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THE BIBLE AND MICROBIOLOGY

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Introduction.

Walt Disney was not thinking about microbiology when he commissioned the song "It's a Small World After All", but he might as well have. We now know that life on Earth would not be possible without microorganisms. In the absence of nitrogen-fixing bacteria plants could not grow. And without the biodegrading action of microbes, we would run out of the essential elements of carbon, sulfur and phosphorous. Neither would there be a source for vitamin B_{12} for mammals.

Although not essential for life, cheese, yogurt, pickles sauerkraut and bread certainly add to its joy. Some would add fermented grape juice and beer to the list of delectable products of microbial action. A darker consequence of the stealthy microorganisms was humanity's almost total defenselessness against unseen pathogens.

Mankind lived for more than 50 centuries in blissful ignorance of this invisible world including the 1600 years during which the books of the Bible were written. Not surprisingly, the words "microorganisms" or "microbiology" do not appear in even the most modern translations of the Bible.

But if microorganisms are indeed ubiquitous and indispensable, it is reasonable to expect to find evidences of their activities in the biblical record. Such an approach may enrich our grasp of the sacred text. This paper intends to show that there is more microbiology in the Bible than meets the eye!

Microbiology, a sub-discipline of biology, studies unicellular organisms too small to be seen with the naked eye. The resolution of the human eye, the smallest gap that we can see, is approximately 30 micrometers. Microorganisms are typically only a few micrometers in size, safely invisible to us. This is a blessing, because could we see the thousands of microbes on our skin, in the air we breath and around us everywhere, we would do little else than fuss over them.

Microbiology concerns itself with both disease causing bacteria, fungi, viruses and the host of non-pathogenic small organisms.

The concept of contagious disease is first seen in the Old Testament, but the thought that the agents of contagion were invisible creatures came much later. According to available records, the Roman writer Varro mentioned it first in second century BC. It was subsequently repeated by other Greek, Roman and Arabic writers, then by Roger Bacon in the 13-th century and Fracastorius of Venice in the 16-th century (1).

The first unveiling of bacteria occurred in the 1670-s, thanks to the exceptional work of Anton van Leeuwenhoek, of Delft, Holland. A cloth merchant by profession, as a hobby he ground small glass lenses which he mounted between thin sheets of silver or brass. He placed a moveable platform next to the lens to mount objects or small vials with liquid. His lenses were of exceptionally high quality, accomplishing several hundred fold magnification. Leeuwenhoek was also blessed with superbly keen eyesight. One of the first subjects he examined was a suspension of pepper in water, hoping to discover the

cause of its hotness on the tongue. He was expecting to see little sharp barbs, which would explain the pepper's irritating property. Instead he saw bacteria, which he called "animacules" (2).

It took centuries more work by many scientists, among them F. Redi, T. Scwann, L. Pasteur, P. Ehrlich and R. Koch to establish microbiology as a science of vital importance (1). In the twentieth century research in microbiology lead the revolution in understanding biology, culminating in the cloning of Dolly, the sheep. Today we are aware that the thousands of kinds of microorganisms are life forms distinctly different from animals and plants, yet operating on analogous molecular logic.

A personal journey into microbiology.

As a youngster in Hungary, I wanted to become a doctor, but coming to the US, I ended up studying chemistry in college. I was especially attracted to organic chemistry. In my junior year I took a course in biochemistry, and I realized that this subject combined my interests of chemistry and medicine. So I continued with biochemistry in graduate school.

Biochemistry is a study of the chemistry of life. Paradoxically, in order to study the chemistry of living matter, one has to take the living tissue apart, thereby killing it. As a graduate student, one of my laboratory exercises called for taking apart a white albino rat, removing its liver and study its cholesterol metabolism.

I performed the experiment as required, heart-sickened from the act of killing the cute laboratory rat. I realized that as a biochemist I may have to do this may times during my carrier, and I wasn't sure that I could do that. Fortunately I discovered that not all biochemists worked with animal tissues. There were professors in my department, who worked with bacteria. I arranged to do my thesis work in one such laboratory, and I have continued to work with bacterial cells ever since. To be sure, studying the biochemistry of bacteria also involves killing microorganisms. But, bacteria belong to a different class of living entities than albino rats. Every time we use mouthwash, we are guilty of killing microorganisms in the oral cavity.

