Human Evolution: Directed?

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Human Evolution: Directed?

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1. Introduction

The task that I am about to undertake is one that has posed a great challenge to me. I grew up in Abadan, Iran on the banks of the Persian Gulf. I was almost 16 when I immigrated to the United States. Following in the path of older sibling, I first entered UT Arlington with plans to get a degree in Electrical Engineering. Somewhere along the way, I began to explore Biomedical Engineering, which required an MD/ Ph.D. degree program and I was steered towards Medical School and Life Sciences. I eventually graduated with BSEE and went on to Southwestern Medical School where I graduated in 1986 with an MD degree, not having pursued the Biomed route. Instead, I am having a most satisfying career in Family Medicine.

One of the courses in Biology that I took was Comparative Anatomy. It turned out to be one of the toughest courses ever, but one that I would always recall

fondly. I had not heard any total rejections of the theory that explained human origin first promoted by Charles Darwin. One afternoon as we were walking to the class, a well-dressed gentleman greeted each of us at the door and handed us a pamphlet. Most of my classmates giggled about it and threw it away. The pamphlet had to do with Evolution. It was produces by a Christian group that insisted that Darwin's theory is nothing but a theory whereas the proof of Creation was obviously from the Bible. From his perspective, science had abandoned God, and in order to remain obedient to God, he had to abandon science. This brought to my attention some of the problems related to the conflict between Science and Religion. I wondered how it was that a great Religion of God was unable to accommodate advances in science. Were we expected to ignore what we learned in class, or we to suppress the new information and continue to hang onto others based on faith? This honest question allowed me to think outside the box of Academia and to try to keep an open mind while exploring each theory.

The intent of this writing is to shed light on this subject. I hope that this will allow all readers the opportunity to independently investigate the truth about where we came from. I further hope that the reader will get a sense of where we are going. In order to study the Evolution of Mankind, one needs to look back in History. The older Eastern thought and Philosophy is full of references to the life on this Earth in different contexts. Sometimes, it is considered a life that is totally meaningless, not different than that of the Animal. The great Persian poet Omar Khayyam said that before us there has been life, and after us there will be life. We were not asked whether we wanted to be here; what is the purpose of our presence? On the other hand, the belief in Afterlife which has been present for at least 3 millennia, either through religion or through mythology attempted to make sense of the reason for our presence; We are here before we can reach another Realm that is beyond comprehension. If one believes in Spirituality, one will follow the Guidance of the Divine Messengers as to the way that one's life should be led.

The Scriptures of all Religions tell us that an Omnipotent God created us. If we were to interpret that literally, we came into existence from nothing, we were created de novo. If we do in fact believe in the Great powers of the Almighty, it would not necessarily be beyond comprehension that such an event indeed took place. However, evidence of History of the Universe suggests that at some moment in History, the entirety of the universe began in a frightfully pregnant moment of the Big Bang. The world of existence then was present for billions of years before it was suitable for the earliest forms of life to develop upon it. The Qur'an tells us that the One and Only God created the World above and the World below and all betwixt. The concept of the Creator and the world of Creation need not rest upon whether the Human Beings (or other Life forms) were created de novo. Even if you believe the Big Bang Theory, one still wonders about what there was before that fruitful moment.

We will examine Mr. Darwin's theory about the Origin of Species and the

Descent of Man. I would rather call it the Ascent of Man, as the biological record will indicate that Man acquired many new features along the way and became much more complex. I will accept the term of Descent only in terms of historical timeline. I have chosen to use Mr. Darwin's own words from the chapter summaries that he has provided. I shall also list some of his own critique of his work. We will then move to another book that critically examines Darwin's theory, called the Great Evolution Mystery, in which Mr. Gordon Taylor explains his views of Darwin's shortcomings and how in fact he failed at describing the origin of species, even though that was the title of his work.

Human origin through the biological record is itself very fascinating and an area of ongoing research. We will explore some of the data and try to get a sense of the timeline. We will explore Modern man versus older ancestors. Exactly where the line is drawn is an important area that provokes great deal of thinking. We will rely on earlier concepts of speciation to help us with that. We will look at the evidence of earliest humans.

In the last section, I will explore a new perspective. This perspective will allow the scientist to have his cake and eat it too. It is based on the idea that while we will spend a great deal of time on this perspective of Human Evolution, I will also explore other aspects of Evolution. Beyond the initial biology of Man, the evolution of our social structure, Economics, and Spirit is worth further examination. We will also visit briefly the evolution of the Universe. This will hopefully allow for a perspective of the Universal timeline as compared to Biological timeline and the Human timeline.

I would be most appreciative of receiving feedback and questions from readers. This will allow me to clarify any areas that may be necessary. I can be reached via e-mail at fariborzd@Home.com.

2. EVOLUTION according to DARWIN

I. Charles Darwin was born in 1809. He was not interested in a career in Medicine, despite his father's desire who was a physician. Instead, he became an entomologist. Through personal connections, he was given an opportunity to travel for science. He voyaged with the Beagle in southern waters between 1831 and 1836. He was only 22 years of age at the time of the trip. He made extensive observations of coral reefs and living animals and fossils. His record keeping was quite detailed and included even minute details. While reading Malthus on Population, he realized that in the struggle for survival, the favorable variations would be propagated. He then published, along with A.R. Wallace, On the Tendency of Species to form varieties. On Nov 24, 1859, the Origin of Species was published. In 1871, the Descent of Man was published. He died in 1882 and was buried in Westminster Abbey, beside Sir Isaac Newton.

II. The Origin of Species is written in 15 chapters. The first chapter deals with variations under domestication where he attempts at differentiating varieties and species. By this time in biological sciences a

lot of preliminary work has already been done in Taxonomy and attempts to distinguish different species. In the chapter summary he states: "the amount of difference considered necessary to any two forms the rank of species can not be defined." He then goes on to say that the most flourishing species yield the greatest number of varieties. In the next chapter, the variation under nature is discussed. In chapter three, the basic tenets of the theory are laid out in Struggle for Existence. The fourth chapter follows this on Natural Selection. It is here that "the Survival of the Fittest" is coined. "If under changing conditions of life organic beings present individual differences in almost every part of their structure, and this can not be disputed. If there be, owing to this geometric rate of increase, a severe struggle for life at some age, season, or year, and this can certainly not be disputed; ... But if variations useful to any organic being ever do occur, assuredly individuals thus characterized will have the best chance of being preserved in the struggle for life. This principle of preservation, or the survival of the fittest, I have called Natural Selection."

In chapter 7, the topic of discussion is hybridism. The first crosses between forms/species are usually sterile. "The sterility of first crosses and their hybrid progeny has not been acquired through natural selection." After further discussion of this problem, he says: " But why, in the case of distinct species, the sexual elements should so generally become modified, leading to their mutual infertility, we do not know." In chapter 8, the discussion is about instinct and how thru inheritance, the birds using mud for their nest exhibit the same behavior, whether in South Africa or the British Isles. " Finally, it may not be a logical deduction, but to my imagination it is far more satisfactory to look as such instincts ... as small consequences of one general law leading to the advancement of all organic beings, namely, multiply, vary, let the strongest live and the weakest die."

In the summaries for chapters 10 and 11, on page 179, an examination is made of the geological record. Darwin claims that there are transitional stages between species, but that these records are obscured due to their relative short span compared to the stable form. "The extinction of old forms is the almost inevitable consequence of the production of new forms." In chapter 14, a new classification scheme is suggested which he calls the " Natural System: it is genealogical in its attempted arrangement, with the grades of acquired difference marked by terms, varieties, species, genera, families, orders, and classes".

In chapter 15, Darwin recapitulates some of the points. "Nothing at first can appear more difficult to believe than that the more complex organs and instincts have been perfected, not by means superior to, though analogous with, human reason, but by the accumulation of innumerable slight variation, each good for the individual possessor." On the aspects of the geological record and the connecting links, he writes: " On this doctrine of the extermination of an infinitude of connecting links, between the living and extinct forms... I can only answer these questions on the supposition that the

geological record is far more imperfect than most geologists believe." On discussing habit and instinct, he states: "Habit no doubt often comes into play in modifying instinct; but is certainly not indispensable, as we can see in the case of neuter insects which leave no progeny to inherit the effects of long-continued habits."

"The similar framework of bones in the hands of a man, wing of a bat, fin of the porpoise, and leg of the horse... explain themselves on the theory of descent with slow and slight successive modifications. We clearly see why the embryos of mammals, birds, reptiles, and fishes should be so closely similar, and so unlike the adult forms. We may cease marveling at the embryo of an air breathing mammal or bird having branchial slits and arteries running in loops, like those of the fish which has to breathe the air dissolved in water by the aid of well developed branchiae." He then goes on to repeat: "I am convinced that natural selection has been the main but not the exclusive means of modification"

"I see no good reason why the views given in this volume should shock the religious feelings of any one. A celebrated author and divine has written to me that 'he has gradually learnt to see that it is just as noble a conception of the Deity to believe that He created a few original forms capable of self development into other and needful forms, as to believe that He required a fresh act of creation to supply the voids caused by the actions of His laws.'" "Analogy would lead me one step farther, namely, to the belief that all animals and plants are descended from some one prototype. But analogy may be a deceitful guide."

"These laws taken in the largest sense, being Growth with Reproduction; Inheritance; Variability; Struggle for life, and as a consequence to Natural Selection, entailing Divergence of Character and the Extinction of less-improved forms. Thus, from the war of nature, from famine and death, the most exalted object, which we are capable of conceiving, namely, the production of higher animals directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into few forms or one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."

III. The Descent of Man is divided such that each segment deals with a different aspect of the human species. In the introduction, he writes: "The sole object of this work is to consider, firstly, whether man, like other species, is from some pre-existing form; secondly, the manner of his development; thirdly, the value of the differences between the so-called races of man." "This work contains hardly any original facts in regards to man."

