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The Great Debate
Evolution vs. Creationism

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ABSTRACT (100-200 WORDS):

Should we believe that life was created, or that it evolved over millions of years? Evolution is the fundamental principal of all of Biology, and although it has a wealth of information in its favor there are still many skeptics that fail to recognize its credibility. The purpose of my thesis is to present this evidence in a logical order, so that a creationist that doesn't believe evolution exists, may at least consider it as an explanation of the development of life on earth. I'm not attacking religion, just exploring alternative answers. By examining testimonies and arguments on both sides of the issue, I have concluded that this debate will continue for a long time to come, with no definitive answers in sight...

Many great debates have come up and gone throughout the history of man and civilization, but most of these debates have died out over time as a result of greater knowledge and understanding through technology, observation, and experimentation. This is not the case, however, of one such issue: Evolution vs. Creationism. Not only has the debate been a long battle in the scientific and religious communities, but it seems to just be picking up steam as we roll into the new millennium, with no clear answers as to who is right and who is wrong. Or is there? The issue has seemed to reach its present dichotomy of us (the evolutionists) against them (the creationists); the good guys vs. the bad guys if you will...And trust me when I say that we are not the good guys. Nonetheless, in any proper platform of debate, it should be known that both respective sides of the issue should clearly advocate of side of the dispute, but more importantly strive to understand the complexity, motives, arguments, and range of beliefs of your adversaries. Both scientists and educators must give a clear and usually uncompromising response to the attempts of the creationist community, either to eliminate the teaching of evolution in schools or implement the oxymoronic alternative that they call "creation science", which is not science at all, but merely a feeble attempt to answer many of the fundamental questions of science through religious doctrine. Just simply eliminating the concept of evolution from the educational curriculum would devastate the very integrity of our educational system fro two major reasons:

Science doesn't strive for unattainable certainty, but the mechanisms that govern evolution are as well confirmed as any other major discovery of science, such as the origin of the solar system or the table of periodic elements. More importantly to the scientific community is that evolution is regarded as the heart and soul of the biological

sciences, and not some insignificant hypothesis that can be thrown into the wayside in the name of educational peace. For scientists and educators to do this would stand against everything that they represent. Whether it is practical reasons of comfort or simple diplomacy, the biological community cannot afford to not teach the most important and highly confirmed concept of their chosen subject.

Allowing the concept of the so-called "creation science" as a replacement for evolution within the public schools would be a disaster. You cannot implement the ideas of a religious minority into the scientific parameters set forth in science, much less biology just based on the simple fact that their conclusions are often not based on scientific inquiries rather than the opinions of a few. Even if you allowed this to happen, you would still only be using the minority of religious views of most Americans, without being inclusive of the views of all religions. This wouldn't be right either. Therefore, if creationism was taught in the school system, not only would students receive a poor biological background with misinformation and poor evidence, but they would also fail to recognize the important processes and mechanisms that are important in governing the procedures and norms followed by the entire scientific discipline. The biological community has done extremely well in defending their position against the creationist movement, winning almost every legal battle on the basis of First Amendment grounds. However, the creationist movement comes in many flavors, and many of the evolution/creationist controverseries are being won by the creationists in smaller forums on an individual by individual basis. Therefore, the only way to defend against this on a individual by individual basis. Being able to successfully defend evolution to a creationist is to win a small victory in the name of science. The purpose of this paper is

not to badmouth religion, doctrine, or the beliefs shared by many people as to the foundation of our existence. I simply want to share the idea of evolution with the intent of defending it against a creationist adversary. I believe in evolution in much the same way as a theologian believes in the bible. Saying that you are an advocate of evolution doesn't mean that you don't believe in God, it just states that you have conflicting opinions as to how we came to be as we are today. The debate should not be looked at as religion vs. science, because the two cannot stand in genuine opposition of each other, which many people often try to do. Each discipline attacks a vital endeavor of our existence, with science looking at discovering the character of nature and religion focusing on the exploration of our lives as to its meaning and purpose, through moral discussion. Another point that should be made is that many evolutionists and biologists are devoutly religious in their personal lives, and many theologians accept evolution with no negative bearing on the religious inquiry. The separation that exists between science and religion is important to understand if one wishes to fairly debate the issue of evolution vs. creationism. Stephen Jay Gould, who is a professor at the University of Harvard in the department of zoology states that, "This battle must be won, but we cannot prevail or at least not prevail honorably unless we meet our creationist questioners by grappling with their diversity of arguments, and with the respect for the sincere and important reasons behind their misunderstanding of material they properly belongs within the domain of science, and cannot threaten the essence of religion." This means that the best way to defend evolution is to define it and carefully demonstrate how the data presented by many creationists is incorrectly interpreted by using biological data to counteract their arguments.

