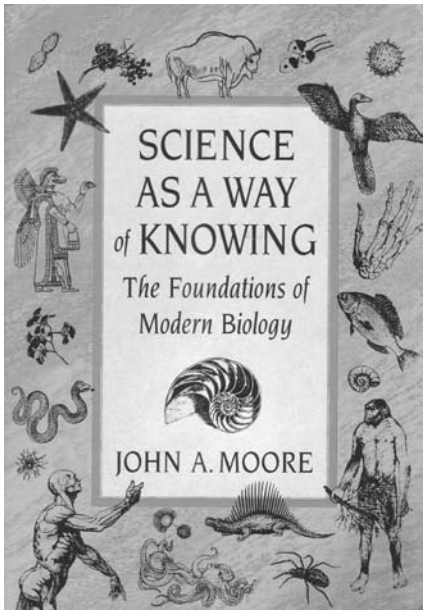
The science of good questions

A review of
Science as a Way of Knowing: The Foundations of Modern Biology
by John A. Moore
Harvard University Press, 1993



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Summary

This standard textbook for American college and university courses in biology challenges creationists on two grounds. First, the author charges that we have ignored the enormous contribution Darwin made to our scientific understanding in biology. Second, in a clever analysis of progress in biological thinking, he shows that not once has that progress come through appeal to supernatural causes, but always through appeal to natural causes. But he is wrong on both charges. Creationists do acknowledge Darwin for his revolutionary contributions to biology, but we can see that he was wrong in giving an originating role to natural selection. And Moore fails to understand that creationists only appeal to miracles in certain areas of historical science, not in operational science. Perhaps the most important, and helpful, point in the book is that scientists cannot produce good answers until they can formulate good questions. Moore's history of science is thus the history of formulating good questions.

But when it comes to the contemporary evidences for evolution, Moore slips back into the classic mode of other textbook writers. Any attempt at critical analysis is entirely lacking, and the promising challenge generated in the historical parts of the book evaporates. He is unable to see beyond his absolute commitment to atheism, so he has to select evidence to support his case, just like everyone else. The book is good in its historical analyses, but as a textbook for biology courses, I would think it far too laborious in outdated details. As a defense of evolution, it is decidedly pedestrian. Unfortunately, most of the students influenced by his historical expertise and persuasive writing style will be naïve, and thus fall prey to his skillful malevolence.

Introduction

This book is the front-line product from a seven-volume work of the same name developed by Moore and others under national patronage. This was meant to be a conceptual framework for all of biology, to provide background materials for introductory biology courses at American colleges and universities. The author was a nationally acclaimed scientist and science historian and Emeritus Professor of Biology at the University of California, Riverside, until his death in 2002. He was a passionate and articulate anti-creationist and this prodigious work was aimed at combating creationism in the classroom. His commitment to atheistic materialism is absolute: 'human life will always be constrained by the basic laws of nature that the gods cannot annul' (p. 504).

Moore argues persuasively that modern creationists are irresponsible in (a) refusing to acknowledge the enormous contribution that Darwin made to our understanding of biology, and (b) continuing to propose supernatural explanations for demonstrably natural phenomena. Superficially, he appears to be right, but is actually quite wrong.

Before Darwin, biology was little more than a prodigious collection of seemingly arbitrary facts. Darwin developed a simple, comprehensive theory (common ancestry via natural selection) that unified it all and gave biologists clear-cut criteria for developing naturalistic explanations of biological entities and processes. This resulted in a revolution in biological thinking for which Darwin will always be remembered. But natural selection can only select from organisms and variations that already exist, so it does NOT explain where they came from, as Darwin claimed. Yet testable theories can be enormously useful, even if they are wrong. They provide a step in the process of understanding.

In contrast, nineteenth-century creationism was, in Moore's view, rather inadequate. For the forty years before Darwin's *Origin of Species*, the views of Cuvier dominated biology. He showed that mummified animals from Egypt were the same as their contemporary descendants. Thus, no change in species had occurred in 3,000 years. From this, Cuvier proposed that organisms must therefore appear today largely as they were created. But Moore overlooks the fact that Linnaeus, a century earlier, had already noted from hybridization studies that the created kind was probably higher than the level of species, at the genus, or perhaps family, level. So 'fixity of species' was not 'the creationist view', but Cuvier's view.