The initial chapter discusses the variability seen in the human species. The social animal—man who lives in communities—falls under different pressures for survival compared to the individual member of the species. "It has been objected to such views as the foregoing, that man is one of the most helpless

and defenceless creatures in the world." As further measures to show that the human has not descended toward a stronger, more fit animal, they point to the absence of great teeth or claws, small strength and speed, lack of great sense of smell, and inability to climb quickly. Darwin argues that this is offset by man's intellectual powers and social qualities. The next chapter deals with mental faculties. The discussion tries to explain the presence of imagination, wonder, curiosity, imitation, and excitement. In regards to belief in God and Religion he writes: "There is no evidence that man was aboriginally endowed with the ennobling belief in the existence of an Omnipotent God." However, if one refers to spiritual agencies under this general category, this is found "to be universal with the less civilised races".

"The same high mental faculties which first led man to believe in unseen spiritual agencies, then in fetishism, polytheism, and ultimately in monotheism, would infallibly lead him, as long as his reasoning power remained poorly developed, to various strange superstitions and customs." He then states in the summary of the chapter that the difference between the mental powers of man and ape, even though tremendous, is of degree not of kind. He then brings up a question that we will explore later on in greater detail. "At what age does the newborn infant possess the power of abstraction, or become self-conscious, or reflect on its own existence? We cannot answer; nor can we answer in regard to the ascending organic scale." In the next chapter he states: "In the great kingdom of the Vertebrata has culminated in man."

In the next chapter the different races are discussed. He says: " We have thus far been baffled in all our attempts to account for the differences between the races of man." In the next chapter, secondary sexual characteristics are discussed: "We may conclude that the greater size, strength, courage, pugnacity, and energy of man, in comparison to woman, were acquired during primeval times and have subsequently been augmented, chiefly through the contests of rival males for the possession of the females.

In the General Summary and Conclusions, he states: "By considering the embryological structure of man... We thus learn that man is descended from a hairy, tailed quadruped, probably arboreal ... the Old and New World monkeys." He then once again reviews the significant evolutionary advantage of the intellectual powers, of language, and of reason. "The development of the moral qualities is a more interesting problem. The foundation lies in the social instincts, including under this term family ties. A moral being is one that can reflect on his past actions and their motives."

"He who believes in the advancement of man from some low organized form, will naturally ask how does this bear on the belief in the immortality of the soul. Few people feel any anxiety from the impossibility of determining at what precise period in the development of the individual man becomes an immortal being; there is no greater anxiety because the period cannot possibly be determined in the gradually ascending organic scale. I am aware that the conclusions arrived at in this work will be denounced by some as highly irreligious"

He then concludes thus: "Man may be excused for feeling some pride at having risen, though not through his own exertions, to the very summit of the organic scale; and the fact having thus risen, instead of having been aboriginally placed there, may give him hope for a still higher destiny in the distant future. But we are not here concerned with hopes or fears, only with the truth as far as our reason permits us to discover it, and I have given the evidence to the best of my ability. We must, however, acknowledge, as it seems to me, that man with all his noble qualities, with sympathy which feels for the most debased, with benevolence which extends not only to other men but to the humblest living creature, with his god like intellect which has penetrated into the movements and constitution of the solar system—with all these exalted powers—Man still bears in his bodily frame the indelible stamp of his lowly origin."

3. Evolution Theory problems according to G. Taylor

Gordon R. Taylor has written many books on different scientific subjects. His work as Chief Science Advisor of BBC Television gave him broad exposure to scientific endeavors. The answer emerging from this book is that "Darwinism is not so much a theory as a subsection of some theory as yet unformulated". The last book written by Gordon R Taylor is The Great Evolution Mystery. The book is a review of Darwin's theory and lists in great detail where the problems with the theory are, and some possible avenues of future exploration; I had looked forward to these explanations as I explored the book, alas, none was forthcoming. It is a way of proposing a bigger question. He died in Dec 1981.

In the introduction Mr. Taylor states: "The fact that an evolutionary process occurred is not in doubt. It is only the mechanism that brought it about which is being questioned." While it is not difficult to see that small variations can occur and were probably acted upon by natural selection, it is much more difficult to grasp these same events describing something complex like the eye. As to the question regards Religious objection, Mr. Taylor ignores this whole aspect and says: "it is the objection of scientists which will here concern us". He reports accounts of a scientific forum in 1967 called The Mathematical Challenges to the Neo-Darwinian theory of Evolution. MIT Professor, Murray Eden, showed at that conference that if it required a mere six mutations to bring about adaptive change, this would occur once in a billion years, and for two dozen genes, it would take 10 billion years. "Since evolution has occurred, something more than chance mutation must be involved... I shall seek to show that a degree of directiveness is compatible with the body of scientific theory, as it exists. After all, we know of one excellent example already. The fertilised egg is clearly programmed to produce an adult organism. The coordination of parts in a living creature is not achieved by chance but by precisely controlled development. We should not, a priori, exclude the possibility that there are programmes in evolutionary development, too.

When in the 1920's the mathematics of the population-based evolution was

worked out this became neo-Darwinism and accepted as fact. However, there are puzzling aspects in this tidy theory. One is the fact that some organisms do not evolve. If it was a great advance for fish to develop jaws, why is it that some jawless creatures such as Lampreys are doing well today? The bacteria dating back to 3.5 billion years ago are virtually unchanged! Then one has to discuss the competition that Darwin said provided for the survival of the fittest. One has to make a distinction between interspecies and intraspecies competition. None of this is fully explained by Darwin, nor are there ever documented cases of new species, only variations thereof. Conclusion to chapter one states: "Darwinism was not a bad first approximation but, just as Newton's law had to be subsumed in Einstein's far more intricate theory, Darwinism is giving way to a far more sophisticated picture of how evolution occurs."

Chapter three is quite interesting as it shows the problem with the fossil record. Darwin had referred to this problem previously and left it at the doorstep of inadequate data. Mr. Taylor points out "there is almost complete absence of fossils capable of supporting the claim that the new forms arose by the gradual accumulation of minute changes. Eggs are first found fully developed; so are feathers. Placental mammals appear simultaneously in 12 groups." The next chapter deals with something rather bizarre, if you consider the Evolution and gradual changes to be an ongoing process. He actually suggests that there are many Biologists that believe that Evolution has come to a stop. "It looks as if evolution developed in two phases, an opening one in which certain major patterns were established and a second phase in which speciation worked within narrower and narrower set limits."

In the fifth section of this chapter titled "Unnatural Selection," he discusses the difficulties with the theory of natural selection. "If the mammals acquired their new features because these had superior survival value to the reptilian features, why did the mammals keep a low profile for 150 million years before beginning to supplant the reptiles? Why, in the Cretaceous, did the mammals suddenly become dominant?.... There can be little doubt, it seems to me, as we look back over the evidence, that the major evolutionary changes as well as the strange changes of pace in evolution, while not fatal to Natural Selection, necessitate postulating mechanisms that lie far outside the limits of natural selection, however valid it may be in narrower contexts."

In chapter 5, several different anomalies of the theory are discussed as concerned the perfections of biological entities. The most fascinating one of these is the eye, and I will spend a great deal of time covering this; I believe you will find this absolutely unbelievable when he puts the facts before you. "Eyes have, as a matter of fact, evolved on at least a dozen different occasions, though each time on a somewhat different plan. Many small sea-creatures have an `eye spot' - a light sensitive group of cells. But these are not eyes; they give no image of the surrounding world. For that you need a lens system and a large number of receptors, with a nerve network to analyse the impulses from them."

He starts out with the sophisticated eye of the shrimp that came into existence some 500 million years ago. "It was the first use of optics in combination with sensory perception in nature and, for my money, the most incredible event in the history of evolution." These eyes are made up of columns that have a lens at one end and a photoreceptor at the other, with sometimes hundreds of these columns being present in one eye. As the columns point in different directions and each produce their own image, these eyes do not give a good `image' but are very efficient at detecting movement at a considerable distance and its direction. "The marvel of the trilobite eye became apparent only in 1973, when Kenneth Tower of the Smithsonian institute reported that the lenses in the eye of fossil trilobites consisted of precisely aligned crystals of calcite. Mounting carefully prepared fossil eyes on the microscope he found that they produced a sharp image at distances ranging from a few millimeters to infinity, without further focusing. Up to this time paleontologists had always assumed that the calcite crystals were a relic of the mineralisation process, which had preserved the whole carcass - but in that case the arrangement would have been random. Now, calcite crystals transmit light with the transparency of glass only if they are exactly aligned with the beam of light entering them. By what mechanism did these `primitive' creatures discover how to incorporate calcite crystals, align them precisely, and protect them with a cornea?"

"But that is only half the story.... In 1968 Dr Clarkson began to investigate this structure with techniques, such as the scanning electron microscope, which had not hitherto been available to zoologists." Dr Riccardo Levi-Setti worked out the findings via reference to optics first shown by Descartes in 1637. Thus the trilobites evolved a lens shaped to correct for optical aberrations identical to that proposed by Descartes and Hughyens half a billion years later. "Why was such perfection needed? But to make the matter more puzzling still there is the fact that some trilobites were blind. How did the earliest trilobites collect together the intricate genetic information needed to construct this semi-miraculous structure? And how strange that all that know-how should have been lost again when the phacoid line of trilobites became extinct at the end of the Devonian. Its collection argues for the existence of some directive force, but its abandonment argues against the existence of a coherent plan."

"The essential features of the vertebrate eye appeared quite suddenly... while we can find precursors for the photosensory cells in the `eye-spot' there are no precursors for the lens. In the course of evolution various refinements were added, notably the ability to distinguish color. Other striking examples of adaptation are the devices, which help nocturnal animals to see in the dark, and those, which protect tropical, diurnal animals from too-bright light. Raptorial birds like the falcon and eagle, as you will know, have acute vision—as much as eight times the resolving power of human vision. As far as I
know, no one has estimated the number of mutations, which would be necessary to bring about all these changes, and not only changes but also the creation of

new structures (such as the iris) for which there was no precedent. Yet the essential features of the eye appeared quite abruptly in evolutionary terms. Evolutionists believe that they can account for the formation of the eye, nevertheless. They can assemble eyes from living creatures of ascending order of complexity and believe that these indicate what may have happened... The weakest feature of this hypothesis—and it is only a hypothesis—is that it
demands a long time for the eye to become reasonably efficient."