"There is a war going on in society-a very real battle...but we must wake up to the fact that, at the foundational level, it's really creation versus evolution." This was said by Ken Ham, the Executive Director of Answers in Genesis, and is a common view shared by many creationists across the country. They believe that evolution and salvation are mutually exclusive concepts. They also believe that the teaching of evolution goes against truth, salvation, and morality, but most importantly that it goes directly against God. The reality of the whole situation is that many teachers are faced with resistance when they attempt to teach evolution in the classroom, as if they were the enemy and our directly defying God. One of the major problems that teachers often have when teaching evolution is that they don't introduce the creationist points of view that supposedly parallel the evidence that supports evolution. This causes many creationists to feel that they are not getting a fair shake, which causes them to lash out at the science community. With the evolution versus creation debate comes great emotion and seriousness, which can not be found even in the greatest of academic controversaries and thinking that a quick solution to the growing controversy can be reached by simple standard academic methods, is a gross underestimation of the differences of the two sides. Attacks on evolution for decades existed in the courts with anti-evolutionary forces attempting to persuade the courts to keep evolution out of the classrooms, but these efforts were not very successful and they have now shifted their resources in order to create a war within science classrooms. By focusing on more student-centered fronts, creationists are encouraging students to engage in fighting evolution education in their schools. Various spokesmen and advocates of creationism have published books that verbally bash the idea of evolution as more or less evil-ution. In one such popular book, readers are told the

following: "Think about it like this: Imagine being in a war and all you know how to do is throw rocks. Your enemy, on the other hand, has rockets and nuclear bombs...In real-life; the Devil is the enemy of mankind. He wants as many people as possible to be deceived and die without knowing about Jesus and without being forgiven for their sins. That way, he keeps people from going to heaven. Evolution is one of his biggest bombs." This is a common view sadly among many creationists around the country, and currently there is no other science that is taught in public schools whose opponents use more war metaphors than the subject of evolution. Moreover, no other science has opponents increasingly focused on recruiting students to their cause. The creationist organization Answers in Genesis has helped seed vast numbers of school creationist clubs by providing start up information and ongoing resource support, through Internet Links and various Web sites. One point will sum up the importance and seriousness that creationists bring to the issue. Many teachers and people in the science community think that there is no need to be concerned about creationists, because their ideas are harmless. The reality is, however, that Anti-evolutionists are well organize, well funded, and numerous enough to cause significant harm. Additionally, anti-evolutionists have large audiences, and, of most direct importance to science instructors, they believe that they are at war with those who teach evolution.

So what is the motivation of these people, and why do they so strongly detest the version of events given in the Bible. These leaders are convinced that the Bible indicates clearly that the diversity of life on earth is not a product of evolution, regardless of whether God controlled the evolution. They understand the Bible to plainly report that God created Adam and Eve in pretty much the same form as humans exist today; they did

not evolve from any lower forms of life. Recent Gallup polls have even reported that 33% of American adults believe that the Bible is the actual word of God, and should be taken literally word for word. These creationist leaders also believe that the Bible is the one-and-only truth, and when they read the accounts in the Bible, they read them as historical truths, rarely as metaphors. To them, the narratives in the Bible are not the same as those in any other books ever known to exist. The Biblical records report the most important aspects of humans' lives—where we came from, why we are here, and where we are going after we die. The biblical records also tell us how we should live our lives, how we should view the laws of the land, and what our relationships should be with our parents, spouses, children, and non-relatives. Many noncreationist Christians, of course, think that there are many truths to be learned and believed from the pages of the Bible. But peculiar to the creationists is their strong belief that humans are not a product of evolution, but instead are special and were created in the image of God. The emotional ties to these beliefs are most likely. the root of the aggressive stance that creationists often take. These beliefs have to do with knowing that the Creator of the universe loves them, and that they are absolutes. If they successfully pass God's judgment, there will be a pleasant life after death and they will potentially see loved ones again who have died. To the creationists, the accuracy of creationism is fundamental to many, if not all, of these beliefs. John Morris, a well known creationist leader says, "If evolution is right, if the earth is old, if fossils date from before man's sin, then Christianity is wrong!" Evolution is wrong to creationists, because it is not in the Bible. If the Bible, described evolution as the origin of man, then we wouldn't even be having this discussion right now, but it doesn't. We believe, as humans, that we were created

special so we have a hard time believing that we evolved. The literal interpretation of the Bible is what causes many people, not to even give evolution a second look. The problem is that the Bible is allegorical; it is a guide that we can use to live a moral and good life. It should not be used to explain historical events pertaining to the earth and development of life. Evolution is a scape-goat for the creationist movement. Many of its adversaries suggest that the teaching of evolution causes social problems, but this doesn't any sense. If evolution directly causes social problems, then that would mean that social problems could not have preexisted evolution, which is a fairly new concept as far as the history of man-kind goes. Clearly, however, this is a ridiculous statement, because man has dealt with numerous social problems long before the mechanisms of evolution came to be. As I stated earlier, though, you need to understand where the creationists are coming from, and why they have such strong feelings against the teachings of evolution. They recognize evolution as a great falsehood, much like a teacher who was to teach that some races are inferior to others, or that people with AIDS deserve to die. Yes, this may sound a little extreme, but to many people evolution is a godless falsehood. The emotional connectedness of creation in our lives is far more satisfying to many people than evolution and thus, its teachings may be met with great resistance. Consider, for example, how incredibly motivating songs are to people. The great patriotic songs that we sing in times of war that bring us together, which make us feel that our side is more virtuous then the enemy. In much the same way, the effect of growing up singing songs in church can leave the same long lasting impression in us. So, in the classroom when science instructors present evolution, they are not only posing an academic challenge to their students, but also an emotional challenge to the creationist ideas that have been

planted in their minds through various sources, including the powerful medium of song. Maybe if we sang songs about evolution from an early age, then we would feel just as strongly.