It so happens that many of the great advances in biochemistry in the past 50 years have come from studying the biochemistry of bacteria. Among the many species of bacteria, one organism towers above all others in significance as the best-studied model organism, *Escherichia coli*. Some wags have gone as far as to classify all living organisms into just two categories: the "coli" and the "un-coli".

The uniqueness of microorganisms.

It is now clear that there are overarching similarities in all biological matter, from bacteria to man. These similarities surface when one compares the gross chemical composition of various organisms or the biochemical logic that animates them.

All living matter is composed of cells. Some organisms, such as ourselves, are organized from millions of different cells. We have skin, muscle, bone, liver, brain cells, all different in structure and function, yet retain certain similarities with each other. Other organisms may contain fewer cells, or consist of only a single, self-contained cell. The most fundamental unit of life is the cell. When a cell is taken apart, life disappears. It can be appreciated, therefore, that the in-depth study of *E. coli* could lead to advances in our general knowledge of life.

The biosphere is essentially coated with microorganisms. It is estimated that nowhere can a gram of soil be found on the surface of the Earth, including the Sahara desert, which contains less than 10,000 microorganisms. Bacteria belong to the robotic class of living matter created by the Lord. Other robots include trees, plants and flowers.

Bio-robots are living organisms without nervous systems. These organisms, although they respond to appropriate external stimuli, are unaware of their existence. They perform photosynthesis, and are the ultimate sources of food on Earth.

Or should we call microorganisms "nano factories"? Some bacteria is able to manufacture thousands kinds of new organic substances starting with glucose. This level of synthetic capacity is on par with those of the industrial chemical giants Dow Chemical Inc. or DuPont Corporation. Bacterial cells are completely automated and, of course, miniaturized.

In comparison with animal and plant cells, microorganisms have a much simpler structure. They do not possess membrane bound nuclei, mitochondria, endoplasmic reticula, etc. For this reason, it was believed for a long time, that bacterial cells were the evolutionary precursors of the more complex animal and plant cells. Further analysis, however, revealed that microorganisms are not just simplified versions of more complex and more specialized cells. Rather, it became evident that microbes are very different forms of life from plants and animals. Moreover, we now understand the reasons for some of these differences.

For example, the lack of membrane-bound nucleus permits the bacterial genetic material to be in intimate contact with the protein synthesizing machinery. This configuration in turn, allows bacterial genes to be activated within minutes. This capacity is essential for the survival of bacterial cells. In contrast, animal and plant cells take hours to activate their genes.

Microbial Signatures in the Bible.

I. Loaded words.

There are terms in the Bible with direct links to microbial activity. These words are listed here in alphabetical order. In parenthesis, their frequency in the King James translation is shown, followed by a biblical text and a short commentary.

1. **Bread** (335).Genesis 14:18 "And Melchizedek king of Salem brought forth bread and wine ..." Bread made from either barley or wheat was the principle food staple in Palestine in Old Testament times. Both leavened and unleavened bread were used, usually in the form of flat loaves. The leavening agent was the microorganism, yeast. Yeasts are unicellular, microscopic fungi.

2 **Boil** (23) II Kings 20: 6 "And Isaiah said, Take a lump of figs. And they took and laid it on the boil, and he recovered." Possibly smallpox (3), caused by variola virus.

3. **Botch** (2) Deuteronomy 28: 27."The Lord will smite thee with the botch of Egypt..." This is an archaic term of "boil".

4. **Cheese** (3). Job 10:10 "Did you not pour me out like milk and curdle me like cheese, ..." Curdled milk contains liquid and solid portions. The liquid, called whey, was generally removed and the solid parts were pressed into a cake form (3). Curdling of milk requires the work of an acid producing microorganism, such as *Lactobacilli* . Curdling can also be achieved by the enzyme "rennet", found in the stomachs of calves.

5. **Consumption** (5). Leviticus 26:16. "...I will even appoint over you terror, consumption..." A disease, causing a wasting away of the body, likely, pulmonary tuberculosis (3). Tuberculosis is caused by *Mycobacterium tuberculosis*. Traces of this affliction are seen in some of the bones of the early Egyptian mummies.