Creationists today certainly do not

hold Cuvier's view, because we now know that variety and change are built into the genetic system. Moreover, modern creationists are faced with the challenge of finding natural mechanisms to explain an enormous post-Flood glut of variation (for example, all the daisy family, grass family, horse family and cat family from single created kinds) followed by rapid achievement of stasis (to account for Cuvier's mummy data and the general trend of species stability observed today). Did, for example, lawn grass, maize and bamboo really develop naturally from a single baramin in just a few hundred years? And if so, how? This is a challenge for creationist biologists.

Moore's second challenge is based on a misunderstanding of the nature of science. He fails to make the crucial distinction between operational science (observations and experiments in the present) and historical science (interpreting the past in terms of present observations). Creationists only appeal to supernatural causes for explaining some aspects of historical science—primordial beginnings and crucial historical events like the Flood of Noah. For operational science, creationists seek natural causes just like everyone else.

Contents

The book is divided into four parts: 'Understanding Nature' (history of scientific thinking from a biological perspective), 'The Growth of Evolutionary Thought' (history of evolutionary thinking), 'Classical Genetics' (history of thinking on inheritance) and 'The Enigma of Development' (history of thought on development). His historical scholarship appears to be first class, having read and critically analyzed a vast amount of historical literature, and his style is lucid and concise. However, his obvious bias in the treatment of contemporary issues suggests that he may have been equally selective in his choice of historical examples, so perhaps his historical scholarship is not so good after all.

Understanding nature

He describes science as

> 'an accretive, self-correcting discipline and, generation after generation, its concepts become more precise and accurate. Many concepts have reached a stage where we say they are true beyond all reasonable doubt' (p. 52).

His definition of truth then becomes anything that is 'beyond reasonable doubt'. For example, if all 'real' biologists accept evolution, then it is true (i.e. beyond reasonable doubt).

But he then continues (on the same page) to illustrate some pitfalls. Ancient Greeks believed that veins carried blood from the liver, and arteries carried air from the lungs. But when faced with the evidence that a cut artery in a living mammal squirted blood, they said the air must have escaped and then the blood rushed in to fill its place since nature abhors a vacuum. That is, the theory determined the interpretation, contrary to the evidence gained from the observations. His point? 'Scientists then *and now* see through the eyes of theory—the operational paradigm of the moment' [emphasis added]. This is a crucial principle that he has highlighted, but he has overlooked its application to his own work!

Science, he says, is 'a community effort … a social enterprise' that needs the input of a cross-section of people. For example, Leonardo Da Vinci dissected more than 30 cadavers to learn how to draw the human body. As a result, his copious illustrations formed a treasure trove of human anatomy at a time when it was sorely needed in medicine. But, alas, they remained in his private note books and were not published until centuries later.

Moore believes the antecedents of the scientific revolution were thus community-oriented learning, of which the key elements were: (a) invention of the printing press that provided mass production of accurate copies of books with the illustrations that are crucial to good biology; (b) universities with libraries where discussion and cooperative research could be carried out; (c) the development of museums where biological specimens could be aggregated and studied to gain insight into life on the larger scale; and (d) formation of the Royal Society of London as a focal point for scientific debate.

His nominated turning point was the year 1543, when the first translation of Archimedes' works on mechanics appeared, Copernicus published his heliocentric view of cosmology, and Vesalius published his book on human anatomy (p. 77). And the consummation came with Sir Francis Bacon's codification of the scientific method in his *Novum Organum* of 1621.

Bacon argued that our view of the world is false and confused because of our preconceived beliefs about it. These 'idols of the mind' come to us through the received 'wisdom' of our community, our own personal beliefs, the inadequacy of common language for conveying scientific truths, and the conceits of philosophical systems built upon *a priori* assumptions (such as superstition, reverence for the authority of ancient authors, and revelations like Genesis creation). We should gather carefully-made observations, and seek reasonable explanations for them, rather than interpreting the world through a preconceived belief system. And having found plausible explanations, test them through further observations.

Moore's views of the church's role in this process are unrelenting:

> 'the attitude of the Church prevented the development of science for more than a thousand years, and inhibited it for centuries thereafter—and does so to some extent to this day'(p. 66).

The reason?

> 'The Church was imprisoned by its own dogma. It had selected the best available scientific data before Copernicus and Vesalius and in that sense it was up to date and correct as it could be. However, concepts that become dogma are not easily changed by better data that suggest new concepts' (p. 79).

This is undoubtedly true and a stern lesson for those modern Christians who would marry their doctrine to contemporary concepts such as

Darwinism and billion-year big bang cosmologies.