The unbelievable battle that is being fought in the classrooms and in other platforms, such as courts and churches has led many creationists to adopt different techniques and new strategies when attacking the evolutionist's point of view. Most creationists don't hesitate to point out that there are some practicing scientists that are creationists. This isn't a lie, because there are some scientists that don't necessarily believe in the mechanisms that govern evolution. A few of these scientists even hold positions at well regarded academic institutions and research universities. The primary reason that creationists have chosen to bring this point into the light, is so they can develop credibility in the scientific community by noting that they have scientists on their side too. However, there have not been any creationist articles published in journals on the matter of attacking the validity of evolution. When creationists here this fact they immediately retaliate and say that the scientific community doesn't want to hear evidence that may discredit evolution. Again this is not true. Many scientists with creationist points of view have been published in the fields of biochemistry, biology, and physics in reputable journals. Creationists seem to think, however, if one of their colleagues publishes a standard scientific journal article concerning human anatomy, having no explicit anti-evolution relevance, that they all of sudden have great arguments for why evolution is impossible. The attribute their lack of recognition by reputable journals to anti-creationist bigotry within the scientific community, and the scientific community has ultimate control over the journals. The bottom line on this issue is the reason that they

are not publishing articles with evidence against evolution is they don't have any strong data to support their claims to begin with. A simple counter to these arguments of bigotry and biases with the scientific community lies within a history lesson of sorts. Hundreds of years ago publications in science were much more creationistic than evolutionary, but as time passed, the articles in the journals became more evolutionary to the point that they are at today where it is nearly impossible to find a standard scientific journal article that challenges evolution. The reasons for this shift in the scientific community are a result of a couple reasons. 1) Generations of scientists have compiled an overwhelming amount of evidence leading them to conclude that evolution is scientifically tenable and creationism is not. 2) Another reason is that the scientific community has changed its views on its fundamental principals of science. Scientists today now use Methodological naturalism as their governing structure. Methodological naturalism means that scientists use methods that pursue natural causes of phenomena rather than supernatural causes. The response to this by creationist leaders is that they openly allege that evolution did not gain its status as the scientific theory for life's diversity through rational scientific exploration of the data over the years, but rather that evolution has become fundamental to the life sciences for religious reason. As outrageous as this may sound, these creationist leaders believe that the rise of evolutionary theory and the decline of creationist convictions in science is primarily the result of one long war waged by God against the scientific community! Creationists are not going as far to claim that scientists are all involved together in a massive conspiracy to somehow overthrow the creationist movement, rather they are more likely than others to accept a worldview-one in which natural forces in the world cause things to occur.

Creationists believe that holding a naturalistic worldview is a sin, because the idea of naturalism removes God from activities of specially creating planets, stars, organisms, and humans as we see them today. They suggest that the reason the scientists arrive at their conclusions of evolution, is because of the simple fact that they possess and exercise this naturalistic view. The error that the creationists make by using this type of logic in their defense is the fact that many scientists who have provided data for the good of evolution and for furthering its credibility within the scientific community also believe in God, and our devout Christians. Polls have shown that 40% of scientists also believe in a Personal God, and this statistic has been fairly constant for the last 100 years. It is obvious to me that these scientists find no conflicts between their scientific work and their religion. Many of these scientists have a wide variety of beliefs that pertain to God and evolution. Some think that God controls every step of the evolutionary process, while others feel that the true randomness of evolution is by God's choice. The literal creationists attack these scientists who believe in God and evolution as Christians that are falling short of Christian's standards, just because they advocate evolution as being accurate.

When it comes to literalist beliefs concerning science and the Bible, literalists hold the belief that the Bible is inerrant. Henry Morris, a leader in the creationist field, states "We can be confident that the scientific data will correlate with Scripture all right, because the same God who wrote the Word made the world!" Then how do the creationists defend themselves against the overwhelming scientific data that clearly doesn't correlate with the readings of the Bible. Well there approach to these arguments is fairly easy. Literalists of the Bible believe that the scientists' conclusions must be inaccurate

whenever they don't concur with the Bible as to the cause of the phenomenon being examined. Creationists refer to this literal interpretation of the Bible as "good science" or "true science". Professional creationists contend that it is the science instructors who teach evolution who are the ones who do not understand the true methods and facts of science and, therefore, must be further educated. Further educated by whom you may ask? By the creationists of course....