6. **Cucumbers** (2) Numbers 11:5. " We remember the fish, which we did eat in Egypt freely; the cucumbers, and the melons, and the leeks, and the onions, and the garlic: ..." It may be supposed that the preserved forms of this plant, pickles were also part of the Israelites diet. Actual mention of cured cucumbers occurs later, in the writings of Aristotle and Pliny.

7. **Dough** (8) Hosea 7:4 " They are all adulterers, as an oven heated by the baker, who ceaseth from raising after he hath kneaded the dough, until it be leavened." Dough is the pre-baked stage of bread.

8 **Dung** (34) Luke 13:8 " And he answering said unto him, Lord, let it alone this year also till I dig about it and dung it:" Undigested bowel content , mixed with large quantities of intestinal microorganisms. As an animal product, it was suitable for fuel or for fertilizer.

9. **Dysentery (bloody flux)** (1). Acts 28: 7, 8 "In the same quarters were possessions of the chief man of the island, whose name was Publius: who received us, and lodged us for three days courteously. And it came to pass, that the father of Publius lay sick of fever and of a bloody flux (dysentery): to whom Paul entered in, and prayed, and laid his hands on him, and healed him." This illness is manifested by the inflammation of the lower intestines, frequently accompanied by fever and hemorrhage of the bowels. A major cause of dysentery is one of the *Shigella* species of enterobacteria.

10. **Fever** (9) Mathew 8: 14." And when Jesus was come into Peter's house, he saw his wife's mother laid, and sick of fever." Most fevers are caused by bacterial substances, endotoxins from gram negative bacteria or toxins from gram positive bacteria (6) or by viral infection.

11. **Leaven** (33) Leviticus 2:11. "No meat offering, which ye shall bring unto the Lord, shall be made with leaven; for ye shall burn no leaven, nor any honey, in any offering of the Lord made by fire." A synonym for yeast, unicellular forms of fungi. They are found in the air, in the soil or on plant surfaces. They are especially abundant in sugar containing liquids or on fruits. Of thousands of different strains of yeasts, the most useful ones are from the *Saccharomyces* family.

12. **Leprosy** (65) II Chronicles 26: 19. " Then Uzziah was wroth, and had a censer in his hand to burn incense: and while he was wroth with the priests, the leprosy even rose up in his forehead before the priests in the house of the Lord, from beside the incense altar." In the Bible as many as seven different diseases may be included under this term (3), most, if not all, are caused by microorganisms, such as *Lepra vulgaris, Lepra tubercoloides, Lepra anaesthetica* and *Mycobacterium tuberculosis*. The "leprosy" of clothing or of houses (Leviticus 13: 47-59, 14: 34-48) manifesting in green or red streaks were probably some forms of mildew or fungus (3).

13. **Mildew** (5) Amos 4:9 "I have smitten you with blasting and mildew: when your gardens and your vineyards and your fig trees increased, the palmerworm devoured them: yet have ye not returned unto me, ..." The Hebrew term "yeraquin " (paleness) is not referring to the growth of fungi., rather to a plant disease (3), which may or may not be related to microorganisms.

14. **Pestilence** (49) Leviticus 26: 25 " ...and when ye are gathered together within your cities, I will send the pestilence among you..." This term refers to infectious diseases that reach epidemic proportions. One of the three big scourges of mankind, along with famine and the sword (3). The agents of pestilences were likely microorganisms; bacteria or viruses.

15 **Plague** (118) Numbers 14; 37 "Even those men that did bring up the evil report upon the land, died by the plague before the Lord." A divine visitation as punishment for sins, manifesting in virulent disease or a catastrophe (3). The disease identified as "plague" or the "black death" in modern times is caused by the organism *Yersinia pestis.*

16 **Strong drink** (20) Luke 1:15 "For he shall be great in the sight of the Lord, and shall drink neither wine nor strong drink;..." (alcoholic beverage, usually beer). Beer was widely used in the ancient orient. According to ancient records there were at least sixteen different kinds of beer; such as dark, light, young and lager. They were made from barley, emmer (a Eurasian wheat) or figs (3).