He then gives a list that summarizes the discussion so far. "In the preceding chapters we have seen at least a dozen areas where the theory of evolution by natural selection seems either inadequate, implausible, or definitely wrong. Let me briefly summarise them.

The suddenness with which major changes in pattern occurred and the virtual absence of any fossil remains from the period in which they were alleged to be evolving.

The suddenness with which new forms `radiated' into numerous variants.

The suddenness of many extinctions and the lack of obvious reasons for such extinction.

The repeated occurrence of changes calling for numerous coordinated innovations, both at the level of organs and of complete organisms.

The variations in the speed at which evolution occurred.

The fact that subsequently no new Phyla have appeared, and no new classes and orders. This fact, which has been much ignored, is perhaps the most powerful of all arguments against Darwin's generalisation.

The occurrence of parallel and convergent evolution, in which similar structures evolve in quite different circumstances.

The existence of long-term trends (orthogenesis)

The appearance of organs before they are needed (Pre-adaptation)

The occurrence of `overshoot' or evolutionary `momentum'.

The puzzle of how organs, once evolved, come to be lost (degeneration).

The failure of some organisms to evolve at all.

... The failure of various conceivable patterns to emerge, despite the overwhelming tendency to diversify. (The curious absence of six-legged tigers)..."

The next chapter deals with something that I had previously brought up, namely, that The Origin of Species book really does not explain the origin of the species. Mr. Taylor points out: "First, if a line of organisms

can steadily modify its structure in various directions, why are there any lines stable enough and distinct enough to be called species. The second problem is this... the evolution of a new species can occur comparatively rapidly... Despite this, many species and even whole families remain inexplicably constant." Then he explains the problem with the `niche', which the traditional opinion holds that species adapt to a niche. Why then would a species that has adapted to a niche move to a different niche? A niche is a place that a species has occupied and until this occupation occurs, we don't know exactly what constitutes a `niche'. "Adaptation, in short, is distinct from speciation."

The difficulty with Taxonomy is that organisms of identical genetic material may appear differently; conversely, organisms of different genetic material may appear identical. This is a question about form, which is the outward manifestation of the internal genetic makeup. In order to organize the species then, in Biology, a species is a group of creatures that can inter-breed. "Evolutionists seem agreed that speciation occurs before adaptation. Thanks to some genetic shake-up, organisms evolve a new structure, which then enables them to occupy a new niche or function more effectively in their existing niche. They then may adapt to the new situation. `Speciation is not a route to improved adaptation' concludes Douglas Futuyama. `The time honored diagrams of evolutionary change are probably wrong.' "Perhaps the most pregnant of the questions associated with speciation is whether it truly accounts for the major divisions into Phyla which have remained stable for so long... I think rather that the answer is to be found in Genetics. Within these limits there would be further decision points, and so on...The most prominent thing about evolution is that it is going somewhere. Organisms are becoming more complicated; their capacities are becoming more sophisticated. Species formation absolutely fails to explain why this should be. Behavior too becomes more sophisticated. Why should it be?" It is not just the Phyla, but also the kingdoms are not changing. The broad categories are rather fixed but variation is seen in the lesser categories.

The next chapter deals with Genetics. As it is commonly known, the nucleus of a cell contains DNA material. Most of the DNA is generally inactive except at the time that the cell divides. The active part of the DNA transmits the information within it via messenger RNA to the cytoplasm where the encoded information produces proteins. Proteins are made up of 20 plus amino acids, which can be linked together according to the genetic code. The reason proteins are important is related to the speed of chemical reactions. Most chemical reactions occur at a very slow rate if each two molecules had to directly interact. Biological cells have solved this problem by using enzymes. The enzyme is made up of different segments, and the alignment of the amino acids in the protein gives it a unique three-dimensional state. Enzymes speed up the biochemical reactions by more rapidly bringing the two chemicals together. This becomes an important step in biological processes. The surface of the cell is also quite fascinating in that many lipid, proteins and other structures form a complicated flowing interconnected layer that communicates information from the

cells to the outside and vice versa. I should also mention that the basic building blocks of the genetic information consist quite elegantly of 4 units called nucleotides. The biochemistry of how the pairing work and how this simple set produces the amino acids earned Watson and Crick Nobel prizes.

How then the information within the Gene is controlled and how much of the information is released and under what circumstances is being studied in greater and greater detail by modern geneticists. Much about this process is known, and much is yet to be worked out. "It might reasonably be thought that the amount of DNA in the Genome would increase pretty steadily as we advance up the evolutionary scale... While the mammalian cell seems to have about 800 times the DNA of a bacterium... the organism with the most DNA is the lily, which can have from 10,000 to 100,000 times as much DNA as a bacterium." This is a most interesting point. The level of perfection and complication of the structures does not directly correlate with the Genome size! "It may be that it is not genes (that is, strings of nucleotides) which determine structure so much as the relationship between such entities."

In chapter 9, the regulation and control of the gene is further described. A great deal of work is being done in this area including the recent completion of the human genome project. The control mechanisms of the Gene may exert their control by direct control of a chemical reaction, by occasional control of expression of certain annual genes, or by long-term controls. This part is quite relevant to organ development of biological entities. A mutation may cause no consequential damage, if it causes changes during non-expression time of a gene; Conversely, a mutation of a major Gene may cause total absence or failure of an organ. It gets even more exciting. "There is a special case of whole blocks of genes being switched on and off... namely metamorphosis—the transformation of tadpole to frog, of chrysalis to butterfly, of Larva to jellyfish." "Apart from the many difficulties in understanding how such a radical change comes about, there is the larger question of why it should happen? Can there really be an evolutionary advantage in constructing one sort of organism and then throwing it away and starting again?"

"The tadpole is essentially a fish," says Earl Frieden of Florida State University. Maybe the tadpole/fish carries all the genetic information needed for an amphibian. These can all then be activated at once to produce a frog in the case of Tadpole or produce Amphibians from certain groups of fish. "It becomes easy to understand why twelve mammalian lines began to exhibit similar characteristics." One can presume that similar factors, environmental or otherwise, stimulated the same gene activation process. So long as the same factor produces the same result, separate lines can develop in geographically distinct areas in nearly identical ways. "That these sequences of coordinated reactions ... should all have arisen by chance mutation of single genes is in the highest degree unlikely."

In chapter 10, the Evolution's biggest step is discussed. By this I am referring to multicellular organism formation, about 870 million years ago. Until this point what we have is the `primordial soup' as referred to by other

authors. At this time some early cell colonies are formed. "They did not assemble simply in clotted masses or chains, but formed neat and purposeful patterns". Any time you have more than one cell, more than one organ, or more than one person, communication becomes of paramount importance. Much is yet to be worked out by biochemists as to the exact nature of these processes. It is evident that group formation required a way of communication between unicellular organisms, and this either developed or was latent in the genome and became activated. Eventually Protochordates developed and there from eventually Man, presumably. As soon as the organisms become multicellular, sexual reproduction becomes a possibility. "Since an organism reproducing sexually loses half its genes it suffers a 50 percent disadvantage. On the other hand, it gains in flexibility. Asexual reproduction is efficient in the short run, sexual reproduction in the long run. This brings us to a real brain-busting problem: how can selection favor a mechanism which will only show benefits in the future, if at all?"

The origin of life is discussed next. This chapter reminded me of a book I read years ago written by Nobel laureate Francis Crick called Life Itself. In that book he hypothesized that the basic beginning of life was transported here onto earth millions of years ago in the form of bacteria. Presumably, some intelligent outer space entity selected Earth as a good fertile ground for a grand experiment. This is really interesting whatever way you look at it, science or fiction. I want you to keep in mind how the act of Evolution from this point forward is presumed by many to be a random occurrence but the germinating seed is in fact planted by an intelligent choice.

If life arose spontaneously, then it could have done so more than once. However, the fact that the genetic code between all phyla is nearly identical, argues in favor of single event, or else the restrictions in initiation of life are such that at multiple times the same pathway was chosen. The time for this can be approximated to about a billion years after the Earth was formed, some 3.5 billion years ago. In 1954, an experiment at Berkeley showed that combination of the initial elements of Earth's atmosphere and electrical discharges could produce amino acids. As we have seen previously, the alignment of different amino acids produces proteins. You need DNA to produce the sequence needed for proteins, but you need Enzymes (proteins) to make DNA. This is another example of the old Chicken and Egg question. The degree of complexity of biochemical processes is such that randomly selected events are highly unlikely to be able to produce it. "The late H. Quastler, a prominent biochemist, calculated the odds against it at 10301 to 1, that is, ten followed by 301 zeros to one, i.e., virtually impossible."

What is meant by Life, anyway? I previously attempted a simple answer to species definition based on biology. You can define life as something that is animate. You can define it as something that reproduces. You can define it something that moves. As we have learned more and more about the atom and how active it is, even in inanimate objects, this question is harder and harder to answer. "... Perhaps the best criterion of life is its capacity

for self-repair". I personally prefer the distinction based on production of energy, a biochemical process but this definition encompasses both perspectives. "It was not enough for chance to bring about the formation of replicating molecules. Right from the start, there must have been an energy source."

The Sun provides the energy to us all on the Earth. The primitive cells had to devise a way of taking advantage of this energy source. The initial atmosphere as well as the water above these primitive cells filtered out much of the radiation from the sun. In fact the high-energy waves, if not filtered, can irreparably damage the DNA. So the initial DNA can only survive where there exists such an atmospheric filter. The energy, of course, is trapped through photosynthesis by plants and this energy source is then recycled as you go up the food chain. Photosynthesis utilizes Chlorophyll.