Although people trying to introduce creationism into science generally try doing so through what they feel is a "scientific" approach, their underlying motivation is invariably religious. Many people feel that in addition to this many creationists are simply trying to replace the teaching of evolution in the classroom with creationism and inject their religious doctrine. They want to counter the so called "bad" science, and teach what they feel is the "good science". However, the surface arguments that creationists put forward are not good science, in fact, their not usually science at all and can usually be examined to have many scientific inaccuracies. Because many people believe that life arose on earth by one of two processes, evolution or creation. Because of this dichotomy, creationists often present arguments against evolution in the hopes of demonstrating to others that life has therefore come to be by creation. Some of these creationist arguments include:

1) Biological life could not have developed from the inanimate via natural processes.
2) The diversity of life we see today could not have evolved from lower life forms.
3) No evolution can occur beyond, the phylogenic level of family.
4) Humans did not evolve from lower animals and, since their creation, have always possessed all the characteristics of humans today.

5) The earth and the universe are not billions of years old but rather 10,000 years old or less.

6) Most sedimentary rocks containing fossils are the result of a global flood occurring less than 10,000 years ago.

7) All organisms when they were originally supernaturally created were created perfectly and over time have experienced physical degeneration.

While most creationists contend that their only two positions to this issue, evolution and creation, they are always demanding fairness of equal time in the classroom where religion doesn't belong anyway. But let us just say that they are right for a minute. Well then instead of always attacking evolution as a bad science, then the creationists must do more than disconfirm evolution in order to have their position accepted by the scientific community. If creationists want to have equal time in the science classroom, then alternative explanations would need to have equal time in the classroom as well. For example, there is a movement known as the Raelian movement which by some estimates has over 50,000 followers. Their position is nor creationism or evolution. They basically believe that a nonsupernatural extraterrestrial intelligent designer has run a long term experiment to create life on earth. This is where the irony in the creationist arguments lies. Although it is fair to say that the creationists are not satisfied with evolution being taught in the classroom, they would probably also not accept the teaching of the Raelian beliefs either. So, where is the fairness, which they so vividly talk about! Creationists are quick to change the topic when faced with this so called argument, because they know if they allowed this discipline to be allowed its fair time, then it would ultimately be even more offensive to them, then evolution is now.

In order to properly defend evolution, you need to be able to effectively answer some of the common questions of creationists. One very common question asked is, "What do you mean by evolution?" Very often creationists are asking this question, not seeking a technical answer, such as hereditary characteristics of a group of organisms or descent with modification of different lineages from common ancestors. They are usually trying to discern whether or not you mean that a great variety of organisms living today descended from a common ancestor. Many times creationists are also asking this question, because they want to make sure that you are not speaking about horizontal evolution. Horizontal evolution is the belief that organisms can very within their supernaturally created "kinds". This idea is accepted in the creationist views. For example, dogs may have changed into the various breeds of today. However, changes that occur beyond the phylogenic level of family, is not accepted by the creationists and is often referred to as vertical evolution, which they contend has never occurred. People who hold these types of doctrines often want to know whether your meaning of evolution is synonymous with, or at least compatible with, their meaning of evolution. I guess this question can be regarded as the litmus test, to see if you are knowledgeable about evolution. Another common question asked by the lay creationist is, "If organisms evolved, then why do they look so well designed." This is an extremely good question and is one of the most common questions asked by creationists. To most people the organisms on our planet appear to operate extremely well, so well in fact, that it seems absurd to them that somebody would even put forward evolution to explain what seems to be so clearly designed. The approach that should be taken, in order to, defend evolution is to explain how something familiar could appear to have been designed for

the current use, but, in fact, may not have been. The following example is a good way of thinking about how this could be true: Let's say that you're in a first aid class and your learning how to treat a person with a blocked airway. After exhausting a list of possible ways to clear the airway, the instructor taught the class a technique that was of last resort- the tracheotomy. By using a Bic pen, a person can use the hollow body of the pen to get air to the person in need. Now let us just say that someone from an African tribe, who has never seen a pen before, observed you doing this. To put it simply, the person from the African tribe might reason that the pen's use as an emergency airway was the primary reason for its design because it worked so well for this purpose. By using these kinds of silly examples it can be easy to explain a more complex answer. Another way that you might counter a question of intelligent design is with evolution via natural selection. Many people asking questions about evolution are often unaware of counterexamples. Much evidence present in the fossil record suggests that the average length of time a species survives after its first appearance is relatively short when you look at it from a geological standpoint and the age of the earth. Whether you are talking about mammals, insects, or even marine invertebrates, the average existence then extinction is usually only a couple of million years. In simple terms, things aren't perfectly designed by a creator. If they were, then everything that ever lived would still be alive, and that is not the case. Yet, another popular question asked by creationists is, "since scientists don't know every detail about how evolution occurs, then shouldn't they at least consider supernatural causes as alternative possibilities." The answer is a big NO. Just because we currently may not have a scientific explanation for every aspect of every phenomenon does not therefore require that we invoke supernatural causes and teach them as science.