17. **Vinegar** (11) Ruth 2:14 "And Boaz said to her, at mealtime come thou hither, and eat of the bread, and dip thy morsel in the vinegar..." Vinegars are the products of a second fermentation of alcoholic substances. Besides wine vinegar, many different types of vinegars exist. Agricultural products, fruits, grains, solutions of honey or molasses are first fermented to an alcoholic product by yeasts and bacteria. In this process air is carefully excluded. During vinegar fermentation, bacterial species of *Acetobacter* oxidize alcohol to acetic acid in the presence of air (7).

18 **Wine** (214) Mark 15:23 "And they gave him to drink wine mingled with myrrh..." (fresh or fermented grape juice). Fermentation was accomplished by yeast cells, which, under certain conditions, convert glucose (grape sugar) to ethanol and carbon dioxide.

19. **Yeast** (77) See "leaven".

II. Microorganisms lurking around the corner.

There are phenomena and events in the Bible, with links to microbial activities. These microbial connections are less obvious and some may even be speculative. Although hidden in the background, microorganisms are important participants.

1. Genesis 1:11. "And God said, let the earth bring forth grass, the herb yielding seed and the fruit tree after his kind,..."

The creation of plants, serving as food sources for mankind, land animals and birds had a high priority. Not spelled out are the microorganisms, such as the *Rhyzobia, Azobacter* and *Klebsiella* species, without which none of the plants could grow. These and other selected species of microorganisms establish symbiotic existence with the roots of the plants and provide them with useable forms of nitrogen such as nitrates, nitrites and ammonia. Even though the top soil of the freshly created earth may have been well fertilized with nitrates, it is reasonable to expect that the newly created plants were endowed with nitrogen fixing symbiots on the third day of creation.

2. Leviticus 25: 4,5 "But in the seventh year shall be a Sabbath of rest unto the land, a Sabbath for the Lord thou shalt neither saw thy field, nor prune thy vineyard. That which groweth of its own accord of thy harvest thou shalt not reap, neither gather the grapes of thine vine undressed: for it is a year of rest unto the land."
This practice enabled the microorganisms in the roots of the un-harvested vegetation to enrich the soil with nitrates. This prevented the land becoming infertile from over-use.

3. Genesis 1:24 " And God said let the earth bring forth the living creature after his kind, cattle, and creeping thing,..."

Among the animals were the "cattle", a term for domesticated animals in the Scriptures including horses, goats, sheep and the oxen (3). These ruminants obtain most of their required proteins from the digestion of microorganisms that grow in their rumen (4). Bacterial growth in the rumen becomes possible when the animal eats grass, rich in

cellulose, indigestible by the cattle, but the bacterial residents of the rumen readily degrade it to glucose and use it to grow.

4. Genesis 1:27 "So God created man in his image,...male and female created he them."

There is no reason to suppose that what we now know about our biochemistry and physiology did not, to a large extent, apply to the first humans. We now have in our colon a host of helpful bacteria which assists us in digestion and provide much needed vitamins. One such organism is the famous *Escherichia coli*. This happens to be the most studied non-human organism. A group of genes in this bacterium, called the "lactose (lac) operon" codes for proteins which metabolize "milk sugar" or "lactose". The existence of these genes in *E. coli* has long puzzled scientists, because it is very unlikely that *E. coli,* living in the colon, ever comes in contact with milk sugar. That substance, if ingested, is efficiently degraded and absorbed in the small intestine. Of late, however, it was discovered that the lac operon is also activated by a plant based substance, "beta galactosyl glycerol", an indigestible component of green plants. Therefore, it appears, that *E. coli* was designed to exist in the colon of vegetarian mammals, able to utilize the "crumbs" of vegetarian diet. Moreover, the presence of the enzyme "alcohol dehydrogenase" in our liver may be construed as an indication that the Creator intended to put microorganisms into our colon. Alcohol is a normal byproduct of bacterial metabolism. In the absence of this enzyme, which converts alcohol to metabolizable substances, all of us would walk around half inebriated. As our own metabolism does not

produce any alcohol, detoxification of bacterial alcohol seems to be the sole function of this enzyme. The Creator made provision to protect Adam and Eve from the harmful consequences of their own *E. coli.*

5. Genesis 50:2 "And Joseph commanded his servants the physicians to embalm his father: and the physicians embalmed Israel."