To some extent Bacon was right. Medieval views of the world were in many cases fatally erroneous (i.e. the fallacious idea that mouse dung had at least 15 medicinal uses), and it was through careful observations and reasonable explanations that many of these errors were corrected and science has blossomed. And science continues to blossom in the hands of atheists who care nothing for the supernatural, which superficially seems to support Moore's case that science is

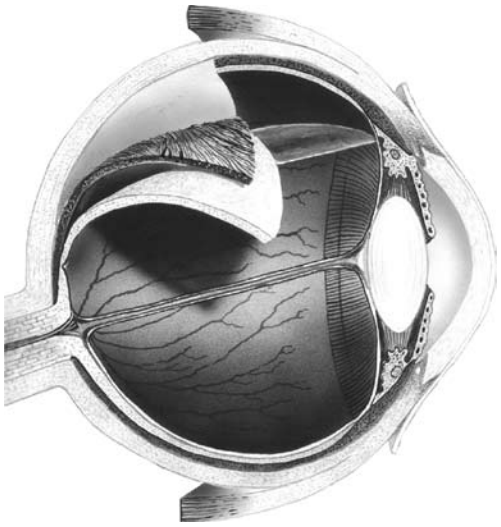
> 'a way of knowing by accumulating data from observations and experiments, seeking relationships of the data with other natural phenomena and excluding supernatural explanations' (p. 503).

But this analysis again ignores the distinction between operational science and historical science. It also ignores the fact that the scientific revolution was started by biblical creationists.[2] And, crucially for creationists, Bacon's analysis misrepresents (as an unreliable 'idol of the mind') the eyewitness account in the Bible that God created the universe in six days in the time of Adam, somewhere around 4,000 BC.

The growth of evolutionary thought

According to Moore, the three great challenges to 19th-century biology were: (a) the extraordinary diversity of species, (b) the exquisite adaptations to differing ways of life, and (c) the 'scale of nature' (the almost continuous variation in form from microbe to man). However, the variation is not 'almost continuous'. That is what Darwin expected, but the lack of transitional fossils and the very existence of a classification system speaks against 'almost continuous variation'. Stephen Jay Gould wrote at length about this conundrum for evolutionists. Moore caricatures the creationist view as 'God did it', correctly pointing out that such a view yields little in the way of testable hypotheses for scientific investigation.

When Darwin set out on the *Beagle*, he saw something that Cuvier did not—geographic variation. Cuvier's Egyptian mummies included the sacred ibis—migratory birds that remain true to type across their range of habitats (as well as domesticated animals that were *bred* to remain true to type). But the Galápagos turtles and finches were more restricted in their movements, thus allowing variations to accumulate over time. The genie of variation escaped from the bottle of stasis and the Darwinian revolution was on its way.



Cross-section of the human eye. Based on inductive reasoning, in his book Natural Theology, *William Paley argued that the intricate design of the eye implied the existence of a designer.*

Moore is very complimentary towards the natural theologians (Paley and others), but he dismisses Paley's arguments about the watch and the human eye because they are deductive. Given the existence of a Deity, he says, whatever we see around us must be his handiwork. But Moore is too committed to his own viewpoint to see his error. Paley's argument is not deductive, it is *inductive*. Paley argues from the evidence to the explanation (watch to watchmaker, eye to eye-maker), the very same process of induction that Moore champions as the way to cut through Bacon's idols of the mind. Big mistake!

Then follow 10 deductions from Darwin's theory that are put to the test. Moore, here, shows great skill in turning a sow's ear into a silk purse. When it comes to the fossil evidence for gradual change over time, he admits, 'Darwin failed … [and] even today there are not many such examples' (p. 154), so he diverts attention to the related question of intermediate forms. 'Only one was available to Darwin in his lifetime', *Archaeopteryx*, which 'remains today as one of the best examples of a link no longer missing' (pp. 156–157). However, *Archaeopteryx* is not the ancestor of any other known bird, so it cannot be the link between reptiles and birds. But Moore does not let such logic interfere with his narrative of Darwin's 'triumph'.