Scientific explanations are different from religious explanations, and many highly religious scientists have no problems conducting their scientific research while maintaining their religious background of worship. Even scientists that believe that God may be involved with the processes of evolution still make the distinction between scientific explanations and religious explanations. I think that one of the major issues that face biologists is that when they are defending evolution to the creationist community that they are not speaking in the same language that the creationists are. This may sound strange. I don't mean different languages as in English or Spanish, but rather a different language as in the way that they define things. You can't hope to defend evolution effectively if you are not defining terms in the same way that your opposition is, and if you indeed do define them differently, you need to let them know how you are defining things so they understand you. The American public is generally biologically illiterate, so many of the misconceptions about evolution are spurned from their lack of biological knowledge. It would be the same as someone preaching about the Bible, if they never read it. Where is their credibility? I have talked about creation and some of the creationist views as I understand them. I am not saying that they are wrong and I am right, I just want to respond to their arguments with counter-arguments of my own. My hope is that they give evolution a fair shake, like I have given creationism a fair shake.

When looking at evolution, you need to first look at science in general, because there are certain things that you need to define about the discipline of science. One of the number one rules of science is that you need to know that science does not use three words: fact, true, and prove....

Scientists do not gather facts, they gather data. A fact is a single repeatable observation, science doesn't deal with facts it deals with data. Science cannot defend facts, but science can defend data. For data to be significant, it has to be substantiated and correlate with other data. They use this data to make generalizations. Scientists use these generalizations to predict the future, but there is always the probability that data exists to falsify their generalizations. In order for something to be a fact, in science, you need to observe it in every instance that there has ever been, every instance now, and every instance that there will ever be, and that is just not possible. Einstein said it best when he said, "a thousand experiments can't prove me true, but one can prove me wrong." This is why we can't use true, in science, because nothing is invariably true. Yes, some things are true. In mathematics for example, 1+1 is 2 that is a fact, it is a tautology. A tautology is a statement that is true by definition alone; it is a sure thing with a probability of 1. Now saying that all men are mortal, as crazy as it sounds does not have a probability of 1, because you would need to know that every man that ever lived was mortal, every man that lives now is mortal, and every man that will ever live will be mortal. The probability is close to 1, but it is not quite 1. Religion has moral truths, which are not literally true. This is a good example right away of how the two separate disciplines define truth differently. This is why they should be kept separate. They deal and define separate issues in separate ways. Another important aspect of science is where do scientific theories come from in the first place? To easily understand this, I will use a simple example. When you walk into a bedroom and flick on the light switch and nothing happens, chances are that you flick the switch on and off a couple of times. Even though that you may not be conscious of doing so, you have just performed

a hypothesis that the switch isn't working, and an experiment by trying the switch a couple of times. You then reject the hypothesis that the switch isn't working and replace it with the hypothesis that it isn't the switch that is bad, but it is the bulb that isn't working. If you replace the bulb and it lights up then you have confirmed the "bad bulb" hypothesis, but if it doesn't then you check the fuse box or circuit breaker. We use these logical, sequences of steps many times each day without thinking about the process. Scientists use these steps in much the same way. This process is invariably termed the scientific method. The vast body of knowledge that we call science proceeds via the scientific method. The fact of the matter is that there is no domain of human knowledge or endeavor that is more open to scrutiny than science; it is in the very nature of science that it be honest, fair, and ready at all times to admit its errors and revise its theories. The scientific method involves the observation of phenomena or events in the real world, the statement of a problem, some reflection and deduction on the observed facts and the possible causes and effects, the formation of a hypothesis, the testing of the hypothesis, and when tests repeatedly confirm the hypothesis; the formation of a theory. The theory of evolution has been developed and refined by thousands of biologists over more than a century. It has helped us to provide predictions that have survived repeated testing. Therefore a scientific theory such as evolution is much more than just an array of logical propositions, but rather a collection of evidence, that has explanatory power, in describing some part of the real world.

The steps of the scientific method, established long before Darwin, were followed very carefully in the development of evolutionary theory. There have been many ideas related to biological evolution, but the only one to survive the test of time was proposed

by the English naturalists Charles Darwin and Alfred Russel Wallace in separate papers before the Linnean Society in London in 1858. In 1859, Darwin published *On Origin of Species*, in which he not only elaborated the theory of evolution, but also proposed a mechanism by which it could work. Today the theory of evolution forms the foundation of the biological sciences and their applied sub disciplines of medicine and agriculture, by providing the conceptual framework for both experimentation and prediction. Darwin noticed that many animals and plants produced many more offspring than actually survived. The oceans are full of larvae of thousands of organisms that never reach maturity. Thus, the reproductive capacity of organisms greatly exceeds any actual population size. In addition to this concept, Darwin also noticed that no two individuals of a species, other than identical twins, are alike. This demonstrates that there is extreme variation in nature. Darwin therefore reasoned that there is competition for survival whether it is for mates, food, shelter and other resources. The variation that exists in nature results in favorable traits tending to be preserved and unfavorable traits tending to die out. He called this process natural selection. The consequence of natural selection is biological evolution, which Darwin termed "descent with modification." More then a century later, the definition that Darwin laid forth on evolution is still considered a good description. Darwin had no knowledge of genetics or the fossil record, which was just beginning to be understood, so the fact that he arrived at the conclusions that he did without any knowledge of genetics or the fossil record is quite remarkable since it is still essentially the view that science has today. In today's terminology the relationship between natural selection and evolution is as follows. Some variants may be better adapted to their environment than others of their sort, and will therefore tend to survive to