Ancient Egyptians were the masters of preserving dead bodies from decay, caused by bacteria and fungi. Their motive for mummification lay in the belief that upon death the person's Ka (vital force) and Ba (personality) left the body. But they could be lured back if the dead body was made attractive enough. So, the embalmers first removed the internal organs that were perishable, except the heart, rinsed the body with wine (which sterilized the flesh), packed it in a form of natural salt called natron, and dried the corpse for forty days on the embalming table. Then the skin of the blackened and shriveled body was restored with massaging, ointments and perfumes, padded under the skin and painted. Finally the corpse was coated with warm resin and wrapped from head to toe in linen strips (5). The process of drying took 40 days, and a first class embalming occupied 70 days.

Joseph's motive for embalming Israel was most likely to permit the long journey back to the cave in the field of Machpelah in Canaan, where Abraham, Sarah, Isaac, Rebekah and Leah were buried.

6. Numbers 11: 5. "We remember the fish, which we did eat in Egypt freely; the cucumbers, and the melons, and the leeks, and the onions, and the garlic: ..."

The Egyptians thought that garlic and onion aided endurance. During the construction of pyramids, workers received large amounts of radish, garlic and onions. Herodotus, the Greek historian reports seeing an inscription on a pyramid that 1600 talents of silver were spent on these food items. We now know that garlic contains a natural antibiotic, Allicin and onion, Allistatin. These substances effectively protected the pyramid builders from contagious infections in the overcrowded work camps (8).

7. Deuteronomy 7:15. " And the Lord will take away from thee all sickness, and will put none of the evil diseases of Egypt, which thou knowest, upon thee;..."

Egyptian medical knowledge was the most advanced in antiquity. Even from our modern perspective, some of their procedures are admirable. For example, for the common cold, their remedy was the milk of a mother who had given birth. Extant records reveal the presence of the following illnesses caused by microorganisms, bacteria or viruses: bubonic plague (*Yersinia pestis)*, small pox (variola virus), measles (measles virus), cholera (*Vibrio choerae*), leprosy (*Mycobacterium leprae*), tuberculosis (*Mycobacterium tuberculosis*), pneumonia (*Streptococcus pneumonia* and polio (polio virus) (8,9,10).

8. Numbers 5:2 " Command the children of Israel, that they put out of the camp every leper, and every one that hath an issue, and whosoever is defiled by the dead:"

Ignaz Semmelweis, a Hungarian physician working in the Maternity Department of the Vienna Lying-in Hospital, where the poor and unwed came for obstetric care, observed that more young women came down with puerperal sepsis (childbed fever) who were assisted by medical students, than those that were helped by midwives. Pondering the cause for this, he realized that the medical students routinely came to the hospital from autopsies. His conclusion was that the necrotic tissue of the corpses contained infectious agents. When he forced the medical students to disinfect their hands prior to delivery, the incidents of childbed fever declined (11). Indeed, we now know that the infectious agents are *Streptococci*. Here we find a valid scientific reason for the prohibition of handling corpses, and for the designation "unclean".

9. Numbers 5: 3 "Both male and female shall ye put out, without the camp shall ye put them: that they defile not their camps, in the midst whereof I dwell."
Isolation of sufferers from contagious diseases is first seen in the writings of Moses. This practice was not borrowed from the Egyptians, who had the most advanced overall medical know-how of the ancient world. Rather, this is an example of divine solicitude for human welfare. It preceded many hundreds of years the idea of contagion.

10. Leviticus 12:1-15:33. The law of purity of persons, garments and houses. Under certain conditions, persons, garments and even houses were declared "unclean".

Being unclean meant exclusion from the communal life of the Israel. Events or conditions that rendered persons and their garments "unclean" produced patches of fertile

environment for bacterial growth either on body surfaces or on clothes. It is now known, that microorganisms prefer to proliferate on solid surfaces, forming biofilms, which can be persistent sources of infection. It is noteworthy, that the remedy for the "unclean" condition was washing of the body or the garment. The remedy of mold infected houses was the destruction of the house and removal of the structural components to outside the camp.

11. Exodus 16: 20 "Notwithstanding they hearkened not unto Moses: but some of them left of it until the morning, and it bred worms, and stank: and Moses was wroth with them."