When it comes to whether natural selection actually works or not, he admits that in Darwin's day 'with the field so lacking in rigor, the possible became probable, and the probable became acceptable' (p. 163). According to his earlier definition of truth, that which is 'widely accepted' becomes 'beyond reasonable doubt' and therefore 'true'. But it is the peppered moth (*Biston betularia*) that Moore uses to seal his case for natural selection. '*Biston* rests on tree trunks', he says, confidently. However, we now know that *Biston* does not rest on tree trunks but hides among the foliage, so the proposed selection mechanism (predation by birds in daylight) does not exist.[3] My, how fickle a thing is 'truth'. He then tells us that Mendel's discovery of genes supports Darwin, without mentioning the awkward fact that until mutation was discovered much later, the existence of such fixed units of inheritance pointed to a limited supply of existing natural variation, when Darwin needed unlimited new natural variation for his theory to work.

In chapter nine, Moore's scholarship slips further. In comparative anatomy, he says, 'If each species had been created and remained in essentially the same form until the present, there could

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Gregor Mendel, the father of genetics and a contemporary of Charles Darwin, showed that units of inheritance (genes) remained basically fixed and only allowed for limited natural variation.

be no biological relatedness among different species.' He has allowed his bias to overcome not only good sense, but the very creationist literature he is supposedly countering. His statement can be seen in its absurdity in an analogy: 'if cars come from different factories, there cannot be any similarities among them'. But just as different car manufacturers use the same kinds of materials to make the same kinds of design components to achieve similar practical tasks, so any intelligent creator of anything will use similar materials and design components to accomplish comparable tasks in different kinds of creations. Creationists have long argued that comparative anatomy is not unique evidence for common ancestry, because it points equally well to common design. Moore's elaborate and detailed exposition on comparative anatomy is therefore a steal for evolution, since creation has been deleted from consideration at the outset.

Moore's embryology features: 'All [vertebrate embryos] pass through an early stage with … pharyngeal gill pouches' (p. 181). But embryologists have long known that these features in human embryos develop into a variety of different structures, none of which has anything to do with respiration, so they are not homologous with gills.[4] It is only evolutionary bias and wishful thinking that makes them 'gill pouches'.

The issue of classification is posed as being unanswerable in creationist terms (p. 183). Why would the Creator make a continuous series of organisms if they were all separately created? But, he says, this continuous series is easily explained by evolution from a common ancestor. He mentions the relatedness at the genus and species level, but conveniently overlooks the persisting evidence for unbridgeable gaps at the higher levels of family, order, class, phylum and kingdom. Indeed, his words are so carefully chosen as to adduce deliberate deception (or at least, willing ignorance).

The unity of life at the microstructure and molecular level is given as further evidence for evolution. After listing 10 such evidences, he goes on to say,

> 'Although the sorts of data just listed are not proof of evolution, there is no other naturalistic explanation that can make as much sense of them. Similarly, there are no molecular data that falsify the concept of evolution' (p. 189).

But what can 'no other naturalistic explanation' possibly mean? He has not put forward any other possible naturalistic explanation, so this is just a rhetorical device—he realizes that his argument is weak, so he thumps the pulpit! And the claim that 'no molecular data falsify evolution' means he cannot see the wood for the trees.

The coded information on the DNA molecule (which is the underlying mechanism that produces the molecular similarities) is itself an evidence of intelligent design.[5] Coded information relies on symbolism—each element of the code symbolically represents an amino acid or a stop sign (just as each word in this sentence symbolically represents a concept in the English language). Symbolism can only be created in the mind—it is the mind that links the symbol with the concept that it represents. Therefore, coded information, such as we see on the DNA molecule, can only be the product of a mind (or of an intelligently designed machine that can reproduce the symbolic workings of the mind). No natural or chance process can produce such coded information.

He goes on to say:

> 'Molecular evolution is now in a period of validation. Its discoveries are in accord with what previous [morphological] methods have established … we would be in serious trouble if that had not been the case' (p. 190).

This is not so. At the genus and species level, molecular methods have certainly helped to sort out and clarify the morphological systems of taxonomy. But when it comes to the higher categories of families and beyond, the results have been chaotic. For example, among the flowering plants, recent molecular phylogenies are totally at odds with previous results. And in fact, no 'validation' occurs—people just change their thinking to adjust to the new arrangements and carry on regardless! No-one can go back in a time machine to see what actually happened, so it doesn't make any difference, anyway.

He ends his 'formal analysis of Darwinism' by quoting Dobzhansky and Medawar, respectively: 'Nothing in biology makes sense except in the light of evolution', and 'The alternative to thinking in evolutionary terms is not to think at all.' These statements 'are fully accepted by scientists familiar with the data of biology and geology' (p. 191) and so, according to his earlier definition, are 'true'.