maturity and to leave more offspring than will organisms with less favorable variations. This is referred to as differential reproduction of genetic variants and is the modern definition of natural selection. It results in a change in the gene frequency over time within a population. There are more of some genes and fewer of others. To sum it up, evolution is a change in gene frequency brought about by natural selection and other processes acting upon variations produced by sexual reproduction, mutation, and other mechanisms. The environment is therefore the overall selecting agent, because as the environment changes over time, different variations will be selected under different environmental conditions.

Natural selection is reflected particularly in adaptation, and although it the major source of evolutionary change, it is not the only one. Darwin was aware of these other forces besides natural selection that are involved with descent with modification. Evolutionary change is typically driven by environmental forces, but it may also be random or neutral. For example, let us say that there is a population of snails. Some are light snails and some are dark snails. A hurricane blows one of the light snails far away to an island, and the particular species of snail is hermaphroditic. This one snail may eventually produce a whole population of white snails, with a gene frequency that is quite different then the original population, due to the founder principle. This is a process by which some genes may be lost, and some formerly scarce genes may be common in the new population. It is a result of sheer chance, not natural selection, but evolution still occurs as we have seen in small, newly established populations of animals such as many of the animals on the well-known Galapagos Islands.

Genetic drift is a similar phenomenon that results in the random loss of alleles. In a small population, certain genes, perhaps including favorable ones, can be eliminated by the accidental death of their carriers, before they have reproduced. This sort of change in gene frequency is not a result of natural selection. For example, the only two toads with novel skin pigmentation in a population of drab individuals may be squashed by a beer truck while crossing the street at night. Their death is not related to the survival value of their genes for novel skin pigmentation; it is just bad luck, not natural selection.

Another mechanism of nonadaptive evolution is mutation pressure, which involves a change of gene frequency due to the more frequent occurrence of a mutation than its corresponding back mutation. Even mildly harmful mutations that are ordinarily removed by natural selection can become established in a population if they arise at a rate faster than natural selection can remove than. These nonadaptive sources of evolution demonstrate that Darwin did not have the last word evolution. Darwin may not have known much about these concepts, but he did point us in the right direction. It is the process of evolution, led in part by natural selection and in part by the various nonadaptive causes of gene-frequency change that I mentioned earlier, that has produced the diversity of life on Earth. Evolution is real, is it so hard to believe. For example, consider the great variety of dog breeds, livestock, and strains of crops. In all of these cases, humans have helped to direct evolution. Nature does the same thing, only much more slowly. Somewhere in the range of millions of years is a good approximation.

So where is the evidence of evolution? Evolution has produced 2 million species of microbial, plant, and animal species that we have named and thirty times as many species that we haven't named. The fundamental unity of this great diversity of life lies in the

fact that virtually all organisms carry their genetic information on the DNA molecule. The only reasonable explanation for this is that all organisms come from a common descent. DNA isn't the only structures that show remarkable similarities in all organisms. The same 20 amino acids compose the proteins of all living organisms, and other various metabolic pathways such as the Krebs Cycle and the cytochrome system are universal in a wide variety of plants and animals. These and other common threads among living things are completely consistent with a theory of descent with modification

Comparative immunology can also be used to show evolutionary relationships. For example, the fluid portion of the blood called the serum in each species of animals contains its own set of proteins. If you were to inject human serum into a rabbit, than the rabbit would form antibodies to attack the foreign proteins. What this tells us is that species that are more closely related share many of the same serum proteins. This is evident in the fact that humans have similar serum proteins to the great apes, followed by the Old World Monkeys and the New World Monkeys. Since protein formation is under direct genetic control, many genes are apparently shared by humans and the great apes. In fact, we share with chimpanzees and gorillas about 99 percent of the genes that code for proteins. Other primates share fewer of these genes with us, and if you were to test other organisms such as turtles, frogs, dogs, and chickens, you would see that they share progressively less genetic similarities with humans. Taxonomists use this technique to show immunological distances and relationships and thereby help to place organisms in a hierarchical arrangement that corresponds with the way we evolved through time. Evidence of similar relationships can be seen in the hemoglobin of humans when compared with chimpanzees and gorillas. Out of 141 possible amino acids that make up

hemoglobin, humans show the identical sequence except for one amino acid difference, when compared to the sequence present in the gorilla. The possibility of this being coincidental is not likely.