Until chemical processes have produced this molecule, one could not begin this whole cascade. "It turns out that there are two distinct chemical systems at work, each with its own enzyme." Recall the discussion about the enzyme and the DNA in this primordial soup. "One builds the components, the other forms them into a ring. So here again we have an improbable coincidence. The formation by chance of one enzyme without the other would have been useless. "...It is hard to swallow the idea that chance... built up such an extremely elaborate mechanism as photosynthesis." The alternative theory that life originated in space does not avoid these difficulties.

About a billion years ago, another major step took place. The small bacteria-like cells that do not have a nucleus, developed one. This new cell is called the Eukaryote. This is a larger cell whose genetic material within the nucleus is divided into chromosomes. When these cells divide, the splitting of the DNA and making a carbon copy of the original DNA form the daughter cells. Sexual reproduction becomes possible at this point, when the half-cell joins a different half-cell. The entire process of natural selection depends on this variability that is now produced. "It took three billion years to get from prokaryote to eukaryote, as against less than half a billion to form life itself. That doesn't seem to make sense. If photosynthesis is such a great advance, why did many anaerobic forms persist so long?" This points to something that we discussed before. Recall please how natural selection always supposedly seeks the fittest, yet some species have not changed much for millions of years. "Why did diversification occur so late—after 85% of earth's
history?" I will discuss the Aging process in some detail later on.

Before we go on the next chapter, I want to explain the concept that Energy transformation is synonymous with Life. For this I went back to dreadful days of Biochemistry in Medical School using L. Stryer's textbook. This was my first rather overwhelming exposure to biochemistry. I had already suffered through two courses in Organic Chemistry in undergraduate school. Those were really mind-boggling topics trying to make sense of molecular structures in three dimensions. Then by studying biochemistry, I began to develop a sense of awe

for the various detailed pathways that are hard at work inside every cell. I have added some pages from this book to make my point about energy. One describes the process of photosynthesis, one the process of Glycolysis, and the last one the citric acid cycle. The processes were discovered in the last 50 years or so. They are quite complex, and understanding them gives greater credence to the improbably high number that H. Quastler had calculated.

Chapter 12 discusses the effects of behavior once again. As we have previously pointed out, an animal's behavior sometimes precedes the gene or the need for a gene that produces the structural changes demanded by the environment. He ends the chapter with a quote from Professor James S. Coleman of Johns Hopkins University. "Once I was sitting on the edge of a cliff, a bundle of gnats hovered in front of me, and offered a strange sight. Each gnat was flying at high speed yet the bundle was motionless. Each gnat sped in an ellipse, spanning the diameter of the bundle, and by his frenetic flight maintaining the bundle motionless. Suddenly, the bundle itself darted—and then hovered again. It expanded and its boundaries became diffuse; then it contracted into a hard tight knot and darted again—all the while composed of nothing other than gnats
flying their endless ellipses. It finally moved off and disappeared... Such a phenomenon offers enormous intellectual problems: how is each gnat's flight guided, when its direction bears almost no relation to the direction of the bundle? How does he maintain the path of his endless ellipse? And how does he come to change it when the bundle moves? What is the structure and what are the signals by which the control is transmitted?"

The last chapter is intriguingly titled "Chance or Purpose". After some rediscussion of some of the problems and examples with Darwinian theory of evolution, we get to the crux of the matter of this project. Mr. Taylor states: "A problem of a more philosophical nature is presented by the continual increase in complexity as we ascend the evolutionary scale.... If mere survival is the criterion for success, what was wrong with the rabbit, as Professor von Bertalanffy, of the State University of New York, asks. Or, for that matter with Bacteria... Some much more general theory seems to be required if a comprehensive account of evolution is to be written, involving principles of organisation which transcend those of Genetic control... That Darwin's ideas need setting in a larger framework no more detracts from his greatness than Einstein's theory did from Newton's."

Not to insult anyone's intelligence and for sake of clarity, Einstein's theory of relativity expanded the Newtonian theory of Mechanics. It gave an explanation where the original Newtonian Mechanics did not explain experimental data, namely at atomic level and/or at high rates of speed, i.e., close to that of Light waves.

In the next section of the book, an analogy is used which I believe to be quite good in helping one gain a perspective on this whole issue of evolution. "The metaphor is that of rising tide flooding into a broad river estuary. As it fills up the channels and available depressions, the sea extends its coverage

but this produces no definable pattern. The height of the tide is correlated with the area finally covered but the pattern remains entirely on the lie of the land. To predict it we don't need further information from the water, we just need a good orographical map. In the same way, it is the environment which sets constraints to the pattern of evolution... As Mathematicians would say, it may be vectored—vector being a term indicating direction without any hint of what is moving, or how smoothly or how fast." Orography is study of or information gained from topography, and mapping of mountains.

Traditional philosophy and religion has, of course, placed man at the summit of the evolutionary ladder. In many of the discussions about science and religion, the changes in attitude over the last two centuries are evident. Man no longer is the epitome of the world, nestled in a world created for him, living on an Earth that is the center of the universe. "The mistake here, and it is often made, is to assume that adaptedness is the same as evolvedness. Flexibility, not adaptedness, is the name of the game in evolution." What it does seem to have been ... is evolution in complexity. But is growth in complexity the object of the operation or simply an inescapable side effect? ... Darwin put ability to survive as the prime criterion of evolutionary success. But something more than survival seems to be at work."

To shed light on this topic, he then discussed self-assembly. Simply put, at all different levels, one sees examples of assembly. Subatomic particles assemble in certain order. Atoms arrange themselves in certain orders to make molecules. Molecules of Amino acids arrange themselves into certain patterns, much like the DNA molecules do. Collections of cells become organs, and collections of organs become animals. Bacteria grow in colonies; Geese gather in flocks, and people live in societies. Planets orbit around stars, which in turn are part of a galaxy. The galaxies, in turn, form certain families and orders. This repeating pattern being present at every level of existence.

A theory proposed as a way to explain this, is Non-Equilibrium Thermodynamics. "The theory states that a steady throughput and a steady selection of more stable conditions necessarily causes a steady increase in order. The result is a self-ordering of living systems, amounting to self-design". This has been shown in computer simulations. "A gene system with 10,000 genes could produce 10 to 3,000 possible combinations... There are powerful deep underlying constraints that do not need natural selection." When a computer simulation of the speciation process randomly assigned one of three options to each species, the result very much matched the current evolutionary data. The three choices were to persist, branch, or become extinct. This is quite interesting. However, you should keep in mind that the simulation is just that, there is no experimental proof yet. This brings to my mind some thoughts related to the topic of randomness. For example, the machines at casinos are supposedly randomly programmed. The fact that you can design randomness through a computer program is itself an interesting topic, which we'll not delve into.

The last topic discussed in this book is the `Form'. " Too many biologists assume that, somehow, the genetic material prescribes the form of the organism

as well as specifying the raw materials. This cannot be entirely true... form is certainly dependent on external factors, at least in some cases... Since change of form is the core of evolutionary studies... We cannot say that evolution has been `explained' until we know more about the factors which determine form... " I'll come back to this later.

"Progress has been prevented by the rigid dogmatism of the Neo-Darwinians... Now, however, the attempt to present Darwinism as established dogma, immune from criticism, is disintegrating... It is unfortunate that the Creationists are exploiting this new atmosphere by pressing their position... In the world as a whole, there is a growing recognition that life is more complex, even more mysterious, than we supposed... The probability that there are forces at work in the universe of which we have as yet scarcely an inkling is not too bizarre to entertain." We have much to learn and much to explore. He has a great point about the Darwin's theory being dogmatically accepted. It should be like any other theory. It should be examined objectively. However, whenever science is mixed with either religion or politics, it is possible that objectivity may be lost.

4. The Form and Embryology

We have reasonably established a pattern of evolution and looked at the biological data that gives us an understanding of the genetic information that we possess and that we pass on. We have looked at the limited ability of this to generate life; but rather, this variability may explain some aspects of differentiation and speciation. We have noted that the Genome probably has stored within it many different options which become manifest under the proper environmental stimuli. The genetic information, as we know it today, does not clearly explain how the final form is developed. I am going to spend some time on this topic.

The science of Embryology is quite complex and singularly fascinating. We all know the sperm and egg story where two half-cells develop into an individual. The new area of fetal research is based upon the ability of that initial cell to transform into any type of cell or organ. All we have to do is to figure out the biochemical switch that makes that decision for the cell, and we have eliminated a lot of human misery. These cells will then be used to repair or replace defective parts or organs and to cure many degenerative diseases.

The initial cell that is produced from the union of the egg and sperm, barring any abnormal genetic transfer, has 46 chromosomes, including XX or XY combination. This cell is nearly 50% from a `foreign' source. Ordinarily, when a foreign body enters the body, the Immune system will attack it and try to get rid of it. This function, of course, provides the mechanism by which most germs are eradicated. However, intriguingly, the partially foreign cell is allowed to increase in size initially for a few days within the female organs and after attachment to the uterus, for 9 months, partially barricaded within multiple layers. This is an unsolved mystery.

The fertilized egg divides into two presumably identical cells. If a break

occurs at this division, each of these cells will produce a complete fetus. The next division produces 4 cells, and so on. By day 4, the cells have organized themselves into a cell mass at the edge of a large globe formed by a thin layer of cells. Implantation will be in the next 2 days. At this time, a significant act of differentiation has occurred. Some of these cells are destined to become the protective layer; other cells will become the Embryo. Through unknown mechanisms, each of these groups of cells then organizes further. The cells that will produce the embryo will slowly develop segmentation and cavitation and from that early germinal body parts appear. I have alluded to the tail and the gills of this embryo previously. These are resorbed as the embryo develops. I have seen newborn infants delivered with `a tail', which is a horrifying experience for the parents but is easily amenable to surgical correction. Somehow, these cells find their way to the right places, and eventually form a fetus that grows to several pounds at the time of delivery.

Another fascinating concept associated with growth and development concerns the issue of symmetry. Some of the first multicellular organisms were radially symmetrical; That is to say, round. Most, however, are longitudinally symmetrical, much like us. That is to say, one side is mirror image of the other. The two sides are so close to each other that this issue is easily ignored. I recall vividly a patient with `Hemi-Hypertrophy' that I cared for years ago.