A possible reason why manna became odoriferous overnight would have been the growth of microorganisms on the sugary medium. Sulfur containing substances often have bad odor and proteins are good sources of sulfur. Manna had to contain proteins to meet the essential amino acid requirements of the children of Israel. Since Friday's manna was stable overnight, perhaps it came with added preservatives.

Some of the "whys" of microorganisms.

This section of the paper is devoted to reflections on the existence of microorganisms from a religious perspective. One is encouraged in this exercise by the text of Colossians 1:15: "For by him were all things created, that are in heaven, and that are in earth, visible and invisible, ..."

Pathogens.

Creationist arguments for an appreciation of the extraordinary nature of microorganisms need to be tempered by accounting for the existence of pathogens. Did the Creator make pathogenic organisms? Pathogens do not contribute to the well being of the biosphere. They bring pain, suffering and death to their victims. When the Lord pronounced the original creation "very good" (Genesis 1:31), it included all of the microorganisms that contributed to the well being of the biosphere.

It is significant that of the hundreds of thousands of species of microorganisms only one or two percent cause disease. In many of these, the disease causing genes are located not on the chromosome but on extra-chromosomal plasmids, suggesting that the bad genes are later modifications of benign organisms. For example, a pathogenic variety of *E. coli*, strain 0157:H7, causes hemorrhagic colitis. This organism colonizes in the small intestine of the host and secretes large quantities of toxins, which damage the lining of the intestine. The plasmid with genetic information for these toxins, somewhere in the distant past, turned a harmless organism into a dangerous pathogen. Just where these harmful plasmids came from, no one knows. But the Christian suspects: "An enemy hath done this" (Mathew 13:28). The motive of the adversary of God and man is to cast the Creator in a negative light as responsible for pathogens.

Invisibility

It may strikes us as odd, that there exists a host of vitally important organisms just under the radar screen of our vision. From modern perspective, an elementary concept such as the existence of microorganisms would seem to be helpful and important information for Moses and the Israelites. But nowhere in the Bible do we find direct reference to microorganisms. We have to conclude that explicit knowledge of microbiology was not a prerequisite for salvation either in ancient times or now.

Though we saw that the rules of health, the designations of "clean" and "unclean" served as effective protectors against epidemic sized outbreaks, still it would have been to mankind's advantage to be aware of microorganisms in the long centuries of antiquity and beyond.

The same may be said of many other discoveries of the past 350 years. Solomon could not have anticipated the explosion of knowledge of our times. (" The thing that hath been, it is that which shall be and that which is done is that which shall be done: and there is no new thing under the sun" Ecclesiastes 1:9). When the Lord told the first couple, "Be fruitful, and multiply, and replenish the earth and subdue it" (Genesis 1:28) it was a mandate for research and discovery. But mankind was also instructed by the Lord, and perhaps microorganisms were introduced to Adam and Eve and to their fellow antediluvians. If this was the case, much of this knowledge was lost. Solomon would

have been impressed with microorganisms and would have revised this verse to say, " you haven't seen anything yet!"

Invisible no longer

We are certainly richer for being aware of our invisible companions. And one lifetime is not nearly enough to study these fascinating creatures. For starters, bacteria are very different forms of life than animals or plants. Though structurally much simpler than multicellular life forms, bacteria are more hardy and versatile. Their biosynthetic capacity, the potential to manufacture in excess of 3000 different substances, is on par with the giant chemical manufacturers DuPont or Dow Chemical Corporations. As a chemical factory, bacterial cells are fully automated, miniaturized and they replicate themselves once an hour or less.

The existence of microorganisms permits the "law of biochemical infallibility" to function. This "law" states that every naturally made substance, however complex, is degradable. On Earth, elements making up the important components of the biosphere, -- carbon, oxygen, hydrogen, sulfur and nitrogen -- are in constant flux. Without total biodegradability of naturally synthesized organic substances, the biosphere would run of one or more of these elements. It is totally beyond our ability to appreciate the sophistication and depth of know-how required to bring into existence the perfectly balanced system of the biosphere, where each of the hundreds of thousands (perhaps millions?) of different compounds are accounted for.