The relationship inferred from these biochemical and immunological techniques agree very nicely with relationships based on morphology, which in the past was almost all that taxonomists had to classify organisms. Shared similarities and differences are, in fact, the classification of plants and animals. The reason for the similarities and differences is that some organisms are more closely related to each other by descent than others are. For example, the forelimbs of frogs, crocodiles, birds, bats, horses, whales, and humans show essentially the same bony structures, relationship of parts, and embryological development. They are similar in all these ways because they derive from the same ancestral prototype, which has been modified by natural selection over millions of years for different functions in different environments. The terrestrial vertebrates are in fact all derived from lobe-finned fishes that had the same arrangement of limb bones as the land animals do. Other morphological evidence for evolution is presented by vestigial organs in animals. These are structures that were well developed and useful in ancestral species but are reduced or almost eliminated in importance and size in the more recently derived species. For example, traces of hind limbs exist in whales and primitive snakes such as pythons and boas. These vestigial structures surely have no value to the whales or snakes and further support the evolutionary explanation that whales evolved from terrestrial mammals and snakes from lizards. The creationists' notion that whales and snakes were individually created by God, therefore presumably complete with their useless vestigial organs, is not testable and explains nothing. Humans, too, have numerous vestigial

organs, such as tail vertebrate, ear-wiggling muscles, appendix, wisdom teeth, and a third eyelid. At one time these structures may have had an advantage to our ancestors, but through natural selection and descent with modification, they are no longer useful to us. Evolution has occurred.

Comparative embryology is another field of study that reflects evidence for evolution. There are many features that are present in embryology among organisms that are related. Therefore it can be observed that the more related that animals are, than the more similarities that can be seen in there embryonic development. For example, all the vertebrates have remarkably similar structures early on in embryonic development. Even though vertebrates such as reptiles, birds, and mammals do not breathe through gill openings, they still go through the gill-slit stage during embryonic development just like fish do. How would creation explain this? The fact is that the process of evolution is a perfect model of how something like this could take place. Many of the higher vertebrates, such as humans, for example have the same genes as fish do; the only difference is that in humans these genes are turned off during the early stages of development to adult. Another example of this is in baleen whales, which eat plankton, and lack teeth as adults. However, there embryos still contain rudiments of teeth, which suggests that somewhere in the history of whales, the baleen whales branched off and evolved from the toothed whales. Teeth are also present in some species of birds, and since many people feel that birds evolved from reptiles, the presence of teeth in birds makes perfect sense. The fossil record concurs with this data as many fossils have been discovered that are clearly intermediates between reptiles and birds. Even reptilian like mammals in the fossil record demonstrate how certain bones in the reptilian jaw evolved

into the hammer and the anvil of the middle ear. By using embryology and paleontology, and looking at intermediates of the fossil record we have a clear picture in most cases of how whole structures were absent in ancestral types of animals, but are now present in their relatives of today.

Biogeography, which is the study of the geographic distribution of organisms around the Earth, also reflects decent with modification. Darwin was probably the chief person, in developing this idea. He noticed that volcanic islands had flora and fauna that looked extremely similar to the land mass that they were closest to. How could this happen? One of the prime examples of biogeography that Darwin observed on his five year voyage around the world on the H.M.S Beagle was on the Galapagos Islands. He spent a couple of weeks there, and did not fully understand how evolution could work. However, the fauna that he observed on the four islands that he visited pushed him in the right direction of how evolution could occur. What Darwin observed were Galapagos finches, tortoises, iguanas, and other animals that were very distinctive to species that he observed on the South American mainland. He noticed that although the species that he observed were similar to South American animals that he looked at, that they had subtle differences not only from mainland animals, but also from island to island. Otherwise they were remarkably similar. The most well known of his finds was that of the Galapagos finches, which differed with respect to size and shape of their beaks, from island to island, but were otherwise extremely similar to the mainland finches. He eventually was able to conclude that some finches were blown off the mainland by storms and newly colonized the islands where they had no competition. From this they were able to radiate into the many different forms that Darwin observed on his voyage. Each

type of finch found its own ecological niche, which consisted of its own set of environmental pressures, and this has led to the formation of new species from their ancestral finch relatives. This would have likewise, been the mechanism for the tortoises and the iguanas that Darwin observed also. Darwin's insight into the idea that species have the ability to change was the beginning of the end of the concept that species were created individually at one point in time. It could be said that at this point the evolution vs. creationism debate was born. As I have mentioned, whether it be immunology, paleontology, embryology, or even biogeography, they all point in the same direction. Evolution has occurred and cannot be shunned away, for it has far too much evidence in its corner. Even after all this evidence, there is still the fossil record, which is probably the most convincing of all the evidence. Thousands upon thousands of fossils have been catalogued and dated. Lineages of animals have been established that date back millions of years from the most primitive of animals in the lineage to their most recent ancestors. The most important part of these fossils, however, may be all the transitional fossils of these distinct lines that exist in between and give us a clear line of change from the past to the present. One of the most famous examples of a transitional fossil is Archaeopteryx, a crow-sized animal that dates back to the Jurassic Period. Today it is classified as a bird, but before impressions of feathers were noticed in the fossil, Archaeopteryx was thought to be a reptile based on its skeletal structure. Some of its reptilian features included; a toothed jaw, clawed fingers, abdominal ribs, and an elongated bony tail. However, it also had some bird-like characteristics such as a wishbone and a bird-like pelvis. Archaeopteryx clearly demonstrates an intermediate between reptiles and birds, whether it is a direct relative of modern birds is not known,

but it is clear that an animal like the Archaeopteryx was the forerunner for modern birds. Descent with modification if you will has occurred. Fossils provide hard evidence that evolution has occurred.