One side of his body was of average size; the other half was about 10% larger. As you can guess, he appeared quite unusual when undressed, as his clothing covered the difference between his arms and legs. The half-faces each were normal from a side view, and only unusual from frontal view. This phenomenon is easily noticed in daily life. Consider how you view yourself in the mirror daily. The person you see in the mirror stands opposite the way a person in front of you would. When you lift your right hand to shave in the morning, your mirror image uses its left hand. (Incidentally, a common surgical mistake is to remove the wrong-sided part.) When you see yourself in a home video, the person of yourself in front of you is different than your mirror image.
Sometimes this change is minuscule, and other times more noticeable. Some Plastic Surgery colleagues utilize a software-imaging program that takes advantage of this information. The computer reproduces the exact image of each side of the person's face and produces two different faces. The patient then chooses their preferred image prior to the surgeon reshaping any parts, e.g., the nose.

Going back to the question of the Form. Once the separate organs have developed, the cells can regenerate the organ, but, quite often, are no longer able to regenerate the organism. If a cell that is destines to become a hand, is removed and placed in a different area, amongst a new group of cells, sometimes the cell will transform and become one of the new groups. This shows that the ability to transform is not completely lost and given the proper environmental stimuli the genetic information stored within the cell can be

re-triggered. How the final form comes to be is still a mystery.

We can safely say that different species and animals have come from some animals or plants before them. This process is probably not a random process as we have seen. It most likely is a Vector, a directed process. Most biologists have taken this to reflect their Materialist ideology and to conclude that this process does not require divine intervention and therefore, as Nietzsche said nearly 100 years ago, that God is dead. I hope that you read on and arrive at your own conclusions.

5. Evolution of the Individual, and the question of Aging

This segment will explore the individual's growth and in one sense, evolution, throughout his life. Every person reading this book should feel a great sense of joy from being the winner of a great biological lottery. In this lottery, upwards of 100 million sperm are swimming as fast as they can to reach their destination, the egg. As soon as you beat every other sperm and entered the egg, there were changes produced within the egg that prevented any other intruder. That is how we all began, in a fantastic tumultuous race. From that point, each cell grew into an embryo and eventually a fetus. The fetus is protected from the assault of the mother's immune system throughout the pregnancy. The fetus, obviously, has shared genetic information from both parents, in nearly equal amounts.

The perception level of the fetus is very limited, even though there is evidence that later on in fetal life, there is perception of sounds (especially of mother's voice) and some perception of light and also pain. Then the fetal life comes to a traumatic end, and we are born into a cold cruel world with limited capability to care for ourselves. At that point some perception is present, but the faculties of a newborn are most concerned with nutrition and growth. An interesting side point is that without a loving environment some may fail to thrive and grow.

The newborn's ability to understand events around it is limited. Its ability to move about is rather limited. However, as time goes, the infant develops increasing understanding of the world and begins to feed itself and learn to walk about unassisted. There are some innate fears such as fear of separation that infant is born with and has to overcome. Increasingly, the infant becomes aware of its `self' and begins to explore the surroundings. Initially, the infant/child can only think in concrete terms and over time, the abstract thinking occurs. Generally speaking by the middle of the third grade, the child can have some abstract thought process. By this I mean, that the child can allow for variations from his/her expectations without having a sense of loss. That means the child can now perform some rudimentary deductive reasoning. By this time, the child is reasonably capable of taking care of him/herself. She/he also becomes curious about the world her/him and begins to ask questions such as `Where did I come from?' and `How did the mountains and oceans appear?' By this age, one can expect the child to be able to take on some degree of

responsibility for her/his actions.

By the time of early adolescence, about 13 (younger for girls), the physical maturity is at a prepubertal/pubertal level. If necessary, the adolescent can reasonably take care of herself/himself. A significant amount of logical deduction and reasoning and power of extrapolation has appeared. An early hormonal change is having an effect on the thinking and the concept of boy vs. girl has developed in a meaningful way. These powers are augmented during puberty. At this time, as sexual maturation occurs, the concept of one's own sexuality becomes important. Dr Freud, and others since, have written volumes about the internal working of the ego, etc. which we will not delve into. Suffice it to say that one's sexual identity of one's self plays an important role in the person's outlook on themselves and the outside world. This is the time when everyone feels that they can change the world if they so desire. After this time, there is gradual escalation of the powers of reasoning and understanding, if properly developed. The physical body continues to mature, especially if trained, and within the next few years reaches its peak and thereafter we see a slow gradual decline in function, that is significantly controlled by one's own behavior.

The college years are probably the most important in the continuous intellectual progression of the person. We are quite lucky in the USA that most high school students can go on to collegiate training if they so desire. When I graduated from high school in Iran and took the National College Entrance Exam, I was one of 300,000 applicants vying for 12,000 slots. The higher education system in America is a great asset that is sometimes overlooked. During these collegiate years a lot of great thinking takes place. This is the first time that one begins to think long term. What course of study should one undertake? What sort of life style should one endeavor to achieve? What about the right time to start a family? I assume that an occasional thought of retirement may be entertained, as well.

We have then arrived at the economically most productive phase of each person's life. Somewhere around forty, if not before, the questions about Faith, God, and the End become much more important. All the time that she/he has spent to prepare one's self for the society, to begin a family, to acquire education, is now placed in perspective. `Whence did I originate and why?' Becomes a soul-searching mission. `Where do we go from here?' is then the follow-up question to be answered by each person. Let me discuss a few thoughts about this before going on to the question of aging.

Each person, in due time, will decide on their life's philosophy and approach. Depending on the path chosen, one's actions and plans will be affected. I will share with you some thoughts from the Scriptures of the Bahá'í Faith that may shed some light on this topic. "The fruits of the tree of man have ever been and are goodly deeds and a praiseworthy character." (Bahá'u'lláh: Epistle to the Son of the Wolf, page 26). Bahá'u'lláh says that the purpose of life is good deeds presumably emanating from the person with good character. "Know ye that the world and its vanities and its

embellishments shall pass away. Nothing will endure except God's Kingdom which pertaineth to none but Him, the Sovereign Lord of all, the Help in Peril, the All-Glorious, the Almighty. The days of your life shall roll away, and all the things with which ye are occupied and of which ye boast yourselves shall perish (Bahá'u'lláh: Gleanings, page 125). Regardless of one's belief in afterlife, clearly at this stage in one's life, one begins to worry about the time of the end of one's life.

"These few brief days shall pass away, this present life shall vanish from our sight; the roses of this world shall be fresh and fair no more, the garden of this earth's triumphs and delights shall droop and fade. The spring season of life shall turn into the autumn of death, the bright joy of palace halls give way to moonless dark within the tomb. And therefore is none of this worth loving at all, and to this the wise will not anchor his heart." ('Abdu'l-Bahá: Selections from the Writings of 'Abdu'l-Bahá, pages 220-221) Once again the theme of lack of permanence of the physical world is highlighted, this time by Abdul-Baha.

So now we come to the question of aging. We have seen so far that the life of the embryo was pre-programmed to pass through different stages to produce the human infant. We have now seen that the life of the person has been pre-programmed to find a definite path of maturity onto an advanced age. You probably have heard about the recent biochemical discovery of the enzyme, Telomerase, which may regulate the growth of the human cell and may play an important role in aging. You may also be familiar with an abnormal aging pattern that is seen in the people afflicted with Progeria, in which case the entire process of aging is accelerated such that a seven year old may have an aged body of a 60 year old. These things point to some things about Aging that I have found fascinating. When I first studied the aging process, I was quite intrigued by the idea of a maximum life span. Regardless of how the human individual takes care of herself/himself, there is a pre-programmed biological death time at 115-125 years of age. I was so shocked to learn that we were indeed programmed for destruction. This pattern is also seen in any other biological entity, from trees and plants to bacteria and bees. There are certain patterns that one can find, depending on the content of the genome.

There are many factors that contribute to aging. We have talked about genetic control of cells, but it also is important to keep in mind other genetic factors inherited from both parents. DNA is damaged at different rates in different organisms. Dogs lose genetic material seven times faster than humans and, interestingly, this corresponds to the ratio of life span between dog and human. The environment definitely affects the aging process. The temperature and metabolic rate also affect the organism's age. Larger animals with slower metabolism tend to have a longer life span than smaller animals with a more rapid metabolism. Free radicals cause injuries to the cell and scavengers of free radicals, Antioxidants, help control and/or repair this process. Ionizing radiation is associated with cell injury; however, a small dose of radiation administered to mice and insects actually increases their life span.

Let's study the process of Death and Aging in greater detail. Every cell is programmed for a certain number of reproductions beyond which it either dies or becomes stagnant without further reproduction. Cell death occurs either by Necrosis or Apoptosis. (Geriatrics, 3rd Ed., page 10) Necrosis occurs as a result of intracellular release of enzymes and of massive release of electrolytes and calcium that destroy the cell in a rather dramatic fashion. Apoptosis is probably organized under genetic control and is `a gradual and orderly form of cell death that occurs in the absence of overwhelming external injury'. Why would there be a gene for programmed cell death? The loss of the control on cellular growth produces a tumor or cancer, which is disastrous for the organism in many cases.

There are two types of cells. One type is the type of cell, like the Myocardial cells of the heart, and nerve cells (Neurons) that last throughout the person's life and does not replicate. The other cells are proliferative, and this includes fibroblasts (these multiply to produce the scar that closes wounds), Gastrointestinal mucosal lining that are shed in the process of digestion, and all of the different blood cells. There is a genetic clock within the nucleus of the cells that sets the number that they may reproduce/replicate. Red blood cells do not have nuclei, and their age limit is about 120 days. The red cell becomes stiff due to loss or distortion of proteins within the cell and gets `stuck' within the ReticuloEndolethial system and becomes cleared. It is unclear what effect these cellular processes have on the age of the organism.