The principle of continual breakdown and re-synthesis of biomatter in living organisms is consistent with Revelation 21: 5 :"and he that sat upon the throne said, Behold, I make all things new,..." Parallel with the elaborate biochemical processes that produce the exquisitely complex components of living matter, there exist a second set of equally complex system, which functions to degrade these components. Under normal conditions the two systems are in perfect balance. The reason for this dual system of synthesis and degradation is that components of living matter experience a certain amount of wear and tear during their normal operation.

Surprisingly, metabolism in air yields destructive derivatives of oxygen. Although every cell is equipped to neutralize these rogue substances, they still manage to "nick and scratch" our beautiful biological furniture. That is why in a systematic manner, all biological components are periodically renewed to "factory fresh" condition. There is no reason to suspect that this was not so from the very beginning of creation. Thus, we would have biological turnover operate in the original "Garden of Delight" (Eden).

A Dynamic Universe

Movement characterizes every aspect of the known universe, from the microscopic to the galaxies. Only at temperatures of absolute zero (-273 ^{0}C) does matter stop vibrating. The Creator is not interested in stagnation on any level of the Universe. From such considerations we assume that when communications between us and the rest of the

universe improves, we will be made aware of the means by which everyone in the universe keeps time. It will be thrilling to discover the true age of the galaxies and the universe. Those of us who are watch addicts will be interested in wearing a universal time keeper, so that we are reminded of the current time in the neighboring planets and galaxies. We would not want to make a phone call there at inopportune times.

Mutual interdependence.

It would be safer for each type of organism if they were completely self-sufficient. On Earth this would require the ability to utilize light for energy as well as the gases carbon dioxide and nitrogen, to make organic compounds. Although there are a few microorganisms that are able to do this, humans and the rest of the millions of species of microorganisms, plants, animals are totally dependent on each other (Figure 1). This means that the fate of all organisms is inexorably interlinked. We either flourish together or perish together. This may be the reason why the entire biosphere had to suffer the consequences of man's rebellion.

Figure 1 suggests that microorganisms, plants and humans/animal form a closed interdependent circle, powered by energy from the sun. This indeed is our current perspective on the biosphere. But it may be woefully deficient. Missing from this chart is the role of the Creator in sustaining our world.

"It is supposed that matter placed in certain relations and left to act from fixed laws with which God himself cannot interfere; that nature is endowed with certain properties and placed subject to laws and is then left to itself to obey its laws and perform the work originally commanded.

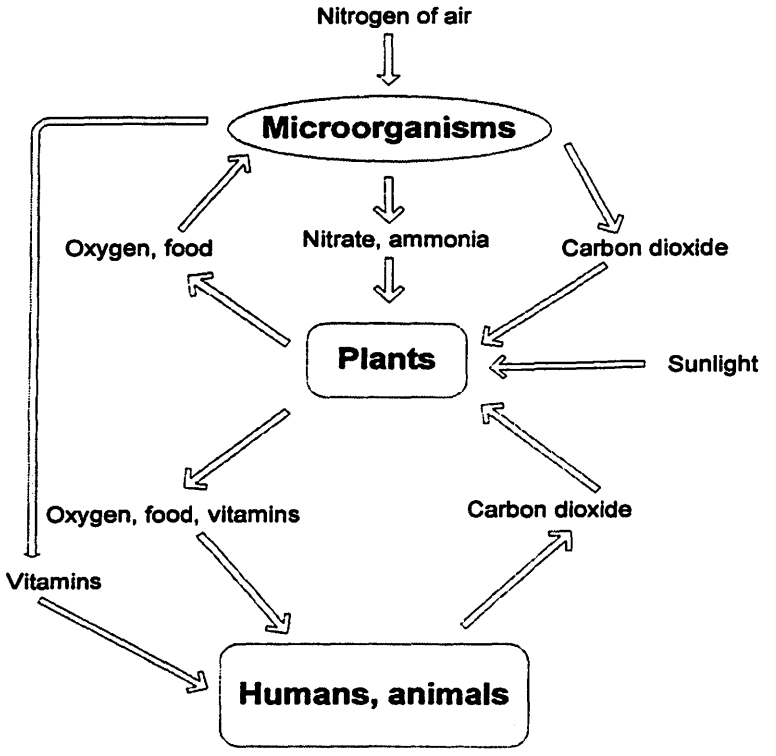

Figure 1. Interdependence of Organisms in the Biosphere.

