remove the electrons from the hydrogen of water, releasing oxygen. The electrons are transferred to P700 by a transport system coupled with the phosphorylation of ATP at PS II level.

The dark reaction involves steps that start with the uptake of carbon dioxide and its reduction to NADPH2 to form the various carbohydrates. In the initial reaction ribulose diphosphate is integrated with carbon dioxide and water to produce two molecules of phosphoglycerate. These sugars are phosphorylated by ATP and form an activated molecule that is able to accept hydrogen from NADPH to form phosphoglyceraldehyde from which glucose and other complex carbohydrates form. In several steps of this complex cycle of reactions, ATP is used as energy source.

Integration of Faith What is God's purpose in creating plants in this world? For man's food? To utilize carbon dioxide? For beautifying the earth? Does God expect to care for plants?

Synthesis of Proteins - Translation

Protein synthesis involves the use of ribosomes either free or attached. The process is mediated by specific enzymes which assemble the amino acids into protein chains as coded in the DNA. These codes are reproduced in RNA (ribonucleic acids). Three kinds of RNAs are known: a) messenger RNA, b) transfer RNA, and c)ribosomal RNA. The mRNA carries the code as copied from the DNA The tRNA picks up the specified amino acid from the cytoplasm to the ribosome. The rRNA is a part of the ribosome. The ribosome consists of a large and a smaller subunit.

The first step is the binding of the small ribosomal subnunit to the mRNA binding site, which contains an AUG codon to signal the start of translation as well as additional sequenes that differentiat eht starting AUG codon from others within the message. In eukaryotes synthesis is initiatted by an unformylated initiator methionine-tRNA. The initial methionine is removed from the finished polypeptide. Three protein initiation factors associated with the smaller subunit are also required. Once the large ribosomal subunit binds to the small subunit, the initiation factors released.

Other protein factors are required for polypeptide chain elongation. These are free in the cytoplasm and involved in bringing the correct amino acyl-tRNA to the ribosome and in the translocation process that occurs when the ribosome moves from one codon to the next.

The large ribosomal subunit contains the enzyme that catalyzes the formation of the peptide bond and provides the aminoacyl and peptidyl sites that can accommodate the two tRNA molecules whose amino acids are being added to the protein chain.

Chain termination occurs when the 70S ribosome reaches a termination codon, which is recognized by one of two protein releasing factors. During protein synthesis each mRNA molecule is translated by several ribosomes simultaneously. This increases the speed with which a long protein chain can be translated.

Integration of Faith Did you ever wonder why the process of protein synthesis is so complex and intricately regulated? What if it is simple enough for man to replicate and mass produce protein? Would that be producing life? Getting a glimpse of the incomprehensible process of protein synthesis would you believe that the cell could not have come into existence by chance as the evolutionary model assumes?

CONCLUSIONS

The complexity of the observed features and intricacies of the known functions of the cell baffles the imagination. The design and efficiency of structures and the delicately intertwined relations of functions of organelles reveals that only a superior Intelligence could have created the the amazing cell. Much more remains unknown about the cell and its functions and perhaps these will never be revealed to human minds by the Creator. But God has made His inimitable imprint on the cell that no thinking individual can miss: WHAT HATH GOD WROUGHT.

Integration of spiritual truths in classroom situation can be done in any subject if the teacher is motivated with a burden for the salvation of her pupils. The effectiveness of integration of faith and learning is greatly affected by the life and attitude of the teacher. Holmes wrote that "the most important factor in the teacher is her attitude toward learning." If she exhibits positive attitude the students will respond positively to her efforts. A positive attitude on the part of the teacher is shown by:

1. coming to class on time (preferably before class time)
2. practising what she teaches.
3. encouraging the asking of questions in and out of the classroom
4. preparing what and how to teach the lesson in an interesting and effective way.
5. showing a friendly and helpful attitude.
6. joining the students in their social activities
7. knowing the students by their first names.
8. willingness to help students with their problems.

What is integration of faith and learning? Eager, Dean of the Sschool of Graduate Studies, AIIAS, explains,

> "Integrating faith and learning in education is providing a holisticcally oriented environment for Christian thinking and living. This environment will lead young people through experiences and challenges so that the character of each will grow to become like Christ´s."

What personal benefit does anyone get in integrating faith and learning in the classroom or anywhere else? Holmes encourages:

> "Integration should be seen not as an achievement but as an intellectual activity that goes on for as long as we keep learning anything at all. Not only as an intellectual activity, however, for integrated learning will contribute to the integration of faith into every dimension of a person´s life and character."

Finally, what is the ultimate aim of the integration of faith and learning? Rasi, Director of Education, General Conference of Seventh-day Adventists clearly states:

> "The integration of faith and learning is a deliberate and systematic process of approaching the entire educational enterprise from a biblical perspective. Its aim is to ensure that the students, under the influence of Christian teachers and by the the time they leave school, will have freely internalized biblical values and a view of knowledge, life, and destiny that is Christ-centered, service-oriented, and kingdom-directed."

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