Another theory of aging involves a Neuroendocrine pacemaker. Production of several different hormones is under the control of the HPA axis (Hypothalamus-Pituitary-Adrenal). This system is also involved in the process of Diurnal variation. This process adjusts the body's internal clock such that our internal workings follow the normal day/night variation. The grand final theory on aging, yet to be devised, will probably need to take into account the Genetic aspect, the Environmental factor, the Hormonal influence, the Free radical damage, the Radiation exposure, and the Metabolic rate. But most important of all, there is a programmed death of the organism, probably transmitted via DNA that sets a limit on our stay here on Earth, regardless of the other influences. We have much to learn about this process, but as became clear during our study of the Evolution of Species, there is an underlying control and program.

Let us accept then that there is an underlying program in the growth, development, and evolution of the individual. We cannot be certain as to the degree of rigidity of this program at this time. Where does free will come in? How much is programmed? How much do we choose? There is no doubt that each of us, being endowed with different DNA content, are different to some degree, yet there is a general concordance in the way each of us grows through life and passes each stage. Even when we make a decision, one can argue that the process leading to that decision was part of one's underlying psyche and therefore not completely a free choice. It makes me think of the free will during

presidential elections. We certainly get to choose one out of two maybe three candidates in November, but before the final vote, the field is significantly narrowed and our choices reduced.

Ever since the recent cloning of sheep and discussions about cloning of humans this matter can be seen under a new light. If I was cloned, would my clone wish to spend time away from his family and work on this manuscript or would he instead prefer to watch College Basketball? That would be interesting to answer. Never the less, I think one can say that given our genetic make up and the influence of the environment, we do have some will of ourselves.

Consider this: "Some things are subject to the free will of man, such as justice, equity, tyranny and injustice, in other words, good and evil actions; it is evident and clear that these actions are, for the most part, left to the will of man. But there are certain things to which man is forced and compelled, such as sleep, death, sickness, decline of power, injuries and misfortunes; but in the choice of good and bad actions he is free, and he commits them according to his own will. ('Abdu'l-Bahá: Some Answered Questions, page 248)"

We cannot control that underlying program for the evolution of our individual life, but we can control our actions within certain parameters. What if we do make all the `right' choices? Then we have truly prepared ourselves. "Man's physical existence on this earth is a period during which the moral exercise of his free will is tried and tested in order to prepare his soul for the other worlds of God, and we must welcome affliction and tribulations as opportunities for improvement in our eternal selves. (UHJ, Lights of Guidance, Page: 368). There are many different ways of defining the purpose of existence. In this particular statement, the physical body is a vehicle of the soul. The afflictions mentioned may be of the kind that tests one's devotion to God, and these allow for the better preparation of the soul that successfully has handled its tests and tribulations.

The closing message on this topic is the fact that we see a lot of programming at different levels of life. In a sense, that is what I hope you got out of it. There were other points made about aging, afterlife, purpose of life, but we are not trying to answer all those issues here. Rather, those are to pique your interest and hopefully some soul searching of your own to find your comfort zone with these ideas. This theme of has recurred in every topic: Directedness.

6. The Origin of Human beings

A Review of African Exodus

In this segment, we'll explore a deeper examination of human evolution. We have discussed previously Darwin's two works along with a review of the problems stemming from those explanations. We shall turn our attention, now, to the origins of the Human beings, Homo sapiens, the wise man. To delineate this fascinating topic in detail, I will review the book African

Exodus, written by a Paleoanthropologist, Christopher Stringer, and a journalist, Robin McKie. The book is written in 9 chapters and several wonderful illustrations. The book is historical as relates to the experience of Mr. Stringer through his graduate training and also historical as to the state of common knowledge and scientific dogma. As we work through, please pay attention to different definitions of Human beings, from a biological and a philosophical standpoint that will be introduced. The time frames will dovetail very nicely into some of the other contents of this book. The first portion of the book explores the Anatomical data. The second segment will delve into the more modern Genetic data. Lastly, this is an area of ongoing research and we'll undoubtedly witness many interesting discoveries in the years ahead.

In the first chapter, the Kibish enigma, the author explores a partial human skull discovery from around the River Kibish, Ethiopia. The unusual feature of this skull is that it looks very much like that of Homo sapiens but the dating did not match the current theory in 1970's. At that time, it was believed that man had descended from the Neanderthal about 60,000 years ago. This enigmatic skull was dated at 100 to 130 thousand years ago! As it is customary, several different scientific teams and many different museums study most of these significant remains. So the data and recordings are fairly scientific and less error-prone than some of the finds that we'll discuss in the future where single studies are made. This inadequacy of the theory to explain the findings of the Kibish skull became the basis of Mr. Stringer's out of Africa theory that took many other years and much more detail to finalize.

The next chapter is `East Side Story'. This is the story of the first "upright monkey" that began the evolutionary line that led to humans. Pay close attention to this division caused by Geological changes. The human species belongs to the order of primates, a group of animals that are tree loving and dexterous. This group had thrived for many millions of years from 25 million to 10 million years ago. About that time the monkeys began to take over the forests, presumably due to their smaller size. The apes became isolated in the jungles of Africa and SE Asia. The numbers of the Apes has been on a decline since then. The four major species extant today are the gorilla, the orangutan, the common chimpanzee, and the pygmy chimpanzee. The only exception to this rule of continuous decline is the hominids.

Presumably in the struggle for survival under more restricted food supply, some Apes began to adapt to the life on the ground and began to give up their tree life. There is evidence that about 4.5 million years ago in Africa, there lived Ardipithecus ramidus (ground ape, root). This is the earliest remains of an upright Ape. It had a small brain and ape-like teeth. This is also a time that geological record indicates that there was a great rift in Africa. The movement of tectonic plates produced a more arid East side of the African continent. Geological barriers then physically divided the population of this common ancestor of humans and apes. The western population developed in the more arboreal jungles of West Africa. The Eastern population developed in the arid dry lands of then East Africa.

Around this time, a new species is found in Africa, Australopithecus afarensis (Southern Ape, Afar=Ethiopia) has very clear features of bipedalism, more so than the ramidus that we met earlier. The upright stance is a most significant evolutionary step. It allowed the upright animal farther visual field and freed the hands for manipulation of tools and the environment. The hot climate may have made upright stance more energy efficient. There is scientific evidence that the upright animal receives 60% less heat compared to four-legged companion. The area that is exposed to the rays of the Sun is much smaller with bipedalism. The afarensis is quite Ape-like except for bipedal motion. There is a great disparity between the size of the male and the female of the species and there is little or no evidence of tool making ability. The brain size is still about 400cc volume, a paltry volume compared to modern man's 1400cc brain. This species faded from the fossil record about three million years ago.

A new species was discovered near Taung in South Africa and named Australopithecus africanus (Southern Ape-Africa). The descriptions developed from these finds formed the basis of parts of the movie 2001: A Space Odyssey. This species is very similar to the afarensis. The one significant exception is that the female and the male are much closer in size. This species disappears from the fossil record about 2 million years ago.

From the africanus lineage, there arise two separate lines of hominid development. Three species developed of the `robust' lineage, since they possessed thick jaws and big back teeth. The other species took the flexible approach to dietary intake and is therefore classified as `gracile' meaning lightly-built. This is biologically the first real human. The species is called Homo habilis (man-handy). This may actually be subdivided further into large habilis and small habilis. This first member of the Genus Homo appeared about 2.3 million years ago. This species like the others we have looked at was bipedal. The brain size was about 750cc volume, a significant jump. This group was involved in tool making on a regular basis. Coexistent with these is another species that survived much longer and may have been around as late as 100,000 years ago in certain parts of Asia. This was the Homo erectus. The erectus people were sophisticated toolmakers, well beyond use of tools. This use of tools allowed for a new source of food: meat.

The erectus has a small gut and somewhat larger brain. Stay tuned, as more modern species/subspecies of the Genus Homo will be discussed.

There has been much confusion about the origin of human beings in the last 1.5 million years. Some people suggest that all hominids since the erectus are parts of the same species. However, there are enough anatomical differences to be able to list them as separate species. We dealt with this question previously. What is it that exactly defines a species? Is it their anatomy? Is it their behavior? Is it their ability to interbreed? This last idea is the most enduring way to separate different species. However, the bone and skeleton

do not provide us with this most important piece of evidence!

The next chapter on The Grisly Folk discusses the issues mentioned above. This chapter also provides the basic outline of the human lineage. About 400,000 years ago a new species has evolved from the erectus, Homo heidelbergensis (man—Heidelberg, Germany). This species has a thick, chinless lower jaw. These people were bipedal and had a fairly large brain size. The significance of the chin will be dealt with later on. The species then further differentiated. The population North of Sahara became the Neanderthal, Homo neanderthalis (Man—Neander, near Dusseldorf, Germany). The population South of the Sahara became the first modern humans.

The next chapter's title is "Time and Chance." It gives detailed description of the archaeological dig of the burial site of a Neanderthal infant. Let's spend time going over some of the Neanderthal features. This will be very interesting. The brain size of the Neanderthal is 1200-1750 cc. As you recall, on average this is bigger than Homo sapiens. However, the thinking part of the brain, the frontal lobes, is more developed in the Homo sapiens. Then the glowering twin-arched brow ridge is a major distinction since the brow ridge in Homo sapiens is non-existent. There is a nice discussion about speech, the evolution of the Larynx, voice box. The continual lowering of the Larynx allowed for a larger column of air being used for speech, and the larger the column, the wider the range of speech. The first anatomical evolutionary changes of speech are seen in the Homo erectus. The Neanderthal was very similar to us. They had an upright stance, their anatomy was very similar; they had reasonable power of speech, ability to make use of fire, utilized shelter, and constructed tools.