In 'Life over time', he says:

> 'The data of paleontology that were supportive of the concept of evolution a century ago have now reached the state where all with an open mind will regard them as complete proof. … In Darwin's day the principle information desired was whether or not organisms intermediate between major groups had ever existed … *Archaeopteryx*, the fossil, said yes.'

But today, 'there is almost

no solid information … [on] the very important question [of] the antecedents of the phyla' (p. 192). So here we have 'complete proof' based on one fossil (which cannot be the link between reptiles and birds) and no information on the 'very important question' of the origin of the phyla. Once you believe, of course, the evidence is irrelevant. But in fact we do have extraordinarily powerful evidence about the antecedents of the phyla—there are none. The fossil record is now regarded as being almost complete at the phylum level—that is, paleontologists have little expectation of finding any new phyla. This is very powerful evidence for special creation and a strong refutation of evolution.

The chordates (i.e. the vertebrates and their supposed relatives), he says, 'provide us with the best possibilities for discovering fossil lineages' (p. 193). This is grossly erroneous. The vertebrates provide good fossils for evolutionists only because they are always fragmentary (the all-important soft tissues are rarely preserved, and never in useful detail) and thus the bones allow endless evolutionary speculation. The best organisms for determining fossil lineages are actually the arthropods (insects, crustaceans, spiders) and plants, because they have tough external tissues and are often preserved in exquisite anatomical detail. Arthropods and plants are notorious for 'missing links' and argue strongly against evolution, but Moore does not mention any of this.

Regarding the origin of life, Moore does not even give a single hint of the insurmountable barriers to his evolutionary hypotheses. He attributes cell-like properties to chemicals without any mention of the irreducibly complex structure of cells (that is, the cell-like behaviours do not exist in chemicals, and only arise *after* the formation of cells). Nor does he mention the problems posed by hydrolysis, chirality, and the origin of information.

His treatment of the animal phyla is likewise misleading. He describes nine 'natural' phyla, with the Burgess Shale creatures only being referred to as 'the 17 Problematica'. Yet four years earlier, Gould had already popularized this fossil treasure trove and told the world that there were more than twenty animal phyla and that 'the maximum range of anatomical possibilities [arose] with the first flush of diversification. Later history is a tale of restriction [and decimation]'[6]—exactly the *opposite* of the pattern of slowly increasing diversity expected by Darwin.

Photo by Warwick Armstrong

Moore believes that the crossopterygians (lobe-finned fishes) were 'the direct ancestors of the amphibians', and their lobed fins turned into arms and legs. However, detailed studies of the 'living fossil' crossopterygian, coelacanth, have shown that it does not use its fins for walking on the ocean bottom but for deft manoeuvring when swimming.

His section on the evolution of the vertebrates is classic bluff—with no mention of the gaps or problems. For example, the crossopterygians (lobe-finned fishes), he confidently asserts, were 'the direct ancestors of the amphibians' and their lobed fins turned into arms and legs. He makes no mention of the detailed studies of *Latimeria* (the 'living fossil' crossopterygian, or coelacanth) in its natural habitat that show it is a remarkably agile swimmer, and it lives its whole life in the water column, never even resting on the bottom, and never uses its lobed fins as 'legs' for walking.

Classical genetics

Moore's fascination with history now resurfaces and his description of the history of thinking about the enigma of inheritance is first class. The first step was to clarify the nature of life. German pathologist Rudolf Virchow succeeded in formulating the 'law of biogenesis' ('all cells from cells') in 1855, and Frenchman Louis Pasteur used it to refute the idea of spontaneous generation in 1864.

His analysis of Mendel's work puts it on a par with Darwin's *Origin* in historical importance, and he then gives a convincing explanation for the failure of Mendel's work to be appreciated (pp. 296–301). It was not the result of publication in an obscure journal, because Mendel lectured on the subject, and his paper was cited in at least two other important works on hybridization. Two reasons stand out: (a) his results with peas could not be replicated in other plants (he published only the 'best' data, which later statisticians would call 'too good to be true'), and (b) advances in cell biology had not yet provided a cytological basis for understanding it. When de Vries and Correns (and perhaps Tschermak and Bateson) independently 'rediscovered' Mendel's work in 1900, it was because they had already discovered the same principles in their own work and they simply recognized Mendel's priority. Just two years later, cytology joined the fray when Sutton identified the segregation of Mendel's units of inheritance with the behaviour of chromosomes in the cell nucleus during meiosis and fertilization, and Mendelian genetics was born. It faced great opposition, however, because 'not one of the original Mendelian rules was found to be valid for all cases' (p. 321). Clearly, genetics was a complex field.