This is false science; there is nothing in the word of God to sustain it. God does not annul His laws but He is continually working through them as His instruments. They are not self working. God is perpetually at work in nature...It is not by an original power inherent in nature that year by year the earth yields its bounties and continues its march

around the sun...It is by His power that vegetation is caused to flourish, that every leaf appears and every flower blooms... In God we live and move and have our being" (12).

These and other similar passages in the writings of Ellen White suggest the Lord's intimate engagement in the operation of our world. But science and scientists, including this writer, are clueless to deal with such a concept. To us matter behaves in a perfectly predictable manner, obeying the fundamental laws of gravity, attractions between positive and negative charges, etc. Chemical properties of each element depend on the configuration of its valence electrons. Biochemical properties of living matter are understood, based on the characteristics of proteins, nucleic acids, carbohydrates and lipids.

While it may be suggested that the Lord works precisely through these and other laws of nature, it is a very unsatisfactory solution, because it is not testable. Moreover, it renders the Lord directly responsible for every undesirable physical event in the world. If the Lord directly pushes atoms and molecules around, then He would surely stop doing it when it comes to an explosion by a suicide bomber!

Accepting the Creatorship of the Lord does imply that all matter proceeded from Him, and that the Lord is aware of every atom in the Universe. But it does not necessarily follow that the Lord micromanages the Universe through actively superintending every chemical change.

I am more comfortable letting the mystery of the nature of the Lord's involvement with our world linger until we enroll in a university on the earth made new. There I will be perfectly willing to revise the organizational chart of Figure 1 to include the vital connections between humanity and the rest of the Universe.

Conclusions.

1. Microbiology is a discipline of the "time of the end", when, according to a secondary interpretation of the prophecy of Daniel 12:4, "knowledge shall be increased" Our ignorance of this subject for five millennia is symptomatic of humanity's chronic lack of awareness of reality, of its helplessness, of its need of enlightenment. From our modern perspective, we appreciate more than the ancients, the solicitude and care of the Creator for His bumbling children, in providing them with rules and regulations which, if obeyed, protected them from outbreaks of epidemics.

2 Microbiology revealed a new dimension of the Creator's technical ability. The miniaturized marvels that microorganisms are, push the boundaries of possibilities almost beyond our capacity to imagine. The text in Genesis 18:14 comes to mind: " Is any thing too hard for the Lord?"

3. If the biblical material dealt with real-life events, then it was reasonable to expect to find in it evidences of activities of the ubiquitous microorganisms. That these were indeed found, supports the realism of the Bible

References.

1. Joklik, W. K., Willet, H. P, and Amos B. D. Zinsser Microbiology, 18-th Edition. Appleton-Century-Crofts, Norwalk, Conn., 1984.

2 Dubos, R. The Unseen World. The Rockefeller Institute Press, New York, 1962.

3. Horn, S. H. Seventh-day Adventist Bible Dictionary. Review and Herald Publishing Association, Washington, D. C. 1960

4. Brooker, J. D., Lum, D. K., Miller, S. Skene, I. and O'Donovan, L,. Rumen microorganisms as providers of high quality protein. Livestock Research for Rural Development Volume 6, March 1995.

5. Mummies of China, Mummies 101. Nova Online. http://www.pbs.org/wgbh/nova/chinamum/mummies101.html

. Braumwald, E., Fauci, A. S., Kasper, D. L., Hauser, S. L., Longo, D. L. and Jameson, J. L. Harrison's Principles of Internal Medicine. McGraw-Hill, New York, 15-th Edition. 3001, p92.

7. World Book Encyclopedia, World Book Inc. 1990. Chicago, London, Sydney, Toronto

8. Arab, S. M. "Medicine in Ancient Egypt, Part 3". www. arabworldbook.com/articles8c.htm

9. Ancient Egyptian Medicine. wysiwyg://80/http://nefertiti.iwebland.com/timelines/topics/medicine.htm

10 Medicine in Ancient Egypt http://www.indiana.edu/~ancmed./egypt.htm

11. Ignaz Semmelweis http://www.cc.nih.gov/hes/semmelweis.html

12. Testimony for the Church, volume 8, Ellen G. White, pp 259, 260.