The Neanderthal lived from 200,000 to 30,000 years ago. They have been found in Europe, and eastward to Moscow. The Middle East was probably at the far reaches of the Neanderthal. Modern humans probably coexisted with the Neanderthal for many years in such areas. Since we have described them as separate species, and separate species do not mate, it is safe to say that their coexistence was not one of intermingling. So, what happened to these relatives to modern man? Why did we survive and they didn't? There is a significant amount of debate on this issue. There are a lot of different ideas. One idea that seems to make sense and matches the archeological findings is that Neanderthal stayed in the same shelter. By contrast, modern man was always mobile, similar to modern hunter-gatherers. The organizational efficiency of modern man probably eventually won out over a somewhat more physically superior species. Nevertheless, modern man had concurred most of the globe for a long time before it took over the Neanderthal some 30,000 years ago in Western Europe.

The next chapter discusses `the Mother of all Humans', also referred to as the African Eve. Most of this is based upon genetic theory. The genes as we discussed in the first portion of this book, are responsible for the information that is transmitted in each cell. These genes from the nucleus divide in half and combine with another half to make a new cell. However,

something very interesting happens in Primates. Since the tiny sperm only has energy cells, mitochondria, in its tail and the tail is lost at the moment of conception, the new cell from this union always carries the mother's mitochondria that are present in the egg. One can look at the variations within the genes from the mitochondria, and from the nucleus and then have a scientific estimate of their separation time in history. According to these calculations the common ancestor to all humans, the African Eve, must have lived some 200,000 years ago.

There is another interesting genetic piece located on chromosome 12. The people in sub-Saharan Africa show total variability in this segment, consistent with variable population. However, the genetic variability does NOT exist in the rest of the world. This means that a small band of these Africans migrated out to conquer the rest of the world and that only one wave was successful. This migration occurred between 100,000 and 90,000 years ago. The African Eve, which was probably indeed a village of African women, was probably the first humans. The group that spun off about 100,000 years ago to spread to the rest of the world is the modern Homo sapiens, basically us 10,000 generations removed.

There are two separate discussions in the next chapter called "the Footprints on the Sands of Time". First is the timetable for the migration of the original human settlers out of Africa. The spread throughout Africa occurred about 100,000 years ago, as well as spread to Asia. By 60,000 years ago, the Eastern Asia was conquered and about 35,000 years ago this group progressed onto Alaska and spread southward thereon to occupy the continent. Some 40,000 years ago, Europe was finally conquered as we previously discussed with the history of the Neanderthals. Some 50,000 years ago, a group of Asians migrated across to form the Australian Aborigines. The actual picture probably is not quite as neat and clean but this is rather brief representation.

Second, there is a discussion about radiocarbon dating, which is our best method for dating fossils less than 30,000 years old. Let's go back in time to 1912. At Piltdown near Sussex a skull had been found in a gravel pit that had a modern braincase and orangutan jaw. This was immediately dubbed the missing link. That is the link missing in the Darwin's biological tree of evolution that shows humans evolved from modern Apes (Darwin actually said old world monkeys). Around the same time, on Oct 10, 1912, there was a speech given at Stanford University on this topic. The speaker was not a scientist. The speaker was Abbas Effendi, commonly known as Abdul-Baha, the son of Bahá'u'lláh, the founder of the Bahá'í Faith. We discussed some of His thoughts on evolution previously. In discussing anatomical evolution He says: "They find that his anatomy has undergone successive changes, finally assuming human form, and that these intermediate forms or changes are like links connected. Between man and the ape, however, there is one link missing, and to the present time scientists have not been able to discover it. The lost link of Darwinian theory... will never be found." ('Abdu'l-Bahá: Promulgation of Universal Peace, pages 358-9)

What a contrast of opinion between scientific community and Religious community! We talked about tests before. This is an example of those tests of faith that the people at that time had to endure. Luckily, in the Bahá'í Faith
Religion and Science are compatible. On this particular issue, it didn't seem to be so until 1953 when scientists using radiocarbon dating proved that the Piltdown skull was a fake. I hope that the rest of this writing has proven His word that between modern man and Ape there will not be a missing link.

The next chapter, the Sorcerer, has a marvelous discussion of the language. With the act of speaking about 100 different muscles (diaphragm, tongue, mouth, back of throat-oropharynx, etc.) have to be coordinated through our nervous system to phonate-produce speech. Jane Goodall (of the Gorilla study fame) is quoted as saying that spoken language is the most important character that differentiates us from lower animals. This is probably the final change that made us human. We went from walking on fours to walking upright. We abandoned the tree life. We developed larger brains. Now we acquired language. The use of language probably produced the social cohesiveness we needed to survive better than other hominids.

The final chapter, "Prometheus Unbound," discussed some general trends in human evolution. An interesting finding is that our body and brain sizes have shrunk about 10% all over the globe over the last 10,000 years. This may correspond to development of farming which began about 10,000 years ago, followed by pottery about 7000 years ago. Agriculture and pottery probably changed the diet of humans such that we relied more on carbohydrates than fat and meat. The typical hunter-gatherer society has a higher percentage of fat in their diet. This change probably brought about the first true cohesion of human society that had cooperation from all members and division of labor. The author then gives a nice humanistic editorial about the problems facing mankind. The problems with racial differences and technology especially deadly ones such as nuclear arms are discussed. Our species has been too successful for its own good. We have gone from 10,000 members about 100,000 years ago to 10,000,000,000 members today. This great Mother Earth can't necessarily keep up with the 3500 calorie per day consumption of all these people forever.

Section 7: Time

It's now time to discuss time. Each biological entity has a general sense of the passage of time. Looking at humans, we have our daily schedules of modern time. We have a broader sense of time in terms of seasons that change each year. We also have a sense of years by seeing the aging process in our cohorts and ourselves. Even though we have a good idea of what time is, there is much to be explored about it. We also share with many animals, diurnal variations of hormones that produce our sleep-wake cycle. The female of many species undergoes seasonal changes in preparation for their reproductive cycle. As one goes further away from the Equator towards either pole, the length of Day changes with significant subsequent changes on the

individual's functioning. Our normal daily activities are under a biological clock in the central nervous system that controls our biorhythms.

The basic building blocks of the world are atoms that bind together in molecules. Each atom has a certain set of particles of electrons, neutrons, and also subatomic particles. The field of particle physics is still in its infancy and probably will provide us with many great discoveries in this century. Suffice it to say, that for the most part, atoms live forever. If an atom is part of the food consumed by an animal and becomes a segment of the animal, it still persists, as an atom even after the animal is no longer alive! In other words, time has no consequence for the atom. Atoms change with time and given enough energy can become heavier. This is how scientists have placed a time of 15-20 billion years for the age of our universe.

Before Albert Einstein, time was considered a constant, never changing factor. We live in a space-time domain. Time is unidirectional; it always moves forward, seemingly outside our control. For objects that move slowly relative to the speed of light (186,000 miles per second; a photon of light will travel around the Earth nearly 8 times in one second) it does in fact seem that time is constant. If you look at objects that are at or near the speed of light, the story takes a strange turn. Time in fact slows down at higher speeds. At the speed of light, time stands still. The photon of light lives forever, since it travels at the speed of light.

When we think of an event, we think of a location and a time. Any event on the surface of the Sun takes 8 minutes to reach us on Earth. In other words, we are totally oblivious to that event for 8 minutes. You may also say that event has not occurred for people on Earth until they can note the event. You may be familiar with the concept of light-year. This is a measure of distance not time. This is the distance that light travels in one year. This is equal to 66,000 times the distance between the Sun and mother Earth. If you can somehow get a mental picture of a light-year, imagine now that many distant stars are several million light-years away! Many astronomers believe that the universe is expanding. Since we are imagining things, let's do one more thing together. Imagine yourself at the edge of the expanding universe. Normally, the empty spaces in between stars and planets are confined by other celestial structures. At the edge of the universe, what are you expanding into?

When it comes to gravity and the theory of relativity, there is nothing more unusual than the black hole. This is an area with gravity so strong that light does not leave it. If light cannot leave it, then no information can be received from within it. We can only tell that a black hole exists because of the rotation of masses of gas and matter into the gravitational field. If you survive your travel through the black hole, you may end up in a different universe with a different space-time existence!

Let's travel back now to the big bang. It seems that a great creation of mass took place about 20 billion years ago. The concept of life and death of stars has been studied for millennia. These studies have given us information about

what occurred after the big bang and the development of stars and planets. But what was there before the big bang? Everything we know or feel intuitively about our world comes from our understanding of space-time of our existence. Think outside the box for a moment. Was there mass before the fateful moment of the Big Bang?

It seems unlikely. Was there time before the creation of our world? It seems unlikely, since time is a creation of the universe of space-time. It was a world of no mass and no time. It is impossible for us to imagine something like that in a clear palpable way. Time is no longer what our ancestors believed it to be.

8. A New Perspective

We have dealt mainly with the facts of the scientific theory so far. We concerned ourselves with whether the theory of evolution in fact fits the scientific data. We looked at the myriad of the problems that are not explained by the theory as commonly understood. In order to gain a new insight into this topic, I will now switch gears and ask you to join me on a journey of a new sort. The traditional religious view of creation has its own group of adherents. In fact, anyone questioning some of these scientific thoughts that have been presented so far, whether based on religious or philosophical viewpoints, will be branded automatically as a creationist. However, there is a new breath of freshness to religious thought since Bahá'u'lláh, founder of Bahá'í Faith, emerged in Persia in mid nineteenth century. He professed that science and Religion are the two wings upon which humanity can soar to new heights. So, even though this short chapter is about a religious figure, I beg your indulgence and hope that you'll stay for the remainder of the ride.

We visited Abdul-Baha briefly previously when we discussed His speech about the missing link. Abdul-Baha, eldest son of Bahá'u'lláh, was asked about the state of the Human Beings and many other topics dealing with interpretation of verses from previous Holy Scriptures. These conversations are recorded by Laura Clifford Barney in the book Some Answered Questions. He deals extensively with issues of spirituality, the element that separates us from animals. I should mention that Abdul-Baha is also referred to as the Center of the Covenant, and was appointed the sole interpreter of His Father's (Bahá'u'lláh's) teachings. He was imprisoned as a youth and did not gain his freedom until the age of 64.