Surprisingly, the word 'mutation' is slipped in without any special comment on page 315. Not a single mention is made of the huge challenge that Mendel's fixed units of inheritance posed for Darwin; specifically, his need for new, continual and unlimited variation, and the breakthrough that mutation provided. This is another

example of how Moore selects his facts to suit his bias.

At the end of his in-depth history of genetics, he makes an important admission: 'There appears to be nothing in a living cell that is not in some way required for DNA to be replicated.' One could hardly ask for a better definition of 'irreducible complexity'—the principle that excludes any, and all, step-wise theories of chemical evolution of life from non-life. Admittedly, Behe's book on the subject did not appear until 1996;[7] however, Michael Polanyi described the irreducible structure of life in 1968:

> 'The morphology of living things transcends the laws of physics and chemistry … Both machines and living mechanisms are irreducible to [those] laws … recognition of the impossibility of understanding living things in terms of physics and chemistry, far from setting limits to our understanding of life, will guide it in the right direction.'[8]

The enigma of development

Ernst Haeckel is infamous for publishing fraudulent drawings of embryos supposedly supporting the 'biogenetic law' that 'ontogeny recapitulates phylogeny'—that is, embryonic development retraces evolutionary history. While creationists cry 'foul' at Haeckel's fraud, Moore points out that, in embryology, as in many other fields of biology, Darwin's theory did give biologists practical ideas for generating questions and seeking answers in a subject that previously lacked them because life was otherwise too complex and too diverse to comprehend. I agree that no-one should rob Darwin of this legacy. While Moore acknowledges that recapitulation was rejected in the late 19th and early 20th centuries, he believes that 'the baby was thrown out with the bathwater'. He proposes that Haeckel's law should simply be modified by adding 'not quite' and 'sometimes' (p. 414). Moore actually fails to mention the fraudulent nature of Haeckel's drawings, which illustrates well that he has selected his material to meet his purpose.

A detailed description of development of the frog then follows. We then read that George Newport, in the mid-19th century, discovered not only that sperm enters the egg to effect fertilization, but that the point of entry of the sperm determines the orientation of subsequent development. The implications of this observation for the ethics of embryo experimentation are profound.[9] Then followed a long dispute about whether subsequent development of the embryo was centrally regulated, or mosaic—that is, different cells developing independently of others. The resolution came in 1900, when E.B. Wilson realized that central control universally began in the ovum (i.e. before fertilization) and later became mosaic, but different timing of this transition gave different apparent embryological patterns in different species. By the 1930s, it was established that 'the development of a part depends upon the entire embryo' (p. 475). Since the pattern of organization can be traced back to the ovum, the principle is profound, and appears to be why Moore calls this part of the book 'The Enigma of Development'.

He ends by reasserting that the information on the DNA is primary, yet the early thought that genes control everything is wrong. Clearly, there is an interaction between genes and cytoplasm during development, and the latter exercises feedback control over expression of the former. Yet it is the whole organism that determines the outcome. This overall organization begins in the ovum and, he suggests, is coordinated by the mother that produced the ovum. 'What genes do can be affected by the cytoplasm in which they function' (p. 496). This, I suggest, is where creationists may find a mechanism for the stasis of the created kinds—in the cellular architecture and contents that are passed unchanged from mother to offspring during reproduction. As the Apostle Paul says, 'not all flesh is alike, but there is one kind for men, another for animals, another for birds, and another for fish' (1 Corinthians 15:39). The genes provide a vast amount of necessary information, but it is the different originating *cells* that determine what is done with it in reproducing the different created kinds. Since the cell is passed on unchanged from the mother in the ovum, apes will produce apes and humans will produce humans. No matter how similar their DNA may be, it is their *cells* that will prevent ape DNA from producing humans.

Conclusion

By way of conclusion, Moore says 'The basis of evolution is built into the mechanism for cell reproduction through errors in the replication of DNA' (p. 501). But not a single line of evidence in the whole 500 pages supports this statement. It is nothing more than the conclusion that one must come to if evolution is assumed to be true. He goes on, 'Science does not refute the gods; it merely ignores them in its explanations of the natural world' (p. 502). Perhaps the 'enigma' persists for this very reason.

References

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