What do the rock layers tell us? First of all, what we know about the rock layers are that the different strata were deposited at different times. The Law of Superposition tells us that the oldest layers are at the bottom and the youngest layers are on top. This helps us to provide a relative age of each stratum. By carefully examining these stratum it can be found that particular organisms are embedded in the same age strata. In general, the more primitive forms are found in the older rocks, and the more advanced forms are found in the younger rocks. Thus, there are many fossils of fish in older strata and no mammals. This technique is very useful, because it can be used to help age specific stratum in different parts of the world that are thousands of miles apart. The same organisms should, therefore, be found in the same stratum no matter what part of the world they are found in. So it can be seen that the ground for the Theory of Evolution and change, has been present long before the time of Darwin and the finches.

I have shown examples of how different mechanisms can drive evolution, but what about something that we can see in our lifetime? For example, how about something as simple as air pollution? Can we observe air pollution in nature affecting the natural selection of an organism? Let's look at a classic example of how this could exist in nature. Around the 1850's, the industrial revolution was taking place and factories spewed sooty ash into the atmosphere covering the landscape and even darkening the bark of the surrounding trees. The Peppered Moth, which can exist in two phenotypes, were abundant is the local forested areas. At the beginning of the Industrial Revolution,

roughly the entire population of Peppered Moths that existed was white. Over time as the soot from the factories blackened the bark of the normally lighter colored trees, the white moths that hid from predatory birds on the lighter colored bark gradually became easier to see. This caused the white moths to be selected against by the environment, and now it became advantageous to be a darker colored moth, since the dark moths could camouflage themselves better than the white moths. The frequency of variation in color therefore shifted to the black moths. In the 1950's strict anti-pollution laws were passed that have caused the average tree color to lighten again. As would be predicted by natural selection, the white moth numbers began to steadily increase. This specific case has been referred to as industrial melanism, and is an impressive example of how evolution can even be present right in front of our eyes.

Now that I've talked about examples of evolution in other animals, let us now examine the evidence of evolution for the rise of modern humans. We believe that the beginning of human evolution began with a genus known as the australopithecines, which are sometimes referred to as the ape-men, since they show many characteristics as intermediates between the apes and our genus, Homo. Skulls found indicate that the australopithecines exhibited lines of cranial change that followed the path towards Homo descent. Fossils of the pelvis and the discovery of the valgus knee, also demonstrated that the australopithecines were upright walkers. With the discovery of the famous "Lucy" fossils, paleontologists now had a fossil that clearly wasn't in the genus Homo, but was more human-like. Since it was discovered in the Afar region of Africa, it was placed in a group named Australopithecus afarensis. Lucy is clearly a transitional fossil in the fossil record, with an ape-like body and an upright head. This species persists in

the fossil record with little evidence of change. Scientists believe that A. afarensis then gave rise to A. africanus 2.8 to 1.9 million years ago, from which came A .robustus and A. boisei in southern and eastern Africa about 2.0 million years ago. Recent findings have shown that the finger bones of A. robustus had padded finger-tips much like humans, which may have resulted in the development of increased blood supply leading to increased motor skills in the hands. This increased precision of the hands would lead to use of tools, ect. The first tools weren't found until the earlier appearance of the genus Homo. This is where the first real humans are thought to have come about, with the appearance of the Homo hablilus. From here it is thought with, the discovery of more fossils that Homo erectus than evolved about 1.5 million to 500,000 years ago. Homo erectus than is thought to have migrated out of Africa, and later evolved into the Homo sapiens, which then formed into modern man. All of the fossil evidence that has been found makes it completely clear that human evolution has taken place.

Evolution should be looked at with serious credibility, because there is an overwhelming wealth of information that exists in its favor. Evolution is real and should be taught in the school system. Whether creationists believe it or not, evolution is important as a foundation to all of biology. I hope that what you take from this paper if you are someone who believes strictly in creation is that evolutionists are not trying to bash religion, but instead are trying to understand the world we live in through experimentation, data, and evidence. They are not stating the mechanisms of evolution as fact and stories of creation as fiction, but instead simply are suggesting that all the evidence that we have found, strongly correlates with the likely possibility that evolution has taken place. If creationists are going to say that evolution is wrong, than it is their

obligation to tell us what is right. Not only by using the Bible, but also using as much evidence as evolution has used to back up their claims. "If you say the earth is not round, then you are obligated to tell us what shape it is..."

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