On the issue of evolution and descent of man from animal He said: "all these endless beings which inhabit the world, whether man, animal, vegetable, mineral—whatever they may be—are surely, each one of them, composed of elements... It is confirmed through evidences and proofs that every being universally acts upon other beings, either absolutely or through association. Finally, the perfection of each individual being—that is to say, the perfection which you now see in man or apart from him, with regard to their atoms, members or powers—is due to the composition of the elements, to their measure, to their balance, to the mode of their combination, and to mutual

influence. When all these are gathered together, then man exists." He is actually drawing an even more direct connection between man and the environment. He is going to the basic elemental/atomic level to connect us to the universe. An interesting side note is that He never had the opportunity for higher education and His is an innate knowledge of the world.

He then magnifies his point. "As the perfection of man is entirely due to the composition of the atoms of the elements, to their measure, to the method of their combination, and to the mutual influence and action of the different beings - then, since man was produced ten or a hundred thousand years ago from these earthly elements with the same measure and balance, the same method of combination and mingling, and the same influence of the other beings, exactly the same man existed then as now. This is evident and not worth debating... " ('Abdu'l-Bahá: Some Answered Questions, pages 178-179) Notice how he places the time of existence of man in the 10,000 to 100,000 year time frame. He may have simply said these numbers quite randomly as we all may on occasion. However, I want you to keep these dates in the back of your mind!! Another interesting point is the influence of other beings. We have seen repeatedly how the environment has a profound influence on the organism, or even the cells within the organs of each cell. I suppose one might interpret Him as saying that the proper environment and the proper balance of elements has led to the existence of Man.

"Thus it is evident and confirmed that the development and growth of man on this earth, until he reached his present perfection, resembled the growth and development of the embryo in the womb of the mother: by degrees it passed from condition to condition, from form to form, from one shape to another, for this is according to the requirement of the universal system and Divine Law... And in the same way, man's existence on this earth, from the beginning until it reaches this state, form and condition, necessarily lasts a long time, and goes through many degrees until it reaches this condition." Here He compares the growth and development of the Human Race with same Ontogeny that we alluded to previously. It was not that long ago that the scientists, looking under their newly invented microscope, claimed that they could see a microscopic person within the head of the sperm. It was presumed then that the body was whole and only grew in size in utero. I use this as an example of how far our knowledge has progressed in the last two centuries. Divine Law and Universal system sound pretty synonymous.

The Master, as He was respectfully and affectionately called, goes on to make the most important statement. This is the Crux of the whole issue. This is the answer to the $64,000 question posed some time ago: "But from the beginning of man's existence he is a distinct species. In the same way, the embryo of man in the womb of the mother was at first in a strange form; then this body passes from shape to shape, from state to state, from form to form, until it appears in utmost beauty and perfection. But even when in the womb of the mother and in this strange form, entirely different from his present form and figure, he is the embryo of the superior species, and not of the animal;

his species and essence undergo no change." What exactly is He telling us? Is this just a matter of word play? This is a most interesting comparison that He has chosen to use. Interestingly, both Embryology and Evolutionary science are still incompletely understood, even today. Abdul-Baha does have a terrifically uncanny way with analogies and metaphors. The 6-week embryo that has gills is pregnant with the potential to become human, even though this is not readily apparent if you examine such a specimen. The very basic molecules that went on to produce `life' were pregnant with the potential to produce the Human species. We got an idea of this while working our way through the genetic changes and control mechanisms and how the genetic information lies hid until the proper environmental context/stimuli is present.

Recall that Charles Darwin never told us the origin of the species. We discussed the biological way of separating the species based upon reproductive receptivity. There are a lot of pieces missing from that puzzle. Let's go back to our great source: "let us suppose that there was a time when some animals, or even man, possessed some members which have now disappeared; this is not a sufficient proof of the change and evolution of the species. For man, from the beginning of the embryonic period till he reaches the degree of maturity, goes through different forms and appearances. His aspect, his form, his appearance and color change; he passes from one form to another, and from one appearance to another. Nevertheless, from the beginning of the embryonic period he is of the species of man - that is to say, an embryo of a man and not of an animal; but this is not at first apparent, but later it becomes visible and evident. For example, let us suppose that man once resembled the animal, and that now he has progressed and changed. Supposing this to be true, it is still not a proof of the change of species."

" We will state it more clearly. Let us suppose that there was a time when man walked on his hands and feet, or had a tail; this change and alteration is like that of the fetus in the womb of the mother. Although it changes in all ways, and grows and develops until it reaches the perfect form, from the beginning it is a special species.... To recapitulate: as man in the womb of the mother passes from form to form, from shape to shape, changes and develops, and is still the human species from the beginning of the embryonic period - in the same way man, from the beginning of his existence in the matrix of the world, is also a distinct species - that is, man - and has gradually evolved from one form to another. Therefore, this change of appearance, this evolution of members, this development and growth, even though we admit the reality of growth and progress, (if we admit that had formerly been a quadruped) does not prevent the species from being original. Man from the beginning was in this perfect form and composition, and possessed capacity and aptitude for acquiring material and spiritual perfections... " ('Abdu'l-Bahá: Some Answered Questions, pages 191-194) This is a grand statement made a long time ago, long before knowledge of genetics had progressed this far. What is being proposed is that anatomical changes at the level of form, which is visible, does not provide any proof. Abdul-Baha is

saying that the Darwinian theory is incomplete. Quite an amazing fellow, this Abdul-Baha.

The human species is original. All other species are as well.
The blue print of future humans has been present for billions of years within the matrix of the biological genome. When the necessary and appropriate environmental stimuli have transpired and the biochemical constraints have been satisfied, the species becomes evident. The genetic programming is what allows this terrific transformation to take place. This programming is directed like a vector.

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GLOSSARY:

AdaptationAbility to survive in a new setting.

Amino AcidBuilding blocks of Proteins.

ArdipithecusGround Ape.

ArthropodThe Phylum that includes insects and Arachnids (Spiders).

AustralopithecusSouthern Ape.

Bipedalismability to walk on two limbs.

CalciteThe crystal form of Calcium Carbonate, the constituent of Marble.

CambrianA Geological epoch from 600 to 500 million years ago.

CellThe building blocks of an Organ.

CenozoicMore modern Geological time from 63 million years ago till now.

ChromosomeA segment of nucleus that contains certain genes. We have 46 chromosomes.

CovenantA contract.

CretaceousA Geological epoch from 130 to 65 million years ago.

DevonianA Geological epoch from 400 to 350 million years ago.

DexterousAble to use hands

DiurnalThe usual biological variation within a 24-hour day.

DNADeoxyribo Nucleic Acid, genetic vocabulary.

DogmaA scientific truth believed by a presumed majority

DomesticationThe process by which plants or animals are taken out of their own `wild' environment and raised in man-made environment.

EnzymeA protein that increases the rate of a biochemical reaction.

EukaryoteA cell containing a nucleus.

FamiliesA group in the classification system that contains many Genera.

FertilizationThe process by which the female egg accepts a sperm and therefore acquires a full set of genes. The first step in production of pregnancy.

FetishismThe belief in magical powers of certain objects by primitive cultures.

FossilThe remains of animals that are preserved by Geological processes.

GeneThe information within each cell that has the programming for function.

GeneraPlural of Genus.

GenomeThe total collection of the genes in a living organism.

GenusA group in the classification system that includes many similar Species.

GeologyThe study of different layers of the Earth.

Geometric rateA rate that is not linear and keeps accelerating; Over time the difference between these two types of growth can be very high.

Glacial Agesee Pleistocene

GracileLightly built

HomoHuman like animal.

HybridismThe production of `Hybrid" plants by attaching different plants, such that the new plants have characteristics of both plants.

HypothesisA theory or statement put forth to explain a finding.

Hypertrophygrowth.

InstinctBehavior that is performed, presumptively, without conscious forethought.

IrisThe structure in the eye that

changes its size to adjust the amount

JurassicA Geological epoch from 180 to 135 million years ago.

KingdomThe largest classification category that includes many Phyla.

LarynxOrgan of speech; Adam's apple.

MammalsThe classification group of Animals that are vertebrate, and warm-blooded. The females generally have milk glands (Breasts) referred to as Mammae

MesozoicA Geological epoch from 230 to 65 million years ago

MitochondriaA small organelle within each cell that is the energy center.

Newton's LawsThese laws described and explained force, motion and Gravity. They explained very well the celestial movements but were later made more complete by Einstein's laws.

NucleusThe central core of each cell that contains most of the genes.

OrderA group in the classification scheme that contains many families.

OrographyStudy of topography; Study of elevations of the land.

Photo-Light.

Photo-receptorAnything that receives light.

PhylaPlural of Phylum

PhylumA group in the classification system that includes many classes.

PlacentaThe organ that allows communication of blood from mother to fetus in the uterus; also, referred to as Afterbirth.

PleistoceneGeological epoch 2 million years ago till about 11000 years ago.

PolytheismThe belief in multiple Gods.

Pre-CambrianA geological epoch more

than 600 million years ago.

Primatebiological order that includes Monkeys, Ape, and man.

PrometheusA Titan who gave man `Fire' according to Greek mythology.

ReptileA group of cold-blooded Animals including the Snakes.

Reptilianof or related to the Reptile.

RobustHeavily built.

SpeciesA group of organisms that are similar and can interbreed.

SterilityInability to further reproduce or have offspring.

SuperClassA group not large enough to be a Phylum but too large to be a class.

TadpoleThe first stage in development of the frog that occurs underwater.

TaxonomyA system of classification for living organisms.

TrilobiteA member of now extinct marine arthropod.

VarietiesDifferent forms within a Species that are quite different, yet fall under the same general category as species.

VectorA Mathematical entity symbolized by an arrow, representing direction of a force.

Appendices

1. Summary of chapter on Photosynthesis

2. Summary of chapter on Glycolysis—Production of Energy

3. Summary of chapter on Citric Acid cycle—Conversion of fuel into Energy

4. Geologic time scale

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